IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS

# Capacitated Clustering via Majorization-Minimization and Collaborative Neurodynamic Optimization

Hongzong Li<sup>®</sup> and Jun Wang<sup>®</sup>, Life Fellow, IEEE

Abstract—This paper addresses capacitated clustering based on majorization-minimization and collaborative neurodynamic optimization (CNO). Capacitated clustering is formulated as a combinatorial optimization problem. Its objective function consists of fractional terms with intra-cluster similarities in their numerators and cluster cardinalities in their denominators as normalized cluster compactness measures. To obviate the difficulty in optimizing the objective function with factional terms, the combinatorial optimization problem is reformulated as an iteratively reweighted quadratic unconstrained binary optimization problem with a surrogate function and a penalty function in a majorization-minimization framework. A clustering algorithm is developed based on CNO for solving the reformulated problem. It employs multiple Boltzmann machines operating concurrently for local searches and a particle swarm optimization rule for repositioning neuronal states upon their local convergence. Experimental results on ten benchmark datasets are elaborated to demonstrate the superior clustering performance of the proposed approaches against seven baseline algorithms in terms of 21 internal cluster validity criteria.

*Index Terms*—Capacitated clustering, collaborative neurodynamic optimization (CNO), iteratively reweighted optimization, majorization-minimization, quadratic unconstrained binary optimization.

# I. INTRODUCTION

**C**LUSTERING is one of the most fundamental means of data processing. It is to find a set of clusters in unlabeled data. In many applications, some prior information on the clusters is available in the form of constraints or partially labeled data. As a basic form of semi-supervised learning, constrained clustering incorporates available prior information/knowledge into clustering. Clustering performance can be boosted by leveraging the constraints that confine the search space. Several types of constraints are utilized in constrained clustering:

Manuscript received 21 July 2022; accepted 4 October 2022. This work was supported in part by the Research Grants Council of the Hong Kong Special Administrative Region of China under Grant 11202019 and Grant11203721 and in part by the Laboratory for AI-Powered Financial Technologies. (*Corresponding author: Jun Wang.*)

Hongzong Li is with the Department of Computer Science, City University of Hong Kong, Hong Kong (e-mail: hongzli2-c@my.cityu.edu.hk).

Jun Wang is with the Department of Computer Science and the School of Data Science, City University of Hong Kong, Hong Kong (e-mail: jwang.cs@cityu.edu.hk).

Color versions of one or more figures in this article are available at https://doi.org/10.1109/TNNLS.2022.3212593.

Digital Object Identifier 10.1109/TNNLS.2022.3212593

cluster-level constraints, such as cardinality constraints [1], [2], [3], [4], [5], [6], [7], [8] and capacity constraints [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], instance-level constraints [27], such as must-link and cannot-link constraints [28], and rank constraint [29].

1

Capacitated clustering is an important type of constrained clustering. It arises in many applications, including vehicle routing [30], [31], [32], very large-scale integrated circuit design [33], mail delivery [34], sibling reconstruction [35], mobility network handover minimization [20], [36], facility layout [37], [38], reviewer groups construction [39], wireless and wired network integration [40], and stock market index tracking [41].

In the literature, capacitated clustering is commonly formulated as a combinatorial optimization problem [9]. In the existing problem formulation, the objective function is composed of multiple functional terms, and each term sums the dissimilarity coefficients (e.g., distances) between every pair of data in a cluster to quantify the within-cluster compactness [9], [11], [12], [16], [17], [19], [20], [21], [23], [24], [25], [26]. Existing capacitated clustering methods can be classified into two major categories: mathematical programming methods and heuristic or meta-heuristic methods. Specifically, mathematical programming methods include the branch and cut method [19], the Lagrangian relaxation method [17], etc. In view that most combinatorial optimization problems are NP-hard [42], heuristic and meta-heuristic methods are widely used, including scatter search [12], tabu search (TS) [18], variable neighborhood search [25], neighborhood decomposition-driven variable neighborhood search (NDVNS) [26], iterated variable neighborhood search (IVNS) [21], greedy random adaptive search procedure and adaptive memory programming [11], reactive greedy randomized adaptive search procedure with path relinking [16], TS with variable neighborhood search [20], greedy randomized adaptive search procedure with TS [20], greedy randomized adaptive search procedure with variable neighborhood search [20], general variable neighborhood search (GVNS) [25], skewed GVNS (SGVNS) [25], etc. Although heuristic and meta-heuristic methods can often find good solutions, the solution quality varies without guaranteeing global optimality.

Over the last few decades, neurodynamic optimization approaches emerged as computationally intelligent optimizers based on recurrent neural networks for solving various optimization problems, such as combinatorial optimization problems [43]. It is very difficult, if not impossible, for an individual recurrent neural network to solve a combinatorial optimization problem, as it may easily get stuck in a local minimum. As such, more than one neurodynamic model is needed to work collaboratively. In recent years, a hybrid intelligence framework called collaborative neurodynamic optimization (CNO) has been developed based on multiple neurodynamic models coordinated by using meta-heuristics. The multiple neurodynamic models operate concurrently for scattered local searches, and their initial states are reinitialized repeatedly by using a meta-heuristic rule for repositioning the searches. It integrates the scatter search capability of multiple neurodynamic models together with the global search capability of meta-heuristics. It is proven that CNO approaches are almost surely convergent (i.e., with probability one) to the global optimal solutions of optimization problems [44], [45], [46], [47], [48].

In this paper, we first propose an objective function with multiple functional terms normalized by the cluster sizes to measure the within-cluster compactness. Next, we formulate capacitated clustering as an iteratively reweighted quadratic unconstrained binary optimization problem with a surrogate function and a penalty function in a majorizationminimization framework. We develop a CNO-driven capacitated clustering algorithm based on a population of Boltzmann machines (BMs) with momentum terms for solving the reformulated problem. The novelties and contributions of this work are summarized as follows.

- The reformulated objective function with the total within-cluster dissimilarity of every cluster normalized by its cluster cardinality is able to characterize the cluster compactness naturally, independent of cluster sizes.
- 2) The iteratively reweighted quadratic unconstrained binary optimization problem reformulation with a surrogate function enables avoiding the direct use of the reformulated objective function with factional terms while keeping their cluster normalization effect.
- 3) The CNO-driven clustering algorithm with a population of BMs operating in parallel fully utilizes the hill-climbing capability of BMs in scattered searches.
- Extensive experimental results on ten benchmark datasets show that the CNO-driven clustering algorithm statistically outperforms seven prevailing baselines in most internal cluster validity indices.

The remaining paper is arranged as follows. In Section II, background knowledge on neurodynamic optimization to be used in Section IV is introduced. In Section III, capacitated clustering is reformulated as an iteratively reweighted quadratic unconstrained binary optimization problem. In Section IV, a CNO-driven capacitated clustering algorithm is delineated. In Section V, experimental results are discussed in detail. In Section VI, concluding remarks are given.

# II. BACKGROUND KNOWLEDGE

# A. Neurodynamic Optimization Models

1) Discrete Hopfield Network: The discrete Hopfield network (DHN) is an exemplar of recurrent neural networks characterized by its binary or bipolar states and hard-limiter activation function operating in discrete time [49]

$$\begin{cases} u(t+1) = Wx(t) - \theta \\ x(t) = \sigma(u(t)) \end{cases}$$
(1)

where  $u \in \Re^n$  is the net-input vector,  $x \in \Re^n$  is the state vector,  $W \in \mathbb{R}^{n \times n}$  is the connection weight matrix,  $\theta \in \mathbb{R}^n$  is the threshold vector, and  $\sigma(\cdot)$  is a vector-valued hard-limiter activation function defined elementwise as follows:

$$\sigma(u_i) = \begin{cases} 0, & \text{if } u_i(t) \le 0\\ 1, & \text{if } u_i(t) > 0. \end{cases}$$

It is shown in [49] that the DHN in (1) is completely stable; i.e., the state of the DHN is convergent to an equilibrium from any initial state, and if the connection weight matrix is symmetric (i.e.,  $W = W^T$ ), the main diagonal elements of W are zero (i.e.,  $w_{ii} = 0$ ,  $\forall i$ ), and the activation takes place asynchronously. It is also shown in [49] that the DHN is convergent to a local minimum of the following binary optimization problem:

$$\min -\frac{1}{2}x^T W x + \theta^T x \quad \text{s.t. } x \in \{0, 1\}^n.$$
 (2)

It means that an equilibrium  $\bar{x}$  is a local optimum of the optimization problem earlier. As the right-hand side of (1) is equal to the negative gradient of the objective function to be minimized, the DHN neurodynamics forms a gradient flow moving among vertices of the unit hypercube coordinatewise. Note that the binary states of the DHN depend exclusively on the sign of the negative gradient of the objective function without any historical effect.

If W in the quadratic term of (2) is asymmetric in a given problem, its symmetry can be equivalently realized by replacing it with  $(W + W^T)/2$ . The zero diagonal elements of W can equivalently realized by adding a linear term diag $(w_{11}, \ldots, w_{nn})x$ , in view that  $x_i^2 = x_i$  for  $i = 1, 2, \ldots, n$  due to the binary nature of the state variable  $x_i \in \{0, 1\}$ .

As a variant of the DHN, a DHN with a momentum term (DHNm) [50] is developed as follows:

$$\begin{cases} u(t+1) = u(t) + Wx(t) - \theta \\ x(t) = \sigma(u(t)) \end{cases}$$
(3)

where u(0) = 0. With the addition of the momentum term u(t) in the DHN dynamic equation, the DHNm in (3) takes its historical effect into account and enriches its dynamic behaviors. It is shown that all neuronal states in the DHNm

in (3) can be activated synchronously and are convergent to local or near optima [51], [52]. The DHNm is widely used in many applications, such as graph planarization [50], independent set maximization [53], checkerboard tiling [54], data sorting [55], map coloring [51], string search [56], channel assignment in cellular radio networks [57], magnetic resonance image segmentation [58], bipartite subgraph matching [59], broadcast scheduling [60], facility layout [61], via minimization [62], programmable logic array folding [63], microcode optimization [64], etc.

2) Boltzmann Machine: The BM [65] is a stochastic version of the DHN. For searching and optimization, it is a parallel realization of simulated annealing [66] minimizing (2). Unlike the Hopfield network, the *i*th neuron in a BM is activated according to the probability defined as follows:

$$\begin{cases} p(x_i(t) = 1) = \frac{1}{1 + \exp\left(-\frac{u_i(t)}{T(t)}\right)} \\ p(x_i(t) = 0) = 1 - p(x_i(t) = 1) \end{cases}$$
(4)

where  $u_i$  is defined as in (1), T is the temperature parameter decreasing over time. An exponential multiplicative cooling schedule of the temperature is defined in [67]

$$T(t) = T_0 a^t \tag{5}$$

where  $T_0$  is the initial temperature and  $\alpha \in (0, 1)$  is a cooling rate parameter. It is known that a BM with a sufficiently large initial temperature and sufficiently long cooling schedule is almost surely convergent to a global optimal solution of a given combinatorial optimization problem [68], [69].

The BM is applicable to a wide range of combinatorial optimization problems, including the independent set problem [68], the max-cut problem [68], the graph coloring problem [68], the traveling salesman problem [69], the matching problem [66], and the graph partitioning problem [66].

## B. Collaborative Neurodynamic Optimization

CNO approaches are developed for solving various complex optimization problems, such as distributed optimization [70], [71], global optimization [44], [45], [46], [47], multiobjective optimization [71], [72], and combinatorial and mixed-integer optimization [46], [48]. They inherit the almost-sure convergence property proven theoretically in [46]. CNO is customized as computationally intelligent optimizers in various applications, such as nonnegative matrix factorization [73], vehicle-task assignment [74], [75], stock portfolio selection [76], spiking neural network regularization [77], and hash bit selection [78].

The neurodynamic models used in existing CNO approaches include projection neural networks [72], [73], [74], [76], [79] and DHNs (1) [75], [78]. Almost all of the CNO algorithms use a particle swarm optimization rule to reposition the neural

searches. The standard rule is defined in [80]

$$v_{i}(t+1) = c_{0}v_{i}(t) + c_{1}r_{1}\left(x_{i}^{*}(t) - x_{i}(t)\right) + c_{2}r_{2}\left(x^{*}(t) - x_{i}(t)\right) \text{if } (r_{3} < S(v_{id}(t))), \text{ then } x_{id}(t) = 1, \text{ else } x_{id}(t) = 0$$
(6)

where  $x_i(t)$  is the position of the *i*th particle at the *t*th iteration,  $v_i(t)$  is the velocity of the *i*th particle,  $x_i^*(t)$  is the present best position in terms of a given objective function for the *i*th particle,  $x^*(t)$  is the best position of the population,  $c_0$  is a positive inertia parameter,  $c_1$  and  $c_2$ are two positive weighting parameters, and  $r_1$  and  $r_2$  and  $r_3$  are random values in [0, 1],  $S(\cdot)$  is a sigmoid limiting transformation.

# **III. PROBLEM FORMULATIONS**

Suppose that *n* data vectors with *m* features  $\underline{v}_i \in \Re^m$  are to be clustered into *p* mutually exclusive clusters. The capacitated clustering problem is commonly formulated as follows [9], [11], [12], [16], [17], [19], [20], [21], [23], [24], [25], [26]:

$$\min_{x} \sum_{l=1}^{p} \sum_{i=1}^{n} \sum_{j < i} d_{ij} x_{il} x_{jl}$$
s.t. 
$$\sum_{l=1}^{p} x_{il} = 1, \quad i = 1, 2, \dots, n$$

$$\sum_{i=1}^{n} a_{il} x_{il} \le b_{l}, \quad l = 1, 2, \dots, p$$

$$x_{il} \in \{0, 1\}, \quad i = 1, 2, \dots, n; \quad l = 1, 2, \dots, p$$
(7)

where  $x_{il}$  is the binary decision variable defined as  $x_{il} = 1$  if datum *i* is assigned to cluster *l* or  $x_{il} = 0$ , otherwise,  $d_{ij}$  is the dissimilarity coefficient (e.g., distance) between samples *i* and *j*,  $a_{il}$  is a capacity coefficient for datum *i* and cluster *l*, and  $b_l$  is the capacity of cluster *l*. It contains *np* binary decision variables and n + p linear constraints. The first set of constraints ensures that each datum belongs to exactly one cluster. The second set contains capacity constraints that restrict the cluster size.

Different from k-means and k-medoid clustering, the objective function in the quadratic assignment problem formulation is centerless without the need for selecting cluster representatives (e.g., centroids or medoids). Instead, the clustering results depend mutually on the sums of intracluster dissimilarity coefficients in all clusters. In other words, the objective function value to be minimized is the total intracluster dissimilarity.

As aforementioned in Section I, there is a shortcoming in the objective function in problem (7). As the total within-cluster dissimilarity is quadratically proportional to the cluster size, it would result in unnaturally balanced clusters. To illustrate this point, consider a simple case to cluster an even number of data into two clusters (i.e., n is even and p = 2). If the two clusters contain equal numbers of data

INFORMATION ON THE INTERNAL CLUSTER VALIDITY INDICES, WHERE  $\uparrow$  AND  $\downarrow$  INDICATE THEIR DESIRABILITY

TABLE I

Measure	acronym	definition	$\uparrow$ or $\downarrow$	ref.
McClain-Rao Index	MRI	$N_B S_W / N_W S_B$	$\downarrow$	[93]
G+ Index	GPI	$2s^-/(N_T(N_T-1))$	$\downarrow$	[94]
Baker-Hubert Gamma Index	BHGI	$(s^+ - s^-)/(s^+ + s^-)$	1	[95]
C Index	CI	$(S_W-S_{\min})/(S_{\max}-S_{\min})$	Ļ	[96]
Tau Index	TI	$(s^+ - s^-)/(\sqrt{N_B N_W (N_T (N_T - 1)/2)})$	1	[97]
Dunn Generalized Index	DGI	$\min_{k \neq k'} \delta(C_k, C'_k) / \max_k \Delta(C_k)$	↑	[98]
Ratkowsky-Lance Index	RLI	$\sqrt{\sum_{j=1}^{m} (BGSS_j/TSS_j)/mp}$	↑	[99]
Calinski Harabasz Index	CHI	(n-p)BGSS/(p-1)WGSS	1	[100]
Ray-Turi Index	RTI	$WGSS/(n\min_{k< k'}   c_k - c_{k'}  ^2)$	↓	[101]
Wemmert-Gancarski Index	WGI	$\frac{1}{n}\sum_{k=1}^{p} \max\{0, n_k - \sum_{x \in C_k} (  x - c_k   / \min_{k \neq k'}   x - c_{k'}  )\}$	↑	[97]
Dunn Index	DI	$\min_{i,j} \{ \min_{x \in C_i, y \in C_j} d(x, y) \} / \max_k \{ \max_{x, y \in C_k} d(x, y) \}$	↑	[102]
Trace WiB Index	TWBI	$Tr(WG^{-1}.BG)$	↑ (	[103]
Ball-Hall Index	BHI	$\frac{1}{p}\sum_{k=1}^{p}\frac{1}{n_{k}}\sum_{x\in C_{k}}  x-c_{k}  ^{2}$	1	[104]
PBM Index	PBMI	$\left(\frac{1}{p} \times \frac{\sum_{k \in D} d(x,c)}{\sum_{k=1}^{p} \sum_{x \in C_{k}} d(x,c_{k})} \times \max_{k < k'} d(c_{k} - c_{k'})\right)^{2}$	<b>↑</b>	[105]
Xie-Beni Index	XBI	$WGSS/[n \times \left(\min_{i < j} \{\min_{x \in C_i, y \in C_j} d(x, y)\}\right)^2]$	Ļ	[106]
Davies Bouldin Index	DBI	$\frac{1}{p} \sum_{i=1}^{n} \max_{j \neq i} \{ \frac{1}{n_i} \sum_{x \in C_i}   x - c_i   + \frac{1}{n_i} \sum_{x \in C_j}   x - c_j   / d(c_i, c_j) \}$	Ļ	[107]
Det Ratio Index	DRI	$\det{(T)}/\det{(WG)}$	↓ ↓	[108]
Ksq DetW Index	KDWI	$p^2 \det(WG)$	1	[109]
Log Det Ratio Index	LDRI	$n\log(\det{(T)}/\det{(WG)})$	↓	[108]
Log SS Ratio Index	LSSRI	$\log(BGSS/WGSS)$	↓	[110]
Trace W Index	TWI	Tr(WG)	1	[111]

D: data set; c: center of D;  $C_i$ : the *i*-th cluster;  $n_i$ : the number of data in  $C_i$ ;  $c_k$ : center of  $C_k$ ; c: center of the whole set of data; d(x, y): distance between x and y;  $S_W$ : the sum of the within-cluster distances  $\sum_{k=1}^p \sum_{x,y \in C_k, x < y} d(x, y)$ ;  $S_B$ : the sum of the betweencluster distances  $\sum_{k < k'} \sum_{x \in C_k, y \in C_{k'}, x < y} d(x, y)$ ;  $N_W$ : the total number of distances between pairs of points belonging to the same cluster;  $N_B$ : the total number of distances between pairs of points that do not belong to the same cluster;  $s^+$ : the number of times a distance between two points that belong to the same cluster is strictly smaller than the distance between two points not belonging to the same cluster;  $s^-$ : the number of times a distance between two points lying in the same cluster is strictly greater than a distance between two points not belonging to the same cluster;  $N_T$ : the total number of pairs of points in the dataset n(n-1)/2;  $S_{\min}$ : the smallest within-cluster distance;  $S_{\max}$ : the largest within-cluster distance;  $\Delta(C_k)$ : the within-cluster distances  $\sum_{x,y \in C_k, x \neq y} d(x, y)/(n_k(n_k-1))$ ;  $\delta(C_k, C'_k)$ : the between-cluster distance min $_{x \in C_k, i \neq C'_k} d(x, y)$ ;  $BGSS_j$ :  $\sum_{k=1}^p n_k (c_k^j - c^j)^2$ ;  $TSS_j$ :  $\sum_{i=1}^N (D_{ij} - c^j)$ ; BGSS:  $\sum_{k=1}^p n_k ||c_k - c||^2$ ; WGSS:  $\sum_{k=1}^p \sum_{x \in C_k} ||x - c_k||^2$ ;  $T := t_{ij} = \sum_{x \in D} (x^i - c^i)(x^j - c^j)$ ;  $WG^k \in \mathbb{R}^{p \times p}$  is the within-group scatter matrix of cluster k, and its elements  $w_{ij}^k := n_k \operatorname{Cov}(x_k^i, x_k^j); w_{ij}^k := n_k \operatorname{Var}(x_k^i)$ , where  $x_k^i$  denotes the *i*th feature of a sample point in cluster  $k;WG = \sum_{k=1}^p WG^k;BG$  is between-group scatter matrix, and its element  $b_{ij} = \sum_{k=1}^p n_k (c_k^i - c^i)(c_k^j - c^j)$ .



Fig. 1. Illustration of the clustering results based on the distance measures with and without normalization.

(i.e.,  $n_1 = n_2 = n/2$ , where  $n_l$  denotes the number of data in cluster l), then the total number of weighted connections is up to  $n^2/2$ . Now suppose that cluster 1 contains q more data than cluster 2. Then,  $n_1 = (n+q)/2$ ,  $n_2 = (n-q)/2$ , and the total number of weighted connections increases to  $(n^2+q^2)/2$ 

TABLE II

PARAMETERS OF THE DATASETS (I.E., n, m, p, AND b), PROBLEM (15) (I.E., PENALTY PARAMETER  $\rho$ ), BMM COOLING SCHEDULE (5) (I.E.,  $T_0$ ), AND CNO-CC (I.E., M AND N) USED IN THE EXPERIMENTS

Dataset	n	m	p	b	ρ	$T_0$	M	N
SJC1	100	2	10	720	5	2.6	500	8
SJC2	200	2	15	840	6	2.5	500	8
SJC3a	300	2	25	740	5	1.7	500	16
SJC3b	300	2	30	740	6.5	2.5	900	8
SJC4a	402	2	30	840	6.5	1.7	800	32
SJC4b	402	2	40	840	5.5	1.4	500	16
U724_010	724	2	10	4175	8	2.5	600	32
Doni1	1000	2	6	200	7	2.5	800	16
R11304_010	1304	2	10	7237	45	2.5	1000	64
Doni2	2000	2	6	400	7	2.5	1000	64

(i.e.,  $q^2/2$  more). As a result, the clustering results based on the formulation in (7) tend to be unnaturally balanced in terms

LI AND WANG: CAPACITATED CLUSTERING VIA MAJORIZATION-MINIMIZATION AND CNO

## TABLE III

MEAN VALUES AND STANDARD DEVIATIONS OF 21 INTERNAL CLUSTER VALIDITY CRITERIA RESULTING FROM CNO-CC AND SEVEN BASELINES ON
SJC1 ( $n = 100$ , $p = 10$ , AND $b = 720$ ), SJC2 ( $n = 200$ , $p = 15$ , AND $b = 840$ ), SJC3a ( $n = 300$ , $p = 25$ , AND $b = 740$ ),
AND SJC3b $(n = 300, p = 20, \text{ AND } b = 740)$

SJC1	CNO-CC	TS [20]	GRASP-VND [20]	GRASP-VND-TS [20]	IVNS [21]	GVNS [25]	SGVNS [25]	NDVNS [26]
MRI↓ CPI↓	$0.2912 \pm 0.0061$	$0.3185 \pm 0.0126$	$0.3031 \pm 0.0101$	$0.3043 \pm 0.0060$	$0.2898 \pm 0.0055$	$0.2885 \pm 0.0057$	$0.2907 \pm 0.0061$	$0.2998 \pm 0.0082$
BHGI↑	$0.0089 \pm 0.0007$ $0.8999 \pm 0.0080$	$0.0120 \pm 0.0013$ $0.8606 \pm 0.0167$	$0.0103 \pm 0.0011$ $0.8784 \pm 0.0136$	$0.0104 \pm 0.0008$ $0.8775 \pm 0.0080$	$0.0087 \pm 0.0008$ $0.8965 \pm 0.0080$	$0.0086 \pm 0.0006$ $0.8985 \pm 0.0083$	$0.0088 \pm 0.0007$ $0.8954 \pm 0.0087$	$0.0098 \pm 0.0009$ $0.8841 \pm 0.0110$
CI↓ TI↑	$0.0448 \pm 0.0033$ $0.3790 \pm 0.0049$	$0.0613 \pm 0.0069$ $0.3564 \pm 0.0069$	$0.0535 \pm 0.0056$ $0.3608 \pm 0.0059$	$0.0540 \pm 0.0034$ $0.3608 \pm 0.0044$	$0.0461 \pm 0.0033$ $0.3686 \pm 0.0042$	$0.0453 \pm 0.0034$ $0.3696 \pm 0.0045$	$0.0466 \pm 0.0036$ $0.3680 \pm 0.0047$	$0.0514 \pm 0.0045$ $0.3644 \pm 0.0054$
DGİ↑	$0.3736 \pm 0.0410$	$0.2722 \pm 0.0744$	$0.3519 \pm 0.0543$	$0.3293 \pm 0.0923$	$0.3925 \pm 0.0328$	$0.3819 \pm 0.0353$	$0.3766 \pm 0.0302$	$0.3015 \pm 0.0793$
KLI CHI↑	$102.4833 \pm 5.3809$	$76.3844 \pm 12.2112$	$0.2998 \pm 0.0013$ 88.1989 ± 8.4837	$0.2990 \pm 0.0024$ 84.1652 $\pm$ 9.9181	$99.7049 \pm 4.7139$	$100.8864 \pm 4.8262$	$99.2471 \pm 4.7849$	$86.8653 \pm 11.7945$
RTI↓ WGI↑	$0.3876 \pm 0.0834$ $0.4819 \pm 0.0202$	$1.2469 \pm 1.4654$ $0.388 \pm 0.0331$	$55.6331 \pm 242.9702$ $0.4398 \pm 0.0355$	$0.8844 \pm 0.9473$ $0.4311 \pm 0.0305$	$0.4567 \pm 0.3158$ $0.4844 \pm 0.0175$	$0.3889 \pm 0.2383$ $0.4878 \pm 0.0185$	$0.4203 \pm 0.2383$ $0.4819 \pm 0.0202$	$1.4253 \pm 3.1528 \\ 0.4468 \pm 0.0310$
	$0.0799 \pm 0.0095$	$0.0582 \pm 0.0151$	$0.0739 \pm 0.0099$	$0.0676 \pm 0.0180$	$0.0789 \pm 0.0073$	$0.0772 \pm 0.0074$	$0.0747 \pm 0.0071$	$0.0630 \pm 0.0149$
BHI↑	$0.0089 \pm 0.0006$	$0.0131 \pm 0.0036$	$0.0107 \pm 0.0012$	$0.0118 \pm 0.0031$	$\begin{array}{c} 19.9329 \pm 0.4223 \\ 0.0094 \pm 0.0004 \end{array}$	$0.0094 \pm 0.0004$	$0.0095 \pm 0.0004$	$0.0117 \pm 0.0031$
PBMI↑ XBI↓	$0.1055 \pm 0.0054$ 9.0244 $\pm$ 1.4727	$0.0792 \pm 0.0113$ 14.1175 $\pm$ 5.3499	$0.0953 \pm 0.0096$ $10.1555 \pm 1.9040$	$\begin{array}{c} 0.0910 \pm 0.0099 \\ 10.7707 \pm 2.9138 \end{array}$	$0.1072 \pm 0.0043$ $9.0814 \pm 1.5593$	$\begin{array}{r} \textbf{0.1083} \pm \textbf{0.0042} \\ \textbf{9.5577} \pm \textbf{1.5712} \end{array}$	$0.1065 \pm 0.0049$ $9.9171 \pm 1.3681$	$0.0950 \pm 0.0094$ 11.0226 $\pm$ 2.1915
DBI↓ DRI↑	$0.8325 \pm 0.0442$ 98 7081 ± 8 8463	$1.2400 \pm 0.4275$ 60.6881 + 14.4335	$1.8042 \pm 3.3009$ 78 4804 $\pm$ 13 0010	$1.0808 \pm 0.2865$ 72 4738 $\pm$ 12 2052	$0.8628 \pm 0.0878$ 94 7907 $\pm 8.8444$	$0.8417 \pm 0.0729$ 97 2317 $\pm$ 8 8509	$0.8573 \pm 0.0715$ 94 7061 $\pm$ 8 6671	$1.1279 \pm 0.3939$ 77 3635 $\pm$ 15 9286
	$18.2605 \pm 1.6466$	$31.5014 \pm 9.4670$	$23.4615 \pm 4.3656$	$25.5810 \pm 5.7475$	$19.0216 \pm 1.7137$	$18.5441 \pm 1.7129$	$19.0367 \pm 1.7296$	$24.2377 \pm 6.0042$
LDRI↑ LSSRI↑	$458.8339 \pm 8.9885$ $2.3258 \pm 0.0535$	$407.5064 \pm 26.4344$ $2.0195 \pm 0.1753$	$434.8922 \pm 17.4596$ $2.1725 \pm 0.0983$	$426.7030 \pm 19.3799$ $2.1226 \pm 0.1317$	$454.7617 \pm 9.1900$ $2.2986 \pm 0.0472$	$457.3108 \pm 9.1915$ $2.3103 \pm 0.0482$	$454.6813 \pm 9.1303$ $2.2939 \pm 0.0480$	$432.6364 \pm 22.2501$ $2.1523 \pm 0.1443$
TWI↓	$0.8889 \pm 0.0440$	1.1808 ± 0.1958	$1.0234 \pm 0.0918$	$1.0731 \pm 0.1376$	$0.9110 \pm 0.0390$	$0.9013 \pm 0.0398$	0.9148 ± 0.0397	$1.0462 \pm 0.1425$
SJC2 MRU	$0.2196 \pm 0.0008$	18 [20] 0.2368 ± 0.0046	GRASP-VND [20] 0.2294 ± 0.0042	$0.2275 \pm 0.0041$	$10002231 \pm 0.0021$	$\frac{\text{GVNS}[25]}{0.2237 \pm 0.0015}$	367NS[25]	$\frac{\text{NDVNS}[26]}{0.2260 \pm 0.0025}$
GPI↓	$0.0030 \pm 0.0001$	$0.0042 \pm 0.0003$	$0.0037 \pm 0.0042$	$0.0036 \pm 0.0003$	$0.0033 \pm 0.0002$	$0.0033 \pm 0.0001$	$0.0031 \pm 0.0001$	$0.0035 \pm 0.0002$
CI↓	$\begin{array}{c} 0.9505 \pm 0.0012 \\ 0.0290 \pm 0.0006 \end{array}$	$0.9302 \pm 0.0056$ $0.0398 \pm 0.0027$	$0.9375 \pm 0.0048$ $0.0358 \pm 0.0023$	$0.9398 \pm 0.0045$ $0.0347 \pm 0.0022$	$0.9443 \pm 0.0027$ $0.0324 \pm 0.0012$	$0.9440 \pm 0.0018$ $0.0326 \pm 0.0009$	$0.9465 \pm 0.0011$ $0.0314 \pm 0.0006$	$0.9411 \pm 0.0030$ $0.0340 \pm 0.0014$
TI↑ DGI↑	$0.3313 \pm 0.0021$ $0.4445 \pm 0.0363$	$0.3208 \pm 0.0025$ $0.2543 \pm 0.1119$	$0.3220 \pm 0.0017$ $0.3048 \pm 0.1258$	$0.3231 \pm 0.0017$ $0.3231 \pm 0.0822$	$0.3238 \pm 0.0008$ $0.3590 \pm 0.0697$	$0.3243 \pm 0.0011$ $0.3875 \pm 0.0681$	$0.3246 \pm 0.0006$ $0.3664 \pm 0.0507$	$0.3229 \pm 0.0013$ $0.3553 \pm 0.0788$
RLI↑	$0.2513 \pm 0.0002$	$0.2492 \pm 0.0010$	$0.2497 \pm 0.0011$	$0.2502 \pm 0.0008$	$0.2506 \pm 0.0006$	$0.2507 \pm 0.0002$	$0.2510 \pm 0.0002$	$0.2503 \pm 0.0006$
RTI↓	$\begin{array}{c} 258.5575 \pm 5.5617 \\ 0.2915 \pm 0.0265 \end{array}$	$1.4581 \pm 3.6889$	$0.8145 \pm 1.3649$	$0.5058 \pm 0.4307$	$0.3317 \pm 0.0644$	$0.3641 \pm 0.0772$	$0.3172 \pm 0.0221$	$0.5341 \pm 0.6963$
WGI↑ DI↑	$\begin{array}{c} 0.5047 \pm 0.0140 \\ 0.1036 \pm 0.0068 \end{array}$	$\begin{array}{c} 0.4345 \pm 0.0206 \\ 0.0543 \pm 0.0257 \end{array}$	$\begin{array}{c} 0.4619 \pm 0.0211 \\ 0.0605 \pm 0.0298 \end{array}$	$0.4713 \pm 0.0191 \\ 0.0666 \pm 0.0203$	$\begin{array}{c} 0.4850 \pm 0.0123 \\ 0.0747 \pm 0.0186 \end{array}$	$0.4836 \pm 0.0115$ $0.0829 \pm 0.0154$	$0.4899 \pm 0.0093$ $0.0852 \pm 0.0116$	$\begin{array}{c} 0.4761 \pm 0.0130 \\ 0.0702 \pm 0.0211 \end{array}$
TWBI↑	$39.8867 \pm 1.3068$	$30.7008 \pm 3.9930$	$32.8270 \pm 4.7591$	$34.9680 \pm 4.3016$	$37.3805 \pm 3.3259$	$37.8883 \pm 2.1739$	$38.8283 \pm 0.8177$	$36.4887 \pm 3.3470$
PBMI↑	$0.0882 \pm 0.0033$	$0.0737 \pm 0.0051$	$\begin{array}{c} 0.0038 \pm 0.0020 \\ 0.0758 \pm 0.0052 \end{array}$	$0.0798 \pm 0.0046$	$0.0812 \pm 0.0036$	$0.0829 \pm 0.0049$	$0.0818 \pm 0.0010$	$0.0800 \pm 0.0040$
XBI↓ DBI↓	$7.5351 \pm 1.2285$ $0.8143 \pm 0.0189$	$98.7739 \pm 258.4076$ $1.0817 \pm 0.4001$	$88.2315 \pm 237.7553$ $1.0054 \pm 0.2123$	$11.1/35 \pm 2.8489$ $0.9441 \pm 0.1134$	$10.9023 \pm 2.9168$ $0.8619 \pm 0.0455$	$0.8764 \pm 0.0384$	$11.4161 \pm 2.5194$ $0.8448 \pm 0.0105$	$10.4440 \pm 2.8216$ $0.9206 \pm 0.1464$
DRI↑ KDWI⊥	$394.4584 \pm 10.9094$ 94.7196 $\pm 2.6533$	$244.0968 \pm 52.0090$ $160.8219 \pm 39.6709$	$277.7956 \pm 65.5524$ $143.0536 \pm 39.0039$	$307.0154 \pm 56.5147$ 126.6106 $\pm$ 29.1817	$343.1438 \pm 44.8690$ 111.3756 $\pm$ 20.9530	$350.5524 \pm 20.1827$ $106.8548 \pm 6.4191$	$369.8853 \pm 8.269$ $100.9878 \pm 2.3516$	$322.0058 \pm 44.7075$ $118.9380 \pm 23.0074$
	$1195.4295 \pm 5.5669$	$1094.7444 \pm 46.0297$	$1119.4389 \pm 51.4379$	$1141.6510 \pm 41.1824$	$1165.5769 \pm 31.2172$	$1171.5785 \pm 11.7554$	$1182.5898 \pm 4.5613$	$1152.6488 \pm 32.6283$
TWI↓	$2.9737 \pm 0.0131$ 1.3040 ± 0.0163	$1.7021 \pm 0.1300$	$1.6173 \pm 0.2428$	$2.8231 \pm 0.1123$ $1.5117 \pm 0.1692$	$1.4226 \pm 0.0981$	$1.3917 \pm 0.0375$	$1.3492 \pm 0.0124$	$1.4694 \pm 0.1377$
SJC3a	CNO-CC	TS [20]	GRASP-VND [20]	GRASP-VND-TS [20]	IVNS [21]	GVNS [25]	SGVNS [25]	NDVNS [26]
MRI↓ GPI↓	$\begin{array}{c} 0.1708 \pm 0.0013 \\ \textbf{0.0012} \pm \textbf{0.0000} \end{array}$	$\begin{array}{c} 0.1841 \pm 0.0030 \\ 0.0017 \pm 0.0001 \end{array}$	$\begin{array}{c} 0.1753 \pm 0.0025 \\ 0.0014 \pm 0.0001 \end{array}$	$\begin{array}{c} 0.1756 \pm 0.0023 \\ 0.0014 \pm 0.0001 \end{array}$	$\begin{array}{c} 0.1700 \pm 0.0010 \\ 0.0012 \pm 0.0000 \end{array}$	$\begin{array}{c} 0.1723 \pm 0.0015 \\ 0.0013 \pm 0.0001 \end{array}$	$0.1712 \pm 0.0009$ $0.0012 \pm 0.0000$	$\begin{array}{c} 0.1739 \pm 0.0018 \\ 0.0013 \pm 0.0001 \end{array}$
BHGI↑ CU	$0.9680 \pm 0.0012$ $0.0210 \pm 0.0007$	$0.954 \pm 0.0032$ $0.0289 \pm 0.0015$	$0.962 \pm 0.0024$ $0.0244 \pm 0.0013$	$0.9616 \pm 0.0025$ $0.0246 \pm 0.0012$	$0.9669 \pm 0.0012$ $0.0218 \pm 0.0005$	$0.9649 \pm 0.0017$ $0.0230 \pm 0.0008$	$0.9659 \pm 0.001$ $0.0224 \pm 0.0005$	$0.9632 \pm 0.0018$ $0.0238 \pm 0.0009$
	$0.2653 \pm 0.0019$	$0.2572 \pm 0.0012$	$0.259 \pm 0.0008$	$0.2588 \pm 0.0011$	$0.2597 \pm 0.0005$	$0.2592 \pm 0.0008$ $0.2592 \pm 0.0008$	$0.2594 \pm 0.0007$	$0.2588 \pm 0.0007$ $0.2854 \pm 0.0542$
DGI† RLI↑	$0.3717 \pm 0.0504$ $0.1970 \pm 0.0001$	$0.1955 \pm 0.0875$ $0.196 \pm 0.0006$	$0.2586 \pm 0.0889$ $0.1965 \pm 0.0003$	$0.2742 \pm 0.0692$ $0.1965 \pm 0.0004$	$0.3501 \pm 0.0704$ $0.1969 \pm 0.0003$	$0.3079 \pm 0.049$ $0.1968 \pm 0.0002$	$0.3390 \pm 0.0439$ $0.1969 \pm 0.0001$	$0.2854 \pm 0.0543$ $0.1966 \pm 0.0002$
CHI↑ RTI↓	$\begin{array}{c} 404.7875 \pm 6.9407 \\ 0.3630 \pm 0.1204 \end{array}$	$302.7338 \pm 35.5859 \\ 1.1273 \pm 1.6790$	$344.7671 \pm 33.9902$ $1.2072 \pm 2.678$	$347.9867 \pm 32.7213 \\ 0.5998 \pm 0.3756$	$387.5973 \pm 25.0785$ $0.6124 \pm 0.6477$	$379.5439 \pm 15.2302$ $0.4331 \pm 0.1142$	$387.4522 \pm 7.5671 \\ 0.4929 \pm 0.2348$	$364.6832 \pm 16.9603 \\ 0.6200 \pm 0.5232$
WGI↑	$0.5066 \pm 0.0060$ 0.0915 ± 0.0114	$0.4231 \pm 0.0126$ 0.0418 $\pm$ 0.0187	$0.467 \pm 0.0144$ 0.053 ± 0.0183	$0.4666 \pm 0.0120$ 0.0526 $\pm 0.0154$	$0.4911 \pm 0.0099$ 0.0731 $\pm$ 0.0172	$0.4825 \pm 0.0072$ 0.0637 $\pm 0.0175$	$0.4873 \pm 0.0046$ 0.0704 ± 0.0141	$0.4751 \pm 0.0115$ 0.0577 $\pm 0.0177$
TWBI↑	$72.0777 \pm 2.2505$	$54.9746 \pm 6.9229$	$62.0912 \pm 6.9259$	$62.0780 \pm 5.2805$	$69.5166 \pm 3.4699$	$68.0131 \pm 2.5883$	$69.3132 \pm 2.1077$	$66.1876 \pm 2.8711$
BHI↑ PBMI↑	$0.0036 \pm 0.0001$ $0.0634 \pm 0.0018$	$0.0055 \pm 0.0015$ $0.0510 \pm 0.0029$	$0.0048 \pm 0.0011$ $0.0571 \pm 0.004$	$0.0045 \pm 0.0009$ $0.0583 \pm 0.0027$	$0.0040 \pm 0.0006$ $0.0624 \pm 0.0022$	$0.0040 \pm 0.0002$ $0.0605 \pm 0.0018$	$0.0039 \pm 0.0001$ $0.0618 \pm 0.0012$	$0.0042 \pm 0.0003$ $0.0593 \pm 0.0020$
XBI↓ DBI↓	$9.3436 \pm 2.0224$ $0.8200 \pm 0.0216$	$18.3319 \pm 7.0728$ $1.1033 \pm 0.2320$	$10.4922 \pm 1.9231$ $1.0189 \pm 0.259$	$11.3083 \pm 2.2616$ 0.9311 $\pm$ 0.0661	$8.0296 \pm 2.3749$ 0.8987 + 0.1277	$11.3727 \pm 2.5176$ 0.8755 $\pm$ 0.0355	$9.3656 \pm 2.4405$ $0.8684 \pm 0.0278$	$10.9898 \pm 2.6433$ 0.9115 $\pm$ 0.0806
	$1100.1036 \pm 36.3253$	$646.8354 \pm 133.3649$	$827.5845 \pm 131.2393$	$835.3834 \pm 131.4999$	$1021.8948 \pm 109.4389$	$976.6157 \pm 70.6804$	$1012.7544 \pm 37.0671$	$904.9806 \pm 77.1335$
LDRI†	$132.2090 \pm 0.0241$ 2100.7924 $\pm$ 9.9122	$1934.6818 \pm 68.8172$	$2011.5618 \pm 51.6638$	$240.3349 \pm 40.3217$ $2014.3997 \pm 51.6033$	$2076.8366 \pm 37.2388$	$206.1098 \pm 10.5349$ $2064.4296 \pm 22.8465$	$2075.9358 \pm 11.0679$	$2041.2665 \pm 26.9296$
LSSRI↑ TWI↓	$\begin{array}{r} 3.5645 \pm 0.0172 \\ 1.0829 \pm 0.0181 \end{array}$	$3.2671 \pm 0.1241$ $1.4538 \pm 0.1831$	$3.3991 \pm 0.1049$ $1.2774 \pm 0.1374$	$3.4089 \pm 0.0995$ $1.2647 \pm 0.1282$	$3.5190 \pm 0.0707$ $1.1343 \pm 0.0848$	$3.4995 \pm 0.0412$ $1.1542 \pm 0.0474$	$3.5207 \pm 0.0196$ $1.1300 \pm 0.0216$	$\begin{array}{r} 3.4592 \pm 0.0478 \\ 1.2005 \pm 0.0572 \end{array}$
SJC3b	CNO-CC	TS [20]	GRASP-VND [20]	GRASP-VND-TS [20]	IVNS [21]	GVNS [25]	SGVNS [25]	NDVNS [26]
MRI↓ GPI↓	$0.1944 \pm 0.0019$ $0.0020 \pm 0.0001$	$0.2084 \pm 0.0031$ $0.0027 \pm 0.0002$	$0.2025 \pm 0.0050$ $0.0025 \pm 0.0002$	$0.2031 \pm 0.0046$ $0.0025 \pm 0.0002$	$0.1936 \pm 0.0022$ $0.0020 \pm 0.0001$	$0.1962 \pm 0.0022$ $0.0022 \pm 0.0001$	$0.1937 \pm 0.0032$ $0.002 \pm 0.0001$	$0.1989 \pm 0.0022$ $0.0023 \pm 0.0001$
BHGI↑	$0.9567 \pm 0.0020$ 0.0263 $\pm$ 0.0011	$0.9407 \pm 0.0034$ $0.0347 \pm 0.0017$	$0.9463 \pm 0.0050$ $0.0317 \pm 0.0026$	$0.9456 \pm 0.0050$ $0.0320 \pm 0.0024$	$0.9555 \pm 0.0022$ $0.0270 \pm 0.0011$	$0.9528 \pm 0.0023$ 0.0284 $\pm 0.0012$	$0.9553 \pm 0.0029$ 0.0270 $\pm 0.0016$	$0.9503 \pm 0.0022$ 0.0207 $\pm 0.0011$
TI↑	$\begin{array}{c} 0.0203 \pm 0.0011 \\ 0.2939 \pm 0.0024 \end{array}$	$0.0347 \pm 0.0017$ $0.2858 \pm 0.0017$	$0.0317 \pm 0.0020$ $0.2864 \pm 0.0013$	$0.0320 \pm 0.0024$ $0.2863 \pm 0.0017$	$0.0270 \pm 0.0011$ $0.2888 \pm 0.0007$	$\begin{array}{c} 0.0284 \pm 0.0012 \\ 0.2880 \pm 0.0009 \end{array}$	$0.0270 \pm 0.0010$ $0.2888 \pm 0.0007$	$0.0297 \pm 0.0011$ $0.2878 \pm 0.0010$
DGI↑ RLI↑	$\begin{array}{c} 0.3511 \pm 0.0375 \\ 0.2190 \pm 0.0001 \end{array}$	$\begin{array}{c} 0.1351 \pm 0.0747 \\ 0.2172 \pm 0.0006 \end{array}$	$\begin{array}{c} 0.2280 \pm 0.0912 \\ 0.2180 \pm 0.0007 \end{array}$	$\begin{array}{c} 0.2047 \pm 0.0810 \\ 0.2178 \pm 0.0007 \end{array}$	$\begin{array}{c} 0.2570 \pm 0.0736 \\ 0.2188 \pm 0.0004 \end{array}$	$\begin{array}{c} 0.2478 \pm 0.0810 \\ 0.2185 \pm 0.0005 \end{array}$	$\begin{array}{c} 0.2434 \pm 0.0532 \\ 0.2186 \pm 0.0006 \end{array}$	$\begin{array}{c} 0.1990 \pm 0.0883 \\ 0.2182 \pm 0.0006 \end{array}$
CHI↑ RTI↓	$371.6300 \pm 9.3640$ 0 3934 $\pm$ 0 0867	$266.1958 \pm 28.3107$ $26.8980 \pm 106.1727$	$306.6767 \pm 37.512$ 0.9980 + 1.0222	$301.2459 \pm 38.7819$ 6 6252 $\pm 24.4985$	$354.9103 \pm 30.2928$ 0.6246 ± 1.0461	$336.7602 \pm 27.6364$ 0 5880 ± 0 3407	$349.9783 \pm 30.5821$ 0.5670 ± 0.5334	$320.2670 \pm 33.5022$ 0.5195 ± 0.1956
WGI↑	$0.4739 \pm 0.0144$	$0.4069 \pm 0.0180$	$0.4208 \pm 0.0278$	$0.4247 \pm 0.0218$	$0.4763 \pm 0.0097$	$0.4613 \pm 0.0141$	$0.4735 \pm 0.0156$	$0.4466 \pm 0.0134$
DI↑ TWBI↑	$\begin{array}{r} 0.0705 \pm 0.0138 \\ 50.9202 \pm 1.8003 \end{array}$	$0.0252 \pm 0.0133$ $38.0629 \pm 5.3262$	$0.0420 \pm 0.0179$ $42.9237 \pm 5.9219$	$0.0348 \pm 0.0149$ 42.4517 $\pm 5.2993$	$0.0447 \pm 0.0144$ $50.2138 \pm 3.5694$	$0.0451 \pm 0.0188$ $48.3719 \pm 3.3310$	$0.0427 \pm 0.0150$ $50.1709 \pm 2.1726$	$0.0382 \pm 0.0176$ $45.0213 \pm 4.4839$
BHI↑ PBMI↑	$0.0050 \pm 0.0002$ $0.0686 \pm 0.0021$	$\begin{array}{r} 0.0084 \pm 0.0020 \\ 0.0562 \pm 0.0038 \end{array}$	$\begin{array}{c} \textbf{0.0068} \pm \textbf{0.0016} \\ 0.0612 \pm 0.0051 \end{array}$	$0.0068 \pm 0.0014$ $0.0614 \pm 0.0050$	$\begin{array}{c} 0.0056 \pm 0.0010 \\ 0.0683 \pm 0.0029 \end{array}$	$0.0060 \pm 0.0009$ $0.0663 \pm 0.0027$	$0.0057 \pm 0.0009$ $0.0684 \pm 0.0030$	$\begin{array}{c} 0.0066 \pm 0.0015 \\ 0.0638 \pm 0.0033 \end{array}$
XBI	$11.7227 \pm 2.8035$ 0.8754 $\pm$ 0.0201	$166.3153 \pm 343.7722$	$\infty \pm \text{NaN}$	$121.7859 \pm 316.5259$ $1.2008 \pm 0.7705$	$54.2989 \pm 176.7933$	$56.1617 \pm 185.2908$	$16.1663 \pm 3.1423$	$102.1993 \pm 255.3857$ $1.0084 \pm 0.1657$
DBI↓ DRI↑	$574.9973 \pm 29.9329$	$316.2264 \pm 59.0211$	$410.0772 \pm 83.8439$	$395.9581 \pm 85.6028$	$535.1819 \pm 70.7836$	$486.9883 \pm 65.3027$	$522.5146 \pm 71.7992$	$440.3768 \pm 77.6892$
KDWI↓ LDRI↑	$223.4398 \pm 11.3645$ 1905.9296 $\pm$ 15.4340	$419.3810 \pm 81.5267$ $1721.8702 \pm 57.0050$	$326.8737 \pm 76.2076$ 1798.4602 $\pm 65.2702$	$341.42/8 \pm 89.9719$ 1786.9037 $\pm$ 71.1263	$244.5495 \pm 40.8939$ $1881.8742 \pm 44.5762$	$268.2979 \pm 40.8280$ $1853.6927 \pm 42.8079$	$250.1556 \pm 37.5735$ $1874.7225 \pm 43.2939$	$301.1391 \pm 60.7441$ $1821.3874 \pm 57.0240$
		$28885 \pm 0.1068$	$3.0279 \pm 0.1279$	$3.0001 \pm 0.1367$	$3.1777 \pm 0.0921$	$3.1257 \pm 0.0852$	$3.1637 \pm 0.0901$	$3.0733 \pm 0.1088$
LSSRI↑ TWI⊥	$3.2272 \pm 0.0251$ $1.5009 \pm 0.0360$	$2.0833 \pm 0.1003$ $2.0831 \pm 0.2115$	$1.8287 \pm 0.2323$	$1.8638 \pm 0.2572$	$1.5795 \pm 0.1498$	$1.6593 \pm 0.1401$	$1.6004 \pm 0.1419$	$1.7478 \pm 0.1873$

of resulting cluster sizes. Consider a simple example illustrated in Fig. 1, where five samples are to be partitioned into two clusters. If the total within-cluster Euclidean distance is used as the objective function, then the total within-cluster distance of the resulting clusters surrounded by the two ellipses is  $5+\sqrt{2}$  ( $\approx 6.414$ ), whereas more natural clusters surrounded by the two circles result in a bigger total within-cluster distance (i.e.,  $4 + 2\sqrt{2} \approx 6.828$ ).

The unnatural clustering result is because the sum of dissimilarity coefficients in each cluster is not normalized by the size of the cluster, and the terms in the objective function (i.e., the numbers of intra-cluster weighted con-

## IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS

#### TABLE IV

# MEAN VALUES AND STANDARD DEVIATIONS OF 21 INTERNAL CLUSTER VALIDITY CRITERIA RESULTING FROM CNO-CC AND SEVEN BASELINES ON SJC4a (n = 402, p = 30, and b = 840), SJC4b (n = 402, p = 40, and b = 840), DON11 (n = 1000, p = 6, and b = 200), and U724 010 (n = 724, p = 10, and b = 4175)

				_ `				
SJC4a	CNO-CC	TS [20]	GRASP-VND [20]	GRASP-VND-TS [20]	IVNS [21]	GVNS [25]	SGVNS [25]	NDVNS [26]
MRI↓	$0.1617 \pm 0.0009$	$0.1745 \pm 0.0034$	$0.1656 \pm 0.0024$	$0.1662 \pm 0.0026$	$0.1608 \pm 0.0006$	$0.1630 \pm 0.0016$	$0.1609 \pm 0.0011$	$0.1652 \pm 0.0023$
GPI↓	$0.0009 \pm 0.0000$	$0.0012 \pm 0.0001$	$0.0010 \pm 0.0001$	$0.0010 \pm 0.0001$	$0.0009 \pm 0.0000$	$0.0009 \pm 0.0001$	$0.0009 \pm 0.0000$	$0.0010 \pm 0.0001$
CU	$0.9722 \pm 0.0007$ 0.0203 $\pm$ 0.0005	$0.9597 \pm 0.0034$ $0.0278 \pm 0.0017$	$0.9675 \pm 0.0024$ $0.0232 \pm 0.0013$	$0.9669 \pm 0.0030$ $0.0235 \pm 0.0014$	$0.9/16 \pm 0.000/$ $0.0208 \pm 0.0004$	$0.9700 \pm 0.0017$ $0.0218 \pm 0.0009$	$0.9717 \pm 0.0009$ $0.0208 \pm 0.0006$	$0.9676 \pm 0.0024$ $0.0230 \pm 0.0013$
TI↑	$0.2445 \pm 0.0018$	$0.2380 \pm 0.0010$	$0.2399 \pm 0.0013$	$0.2396 \pm 0.0012$	$0.2401 \pm 0.0006$	$0.2404 \pm 0.0009$	$0.2405 \pm 0.0004$	$0.2395 \pm 0.0011$
DGI↑ DL I♠	$0.3219 \pm 0.0371$	$0.1878 \pm 0.0818$	$0.2701 \pm 0.0642$	$0.2859 \pm 0.0444$	$0.3195 \pm 0.0166$	$0.3090 \pm 0.0546$	$0.3135 \pm 0.0243$	$0.2738 \pm 0.063$
KLI† CHI↑	$0.1802 \pm 0.0000$ 498.6002 + 6.0055	$0.1793 \pm 0.0005$ 369 2308 $\pm$ 52 5659	$0.1799 \pm 0.0002$ 443 6728 $\pm$ 32 5099	$0.1798 \pm 0.0003$ 441 9115 $\pm$ 37 6014	$0.1802 \pm 0.0000$ 493 8303 + 7 7804	$0.1801 \pm 0.0002$ 474 4083 $\pm$ 31 0926	$0.1802 \pm 0.0000$ 494 3243 + 8 7970	$0.1799 \pm 0.0002$ 444 7208 $\pm$ 38 7877
RTI↓	$0.3992 \pm 0.0771$	$1.2593 \pm 2.3404$	$0.6141 \pm 0.4526$	$0.5599 \pm 0.2479$	$0.3759 \pm 0.0618$	$0.4317 \pm 0.0818$	$0.3529 \pm 0.0752$	$0.4639 \pm 0.1143$
WGI↑ DI↑	$0.4956 \pm 0.0072$	$0.4146 \pm 0.0179$	$0.4571 \pm 0.0144$ 0.0502 $\pm$ 0.0128	$0.4552 \pm 0.0138$	$0.4884 \pm 0.0038$	$0.4794 \pm 0.0091$	$0.4892 \pm 0.0099$ 0.0630 $\pm$ 0.0065	$0.4636 \pm 0.0157$
TWBI↑	$78.5796 \pm 1.0125$	$59.2018 \pm 7.5660$	$70.0792 \pm 0.0138$	$70.3298 \pm 0.0132$	$0.0628 \pm 0.0083$ 77.9525 $\pm 1.3813$	$74.732 \pm 5.0563$	$0.0639 \pm 0.0063$ 77.6053 $\pm 1.5804$	$0.0481 \pm 0.0143$ $70.5927 \pm 5.5945$
BHI↑	$0.0033 \pm 0.0001$	$0.0052 \pm 0.0015$	$0.0040 \pm 0.0006$	$0.0039 \pm 0.0004$	$0.0034 \pm 0.0001$	$0.0036 \pm 0.0005$	$0.0034 \pm 0.0001$	$0.0040 \pm 0.0007$
PBMI↑ VBI↓	$0.0463 \pm 0.0011$ 12.4057 $\pm$ 2.6121	$0.0378 \pm 0.0031$ 56 6422 $\pm$ 166 5107	$0.0432 \pm 0.0019$ 13 8765 $\pm$ 3 2790	$0.0434 \pm 0.0021$ 13 7061 $\pm$ 3 0683	$0.0468 \pm 0.0011$ 11.6069 $\pm 0.7190$	$0.0457 \pm 0.0012$ 12 5355 $\pm$ 2 8518	$0.0470 \pm 0.0011$ 12 3814 $\pm$ 2 3056	$0.0439 \pm 0.0019$ 13 5358 $\pm$ 2 2493
DBI↓	$0.8499 \pm 0.0235$	$1.1145 \pm 0.4061$	$0.9412 \pm 0.0792$	$0.9223 \pm 0.0534$	$0.8524 \pm 0.0157$	$0.8764 \pm 0.0430$	$0.8393 \pm 0.0238$	$0.9178 \pm 0.0667$
DRI↑	$1544.5359 \pm 35.9685$	$893.5758 \pm 218.3921$	$1245.1532 \pm 165.9415$	$1237.3347 \pm 178.8119$	$1517.4247 \pm 46.4320$	$1410.7967 \pm 160.0167$	$1518.5656 \pm 50.9333$	$1252.9298 \pm 185.1040$
LDRI†	$405.7688 \pm 9.3628$ 2951.5735 $\pm 9.3185$	$747.2372 \pm 204.5497$ 2719 3315 $\pm$ 104 4913	$513.1724 \pm 81.2655$ 2861 2945 + 58 0770	$518.8592 \pm 93.3179$ $2857.9441 \pm 64.5988$	$413.1/43 \pm 12.010/$ 2944 379 + 12 2879	$452.4415 \pm 79.659$ 2912.0389 $\pm$ 56.1234	$412.9747 \pm 15.0045$ 2944 6335 + 14 0181	$513.2491 \pm 96.7607$ 2862 7154 $\pm$ 66 6842
LSSRI↑	$3.6601 \pm 0.012$	$3.3497 \pm 0.1480$	$3.5408 \pm 0.0766$	$3.5358 \pm 0.0908$	$3.6505 \pm 0.0157$	$3.6081 \pm 0.0733$	$3.6514 \pm 0.0181$	$3.5419 \pm 0.0933$
TWI↓	$1.3457 \pm 0.0157$	$1.8363 \pm 0.2714$	$1.5154 \pm 0.1179$	$1.5245 \pm 0.1431$	$1.3585 \pm 0.0208$	$1.4192 \pm 0.1133$	$1.3573 \pm 0.0244$	$1.5157 \pm 0.1467$
SJC4b	CNO-CC	TS [20]	GRASP-VND [20]	GRASP-VND-TS [20]	IVNS [21]	GVNS [25]	SGVNS [25]	NDVNS [26]
MRI↓ GPU	$0.1404 \pm 0.0007$ 0.0005 $\pm$ 0.0000	$0.1525 \pm 0.0019$ 0.0007 $\pm$ 0.0000	$0.1421 \pm 0.0010$	$0.1420 \pm 0.0012$	$0.1387 \pm 0.0004$	$0.1409 \pm 0.0011$	$0.1412 \pm 0.0015$ 0.0005 $\pm$ 0.0000	$0.1433 \pm 0.0019$
BHGĬ↑	$0.0005 \pm 0.0000$ $0.9789 \pm 0.0005$	$0.9687 \pm 0.0000$	$0.9766 \pm 0.0009$	$0.9767 \pm 0.0009$	$0.9789 \pm 0.0004$	$0.9776 \pm 0.0007$	$0.9774 \pm 0.0011$	$0.9760 \pm 0.0016$
CI↓	$0.0169 \pm 0.0003$	$0.0239 \pm 0.0010$	$0.0186 \pm 0.0005$	$0.0186 \pm 0.0006$	$0.0170 \pm 0.0003$	$0.0180 \pm 0.0005$	$0.0181 \pm 0.0008$	$0.0188 \pm 0.0010$
Π T DGI↑	$0.2119 \pm 0.0016$ 0.3799 $\pm$ 0.0312	$0.2058 \pm 0.0009$ $0.1994 \pm 0.1107$	$0.2073 \pm 0.0010$ $0.3497 \pm 0.0385$	$0.2072 \pm 0.0007$ $0.3406 \pm 0.0548$	$0.2072 \pm 0.0004$ $0.3363 \pm 0.0349$	$0.20/4 \pm 0.000/$ 0.3514 ± 0.0396	$0.2075 \pm 0.0007$ $0.3148 \pm 0.1175$	$0.2091 \pm 0.0011$ 0.3516 $\pm$ 0.0507
RLI↑	$0.1566 \pm 0.0000$	$0.1562 \pm 0.0002$	$0.1565 \pm 0.0000$	$0.1566 \pm 0.0000$	$0.1566 \pm 0.0000$	$0.1566 \pm 0.0000$	$0.1566 \pm 0.0000$	$0.1565 \pm 0.0001$
CHI↑ PTL	$513.725 \pm 5.4451$	$384.1615 \pm 47.2820$	$480.8249 \pm 10.8762$	$484.1197 \pm 11.2747$	$512.7677 \pm 6.3912$	$495.8291 \pm 8.0646$	$492.8008 \pm 13.3102$	$475.9606 \pm 19.9467$
WGI↑	$0.5774 \pm 0.0441$ $0.5063 \pm 0.0056$	$0.8497 \pm 0.9094$ $0.4191 \pm 0.0112$	$0.4787 \pm 0.1439$ $0.4785 \pm 0.0104$	$0.4270 \pm 0.0043$ $0.4814 \pm 0.0086$	$0.3184 \pm 0.0202$ $0.4991 \pm 0.0025$	$0.3830 \pm 0.0707$ $0.4877 \pm 0.0086$	$0.3800 \pm 0.0391$ $0.4824 \pm 0.0111$	$0.4701 \pm 0.1414$ $0.4825 \pm 0.0113$
DI↑	$0.0935 \pm 0.0116$	$0.0435 \pm 0.0248$	$0.0787 \pm 0.0120$	$0.0805 \pm 0.0156$	$0.0853 \pm 0.0098$	$0.0872 \pm 0.0114$	$0.0764 \pm 0.0295$	$0.0807 \pm 0.0170$
T WBI∏ BHI↑	$111.8347 \pm 1.7476$ $0.0023 \pm 0.0000$	$0.0036 \pm 0.0010$	$0.0026 \pm 0.0001$	$0.0026 \pm 0.0004$	$113.0038 \pm 1.0039$ $0.0024 \pm 0.0000$	$0.0025 \pm 0.0000$	$0.0025 \pm 0.0001$	$0.0026 \pm 0.0001$
PBMI↑	$0.0388 \pm 0.0014$	$0.0308 \pm 0.0017$	$0.0358 \pm 0.0008$	$0.0359 \pm 0.0008$	$0.0372 \pm 0.0006$	$0.0366 \pm 0.0010$	$0.0362 \pm 0.0012$	$0.0355 \pm 0.0011$
XBI↓ DBI↓	$7.7450 \pm 0.8843$ $0.8171 \pm 0.0154$	$\infty \pm \text{NaN}$ 1.0310 + 0.1911	$8.9076 \pm 2.0437$ $0.8820 \pm 0.0265$	$9.6219 \pm 2.5903$ $0.8704 \pm 0.0208$	$9.4975 \pm 1.5049$ 0.8319 $\pm$ 0.0146	$8.9239 \pm 1.7979$ 0.8514 $\pm$ 0.0221	$\infty \pm \text{NaN} = 0.8579 \pm 0.0147$	$8.6996 \pm 2.6812$ $0.8797 \pm 0.0313$
DRI∱	$3085.3363 \pm 64.6932$	$1787.1545\pm378.1010$	$2721.2710\pm125.5754$	$2750.2717\pm124.7211$	$3095.0143\pm74.1641$	$2891.1427\pm103.2887$	2853.8801 ± 151.9160	2669.9930 ± 211.5043
KDWI↓ I DRI↑	$361.0846 \pm 7.4726$ $3229.7520 \pm 8.3742$	$659.5691 \pm 184.6830$ 2000 0735 $\pm$ 08 3203	$410.0756 \pm 19.4624$ $3178 9453 \pm 18.8101$	$405.7197 \pm 18.8605$ $3183.2219 \pm 18.4518$	$360.0034 \pm 8.6210$ 3230 9846 $\pm$ 9.6302	$385.6469 \pm 13.7859$ $3203.4579 \pm 14.3661$	$391.2915 \pm 21.4836$ $3197.9354 \pm 21.7116$	$419.6211 \pm 33.8974$ $31705005 \pm 32.1289$
LCCDIA	4.0126 0.0106	$27150 \pm 0.1222$	$3.9472 \pm 0.0228$	$3.0540 \pm 0.0234$	$4.0117 \pm 0.0125$	$3.0780 \pm 0.0163$	$3.0717 \pm 0.0272$	$39364 \pm 0.0421$
LOOKI	$4.0130 \pm 0.0100$	$5.7150 \pm 0.1552$	5.9472 ± 0.0220	$5.9340 \pm 0.0234$	$4.0117 \pm 0.0125$	$5.9780 \pm 0.0103$	$3.9717 \pm 0.0272$	2.2201 ± 0.0151
TWI	$4.0136 \pm 0.0106$ $0.9522 \pm 0.0098$	$1.2860 \pm 0.1796$	$1.0165 \pm 0.0228$	$\frac{5.9940 \pm 0.0234}{1.0097 \pm 0.0233}$	$4.0117 \pm 0.0123$ $0.9540 \pm 0.0117$	$0.9860 \pm 0.0103$ $0.9860 \pm 0.0158$	$0.9924 \pm 0.0268$	$1.0278 \pm 0.0427$
TWI↓ Doni1	4.0136 ± 0.0106 0.9522 ± 0.0098 CNO-CC	$   \begin{array}{r}     3.7130 \pm 0.1332 \\     1.2860 \pm 0.1796 \\     \hline     TS [20]   \end{array} $	$\begin{array}{c} 3.3472 \pm 0.0220 \\ 1.0165 \pm 0.0228 \\ \hline \\ GRASP-VND \ [20] \end{array}$	$\frac{3.3340 \pm 0.0234}{1.0097 \pm 0.0233}$ GRASP-VND-TS [20]	4.0117 ± 0.0123 0.9540 ± 0.0117 IVNS [21]	0.9860 ± 0.0103 GVNS [25]	$\frac{3.3717 \pm 0.0272}{0.9924 \pm 0.0268}$ SGVNS [25]	$\frac{1.0278 \pm 0.0427}{\text{NDVNS [26]}}$
Doni1 MRI↓ GPU	$\begin{array}{r} 4.0136 \pm 0.0106 \\ 0.9522 \pm 0.0098 \\ \hline \\ \hline \\ \hline \\ \hline \\ \hline \\ 0.3972 \pm 0.0030 \\ 0.0335 \pm 0.0006 \\ \hline \end{array}$	$\begin{array}{r} 3.7130 \pm 0.1332 \\ 1.2860 \pm 0.1796 \\ \hline TS \ [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0773 \pm 0.0018 \end{array}$	$\begin{array}{c} 1.0165 \pm 0.0228 \\ \hline 1.0165 \pm 0.0228 \\ \hline 0.03703 \pm 0.0069 \\ 0.0274 \pm 0.0022 \end{array}$	$\begin{array}{c} 3.9340 \pm 0.0234 \\ 1.0097 \pm 0.0233 \\ \hline \\ \text{GRASP-VND-TS [20]} \\ 0.368 \pm 0.0057 \\ 0.0268 \pm 0.002 \end{array}$	$\begin{array}{r} 4.0117 \pm 0.0123 \\ 0.9540 \pm 0.0117 \\ \hline \\ IVNS \ [21] \\ \hline \\ 0.3657 \pm 0.005 \\ 0.0261 \pm 0.0018 \end{array}$	$\begin{array}{r} 3.9780 \pm 0.0103 \\ 0.9860 \pm 0.0158 \\ \hline \\ \text{GVNS} [25] \\ \hline 0.365 \pm 0.0053 \\ 0.0257 \pm 0.0019 \\ \hline \end{array}$	$\begin{array}{r} 3.9717 \pm 0.0272 \\ 0.9924 \pm 0.0268 \\ \hline \\ SGVNS [25] \\ \hline \\ 0.3662 \pm 0.0053 \\ 0.0262 \pm 0.0010 \\ \hline \end{array}$	$\frac{1.0278 \pm 0.0427}{\text{NDVNS [26]}}$ $\frac{0.3694 \pm 0.0065}{0.0272 \pm 0.0022}$
LSSRI TWI↓ Doni1 MRI↓ GPI↓ BHGI↑	$\begin{array}{c} 4.0136 \pm 0.0106 \\ \hline 0.9522 \pm 0.0098 \\ \hline \\ \hline \\ CNO-CC \\ \hline 0.3972 \pm 0.0030 \\ 0.0335 \pm 0.0006 \\ 0.7605 \pm 0.0045 \\ \end{array}$	$\begin{array}{r} 3.7130 \pm 0.1332 \\ \hline 1.2860 \pm 0.1796 \\ \hline TS \ [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.8085 \pm 0.0133 \end{array}$	$\begin{array}{c} 3.7702 \pm 0.0228 \\ \hline \textbf{GRASP-VND} \ [20] \\ \hline \textbf{0.3703} \pm 0.0069 \\ \hline \textbf{0.0274} \pm 0.0022 \\ \hline \textbf{0.8072} \pm 0.0165 \end{array}$	$\begin{array}{c} \text{GRASP-VND-TS} \ [20] \\ \hline 0.368 \pm 0.0023 \\ \hline 0.0268 \pm 0.002 \\ 0.8114 \pm 0.0151 \end{array}$	$\begin{array}{r} 4.0117 \pm 0.0123 \\ 0.9540 \pm 0.0117 \\ \hline \\ 0.3657 \pm 0.005 \\ \hline \\ $	$\begin{array}{r} 0.9860 \pm 0.0103\\ 0.9860 \pm 0.0158\\ \hline \\ \text{GVNS} [25]\\ \hline 0.365 \pm 0.0053\\ 0.0257 \pm 0.0019\\ 0.8195 \pm 0.0147\\ \end{array}$	$\begin{array}{r} 3.9717 \pm 0.0272 \\ 0.9924 \pm 0.0268 \\ \hline \\ \hline \\ SGVNS [25] \\ \hline \\ 0.3662 \pm 0.0053 \\ 0.0262 \pm 0.0019 \\ 0.8158 \pm 0.0148 \\ \end{array}$	$\begin{array}{r} 1.0278 \pm 0.0427 \\ \hline 1.0278 \pm 0.0427 \\ \hline 0.0427 \\ \hline 0.3694 \pm 0.0065 \\ \hline 0.0272 \pm 0.0022 \\ \hline 0.8085 \pm 0.0167 \\ \end{array}$
LSSRI TWI↓ Doni1 MRI↓ GPI↓ BHGI↑ CI↓	$\begin{array}{c} 4.0136 \pm 0.0106\\ \hline 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0971 \pm 0.0006\\ \hline \end{array}$	$\begin{array}{c} 3.7150 \pm 0.1352 \\ \hline 1.2860 \pm 0.1796 \\ \hline TS \ [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.8085 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ \hline 0.0090 \pm 0.0040 \\ \hline \end{array}$	$\begin{array}{c} 3.9472 \pm 0.0228 \\ \hline GRASP-VND [20] \\ \hline 0.3703 \pm 0.0069 \\ 0.0274 \pm 0.0022 \\ 0.8072 \pm 0.0165 \\ 0.0801 \pm 0.0044 \\ 0.4205 \pm 0.0104 \\ \end{array}$	$\begin{array}{c} 3.5340 \pm 0.0234 \\ 1.0097 \pm 0.0233 \\ \hline \\ \textbf{GRASP-VND-TS} \ [20] \\ 0.368 \pm 0.0057 \\ 0.0268 \pm 0.002 \\ 0.8114 \pm 0.0151 \\ 0.0788 \pm 0.0037 \\ 0.40051 \pm 0.0037 \\ 0.00$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.9540 \pm 0.0117\\ \hline \\ IVNS \ [21]\\ \hline \\ 0.3657 \pm 0.005\\ \hline \\ 0.0261 \pm 0.0018\\ \hline \\ 0.817 \pm 0.0138\\ \hline \\ 0.0773 \pm 0.0033\\ \hline \\ 0.0773 \pm 0.0033\\ \hline \end{array}$	$\begin{array}{c} 3.9780 \pm 0.0103\\ 0.9860 \pm 0.0158\\ \hline \\ \text{GVNS} \ [25]\\ \hline \\ 0.365 \pm 0.0053\\ 0.0257 \pm 0.0019\\ 0.8195 \pm 0.0147\\ 0.0768 \pm 0.0035\\ 0.0035\\ \hline \end{array}$	$\begin{array}{c} 3.9717 \pm 0.0212 \\ \hline 0.9924 \pm 0.0268 \\ \hline \text{SGVNS} [25] \\ \hline 0.3662 \pm 0.0053 \\ 0.0262 \pm 0.0019 \\ 0.8158 \pm 0.0148 \\ 0.0776 \pm 0.0036 \\ 0.4074 \pm 0.0002 \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427 \\ \hline 1.0278 \pm 0.0427 \\ \hline 0.0594 \pm 0.0065 \\ 0.0272 \pm 0.0022 \\ 0.8085 \pm 0.0167 \\ 0.0796 \pm 0.0043 \\ 0.0043 \\ 0.0043 \\ 0.0044 \\ \end{array}$
LSSRI            TWI↓           Doni1           MRI↓           GPI↓           BHGI↑           CI↓           TI↑           DGI↑	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline \text{CNO-CC}\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ \end{array}$	$\begin{array}{c} 3.7150 \pm 0.1332 \\ 1.2860 \pm 0.1796 \\ \hline \\ $	$\begin{array}{c} 3.9712 \pm 0.0228 \\ \hline 0.0278 \pm 0.0228 \\ \hline 0.3703 \pm 0.0069 \\ 0.0274 \pm 0.0022 \\ 0.8072 \pm 0.0165 \\ 0.0801 \pm 0.0044 \\ 0.4305 \pm 0.0101 \\ 0.0214 \pm 0.0044 \\ \end{array}$	$\begin{array}{c} 3.5240 \pm 0.0234 \\ 1.0097 \pm 0.0233 \\ \hline \\$	$\begin{array}{c} 4.0717 \pm 0.0123 \\ 0.9540 \pm 0.0117 \\ \hline \\ IVNS \ [21] \\ \hline \\ 0.3657 \pm 0.005 \\ 0.0261 \pm 0.0018 \\ \hline \\ 0.817 \pm 0.0138 \\ \hline \\ 0.0773 \pm 0.0033 \\ \hline \\ 0.4361 \pm 0.0086 \\ \hline \\ 0.0241 \pm 0.0076 \\ \hline \end{array}$	$\begin{array}{c} 3.9760 \pm 0.0158 \\ \hline 0.9860 \pm 0.0158 \\ \hline \text{GVNS} [25] \\ \hline 0.365 \pm 0.0053 \\ 0.0257 \pm 0.0019 \\ 0.8195 \pm 0.0147 \\ 0.0768 \pm 0.0035 \\ 0.4376 \pm 0.0035 \\ 0.0026 \pm 0.0076 \\ \hline \end{array}$	$\begin{array}{r} 3.9717\pm0.0272\\ 0.9924\pm0.0268\\ \hline \\ {\rm SGVNS}\ [25]\\ \hline \\ 0.3662\pm0.0019\\ 0.8158\pm0.0148\\ 0.0776\pm0.0036\\ 0.4354\pm0.0033\\ 0.0245\pm0.0076\\ \end{array}$	$\begin{array}{r} \hline 0.037 \pm 0.0427 \\ \hline 1.0278 \pm 0.0427 \\ \hline \hline 0.3694 \pm 0.0065 \\ \hline 0.0272 \pm 0.0022 \\ 0.8085 \pm 0.0167 \\ \hline 0.0796 \pm 0.0043 \\ 0.4312 \pm 0.0104 \\ \hline 0.0268 \pm 0.0089 \\ \hline \end{array}$
$\begin{array}{c} \text{LSSRI}\\ \text{TWI} \\ \hline \\ \text{Doni1} \\ \hline \\ \text{MRI} \\ \text{GPI} \\ \text{BHGI} \\ \text{CI} \\ \text{CI} \\ \text{TI} \\ \text{DGI} \\ \text{RLI} \\ \end{array}$	$\begin{array}{c} \textbf{4.0136 \pm 0.0106} \\ \textbf{0.9522 \pm 0.0098} \\ \hline \\ \hline \\ \textbf{CNO-CC} \\ \textbf{0.3972 \pm 0.0030} \\ \textbf{0.0335 \pm 0.0006} \\ \textbf{0.7605 \pm 0.0045} \\ \textbf{0.0971 \pm 0.0018} \\ \textbf{0.4025 \pm 0.0026} \\ \textbf{0.4025 \pm 0.0026} \\ \textbf{0.3503 \pm 0.0098} \\ \textbf{0.3503 \pm 0.0005} \end{array}$	$\begin{array}{c} 3.7150 \pm 0.1332 \\ 1.2860 \pm 0.1796 \\ \hline TS \ [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.8085 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.3419 \pm 0.0058 \end{array}$	$\begin{array}{c} 3.742 \pm 0.0228 \\ \hline 1.0165 \pm 0.0228 \\ \hline 0.0274 \pm 0.0022 \\ 0.0074 \pm 0.0022 \\ 0.0072 \pm 0.0165 \\ 0.0801 \pm 0.0044 \\ 0.4305 \pm 0.0101 \\ 0.0214 \pm 0.0044 \\ 0.3458 \pm 0.0079 \end{array}$	$\begin{array}{c} 3.5340 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline \textbf{GRASP-VND-TS} \ [20] \\ \hline 0.368 \pm 0.0057 \\ 0.0268 \pm 0.002 \\ 0.8114 \pm 0.0151 \\ 0.0788 \pm 0.0037 \\ 0.4327 \pm 0.0093 \\ 0.0241 \pm 0.0093 \\ 0.0241 \pm 0.0062 \\ 0.3454 \pm 0.0069 \end{array}$	$\begin{array}{c} 4.0117 \pm 0.0123 \\ 0.9540 \pm 0.0117 \\ \hline 1VN8 \ [21] \\ \hline 0.3657 \pm 0.005 \\ 0.0261 \pm 0.0018 \\ \hline 0.817 \pm 0.0013 \\ \hline 0.0173 \pm 0.0033 \\ \hline 0.4361 \pm 0.0086 \\ \hline 0.0241 \pm 0.0086 \\ \hline 0.0241 \pm 0.0061 \\ \hline 0.3433 \pm 0.0068 \\ \hline \end{array}$	$\begin{array}{c} 3.9760\pm0.015\\ 0.9860\pm0.0158\\ \hline \textbf{GVNS}\ [25]\\ \hline \textbf{0.365}\pm0.0019\\ 0.827\pm0.0019\\ 0.8195\pm0.0013\\ \textbf{0.0768}\pm0.0035\\ \textbf{0.4376}\pm0.0092\\ 0.0226\pm0.0073\\ 0.3415\pm0.0073\\ \end{array}$	$\begin{array}{c} 3.971 \pm 0.0272 \\ 0.9924 \pm 0.0268 \\ \hline \\ \textbf{SGVNS} [25] \\ \hline \\ 0.3662 \pm 0.0019 \\ 0.8158 \pm 0.0148 \\ 0.0776 \pm 0.0036 \\ 0.4354 \pm 0.0093 \\ 0.0245 \pm 0.0072 \\ \hline \\ 0.3438 \pm 0.0072 \\ \hline \end{array}$	$\begin{array}{r} \begin{array}{r} \text{NDVNS} \pm 0.0427\\ \hline \text{NDVNS} \ [26] \\ \hline \\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline \\ \textbf{0.0268} \pm 0.0089\\ 0.3462 \pm 0.0079 \end{array}$
$\begin{array}{c} \text{LSSRI}\\ \text{TWI} \\ \hline \text{Doni1} \\ \hline \\ \text{MRI} \\ \text{GPI} \\ \text{GPI} \\ \text{BHGI} \\ \text{CI} \\ \text{TI} \\ \text{CII} \\ \text{TI} \\ \text{CII} \\ \text{TII} \\ \text{DGI} \\ \hline \\ \text{RLI} \\ \text{CHI} \\ \end{array}$	4.0156 ± 0.0106 0.9522 ± 0.0098 CNO-CC 0.3972 ± 0.0030 0.3355 ± 0.0006 0.7605 ± 0.0045 0.0971 ± 0.0018 0.4025 ± 0.0026 0.0131 ± 0.0098 0.3603 ± 0.0098 0.5603 ± 0.0098 0.5614 ± 0.0098 0.5614 ± 0.0098 0.5614 ± 0.0098	$\begin{array}{c} 3.7130 \pm 0.1352\\ 1.2860 \pm 0.1352\\ 1.2860 \pm 0.1796\\ \hline TS \left[ 20 \right]\\ 0.0770 \pm 0.00064\\ 0.0273 \pm 0.0018\\ 0.0805 \pm 0.0133\\ 0.0800 \pm 0.0040\\ 0.4314 \pm 0.008\\ 0.0113 \pm 0.009\\ 0.3449 \pm 0.0058\\ 514.6513 \pm 64.2013\\ 0.6985 \pm 0.0723\\ \end{array}$	$\begin{array}{c} 3.7472\pm 0.0228\\ 1.0165\pm 0.0228\\ \hline \\ \mathbf{GRASP-VND} \ [20]\\ 0.3703\pm 0.0069\\ 0.0274\pm 0.0022\\ 0.8072\pm 0.0165\\ 0.0801\pm 0.0044\\ 0.4305\pm 0.0101\\ 0.0214\pm 0.0044\\ 0.3458\pm 0.0079\\ 525, 7927\pm 90.9895\\ 50, 6981\pm 0.0048\\ 50, 6981\pm 0.0018\\	$\begin{array}{c} 3.5940\pm0.0233\\ 1.0007\pm0.0233\\ \hline \end{array}\\ \begin{array}{c} \text{GRASP-VND-TS} \ [20]\\ \hline 0.368\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0003\\ 0.04327\pm0.0093\\ 0.02241\pm0.0062\\ 0.3454\pm0.0062\\ 0.3454\pm0.0069\\ 524.7544\pm71.9468\\ 0.6664\pm0.0097\\ \end{array}$	4.0117 ± 0.0112 0.9540 ± 0.0117 IVNS [21] 0.3657 ± 0.005 0.0261 ± 0.0018 0.817 ± 0.0138 0.0773 ± 0.0033 0.4361 ± 0.0088 0.0241 ± 0.0071 0.3433 ± 0.0068 510.0968 ± 74.9872 0.6294 ± 0.0854	$\begin{array}{c} 0.3763\pm0.0103\\ 0.9860\pm0.0158\\ \hline \text{GVNS}\ [25]\\ \hline 0.0257\pm0.0013\\ 0.0257\pm0.0019\\ 0.8195\pm0.0147\\ 0.0768\pm0.0035\\ 0.4376\pm0.0092\\ 0.0226\pm0.0076\\ 0.3415\pm0.0073\\ 489.8569\pm80.0607\\ \hline 8.569\pm80.0607\\ \hline \end{array}$	$\begin{array}{c} 3.9717\pm0.2272\\ 0.9924\pm0.0268\\ \hline SGVNS [25]\\ 0.3662\pm0.0053\\ 0.0262\pm0.0019\\ 0.8158\pm0.0148\\ 0.0776\pm0.0036\\ 0.4354\pm0.0076\\ 0.3438\pm0.0077\\ 514.7695\pm79.1941\\ 0.6256\pm0.0076\end{array}$	3.328 ± 0.0427           1.0278 ± 0.0427           NDVNS [26]           0.3694 ± 0.0065           0.0272 ± 0.0022           0.8085 ± 0.0167           0.0796 ± 0.0043           0.4312 ± 0.0104           0.268 ± 0.0089           0.3462 ± 0.0079           552.1621 ± 912.768           0.5000 ± 0.0043
$\begin{array}{c} \text{LSSR1}\\ \text{TWI}\\ \hline \\ \textbf{MRI}\\ \text{GPI}\\ \text{BHGI}\\ \text{CI}\\ \text{CI}\\ \text{TI}\\ \text{CII}\\ \text{RII}\\ \text{CHI}\\ \text{RII}\\ \text{WGI}\\ \end{array}$	4.0156 ± 0.0106 0.9522 ± 0.0098 CNO-CC 0.3972 ± 0.0030 0.333 ± 0.0006 0.7605 ± 0.0045 0.0971 ± 0.0018 0.4025 ± 0.0026 0.0131 ± 0.0098 0.5303 ± 0.0098 0.5303 ± 0.0036 0.8511 ± 0.0243 0.482 ± 0.0036	$\begin{array}{c} 3.7130 \pm 0.1352\\ 1.2860 \pm 0.1352\\ 1.2860 \pm 0.1796\\ \hline TS \left[ 20 \right] \\ \hline 0.3701 \pm 0.0004\\ 0.0273 \pm 0.0018\\ 0.8085 \pm 0.0133\\ 0.8080 \pm 0.0040\\ 0.4314 \pm 0.008\\ 0.0113 \pm 0.009\\ 0.3449 \pm 0.0058\\ 514.6513 \pm 64.2013\\ 0.6085 \pm 0.0733\\ 0.4845 \pm 0.013\\ \end{array}$	$\begin{array}{c} 3.772\pm0.0228\\ 1.0165\pm0.0228\\ \hline \mbox{GRASP-VND} \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0097 \pm 0.0233 \\ \hline 0.0057 \pm 0.0233 \\ \hline 0.368 \pm 0.0057 \\ 0.0268 \pm 0.0027 \\ 0.0268 \pm 0.0027 \\ 0.03114 \pm 0.0151 \\ 0.0788 \pm 0.0037 \\ 0.4327 \pm 0.0093 \\ 0.04241 \pm 0.0062 \\ 0.3454 \pm 0.0062 \\ 0.3454 \pm 0.0069 \\ 524.7544 \pm 71.9468 \\ 0.6164 \pm 0.0897 \\ 0.4907 \pm 0.0041 \\ \hline	4.017 ± 0.0123 0.9540 ± 0.0117 IVNS [21] 0.3657 ± 0.005 0.0261 ± 0.0018 0.817 ± 0.0138 0.0773 ± 0.0038 0.0734 ± 0.0086 0.0241 ± 0.0086 0.0241 ± 0.0086 0.0241 ± 0.0086 0.0264 ± 0.0854 0.6284 ± 0.0854	$\begin{array}{c} 0.3760\pm0.0153\\ 0.9860\pm0.0158\\ \hline \text{GVNS}\ [25]\\ \hline 0.365\pm0.00153\\ 0.0257\pm0.0017\\ 0.8195\pm0.0147\\ 0.0768\pm0.0035\\ 0.0226\pm0.0076\\ 0.0226\pm0.0076\\ 0.3415\pm0.0073\\ 489.8569\pm80.06073\\ 0.659\pm0.00043\\ 0.4895\pm0.00023\\ \hline 0.4895\pm0.00023\\ 0.4895\pm0.$	$\begin{array}{c} 3.9717 \pm 0.0272 \\ 0.9924 \pm 0.0268 \\ \hline \\ SGVNS [25] \\ \hline \\ 0.3662 \pm 0.0053 \\ 0.0262 \pm 0.0019 \\ 0.8158 \pm 0.0148 \\ 0.0776 \pm 0.0036 \\ 0.4354 \pm 0.0076 \\ 0.348 \pm 0.0076 \\ 0.348 \pm 0.0077 \\ 514.7695 \pm 7.9.1941 \\ 0.6256 \pm 0.0879 \\ 0.4891 \pm 0.0072 \\ \end{array}$	$\begin{array}{r} 3.323 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS} [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ \hline 532.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0959\\ \hline 0.4882 \pm 0.0099\\ \hline 0.4882 \pm 0.0099\\ \hline \end{array}$
$\begin{array}{c} \text{LSSRI}\\ \text{TWI}\\ \hline\\ \text{Doni1}\\ \hline\\ \text{MRI}\\ \text{GPI}\\ \text{BHGI}\\ \text{CI}\\ \text{CI}\\ \text{TI}\\ \text{CI}\\ \text{CI}\\ \text{RII}\\ \text{CHI}\\ \text{RII}\\ \text{WGI}\\ \hline\\ \text{DI}\\ \hline\\ \end{array}$	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline \\ \hline$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS \left[ 20 \right] \\ \hline 0.0701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.08085 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.013 \\ 0.4845 \pm 0.013 \\ 0.0016 \pm 0.0012 \\ \end{array}$	$\begin{array}{c} 3.772\pm0.0228\\ 1.0165\pm0.0228\\ \hline GRASP-VND [20]\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005 \end{array}$	$\begin{array}{c} 3.540\pm0.223\\ 1.007\pm0.223\\ \hline 0.026\pm0.0057\\ 0.0268\pm0.0007\\ 0.0268\pm0.002\\ 0.8114\pm0.0151\\ 0.0788\pm0.0037\\ 0.4327\pm0.0093\\ 0.0241\pm0.0062\\ 0.3454\pm0.0069\\ 524.7544\pm71.9468\\ 0.6164\pm0.0897\\ 0.4907\pm0.0041\\ 0.0033\pm0.0004 \end{array}$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.0540\pm 0.00117\\ \hline 1VNS [21]\\ \hline 0.3657\pm 0.005\\ 0.0261\pm 0.0018\\ \hline 0.0773\pm 0.0033\\ \hline 0.0773\pm 0.0033\\ \hline 0.0731\pm 0.0033\\ \hline 0.0731\pm 0.0033\\ \hline 0.0241\pm 0.0085\\ \hline 510.0968\pm 7.49872\\ 0.6284\pm 0.00854\\ \hline 0.4887\pm 0.0027\\ \hline 0.0034\pm 0.00061\\ \hline \end{array}$	$\begin{array}{c} 3.9760\pm0.0158\\ 0.9860\pm0.0158\\ \hline 0.9860\pm0.0158\\ \hline 0.0257\pm0.0019\\ 0.0257\pm0.0019\\ 0.0165\pm0.00147\\ 0.0768\pm0.0035\\ 0.4376\pm0.0092\\ 0.0226\pm0.0076\\ 3.3415\pm0.0073\\ 489.8569\pm0.0904\\ 0.4895\pm0.0022\\ 0.0022\pm0.0022\\ \end{array}$	$\begin{array}{c} 3.9711\pm 0.0227\\ 0.9924\pm 0.0278\\ \hline SGVNS [25]\\ 0.3662\pm 0.0013\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.0245\pm 0.0076\\ \hline 0.3438\pm 0.0077\\ 514.7695\pm 79.1941\\ 0.6256\pm 0.0879\\ 0.4891\pm 0.0027\\ 0.0024\pm 0.0077\\ \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0099\\ \hline 0.3462 \pm 0.0079\\ \underline{532,1621 \pm 91,2768}\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.0036 \pm 0.0009\end{array}$
$\begin{array}{c} \text{LSSRI}\\ \text{TWI}\\ \text{TWI}\\ \hline\\ \text{Donil}\\ \text{MRI}\\ \text{GPI}\\ \text{BHGI}\\ \text{CI}\\ \text{BHGI}\\ \text{CI}\\ \text{CI}\\ \text{CII}\\ \text{CII}\\ \text{RII}\\ \text{CHI}\\ \text{RII}\\ \text{CHI}\\ \text{RII}\\ \text{BHI}\\ \text{BHI}\\ \end{array}$	4.0156 ± 0.0106 0.9522 ± 0.0098 CNO-CC 0.3972 ± 0.0030 0.0335 ± 0.0006 0.7605 ± 0.0045 0.0971 ± 0.0018 0.4025 ± 0.0026 0.131 ± 0.0098 0.3033 ± 0.0098 0.3033 ± 0.0098 0.3033 ± 0.0005 580.2544 ± 6.2335 0.482 ± 0.0336 0.0015 ± 0.0011 5.9131 ± 0.0761 0.0166 ± 0.0001	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0805 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0098 \\ 0.3449 \pm 0.0098 \\ 1.46513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0015 \pm 0.0714 \\ 0.0015 \pm 0.0013 \\ 0.0015 \pm 0.$	$\begin{array}{c} 3.7472\pm0.0228\\ 1.0165\pm0.0228\\ \hline \textbf{GRASP-VND} \ [20]\\ \hline \textbf{O}.3703\pm0.0069\\ 0.0274\pm0.0022\\ 0.8072\pm0.0165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0045\\ 0.0481\pm0.0079\\ 0.257.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5536\pm0.7249\\ 0.0151\pm0.0037\\ 0.0151\pm0.003$	$\begin{array}{c} 3.5949 \pm 0.0233\\ 1.0007 \pm 0.0233\\ \hline 0.0056 \pm 0.0057\\ 0.0268 \pm 0.00057\\ 0.0268 \pm 0.00057\\ 0.0268 \pm 0.00057\\ 0.0268 \pm 0.00057\\ 0.0268 \pm 0.0007\\ 0.0788 \pm 0.0007\\ 0.0241 \pm 0.0093\\ 0.0241 \pm 0.0093\\ 0.0241 \pm 0.0069\\ 0.3454 \pm 0.0069\\ 0.3454 \pm 0.0093\\ 0.0241 \pm 0.0006\\ 0.355527 \pm 0.0003\\ 0.0031 \pm 0.0004\\ 0.0033 \pm 0.0006\\ 5.5527 \pm 0.6696\\ 0.015 \pm 0.0031\\ \end{array}$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.9540 \pm 0.00117\\ \hline IVNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0773 \pm 0.0038\\ \hline 0.0773 \pm 0.0038\\ \hline 0.0773 \pm 0.0038\\ \hline 0.0734 \pm 0.0088\\ \hline 0.0241 \pm 0.0081\\ \hline 0.0434 \pm 0.0068\\ \hline 510.0968 \pm 74.9872\\ \hline 0.0284 \pm 0.0084\\ \hline 0.0284 \pm 0.0084\\ \hline 0.0344 \pm 0.0084\\ \hline 0.0344 \pm 0.0084\\ \hline 0.0344 \pm 0.0086\\ \hline 5.5409 \pm 0.7499\\ \hline 0.0158 \pm 0.0023\\ \hline \end{array}$	$\begin{array}{c} 3.9765\pm0.0158\\ 0.9860\pm0.0158\\ \hline 0.9860\pm0.0158\\ \hline 0.9805\pm0.0053\\ 0.0257\pm0.0019\\ 0.8195\pm0.0147\\ 0.0768\pm0.0035\\ 0.4376\pm0.0092\\ 0.0226\pm0.0073\\ 0.3415\pm0.0073\\ 489.8569\pm80.0607\\ 0.659\pm0.0092\\ 0.00226\pm0.0007\\ 5.2615\pm0.0077\\ 0.0157\pm0.0022\\ \end{array}$	$\begin{array}{c} 3.9717\pm0.0272\\ 0.9924\pm0.0268\\ \hline SGVNS [25]\\ \hline 0.3662\pm0.0053\\ 0.0262\pm0.0019\\ 0.8158\pm0.0148\\ 0.0776\pm0.0036\\ 0.4354\pm0.0093\\ 0.0245\pm0.0072\\ 514.7695\pm79.1941\\ 0.6256\pm0.0879\\ 0.4891\pm0.0027\\ 0.0034\pm0.0007\\ 5.5540\pm0.07614\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.0156\pm0.0031\\ 0.00314\pm0.0003\\ 0.0156\pm0.0031\\ 0.00314\pm0.0003\\ 0.0156\pm0.0031\\ 0.00314\pm0.0003\\ 0.0156\pm0.0031\\ 0.00314\pm0.0003\\ 0.0034\pm0.0034\\ 0.0034\pm0.0003\\ 0.0034\pm0.0003\\ 0.0034\pm0.0003\\ $	0.0278 ± 0.0127           1.0278 ± 0.0127           NDVNS [26]           0.3694 ± 0.0065           0.0272 ± 0.0022           0.8085 ± 0.0167           0.0796 ± 0.0043           0.4312 ± 0.0104           0.026 ± 0.0079           532.1621 ± 91.2768           0.5999 ± 0.0059           0.4682 ± 0.0099           0.0036 ± 0.0099           0.0036 ± 0.0099           0.015 ± 0.0039           0.015 ± 0.0039           0.015 ± 0.0039           0.015 ± 0.0039           0.015 ± 0.0039
$\begin{array}{c} \text{LSSKI}_{ }\\ \hline \text{TWI}_{\downarrow}\\ \hline \text{Donil}\\ \hline \text{GPI}_{\downarrow}\\ \text{BHGI}^{\uparrow}\\ \text{CI}_{\downarrow}\\ \text{CI}_{\downarrow}\\ \text{TI}^{\uparrow}\\ \text{RLI}^{\uparrow}\\ \text{CHI}^{\uparrow}\\ \text{RII}^{\uparrow}\\ \text{BHI}^{\uparrow}\\ \hline \text{BHI}^{\uparrow}\\ \end{array}$	$\begin{array}{c} \textbf{4.0156} \pm 0.0106\\ \textbf{0.9522} \pm 0.0098\\ \hline \textbf{CNO-CC}\\ \hline \textbf{0.3972} \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0018\\ 0.4025 \pm 0.0026\\ \textbf{0.1013} \pm 0.0098\\ \textbf{0.303} \pm 0.0098\\ \textbf{0.303} \pm 0.0098\\ \textbf{0.303} \pm 0.0005\\ \textbf{580.2544} \pm 6.2935\\ \textbf{0.5811} \pm 0.0236\\ 0.0015 \pm 0.0011\\ \textbf{5.9131} \pm 0.0761\\ 0.0105 \pm 0.0001\\ 0.0106 \pm 0.0001\\ 0.0218 \pm 0.0001\\ \end{array}$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1796 \\ \hline \\ \mbox{TS} \ [20] \\ \hline \\ \mbox{TS} \ [20] \\ 0.073 \pm 0.0018 \\ 0.0034 \pm 0.0040 \\ 0.4314 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 0.113 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.6085 \pm 0.0733 \\ 0.6085 \pm 0.0733 \\ 0.0016 \pm 0.0012 \\ 5.6667 \pm 0.6746 \\ 0.0152 \pm 0.0027 \\ 0.0247 \pm 0.0027 \\ 0.0047 \pm 0.0028 \\ 0.0047 \pm 0.0048 \\ 0.0047 \pm 0.0048 \\ 0.0047 \pm 0.0048 \\ 0.0048 \pm 0.0048$	$\begin{array}{c} 3.742\pm0.0228\\ 1.0165\pm0.0228\\ \hline \text{GRASP-VND} \ [20]\\ \hline 0.3703\pm0.0069\\ 0.0274\pm0.0062\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.8895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5635\pm0.7249\\ 0.0151\pm0.0037\\ 0.003\pm0.0015\\ 0.0037\\ 0.0038\pm0.0011\\ \end{array}$	$\begin{array}{c} 3.540\pm0.223\\ 1.007\pm0.223\\ \hline \\ 1.007\pm0.238\\ \hline \\ \hline \\ GRASP-VND-TS [20]\\ \hline \\ 0.268\pm0.002\\ 0.8114\pm0.0151\\ 0.0788\pm0.0037\\ 0.4327\pm0.0093\\ 0.4327\pm0.0093\\ 0.4327\pm0.0093\\ 0.4327\pm0.0093\\ 0.4327\pm0.0093\\ 0.4324\pm0.0062\\ 0.3454\pm0.0089\\ \hline \\ 0.4907\pm0.0041\\ 0.003\pm0.0006\\ 5.5627\pm0.6696\\ 0.015\pm0.0031\\ 0.0248\pm0.0015\\ \hline \end{array}$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.9540 \pm 0.0117\\ \hline IVNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.073 \pm 0.0033\\ 0.4361 \pm 0.0086\\ \hline 0.0241 \pm 0.0078\\ \hline 0.0241 \pm 0.0078\\ \hline 0.0241 \pm 0.0078\\ \hline 0.0268 \pm 0.0086\\ \hline 0.0241 \pm 0.0086\\ \hline 0.0268 \pm 0.0044\\ \hline 0.0006\\ \hline 0.0258 \pm 0.0014\\ \hline 0.0258 \pm 0.0014\\ \hline 0.0258 \pm 0.0014\\ \hline 0.0058 \pm 0.0014\\ \hline 0.0258 \pm 0.0014\\ \hline 0.0058 \pm 0$	$\begin{array}{c} 3.9765\pm0.0153\\ 0.9860\pm0.0158\\ \hline \text{GVNS} [25]\\ 0.0257\pm0.0015\\ 0.0257\pm0.0019\\ 0.8195\pm0.0147\\ 0.0768\pm0.0032\\ 0.04376\pm0.0092\\ 0.0226\pm0.0076\\ 0.3415\pm0.0073\\ 489.8569\pm8.00607\\ 0.659\pm0.0092\\ 0.0032\pm0.0007\\ 5.2615\pm0.077\\ 0.0167\pm0.0034\\ 0.025\pm0.0011\\ \end{array}$	$\begin{array}{c} 3.9717\pm0.2272\\ 0.9924\pm0.0268\\ \hline SGVNS\ [25]\\ \hline 0.3662\pm0.0053\\ 0.0262\pm0.0019\\ 0.8158\pm0.0148\\ 0.0776\pm0.0036\\ 0.4354\pm0.0076\\ 0.4354\pm0.0076\\ 0.3438\pm0.0072\\ 514.7695\pm79.1941\\ 0.6256\pm0.0879\\ 0.4891\pm0.0027\\ 0.0034\pm0.0027\\ 0.0034\pm0.0007\\ 0.0034\pm0.0003\\ 0.0034\pm0.$	$\begin{array}{c} 0.1528 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \textbf{NDVNS} [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \textbf{0.0268} \pm 0.0089\\ 0.3462 \pm 0.0079\\ \hline 552.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0959\\ \hline 0.4882 \pm 0.0099\\ \hline 0.4882 \pm 0.0099\\ \hline 0.0364 \pm 0.7409\\ 0.0054 \pm 0.7409\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ \hline \end{array}$
$\begin{array}{c} LSSKI \\ TWI \downarrow \\ \hline Donil \\ \hline MRI \downarrow \\ GPI \downarrow \\ BHGI \uparrow \\ CI \downarrow \\ TI \uparrow \\ DGI \uparrow \\ RLI \uparrow \\ CHI \uparrow \\ RTI \downarrow \\ WGI \uparrow \\ DI \uparrow \\ TWBI \uparrow \\ BHI \uparrow \\ XBI \downarrow \\ DPDI \uparrow \\ \end{array}$	4.0156 ± 0.0106 0.9522 ± 0.0098 CNO-CC 0.3972 ± 0.0030 0.0335 ± 0.0006 0.7605 ± 0.0045 0.0971 ± 0.0018 0.4025 ± 0.0026 0.0131 ± 0.0098 0.3603 ± 0.0005 580.2544 ± 6.2335 0.5811 ± 0.0243 0.482 ± 0.0036 0.0015 ± 0.0011 5.9131 ± 0.0761 0.0106 ± 0.0001 0.0166 ± 0.0001 0.2183.0483 ± 20106.9153	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1796 \\ \hline TS \ [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0080 \pm 0.00133 \\ 0.0800 \pm 0.00400 \\ 0.4314 \pm 0.009 \\ 0.4314 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0016 \pm 0.0012 \\ 5.6667 \pm 0.6734 \\ \hline 0.0152 \pm 0.0027 \\ 0.0247 \pm 0.0027 \\ 0.0047 \pm 0.0047 \\ 0.00$	$\begin{array}{c} 3.742\pm0.0228\\ 1.0165\pm0.0228\\ \hline \textbf{GRASP-VND} \ [20]\\ \hline 0.3703\pm0.0069\\ 0.0274\pm0.0062\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.8895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.0724\\ 0.00151\pm0.0037\\ 0.023\pm0.00151\\ 1\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399 \end{array}$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline 0.0057 \pm 0.0233 \\ \hline 0.368 \pm 0.0057 \\ 0.0268 \pm 0.002 \\ 0.0151 \pm 0.0037 \\ 0.0271 \pm 0.0093 \\ 0.02241 \pm 0.0062 \\ 0.3454 \pm 0.0062 \\ 0.3454 \pm 0.0097 \pm 0.0041 \\ 0.0033 \pm 0.0006 \\ 5.5627 \pm 0.6696 \\ 0.015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 1275.047 \pm 432.8792 \\ \hline 0.5031 \\ 0.0284 \\ 0.015 \\ 0.0284 \\ 0.015 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0031 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0031 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0284 \\ 0.0015 \\ 0.0031 \\ 0.0284 \\ 0.0015 \\ 0.0031 \\ 0.0284 \\ 0.0015 \\ 0.0031 \\ 0.0084 \\ 0.0015 \\ 0.0031 \\ 0.0284 \\ 0.0015 \\ 0.0031 \\ 0.0084 \\ 0.0015 \\$	$\begin{array}{c} 4.0117 \pm 0.0123 \\ 0.9540 \pm 0.0117 \\ \hline 1VNS [21] \\ \hline 0.3657 \pm 0.005 \\ 0.0261 \pm 0.0018 \\ 0.073 \pm 0.0038 \\ 0.073 \pm 0.0038 \\ 0.073 \pm 0.0038 \\ 0.0241 \pm 0.0036 \\ 0.0241 \pm 0.0086 \\ 0.0241 \pm 0.0086 \\ 0.0241 \pm 0.0086 \\ 0.0241 \pm 0.0086 \\ 0.0343 \pm 0.0068 \\ 510.0968 \pm 74.9872 \\ 0.0628 \pm 0.00854 \\ 0.034 \pm 0.0068 \\ 0.034 \pm 0.0068 \\ 0.034 \pm 0.0027 \\ 0.0034 \pm 0.0026 \\ 0.0158 \pm 0.0129 \\ 0.0158 \pm 0.0149 \\ 0.0158 \pm 0.0149 \\ 0.0158 \pm 0.0149 \\ 0.0158 \pm 0.0014 \\ 0.0255 \pm 0.0014 \\ 0$	$\begin{array}{c} 0.9860\pm0.0153\\ 0.9860\pm0.0158\\ \hline \text{GVNS}\ [25]\\ 0.0257\pm0.0013\\ 0.0257\pm0.0019\\ 0.8195\pm0.0147\\ 0.0768\pm0.0035\\ 0.4376\pm0.0092\\ 0.0226\pm0.0076\\ 0.3415\pm0.0073\\ 489.8569\pm80.0607\\ 0.659\pm0.0007\\ 0.659\pm0.0007\\ 5.2615\pm0.0071\\ 5.2615\pm0.0071\\ 0.0032\pm0.00034\\ 0.0032\pm0.00034\\ 0.0032\pm0.00034\\ 0.0032\pm0.00034\\ 0.0032\pm0.00034\\ 0.0032\pm0.00034\\ 0.0035\pm0.0001\\ 1260\pm0.0034\\ 0.0035\pm0.0011\\ 1260\pm0.0035\\ 0.0034\\ 0.0035\pm0.0011\\ 0.0034\pm0.0034\\ 0.0035\pm0.0001\\ 0.0034\pm0.0034\\ 0.0035\pm0.0001\\ 0.0034\pm0.0034\\ 0.0035\pm0.0001\\ 0.0034\pm0.0034\\ 0.0035\pm0.0001\\ 0.0034\pm0.0034\\ 0.0035\pm0.0001\\ 0.0034\pm0.0034\\ 0.0035\pm0.0001\\ 0.0034\pm0.0034\\ 0.0035\pm0.0003\\ 0.0035\pm0.0003\\ 0.0034\pm0.0034\\ 0.0035\pm0.0003\\ 0.0034\pm0.0034\\ 0.0035\pm0.0003\\ 0.0035\pm0.0003\\ 0.0034\pm0.0034\\ 0.0035\pm0.0003\\ 0.0035\pm0.0003\\ 0.0034\pm0.0034\\ 0.0035\pm0.0003\\ 0.003\pm0.0003\\ 0.003\pm0.0003\\ 0.003\pm0.0003\\ 0.0003\pm0000\\ 0.003\pm$	$\begin{array}{c} 3.9717 \pm 0.0272 \\ 0.9924 \pm 0.0268 \\ \hline SGVNS [25] \\ \hline 0.3662 \pm 0.0053 \\ 0.0262 \pm 0.0019 \\ 0.0262 \pm 0.0019 \\ 0.0263 \pm 0.0018 \\ 0.0776 \pm 0.0036 \\ 0.4354 \pm 0.0076 \\ 0.4354 \pm 0.0076 \\ 0.3438 \pm 0.0072 \\ 514.7695 \pm 79.1941 \\ 0.6256 \pm 0.0879 \\ 0.4891 \pm 0.0027 \\ 0.0034 \pm 0.0007 \\ 5.5540 \pm 0.7614 \\ 0.0156 \pm 0.0034 \\ 0.0033 \pm 0.0011 \\ 10.0156 \pm 0.0034 \\ 0.0034 \pm 0.0017 \\ 5.5540 \pm 0.7614 \\ 0.0156 \pm 0.0034 \\ 0.0034 \pm 0.0017 \\ 0.0156 \pm 0.0034 \\ 0.0034 \pm 0.0017 \\ 0.0253 \pm 0.0014 \\ 0.0034 \pm 0.0017 \\ 0.$	$\begin{array}{r} 0.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline NDVNS [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ \hline 532.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0959\\ 0.0036 \pm 0.0099\\ 0.0036 \pm 0.0099\\ 0.0036 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.015\\ 1116.3151 \pm 306.0384\\ 0.0561 \pm 0.015 \\ \end{array}$
$\begin{array}{c} LSSKI \\ TWI \downarrow \\ \hline \\ Donil \\ \hline \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ $	$\begin{array}{c} 4.0156 \pm 0.010166\\ 0.9522 \pm 0.0008\\ \hline \\ \hline$	$\begin{array}{c} 3.7130 \pm 0.1352\\ 1.2860 \pm 0.1352\\ 1.2800 \pm 0.1796\\ \hline TS \left[ 20 \right] \\ 0.3701 \pm 0.0064\\ 0.0273 \pm 0.0018\\ 0.0085 \pm 0.0133\\ 0.0800 \pm 0.0040\\ 0.4314 \pm 0.008\\ 0.0113 \pm 0.009\\ 0.3449 \pm 0.0058\\ 514.6513 \pm 64.2013\\ 0.0685 \pm 0.01733\\ 0.0485 \pm 0.012\\ 5.6667 \pm 0.6734\\ 0.0152 \pm 0.0027\\ 0.0247 \pm 0.0027\\ 0.0247 \pm 0.0027\\ 0.0247 \pm 0.0027\\ 1.0726 \pm 1.9698\\ 1.35595 \pm 1.9698 \\ \end{array}$	$\begin{array}{c} 3.712\pm0.0228\\ 1.0165\pm0.0228\\ \hline \textbf{GRASP-VND}\ [20]\\ \hline \textbf{ORASP-VND}\ [20]\\ \hline \textbf{ORASP-VND}\ [20]\\ 0.0274\pm0.0069\\ 0.0274\pm0.0065\\ 0.0801\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 525.7927\pm90.9895\\ 525.7927\pm90.9895\\ 5.5636\pm0.0005\\ 5.5636\pm0.0005\\ 5.5636\pm0.0005\\ 0.0015\pm0.0003\\ 0.0015\pm0.0003\\ 0.0015\pm0.0003\\ 0.0015\pm0.0003\\ 0.0015\pm0.0004\\ 153.4854\pm515.7399\\ 1.0625\pm0.1622\\ 13.7298\pm2.8103\\ \end{array}$	$\begin{array}{c} 3.540\pm0.223\\ 1.0007\pm0.023\\ \hline 0.0056\pm0.0057\\ 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0788\pm0.0037\\ 0.4327\pm0.0093\\ 0.0241\pm0.0069\\ 5.24,7544\pm71.9468\\ 5.0037\pm0.0069\\ 5.24,7544\pm71.9468\\ 0.003\pm0.0069\\ 5.24,7544\pm71.9468\\ 0.003\pm0.0006\\ 5.5627\pm0.6696\\ 0.015\pm0.0031\\ 0.0248\pm0.0015\\ 1.275.047\pm432.8792\\ 1.0501\pm0.1291\\ 1.35771\pm2.3868\end{array}$	$\begin{array}{c} 4.0117 \pm 0.0125\\ 0.0540 \pm 0.0117\\ \hline IVNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ 0.073 \pm 0.0038\\ 0.0773 \pm 0.0038\\ 0.0773 \pm 0.0038\\ 0.073 \pm 0.0038\\ 0.0241 \pm 0.0038\\ 0.0241 \pm 0.0038\\ 0.0241 \pm 0.0086\\ 510.0968 \pm 74.9872\\ 0.6284 \pm 0.0086\\ 510.0968 \pm 74.9872\\ 0.0343 \pm 0.0068\\ 510.0968 \pm 0.0027\\ 0.0034 \pm 0.00$	$\begin{array}{c} 3.9760\pm0.0158\\ 0.9860\pm0.0158\\ \hline 0.9860\pm0.0158\\ \hline 0.9860\pm0.0158\\ \hline 0.0257\pm0.00053\\ 0.0257\pm0.00053\\ 0.0256\pm0.00147\\ 0.0768\pm0.00052\\ 0.0226\pm0.0076\\ 0.3415\pm0.0073\\ 489.8569\pm80.06073\\ -0.032\pm0.0007\\ 0.3415\pm0.0073\\ -0.0025\pm0.0007\\ 5.2615\pm0.77\\ 0.0167\pm0.0003\\ 0.0025\pm0.00011\\ 1260.0305\pm305.6108\\ 1.1265\pm0.51212\\ 12.4065\pm2.6831\\ \hline 0.22121\\ 12.4065\pm2.6831\\ \hline 0.00158\\ 0.00158\\ -0.00158\\ -0.001168\\ $	$\begin{array}{c} 3.9111\pm 0.0227\\ 0.9924\pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662\pm 0.0053\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.0245\pm 0.0076\\ \hline 0.3438\pm 0.0077\\ \hline 0.3438\pm 0.0077\\ \hline 1514,7695\pm 79,1941\\ 0.0025\pm 0.0077\\ 0.4891\pm 0.0027\\ 0.35340\pm 0.7614\\ 0.00156\pm 0.0034\\ 0.0015\pm 0.0014\\ 0.0015\pm 0.$	$\begin{array}{c} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \textbf{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0099\\ 0.3462 \pm 0.0079\\ \hline 522.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0959\\ \hline 0.4882 \pm 0.0097\\ 0.6184 \pm 0.7409\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 1116.3151 \pm .306.0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ \hline \end{array}$
LSSKI TWIL Donil MRIL GPL BHGIT CIL TIC RLI CHIT RLI CHIT RTIL WGI MIT BHIT DBIT DBIL DBIL DBIL DBIL DBIL CHIT CHIT CHIT CHIT CHIT CHIT CHIT CHIT	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0033 \pm 0.0098\\ 0.131 \pm 0.0098\\ 0.503 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.0238\\ 0.482 \pm 0.0036\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0166 \pm 0.0007\\ 21583 0.483 \pm 20106 9153\\ 0.0933 \pm 0.0083\\ 15.0016 \pm 0.2518\\ 977.5146 \pm 16.282\\ 977.$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1796 \\ \hline TS \left[ 20 \right] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0085 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0015 \pm 0.0025 \\ 24048432 \pm 0.0025 \\ 24048432 \pm 36881.8857 \\ 1.3.5595 \pm 1.9698 \\ 1104.4573 \pm 1.70.5992 \\ \hline \end{array}$	$\begin{array}{c} 3.7472\pm0.00228\\ 1.0165\pm0.0228\\ \hline \textbf{GRASP-VND}\ [20]\\ \hline \textbf{ORASP-VND}\ [20]\\ \hline \textbf{ORASP-VND}\ [20]\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.3405\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm9.09895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0014\ 1634.3854\pm515.7399\\ 1.0625\pm0.1622\\ 13.7288\pm2.8103\\ 1113.2937\pm235.4821\\ \hline \end{array}$	$\begin{array}{c} 3.540\pm0.223\\ 1.007\pm0.223\\ 1.007\pm0.223\\ \hline \\ \hline$	$\begin{array}{c} 4.0117\pm 0.0125\\ 0.0540\pm 0.00117\\ \hline 1VNS\ [21]\\ \hline 0.3657\pm 0.005\\ 0.0261\pm 0.0018\\ \hline 0.077\pm 0.0138\\ \hline 0.077\pm 0.0138\\ \hline 0.077\pm 0.0033\\ \hline 0.0361\pm 0.0033\\ \hline 0.0361\pm 0.0033\\ \hline 0.0341\pm 0.0085\\ 510.0068\pm 74.9872\\ \hline 0.0284\pm 0.0084\\ \hline 0.0285\pm 0.0021\\ \hline 0.0255\pm 0.0014\\ \hline 1149.9033\pm 297.29\\ \hline 11029\pm 0.1134\\ \hline 3.1675\pm 2.5270\\ \hline 1155.9904\pm 224.468\\ \hline \end{array}$	$\begin{array}{c} 3.9765\pm0.0153\\ 0.9860\pm0.0158\\ \hline 0.9860\pm0.0158\\ \hline 0.9860\pm0.0158\\ \hline 0.9860\pm0.0053\\ 0.0257\pm0.0019\\ 0.0257\pm0.0019\\ 0.0768\pm0.0035\\ 0.4376\pm0.0092\\ 0.0226\pm0.0076\\ 0.3415\pm0.0073\\ 489.8569\pm0.0092\\ 0.0639\pm0.0092\\ 0.0639\pm0.0092\\ 0.0639\pm0.0092\\ 0.0639\pm0.0092\\ 0.0639\pm0.0092\\ 0.0639\pm0.0092\\ 0.0022\pm0.0007\\ 5.2615\pm0.77\\ 0.0167\pm0.0034\\ 0.025\pm0.0011\\ 1260\pm0.305\pm305.6108\\ 1.1265\pm0.53594\\ 1229.4842\pm225.5594\\ \end{array}$	$\begin{array}{c} 3.9717\pm0.2272\\ 0.9924\pm0.0268\\ \hline SGVNS\ [25]\\ \hline 0.3662\pm0.0053\\ 0.0262\pm0.0019\\ 0.8158\pm0.0148\\ 0.0776\pm0.0036\\ 0.4354\pm0.0093\\ 0.0245\pm0.0076\\ \hline 0.3438\pm0.0072\\ 514.7695\pm79.1941\\ 0.6256\pm0.0879\\ 0.4891\pm0.0027\\ 0.0034\pm0.0007\\ 5.5540\pm0.7614\\ 0.0156\pm0.0034\\ 0.0253\pm0.0014\\ 1160.1052\pm299.5600\\ 1.0937\pm0.1214\\ 13.2967\pm2.6439\\ 1146.0090\pm2.31.6428\\ \end{array}$	$\begin{array}{r} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline NDVNS [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0099\\ \hline 0.3462 \pm 0.0079\\ \hline 532.1621 \pm 91.2768\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ 1094.1964 \pm 2.38.0447\end{array}$
LSSRI TWIL BHGIT BHGIT CLI TIT DGIT RLIT CHIT CHIT BHIT BHIT BHIT DBIL DBIL DBIL DBIL DBIL LDRIT LSSRI	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline \\ \hline \\ CNO-CC\\ \hline \\ 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3032 \pm 0.0005\\ \hline \\ 0.0313 \pm 0.0098\\ 0.3032 \pm 0.0001\\ \hline \\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.0248\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0106 \pm 0.0017\\ 0.0106 \pm 0.0007\\ 1.0007\\ $	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0805 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0098 \\ 0.0113 \pm 0.0098 \\ 0.04845 \pm 0.013 \\ 0.0685 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0068 \pm 0.0713 \\ 0.0247 \pm 0.0025 \\ 24404.8432 \pm 36881.8857 \\ 1.0726 \pm 0.0325 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 1.0998 \\ 1104.4573 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 0.9437 \pm 0.125 \end{array}$	$\begin{array}{c} 3.7472\pm0.0228\\ 1.0165\pm0.0228\\ \hline \textbf{GRASP-VND} \ [20]\\ \hline \textbf{O}, 3703\pm0.0069\\ 0.0274\pm0.0062\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3438\pm0.0079\\ 525,7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0038\pm0.0014\\ 1634.3854\pm5.15.7399\\ 1.00238\pm0.0014\\ 1634.3854\pm5.15.7399\\ 1.00238\pm0.0014\\ 113.2937\pm2.35.4821\\ 2598.9274\pm2.10.2179\\ 0.9822+0.1748\\ \end{array}$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline 0.0057 \pm 0.0233 \\ \hline 0.0368 \pm 0.0057 \\ 0.0268 \pm 0.0007 \\ 0.0268 \pm 0.0007 \\ 0.0268 \pm 0.0007 \\ 0.04327 \pm 0.0093 \\ 0.04327 \pm 0.0093 \\ 0.0241 \pm 0.0062 \\ 0.3454 \pm 0.0069 \\ 0.3454 \pm 0.0069 \\ 0.3454 \pm 0.0069 \\ 0.3454 \pm 0.0069 \\ 0.3454 \pm 0.00015 \\ 0.0031 \pm 0.0004 \\ 0.0015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 0.105 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 1275.047 \pm 432.8792 \\ 1.0501 \pm 0.129 \\ 114.6036 \pm 210.4013 \\ 2592.8983 \pm 183.0573 \\ 0.9615 \pm 0.1398 \\ 0.0915 \pm 0.0398 \\ 0.0915 \\ 0.0915 \\ 0.0915 \\ 0.0915 \\ 0.0915 \\ 0.0915 \\ 0.091$	$\begin{array}{c} 4.0117\pm 0.0125\\ 0.0540\pm 0.0117\\ \hline 1VNS\ [21]\\ \hline 0.3657\pm 0.005\\ 0.0261\pm 0.0018\\ \hline 0.0261\pm 0.0018\\ \hline 0.077\pm 0.0138\\ \hline 0.077\pm 0.0138\\ \hline 0.077\pm 0.0033\\ \hline 0.073\pm 0.0033\\ \hline 0.073\pm 0.0033\\ \hline 0.0241\pm 0.0078\\ \hline 0.0068\pm 74.9872\\ \hline 0.025\pm 0.0018\\ \hline 0.0058\pm 0.0058\\ \hline 0.025\pm 0.0012\\ \hline 0.0158\pm 0.0023\\ \hline 0.025\pm 0.0014\\ \hline 1.1029\pm 0.0134\\ \hline 1.153.9904\pm 224.468\\ 2559.9236\pm 1.94.6549\\ \hline 0.9321\pm 0.168\\ \hline 0.0148\\ \hline$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline 0.9860 \pm 0.0158\\ \hline 0.9860 \pm 0.0158\\ \hline 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0255 \pm 0.00147\\ 0.0768 \pm 0.0035\\ 0.4376 \pm 0.0092\\ 0.0226 \pm 0.0073\\ 0.3415 \pm 0.0022\\ 0.0032 \pm 0.0007\\ 5.2615 \pm 0.777\\ 0.0167 \pm 0.0021\\ 0.0035 \pm 0.0011\\ 1260.0305 \pm 305.6108\\ 1.1265 \pm 0.1212\\ 1229.8482 \pm 235.5594\\ 2497.4316 \pm 205.5728\\ 0.8899 \pm 0.155\end{array}$	$\begin{array}{c} 3.9111 \pm 0.0227\\ 0.9924 \pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0093\\ 0.0245 \pm 0.0076\\ 0.3438 \pm 0.0072\\ 514.7695 \pm 79.1941\\ 0.6256 \pm 0.0879\\ 0.4891 \pm 0.0027\\ 0.0034 \pm 0.0007\\ 5.5540 \pm 0.07614\\ 0.0156 \pm 0.0034\\ 0.0155 \pm 0.0014\\ 1160.1052 \pm 299.5600\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 1146.0096 \pm 231.6428\\ 2568.2981 \pm 202.2223\\ 0.9402 \pm 0.1533\\ \end{array}$	$\begin{array}{r} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline NDVNS [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ \hline 0.3462 \pm 0.0079\\ \hline 532.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0959\\ \hline 0.4882 \pm 0.0099\\ \hline 0.0056 \pm 0.0093\\ \hline 0.0056 \pm 0.0038\\ 0.0241 \pm 0.0015\\ \hline 1116.3151 \pm 30.0384\\ \hline 1.0563 \pm 0.1488\\ \hline 1.3512 \pm 238.047\\ \hline 1094.1964 \pm 238.0447\\ \hline 2616.0463 \pm 212.5089\\ \hline 0.9704 + 0.1733\\ \hline \end{array}$
LSSKI TWIL Bonil MRIJ GPL1 BHG1↑ CLI TI↑ CHI↑ CHI↑ CHI↑ CHI↑ BHI↑ DG1↑ BHI↑ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ LSRI↑ LSRI↑ TWI↓	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.0335 \pm 0.0006\\ 0.0765 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3603 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.023\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0105 \pm 0.0011\\ 5.9131 \pm 0.00761\\ 0.0105 \pm 0.0011\\ 0.0218 \pm 0.0001\\ 0.0106 \pm 0.0218\\ 0.0001 \pm 0.0218\\ 0.0001 \pm 0.0011\\ 0.0106 \pm 0.0218\\ 0.0001 \pm 0.0218\\ 0.0001 \pm 0.0218\\ 0.0001 \pm 0.0011\\ 0.0106 \pm 0.0218\\ 0.0001 \pm 0.0218\\ 0.0001 \pm 0.0011\\ 0.0106 \pm 0.0218\\ 0.0001 \pm 0.0011\\ 0.0106 \pm 0.0218\\ 0.0001 \pm 0.0011\\ 0.0106 \pm 0.0011\\ 0.0106 \pm 0.0010\\ 0.0106 \pm 0.0010\\ 0.0101 \pm 0.0010\\ 0.0101 \pm 0.0011\\ 0.0101 \pm 0.0010\\ 0.0101 \pm 0.0001\\ 0.0101 \pm 0.0010\\ 0.0101 \pm 0.0001\\ 0.0011 \pm 0.0001\\ 0.$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1796 \\ \hline {\rm TS} \ [20] \\ \hline 0.0770 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0035 \pm 0.0013 \\ 0.0800 \pm 0.0040 \\ 0.04314 \pm 0.009 \\ 0.04314 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0016 \pm 0.0012 \\ 0.00152 \pm 0.0027 \\ 0.0247 \pm 0.0025 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 0.1255 \\ 1.4881 \pm 1.0373 \\ 1.4881 \pm 1.0373 \\ \end{array}$	$\begin{array}{l} 3.7472\pm0.0228\\ 1.0165\pm0.0228\\ \hline \textbf{GRASP-VND} \ [20]\\ \hline \textbf{O}, 3703\pm0.0069\\ 0.0274\pm0.0062\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3455\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\\ 0.0035\pm0.0015\\ 0.0037\\ 0.0035\pm0.0015\\ 1.0037\\ 0.0238\pm0.0015\\ 1.0037\\ 0.0238\pm0.0015\\ 1.0037\\ 1.0238\pm0.0014\\ 1.3854\pm5.15.7399\\ 1.0625\pm0.1622\\ 1.3.7298\pm2.8103\\ 1.132937\pm2.35.4821\\ 2598.9274\pm2.10.2179\\ 0.9582\pm0.1748\\ 1.3953\pm1.4334\\ \end{array}$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline 0.0058 \pm 0.0057 \\ 0.0268 \pm 0.0007 \\ 0.0268 \pm 0.002 \\ 0.0151 \pm 0.00151 \\ 0.0788 \pm 0.0037 \\ 0.0237 \pm 0.0093 \\ 0.04327 \pm 0.0093 \\ 0.04327 \pm 0.0093 \\ 0.04327 \pm 0.0093 \\ 0.0434 \pm 0.0062 \\ 0.0344 \pm 0.0062 \\ 0.0344 \pm 0.0061 \\ 0.0033 \pm 0.00041 \\ 0.0033 \pm 0.00041 \\ 0.0033 \pm 0.00041 \\ 0.0033 \pm 0.00015 \\ 0.015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 0.015 \pm 0.01398 \\ 11.3491 \pm 1.1519 \end{array}$	$\begin{array}{c} 4.0117\pm 0.012\\ 0.9540\pm 0.0117\\ \hline 1VNS\ [21]\\ \hline 0.3657\pm 0.005\\ 0.0261\pm 0.0018\\ \hline 0.0261\pm 0.0018\\ \hline 0.077\pm 0.0038\\ \hline 0.0201\pm 0.0086\\ \hline 0.018\pm 0.0026\\ \hline 0.0255\pm 0.0014\\ \hline 1149.9003\pm 227.29\\ \hline 1.1029\pm 0.01134\\ \hline 1153.9004\pm 224.468\\ 2559.9236\pm 1.94.6549\\ \hline 0.9221\pm 0.146\\ \hline 1.5937\pm 1.2042 \end{array}$	$\begin{array}{c} 0.9860\pm 0.0158\\ 0.9860\pm 0.0158\\ \hline 0.9860\pm 0.0158\\ \hline 0.9860\pm 0.0158\\ \hline 0.0257\pm 0.0019\\ 0.0257\pm 0.0019\\ 0.0257\pm 0.00147\\ 0.0768\pm 0.0032\\ 0.04376\pm 0.0092\\ 0.0226\pm 0.0076\\ 0.3415\pm 0.0073\\ 489.8569\pm 80.0607\\ 0.639\pm 0.0002\\ 0.04895\pm 0.0002\\ 0.04895\pm 0.0002\\ 0.0032\pm 0.0007\\ 5.2615\pm 0.0011\\ 0.035\pm 0.0013\\ 0.025\pm 0.0011\\ 1260.0305\pm 305.6108\\ 1.1265\pm 0.1514\\ 2497.4316\pm 205.5728\\ 0.8899\pm 0.1554\\ 11.9514\pm 1.2803\\ \hline 0.0514\pm 1.2803\\ \hline 0.0514\pm 1.2803\\ \hline 0.0514\pm 1.2803\\ \hline 0.0514\pm 1.2803\\ \hline 0.0015\pm 0.01554\\ \hline 0.001554\\ \hline 0.001554\\ \hline 0.01554\\ \hline 0.001554\\ \hline 0.000555\\ \hline 0.001554\\ \hline 0.000555\\ \hline 0.000555\\ \hline 0.000555\\ \hline 0.0005$	$\begin{array}{c} 3.9111\pm 0.0227\\ 0.992\pm 4\pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662\pm 0.0053\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.4354\pm 0.0072\\ 0.4354\pm 0.0076\\ 0.3438\pm 0.0072\\ 514.7695\pm 79.1941\\ 0.6256\pm 0.0879\\ 0.44891\pm 0.0027\\ 0.0034\pm 0.0007\\ 0.0034\pm 0.0007\\ 0.0034\pm 0.0007\\ 1.625540\pm 0.7614\\ 0.0156\pm 0.0034\\ 0.0233\pm 0.0014\\ 13.2967\pm 2.6439\\ 1146.0065\pm 231.6428\\ 2568.2981\pm 202.2223\\ 0.9402\pm 0.1533\\ 11.5305\pm 1.2613\\ \end{array}$	$\begin{array}{r} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \textbf{NDVNS} [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ \hline 0.3462 \pm 0.0079\\ \hline 0.4382 \pm 0.0079\\ \hline 0.4382 \pm 0.0079\\ \hline 0.4382 \pm 0.0099\\ \hline 0.4382 \pm 0.0099\\ \hline 0.4382 \pm 0.0099\\ \hline 0.0036 \pm 0.0039\\ \hline 0.0036 \pm 0.0039\\ \hline 0.0036 \pm 0.0039\\ \hline 0.015 \pm 0.0038\\ \hline 0.0241 \pm 0.0015\\ \hline 1116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ \hline 13.9822 \pm 2.8417\\ \hline 1094.1964 \pm 238.0447\\ \hline 2616.9463 \pm 212.5089\\ \hline 0.9704 \pm 0.1743\\ \hline 11.2956 \pm 1.4253\\ \hline \end{array}$
LSSRI           TWIL           MRIJ.           GPL           BHGI^           CIJ.           TI^           RLI.           CHI.           RTI.           CHI.           WGI^           DIT           PBMIT           DBIL	$\begin{array}{c} \textbf{4.0156} \pm 0.0106\\ \textbf{0.9522} \pm 0.0098\\ \textbf{CNO-CC}\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ \textbf{0.3603} \pm 0.0005\\ \textbf{580.2544} \pm 6.2935\\ \textbf{0.5811} \pm 0.0236\\ 0.0015 \pm 0.0016\\ 0.0015 \pm 0.0011\\ \textbf{5.9131} \pm 0.0016\\ \textbf{5.9131} \pm 0.0016\\ \textbf{5.9131} \pm 0.0016\\ \textbf{5.9131} \pm 0.0011\\ \textbf{5.9131} \pm 0.0010\\ \textbf{5.9131} \pm 0.0010\\ \textbf{5.9131} \pm 0.0001\\ \textbf{5.9131} \pm 0.0001\\ \textbf{5.9131} \pm 0.0002\\ \textbf{5.913}	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1796 \\ \hline \text{TS} \ [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0805 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0016 \pm 0.0012 \\ 5.6667 \pm 0.6746 \\ 0.0152 \pm 0.0027 \\ 0.0247 \pm 0.0025 \\ 1.0726 \pm 0.1325 \\ 1.0755 \pm 1.9698 \\ 1104.4573 \pm 1.70.5992 \\ 2596.6638 \pm 149.8041 \\ 1.09437 \pm 0.1255 \\ 11.4881 \pm 1.0373 \\ \hline \text{TS} \ [20] \end{array}$	$\begin{array}{l} 3.7472\pm0.0228\\ 1.0165\pm0.0228\\ \hline \text{GRASP-VND} \ [20]\\ \hline 0.3703\pm0.0069\\ 0.0274\pm0.0062\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0023\pm0.00151\\ 1.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0625\pm0.1622\\ 1.7298\pm2.8103\\ 1113.2937\pm235.4821\\ 22598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline \text{GRASP-VND} \ [20] \end{array}$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline 0.0057 \pm 0.0233 \\ \hline 0.0368 \pm 0.00057 \\ 0.0268 \pm 0.0002 \\ 0.03814 \pm 0.0151 \\ 0.0788 \pm 0.0037 \\ 0.04327 \pm 0.0093 \\ 0.4327 \pm 0.0093 \\ 0.04327 \pm 0.0093 \\ 0.0434 \pm 0.0062 \\ 0.3454 \pm 0.0069 \\ 5.24,7544 \pm 71,9468 \\ 0.0033 \pm 0.0006 \\ 5.5627 \pm 0.6094 \\ 0.0033 \pm 0.0006 \\ 5.5627 \pm 0.6094 \\ 0.0033 \pm 0.0006 \\ 5.5627 \pm 0.6094 \\ 0.0015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 0.015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 1255,047 \pm 432,8792 \\ 1.0501 \pm 0.1398 \\ 1114,6036 \pm 210,4013 \\ 2592,8983 \pm 183,0573 \\ 0.9615 \pm 0.1398 \\ 11.3491 \pm 1.1519 \\ \hline \text{GRASP-VND-TS} [20] \end{array}$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.9540 \pm 0.0117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.073 \pm 0.0033\\ 0.4751 \pm 0.0138\\ \hline 0.0773 \pm 0.0033\\ 0.4361 \pm 0.0086\\ \hline 0.0241 \pm 0.0078\\ 0.4361 \pm 0.0086\\ \hline 0.0241 \pm 0.0078\\ 0.4383 \pm 0.0088\\ \hline 0.0241 \pm 0.0078\\ 0.4887 \pm 0.0028\\ 0.6284 \pm 0.0084\\ 0.6284 \pm 0.0084\\ 0.6284 \pm 0.0084\\ 0.6284 \pm 0.0084\\ 0.6284 \pm 0.0032\\ 0.0188 \pm 0.0032\\ 0.0188 \pm 0.0032\\ 0.0188 \pm 0.0032\\ 0.0255 \pm 0.0014\\ 1149.0033 \pm 297.29\\ 0.0138 \pm 0.0032\\ 1.153.9904 \pm 224.468\\ 2.559.9236 \pm 194.6549\\ 0.9321 \pm 0.146\\ 11.593.791 \pm 1.2042\\ 1VNS [21]\\ \end{array}$	$\begin{array}{c} 3.9765 \pm 0.0153\\ 0.9860 \pm 0.0158\\ \hline 0.9860 \pm 0.0158\\ \hline 0.9860 \pm 0.0158\\ \hline 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.00147\\ 0.0768 \pm 0.0032\\ 0.04376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 80.0607\\ 0.659 \pm 0.0904\\ \hline 0.4895 \pm 0.0902\\ \hline 0.0032 \pm 0.0007\\ 5.2615 \pm 0.077\\ 0.0167 \pm 0.0034\\ 0.025 \pm 0.0011\\ 1260.0305 \pm 305.6108\\ 1.1265 \pm 0.021\\ 12.4065 \pm 2.6831\\ 1229.8482 \pm 235.5594\\ 2497.4316 \pm 205.5728\\ 0.8899 \pm 0.1554\\ 11.9514 \pm 1.2803\\ \hline GVNS [25] \end{array}$	$\begin{array}{c} 3.9111 \pm 0.0226\\ 0.9924 \pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0076\\ 0.4354 \pm 0.0076\\ 0.3438 \pm 0.0072\\ 514.7695 \pm 79.1941\\ 0.6256 \pm 0.0879\\ 0.4891 \pm 0.0027\\ 0.0034 \pm 0.00076\\ 0.0343 \pm 0.0076\\ 1.6256 \pm 0.0879\\ 0.4891 \pm 0.0027\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0007\\ 1.6256 \pm 0.0879\\ 0.4891 \pm 0.0027\\ 1.6256 \pm 0.083\\ 0.0156 \pm 0.0034\\ 0.0054 \pm 0.0034\\ 0.0054 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 13.2967 \pm 0.439\\ 1146.0096 \pm 231.6428\\ 2568.2981 \pm 202.2223\\ 0.9402 \pm 0.1533\\ 11.5305 \pm 1.2613\\ SGVNS [25] \end{array}$	$\begin{array}{c} 0.1528 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \text{NDVNS } [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0089\\ \hline 0.3462 \pm 0.0079\\ \hline 0.3462 \pm 0.0079\\ \hline 0.4612 \pm 0.0279\\ \hline 0.4882 \pm 0.0099\\ \hline 0.0354 \pm 0.0038\\ \hline 0.0241 \pm 0.0015\\ \hline 1116.3151 \pm 306.0384\\ \hline 1.0563 \pm 0.1485\\ \hline 13.9822 \pm 2.8417\\ \hline 1094.1964 \pm 238.0447\\ \hline 22616.9463 \pm 212.5089\\ \hline 0.9704 \pm 0.1743\\ \hline 11.2956 \pm 1.4253\\ \hline NDVNS [26]\\ \hline \end{array}$
LSSRI           TWIL           MRIJ.           GPL           BHGI↑           CI↓           TI↑           DGI↑           RIL↑           PBMI↑           DB↑           TWBI↑           BHI↑           PBMI↓           DB↑           DB↑           DB↑           DB↓           UDT24_010	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0035 \pm 0.0005\\ 580.2544 \pm 0.0236\\ 0.0013 \pm 0.0005\\ 580.2544 \pm 0.0236\\ 0.0013 \pm 0.0001\\ 580.2544 \pm 0.0233\\ 0.482 \pm 0.0036\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0106 \pm 0.0001\\ 0.0218 \pm 0.0007\\ 1.2530 4482 \pm 100.618\\ 1.5016 \pm 0.2518\\ 977.5146 \pm 1.6.232\\ 2708.0265 \pm 1.6.7196\\ 1.0711 \pm 0.0108\\ 1.0.4405 \pm 0.0842\\ CNO-CC\\ \hline 0.2857 \pm 0.0002\\ \hline \end{array}$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0035 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.0144 \pm 0.0085 \\ 0.013 \pm 64.2013 \\ 0.0085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0085 \pm 0.0073 \\ 0.0085 \pm 0.0073 \\ 0.0085 \pm 0.0073 \\ 0.0085 \pm 0.0073 \\ 0.0085 \pm 0.0013 \\ 0.0015 \pm 0.0012 \\ 0.0055 \pm 0.0027 \\ 1.00247 \pm 0.0025 \\ 1.0726 \pm 0.1325 \\ 1.3595 \pm 1.9698 \\ 1104.4573 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 0.9437 \pm 0.1255 \\ 1.4881 \pm 1.0373 \\ TS [20] \\ \hline 0.2904 \pm 0.0021 \\ \hline \end{array}$	$\begin{array}{c} 3.712\pm0.0228\\ 1.0165\pm0.0228\\ \hline \text{GRASP-VND}\ [20]\\ 0.3703\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.3405\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0625\pm0.1622\\ 13.7298\pm2.8103\\ 1113.2937\pm235.4821\\ 2598.9274\pm210.2178\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline \text{GRASP-VND}\ [20]\\ \hline 0.288\pm0.002\\ \hline \end{array}$	$\begin{array}{c} 3.540\pm0.223\\ 1.0007\pm0.0233\\ \hline 0.0051\pm0.0233\\ \hline 0.0268\pm0.00057\\ 0.0268\pm0.00057\\ 0.0268\pm0.00037\\ 0.0268\pm0.0003\\ 0.0241\pm0.00069\\ 0.0241\pm0.00069\\ 0.0241\pm0.00069\\ 524.7544\pm0.00069\\ 524.7544\pm0.00069\\ 524.7544\pm0.00069\\ 5.24.7544\pm0.00069\\ 0.015\pm0.0031\\ 0.0248\pm0.0015\\ 1.0501\pm0.01291\\ 1.35771\pm2.3868\\ 1114.6036\pm210.4013\\ 2592.8983\pm183.0573\\ 0.9615\pm0.1398\\ 11.4991\pm1.1519\\ \hline GRASP-VND-TS [20]\\ 0.2886\pm0.0021\\ \hline \end{array}$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.05404 \pm 0.00117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0371 \pm 0.0033\\ \hline 0.0371 \pm 0.0033\\ \hline 0.0341 \pm 0.0085\\ \hline 510.0968 \pm 74.9872\\ 0.6284 \pm 0.0854\\ \hline 0.0084 \pm 0.00854\\ \hline 0.0034 \pm 0.0005\\ \hline 5.409 \pm 0.0021\\ \hline 0.0034 \pm 0.0005\\ \hline 5.409 \pm 0.0021\\ \hline 0.0034 \pm 0.0005\\ \hline 5.409 \pm 0.0021\\ \hline 1.029 \pm 0.1134\\ \hline 0.0034 \pm 0.0005\\ \hline 5.559.9236 \pm 1.94.654\\ \hline 0.9321 \pm 0.146\\ \hline 1.5397 \pm 1.2042\\ \hline 1.029 \pm 0.015\\ \hline 0.2321 \pm 0.146\\ \hline 1.5937 \pm 1.2042\\ \hline 1.0269 \pm 0.0015\\ \hline \end{array}$	$\begin{array}{c} 3.9760 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0768 \pm 0.0035\\ 0.0376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 80.0607\\ 0.659 \pm 0.00022\\ 0.0022 \pm 0.0007\\ 0.4895 \pm 0.0022\\ 0.0022 \pm 0.0001\\ 1.2603.0305 \pm 305.6108\\ 1.1265 \pm 0.77\\ 0.0167 \pm 0.0031\\ 1.24065 \pm 2.6831\\ 1.29.8482 \pm 235.5594\\ 2497.4316 \pm 205.5728\\ 0.8899 \pm 0.1554\\ 1.19514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ 0.2874 \pm 0.0018\\ \hline \end{array}$	$\begin{array}{c} 3.9111 \pm 0.0226\\ 0.9924 \pm 0.0268\\ \hline SGVNS [25]\\ 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0093\\ 0.0245 \pm 0.0076\\ \hline 0.3438 \pm 0.0076\\ \hline 0.3438 \pm 0.0076\\ \hline 0.3438 \pm 0.0077\\ 0.4891 \pm 0.0027\\ 0.0024 \pm 0.0077\\ 0.0024 \pm 0.0072\\ 0.0024 \pm 0.0072\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0017\\ 0.0035 \pm 0.0014\\ 0.0156 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 1160.1052 \pm 299.560\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 1.3267 \pm 2.6439\\ 1.3265 \pm 2.6439\\ 1.3265 \pm 2.6439\\ 1.4533\\ 1.5305 \pm 1.2613\\ SGVNS [25]\\ 0.2872 \pm 0.0016\\ \hline \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ 5521 (621 \pm 91.2768\\ 0.3999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.4882 \pm 0.0099\\ 0.4882 \pm 0.0097\\ 0.614 \pm 0.7409\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 1116.3151 \pm 366.0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ 2616.9463 \pm 212.5089\\ 0.704 \pm 0.1743\\ 10.9565 \pm 1.4253\\ 1.9565 \pm 1.4253\\ 1.9565 \pm 1.4253\\ 1.9578 \pm 0.0013\\ \hline \end{array}$
LSSRI TWIL MRIL GPL BHGI↑ CL BHGI↑ CL TI↑ DGI↑ RLI↑ RLI↑ RLI↑ RHI↑ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0035 \pm 0.0005\\ 0.0131 \pm 0.0098\\ 0.1033 \pm 0.0098\\ 0.1033 \pm 0.0098\\ 0.1033 \pm 0.0098\\ 0.1033 \pm 0.0098\\ 0.0015 \pm 0.0011\\ 5.90,2544 \pm 6.2935\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0166 \pm 0.0007\\ 21583.0483 \pm 20106.9153\\ 0.9033 \pm 0.0083\\ 15.0016 \pm 0.2518\\ 977.5146 \pm 16.282\\ 2708.0265 \pm 16.7196\\ 1.0711 \pm 0.0166\\ 10.4405 \pm 0.0842\\ \hline CNO-CC\\ 0.2857 \pm 0.0000\\ 0.0067 \pm 0.0000\\ \end{array}$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1352 \\ 1.2800 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0074 \pm 0.0018 \\ 0.0013 \pm 0.0090 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.013 \pm 0.0093 \\ 0.013 \pm 0.0078 \\ 0.013 \pm 0.0013 \\ 0.0085 \pm 0.0013 \\ 0.0085 \pm 0.0013 \\ 0.0085 \pm 0.0013 \\ 0.0015 \pm 0.0012 \\ 0.00247 \pm 0.0025 \\ 24404, 8432 \pm 0.0025 \\ 1.0726 \pm 0.0025 \\ 24404, 8432 \pm 1.0698 \\ 1.0726 \pm 0.0025 \\ 1.04373 \pm 1.705992 \\ 2596.6638 \pm 149, 8041 \\ 0.9437 \pm 0.1255 \\ 11.4881 \pm 1.0373 \\ 1.0293 \\ 1.0294 \pm 0.0021 \\ 0.2094 \pm 0.0021 \\ 0.2094 \pm 0.0021 \\ 0.00072 \pm 0.00002 \\ 0.0002 \\$	$\begin{array}{l} 3.7472\pm0.0028\\ 1.0165\pm0.0228\\ \hline \text{GRASP-VND}\ [20]\\ \hline 0.7703\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm9.09895\\ 0.6181\pm0.0941\\ 0.43872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0014\\ 1634.3854\pm515.7399\\ 1.37298\pm2.8103\\ 1113.2937\pm235.4821\\ 12598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline \text{GRASP-VND}\ [20]\\ 0.288\pm0.002\\ 0.007\pm0.0002\\ 0.0015\pm0.0022\\ 0.007\pm0.0002\\ 0.0015\pm0.0022\\ 0.0012\\ 0.0012\\ 0.0002\\ 0.0012\\ 0.0002\\ 0.0002\\ 0.0012\\ 0.0002\\ 0$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ 1.0077 \pm 0.0233 \\ \hline \\ \hline \\ GRASP-VND-TS [20] \\ 0.368 \pm 0.00057 \\ 0.0268 \pm 0.002 \\ 0.0151 \pm 0.00151 \\ 0.0788 \pm 0.0037 \\ 0.4327 \pm 0.0093 \\ 0.0241 \pm 0.0069 \\ 0.3454 \pm 0.0093 \\ 0.0241 \pm 0.0069 \\ 0.5627 \pm 0.6696 \\ 0.015 \pm 0.0031 \\ 0.0015 \pm 0.0031 \\ 0.00248 \pm 0.0015 \\ 1.0501 \pm 0.0291 \\ 1.0501 \pm 0.1291 \\ 1.35771 \pm 32.3868 \\ 1114.6036 \pm 210.4013 \\ 2592.8983 \pm 183.0573 \\ 0.9615 \pm 0.1398 \\ 11.3491 \pm 1.1519 \\ \hline \\ GRASP-VND-TS [20] \\ 0.2886 \pm 0.0021 \\ 0.2986 \pm 0.0023 \\ \hline \\ 0.2986 \pm 0.0021 \\ 0.2886 \pm 0.0021 \\ \hline \\ 0.0003 \\ \hline \\ 0.0005 \\ \hline \\ 0.0005 \\ \hline \\ 0.0003 \\ \hline \\ 0.0003 \\ \hline \\ 0.0005 \\ \hline \\ 0.0005 \\ \hline \\ 0.0003 \\ \hline \\ 0.0005 \\ \hline \\ 0.0005 \\ \hline \\ 0.0003 \\ \hline \\ 0.0005 \\ \hline \\ 0.0005 \\ \hline \\ 0.0003 \\ \hline \\ 0.0005 \\ \hline \\ 0$	$\begin{array}{c} 4.0117 \pm 0.012\\ 0.0540 \pm 0.0117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.077 \pm 0.0138\\ \hline 0.077 \pm 0.0138\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0361 \pm 0.0083\\ \hline 0.0341 \pm 0.0086\\ \hline 0.0341 \pm 0.0086\\ \hline 0.0341 \pm 0.0086\\ \hline 0.0241 \pm 0.0084\\ \hline 0.0284 \pm 0.0084\\ \hline 0.0284 \pm 0.0084\\ \hline 0.0284 \pm 0.0084\\ \hline 0.0285 \pm 0.0012\\ \hline 0.0255 \pm 0.0014\\ \hline 1.029 \pm 0.1134\\ \hline 1.15990 \pm 2.24468\\ \hline 2.559.9236 \pm 1.94.6549\\ \hline 0.9321 \pm 0.146\\ \hline 11.5937 \pm 1.2042\\ \hline 1VNS [21]\\ \hline 0.2696 \pm 0.0015\\ \hline 0.0696 \pm 0.0015\\ \hline 0.0696 \pm 0.0015\\ \hline 0.0696 \pm 0.0015\\ \hline 0.0069 \pm 0.0005\\ \hline 0.0005 \pm 0.0005\\ \hline$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.01768 \pm 0.00147\\ 0.0768 \pm 0.0035\\ 0.4376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 80.0607\\ 0.659 \pm 0.0092\\ 0.0625 \pm 0.077\\ 0.0639 \pm 0.0002\\ 0.0025 \pm 0.0011\\ 1260 \pm 0.021\\ 0.0025 \pm 0.0011\\ 1260 \pm 0.0011\\ 1220 5 \pm 0.5594\\ 0.025 \pm 0.0011\\ 1220 5 \pm 0.5594\\ 0.0015 \pm 0.0011\\ 1250 5 \pm 0.5594\\ 0.15514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ 0.2874 \pm 0.0018\\ 0.0069 \pm 0.0002\\ 0.0025 \pm 0.0021\\ 0.0025 \pm 0.0021\\ 0.0052 \pm 0.0052\\ 0.0052$	$\begin{array}{c} 3.9717\pm0.2272\\ 0.9924\pm0.0226\\ \hline SGVNS [25]\\ \hline 0.3662\pm0.0053\\ 0.0262\pm0.0019\\ 0.8158\pm0.0148\\ 0.0776\pm0.0036\\ 0.4354\pm0.0093\\ 0.0245\pm0.0076\\ \hline 0.3438\pm0.0072\\ 0.3438\pm0.0072\\ 0.3438\pm0.0072\\ 0.3438\pm0.0072\\ 0.3438\pm0.0072\\ 0.4891\pm0.0027\\ 0.0253\pm0.0014\\ 0.0156\pm0.0034\\ 0.0253\pm0.0014\\ 113.2967\pm2.26439\\ 113.2967\pm2.26439\\ 1146.0096\pm2.31.6428\\ 2568.2981\pm202.2223\\ 0.9402\pm0.1533\\ 11.5305\pm1.2613\\ \hline SGVNS [25]\\ 0.2872\pm0.0016\\ 0.0069\pm0.0002\\ 0.0026\pm0.0021\\ \end{array}$	$\begin{array}{r} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ \underline{532.1621} \pm 91.2768\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.015 \pm 0.0015\\ 116.315 \pm 306.0384\\ 1.0563 \pm 0.1485\\ 1.39622 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ \underline{2616.9463} \pm 212.5089\\ 0.9704 \pm 0.1743\\ \underline{11.2956} \pm 1.4253\\ \hline \text{NDVNS [26]}\\ \hline 0.2872 \pm 0.0013\\ 0.0872 \pm 0.0012\\ \hline \end{array}$
LSSRI            TWIL           MRIJ.           GPL           BHGI↑           CLI↑           RTI↓           BGI↑           DGI↑           BHI↑           VBI↑           DBHI↑           VBI↑           DBHI↑           VBI↑           DBHI↑           VBI↑           DBHI↑           VBH↑           DBH↑           KDWI↓           DBH↑           KDWI↓           DBH↑           BHG↑           TWI↓           DBH↑           BH6           DBH↑           BH1↓           DBH↑           BH1↓           DBH↑           BH1↓           DBH↑           BH1↓           BH1↓ </td <td><math display="block">\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline\\ CNO-CC\\ \hline\\ 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0071 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3032 \pm 0.0005\\ \hline\\ 0.5811 \pm 0.0038\\ 0.3032 \pm 0.0001\\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.0248\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0164 \pm 0.0001\\ 0.0218 \pm 0.0007\\ 1.2158.30483 \pm 20106.9153\\ 0.977.5146 \pm 16.282\\ 2708.0265 \pm 16.7196\\ 1.0711 \pm 0.0182\\ 1.0711 \pm 0.0102\\ 0.0055 \pm 16.7196\\ 1.0711 \pm 0.0108\\ 1.0714 \pm 0.0002\\ 0.0067 \pm 0.0002\\ 0.0067 \pm 0.00002\\ 0.0067 \pm 0.00002\\ 0.0031 \pm 0.0003\\ 0.0003 \pm 0.0003\\ 0.0031 \pm 0.0003\\ 0.0003 \pm 0.00003\\ 0.00003 \pm 0.00003\\ 0.00003 \pm 0.00003\\ 0.000003 \pm 0.00003\\</math></td> <td><math display="block">\begin{array}{c} 3.7130 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0805 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.0098 \\ 0.0113 \pm 0.0098 \\ 0.0113 \pm 0.0098 \\ 0.04845 \pm 0.013 \\ 0.0085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0015 \pm 0.0724 \\ 0.0025 \\ 24404.8432 \pm 3681.8857 \\ 1.0726 \pm 0.0325 \\ 1.0726 \pm 0.0325 \\ 1.0726 \pm 0.0325 \\ 1.04845 \pm 1.0373 \\ \hline 1104.4573 \pm 1.05998 \\ 11104.4573 \pm 1.05998 \\ 1104.4573 \pm 1.05998 \\ 1104.4573 \pm 0.1325 \\ 0.4881 \pm 1.0373 \\ \hline TS [20] \\ \hline 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.00021 \\ 0.0072 \pm 0.00025 \\ 0.0468 \pm 0.0013 \\ \hline \end{array}</math></td> <td><math display="block">\begin{array}{c} 3.7472\pm0.0028\\ 1.0165\pm0.0228\\ \hline \text{GRASP-VND} \ [20]\\ \hline 0.7703\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.00165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3438\pm0.0079\\ 0.257927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0623\pm0.1622\\ 113.2938\pm2.81103\\ 1113.2937\pm235.4821\\ 2598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline \text{GRASP-VND} \ [20]\\ 0.288\pm0.002\\ 0.007\pm0.0002\\ 0.9218\pm0.0026\\ 0.0452\pm0.0013\\ \end{array}</math></td> <td><math display="block">\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline \\ \hline \\ GRASP-VND-TS [20] \\ 0.368 \pm 0.0027 \\ 0.0268 \pm 0.0027 \\ 0.0268 \pm 0.0037 \\ 0.0268 \pm 0.0037 \\ 0.02641 \pm 0.0051 \\ 0.0788 \pm 0.0037 \\ 0.3454 \pm 0.0069 \\ 0.355627 \pm 0.6696 \\ 0.015 \pm 0.0031 \\ 0.0038 \pm 0.0006 \\ 5.55627 \pm 0.6696 \\ 0.015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 1.275.047 \pm 432.8792 \\ 1.0501 \pm 0.1291 \\ 1.35771 \pm 2.3868 \\ 11.3491 \pm 1.1519 \\ \hline \\ \hline \\ GRASP-VND-TS [20] \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0028 \\ 0.00</math></td> <td><math display="block">\begin{array}{c} 4.0117 \pm 0.0125\\ 0.0540 \pm 0.0117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.073 \pm 0.0033\\ \hline 0.073 \pm 0.0033\\ \hline 0.073 \pm 0.0033\\ \hline 0.073 \pm 0.0083\\ \hline 0.0241 \pm 0.0071\\ \hline 0.0098 \pm 74.9872\\ \hline 0.0284 \pm 0.0088\\ \hline 0.0241 \pm 0.0068\\ \hline 510.0968 \pm 74.9872\\ \hline 0.0255 \pm 0.0013\\ \hline 0.0325 \pm 0.0134\\ \hline 115.9904 \pm 224.468\\ \hline 0.9321 \pm 0.146\\ \hline 11.5973 \pm 1.2042\\ \hline IVNS [21]\\ \hline 0.2699 \pm 0.0015\\ \hline 0.0699 \pm 0.0015\\ \hline 0.0646 \pm 0.00012\\ \hline 0.0233 \pm 0.002\\ \hline 0.0233 \pm 0.002\\ \hline 0.0234 \pm 0.0015\\ \hline 0.0646 \pm 0.00012\\ \hline 0.0023 \pm 0.0015\\ \hline 0.0646 \pm 0.00012\\ \hline 0.0023 \pm 0.0015\\ \hline 0.0046 \pm 0.00012\\ \hline 0.0046 \pm 0.0</math></td> <td><math display="block">\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0158 \pm 0.00147\\ 0.0768 \pm 0.0035\\ 0.4376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0022\\ 0.00226 \pm 0.0001\\ 0.345 \pm 0.0022\\ 0.0035 \pm 0.0001\\ 0.345 \pm 0.0022\\ 0.0035 \pm 0.0001\\ 1.265 \pm 0.0011\\ 1260,0305 \pm 305,6108\\ 1.1265 \pm 0.1212\\ 1229,8482 \pm 235,559\\ 0.0164 \pm 2.05372\\ 0.0899 \pm 0.1554\\ 11.9514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ 0.2874 \pm 0.0018\\ 0.0069 \pm 0.0012\\ 0.0024 \pm 0.0014\\ 0.0049 \pm 0.0014\\ 0.0049 \pm 0.0014\\ 0.0049 \pm 0.0014\\ \end{array}</math></td> <td><math display="block">\begin{array}{r} 3.9111\pm 0.0227\\ 0.9924\pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662\pm 0.0053\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.0245\pm 0.0072\\ 0.3438\pm 0.0072\\ 0.3438\pm 0.0072\\ 514.7695\pm 79.1941\\ 0.6256\pm 0.0879\\ 0.4891\pm 0.0027\\ 0.0034\pm 0.0007\\ 5.5540\pm 0.7614\\ 0.0156\pm 0.0034\\ 0.0253\pm 0.0014\\ 1160.1052\pm 299.5600\\ 1.0937\pm 0.1214\\ 13.2967\pm 2.6439\\ 1146.0096\pm 231.6428\\ 2568.2981\pm 202.2223\\ 0.9402\pm 0.1533\\ 11.5305\pm 1.2613\\ \hline SGVNS [25]\\ 0.2872\pm 0.0016\\ 0.0069\pm 0.0002\\ 0.9228\pm 0.0021\\ 0.0447\pm 0.0016\\ \end{array}</math></td> <td><math display="block">\begin{array}{r} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS } [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0079\\ \hline 532.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0059\\ \hline 0.4882 \pm 0.0099\\ \hline 0.0056 \pm 0.0099\\ \hline 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ \hline 1116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ \hline 13.9822 \pm 2.8417\\ \hline 1094.1964 \pm 238.0447\\ \hline 2616.9463 \pm 212.5089\\ \hline 0.9704 \pm 0.1743\\ \hline 112956 \pm 1.4253\\ \hline NDVNS [26]\\ \hline 0.2872 \pm 0.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0018\\ \hline 0.0417 \pm 0.0018\\ \hline \end{array}</math></td>	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline\\ CNO-CC\\ \hline\\ 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0071 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3032 \pm 0.0005\\ \hline\\ 0.5811 \pm 0.0038\\ 0.3032 \pm 0.0001\\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.0248\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0164 \pm 0.0001\\ 0.0218 \pm 0.0007\\ 1.2158.30483 \pm 20106.9153\\ 0.977.5146 \pm 16.282\\ 2708.0265 \pm 16.7196\\ 1.0711 \pm 0.0182\\ 1.0711 \pm 0.0102\\ 0.0055 \pm 16.7196\\ 1.0711 \pm 0.0108\\ 1.0714 \pm 0.0002\\ 0.0067 \pm 0.0002\\ 0.0067 \pm 0.00002\\ 0.0067 \pm 0.00002\\ 0.0031 \pm 0.0003\\ 0.0003 \pm 0.0003\\ 0.0031 \pm 0.0003\\ 0.0003 \pm 0.00003\\ 0.00003 \pm 0.00003\\ 0.00003 \pm 0.00003\\ 0.000003 \pm 0.00003\\$	$\begin{array}{c} 3.7130 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0805 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.0098 \\ 0.0113 \pm 0.0098 \\ 0.0113 \pm 0.0098 \\ 0.04845 \pm 0.013 \\ 0.0085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0015 \pm 0.0724 \\ 0.0025 \\ 24404.8432 \pm 3681.8857 \\ 1.0726 \pm 0.0325 \\ 1.0726 \pm 0.0325 \\ 1.0726 \pm 0.0325 \\ 1.04845 \pm 1.0373 \\ \hline 1104.4573 \pm 1.05998 \\ 11104.4573 \pm 1.05998 \\ 1104.4573 \pm 1.05998 \\ 1104.4573 \pm 0.1325 \\ 0.4881 \pm 1.0373 \\ \hline TS [20] \\ \hline 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.00021 \\ 0.0072 \pm 0.00025 \\ 0.0468 \pm 0.0013 \\ \hline \end{array}$	$\begin{array}{c} 3.7472\pm0.0028\\ 1.0165\pm0.0228\\ \hline \text{GRASP-VND} \ [20]\\ \hline 0.7703\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.00165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3438\pm0.0079\\ 0.257927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0623\pm0.1622\\ 113.2938\pm2.81103\\ 1113.2937\pm235.4821\\ 2598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline \text{GRASP-VND} \ [20]\\ 0.288\pm0.002\\ 0.007\pm0.0002\\ 0.9218\pm0.0026\\ 0.0452\pm0.0013\\ \end{array}$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline \\ \hline \\ GRASP-VND-TS [20] \\ 0.368 \pm 0.0027 \\ 0.0268 \pm 0.0027 \\ 0.0268 \pm 0.0037 \\ 0.0268 \pm 0.0037 \\ 0.02641 \pm 0.0051 \\ 0.0788 \pm 0.0037 \\ 0.3454 \pm 0.0069 \\ 0.355627 \pm 0.6696 \\ 0.015 \pm 0.0031 \\ 0.0038 \pm 0.0006 \\ 5.55627 \pm 0.6696 \\ 0.015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 1.275.047 \pm 432.8792 \\ 1.0501 \pm 0.1291 \\ 1.35771 \pm 2.3868 \\ 11.3491 \pm 1.1519 \\ \hline \\ \hline \\ GRASP-VND-TS [20] \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0028 \\ 0.00$	$\begin{array}{c} 4.0117 \pm 0.0125\\ 0.0540 \pm 0.0117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.073 \pm 0.0033\\ \hline 0.073 \pm 0.0033\\ \hline 0.073 \pm 0.0033\\ \hline 0.073 \pm 0.0083\\ \hline 0.0241 \pm 0.0071\\ \hline 0.0098 \pm 74.9872\\ \hline 0.0284 \pm 0.0088\\ \hline 0.0241 \pm 0.0068\\ \hline 510.0968 \pm 74.9872\\ \hline 0.0255 \pm 0.0013\\ \hline 0.0325 \pm 0.0134\\ \hline 115.9904 \pm 224.468\\ \hline 0.9321 \pm 0.146\\ \hline 11.5973 \pm 1.2042\\ \hline IVNS [21]\\ \hline 0.2699 \pm 0.0015\\ \hline 0.0699 \pm 0.0015\\ \hline 0.0646 \pm 0.00012\\ \hline 0.0233 \pm 0.002\\ \hline 0.0233 \pm 0.002\\ \hline 0.0234 \pm 0.0015\\ \hline 0.0646 \pm 0.00012\\ \hline 0.0023 \pm 0.0015\\ \hline 0.0646 \pm 0.00012\\ \hline 0.0023 \pm 0.0015\\ \hline 0.0046 \pm 0.00012\\ \hline 0.0046 \pm 0.0$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0158 \pm 0.00147\\ 0.0768 \pm 0.0035\\ 0.4376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0022\\ 0.00226 \pm 0.0001\\ 0.345 \pm 0.0022\\ 0.0035 \pm 0.0001\\ 0.345 \pm 0.0022\\ 0.0035 \pm 0.0001\\ 1.265 \pm 0.0011\\ 1260,0305 \pm 305,6108\\ 1.1265 \pm 0.1212\\ 1229,8482 \pm 235,559\\ 0.0164 \pm 2.05372\\ 0.0899 \pm 0.1554\\ 11.9514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ 0.2874 \pm 0.0018\\ 0.0069 \pm 0.0012\\ 0.0024 \pm 0.0014\\ 0.0049 \pm 0.0014\\ 0.0049 \pm 0.0014\\ 0.0049 \pm 0.0014\\ \end{array}$	$\begin{array}{r} 3.9111\pm 0.0227\\ 0.9924\pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662\pm 0.0053\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.0245\pm 0.0072\\ 0.3438\pm 0.0072\\ 0.3438\pm 0.0072\\ 514.7695\pm 79.1941\\ 0.6256\pm 0.0879\\ 0.4891\pm 0.0027\\ 0.0034\pm 0.0007\\ 5.5540\pm 0.7614\\ 0.0156\pm 0.0034\\ 0.0253\pm 0.0014\\ 1160.1052\pm 299.5600\\ 1.0937\pm 0.1214\\ 13.2967\pm 2.6439\\ 1146.0096\pm 231.6428\\ 2568.2981\pm 202.2223\\ 0.9402\pm 0.1533\\ 11.5305\pm 1.2613\\ \hline SGVNS [25]\\ 0.2872\pm 0.0016\\ 0.0069\pm 0.0002\\ 0.9228\pm 0.0021\\ 0.0447\pm 0.0016\\ \end{array}$	$\begin{array}{r} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS } [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0079\\ \hline 532.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0059\\ \hline 0.4882 \pm 0.0099\\ \hline 0.0056 \pm 0.0099\\ \hline 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ \hline 1116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ \hline 13.9822 \pm 2.8417\\ \hline 1094.1964 \pm 238.0447\\ \hline 2616.9463 \pm 212.5089\\ \hline 0.9704 \pm 0.1743\\ \hline 112956 \pm 1.4253\\ \hline NDVNS [26]\\ \hline 0.2872 \pm 0.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0018\\ \hline 0.0417 \pm 0.0018\\ \hline \end{array}$
LSSKI           TWIL           MRIJ           GPL           BHGI↑           CI↓           BHGI↑           CI↓           BHGI↑           CI↓           BHI↑           PBMI↑           PBMI↑           DBI↓           BHGI↑           TWI↓           WGI↓           BHGI↓           CI↓           TT↑           CI↓           TT↓	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline \\ CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3503 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.0238\\ 0.0015 \pm 0.0011\\ 0.0108 \pm 0.0001\\ 0.0105 \pm 0.0011\\ 59131 \pm 0.0761\\ 0.0106 \pm 0.0218\\ 0.0015 \pm 0.0001\\ 0.0106 \pm 0.0218\\ 0.0001 \pm 0.0001\\ 0.0218 \pm 0.0001\\ 0.0108 \pm 0.0001\\ 0.0218 \pm 0.0002\\ 0.0067 \pm 0.0002\\ 0.0067 \pm 0.0000\\ 0.9256 \pm 0.0003\\ 0.0431 \pm 0.0002\\ 0.0067 \pm 0.0000\\ 0.9258 \pm 0.0007\\ 0$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0074 \pm 0.0018 \\ 0.0074 \pm 0.0018 \\ 0.0085 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.0098 \\ 0.0113 \pm 0.0098 \\ 0.0113 \pm 0.0098 \\ 0.3449 \pm 0.0058 \\ 1.04845 \pm 0.013 \\ 0.0068 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.00152 \pm 0.0027 \\ 0.0274 \pm 0.0025 \\ 1.0726 \pm 0.1255 \\ 11.04873 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 0.9437 \pm 0.1255 \\ 11.0481 \pm 1.0373 \\ \hline 1104.4573 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 0.9437 \pm 0.1255 \\ 11.4881 \pm 1.0373 \\ \hline TS [20] \\ \hline 0.2094 \pm 0.0021 \\ 0.0072 \pm 0.0002 \\ 0.9189 \pm 0.0025 \\ 0.0468 \pm 0.0013 \\ 0.3883 \pm 0.0011 \\ 0.3883 \pm 0.0011 \\ \hline \end{array}$	$\begin{array}{c} 3.7472\pm0.0028\\ 1.0165\pm0.0228\\ \hline 0.0274\pm0.0022\\ \hline 0.0274\pm0.0022\\ 0.0070\pm0.0069\\ 0.0274\pm0.0022\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.00044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0017\\ 0.0238\pm0.0017\\ 1.13.2037\pm23.48103\\ 1113.2937\pm23.54821\\ 2598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline \text{GRASP-VND}\ [20]\\ 0.288\pm0.002\\ 0.007\pm0.0026\\ 0.0218\pm0.0026\\ 0.00218\pm0.0026\\ 0.0452\pm0.0021\\ \end{array}$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline \\$	$\begin{array}{c} 4.0117 \pm 0.012 \\ 0.0540 \pm 0.0117 \\ \hline 1 VNS [21] \\ \hline 1 VNS [21] \\ 0.3657 \pm 0.005 \\ 0.0261 \pm 0.0018 \\ \hline 0.0773 \pm 0.0033 \\ 0.0773 \pm 0.0033 \\ 0.0773 \pm 0.0033 \\ 0.0773 \pm 0.0038 \\ 0.0241 \pm 0.0078 \\ 0.0241 \pm 0.0078 \\ 0.0241 \pm 0.0078 \\ 0.0241 \pm 0.0078 \\ 0.0255 \pm 0.0025 \\ 0.034 \pm 0.0058 \\ 0.034 \pm 0.0058 \\ 0.034 \pm 0.0058 \\ 0.034 \pm 0.0058 \\ 0.034 \pm 0.0005 \\ 0.034 \pm 0.0005 \\ 0.0158 \pm 0.0012 \\ 0.0158 \pm 0.0012 \\ 0.0158 \pm 0.0012 \\ 0.0158 \pm 0.0012 \\ 0.0255 \pm 0.0014 \\ 1149.9033 \pm 227.29 \\ 0.0255 \pm 0.0014 \\ 1153.9004 \pm 224.468 \\ 0.559.9236 \pm 194.6549 \\ 0.0255 \pm 0.0015 \\ 0.0069 \pm 0.0015 \\ 0.0069 \pm 0.00015 \\ 0.0069 \pm 0.00015 \\ 0.0069 \pm 0.00015 \\ 0.0059 \pm 0.0002 \\ 0.023 \pm 0.0002 \\ 0.023 \pm 0.0002 \\ 0.023 \pm 0.0002 \\ 0.0009 \pm 0.00002 \\ 0.0009 \pm 0.00002 \\ 0.0009 \pm 0.00002 \\ 0.0009 \pm 0.00002 \\ 0.0000000000 \\ 0.0009 \pm 0.00000 \\ 0.000000000 \\ 0.00000000000$	$\begin{array}{c} 3.9765 \pm 0.0153\\ 0.9860 \pm 0.0153\\ 0.9860 \pm 0.0153\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.00147\\ 0.0768 \pm 0.0032\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0078\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 80.0607\\ 0.659 \pm 0.0904\\ 0.4895 \pm 0.0002\\ 0.0032 \pm 0.0007\\ 0.0032 \pm 0.0001\\ 0.0035 \pm 0.0001\\ 0.0035 \pm 0.0034\\ 0.025 \pm 0.0011\\ 1266.0034\\ 1.1265 \pm 0.1212\\ 12.4065 \pm 2.6831\\ 11.9514 \pm 1.2803\\ 0.059 \pm 0.018\\ 0.059 \pm 0.0018\\ 0.0059 \pm 0.0013\\ 0.059 \pm 0.0018\\ 0.0059 \pm 0.0018\\ 0.0059 \pm 0.0002\\ 0.0022 \pm 0.00018\\ 0.0059 \pm 0.0002\\ 0.0024 \pm 0.0018\\ 0.0069 \pm 0.0002\\ 0.9225 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3897 \pm 0.0009\\ 0.0099 \pm 0.0002\\ 0.0009\\ 0.00009\\ 0.0009\\ 0.0009$	$\begin{array}{c} 3.9111 \pm 0.0226\\ 0.9924 \pm 0.0268\\ \hline \text{SGVNS} [25]\\ \hline 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0076\\ \hline 0.3438 \pm 0.0072\\ \hline 0.3438 \pm 0.0072\\ \hline 0.3438 \pm 0.0072\\ 0.4354 \pm 0.0076\\ \hline 0.3438 \pm 0.0072\\ 0.4354 \pm 0.0076\\ \hline 0.3438 \pm 0.0027\\ 0.4354 \pm 0.0076\\ \hline 0.3438 \pm 0.0027\\ 0.0034 \pm 0.0027\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0007\\ 0.0034 \pm 0.0017\\ 0.0156 \pm 0.0034\\ 0.0155 \pm 0.0014\\ 0.0155 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 1160.0152 \pm 299.5600\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 1146.0096 \pm 231.6428\\ 2568.2981 \pm 202.2223\\ 0.9402 \pm 0.1533\\ 11.5305 \pm 1.2613\\ \hline \text{SGVNS} [25]\\ 0.2877 \pm 0.0016\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.00021\\ 0.447 \pm 0.0016\\ 0.0099 \pm 0.0002\\ \end{array}$	$\begin{array}{c} 0.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \textbf{NDVNS} [26]\\ \hline \textbf{0.3694} \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ \hline \textbf{532.1621} \pm 91.2768\\ \hline \textbf{0.5999} \pm 0.0089\\ 0.0362 \pm 0.0079\\ 0.0435 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 0.0038\\ 0.0241 \pm 0.0015\\ 1.0563 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 1.0563 \pm 0.0038\\ 0.0241 \pm 2.38047\\ 1.0563 \pm 0.1485\\ 13.9822 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ 2616.9463 \pm 212.5089\\ 0.9704 \pm 0.1743\\ 11.2956 \pm 1.4253\\ 1.2956 \pm 1.4253\\ 1.2956 \pm 1.4253\\ 1.2956 \pm 1.4253\\ 1.2956 \pm 1.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0018\\ 0.0447 \pm 0.0008\\ 0.3892 \pm 0.0002\\ 0.3892 \pm 0.0002\\ \end{array}$
LSSRI TWIL MRIL GPIL BHGIT CIL TIT RLIT RLIT BHIT BHIT BHIT BHIT BHIT BHIT CHIT CHIT CHIT CHIT CHIT CHIT CHIT C	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline 0.9522 \pm 0.0030\\ 0.0333 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0033 \pm 0.0005\\ 580.2544 \pm 0.0236\\ 0.0013 \pm 0.0005\\ 580.2544 \pm 0.0236\\ 0.0013 \pm 0.0001\\ 0.0103 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0106 \pm 0.0011\\ 0.0106 \pm 0.0001\\ 0.0218 \pm 0.0007\\ 1.575146 \pm 1.6.232\\ 2708.0265 \pm 1.6.7196\\ 1.0711 \pm 0.0108\\ 10.4405 \pm 0.0842\\ 1.0711 \pm 0.0108\\ 10.4405 \pm 0.0842\\ 1.0711 \pm 0.0108\\ 10.4405 \pm 0.0023\\ 0.0255 \pm 1.6.7196\\ 1.0711 \pm 0.0002\\ 0.0255 \pm 0.0002\\ 0.0325 \pm 0.0002\\ 0.0002\\ 0.0325 \pm 0.0002\\ 0.0002	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline {\rm TS}  [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0085 \pm 0.0133 \\ 0.0805 \pm 0.0038 \\ 0.0113 \pm 0.009 \\ 0.013 \pm 64.2013 \\ 0.0085 \pm 0.00733 \\ 0.4845 \pm 0.013 \\ 0.0085 \pm 0.0073 \\ 0.0085 \pm 0.0073 \\ 0.0085 \pm 0.0073 \\ 0.0085 \pm 0.0073 \\ 0.0015 \pm 0.0027 \\ 0.0072 \pm 0.0027 \\ 1.0726 \pm 0.1325 \\ 1.3595 \pm 1.9698 \\ 1104.4573 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 0.9437 \pm 0.1255 \\ 11.4881 \pm 1.0373 \\ {\rm TS}  [20] \\ \hline 0.2904 \pm 0.0021 \\ 0.0972 \pm 0.0002 \\ 0.9189 \pm 0.0025 \\ 0.0468 \pm 0.0013 \\ 0.3883 \pm 0.001 \\ 0.164 \pm 0.0013 \\ 0.3883 \pm 0.001 \\ 0.104 \pm 0.0372 \\ 0.0072 \pm 0.0002 \\ 0.0104 \pm 0.0072 \\ 0.0002 $	$\begin{array}{c} 3.712\pm0.0228\\ 1.0165\pm0.0228\\ \hline 0.0228\\ \hline 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.3405\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0625\pm0.1622\\ 13.7298\pm2.8103\\ 1113.2937\pm235.4821\\ 25989274\pm210.2178\\ 25989274\pm210.2178\\ 1.3953\pm1.4334\\ \hline 0.688\pm0.002\\ 0.007\pm0.0002\\ 0.0218\pm0.0021\\ 0.0218\pm0.0021\\ 0.0218\pm0.0021\\ 0.0218\pm0.0021\\ 0.0218\pm0.0021\\ 0.0013\pm0.0013\\ 0.3893\pm0.0011\\ 0.1413\pm0.0408\\ 0.3005\pm0.0003\\ 0.3005\pm0.00$	$\begin{array}{c} 3.540\pm0.233\\ 1.0007\pm0.0233\\ 1.007\pm0.238\\ 1.0075\pm0.0237\\ 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0003\\ 0.0241\pm0.0009\\ 0.03454\pm0.0009\\ 0.0241\pm0.0006\\ 0.3454\pm0.00069\\ 524.7544\pm71.9468\\ 0.6164\pm0.00897\\ 0.4907\pm0.0041\\ 0.0033\pm0.0006\\ 5.5627\pm0.0696\\ 0.015\pm0.0031\\ 0.0248\pm0.0015\\ 1.275.047\pm32.8792\\ 1.0501\pm0.1291\\ 1.35771\pm2.3868\\ 1114.6036\pm210.4013\\ 2592.8983\pm183.0573\\ 0.9615\pm0.1398\\ 11.4901\pm1.1519\\ \hline GRASP-VND-TS [20]\\ \hline GRASP-VND-TS [20]\\ 0.2886\pm0.0021\\ 0.0271\pm0.003\\ 0.9208\pm0.0013\\ 0.389\pm0.0011\\ 0.1362\pm0.0437\\ 0.30447\pm0.0013\\ 0.389\pm0.0011\\ 0.1362\pm0.0437\\ 0.30447\pm0.0013\\ 0.3045\pm0.0013\\ 0.394\pm0.0011\\ 0.1362\pm0.0437\\ 0.30447\pm0.0003\\ 0.3045\pm0.0003\\ 0.0398\pm0.00011\\ 0.0362\pm0.0437\\ 0.0013$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.05404 \pm 0.00117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0038\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0361 \pm 0.0038\\ \hline 0.0241 \pm 0.0085\\ \hline 0.0248 \pm 0.0085\\ \hline 0.0248 \pm 0.0085\\ \hline 0.0248 \pm 0.0085\\ \hline 0.0084 \pm 0.0085\\ \hline 0.0085 \pm 0.0018\\ \hline 0.0084 \pm 0.0015\\ \hline 0.0098 \pm 0.0015\\ \hline 0.0089 \pm 0.0005\\ \hline 0.1287 \pm 0.0273\\ \hline 0.0096 \pm 0.0005\\ \hline 0.1287 \pm 0.029\\ \hline 0.1287 \pm 0.0092\\ \hline 0.0005 \pm 0.0005\\	$\begin{array}{c} 3.9760 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0768 \pm 0.0035\\ 0.0376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 80.0607\\ 0.659 \pm 0.0002\\ 0.0022 \pm 0.0022\\ 0.0022 \pm 0.0007\\ 0.4895 \pm 0.00022\\ 0.0022 \pm 0.00022\\ 0.0022 \pm 0.0001\\ 1.2603 0.055 \pm 0.77\\ 0.0167 \pm 0.0031\\ 1.260 \pm 0.055 \pm 0.554\\ 1.129,482 \pm 235.5594\\ 2497,4316 \pm 205.5728\\ 0.8899 \pm 0.1554\\ 1.19514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ \hline 0.2874 \pm 0.0018\\ 0.0025 \pm 0.0021\\ 0.9225 \pm 0.0021\\ 0.9225 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3897 \pm 0.0009\\ 0.1526 \pm 0.0306\\ \hline 0.3005 \pm 0.0002\\ 0.0025 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3897 \pm 0.0009\\ 0.1526 \pm 0.0306\\ \hline 0.3006 \pm 0.0002\\ 0.0011\\ 0.3897 \pm 0.0009\\ \hline 0.0011\\ 0.3897 \pm 0.0009\\ \hline 0.0011\\ 0.3897 \pm 0.0009\\ \hline 0.0001\\ \hline 0.3005 \pm 0.0002\\ \hline 0.0002\\ \hline 0.0011\\ \hline 0.3005 \pm 0.0002\\ \hline 0.0$	$\begin{array}{c} 3.9114 \pm 0.0224\\ 0.9924 \pm 0.0268\\ \hline SGVNS [25]\\ 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0093\\ 0.0245 \pm 0.0076\\ \hline 0.3438 \pm 0.0076\\ \hline 0.3438 \pm 0.0077\\ 514,7695 \pm 0.9076\\ 0.4381 \pm 0.0007\\ 0.0255 \pm 0.0076\\ 0.0024 \pm 0.0072\\ 0.0024 \pm 0.0007\\ 0.0034 \pm 0.0007\\ 0.0035 \pm 0.0014\\ 0.0156 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 0.0152 \pm 299.5600\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 1.3267 \pm 2.6439\\ 1.3267 \pm 2.6439\\ 1.3505 \pm 1.2613\\ SGVNS [25]\\ 0.2872 \pm 0.0016\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0021\\ 0.0447 \pm 0.0010\\ 0.3898 \pm 0.0009\\ 0.1429 \pm 0.0299\\ 0.3066 + 0.0007\\ 0.3006 \pm 0.0001\\ 0.3008 \pm 0.0000\\ 0.3006 \pm 0.0001\\ 0.3008 \pm 0.0001\\ 0.3088 \pm 0.0009\\ 0.3066 \pm 0.0001\\ 0.3098 \pm 0.0001\\ 0.3008 \pm 0.0009\\ 0.3006 \pm 0.0001\\ 0.3008 \pm 0.0001\\ 0.3008 \pm 0.0009\\ 0.3006 \pm 0.0002\\ 0.0029\\ 0.3066 \pm 0.0001\\ 0.3008 \pm 0.0009\\ 0.3006 \pm 0.0002\\ 0.0029\\ 0.3006 \pm 0.0001\\ 0.0009\\ 0.0000\\ 0.0009\\ 0.0000\\ $	$\begin{array}{c} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0099\\ 0.3462 \pm 0.0079\\ 5521 (621 \pm 91.2768\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0097\\ 0.6184 \pm 0.7409\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 1116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ 2616.9463 \pm 212.5089\\ 1.3955 \pm 1.2423\\ 1.2955 \pm 0.0013\\ 0.0099 \pm 0.0012\\ 0.9228 \pm 0.0013\\ 0.0099 \pm 0.002\\ 0.9228 \pm 0.0013\\ 0.0099 \pm 0.0002\\ 0.9228 \pm 0.0013\\ 0.0099 \pm 0.0002\\ 0.3898 \pm 0.0008\\ 0.1255 \pm 0.0277\\ 0.3006 + 0.0002\\ 0.3006 + 0.0002\\ \end{array}$
LSSRI TWIL MRIL GPL BHGI↑ CL CL TI↑ CHI↑ RLI↑ CHI↑ RLI↑ CHI↑ WGI↑ DGI↑ TWBI↑ BHI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ CLL TWI↓ BHI↓ CHI↑	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3977 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0073 \pm 0.0098\\ 0.0033 \pm 0.0005\\ \hline 0.0131 \pm 0.0098\\ 0.3503 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.0013 \pm 0.0008\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0164 \pm 0.0007\\ 1.0218 \pm 0.0000\\ 0.9256 \pm 0.0000\\ 0.9256 \pm 0.0000\\ 0.9258 \pm 0.0007\\ 0.1575 \pm 0.0007\\ 0.0007 \pm 0.0000\\ 0.928 \pm 0.0007\\ 0.1575 \pm 0.0007\\ 0.0009 \pm 0.0000\\ 0.558 \pm 0.549\\ 0.0000\\ 0.558 \pm 0.549\\ 0.0000\\ 0.558 \pm 0.549\\ 0.558\\ 0.0000\\ 0.558 \pm 0.549\\ 0.0000\\ 0.558 \pm 0.549\\ 0.558\\ 0.0000\\ 0.558 \pm 0.549\\ 0.0000\\ 0.558 \pm 0.549\\ 0.558\\ 0.0000\\ 0.558 \pm 0.549\\ 0.0000\\ 0.558 \pm 0.0000\\ 0.558 \pm 0.549\\ 0.0000\\ 0.558 \pm 0.000\\ 0.558 \pm 0.0000\\ 0.558 \pm 0.000\\ 0.558 \pm 0.0000\\ $	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.0771 \pm 0.0018 \\ 0.0273 \pm 0.0018 \\ 0.0027 \pm 0.0018 \\ 0.0038 \pm 0.0133 \\ 0.0800 \pm 0.0040 \\ 0.4314 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0015 \pm 0.0012 \\ 0.00247 \pm 0.0025 \\ 24048 4332 \pm 0.0025 \\ 24048 4342 \pm 0.0025 \\ 24048 4342 \pm 0.0025 \\ 1.3.5695 \pm 1.9698 \\ 1104.4573 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 0.9437 \pm 0.1255 \\ 11.4881 \pm 1.0373 \\ \hline TS [20] \\ 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.0002 \\ 0.9189 \pm 0.0025 \\ 0.0468 \pm 0.0013 \\ 0.3883 \pm 0.001 \\ 0.104 \pm 0.0372 \\ 0.3002 \pm 0.0003 \\ 722.6965 \pm 12.9587 \\ \end{array}$	$\begin{array}{l} 3.712\pm0.0028\\ 1.0165\pm0.0228\\ \hline 0.0228\\ \hline 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.3305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.43452\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0625\pm0.1622\\ 13.7298\pm2.8103\\ 1113.2937\pm235.4821\\ 2598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline {\rm GRASP-VND}\ [20]\\ 0.288\pm0.002\\ 0.9218\pm0.0021\\ 0.9288\pm0.0021\\ 0.9288\pm0.0021\\ 0.9288\pm0.0021\\ 0.9288\pm0.0021\\ 0.9288\pm0.0021\\ 0.9288\pm0.0021\\ 0.9288\pm0.0021\\ 0.9218\pm0.0021\\ 0.9218\pm$	$\begin{array}{c} 3.540\pm0.223\\ 1.0007\pm0.0233\\ 1.007\pm0.0238\\ 1.0075\\ 0.0268\pm0.00057\\ 0.0268\pm0.00057\\ 0.0268\pm0.00057\\ 0.0268\pm0.0003\\ 0.0264\pm0.00093\\ 0.0241\pm0.0002\\ 0.3454\pm0.00093\\ 0.0241\pm0.0002\\ 0.3454\pm0.00093\\ 0.0241\pm0.0002\\ 0.3454\pm0.00093\\ 0.0248\pm0.0015\\ 1.0254\pm0.0015\\ 0.0028\pm0.0028\\ 0.0028\pm0.0028\\ 0.00457\pm0.0013\\ 0.389\pm0.0001\\ 0.0032\pm0.0003\\ 0.3264\pm15.2223\\ 0.0043\pm0.0003\\ 0.3264\pm15.2223\\ 0.0043\pm0.0003\\ 0.3264\pm15.2223\\ 0.0028\pm0.0023\\ 0.3264\pm15.2223\\ 0.0028\pm0.0023\\ 0.3264\pm15.2223\\ 0.0028\pm0.0023\\ 0.0028\pm0.0023\\ 0.0028\pm0.0023\\ 0.0028\pm0.0023\\ 0.0028\pm0.0023\\ 0.0028\pm0.0023\\ 0.0028\pm0.0023\\ 0.0003\\$	$\begin{array}{c} 4.0117 \pm 0.0123\\ 0.0540 \pm 0.00117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0734 \pm 0.0033\\ \hline 0.0734 \pm 0.0033\\ \hline 0.0241 \pm 0.0085\\ \hline 0.0241 \pm 0.0085\\ \hline 0.0241 \pm 0.0085\\ \hline 0.0241 \pm 0.0081\\ \hline 0.0284 \pm 0.0081\\ \hline 0.0285 \pm 0.0012\\ \hline 0.0255 \pm 0.0014\\ \hline 1.029 \pm 0.015\\ \hline 0.0092 \pm 0.0015\\ \hline 0.0092 \pm 0.0015\\ \hline 0.0092 \pm 0.0015\\ \hline 0.0099 \pm 0.0012\\ \hline 0.0009 \pm 0.0002\\ \hline 0.1287 \pm 0.00273\\ 0.0006 \pm 0.0002\\ \hline 0.0002 \pm 9.530\\ \hline 0.0006 \pm 0.0002\\ \hline 0.0007 \pm 0.0007\\ \hline 0.0006 \pm 0.0002\\ \hline 0.0006 \pm 0.0002\\ \hline 0.0007 \pm 0.0007\\ \hline 0.0006 \pm 0.0002\\ \hline 0.0007 \pm 0.0007\\ \hline 0.0006 \pm 0.0002\\ \hline 0.0007 \pm 0.0007\\ \hline 0.0006 \pm 0.0007\\ \pm 0.0007\\ \hline 0$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0157 \pm 0.0013\\ 0.01768 \pm 0.0035\\ 0.0376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 0.0092\\ 0.0639 \pm 0.0090\\ 0.4895 \pm 0.0002\\ 0.0032 \pm 0.0007\\ 0.3415 \pm 0.007\\ 0.3415 \pm 0.0022\\ 0.0032 \pm 0.0001\\ 1.2665 \pm 0.077\\ 0.0167 \pm 0.0034\\ 0.025 \pm 0.0011\\ 1260 \pm 0.0572\\ 0.0011 \pm 0.0034\\ 1.265 \pm 0.55728\\ 0.8899 \pm 0.1554\\ 11.9514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ 0.2874 \pm 0.0018\\ 0.0069 \pm 0.0002\\ 0.9225 \pm 0.0021\\ 0.9429 \pm 0.0021\\ 0.9225 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3897 \pm 0.0003\\ 0.3005 \pm 0.0003\\ 0.3005 \pm 0.0003\\ 741.2396 \pm 11.9724\\ \pm 1.956 \pm 1.9724\\ 0.0036 \pm 0.0003\\ \end{array}$	$\begin{array}{c} 3.9717\pm0.0227\\ 0.9924\pm0.0226\\ \hline 0.9924\pm0.0251\\ \hline 0.9262\pm0.0019\\ 0.8158\pm0.0148\\ 0.0262\pm0.0019\\ 0.8158\pm0.0148\\ 0.0776\pm0.0036\\ 0.04354\pm0.0093\\ 0.0245\pm0.0076\\ \hline 0.3438\pm0.00072\\ 514.7695\pm79.1941\\ 0.6256\pm0.0879\\ 0.4891\pm0.0027\\ 0.0348\pm0.0007\\ 0.035\pm0.0014\\ 0.0156\pm0.0034\\ 0.0253\pm0.0014\\ 100037\pm0.1214\\ 13.2967\pm2.295.560\\ 1.09937\pm0.1214\\ 13.2967\pm2.6439\\ 1146.0096\pm2.31.6428\\ 2268.2981\pm2.002.2223\\ 0.9402\pm0.1533\\ 11.5305\pm1.2613\\ \hline SGVNS [25]\\ 0.2872\pm0.0016\\ 0.0069\pm0.0002\\ 0.9228\pm0.0021\\ 0.0447\pm0.0010\\ 0.3898\pm0.00029\\ 0.1429\pm0.0299\\ 0.3006\pm0.00029\\ 0.3006\pm0.0002\\ 743.0472\pm10.0315\\ \hline \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ \underline{532,1621 \pm 91,2768}\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 1116,3151 \pm 306,0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ 10563 \pm 0.4485\\ 1.39822 \pm 2.8417\\ 1054,1964 \pm 238,0447\\ \underline{2616,0463 \pm 212,5089}\\ 0.9704 \pm 0.1743\\ \overline{11,2956 \pm 1.4253}\\ \hline \text{NDVNS [26]\\ 0.2872 \pm 0.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0018\\ 0.0447 \pm 0.0009\\ 0.3888 \pm 0.0018\\ 0.0447 \pm 0.0009\\ 0.3898 \pm 0.0018\\ 0.0477 \pm 0.0002\\ 0.3898 \pm 0.0002\\ 0.3898 \pm 0.0002\\ 0.3806 \pm 0.0002\\ 0.1255 \pm 0.0277\\ 0.3006 \pm 0.0002\\ 0.0002 \pm 9.0852\\ \end{array}$
LSSRI TWIL MRIL GPIL BHGI↑ CIL DGI↑ RLI↑ CHI↑ RTI↑ WGI↑ DGI↑ TWBI↑ BHI↑ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓ DBI↓	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline\\ CNO-CC\\ \hline\\ 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3033 \pm 0.0005\\ \hline\\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.0238\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0164 \pm 0.0218\\ \pm 0.0007\\ 21583.0483 \pm 0.0007\\ 21583.0483 \pm 0.0007\\ 21583.0483 \pm 0.0007\\ 1.0016 \pm 0.2518\\ 977.5146 \pm 16.282\\ 2708.0265 \pm 16.7196\\ 1.0711 \pm 0.0198\\ 10.4405 \pm 0.0842\\ \hline\\ CNO-CC\\ \hline\\ 0.2857 \pm 0.0002\\ 0.0035 \pm 0.0000\\ 0.2556 \pm 0.0000\\ 0.0255 \pm 0.0000\\ 0.0328 \pm 0.0007\\ 0.3928 \pm 0.0007\\ 0.3938 \pm 0.0007\\ 0.393$	$\begin{array}{c} 3.7130 \pm 0.1332 \\ 1.2860 \pm 0.1332 \\ 1.2860 \pm 0.1332 \\ 0.0273 \pm 0.0018 \\ 0.0273 \pm 0.0018 \\ 0.0074 \pm 0.0018 \\ 0.0074 \pm 0.0018 \\ 0.0013 \pm 0.0018 \\ 0.0013 \pm 0.009 \\ 0.0414 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.0414 \pm 0.008 \\ 0.0113 \pm 0.009 \\ 0.0414 \pm 0.0018 \\ 0.0013 \pm 0.009 \\ 0.0444 \pm 0.0018 \\ 0.0013 \pm 0.0028 \\ 0.0013 \pm 0.0013 \\ 0.008 \pm 0.0013 \\ 0.008 \pm 0.0013 \\ 0.0015 \pm 0.0012 \\ 0.0075 \pm 0.0025 \\ 0.0075 \pm 0.0025 \\ 1.0726 \pm 0.1325 \\ 1.03595 \pm 1.0698 \\ 1104.4573 \pm 10.0598 \\ 1.04843 \pm 1.0373 \\ \hline 0.2094 \pm 0.0025 \\ 0.0072 \pm 0.0002 \\ 0.0003 \pm 0.0003 \\ 0.3883 \pm 0.001 \\ 0.104 \pm 0.0037 \\ 0.3002 \pm 0.0003 \\ 0.2266 \pm 1.29587 \\ 0.2926 \pm 0.0237 \\ 0.4004 \pm 0.0023 \\ 0.4003 \\ 0.0003 \\ 0.2926 \pm 0.0237 \\ 0.4004 \\ 0.0003 \\ 0.2926 \pm 0.0237 \\ 0.4004 \\ 0.0003$	$\begin{array}{c} 3.7612\pm0.0228\\ 1.0165\pm0.0228\\ \hline 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.00165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0625\pm0.1622\\ 113.2937\pm235.4821\\ 2598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline GRASP-VND [20]\\ 0.288\pm0.002\\ 0.007\pm0.0022\\ 0.9218\pm0.0026\\ 0.00218\pm0.0026\\ 0.00218\pm0.0026\\ 0.00218\pm0.0026\\ 0.00218\pm0.0026\\ 0.00218\pm0.0026\\ 0.00218\pm0.0026\\ 0.0025\pm0.0011\\ 0.1413\pm0.4048\\ 0.3005\pm0.0003\\ 73.7558\pm14.1883\\ 0.2762\pm0.0315\\ 0.485\pm0.0021\\ 0.485\pm0.0021\\ 0.485\pm0.0021\\ 0.00315\\ 0.485\pm0.0003\\ 0.00315\\ 0.485\pm0.0003\\ 0.00315\\ 0.0015\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.00315\\ 0.0015\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.00315\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0015\\ 0.0025\\ 0.0015\\ 0.0015\\ 0.0025\\ 0.0015\\$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline 0.0057 \\ 0.0268 \pm 0.002 \\ 0.0151 \\ 0.0268 \pm 0.002 \\ 0.0151 \\ 0.0788 \pm 0.0037 \\ 0.0268 \pm 0.0037 \\ 0.0264 \pm 0.0093 \\ 0.0241 \pm 0.0069 \\ 0.2454 \pm 0.0093 \\ 0.0241 \pm 0.0069 \\ 0.2454 \pm 0.0093 \\ 0.0241 \pm 0.0069 \\ 0.015 \pm 0.0031 \\ 0.0034 \pm 0.00015 \\ 0.015 \pm 0.0031 \\ 0.0034 \pm 0.0015 \\ 1275.047 \pm 432.8792 \\ 1.0501 \pm 0.1291 \\ 13.5771 \pm 2.3868 \\ 113.4907 \pm 0.031 \\ 1.252.8983 \pm 183.0573 \\ 0.9615 \pm 0.1398 \\ 11.3491 \pm 1.1519 \\ \hline 0.2888 \pm 0.0021 \\ 0.0288 \pm 0.0021 \\ 0.0284 \pm 0.0011 \\ 0.389 \pm 0.0013 \\ 0.389 \pm 0.0023 \\ 0.0354 \pm 0.0023 \\ 0.389 \pm 0.0023 \\ 0.389 \pm 0.0023 \\ 0.389 \pm 0.0013 \\ 0.32857 \pm 0.0335 \\ 0.3854 \pm 0.0037 \\ 0.3645 \pm 0.0023 \\ 0.2857 \pm 0.0335 \\ 0.3856 \\ 0.0025 \\ 0.0356 \\ 0.00356 \\ 0.0455 \\ 0.00356 \\ 0.0455 \\ 0.0356 \\ 0.0455 \\ 0.0356 \\ 0.0455 \\ 0.0356 \\ 0.0455 \\ 0.0356 \\ 0.0455 \\ 0.0356 \\ 0.0025 \\ 0.0356 \\ 0.0025 \\ 0.0356 \\ 0.0025 \\ 0.0356 \\ 0.0025 \\ 0.00356 \\ 0.0025 \\ 0.00356 \\ 0.0025 \\ 0.0035 \\ 0.0035 \\ 0.00356 \\ 0.0025 \\ 0.0035 \\$	$\begin{array}{c} 4.0117 \pm 0.0125\\ 0.0540 \pm 0.0117\\ \hline 1VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.077 \pm 0.0038\\ \hline 0.077 \pm 0.0033\\ \hline 0.077 \pm 0.0033\\ \hline 0.077 \pm 0.0033\\ \hline 0.073 \pm 0.0083\\ \hline 0.0241 \pm 0.0084\\ \hline 0.0241 \pm 0.0025\\ \hline 0.0255 \pm 0.0014\\ \hline 0.0255 \pm 0.0014\\ \hline 0.0255 \pm 0.0014\\ \hline 0.0255 \pm 0.0015\\ \hline 0.0255 \pm 0.0014\\ \hline 1.153.9004 \pm 224.468\\ \hline 2.559.9236 \pm 194.6549\\ \hline 0.9321 \pm 0.146\\ \hline 11.5937 \pm 1.2042\\ \hline 1VNS [21]\\ \hline 0.2869 \pm 0.0015\\ \hline 0.0069 \pm 0.0002\\ \hline 0.023 \pm 0.0023\\ \hline 0.023 \pm 0.0023\\ \hline 0.023 \pm 0.0025\\ \hline 0.0009 \pm 0.0002\\ \hline 0.023 \pm 0.0025\\ \hline 0.0000 \pm 0.0002\\ \hline 0.023 \pm 0.0000\\ \hline 0.0000 \pm 0.0002\\ \hline 0.0000 \pm 0.0002\\ \hline 0.0000 \pm 0.0000\\ \hline 0.0000 \pm 0.000$	$\begin{array}{c} 3.9760 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0155 \pm 0.0147\\ 0.0768 \pm 0.0035\\ 0.4376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 80.0607\\ 0.594 \pm 0.0022\\ 0.0022 \pm 0.0007\\ 0.4895 \pm 0.0022\\ 0.0022 \pm 0.0001\\ 1260 \pm 0.025 \pm 0.0011\\ 1260 \pm 0.055 \pm 0.021\\ 1229.8482 \pm 235.5594\\ 2497.4316 \pm 205.5728\\ 0.8899 \pm 0.1554\\ 11.9514 \pm 1.2803\\ \hline 0.0025 \pm 0.0021\\ 0.225 \pm 0.0018\\ 0.0029 \pm 0.0024\\ 0.0028 \pm 0.0021\\ 0.2374 \pm 0.0028\\ 0.0024 \pm 0.0024\\ 0.0024 \pm 0.0028\\ 0.0024 \pm 0.0024\\ 0.00449 \pm 0.0011\\ 0.3897 \pm 0.0009\\ 0.3005 \pm 0.0003\\ 0.0003\\ 0.3005 \pm 0.0003\\$	$\begin{array}{c} 3.9111 \pm 0.0272\\ 0.9924 \pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0093\\ 0.0245 \pm 0.0076\\ 0.3438 \pm 0.0072\\ 0.4891 \pm 0.0027\\ 0.0034 \pm 0.0007\\ 0.0253 \pm 0.0014\\ 0.0156 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 1160.1052 \pm 299.5600\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 1146.0096 \pm 231.6428\\ 2568.2981 \pm 202.2223\\ 0.9402 \pm 0.1533\\ 11.5305 \pm 1.2613\\ \hline SGVNS [25]\\ 0.2872 \pm 0.0016\\ 0.0069 \pm 0.0021\\ 0.0474 \pm 0.0021\\ 0.0474 \pm 0.0021\\ 0.3898 \pm 0.0009\\ 0.1429 \pm 0.0299\\ 0.3006 \pm 0.0002\\ 1.4294 \pm 0.0224\\ 1.0305 \pm 0.2241\\ 0.0364 \pm 0.0021\\ 0.3434 \pm 0.0021\\ 0.3454 \pm 0.0021\\ 0.3$	$\begin{array}{c} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS } [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0089\\ \hline 0.3462 \pm 0.0079\\ 0.3462 \pm 0.0079\\ 0.3462 \pm 0.0079\\ 0.3462 \pm 0.0059\\ 0.4882 \pm 0.0059\\ 0.0036 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 116.3151 \pm 366.0384\\ 1.0563 \pm 0.1485\\ 1.3.9822 \pm 2.38.0147\\ 2616.9463 \pm 212.5089\\ 0.9704 \pm 0.1743\\ \hline 11.2956 \pm 1.4253\\ \hline NDVNS \ [26]\\ \hline 0.2872 \pm 0.0013\\ 0.00417 \pm 0.0018\\ 0.228 \pm 0.0018\\ 0.0447 \pm 0.0018\\ 0.228 \pm 0.0018\\ 0.0447 \pm 0.0002\\ 0.3898 \pm 0.0002\\ 0.1255 \pm 0.0277\\ 0.3006 \pm 0.0002\\ 0.4855 \pm 0.0276\\ 0.4855 \pm 0.0276\\ 0.4855 \pm 0.0268\\ 0.4855 \pm 0.0268\\ 0.4855 \pm 0.0002\\ 0.4855 \pm 0.0$
LSSRI           TWIL           MRIJ.           GPL           BHGI           TIT           DGI           TIT           DGI           TIT           DGI           TIT           DGI           TIT           DGIT           DGIT           DBIL           BHGIT           TWIL           BHGIT	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline \\ CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3032 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.3034 \pm 0.0098\\ 0.3034 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0106 \pm 0.02118\\ 0.0015 \pm 0.0001\\ 0.1218 \pm 0.0007\\ 0.1016 \pm 0.02518\\ 977.5146 \pm 16.282\\ 2708.0265 \pm 16.7196\\ 1.0711 \pm 0.0102\\ 0.0035 \pm 0.0002\\ 0.2256 \pm 0.0003\\ 0.4035 \pm 0.0007\\ 0.2556 \pm 0.00003\\ 0.4031 \pm 0.0007\\ 0.2556 \pm 0.00002\\ 0.0067 \pm 0.00002\\ 0.0007 \pm 0.00002\\ 0.0007 \pm 0.00002\\ 0.0007 \pm 0.00002\\ 0.0007 \pm 0.00002\\ 0.0001 \pm 0.00002\\ 0.00002\\ 0.0001 \pm 0.00002\\ 0.0000 \pm 0.00000\\ 0.0000 \pm 0.0000\\ 0.0000 \pm 0.000$	$\begin{array}{c} 3.749 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.3701 \pm 0.0018 \\ 0.0273 \pm 0.0018 \\ 0.0273 \pm 0.0018 \\ 0.0273 \pm 0.0018 \\ 0.0080 \pm 0.0040 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 0.0113 \pm 0.009 \\ 0.3449 \pm 0.0058 \\ 514.6513 \pm 64.2013 \\ 0.6085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0015 \pm 0.0012 \\ 0.0027 \pm 0.0025 \\ 0.0247 \pm 0.0025 \\ 1.0726 \pm 0.0325 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 0.0027 \\ 0.0247 \pm 0.0025 \\ 1.0726 \pm 0.1325 \\ 1.04.853 \pm 170.5992 \\ 1104.4573 \pm 170.5992 \\ 1104.4573 \pm 170.5992 \\ 1104.4573 \pm 1.0593 \\ 1104.4573 \pm 1.0593 \\ 1104.4573 \pm 0.0025 \\ 0.0072 \pm 0.0002 \\ 0.9189 \pm 0.0025 \\ 0.0046 \pm 0.0013 \\ 0.3883 \pm 0.001 \\ 0.104 \pm 0.0372 \\ 0.3002 \pm 0.0003 \\ 722.6965 \pm 12.9587 \\ 0.2956 \pm 0.0237 \\ 0.4904 \pm 0.0003 \\ 0.0054 \pm 0.0004 \\ 0.0054 \pm 0.0004 \\ 0.0054 \pm 0.0054 \\ 0.00$	$\begin{array}{c} 3.7472\pm0.0028\\ 1.0165\pm0.0228\\ \hline 1.0165\pm0.0228\\ \hline GRASP-VND [20]\\ \hline 0.0774\pm0.0022\\ 0.8072\pm0.0165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0049\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 1.06238\pm0.0014\\ 113.2937\pm235.4821\\ 2598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline GRASP-VND [20]\\ 0.288\pm0.002\\ 0.0021\pm0.0026\\ 0.0452\pm0.0011\\ 0.1413\pm0.0048\\ 0.3005\pm0.0003\\ 737.7558\pm14.1883\\ 0.2762\pm0.0013\\ 0.2762\pm0.0031\\ 0.0451\pm0.0003\\ 0.2762\pm0.0013\\ 0.3851\pm0.0047\\ 0.00276\pm0.00047\\ 0.00276\pm0.00047\\ 0.0075\pm0.00047\\ 0.0076\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0076\pm0.00047\\ 0.0276\pm0.00047\\ 0.0076\pm0.0004\\ 0.00047\\ 0.0076\pm0.0004\\ 0.00047\\ 0.0076\pm0.0004\\ 0.00047\\ 0.0076\pm0.0004\\ 0.00045\\ 0.0004\\ 0.000$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline 0.0368 \pm 0.0027 \\ 0.0268 \pm 0.0027 \\ 0.0268 \pm 0.0027 \\ 0.0268 \pm 0.0037 \\ 0.0268 \pm 0.0037 \\ 0.02641 \pm 0.0061 \\ 0.03454 \pm 0.0062 \\ 0.3454 \pm 0.0061 \\ 0.0033 \pm 0.0006 \\ 0.015 \pm 0.0031 \\ 0.0034 \pm 0.0015 \\ 0.0015 \pm 0.0031 \\ 0.0038 \pm 0.0015 \\ 0.105 \pm 0.0031 \\ 0.228 \pm 0.0015 \\ 0.105 \pm 0.0031 \\ 0.9208 \pm 0.0021 \\ 0.0071 \pm 0.0021 \\ 0.0071 \pm 0.0023 \\ 0.0028 \pm 0.0021 \\ 0.0071 \pm 0.0023 \\ 0.0286 \pm 0.0021 \\ 0.0071 \pm 0.0023 \\ 0.0028 \pm 0.0021 \\ 0.0071 \pm 0.0023 \\ 0.389 \pm 0.0011 \\ 0.1362 \pm 0.0437 \\ 0.3084 \pm 0.003 \\ 732.61 \pm 15.2223 \\ 0.2857 \pm 0.0356 \\ 0.4848 \pm 0.0047 \\ 0.0257 \pm 0.0038 \\ 0.0027 \\ 0.0077 \pm 0.0003 \\ 0.0257 \pm 0.0003 \\ 0.2857 \pm 0.0035 \\ 0.0457 \pm 0.0033 \\ 0.2857 \pm 0.0035 \\ 0.4848 \pm 0.0047 \\ 0.0257 \pm 0.0088 \\ 0.0047 \\ 0.0057 \\ 0.0057 \\ 0.0088 \\ 0.0047 \\ 0.0057 \\ 0.0057 \\ 0.0088 \\ 0.0047 \\ 0.0057 \\ 0.0058 \\ 0.0045 \\ 0.0058$	$\begin{array}{c} 4.0117 \pm 0.012 \\ 0.0540 \pm 0.0117 \\ \hline 1 VNS [21] \\ \hline 1 VNS [21] \\ 0.3657 \pm 0.005 \\ 0.0261 \pm 0.0018 \\ \hline 0.073 \pm 0.0033 \\ 0.073 \pm 0.0033 \\ 0.073 \pm 0.0033 \\ 0.073 \pm 0.0033 \\ 0.0241 \pm 0.0071 \\ 0.0068 \pm 74.9872 \\ 0.0241 \pm 0.0071 \\ 0.2433 \pm 0.0068 \\ 510.0968 \pm 74.9872 \\ 0.025 \pm 0.0015 \\ 0.024 \pm 0.0032 \\ 0.025 \pm 0.0014 \\ 1149.9033 \pm 227.29 \\ 0.0158 \pm 0.0014 \\ 1153.9004 \pm 224.468 \\ 0.9321 \pm 0.0451 \\ 1.5937 \pm 1.2042 \\ \hline 1 VNS [21] \\ \hline 0.268 \pm 0.0015 \\ 0.068 \pm 0.00015 \\ 0.068 \pm 0.00015 \\ 0.068 \pm 0.00015 \\ 0.0258 \pm 0.0015 \\ 0.068 \pm 0.00015 \\ 0.069 \pm 0.00015 \\ 0.069 \pm 0.00015 \\ 0.069 \pm 0.00015 \\ 0.069 \pm 0.00015 \\ 0.0399 \pm 0.0005 \\ 0.0223 \pm 0.0022 \\ 0.0234 \pm 0.022 \\ 0.0245 \pm 0.0021 \\ 0.2629 \pm 0.0202 \\ 0.478 \pm 0.0021 \\ 0.2629 \pm 0.0020 \\ 0.2629 \pm 0.0020 \\ 0.2629 \pm 0.0020 \\ 0.0648 \pm 0.0057 \\ 0.0648 \pm 0.$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0155 \pm 0.0147\\ 0.0768 \pm 0.0035\\ 0.0276 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0022\\ 0.0032 \pm 0.0007\\ 5.2615 \pm 0.777\\ 0.0167 \pm 0.0031\\ 1.265 \pm 0.0011\\ 1229,8482 \pm 235.559\\ 0.011229,8482 \pm 235.559\\ 0.8899 \pm 0.1554\\ 11.9514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ 0.2874 \pm 0.0018\\ 0.0025 \pm 0.0002\\ 0.0225 \pm 0.0002\\ 0.3997 \pm 0.0002\\ 0.3997 \pm 0.0003\\ 0.305 \pm 0.0023\\ 0.305 \pm 0.0003\\ 741,2396 \pm 11.9724\\ 0.2688 \pm 0.025\\ 0.0288 \pm 0.0055\\ 0.0288 \pm 0.0055\\ 0.0288 \pm 0.0055\\ 0.0288 \pm 0.0055\\ 0.0028 \pm 0.0058\\ 0.0058 \pm 0.0058\\ 0.005$	$\begin{array}{c} 3.9111\pm 0.0227\\ 0.9924\pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662\pm 0.0053\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.04354\pm 0.0093\\ 0.0245\pm 0.0076\\ 0.3438\pm 0.0072\\ 514.7695\pm 79.1941\\ 0.6256\pm 0.0879\\ 0.4891\pm 0.0027\\ 0.0034\pm 0.0007\\ 5.5540\pm 0.7614\\ 0.0156\pm 0.0034\\ 0.0156\pm 0.0034\\ 0.0156\pm 0.0034\\ 0.0155\pm 299.5600\\ 1.0937\pm 0.1214\\ 13.2967\pm 2.6439\\ 1146.0096\pm 231.6428\\ 2568.2981\pm 202.2223\\ 0.9402\pm 0.1533\\ 11.5305\pm 1.2613\\ \hline SGVNS [25]\\ 0.2872\pm 0.0016\\ 0.0069\pm 0.0021\\ 0.9228\pm 0.0021\\ 0.0447\pm 0.0016\\ 0.3898\pm 0.0009\\ 0.1429\pm 0.0228\\ 0.0022\\ 14.0096\pm 0.0022\\ 0.38988\pm 0.0009\\ 0.1429\pm 0.0216\\ 0.234\pm 0.021\\ 0.38988\pm 0.0009\\ 0.1429\pm 0.0219\\ 0.3066\pm 0.0002\\ 743.0472\pm 10.0315\\ 0.2734\pm 0.0211\\ 0.0467\pm 0.0073\\ 0.0271\pm 0.0037\\ 0.0271\pm 0.0037\\ 0.0271\pm 0.0037\\ 0.0271\pm 0.0037\\ 0.0271\pm 0.0047\\ 0.0073\\ 0.0271\pm 0.0037\\ 0.0073\\ 0.0271\pm 0.0047\\ 0.0073\\ 0.0073\\ 0.0271\pm 0.0047\\ 0.0073\\ 0.0073\\ 0.0071\\ 0.005\\ 0.0073\\ 0.0071\\ 0.005\\ 0.0073\\ 0.0071\\ 0.005\\ 0$	$\begin{array}{r} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS } [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ \hline 0.3462 \pm 0.0079\\ \hline 532.1621 \pm 91.2768\\ \hline 0.5999 \pm 0.0959\\ \hline 0.4882 \pm 0.0099\\ \hline 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ \hline 1116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ \hline 13.9822 \pm 2.8417\\ \hline 1094.1964 \pm 238.0447\\ \hline 2616.0463 \pm 212.5089\\ \hline 0.9704 \pm 0.1743\\ \hline 112956 \pm 1.4253\\ \hline NDVNS [26]\\ \hline 0.2872 \pm 0.0013\\ 0.0047 \pm 0.0013\\ \hline 0.2872 \pm 0.0013\\ 0.0047 \pm 0.0013\\ \hline 0.2872 \pm 0.0013\\ 0.0474 \pm 0.0019\\ 0.2889 \pm 0.0028\\ 0.0248 \pm 0.0018\\ 0.0477 \pm 0.009\\ 0.3898 \pm 0.0008\\ 0.1255 \pm 0.0277\\ 0.3006 \pm 0.0002\\ 742.7902 \pm 9.0852\\ 0.0288 \pm 0.0085\\ 0.0238 \pm 0.0056\\ \hline 0.0028 \pm 0.005\\ \hline 0.0028 \pm 0.0056\\ \hline 0.0056\\$
LSSRI TWIL MRIL GPIL BHGIT CIL TIT CIT CIT TWIL BHGIT CIL TIT TWIL DIT TWIT DIT TWIT DIT TWIT DIT TWIT DIT TWIT DIT TY UT74_010 MRIL GPIL BHGIT CIL TTT CIT TTT TTT DIT TTTT DIT TTTTT DIT TTTTTTTT	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0108\\ 0.9522 \pm 0.0030\\ 0.0333 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0075 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0033 \pm 0.0005\\ 580.2544 \pm 0.0236\\ 0.0013 \pm 0.0005\\ 580.2544 \pm 0.0233\\ 0.482 \pm 0.0036\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0106 \pm 0.0011\\ 0.0218 \pm 0.0007\\ 1.0218 \pm 0.0007\\ 1.0218 \pm 0.0007\\ 1.0218 \pm 0.0003\\ 1.5016 \pm 0.2518\\ 977.5146 \pm 1.6.282\\ 2708.0265 \pm 1.6.7196\\ 1.0711 \pm 0.0108\\ 10.4405 \pm 0.0802\\ 1.0711 \pm 0.0108\\ 10.4405 \pm 0.0802\\ 1.0711 \pm 0.0108\\ 10.4405 \pm 0.0082\\ 0.0825 \pm 1.6.7196\\ 0.0825 \pm 1.6.7196\\ 0.0025 \pm 0.0002\\ 0.0255 \pm 0.0003\\ 0.431 \pm 0.0002\\ 0.3928 \pm 0.0007\\ 0.575 \pm 0.0397\\ 0.3092 \pm 0.0000\\ 0.242 \pm 0.5499\\ 0.242 \pm 0.5499\\ 0.242 \pm 0.5499\\ 0.242 \pm 0.5499\\ 0.242 \pm 0.0045\\ 0.$	$\begin{array}{c} 3.7130 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline \mathbf{TS} \left[ 20 \right] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0013 \pm 0.0090 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 64.2013 \\ 0.0085 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0085 \pm 0.0073 \\ 0.0015 \pm 0.0027 \\ 0.0027 \pm 0.0025 \\ 1.0026 \pm 0.0025 \\ 1.0026 \pm 0.0025 \\ 1.0026 \pm 0.0025 \\ 1.0026 \pm 0.0025 \\ 1.0025 \pm 1.0698 \\ 1104.4573 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 1.0373 \\ \hline \mathbf{TS} \left[ 20 \right] \\ \hline 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.0002 \\ 0.0188 \pm 1.0073 \\ 1.0373 \\ \hline \mathbf{TS} \left[ 20 \right] \\ \hline 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.0002 \\ 0.0188 \pm 0.0013 \\ 0.3883 \pm 0.001 \\ 0.104 \pm 0.0372 \\ 0.2096 \pm 10.29887 \\ 0.2966 \pm 0.0237 \\ 0.2966 \pm 0.0237 \\ 0.2966 \pm 0.0034 \\ 0.0095 \pm 0.0064 \\ 0.0018 \\ 0.0195 \pm 0.0061 \\ 0.3685 \pm 0.3061 \\ 0.3685 \pm 0.3061 \\ 0.0054 \\ 0.0055 \\ 0.0061 \\ 0.0061 \\ 0.0055 \\ 0.0061$	$\begin{array}{l} 3.712\pm0.0228\\ 1.0165\pm0.0228\\ \hline 0.0228\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 525.7927\pm90.9895\\ 5.5636\pm0.7249\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.003\pm0.0014\\ 0.625\pm0.1622\\ 13.7298\pm2.8103\\ 1113.2937\pm2.35.4821\\ 2598,9274\pm210.2179\\ 0.9582\pm0.01748\\ 11.3953\pm1.4334\\ \hline 0.688\pm0.002\\ 0.007\pm0.002\\ 0.007\pm0.002\\ 0.007\pm0.002\\ 0.0013\pm0.0013\\ 0.3893\pm0.0011\\ 0.1413\pm0.0408\\ 0.3005\pm0.0033\\ 737.7558\pm14.1883\\ 0.2766\pm0.0037\\ 0.276\pm0.0027\\ 0.0076\pm0.0021\\ 0.0047\\ 0.00276\pm0.0027\\ 0.0047\\ 0.0047\\ 0.00276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.00047\\ 0.0076\pm0.00047\\ 0.0076\pm0.00047\\ 0.0276\pm0.00047\\ 0.0276\pm0.0004\\ 0.0047\\ 0.0276\pm0.0004\\ 0.00421\\ 0.0027\\ 0.00276\\ 0.0027\\ 0.$	$\begin{array}{c} 3.540\pm0.0233\\ 1.0007\pm0.0233\\ 1.0007\pm0.0233\\ \hline 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0009\\ 0.0788\pm0.0003\\ 0.0241\pm0.0006\\ 0.3454\pm0.00069\\ 524.7544\pm71.9468\\ 0.0069\\ 524.7544\pm71.9468\\ 0.0003\pm0.0006\\ 5.5627\pm0.0696\\ 0.015\pm0.0031\\ 0.0248\pm0.0015\\ 1.275.047\pm32.8792\\ 1.0501\pm0.1291\\ 1.35771\pm2.3868\\ 1114.6036\pm210.4013\\ 2592.8983\pm183.0573\\ 11.3491\pm1.1519\\ \hline 0.2886\pm0.0021\\ 0.0271\pm0.0033\\ 0.0286\pm0.0021\\ 0.0271\pm0.0033\\ 0.398\pm0.0011\\ 0.362\pm0.0437\\ 0.30261\pm5.2223\\ 0.3261\pm5.2223\\ 0.3251\pm0.336\\ 0.4848\pm0.00047\\ 0.3251\pm0.0338\\ 0.4848\pm0.00047\\ 0.3251\pm0.0038\\ 0.257\pm0.0033\\ 0.2657\pm0.0033\\ 0.2655\pm0.0033\\ 0.2655\pm0.003$	$\begin{array}{c} 4.0117 \pm 0.012\\ 0.0540 \pm 0.0117\\ \hline 1 VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0361 \pm 0.0033\\ \hline 0.0241 \pm 0.0083\\ \hline 0.0241 \pm 0.0085\\ \hline 0.0241 \pm 0.0087\\ \hline 0.0241 \pm 0.0087\\ \hline 0.0241 \pm 0.0087\\ \hline 0.0284 \pm 0.0087\\ \hline 0.0284 \pm 0.0087\\ \hline 0.0084 \pm 0.0082\\ \hline 0.0084 \pm 0.0015\\ \hline 0.0069 \pm 0.0015\\ \hline 0.0289 \pm 0.0005\\ $	$\begin{array}{c} 3.9760 \pm 0.0153\\ 0.9860 \pm 0.0153\\ 0.9860 \pm 0.0153\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0158 \pm 0.0147\\ 0.0768 \pm 0.0035\\ 0.0256 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489,8569 \pm 80.0607\\ 0.3415 \pm 0.0073\\ 489,8569 \pm 80.0607\\ 0.0659 \pm 0.00022\\ 0.0022 \pm 0.0007\\ 5.2615 \pm 0.77\\ 0.0167 \pm 0.0032\\ \pm 0.00011\\ 1260,3005 \pm 305.6108\\ 1.1265 \pm 0.77\\ 0.0167 \pm 0.0031\\ 122,9482 \pm 235.5594\\ 2497,4316 \pm 205.5728\\ 1129,9482 \pm 235.5594\\ 2497,4316 \pm 205.5728\\ 1129,9482 \pm 235.5594\\ 2497,4316 \pm 205.5728\\ 0.0025 \pm 0.0021\\ 0.0025 \pm 0.0021\\ 0.0025 \pm 0.0021\\ 0.0025 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3897 \pm 0.0002\\ 0.3005 \pm 0.0002\\ 0.3005 \pm 0.0003\\ 741,2396 \pm 11.9724\\ 0.2685 \pm 0.0225\\ 0.4875 \pm 0.0025\\ 0.0285$	$\begin{array}{c} 3.9111\pm 0.0227\\ 0.9924\pm 0.0267\\ \hline 0.9924\pm 0.0257\\ \hline 0.3662\pm 0.0053\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.0245\pm 0.0076\\ \hline 0.3438\pm 0.0077\\ \hline 0.3438\pm 0.0077\\ \hline 0.3438\pm 0.0077\\ \hline 0.4354\pm 0.0007\\ \hline 0.3438\pm 0.0077\\ 0.4381\pm 0.0027\\ 0.0025\pm 0.0077\\ 0.4891\pm 0.0027\\ 0.0025\pm 0.0077\\ 0.0025\pm 0.0014\\ 0.0156\pm 0.0034\\ 0.0253\pm 0.0014\\ 0.0152\pm 299.5600\\ 1.0937\pm 0.1214\\ 13.2967\pm 2.6439\\ 1.3267\pm 2.6439\\ 1.3267\pm 2.6439\\ 1.2568\pm 0.0014\\ 0.1533\\ 11.5305\pm 1.2613\\ SGVNS [25]\\ \hline 0.2872\pm 0.0016\\ 0.0059\pm 0.0021\\ 0.9228\pm 0.0021\\ 0.0447\pm 0.0010\\ 0.3898\pm 0.0009\\ 0.1429\pm 0.0299\\ 0.3006\pm 0.0002\\ 743.0472\pm 10.0315\\ 0.2774\pm 0.0047\\ 0.0073\\ 0.0271\pm 0.0047\\ 0.0073\\ 0.0271\pm 0.0047\\ 0.0073\\ 0.0271\pm 0.0047\\ 0.0073\\ 0.0271\pm 0.02457\\ \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0099\\ 0.3462 \pm 0.0079\\ 552.1621 \pm 91.2768\\ 0.4882 \pm 0.0097\\ 0.4882 \pm 0.0097\\ 0.4882 \pm 0.0097\\ 0.4882 \pm 0.0097\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ 25169 40.212 \pm 2.8417\\ 112956 \pm 1.14233\\ 112956 \pm 1.14233\\ 112956 \pm 1.14233\\ 112956 \pm 0.0013\\ 0.0029 \pm 0.0029\\ 0.3282 \pm 0.0013\\ 0.0029 \pm 0.0029\\ 0.3282 \pm 0.0013\\ 0.0099 \pm 0.0002\\ 0.9228 \pm 0.0013\\ 0.0099 \pm 0.0002\\ 0.3288 \pm 0.0018\\ 0.1255 \pm 0.0277\\ 0.3006 \pm 0.0002\\ 0.264 \pm 0.0096\\ 0.1255 \pm 0.0056\\ 0.0238 \pm 0.0056\\ 0.0238 \pm 0.0056\\ 0.0238 \pm 0.0055\\ 0.0238 \pm 0.0951\\ \end{array}$
LSSRI TWIL MRIL GPL BHGIT CLL TIT CLI TIT CLI TT CLI TT TWIL DGIT TWBIT BHIT DBIL DBIL DBIL DBIL DBIL DBIL DBIL DBIL	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0971 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0013 \pm 0.0005\\ \hline 0.3503 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0105 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0105 \pm 0.0017\\ 2.1583.0482 \pm 20106.9158\\ 15.0016 \pm 0.2518\\ 2708.0265 \pm 16.7196\\ 1.0711 \pm 0.0188\\ 1.0012 \pm 0.0002\\ 0.0067 \pm 0.00002\\ 0.0067 \pm 0.00002\\ 0.0057 \pm 0.0002\\ 0.0067 \pm 0.00002\\ 0.0057 \pm 0.0002\\ 0.0057 \pm 0.0002\\ 0.0057 \pm 0.0097\\ 0.1575 \pm 0.0397\\ 0.0092 \pm 0.0002\\ 0.0057 \pm 0.0039\\ 0.0092 \pm 0.0002\\ 0.0057 \pm 0.0039\\ 0.0092 \pm 0.0002\\ 0.0057 \pm 0.0039\\ 0.0092 \pm 0.0002\\ 0.0051 \pm 0.0003\\ 0.0151 \pm 0.0003\\ 0.0151 \pm 0.0003\\ 0.0151 \pm 0.0003\\ 0.0164 \pm 0.0001\\ 0.0105 \pm 0.0001\\ 0.0105 \pm 0.0001\\ 0.0105 \pm 0.0001\\ 0.0164 \pm 0.0001\\ $	$\begin{array}{c} 3.7130 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.0771 \pm 0.0018 \\ 0.0273 \pm 0.0018 \\ 0.0074 \pm 0.0038 \\ 0.013 \pm 0.009 \\ 0.0088 \pm 0.013 \\ 0.0015 \pm 0.0025 \\ 1.00247 \pm 0.0025 \\ 1.0025 \pm 1.9698 \\ 1104.4573 \pm 170.5992 \\ 12596.6638 \pm 1.9698 \\ 1104.4573 \pm 170.5992 \\ 12596.6638 \pm 1.9698 \\ 1104.4573 \pm 170.5992 \\ 12596.6638 \pm 1.9698 \\ 1104.4573 \pm 10.0025 \\ 1.4881 \pm 1.0373 \\ \hline TS [20] \\ 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.0002 \\ 0.9189 \pm 0.0025 \\ 0.0468 \pm 0.0013 \\ 0.3083 \pm 0.001 \\ 0.104 \pm 0.0372 \\ 0.3002 \pm 0.00023 \\ 0.0004 \pm 0.0034 \\ 0.0195 \pm 0.0064 \\ 18.5859 \pm 0.3061 \\ 0.0173 \pm 0.0003 \\ 0.1043 \pm 0.003 \\ 0.1043 \pm 0.003 \\ 0.1043 \pm 0.003 \\ 0.1043 \pm 0.0003 \\ $	$\begin{array}{l} 3.7672\pm0.0028\\ 1.0165\pm0.0228\\ 1.0165\pm0.0228\\ \hline GRASP-VND [20]\\ 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0094\\ 0.4872\pm0.0137\\ 0.003\pm0.0035\\ 5.5636\pm0.7249\\ 0.003\pm0.0014\\ 1634.3854\pm515.7399\\ 1.0625\pm0.1622\\ 13.7298\pm2.8103\\ 1113.2937\pm2.354821\\ 2598.9274\pm210.2179\\ 0.9582\pm0.1748\\ 11.3953\pm1.4334\\ \hline GRASP-VND [20]\\ 0.288\pm0.002\\ 0.097\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.002\\ 0.091\pm0.0002\\ 0.091\pm0.0002\\ 0.091\pm0.0002\\ 0.091\pm0.0003\\ 0.3005\pm0.0013\\ 0.305\pm0.0013\\ 0.305\pm0.0003\\ 0.0054\pm0.0003\\ 0.0076\pm0.0003\\ 0.006\pm0.0003\\ 0.0005\pm0.0003\\ 0.0005\pm0.0003\\ 0.0005\pm0.0003\\ 0.0005$	$\begin{array}{c} 3.540\pm0.223\\ 1.0007\pm0.0233\\ 1.0007\pm0.0238\\ 1.0007\pm0.0238\\ \hline 0.0268\pm0.00057\\ 0.0268\pm0.00057\\ 0.0268\pm0.00057\\ 0.0268\pm0.0003\\ 0.0241\pm0.0002\\ 0.314\pm0.0002\\ 0.3454\pm0.00093\\ 0.0241\pm0.0002\\ 0.3454\pm0.00069\\ 524.7544\pm71.9468\\ 0.0161\pm0.0033\\ 0.0248\pm0.0015\\ 1.0501\pm0.0031\\ 0.0248\pm0.0015\\ 1.0501\pm0.1291\\ 1.35771\pm2.3868\\ 1114.6036\pm2.10.4013\\ 2592.8983\pm183.0573\\ 0.9615\pm0.1398\\ 11.3491\pm1.1519\\ \hline GRASP-VND-TS [20]\\ 0.2886\pm0.0021\\ 0.0278\pm0.0033\\ 0.398\pm0.0013\\ 0.3286\pm0.0023\\ 0.398\pm0.0013\\ 0.3286\pm0.0023\\ 0.398\pm0.0013\\ 0.3286\pm0.0021\\ 0.035\pm0.0033\\ 0.399\pm0.0013\\ 0.3286\pm0.0023\\ 0.389\pm0.0013\\ 0.3285\pm0.0035\\ 0.389\pm0.0013\\ 0.3285\pm0.0035\\ 0.385\pm0.0035\\ 0.384\pm0.0047\\ 0.0255\pm0.0088\\ 8.7672\pm0.0033\\ 0.17\pm0.0003\\ 0.115\pm0.0033\\ 0.017\pm0.0003\\ 0.115\pm0.0033\\ 0.017\pm0.0003\\ 0.115\pm0.0033\\ 0.017\pm0.0003\\ 0.015\pm0.0033\\ 0.017\pm0.0003\\ 0.015\pm0.003\\ 0.015\pm0.003\\ 0.015\pm0.003\\ 0.015\pm0.003\\ 0.015\pm0.003\\ 0.005\pm0.003\\ 0$	$\begin{array}{c} 4.0117 \pm 0.0125\\ 0.05404 \pm 0.00117\\ \hline 1 VNS [21]\\ \hline 1 VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0371 \pm 0.0033\\ \hline 0.0371 \pm 0.0033\\ \hline 0.0341 \pm 0.0085\\ \hline 0.0241 \pm 0.0081\\ \hline 0.0284 \pm 0.0027\\ \hline 0.0284 \pm 0.0027\\ \hline 0.0284 \pm 0.0027\\ \hline 0.0284 \pm 0.0015\\ \hline 0.0284 \pm 0.0015\\ \hline 0.0255 \pm 0.0014\\ \hline 1.149.0032 \pm 297.29\\ \hline 1.1029 \pm 0.1134\\ \hline 1.149.0032 \pm 297.29\\ \hline 1.1029 \pm 0.1134\\ \hline 1.159.9004 \pm 224.468\\ \hline 2.559.9236 \pm 194.6549\\ \hline 0.9321 \pm 0.146\\ \hline 11.5937 \pm 1.2042\\ \hline 1VNS [21]\\ \hline 0.2869 \pm 0.0015\\ \hline 0.0069 \pm 0.0002\\ \hline 0.1287 \pm 0.0025\\ \hline 0.0005 \pm 0.0002\\ \hline 0.1287 \pm 0.0025\\ \hline 0.0005 \pm 0.0002\\ \hline 0.0237 \pm 0.0005\\ \hline 0.0207 \pm 0.0005\\ \hline 0.0005 \pm 0.0002\\ \hline 0.0005 \pm 0.0005\\ \hline 0.0005 \pm 0.0002\\ \hline 0.0005 \pm 0.0005\\ \hline 0.0005$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline \text{GVNS} [25]\\ \hline 0.365 \pm 0.00053\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0014\\ 0.0768 \pm 0.0035\\ 0.0256 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 0.0001\\ 0.4895 \pm 0.0022\\ 0.0032 \pm 0.0022\\ 0.0032 \pm 0.0022\\ 0.0035 \pm 0.0011\\ 1260.3055 \pm 0.051\\ 1229.652 \pm 0.653\\ 1129.8482 \pm 235.5594\\ 2497.4316 \pm 205.5728\\ 0.8899 \pm 0.1554\\ 11.9514 \pm 1.2803\\ \hline \text{GVNS} [25]\\ \hline 0.2874 \pm 0.0018\\ 0.0059 \pm 0.0002\\ 0.9225 \pm 0.0021\\ 0.9449 \pm 0.0018\\ 0.0059 \pm 0.0023\\ 0.9225 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3897 \pm 0.0003\\ 741.2396 \pm 11.9724\\ 0.2685 \pm 0.0023\\ 0.3005 \pm 0.0003\\ 741.2396 \pm 11.9724\\ 0.2685 \pm 0.0023\\ 0.4875 \pm 0.0053\\ 18.9333 \pm 0.2865\\ 0.0169 \pm 0.0002\\ 0.0028 \pm 0.0003\\ 0.1698 \pm 0.0003\\ 0.1698 \pm 0.0003\\ 0.1698 \pm 0.0003\\ 0.0169 \pm 0.0003\\ 0.0008 \pm 0.0003\\ 0.0169 \pm 0.0003\\ 0.0169 \pm 0.0003\\ 0.0005 \pm 0.0002\\ 0.0068 \pm 0.0003\\ 0.0068 \pm 0.0003\\ 0.0068 \pm 0.0003\\ 0.0058 \pm 0.0003\\ 0.0058 \pm 0.0003\\ 0.0058 \pm 0.0003\\ 0.0068	$\begin{array}{c} 3.9711 \pm 0.0227\\ 0.9924 \pm 0.0268\\ \hline SGVNS [25]\\ \hline 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0093\\ 0.0245 \pm 0.0076\\ \hline 0.3438 \pm 0.0077\\ \hline 0.4354 \pm 0.0097\\ \hline 0.4354 \pm 0.0097\\ 0.4354 \pm 0.0077\\ 0.44891 \pm 0.0027\\ 0.6256 \pm 0.0879\\ 0.4891 \pm 0.0027\\ 0.0034 \pm 0.0017\\ 0.0034 \pm 0.0017\\ 0.0034 \pm 0.0014\\ 1160.1052 \pm 2299.560\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 1.3267 \pm 2.6439\\ 1146.0096 \pm 2.31.6428\\ 2568.2981 \pm 202.2223\\ 0.9402 \pm 0.1533\\ 11.5305 \pm 1.2613\\ \hline SGVNS [25]\\ \hline 0.2872 \pm 0.0016\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0021\\ 0.0447 \pm 0.0010\\ 0.3898 \pm 0.0029\\ 0.1429 \pm 0.0299\\ 0.0306 \pm 0.0002\\ 0.3006 \pm 0.0010\\ 0.3898 \pm 0.0029\\ 0.3006 \pm 0.0021\\ 0.0472 \pm 10.0315\\ 0.2774 \pm 0.0241\\ 0.4867 \pm 0.0071\\ 0.0271 \pm 0.0049\\ 19.0032 \pm 0.2457\\ 0.0168 \pm 0.0002\\ 0.1071 \pm 0.0031\\ \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ 552.1621 \pm 91.2768\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 1116.3151 \pm 366.0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ 2616.0463 \pm 212.5089\\ 0.9704 \pm 0.1743\\ 11.2935 \pm 1.4253\\ \hline \text{NDVNS [26]}\\ 0.2872 \pm 0.0013\\ 0.0026 \pm 0.0002\\ 0.9228 \pm 0.0013\\ 0.0026 \pm 0.0002\\ 0.9228 \pm 0.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0013\\ 0.1255 \pm 0.0277\\ 0.306 \pm 0.0002\\ 0.4855 \pm 0.0257\\ 0.238 \pm 0.0051\\ 19.0085 \pm 0.0021\\ 0.1068 \pm 0.0002\\ 0.1068 \pm 0.0002\\ 0.1068 \pm 0.0002\\ 0.0062 \\ 0.0062 \\ 0.0002 \\ 0.0168 \pm 0.0002\\ 0.0062 \\ 0.0002 \\ 0.0168 \pm 0.0002\\ 0.0062 \\ 0.0002 \\ 0.0168 \pm 0.0002\\ \end{array}$
LSSRI           TWIL           MRIJ           GPL           BHGI↑           CI           TI↑           DGI↑           DGI↑           DGI↑           DGI↑           DGI↑           DBI↓           DGI↓           BHGI↑           CL↓           TT↑           BHGI↑           CL↓           TC↑           DGI↑           BHI↑           DGI↑           DGI↑           DH↑           BHI↑           DBH↑           BHI↑           DBH↑           BHI↑           DBH↑           BHI↑           BHI↑           BHI↑	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.131 \pm 0.0098\\ 0.3503 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.0511 \pm 0.028\\ 0.0015 \pm 0.0011\\ 5.90.2544 \pm 6.2935\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0164 \pm 0.0201\\ 0.018 \pm 0.0007\\ 1.2158.0483 \pm 20106.9153\\ 0.9033 \pm 0.0083\\ 15.0016 \pm 0.2518\\ 977.5146 \pm 16.282\\ 2708.0265 \pm 16.7196\\ 1.0711 \pm 0.0108\\ 10.4405 \pm 0.0842\\ \hline CNO-CC\\ \hline 0.2557 \pm 0.0000\\ 0.0256 \pm 0.0000\\ 0.0255 \pm 0.0000\\ 0.0256 \pm 0.0000\\ 0.0255 \pm 0.0000\\ 0.03928 \pm 0.0007\\ 0.30928 \pm 0.0007\\ 0.30928 \pm 0.0007\\ 0.30928 \pm 0.0007\\ 0.3093 \pm 0.0000\\ 0.55842 \pm 0.5499\\ 0.424 \pm 0.0039\\ 0.4051 \pm 0.0003\\ 0.0001 \pm 0.0000\\ 0.0511 \pm 0.0003\\ 0.0001 \pm 0.0000\\ 0.0511 \pm 0.0003\\ 0.0001 \pm 0.0000\\ 0.0511 \pm 0.0003\\ 0.0001\\ 0.1055 \pm 0.0007\\ 10.2882 \pm 68.3431 \\ 0.0882 \pm 68.3431 \\ 0.0882 \pm 68.3431 \\ 0.0002 \pm 0.00007\\ 0.0882 \pm 0.8342\\ 0.0007 \pm 0.0005 \pm 0.00007\\ 0.0055 \pm 0.00007\\ 0.00007\\ 0.0055 \pm 0.00007\\$	$\begin{array}{c} 3.7130 \pm 0.1332\\ 1.2860 \pm 0.1332\\ 1.2860 \pm 0.1332\\ 1.2800 \pm 0.0064\\ 0.0273 \pm 0.0018\\ 0.0073 \pm 0.0018\\ 0.0073 \pm 0.0018\\ 0.0085 \pm 0.0133\\ 0.0800 \pm 0.0040\\ 0.4314 \pm 0.008\\ 0.0113 \pm 0.009\\ 0.0113 \pm 0.009\\ 0.01449 \pm 0.0058\\ 514.6513 \pm 64.2013\\ 0.6085 \pm 0.0733\\ 0.4845 \pm 0.013\\ 0.0016 \pm 0.0012\\ 5.6667 \pm 0.6746\\ 0.00152 \pm 0.0025\\ 10.0247 \pm 0.0025\\ 11.0726 \pm 0.1325\\ 11.0726 \pm 0.1325\\ 11.0726 \pm 0.1325\\ 11.4881 \pm 1.0373\\ \hline 1104.4573 \pm 1.05698\\ 1104.4573 \pm 1.0598\\ 11.4881 \pm 1.0373\\ \hline 0.2904 \pm 0.0021\\ 0.0072 \pm 0.0002\\ 0.0189 \pm 0.0025\\ 0.00464 \pm 0.0013\\ 0.3883 \pm 0.001\\ 0.1044 \pm 0.0032\\ 0.40034 \pm 0.0033\\ 0.4053 \pm 0.0004\\ 18.5859 \pm 0.3066\\ 0.0173 \pm 0.0003\\ 0.1043 \pm 0.0039\\ 0.01043 \pm 0.0039\\ 0.1043 \pm 0.0039\\ 0.01043 \pm 0.0039\\ 0.0104 \pm 0.0031\\ 0.0104 \pm 0.0032\\ 0.0005 \pm 0.0005\\ 0.0173 \pm 0.0003\\ 0.0104 \pm 0.0031\\ 0.0104 \pm 0.0031\\ 0.0104 \pm 0.0031\\ 0.0004\\ 0.0051 \pm 0.0005\\ 0.0073 \pm 0.0003\\ 0.0104 \pm 0.0031\\ 0.0051\\ 0.0072 \pm 0.0005\\ 0.0051\\ 0.0072 \pm 0.0005\\ 0.0051\\ 0.0073 \pm 0.0003\\ 0.0051\\ 0.0073 \pm 0.0003\\ 0.0051\\ 0.0073 \pm 0.0003\\ 0.0051\\ 0.0073 \pm 0.0003\\ 0.0051\\ 0.0003\\ 0.0051\\ 0.0073 \pm 0.0003\\ 0.0031\\ 0.0041\\ 0.0031\\ 0.0031\\ 0.0031\\ 0.0031\\ 0.0043\\ 0.0031\\ 0.0043\\ 0.0031\\ 0.0043\\ 0.0031\\ 0.0043\\ 0.0031\\ 0.005$	$\begin{array}{l} 3.7612\pm0.0228\\ 1.0165\pm0.0228\\ \hline 0.0224\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.3405\pm0.0101\\ 0.0214\pm0.0044\\ 0.3405\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 0.6181\pm0.0941\\ 0.4872\pm0.0137\\ 0.003\pm0.0005\\ 5.5636\pm0.7249\\ 0.0151\pm0.0037\\ 0.0238\pm0.0014\\ 1634.3854\pm515.7399\\ 113.2937\pm235.48103\\ 1113.2937\pm235.48103\\ 1113.2937\pm235.48103\\ 113.3937\pm235.48103\\ 113.3937\pm235.48103\\ 113.3953\pm1.4334\\ \hline GRASP-VND\ [20]\\ 0.288\pm0.002\\ 0.007\pm0.0002\\ 0.0218\pm0.0013\\ 0.0028\pm1.00013\\ 0.3005\pm0.0003\\ 3.7622\pm0.315\\ 0.4851\pm0.0041\\ 0.4131\pm0.4048\\ 0.3005\pm0.0003\\ 737.7558\pm14.1883\\ 0.2762\pm0.315\\ 0.4851\pm0.0047\\ 0.0276\pm0.0084\\ 18.9210\pm0.0273\\ 0.0168\pm0.0004\\ 18.9210\pm0.2727\\ 0.0168\pm0.0004\\ 18.9210\pm0.2727\\ 0.0168\pm0.0004\\ 18.9210\pm0.2727\\ 0.0168\pm0.0004\\ 1129.7696\pm7.5384\\ \end{array}$	$\begin{array}{c} 3.540\pm0.233\\ 1.0007\pm0.0233\\ 1.0007\pm0.0238\\ 1.0007\pm0.0258\\ 0.0268\pm0.002\\ 0.368\pm0.00057\\ 0.0268\pm0.0003\\ 0.0268\pm0.0003\\ 0.0268\pm0.0003\\ 0.0454\pm0.00093\\ 0.0241\pm0.00062\\ 0.0454\pm0.00093\\ 0.0241\pm0.0002\\ 0.015\pm0.0003\\ 0.015\pm0.0003\\ 0.015\pm0.0031\\ 0.00248\pm0.0015\\ 1.0501\pm0.0031\\ 0.00248\pm0.0015\\ 1.0501\pm0.0031\\ 1.0501\pm0.203\\ 1.1519\\ 1.1519\\ \hline GRASP-VND-TS [20]\\ 0.2886\pm0.0023\\ 0.0035\pm0.0003\\ 0.2028\pm0.0013\\ 0.028\pm0.0003\\ 0.028\pm0.0003\\ 0.028\pm0.0003\\ 0.028\pm0.0003\\ 0.2285\pm0.0033\\ 0.028\pm0.0003\\ 0.3285\pm0.0033\\ 0.3285\pm0.0033\\ 0.3285\pm0.0033\\ 0.3285\pm0.0035\\ 0.0035\pm0.0003\\ 0.105\pm0.0003\\ 0.0034\\ 0.0003\\ 0.105\pm0.0003\\ 0.105\pm0.003\\ 0.$	$\begin{array}{c} 4.0117 \pm 0.012\\ 0.0540 \pm 0.0117\\ \hline 1 VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.077 \pm 0.0038\\ \hline 0.077 \pm 0.0033\\ \hline 0.077 \pm 0.0033\\ \hline 0.077 \pm 0.0033\\ \hline 0.073 \pm 0.0083\\ \hline 0.0241 \pm 0.0084\\ \hline 0.0241 \pm 0.0025\\ \hline 0.0242 \pm 0.0024\\ \hline 0.0255 \pm 0.0014\\ \hline 0.0255 \pm 0.0015\\ \hline 0.0225 \pm 0.0014\\ \hline 0.0255 \pm 0.0015\\ \hline 0.0264 \pm 0.022\\ \hline 0.0255 \pm 0.0014\\ \hline 0.0009 \pm 0.0158\\ \hline 0.0022 \pm 0.002\\ \hline 0.023 \pm 0.0002\\ \hline 0.024 \pm 0.0015\\ \hline 0.0269 \pm 0.0002\\ \hline 0.0269 \pm 0.0002\\ \hline 0.0247 \pm 0.0052\\ \hline 0.0277 \pm 0.0052\\ \hline 0.0247 \pm 0.0052\\ \hline 0.0261 \pm 0.0022\\ \hline 0.0161 \pm 0.0022\\ \hline 0.0151 \pm 0.002\\ \hline 0.0151 \pm 0.0022\\ \hline 0.0151 \pm 0.002\\ \hline 0.0151 \pm 0.0022\\ \hline 0.0151 \pm 0.002\\ \hline 0.0151 \pm 0.0$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0013\\ 0.0257 \pm 0.00147\\ 0.0768 \pm 0.0035\\ 0.4376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489.8569 \pm 80.0607\\ 0.659 \pm 0.0092\\ 0.0226 \pm 0.0073\\ 0.659 \pm 0.0002\\ 0.0025 \pm 0.0001\\ 1.265 \pm 0.077\\ 0.0167 \pm 0.0034\\ 0.025 \pm 0.0011\\ 1260.305 \pm 305.6108\\ 0.0025 \pm 0.0011\\ 1260.305 \pm 305.6108\\ 0.025 \pm 0.0011\\ 1265 \pm 0.1212\\ 12.4065 \pm 2.6831\\ 1.265 \pm 0.1212\\ 12.4065 \pm 2.6831\\ 1.2954 \pm 223.5594\\ 0.1554\\ 11.9514 \pm 1.2803\\ \hline 0.0069 \pm 0.0002\\ 0.0225 \pm 0.0024\\ 0.0049 \pm 0.0014\\ 0.0305 \pm 0.0003\\ 0.3005 \pm 0.0003\\ 741.2396 \pm 11.9724\\ 0.2685 \pm 0.0225\\ 0.4875 \pm 0.0053\\ 18.9333 \pm 0.2865\\ 0.0169 \pm 0.0003\\ 18.2766 \pm 4.64781\\ \end{array}$	$\begin{array}{c} 3.9711 \pm 0.0227\\ 0.9924 \pm 0.0226\\ \hline 0.9924 \pm 0.0251\\ \hline 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0019\\ 0.8158 \pm 0.0148\\ 0.0776 \pm 0.0036\\ 0.4354 \pm 0.0093\\ 0.0245 \pm 0.0076\\ \hline 0.3438 \pm 0.0072\\ 0.4891 \pm 0.0027\\ 0.0253 \pm 0.0014\\ 0.0156 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 0.0156 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 0.16256 \pm 2295560\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 115.0052 \pm 1.2613\\ 0.9402 \pm 0.1533\\ 11.5305 \pm 1.2613\\ 0.9402 \pm 0.1533\\ 11.5305 \pm 1.2613\\ 0.0069 \pm 0.00021\\ 0.0477 \pm 0.0012\\ 0.0271 \pm 0.0021\\ 0.0271 \pm 0.0021\\ 0.0477 \pm 0.0012\\ 0.0271 \pm 0.0049\\ 19.0032 \pm 0.2471\\ 0.0053 \pm 0.0021\\ 0.0271 \pm 0.0049\\ 113.72771 \pm 56.2674 \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0093\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0099\\ 0.3462 \pm 0.0079\\ 532.1621 \pm 91.2768\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 110.565 \pm 0.1485\\ 13.9822 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ 2616.9463 \pm 212.5089\\ 0.9704 \pm 0.1743\\ 11.2956 \pm 1.4253\\ \hline \text{NDVNS [26]}\\ 0.2872 \pm 0.0013\\ 0.2872 \pm 0.0013\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0018\\ 0.0447 \pm 0.0009\\ 0.3898 \pm 0.0008\\ 0.1255 \pm 0.0277\\ 0.3006 \pm 0.0002\\ 0.288 \pm 0.0018\\ 0.1255 \pm 0.0277\\ 0.3006 \pm 0.0002\\ 0.238 \pm 0.0018\\ 0.1255 \pm 0.0257\\ 0.2464 \pm 0.0196\\ 0.4855 \pm 0.0051\\ 19.0085 \pm 0.0028\\ 145.1594 \pm 6.36229\\ 145.1594 \pm 6.36229 \end{array}$
LSSRI TWIL MRIL BHGI CIL BHGI CIL BHGI CIL CHI TI TWBI CHI TWBI BHII CHI TWBI DBIL DBIL DBIL CIL CHI CHI CHI CHI CHI CHI CHI CHI CHI CHI	$\begin{array}{r} 4.0156 \pm 0.0106 \\ 0.9522 \pm 0.0108 \\ 0.9522 \pm 0.0098 \\ \hline \\ $	$\begin{array}{c} 3.7130 \pm 0.1332 \\ 1.2860 \pm 0.1332 \\ 1.2860 \pm 0.1332 \\ 1.2800 \pm 0.1332 \\ 0.0071 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0074 \pm 0.0018 \\ 0.0074 \pm 0.0018 \\ 0.0085 \pm 0.0133 \\ 0.0080 \pm 0.0040 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0134 \pm 0.0018 \\ 0.0015 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0016 \pm 0.0712 \\ 0.0025 \pm 0.0736 \\ 0.0015 \pm 0.0725 \\ 0.0025 \pm 0.0737 \\ 0.0247 \pm 0.0025 \\ 0.0025 \pm 0.0025 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 0.1325 \\ 1.0726 \pm 0.1325 \\ 1.04845 \pm 1.0373 \\ 1.04845 \pm 1.0373 \\ 1.04881 \pm 1.0373 \\ 1.04881 \pm 1.0373 \\ 1.04881 \pm 1.0373 \\ 1.0302 \pm 0.00025 \\ 0.0025 \\ 0.0025 \\ 0.0025 \\ 0.0025 \\ 0.0003 \\ 1.0204 \pm 0.0021 \\ 0.0072 \pm 0.0003 \\ 722.6965 \pm 1.29587 \\ 0.2926 \pm 0.0237 \\ 0.4904 \pm 0.0034 \\ 0.0034 \\ 0.0034 \pm 0.0033 \\ 0.1043 \pm 0.003 \\ 0.1043 \pm 0.003 \\ 0.7393 \pm 204.5990 \\ 0.8708 \pm 0.0233 \\ 10.4314 \pm 0.231 \\ 0.3414 \pm 0.233 \\ 10.441 \pm 0.234 \\ 10.441 \pm 0.241 \\ 10.451 \pm 0.004 \\ 10.551 \pm 0.004 \\ 10.551 \pm 0.004 \\ $	$\begin{array}{c} 3.7612 \pm 0.0228\\ 1.0165 \pm 0.0228\\ \hline \text{GRASP-VND} [20]\\ \hline 0.7703 \pm 0.0069\\ 0.0274 \pm 0.0022\\ 0.8072 \pm 0.0165\\ 0.0801 \pm 0.0044\\ 0.4305 \pm 0.0101\\ 0.0214 \pm 0.0044\\ 0.4305 \pm 0.0101\\ 0.0214 \pm 0.0044\\ 0.4305 \pm 0.0079\\ 525.7927 \pm 90.9895\\ 0.6181 \pm 0.0941\\ 0.4872 \pm 0.0137\\ 0.003 \pm 0.0005\\ 5.5636 \pm 0.7249\\ 0.0151 \pm 0.0037\\ 0.0238 \pm 0.0014\\ 1634.3854 \pm 515.7399\\ 1.0625 \pm 0.1622\\ 113.2938 \pm 2.8103\\ 1113.2937 \pm 235.4821\\ 2598.9274 \pm 210.2179\\ 0.9582 \pm 0.1748\\ 11.3953 \pm 1.4334\\ \hline \text{GRASP-VND} [20]\\ \hline 0.288 \pm 0.002\\ 0.007 \pm 0.0002\\ 0.0218 \pm 0.0026\\ 0.0452 \pm 0.0013\\ 0.3893 \pm 0.0011\\ 0.1413 \pm 0.0408\\ 0.3005 \pm 0.0003\\ 737.7558 \pm 14.1883\\ 0.2762 \pm 0.0315\\ 0.4851 \pm 0.0047\\ 0.0276 \pm 0.00315\\ 0.4851 \pm 0.0047\\ 0.0276 \pm 7.53984\\ 1.9270 \pm 7.5384\\ 0.861 \pm 0.0158\\ 107057 \pm 3.0305 \\ \end{array}$	$\begin{array}{c} 3.5940 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ 1.0007 \pm 0.0233 \\ \hline 0.0368 \pm 0.0027 \\ 0.0268 \pm 0.0027 \\ 0.0268 \pm 0.0027 \\ 0.0268 \pm 0.0037 \\ 0.0268 \pm 0.0037 \\ 0.0264 \pm 0.0093 \\ 0.0241 \pm 0.0069 \\ 0.3454 \pm 0.00015 \\ 1.00031 \pm 0.00041 \\ 0.0033 \pm 0.0006 \\ 5.5627 \pm 0.6696 \\ 0.015 \pm 0.0031 \\ 0.0248 \pm 0.0015 \\ 1.275.047 \pm 4.32.8792 \\ 1.0501 \pm 0.1291 \\ 1.35771 \pm 2.3868 \\ 11.3491 \pm 1.1519 \\ \hline 0.886 \pm 0.0021 \\ 0.0071 \pm 0.0003 \\ 0.2088 \pm 0.0021 \\ 0.0071 \pm 0.0003 \\ 0.2028 \pm 0.0021 \\ 0.0071 \pm 0.0003 \\ 0.2028 \pm 0.0021 \\ 0.0035 \pm 0.0021 \\ 0.0035 \pm 0.0036 \\ 0.0457 \pm 0.0036 \\ 0.2057 \pm 0.0035 \\ 0.2857 \pm 0.0035 \\ 0.0478 \pm 0.0047 \\ 0.0037 \pm 0.0003 \\ 0.1063 \pm 0.0003 \\ 0.1074 \pm 0.0003 \\ 0.1075 \pm 0.0003 \\ 0.1074 \pm 0$	$\begin{array}{c} 4.0117 \pm 0.012 \\ 0.0540 \pm 0.0117 \\ \hline 1 VNS [21] \\ \hline 1 VNS [21] \\ \hline 0.3657 \pm 0.005 \\ 0.0261 \pm 0.0018 \\ \hline 0.0261 \pm 0.0018 \\ \hline 0.077 \pm 0.0033 \\ \hline 0.077 \pm 0.0033 \\ \hline 0.077 \pm 0.0033 \\ \hline 0.073 \pm 0.0068 \\ \hline 0.0241 \pm 0.00871 \\ \hline 0.0068 \pm 74.9872 \\ \hline 0.0264 \pm 0.00871 \\ \hline 0.0243 \pm 0.0068 \\ \hline 0.0241 \pm 0.00871 \\ \hline 0.0264 \pm 0.00871 \\ \hline 0.0255 \pm 0.0015 \\ \hline 0.0325 \pm 0.0015 \\ \hline 0.0325 \pm 0.0015 \\ \hline 0.0325 \pm 0.0015 \\ \hline 0.0265 \pm 0.0015 \\ \hline 0.0268 \pm 0.0015 \\ \hline 0.0068 \pm 0.0002 \\ \hline 0.0258 \pm 0.0015 \\ \hline 0.0068 \pm 0.0002 \\ \hline 0.0268 \pm 0.0015 \\ \hline 0.0068 \pm 0.0002 \\ \hline 0.0268 \pm 0.0015 \\ \hline 0.0068 \pm 0.0002 \\ \hline 0.0269 \pm 0.0015 \\ \hline 0.0068 \pm 0.0002 \\ \hline 0.0269 \pm 0.00015 \\ \hline 0.0068 \pm 0.0002 \\ \hline 0.0269 \pm 0.0002 \\ \hline 0.0005 \pm 0.0002 \\ \hline 0.0005 \pm 0.0002 \\ \hline 0.027 \pm 0.0073 \\ \hline 0.0005 \pm 0.0002 \\ \hline 0.0064 \pm 0.0002 \\ \hline 0.027 \pm 0.0037 \\ \hline 18.9646 \pm 0.0002 \\ \hline 0.0061 \pm 0.0037 \\ \hline 0.0061 \pm 0.0037 \\ \hline 0.0061 \pm 0.0002 \\ \hline 0.0061 \pm 0.000$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline 0.9860 \pm 0.0158\\ \hline 0.9851 \pm 0.015\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0013\\ 0.0257 \pm 0.0013\\ 0.0768 \pm 0.0035\\ 0.4376 \pm 0.0092\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0073\\ 0.3415 \pm 0.0022\\ 0.0022 \pm 0.0007\\ 0.52 \pm 0.0001\\ 0.4895 \pm 0.0022\\ 0.0025 \pm 0.0001\\ 1260 \pm 0.025\\ 0.0015 \pm 0.77\\ 0.0167 \pm 0.0034\\ 0.025 \pm 0.0011\\ 1260 \pm 0.035 \pm 0.0011\\ 1260 \pm 0.035 \pm 0.0011\\ 1260 \pm 0.035 \pm 0.0011\\ 1260 \pm 2.6631\\ 1129, 8482 \pm 235.5594\\ 0.1524 \pm 0.0018\\ 0.0069 \pm 0.0022\\ 0.0225 \pm 0.0024\\ 0.0248 \pm 0.0018\\ 0.0069 \pm 0.0003\\ 0.0305 \pm 0.0003\\ 741 \pm 0.0018\\ 0.0268 \pm 10.9225\\ 0.0288 \pm 0.0025\\ 0.0058 \pm 0.0025\\ 0.0168 \pm 0.0033\\ 0.982766 \pm 6.4781\\ 0.855 \pm 0.0187\\ 0.055 \pm 0.00187\\ 0.055 \pm 0.$	$\begin{array}{c} 3.9111 \pm 0.0272 \\ 0.9924 \pm 0.0268 \\ \hline SGVNS [25] \\ \hline 0.3662 \pm 0.0053 \\ 0.0262 \pm 0.0019 \\ 0.8158 \pm 0.0148 \\ 0.0776 \pm 0.0036 \\ 0.4354 \pm 0.0093 \\ 0.0245 \pm 0.0072 \\ 0.3438 \pm 0.0072 \\ 0.3438 \pm 0.0072 \\ 0.3438 \pm 0.0072 \\ 0.3438 \pm 0.0072 \\ 0.4354 \pm 0.0007 \\ 0.4354 \pm 0.0007 \\ 0.4354 \pm 0.0007 \\ 0.4354 \pm 0.0007 \\ 0.4354 \pm 0.0017 \\ 0.4354 \pm 0.0017 \\ 0.4354 \pm 0.0017 \\ 0.0156 \pm 0.0314 \\ 0.0156 \pm 0.0014 \\ 0.0253 \pm 0.0014 \\ 0.1937 \pm 0.1214 \\ 0.3267 \pm 2.6439 \\ 1146.0096 \pm 231.6428 \\ 2568.2981 \pm 202.2223 \\ 0.9402 \pm 0.1533 \\ 11.5305 \pm 1.2613 \\ \hline SGVNS [25] \\ 0.2872 \pm 0.0016 \\ 0.0069 \pm 0.0002 \\ 0.9228 \pm 0.0021 \\ 0.0474 \pm 0.0016 \\ 0.02734 \pm 0.0021 \\ 0.0274 \pm 0.0021 \\ 0.0073 \pm 0.0245 \\ 0.0073 \\ 0.0071 \pm 0.0031 \\ 113.7271 \pm 55.2674 \\ 0.8545 \pm 0.0200 \\ 108 118 \pm 0.2000 \\ 10$	$\begin{array}{c} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS } [26]\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0089\\ \hline 0.3462 \pm 0.0079\\ \hline 0.3462 \pm 0.0079\\ \hline 0.3462 \pm 0.0079\\ \hline 0.3462 \pm 0.0095\\ \hline 0.4882 \pm 0.0099\\ \hline 0.4882 \pm 0.0099\\ \hline 0.4882 \pm 0.0099\\ \hline 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ \hline 1116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ \hline 1.39822 \pm 2.8417\\ \hline 1094.1964 \pm 238.0447\\ \hline 1094.1964 \pm 238.0447\\ \hline 1094.1964 \pm 238.0447\\ \hline 1094.1964 \pm 238.0447\\ \hline 0.8722 \pm 0.0013\\ \hline 0.0282 \pm 0.4013\\ \hline 0.2872 \pm 0.0013\\ \hline 0.288 \pm 0.0002\\ \hline 0.228 \pm 0.0018\\ 0.0474 \pm 0.0096\\ 0.4855 \pm 0.0077\\ \hline 0.3006 \pm 0.0002\\ \hline 742.7902 \pm 9.0852\\ 0.264 \pm 0.0196\\ 0.4855 \pm 0.0056\\ 0.0028 \pm 0.0051\\ \hline 100.0883 \pm 0.0051\\ \hline 0.0167 \pm 0.0028\\ 145.1594 \pm 6.36229\\ 0.8587 \pm 0.0160\\ \hline 1082695 \pm 1.6006\\ \hline 1082695 \pm 1.6006\\ \hline 1082695 \pm 1.6006\\ \hline 1082695 \pm 1.6006\\ \hline 0.8655 \pm 0.0061\\ \hline 109.0085 \pm 0.0051\\ \hline 0.1855 \pm 0.0061\\ \hline 1082695 \pm 1.6000\\ \hline 0.8695 \pm 1.6000\\ \hline$
LSSRI TWIL MRIL GPL BHGI CIL BHGI CIL BHGI CIL BHGI CIL CHI CHI CHI CHI CHI CHI CHI CHI CHI CHI	$\begin{array}{c} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline \\ \hline \\ CNO-CC\\ \hline \\ 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.4025 \pm 0.0026\\ 0.0131 \pm 0.0098\\ 0.3603 \pm 0.0005\\ 0.5811 \pm 0.0298\\ 0.3603 \pm 0.0005\\ 580.2544 \pm 6.2935\\ 0.8511 \pm 0.0243\\ 0.482 \pm 0.0036\\ 0.0015 \pm 0.0011\\ 59131 \pm 0.0761\\ 0.0106 \pm 0.0211\\ 59131 \pm 0.0761\\ 0.0106 \pm 0.0001\\ 0.2188 \pm 0.0007\\ 0.12188 \pm 0.0007\\ 0.2188 \pm 0.0002\\ 0.4025 \pm 16.7196\\ 1.0711 \pm 0.0102\\ 0.0032 \pm 0.0002\\ 0.0057 \pm 0.0002\\ 0.0067 \pm 0.0000\\ 0.9256 \pm 0.0002\\ 0.0067 \pm 0.0000\\ 0.9256 \pm 0.0003\\ 0.431 \pm 0.0007\\ 0.1575 \pm 0.0002\\ 0.0067 \pm 0.0000\\ 0.9256 \pm 0.0003\\ 0.4957 \pm 0.0045\\ 0.0311 \pm 0.0084\\ 0.0017\\ 0.1575 \pm 0.0045\\ 0.0311 \pm 0.0045\\ 0.0114 \pm 0.0045\\ 0.0017\\ 0.2882 \pm 0.63341\\ 0.8216 \pm 0.0124\\ 111.3492 \pm 0.4285\\ 0.524.924 \pm 1.55411\\ 0.0023\\ 0.8216 \pm 0.0124\\ 11.3492 \pm 0.4285\\ 0.0144 \pm 1.5541\\ 0.0023\\ 0.0164 \pm 1.5541\\ 0.0023\\ 0.0007\\ 0.$	$\begin{array}{c} 3.7130 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline {\rm TS}  [20] \\ \hline 0.3701 \pm 0.0064 \\ 0.0273 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0073 \pm 0.0018 \\ 0.0013 \pm 0.0090 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.013 \pm 0.0098 \\ 514.6513 \pm 64.2013 \\ 0.00685 \pm 0.0733 \\ 0.4845 \pm 0.013 \\ 0.0015 \pm 0.0027 \\ 0.0027 \pm 0.0025 \\ 1.0325 \pm 1.0698 \\ 1104.4573 \pm 170.5992 \\ 24404.8432 \pm 1.0698 \\ 1104.4573 \pm 170.5992 \\ 2596.6638 \pm 149.8041 \\ 1.0373 \\ 1.0373 \\ 1.0373 \\ 1.0373 \\ 1.0373 \\ 1.0373 \\ 1.0372 \\ 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.0002 \\ 0.9189 \pm 0.0025 \\ 0.0468 \pm 0.0013 \\ 0.3883 \pm 0.001 \\ 0.104 \pm 0.0372 \\ 0.3022 \pm 0.0003 \\ 0.1043 \pm 0.003 \\ 0.1043 \pm 0.003 \\ 1.0433 \pm 0.003 \\ 0.1043 \pm 0.003 \\ 1.0433 \pm 0.003 \\ 0.1043 \pm 0.003 \\ 1.03433 \pm 0.023 \\ 1.034431 \pm 2.7301 \\ 3796.7629 \pm 99.1802 \\ \end{array}$	$\begin{array}{c} 3.712\pm0.0228\\ 1.0165\pm0.0228\\ \hline 0.0228\\ \hline 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0069\\ 0.0274\pm0.0165\\ 0.0801\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.4305\pm0.0101\\ 0.0214\pm0.0044\\ 0.3458\pm0.0079\\ 525.7927\pm90.9895\\ 525.7927\pm90.9895\\ 5.5636\pm0.0079\\ 5.5636\pm0.0015\\ 0.003\pm0.0005\\ 5.5636\pm0.0005\\ 0.0051\pm0.0035\\ 0.003\pm0.0005\\ 1.0228\pm0.0014\\ 0.0625\pm0.1622\\ 13.7298\pm2.8103\\ 1113.2937\pm2.35.4821\\ 2598.9274\pm210.2179\\ 598.9274\pm210.2179\\ 598.9274\pm210.2179\\ 598.9274\pm210.2179\\ 598.9274\pm210.2179\\ 0.028\pm0.002\\ 0.007\pm0.0002\\ 0.007\pm0.0002\\ 0.007\pm0.0002\\ 0.007\pm0.0002\\ 0.00452\pm0.0013\\ 0.3803\pm0.0011\\ 0.1413\pm0.0408\\ 0.3005\pm0.0003\\ 737.7558\pm14.1883\\ 0.2762\pm0.0013\\ 0.3893\pm0.0011\\ 0.1413\pm0.0047\\ 0.0276\pm0.0034\\ 18.9210\pm0.2727\\ 0.0169\pm0.0003\\ 0.1068\pm0.0003\\ 0.1068\pm0.0003\\ 0.006\pm1.00138\\ 107.0575\pm3.3984\\ 0.861\pm0.0158\\ 107.0575\pm3.3096\\ 3669.0281\pm105.7227 \end{array}$	$\begin{array}{c} 3.540\pm0.0233\\ 1.0007\pm0.0233\\ 1.0007\pm0.0238\\ 1.0007\pm0.0238\\ \hline 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0007\\ 0.0268\pm0.0003\\ 0.0241\pm0.0002\\ 0.3154\pm0.0003\\ 0.0241\pm0.0002\\ 0.3454\pm0.00069\\ 524.7544\pm71.9468\\ 0.0033\pm0.0006\\ 5.5627\pm0.0699\\ 0.4907\pm0.0001\\ 0.003\pm0.0006\\ 5.5627\pm0.0699\\ 0.015\pm0.0031\\ 0.0248\pm0.0015\\ 1275.047\pm32.8792\\ 1.0501\pm0.1291\\ 13.5771\pm2.3868\\ 1114.6036\pm210.4013\\ 2592.8983\pm183.0573\\ 11.3491\pm1.1519\\ 1.3491\pm1.1519\\ 1.3491\pm1.1519\\ 0.2886\pm0.0021\\ 0.0037\pm0.0033\\ 0.0245\pm0.0031\\ 0.0245\pm0.0031\\ 0.02886\pm0.0021\\ 0.0071\pm0.0003\\ 0.9208\pm0.0021\\ 0.0071\pm0.0003\\ 0.2865\pm0.0021\\ 0.0071\pm0.0003\\ 0.2857\pm0.0013\\ 0.3261\pm15.2223\\ 0.0457\pm0.0013\\ 0.3261\pm0.0033\\ 0.017\pm0.0003\\ 0.003\pm127.8648\pm127.8848\pm127.8848\pm127.8848\pm127.8848\pm127.8848\pm127.8848\pm127.8848\pm127.8848\pm0.0003\\ 0.0039\pm0.0039\\ 0.0039\pm0.0039\\ 0.0039\pm0.0039\\ 0.0039\pm0.0033\\ 0.003\pm0.0033\\ 0.017\pm0.0003\\ 0.003\pm0.0033\\ 0.003\pm0.0034\\ 0.003\pm0.0033\\ 0.003\pm0.0034\\ 0.003\pm0.0034\\ 0.003\pm0.0033\\ 0.003\pm0.0034\\ 0.$	$\begin{array}{c} 4.0117 \pm 0.012\\ 0.0540 \pm 0.0117\\ \hline 1 VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0451 \pm 0.0038\\ \hline 0.073 \pm 0.0033\\ \hline 0.0241 \pm 0.0085\\ \hline 0.0241 \pm 0.0085\\ \hline 0.0241 \pm 0.0087\\ \hline 0.0241 \pm 0.0087\\ \hline 0.0241 \pm 0.0087\\ \hline 0.0284 \pm 0.0087\\ \hline 0.0084 \pm 0.0087\\ \hline 0.0034 \pm 0.0026\\ \hline 0.0034 \pm 0.0027\\ \hline 0.0034 \pm 0.0006\\ \hline 5.5409 \pm 0.0027\\ \hline 0.0034 \pm 0.0006\\ \hline 5.5409 \pm 0.0027\\ \hline 0.0034 \pm 0.0026\\ \hline 0.0032 \pm 0.0006\\ \hline 0.0034 \pm 0.0006\\ \hline 0.0038 \pm 0.0002\\ \hline 0.0188 \pm 0.0002\\ \hline 1.1503 9004 \pm 224.468\\ \hline 0.0032 \pm 0.0015\\ \hline 0.0069 \pm 0.0015\\ \hline 0.0069 \pm 0.0015\\ \hline 0.0069 \pm 0.0015\\ \hline 0.0069 \pm 0.0015\\ \hline 0.0279 \pm 0.0005\\ \hline 0.2781 \pm 0.0005\\ \hline 0.0278 \pm 0.0005\\ \hline 0.0168 \pm 0.0002\\ \hline 0.0056 \pm 0.0002\\ \hline 0.0056 \pm 0.0002\\ \hline 0.0056 \pm 0.0026\\ \hline 0.0168 \pm 0.0002\\ \hline 0.0056 \pm 0.0026\\ \hline 0.0056 \pm 0.0056\\ \hline 0.0056 \pm 0.0$	$\begin{array}{c} 3.9760 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ \hline 0.9860 \pm 0.0158\\ \hline 0.9851 \pm 0.013\\ 0.0257 \pm 0.0003\\ 0.0257 \pm 0.0013\\ 0.0255 \pm 0.00147\\ 0.0768 \pm 0.0035\\ 0.0226 \pm 0.0076\\ 0.3415 \pm 0.0073\\ 489,8569 \pm 80.0607\\ 0.3415 \pm 0.0073\\ 489,8569 \pm 80.0607\\ 0.0022 \pm 0.0007\\ 0.0022 \pm 0.0007\\ 0.0025 \pm 0.0027\\ 0.0005 \pm 0.0021\\ 0.0005 \pm 0.0011\\ 1260,0305 \pm 0.0021\\ 124065 \pm 0.0021\\ 124065 \pm 0.0011\\ 1226,0305 \pm 0.0021\\ 0.0055 \pm 0.0011\\ 0.0059 \pm 0.0023\\ 0.0025 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3807 \pm 0.0002\\ 0.0025 \pm 0.0024\\ 0.0449 \pm 0.0011\\ 0.3807 \pm 0.0005\\ 0.00059 \pm 0.0023\\ 0.0059 \pm 0.0023\\ 0.0285 \pm 0.0025\\ 0.0169 \pm 0.0003\\ 0.168 \pm 0.0033\\ 98.2766 \pm 46.4781\\ 0.855 \pm 0.018\\ 107.536 \pm 2.7541\\ 3652.0113 \pm 95.968\\ \end{array}$	$\begin{array}{c} 3.9111 \pm 0.0224\\ 0.9924 \pm 0.0268\\ \hline \\ \hline \\ $ SGVNS [25] \\ \hline \\ 0.3662 \pm 0.0053\\ 0.0262 \pm 0.0013\\ 0.0262 \pm 0.0013\\ 0.0262 \pm 0.0013\\ 0.0264 \pm 0.0093\\ 0.0276 \pm 0.0036\\ 0.4354 \pm 0.0097\\ \hline \\ 0.3438 \pm 0.0077\\ 0.35540 \pm 0.07614\\ 0.0156 \pm 0.0034\\ 0.0156 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 0.0156 \pm 0.0034\\ 0.0253 \pm 0.0014\\ 0.152 \pm 299.5600\\ 1.0937 \pm 0.1214\\ 13.2967 \pm 2.6439\\ 1.3267 \pm 2.6439\\ 1.3605 \pm 2.6439\\ 0.5005 \pm 0.0014\\ 0.1533 \pm 1.2613\\ SGVNS [25]\\ \hline \\ 0.2872 \pm 0.0016\\ 0.0005 \pm 0.0002\\ 0.9228 \pm 0.0021\\ 0.0447 \pm 0.0016\\ 0.0069 \pm 0.0002\\ 0.9228 \pm 0.0021\\ 0.0447 \pm 0.0016\\ 0.3898 \pm 0.0009\\ 0.1429 \pm 0.0299\\ 0.3006 \pm 0.0002\\ 743.0472 \pm 10.0315\\ 0.02714 \pm 0.0249\\ 0.02714 \pm 0.0249\\ 0.02714 \pm 0.0219\\ 0.3073 \pm 0.2457\\ 0.0168 \pm 0.0007\\ 0.0071 \pm 0.0031\\ 13.7271 \pm 56.2674\\ 0.8545 \pm 0.0200\\ 18.1181 \pm 2.0899\\ 3631.5602 \pm 73.2004 \\ 273.0472 \pm 73.2004 \\ \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ \hline 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ \hline 0.0268 \pm 0.0099\\ \hline 0.3462 \pm 0.0079\\ \hline 5.21621 \pm 91.2768\\ \hline 0.52990 \pm 0.0959\\ \hline 0.4882 \pm 0.0099\\ 0.4882 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0018\\ 0.0038\\ 0.0241 \pm 0.0038\\ 0.0241 \pm 0.0038\\ 0.0241 \pm 0.0038\\ \hline 0.0704 \pm 0.1488\\ 1.39822 \pm 2.8417\\ \hline 1094.1964 \pm 238.0447\\ \hline 2516 9463 \pm 212.5089\\ \hline 0.9704 \pm 0.1733\\ \hline 1.2956 \pm 1.4253\\ \hline 0.0028 \pm 0.0013\\ 0.0099 \pm 0.0002\\ 0.3258 \pm 0.0013\\ 0.0028 \pm 0.0012\\ 0.255 \pm 0.0013\\ 0.0028 \pm 0.0012\\ 0.255 \pm 0.0013\\ 0.0028 \pm 0.0012\\ 0.264 \pm 0.0012\\ 0.0288 \pm 0.0005\\ 0.0288 \pm 0.0056\\ 0.0288 \pm 0.0056\\ 0.0288 \pm 0.0002\\ 0.1067 \pm 0.0022\\ 145.1594 \pm 3.6229\\ 0.8587 \pm 0.0169\\ 0.0028 \pm 0.0102\\ 0.0085 \pm 0.0028\\ 0.5594 \pm 0.01649\\ 0.6587 \pm 0.0169\\ 0.0028 \pm 0.01649\\ 0.0028 \pm 0.0102\\ 0.0167 \pm 0.0028\\ 0.0028 \pm 0.0102\\ 0.0055 \pm 0.0105\\ 0.0028 \pm 0.0002\\ 0.0055 \pm 0.0056\\ 0.0028 \pm 0.0002\\ 0.0055 \pm 0.005\\ 0.0002\\ 0.0055 \pm 0.0002\\ 0$
LSSRI TWIL MRIL GPL BHGIT CLL TIT RLIT CHIT RUIT WGIT DIT TWBIT BHIT BHIT BHIT DBL DBL DBL DBL DBL DBL DBL DBL DBL DBL	$\begin{array}{r} 4.0156 \pm 0.0106\\ 0.9522 \pm 0.0098\\ \hline CNO-CC\\ \hline 0.3972 \pm 0.0030\\ 0.0335 \pm 0.0006\\ 0.7605 \pm 0.0045\\ 0.0971 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0071 \pm 0.0018\\ 0.0005 \pm 0.0005\\ \hline 0.0313 \pm 0.0095\\ \hline 0.0313 \pm 0.0095\\ 0.3503 \pm 0.0005\\ 0.0015 \pm 0.0011\\ 5.9131 \pm 0.0761\\ 0.0106 \pm 0.001\\ 0.0218 \pm 0.0007\\ 1.233 0.483 \pm 20106.9152\\ 1.5014 \pm 0.0238\\ 1.5016 \pm 0.0251\\ 1.57146 \pm 1.6.232\\ 2708.0265 \pm 1.6.7196\\ 1.0711 \pm 0.0108\\ 1.0711 \pm 0.0108\\ 1.0715 \pm 0.0397\\ 0.3025 \pm 0.0002\\ 0.0067 \pm 0.0000\\ 0.9256 \pm 0.0003\\ 0.431 \pm 0.0002\\ 0.0057 \pm 0.0039\\ 0.431 \pm 0.0002\\ 0.0057 \pm 0.0039\\ 0.431 \pm 0.0002\\ 0.0392 \pm 0.0007\\ 0.1575 \pm 0.0397\\ 0.3092 \pm 0.0002\\ 0.0431 \pm 0.0002\\ 0.0431 \pm 0.0002\\ 0.0392 \pm 0.0007\\ 0.1575 \pm 0.0397\\ 0.3092 \pm 0.0002\\ 0.0164 \pm 0.0001\\ 0.1095 \pm 0.0007\\ 111.3492 \pm 0.4285\\ 3524 9234 \pm 13.5411\\ 3411.969 \pm 2.739\\ 3326 0.0007\\ 3307 0.0007\\ 0.0007\\ 0.0001\\ 0.0051 \pm 1.35417\\ 311.969 \pm 2.739\\ 3326 0.0007\\ 0.0007\\ 0.0007\\ 0.0007\\ 0.0007\\ 0.0007\\ 0.0007\\ 0.0007\\ 0.0001\\ 0.0001\\ 0.0002 \pm 0.0007\\ 0.0001\\ 0.0002 \pm 0.0007\\ 0.0002 \pm 0.0000\\ 0.00002 \pm 0.0000\\ 0.00002 \pm 0.0000\\ 0.00002 \pm 0.0000\\ 0.00000 \pm 0.$	$\begin{array}{c} 3.7130 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2860 \pm 0.1352 \\ 1.2800 \pm 0.1796 \\ \hline TS [20] \\ \hline 0.0771 \pm 0.0018 \\ 0.0273 \pm 0.0018 \\ 0.0074 \pm 0.0038 \\ 0.013 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.0113 \pm 0.009 \\ 0.013 \pm 0.009 \\ 0.013 \pm 0.009 \\ 0.013 \pm 0.0098 \\ 0.013 \pm 0.0098 \\ 0.013 \pm 0.0013 \\ 0.0085 \pm 0.013 \\ 0.0085 \pm 0.013 \\ 0.0085 \pm 0.013 \\ 0.0015 \pm 0.0012 \\ 0.0055 \pm 0.0025 \\ 24404 \\ 8432 \pm 0.0025 \\ 24404 \\ 8432 \pm 1.0025 \\ 24404 \\ 8432 \pm 1.0005 \\ 1.0726 \pm 0.1328 \\ 1.0726 \pm 0.1328 \\ 1.0726 \pm 1.14881 \\ 1.0373 \\ \hline TS [20] \\ \hline 0.2904 \pm 0.0021 \\ 0.0072 \pm 0.0002 \\ 0.104 \pm 0.0037 \\ 0.0032 \\ 0.0064 \\ 1.2958 \\ 0.0064 \\ 0.0132 \\ 0.0064 \\ 1.2958 \\ 0.0064 \\ 0.0155 \pm 0.0064 \\ 0.8759 \\ 0.0064 \\ 1.8.5859 \\ 0.0064 \\ 0.0073 \pm 0.003 \\ 0.1043 \\ 0.003 \\ 257.3993 \\ 20.4599 \\ 0.0064 \\ 1.8.5859 \\ 0.0064 \\ 1.8.$	$\begin{array}{c} 3.7612 \pm 0.0228\\ 1.0165 \pm 0.0228\\ \hline 0.0274 \pm 0.0069\\ 0.0274 \pm 0.0069\\ 0.0274 \pm 0.0069\\ 0.0274 \pm 0.0069\\ 0.0801 \pm 0.0044\\ 0.3405 \pm 0.0101\\ 0.0214 \pm 0.0044\\ 0.3405 \pm 0.0101\\ 0.0214 \pm 0.0044\\ 0.3458 \pm 0.0079\\ 525.7927 \pm 90.9895\\ 0.6181 \pm 0.0941\\ 0.4872 \pm 0.0137\\ 0.003 \pm 0.0005\\ 5.5636 \pm 0.7249\\ 0.0051 \pm 0.0024\\ 0.0151 \pm 0.0037\\ 0.0238 \pm 0.0014\\ 11534.3854 \pm 515.7399\\ 1.0625 \pm 0.1622\\ 13.7298 \pm 2.8103\\ 1113.2937 \pm 235.4821\\ 2598.9274 \pm 210.2179\\ 0.9582 \pm 0.1748\\ 11.3953 \pm 1.4334\\ 11.3953 \pm 1.4334\\ 0.0075 \pm 0.0023\\ 0.007 \pm 0.0002\\ 0.007 \pm 0.0002\\ 0.007 \pm 0.0002\\ 0.007 \pm 0.0002\\ 0.007 \pm 0.0003\\ 737.7558 \pm 14.1883\\ 0.2762 \pm 0.0131\\ 0.3485 \pm 0.0014\\ 0.2762 \pm 0.0013\\ 0.3055 \pm 0.0003\\ 737.7558 \pm 14.1883\\ 0.2762 \pm 0.0031\\ 0.3055 \pm 0.0003\\ 0.169 \pm 0.0003\\ 0.169 \pm 0.0003\\ 0.169 \pm 0.0039\\ 0.005 \pm 1.05.727\\ 338.2373 \pm 20.7102\\ 32209 \\ 0.0716 \\ 0.0716 \\ 0.0716 \\ 0.0039\\ 0.0003 \\ 0.005 \\ 0.0033 \\ 0.0064 \\ 129.7696 \\ \pm 75.3984\\ 0.07162 \\ 0.0071 \\ 0.0071 \\ 0.0075 \\ \pm 0.0039\\ 0.0064 \\ 150.773\\ 338.2373 \\ \pm 0.07102\\ 3238.2373 \\ \pm 0.07102\\ 32080 \\ 0.0016 \\ 0.0003 \\ 0.0003 \\ 0.005 \\ 0.0071 \\ 0.0071 \\ 0.0075 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0071 \\ 0.0002 \\ 0.0071 \\ 0.0003 \\ 0.0084 \\ 0.0011 \\ 0.0016 \\ 0.0003 \\ 0.0051 \\ 0.0071 \\$	$\begin{array}{c} 3.540\pm 0.0233\\ 1.0007\pm 0.0233\\ 1.0007\pm 0.0233\\ \hline \\ \hline \\ \end{tabular} \\ \end{tabular} \\ \end{tabular} \\ \hline \\ \end{tabular} \\ \end$	$\begin{array}{c} 4.0117 \pm 0.012\\ 0.0540 \pm 0.0117\\ \hline 1 VNS [21]\\ \hline 0.3657 \pm 0.005\\ 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0261 \pm 0.0018\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0361 \pm 0.0088\\ \hline 0.0773 \pm 0.0033\\ \hline 0.0361 \pm 0.0086\\ \hline 0.0241 \pm 0.0086\\ \hline 0.0084 \pm 0.00854\\ \hline 0.0084 \pm 0.0086\\ \hline 0.0244 \pm 0.00854\\ \hline 0.0034 \pm 0.0006\\ \hline 5.5409 \pm 0.0128\\ \hline 0.0258 \pm 0.0012\\ \hline 0.0258 \pm 0.0012\\ \hline 0.0258 \pm 0.0012\\ \hline 1.1629 \pm 0.1134\\ \hline 0.259, 9236 \pm 10.466\\ \hline 1.15937 \pm 1.2042\\ \hline IVNS [21]\\ \hline 0.2869 \pm 0.0015\\ \hline 0.0009 \pm 0.0005\\ \hline 0.0232 \pm 0.0202\\ \hline 0.0247 \pm 0.0052\\ \hline 0.0247 \pm 0.0052\\ \hline 0.0247 \pm 0.0052\\ \hline 0.0247 \pm 0.0052\\ \hline 0.0168 \pm 0.0022\\ \hline 0.0168 \pm 0.0021\\ \hline 0.0064 \pm 0.0021\\ \hline 0.00547 \pm 1.9102\\ \hline 0.0204 \pm 6.5.366\\ \hline 0.3390.1208 \pm 12.2112\\ \hline 0.0108 \pm 1.20120\\ \hline 0.0108 \pm 0.0202\\ \hline 0.0108 \pm 0.0202\\ \hline 0.0108 \pm 0.0202\\ \hline 0.0108 \pm 0.0021\\ \hline 0.00547 \pm 0.0202\\ \hline 0.0108 \pm 0.0202\\ \hline 0.0108 \pm 0.0202\\ \hline 0.0108 \pm 0.0021\\ \hline 0.00547 \pm 0.0021\\ \hline 0.0108 \pm 0.001\\ \hline 0.0108 \pm 0.001\\ \hline 0.0108 \pm 0.001\\ \hline 0.0108 \pm 0.001\\ \hline 0.0108 \pm$	$\begin{array}{c} 3.9765 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.9860 \pm 0.0158\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0257 \pm 0.0019\\ 0.0256 \pm 0.0014\\ 0.0768 \pm 0.0035\\ 0.0256 \pm 0.0070\\ 0.3415 \pm 0.0073\\ 489 8569 \pm 80.0007\\ 0.4895 \pm 0.0022\\ 0.0022 \pm 0.0007\\ 5.2615 \pm 0.77\\ 0.0167 \pm 0.0034\\ 0.025 \pm 0.0011\\ 1260, 3005 \pm 305, 6108\\ 1.1265 \pm 0.77\\ 0.0167 \pm 0.0034\\ 1.295 \pm 0.0001\\ 1.24065 \pm 0.253\\ 0.0025 \pm 0.0011\\ 1260, 3005 \pm 305, 6108\\ 1.129, 482 \pm 235, 5594\\ 2497, 4316 \pm 205, 5728\\ 0.8899 \pm 0.1554\\ 1.19514 \pm 1.2803\\ 0.0059 \pm 0.0002\\ 0.9225 \pm 0.0024\\ 0.0449 \pm 0.0018\\ 0.0025 \pm 0.0023\\ 0.9225 \pm 0.0024\\ 0.0449 \pm 0.0018\\ 0.3087 \pm 0.0003\\ 741, 2396 \pm 11.9724\\ 0.2685 \pm 0.0255\\ 0.0169 \pm 0.0003\\ 741, 2396 \pm 11.9724\\ 0.2685 \pm 0.0255\\ 0.0169 \pm 0.0003\\ 393, 2766 \pm 46, 4781\\ 0.855 \pm 0.018\\ 10, 7536 \pm 2.7541\\ 3652, 2013 \pm 95, 965\\ 3386, 516 \pm 18, 735\\ 30246 + 0.0015\\ 0.0025 \\ 0.0025 \\ 0.0025 \\ 0.0025 \\ 0.0025 \\ 0.0169 \pm 0.0002\\ 0.0053 \\ 10, 7536 \pm 2.7541\\ 3652, 2013 \pm 95, 965\\ 3386, 516 \pm 18, 735\\ 0.0157 \\ 0.0025 \\ 0.0053 $	$\begin{array}{r} 3.9711\pm 0.0227\\ 0.9924\pm 0.0268\\ \hline \\ \hline \\ $GVNS [25]\\ \hline \\ 0.3662\pm 0.0053\\ 0.0262\pm 0.0019\\ 0.8158\pm 0.0148\\ 0.0776\pm 0.0036\\ 0.4354\pm 0.0093\\ 0.0245\pm 0.0076\\ \hline \\ \hline \\ 0.4354\pm 0.0097\\ 0.4354\pm 0.0077\\ \hline \\ 0.4354\pm 0.0077\\ 0.4381\pm 0.0007\\ \hline \\ 0.4354\pm 0.0007\\ 0.4381\pm 0.0007\\ \hline \\ 0.4354\pm 0.0007\\ 0.0253\pm 0.0014\\ 0.0156\pm 0.0034\\ 0.0253\pm 0.0014\\ 1160.1052\pm 2299.5600\\ 1.0937\pm 0.1214\\ 13.2967\pm 2.6439\\ 11.3267\pm 2.6439\\ 11.3267\pm 2.6439\\ 11.3267\pm 2.6439\\ 11.3265\pm 0.0014\\ 11.3267\pm 2.6439\\ 11.3265\pm 0.0014\\ 11.3205\pm 1.2613\\ \hline \\ 0.9402\pm 0.1533\\ 11.3305\pm 1.2613\\ \hline \\ SGVNS [25]\\ \hline \\ 0.2872\pm 0.0016\\ 0.0069\pm 0.0002\\ 0.447\pm 0.0010\\ 0.3898\pm 0.0029\\ 0.3066\pm 0.0002\\ 743.0472\pm 0.0216\\ 0.0271\pm 0.0216\\ 0.0049\\ 10.0271\pm 0.0211\\ 0.0447\pm 0.0010\\ 0.3898\pm 0.0029\\ 0.3066\pm 0.0002\\ 743.0472\pm 10.0315\\ 0.2734\pm 0.0211\\ 0.0447\pm 0.00118\\ 0.00221\pm 0.0229\\ 0.0168\pm 0.0002\\ 0.1071\pm 0.0031\\ 113.7271\pm 5.62674\\ 0.0545\pm 0.0200\\ 108.1181\pm 2.0899\\ 1631.5602\pm 73.2004\\ 3300.5219\pm 14.2905\\ \end{array}$	$\begin{array}{c} 1.0278 \pm 0.0427\\ 1.0278 \pm 0.0427\\ \hline \text{NDVNS [26]}\\ \hline 0.3694 \pm 0.0065\\ 0.0272 \pm 0.0022\\ 0.8085 \pm 0.0167\\ 0.0796 \pm 0.0043\\ 0.4312 \pm 0.0104\\ 0.0268 \pm 0.0089\\ 0.3462 \pm 0.0079\\ 552 1621 \pm 91.2768\\ 0.5999 \pm 0.0959\\ 0.4882 \pm 0.0099\\ 0.0056 \pm 0.0099\\ 0.015 \pm 0.0038\\ 0.0241 \pm 0.0015\\ 1116.3151 \pm 306.0384\\ 1.0563 \pm 0.1485\\ 1.39822 \pm 2.8417\\ 1094.1964 \pm 238.0447\\ 2616 9463 \pm 212.5089\\ 0.3704 \pm 0.1743\\ 1.0956 \pm 1.4253\\ 1.39822 \pm 2.8417\\ 10957 \pm 2.8417\\ 10957 \pm 2.8417\\ 10957 \pm 0.0015\\ 0.2872 \pm 0.0013\\ 0.0069 \pm 0.0022\\ 0.228 \pm 0.0018\\ 0.0099 \pm 0.0092\\ 0.255 \pm 0.0027\\ 0.3006 \pm 0.0002\\ 0.228 \pm 0.0018\\ 0.1255 \pm 0.0027\\ 0.3006 \pm 0.0002\\ 0.228 \pm 0.0018\\ 0.0092 \pm 0.0038\\ 0.1255 \pm 0.0026\\ 0.0228 \pm 0.0018\\ 0.0035 \pm 0.0005\\ 0.0238 \pm 0.0005\\ 1.0056 \pm 0.0002\\ 0.228 \pm 0.0016\\ 0.0022 \pm 0.0051\\ 1.0005 \pm 0.0025\\ 0.0028 \pm 0.0051\\ 1.0005 \pm 0.0022\\ 0.264 \pm 0.0196\\ 0.0238 \pm 0.0051\\ 1.0005 \pm 5.47421\\ 1.301.5994 \pm 53.6229\\ 0.8587 \pm 0.0169\\ 0.0238 \pm 0.0051\\ 1.0018 \pm 5.0016\\ 0.0022 \pm 5.47421\\ 3.301.5997 \pm 1.00390\\ 1.3025 \pm 5.47421\\ 3.301.5997 \pm 1.00390\\ 1.3025 \pm 5.47421\\ 3.301.5997 \pm 0.0050\\ 0.02306 \pm 5.47421\\ 3.301.5997 \pm 0.0050\\ 0.02306 \pm 5.47421\\ 3.301.5997 \pm 0.0050\\ 0.02306 \pm 0.0022\\ 0.0075 \pm 0.0028\\ 0.0025 \pm 0.0026\\ 0.0023 \pm 0.0051\\ 0.0025 \pm 0.0026\\ 0.$

nections in a fully connected data graph) are quadratically proportional to the cluster sizes. To remedy the shortcoming, the quadratic assignment problem formulation can be normalized by using cluster cardinality. The normalized total within-cluster distance for the circled clusters in Fig. 1 is  $1 + \sqrt{2}/2$  ( $\approx 1.707$ ), much smaller than that of the unnatural clusters surrounded by the ellipses ( $(2 + \sqrt{2})/3 + 3/2 \approx 2.638$ ).

Let  $n_l$  be the number of data points in cluster l for l = 1, 2, ..., p. As such, the quadratic assignment problem for capacitated clustering is reformulated as

follows:

$$\min_{x} \sum_{l=1}^{p} \frac{\sum_{i=1}^{n} \sum_{j < i} d_{ij} x_{il} x_{jl}}{\sum_{i=1}^{n} x_{il}}$$
s.t. 
$$\sum_{l=1}^{p} x_{il} = 1, \quad i = 1, 2, \dots, n$$
$$\sum_{i=1}^{n} a_{il} x_{il} \le b_{l}, \quad l = 1, 2, \dots, p$$
$$x_{il} \in \{0, 1\}, \quad i = 1, 2, \dots, n; \quad l = 1, 2, \dots, p. \quad (8)$$

LI AND WANG: CAPACITATED CLUSTERING VIA MAJORIZATION-MINIMIZATION AND CNO

#### TABLE V

Mean Values and Standard Deviations of 21 Internal Cluster Validity Criteria Resulting From CNO-CC and Seven Baselines on Rl1304\_010 (n = 1304, p = 10, and b = 7237) and Doni2 (n = 2000, p = 6, and b = 400)

R11304_010	CNO-CC	TS [20]	GRASP-VND [20]	GRASP-VND-TS [20]	IVNS [21]	GVNS [25]	SGVNS [25]	NDVNS [26]
MRI↓	$0.2961 \pm 0.0017$	$0.2994 \pm 0.0028$	$0.3005 \pm 0.0037$	$0.2987 \pm 0.0030$	$0.2982 \pm 0.0031$	$0.2975 \pm 0.0031$	$0.2967 \pm 0.0022$	$0.2977 \pm 0.0038$
GPI↓	$0.0082 \pm 0.0002$	$0.0086 \pm 0.0003$	$0.0087 \pm 0.0005$	$0.0085 \pm 0.0004$	$0.0084 \pm 0.0004$	$0.0083 \pm 0.0003$	$0.0082 \pm 0.0003$	$0.0084 \pm 0.0005$
BHGI↑	$0.9091 \pm 0.0024$	$0.9048 \pm 0.0038$	$0.9031 \pm 0.0052$	$0.9055 \pm 0.0043$	$0.9064 \pm 0.0044$	$0.9076 \pm 0.0038$	$0.9084 \pm 0.0029$	$0.907 \pm 0.0053$
CI↓	$0.0494 \pm 0.0011$	$0.0515 \pm 0.0018$	$0.0522 \pm 0.0023$	$0.0511 \pm 0.0019$	$0.0507 \pm 0.0019$	$0.0503 \pm 0.002$	$0.0498 \pm 0.0014$	$0.0504 \pm 0.0024$
TI∱	$0.3855 \pm 0.0011$	$0.3836 \pm 0.0016$	$0.3829 \pm 0.0022$	$0.384 \pm 0.0018$	$0.3843 \pm 0.0018$	$0.3847 \pm 0.0016$	$0.3852 \pm 0.0012$	$0.3846 \pm 0.0022$
DGİ↑	$0.0362 \pm 0.0033$	$0.0345 \pm 0.0007$	$0.0364 \pm 0.0044$	$0.0366 \pm 0.0065$	$0.0368 \pm 0.0053$	$0.0364 \pm 0.0043$	$0.0371 \pm 0.004$	$0.0386 \pm 0.0064$
RLI↑	$0.2984 \pm 0.0004$	$0.2979 \pm 0.0008$	$0.2977 \pm 0.0008$	$0.298 \pm 0.0007$	$0.2981 \pm 0.0009$	$0.2983 \pm 0.0005$	$0.2984 \pm 0.0005$	$0.2983 \pm 0.0006$
CHI↑	$12\overline{24.9948 \pm 19.90}23$	$1189.2908 \pm 33.4863$	$1175.1102 \pm 43.5504$	1193.706 ± 37.9317	$1202.5524 \pm 38.5758$	$1212.973 \pm 30.3621$	$1219.3629 \pm 24.8813$	$1207.0595 \pm 45.7817$
RTI↓	$0.3207 \pm 0.0360$	$0.3272 \pm 0.0424$	$0.3312 \pm 0.0312$	$0.3258 \pm 0.0562$	$0.3111 \pm 0.0462$	$0.3143 \pm 0.0338$	$0.3265 \pm 0.0348$	$0.3215 \pm 0.0400$
WGI↑	$0.4786 \pm 0.0085$	$0.4687 \pm 0.0089$	$0.4672 \pm 0.0084$	$0.4701 \pm 0.0100$	$0.4737 \pm 0.0078$	$0.4741 \pm 0.0113$	$0.4773 \pm 0.0074$	$0.4734 \pm 0.0104$
DI↑	$0.0075 \pm 0.0009$	$0.007 \pm 0.0005$	$0.0074 \pm 0.0011$	$0.0075 \pm 0.0013$	$0.0076 \pm 0.0011$	$0.0076 \pm 0.0008$	$0.0078 \pm 0.0011$	$0.008 \pm 0.0012$
TWBI↑	$17.6579 \pm 0.6551$	$17.4335 \pm 0.9964$	$17.2613 \pm 1.0668$	$17.2654 \pm 1.0337$	$17.423 \pm 0.9258$	$17.3198 \pm 0.6741$	$17.4921 \pm 0.695$	$17.2546 \pm 0.795$
BHI↑	$0.0164 \pm 0.0002$	$0.0168 \pm 0.0005$	$0.017 \pm 0.0006$	$0.0168 \pm 0.0005$	$0.0167 \pm 0.0005$	$0.0165 \pm 0.0004$	$0.0164 \pm 0.0003$	$0.0166 \pm 0.0006$
PBMI↑	$0.0899 \pm 0.0025$	$0.0870 \pm 0.0027$	$0.0854 \pm 0.0038$	$0.0868 \pm 0.0033$	$0.0868 \pm 0.0027$	$0.0882 \pm 0.0033$	$0.0891 \pm 0.0025$	$0.0872 \pm 0.0052$
XBI↓	$1325.6158 \pm 184.5429$	1439.6387 ± 36.9777	$1333.4594 \pm 242.7993$	$1344.7535 \pm 271.0738$	$1318.0585 \pm 255.9138$	$1322.0595 \pm 220.8799$	$1282.3469 \pm 233.7296$	$1215.1771 \pm 306.4138$
DBI↓	$0.865 \pm 0.0187$	$0.8909 \pm 0.0307$	$0.9032 \pm 0.0296$	$0.8874 \pm 0.0356$	$0.8782 \pm 0.0339$	$0.8705 \pm 0.0261$	$0.8733 \pm 0.0223$	$0.8759 \pm 0.0356$
DRI↑	$89.5993 \pm 2.6320$	$86.0073 \pm 3.7855$	$84.4232 \pm 4.9749$	$85.9522 \pm 4.9607$	$87.2963 \pm 3.9081$	$87.7477 \pm 3.9199$	$88.7901 \pm 3.1618$	$87.3838 \pm 4.7844$
KDWI↓	$10930.8651 \pm 327.2579$	$11399.1741 \pm 509.9653$	$11630.5094 \pm 700.8956$	$11422.4393 \pm 680.9838$	$11232.5939 \pm 535.0002$	$11173.8979 \pm 511.5732$	$11034.902 \pm 402.9685$	$11233.5019 \pm 671.6296$
LDRI↑	$5861.3923 \pm 38.6691$	$5807.3669 \pm 57.8638$	$5782.1566 \pm 77.6824$	$5805.6358 \pm 76.4867$	$5826.6846 \pm 60.1948$	$5833.4468 \pm 58.9885$	$5849.3037 \pm 47.0158$	$5827.3172 \pm 74.5579$
LSSRI↑	$2.1423 \pm 0.0163$	$2.1125 \pm 0.0285$	$2.1002 \pm 0.0372$	$2.1161 \pm 0.0322$	$2.1234 \pm 0.0327$	$2.1323 \pm 0.0253$	$2.1376 \pm 0.0206$	$2.127 \pm 0.0393$
TWI↓	$21.101 \pm 0.3098$	$21.6750 \pm 0.5567$	$21.9175 \pm 0.729$	$21.6072 \pm 0.6282$	$21.4657 \pm 0.6350$	$21.2939 \pm 0.4844$	$21.1907 \pm 0.3944$	$21.4017 \pm 0.7728$
Doni2	CNO-CC	TS [20]	GRASP-VND [20]	GRASP-VND-TS [20]	IVNS [21]	GVNS [25]	SGVNS [25]	NDVNS [26]
MRI↓	$0.3753 \pm 0.0118$	$0.6574 \pm 0.1238$	$0.3704 \pm 0.0046$	$0.3738 \pm 0.0086$	$0.3703 \pm 0.0047$	$0.3674 \pm 0.0058$	$0.3672 \pm 0.0064$	$0.3705 \pm 0.0050$
GPI↓	$0.0305 \pm 0.0025$	$0.0859 \pm 0.0242$	$0.0289 \pm 0.0014$	$0.0300 \pm 0.0020$	$0.0288 \pm 0.0014$	$\overline{0.0279 \pm 0.0014}$	$0.0281 \pm 0.0019$	$0.0290 \pm 0.0015$
BHGI↑	$0.786 \pm 0.0188$	$0.3854 \pm 0.1755$	$0.7978 \pm 0.0112$	$0.7902 \pm 0.0147$	$0.7988 \pm 0.0115$	$0.8062 \pm 0.0112$	$0.8050 \pm 0.0142$	$0.7972 \pm 0.0122$
CI↓	$0.0842 \pm 0.0069$	$0.237 \pm 0.0673$	$0.0812 \pm 0.0031$	$0.0832 \pm 0.0051$	$0.0811 \pm 0.0031$	$0.0791 \pm 0.0038$	$0.0790 \pm 0.0041$	$0.0812 \pm 0.0032$
TI↑	$0.4194 \pm 0.0111$	$0.2045 \pm 0.0951$	$0.4269 \pm 0.0076$	$0.4224 \pm 0.0085$	$0.4275 \pm 0.0079$	$0.4329 \pm 0.0082$	$0.4322 \pm 0.0096$	$0.4268 \pm 0.0082$
DGI↑	$0.0118 \pm 0.0054$	$0.0014 \pm 0.0037$	$0.0104 \pm 0.0049$	$0.0106 \pm 0.0041$	$0.0109 \pm 0.0049$	$0.0064 \pm 0.0041$	$0.0094 \pm 0.0044$	$0.0099 \pm 0.0049$
RLI↑	$0.3452 \pm 0.0034$	$0.2698 \pm 0.033$	$0.3401 \pm 0.0069$	$0.3423 \pm 0.0052$	$0.3393 \pm 0.0058$	$0.3350 \pm 0.0064$	$0.3368 \pm 0.0062$	$0.3408 \pm 0.0074$
CHI↑	$1004.364 \pm 70.9312$	$372.9465 \pm 278.6564$	$918.6524 \pm 121.5407$	$950.9359 \pm 85.3799$	$900.8383 \pm 93.1683$	$832.1556 \pm 102.1302$	$858.3044 \pm 99.4213$	$926.1673 \pm 123.5089$
RII↓	$0.7277 \pm 0.0926$	$286.6146 \pm 756.3596$	$0.783 \pm 0.1265$	$0.7693 \pm 0.0926$	$0.8277 \pm 0.0832$	$0.8369 \pm 0.1179$	$0.8218 \pm 0.1247$	$0.7578 \pm 0.1395$
WGI↑	$0.4805 \pm 0.0075$	$0.1282 \pm 0.1523$	$0.4819 \pm 0.0062$	$0.4791 \pm 0.0161$	$0.4809 \pm 0.0058$	$0.4760 \pm 0.0126$	$0.4771 \pm 0.0105$	$0.4770 \pm 0.0068$
DI↑	$0.0018 \pm 0.0009$	$0.0002 \pm 0.0006$	$0.0017 \pm 0.0007$	$0.0016 \pm 0.0006$	$\frac{0.0017 \pm 0.0008}{0.0017 \pm 0.0008}$	$0.0011 \pm 0.0007$	$0.0016 \pm 0.0007$	$0.0016 \pm 0.0008$
TWBI↑	$5.2979 \pm 0.2341$	$2.0885 \pm 1.5435$	$4.9342 \pm 0.6000$	$5.1243 \pm 0.3938$	$4.9149 \pm 0.5014$	$4.5688 \pm 0.5101$	$4.7114 \pm 0.4733$	$4.9561 \pm 0.5253$
BHI↑	$0.0159 \pm 0.0016$	$0.0259 \pm 0.0041$	$0.0185 \pm 0.0039$	$0.0173 \pm 0.0023$	$0.0189 \pm 0.0035$	$0.0219 \pm 0.0043$	$0.0212 \pm 0.0044$	$0.0186 \pm 0.0039$
PBMI↑	$0.024/\pm0.0015$	$0.0088 \pm 0.0078$	$0.0254 \pm 0.0012$	$0.0249 \pm 0.0018$	$0.0255 \pm 0.0013$	$0.0261 \pm 0.0018$	$0.0263 \pm 0.0017$	$0.0254 \pm 0.0015$
XBI↓	$9298.6004 \pm 9836.2687$	$InI \pm NaN$	9057.8492 ± 9446.3455	9366.0864 ± 12640.6587	$9209.1882 \pm 11820.1008$	$39882.496 \pm 59725.9982$	$11000.0130 \pm 13644.2871$	$1//88.0306 \pm 36524.9046$
DBI	$0.9/12 \pm 0.0435$	$8.3499 \pm 7.7375$	$1.0194 \pm 0.0646$	$\frac{1.0004 \pm 0.0511}{12.1152 \pm 1.2021}$	$1.0368 \pm 0.0623$	$1.0795 \pm 0.0693$	$1.0692 \pm 0.0694$	$1.0165 \pm 0.0801$
DRIT	$12.8/0/\pm 1.0474$	$4.4601 \pm 3.9682$	$11.5500 \pm 1.9801$	$\frac{12.1153 \pm 1.2931}{5552.2242 \pm 600.4166}$	$11.3390 \pm 1.4/34$	$10.2417 \pm 1.6327$	$10.6/43 \pm 1.55/6$	$11.0810 \pm 1.8093$
	$5192.2702 \pm 388.930$ $5102.0472 \pm 156.2614$	$20008.2012 \pm 6833.5656$	$3918.0700 \pm 1050.4762$	$\frac{5555.2345 \pm 690.4166}{4077.0541 \pm 220.2805}$	1920 1220 ± 275 2005	$6033.1008 \pm 9/9.3266$	$0.550.7247 \pm 912.4482$	$5840.9621 \pm 1016.3060$
LORI	$5105.9472 \pm 150.2014$	$2339.2763 \pm 1148.3803$	$4603.617 \pm 350.2494$	$\frac{4977.0341 \pm 229.3805}{0.865 \pm 0.0025}$	$4639.1239 \pm 273.8005$	$4029.6417 \pm 308.3240$	$4/13.492/\pm 291.2104$	4690.1509 ± 354.5055
TWI	$0.7214 \pm 0.0005$ $245314 \pm 1.1705$	$-0.2202 \pm 0.3020$ 48 002 $\pm$ 10 2581	$0.0201 \pm 0.1355$ 26 2707 $\pm 2.4252$	$255457 \pm 17064$	$265508 \pm 10002$	$0.7267 \pm 0.1193$ 28 0746 $\pm$ 2 2320	$0.7002 \pm 0.1155$ 27 4707 $\pm 2.1470$	$261414 \pm 25181$
1 11 11		$\pi 0.004 \pm 10.4001$	$49.4771 \pm 4.4.1.14$	$44700 \pm 277 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 17700 \pm 177000 \pm 177000 \pm 1770000000000$	$40.0.070 \pm 1.7700$	$40.0190 \pm 4.4.000$	41.477 I I 4.1479	$40.1919 \pm 4.010$

Note that  $\sum_{i=1}^{n} x_{il} = n_l$ . In addition, if  $d_{ij} = d_{ji}$  and  $d_{ii} = 0$ , pr then  $\sum_{i=1}^{n} \sum_{j < i} d_{ij} x_{il} x_{jl} = \sum_{i=1}^{n} \sum_{j=1}^{n} d_{ij} x_{il} x_{jl}/2$ . If  $d_{ij} = ||\underline{v}_i - \underline{v}_j||$ , then we have

$$\sum_{l=1}^{p} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} d_{ij} x_{il} x_{jl}}{\sum_{j=1}^{n} x_{jl}}$$

$$= \sum_{l=1}^{p} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \|\underline{v}_{i} - \underline{v}_{j}\| x_{il} x_{jl}}{\sum_{j=1}^{n} x_{jl}}$$

$$\geq \sum_{l=1}^{p} \frac{\sum_{i=1}^{n} \|\sum_{j=1}^{n} (\underline{v}_{i} - \underline{v}_{j}) x_{jl}\| x_{il}}{\sum_{j=1}^{n} x_{jl}}$$

$$= \sum_{l=1}^{p} \sum_{i=1}^{n} \|\frac{\sum_{j=1}^{n} (\underline{v}_{i} - \underline{v}_{j}) x_{jl}}{\sum_{j=1}^{n} x_{jl}}\| x_{il}$$

$$= \sum_{l=1}^{p} \sum_{i=1}^{n} \|\underline{v}_{i} - \frac{\sum_{j=1}^{n} x_{jl} \underline{v}_{jl}}{\sum_{j=1}^{n} x_{jl}}\| x_{il}$$

where  $\sum_{j=1}^{n} x_{jl} \underline{v}_{j} / \sum_{j=1}^{n} x_{jl}$  is the centroid of cluster *l*. It implies that the objective function (8) is an upper bounding function of the objective function in *k*-means clustering. Nevertheless, the dissimilarity coefficient  $d_{ij}$  in (8) is more general beyond the definition of any norm.

In view that the minimization of a fractional objective function in (8) can be carried out via the minimization of its numerator and the maximization of its denomination simultaneously, problem (8) is reformulated as the following mixed-integer quadratic programming

problem:

$$\min_{x,\lambda} \sum_{l=1}^{p} \sum_{i=1}^{n} \left( \sum_{j < i} d_{ij} x_{il} x_{jl} - \lambda_l x_{il} \right)$$
s.t. 
$$\sum_{l=1}^{p} x_{il} = 1, \quad i = 1, 2, \dots, n$$

$$\sum_{i=1}^{n} a_{il} x_{il} \le b_l, \quad l = 1, 2, \dots, p$$

$$x_{il} \in \{0, 1\}, \quad i = 1, 2, \dots, n; \quad l = 1, 2, \dots, p$$
(9)

where  $\lambda_l$  is a positive of weight for l = 1, 2, ..., p. Let  $\phi_{\lambda}(X)$  denote the objective function to be minimized in problem (9) hereafter.

For given nonzero initial solution x(0), problem (9) can be solved with iterative weights as follows: For t = 0, 1, ...;

$$\lambda_l(t) = \frac{\sum_{i=1}^n \sum_{j < i} d_{ij} x_{il}(t) x_{jl}(t)}{\sum_{i=1}^n x_{il}(t)}, \quad l = 1, 2, \dots, p$$
(10a)

$$x(t+1) = \arg\min_{x \in \mathcal{X}} \sum_{l=1}^{p} \sum_{i=1}^{n} \left( \sum_{j < i} d_{ij} x_{il} x_{jl} - \lambda_l(t) x_{il} \right) \quad (10b)$$

where  $\mathcal{X} = \{x \in \{0, 1\}^{n \times p} | \sum_{l=1}^{p} x_{il} = 1, \sum_{i=1}^{n} a_{il}x_{il} \le b_l, i = 1, 2, ..., n; l = 1, 2, ..., p\}$ . Problem (9) can then be solved as an iteratively reweighted binary quadratic programming problem for given  $\lambda_l(t)$  (l = 1, 2, ..., p) updated iteratively according to (10a). Because of the effect of minimization in (9)

$$\lambda_{l}(t+1) \ge \lambda_{l}(t) = \frac{\sum_{i=1}^{n} \sum_{j < i} d_{ij} x_{il}(t) x_{jl}(t)}{\sum_{i=1}^{n} x_{il}(t)}$$

IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS

The above-mentioned inequality implies that the objective function in (9) is a surrogate function in a majorizationminimization framework [81], [82], [83], [84]. It is proven that the convergence rate of the weight  $\lambda$  in the iterative reweighting procedure (10) is quadratic [85].

The capacitated clustering can be further reformulated in an iteratively reweighted quadratic unconstrained binary optimization problem by introducing a quadratic penalty function into the objective function as an alternative to imposing constraints. The terms in the penalty function are chosen so that the influence of the original constraints on the solution process can alternatively be enforced by the natural functioning of the optimizer as it looks for solutions that avoid incurring the penalties. That is, the penalty terms are formulated so that they equal zero for feasible solutions and are positive for infeasible solutions. For a minimization problem, these penalty functions are added to create an augmented objective function to be minimized. If all the penalty terms can be driven to zero, the augmented objective function becomes the original objective function to be minimized.

To handle the equality constraints in (9), a quadratic penalty term is defined as follows:

$$\phi_1(X) = \frac{1}{2} \sum_{i=1}^n \left( \sum_{l=1}^p x_{il} - 1 \right)^2.$$
(11)

In view that  $x_{il} \in \{0, 1\}$ , and hence,  $x_{il}^2 = x_{il}$ , the penalty term can be equivalently expressed as follows:

$$\phi_1(X) = \frac{1}{2} \sum_{i=1}^n \left( \sum_{l=1}^p x_{il} - 2 \sum_{l=1}^p \sum_{j < l} x_{ij} x_{il} - 1 \right).$$
(12)

A penalty term for the inequality constraint in (13) by using rectified activation function is defined as

$$\phi_2(X) = \frac{1}{2} \sum_{l=1}^{p} \left( \max\left\{ 0, \sum_{i=1}^{n} a_{il} x_{il} - b_l \right\} \right)^2.$$
(13)

With the two penalty functional terms and the quadratic objective function to be minimized, a penalty function and a penalized or augmented objective function are defined as follows:

$$\phi(X) = \phi_1(X) + \phi_2(X)$$
(14)

$$f_{\lambda}(X) = \phi_{\lambda}(X) + \rho\phi(X) \tag{15}$$

where  $\rho$  is a positive penalty parameter, and  $X \in \{0, 1\}^{n \times p}$ .

Based on the penalty function (14) and penalized objective function in (15), problem (9) is reformulated as the following quadratic unconstrained binary optimization problem:

$$\min_{X} f_{\lambda}(X), \quad \text{s.t. } X \in \{0, 1\}^{n \times p}.$$
(16)

It is known that problems (16) and (9) are equivalent in terms of their optimal solutions if the penalty parameter is sufficiently large [86].

## **IV. ALGORITHM DESCRIPTION**

Based on the formulated problem in (16), a CNOdriven capacitated clustering algorithm termed CNO-CC is developed.

In analogy to DHNm, a BM with a momentum term (BMm) is defined as follows:

$$\begin{cases} u(t+1) = u(t) + Wx(t) - \theta \\ p(x_i(t) = 1) = \frac{1}{1 + \exp\left(-\frac{u_i(t)}{T}\right)} \\ p(x_i(t) = 0) = 1 - p(x_i(t) = 1). \end{cases}$$
(17)

In the CNO-CC algorithm, a population of BMms in (17) are employed for distributed local search, and the PSO rule in (6) is used to repetitively update DHN or BM neuronal states upon their local convergence to escape from local optima and move toward global optimal solutions.

<b>Input</b> : Dissimilarity coefficient matrix <i>D</i> , DHN or BM
population size $N$ , termination criterion $M$ , PSO
parameters $c_0$ , $c_1$ , and $c_2$ , initial temperature
parameter $T_0$ .

1 For 
$$i = 1, 2, ..., N$$
, generate random initial neuronal  
state matrices  $X_i(0) \in \{0, 1\}^{n \times p}$ , PSO velocity matrices  
 $V_i \in [-1, 1]^{n \times p}$ ; set initial group-best matrix and initial  
individual-best matrices for the *i*th BM  $X^* = X_i^* = 0$ .  
Set iteration counter  $t = 0$  and termination counter  $\ell = 0$ ;  
a while  $\ell \in M$  do

do

Algorithm 1 describes the CNO-CC algorithm. Steps 3–12 are to obtain the equilibria of BMms for scatter local searches.



Fig. 2. Monte Carlo test results of the CNO-CC algorithm with several values of M and N on the ten datasets. (a) SJC1. (b) SJC2. (c) SJC3a. (d) SJC3b. (e) SJC4a. (f) SJC4b. (g) U724\_010. (h) Doni1.

Steps 13–14 and 17–18 are to update individual and population best solutions, respectively. Steps 23–25 are to reposition the neuronal states using the PSO rule.

In the CNO-CC algorithm, there are two important hyperparameters: the BMm population size denoted by N and the minimum number of consecutive iterations without further improvement denoted by M as the termination criterion. These two hyperparameters usually need to be determined in an ad hoc manner, as they depend on the inherent complexity of the problem under study and the desired spatial and temporal complexities of the solution method. In general, the larger the population size N is, the faster CNO-CC converges to optimal or acceptable high-quality solutions. Therefore, it is a trade-off between the spatial and temporal complexities. Due to the



Fig. 3. Snapshots of objective function value and penalty function value of the CNO-CC algorithm. (a) SJC1. (b) SJC2. (c) SJC3a. (d) SJC3b. (e) SJC4a. (f) SJC4b. (g) U724\_010. (h) Doni1. (i) R11304\_010. (j) Doni2.

stochastic nature of PSO-based reinitialization for multistart scatter search, M needs to be set with a fair value to reach the theoretically proven almost-sure convergence.

# V. EXPERIMENTAL RESULTS

# A. Experiment Setups

As the evaluation of clustering results is subjective, many cluster validity criteria are used to evaluate the multifaced goodness of clustering results. Internal cluster validity criteria are independent of the specific use of similarity or dissimilarity coefficients, whereas external cluster validity criteria depend on the similarity or dissimilarity coefficients used as well as labels. In this study, 21 label-free internal cluster validity criteria in Table I are used for evaluating the clustering performance.

The experiments are based on ten benchmark datasets with given data weights and cluster capacities (i.e.,  $a_{il}$  and  $b_l$  in (7)), exclusively used for capacitated clustering: SJC1, SJC2, SJC3a, SJC3b, SJC4a, SJC4b<sup>1</sup> (used in [12], [13], [14], [15], [22], [87], [88], [89], [90], [91], and [92]), U724\_010<sup>2</sup>

<sup>&</sup>lt;sup>1</sup>http://www.lac.inpe.br/~lorena/instancias.html

<sup>&</sup>lt;sup>2</sup>https://github.com/emuritiba/cccp

LI AND WANG: CAPACITATED CLUSTERING VIA MAJORIZATION-MINIMIZATION AND CNO



Fig. 4. Convergent behavior of the CNO-CC algorithm on the ten datasets with M = 1000 and N = 32. (a) SJC1. (b) SJC2. (c) SJC3a. (d) SJC3b. (e) SJC4a. (f) SJC4b. (g) U724\_010. (h) Doni1. (i) R11304\_010. (j) Doni2.



Fig. 5. Resulting clusters using the CNO-CC algorithm. (a) SJC1. (b) SJC2. (c) SJC3a. (d) SJC3b. (e) SJC4a. (f) SJC4b. (g) U724\_010. (h) Doni1. (i) R11304\_010. (j) Doni2.

(used in [22], [89], [91], and [92]), Doni1, Doni2<sup>1</sup> (used in [22], [87], [88], [90], [91], and [92] ), and R11304\_010<sup>2</sup> (used in [22], [89], and [91]), with their major parameters listed in Table II and the coordinates of the data points available for evaluating the internal validity criteria of clustering results. In this study, the Euclidean distance is used to represent the dissimilarity between data.

The proposed CNO-CC algorithm is compared with seven prevailing capacitated clustering algorithms: TS [20], greedy randomized adaptive search procedure with variable neighborhood descent (GRASP-VND) [20], GRASP-VND and TS (GRASP-VND-TS) [20], IVNS [21], GVNS [25], SGVNS [25], and NDVNS [26] algorithms. The code of CNO-CC is publicly accessible at Github.<sup>3</sup> The codes of the GRASP-VND, TS, GRASP-VND-TS, and IVNS algorithms are obtained following a link in [21]. The codes of GVNS and SGVNS are from http://www.mi.sanu.ac.rs/~nenad/ccp/maintained by Brimberg et al. [25]. The codes of NDVNS are obtained following a link in [26].

# B. Parameters Selection

The values of two hyperparameters N (population size) and M (termination criteria) in Algorithm 1 are set based on 20-run Monte Carlo tests with random initial states on the ten datasets. Fig. 2 depicts the box-plots of the Monte Carlo test results obtained using the CNO-CC algorithm over 20 runs with different initial states on the ten datasets, where a center bar in a box marks the median, the top and bottom of the box denote the upper quartile  $q_n(0.75)$  and the lower quartile  $q_n(0.25)$ , and the whiskers denote the highest or lowest values. As shown in Fig. 2, the objective function values reach their minimum in most runs with M = 500 and N = 8 on SJC1, M = 500 and N = 8 on SJC2, M = 500 and N = 16 on SJC3a, M = 900 and N = 8 on SJC3b, M = 800 and N = 32on SJC4a, M = 500 and N = 16 on SJC4b, M = 600 and N = 32 on U724 010, and M = 800 and N = 16 on Doni1. Table II lists the values of the hyperparameters as well as other parameters used in the experiments. In the BMm, the cooling rate  $\alpha = 0.2$ . In the PSO update rule (6),  $c_0 = 1$  and  $c_1 = c_2 = 2.$ 

<sup>&</sup>lt;sup>3</sup>https://github.com/HongzongLI-CS/CNO-CC-Github

### C. Neurodynamic Behaviors

Fig. 3 depicts ten snapshots of the convergent behaviors of the objective function f(x) in (9) and the penalty function p(x) in (14), resulting from an individual BMm in the inner-loop of CNO-CC (Step 6) on the ten datasets. The snapshots in Fig. 3 show that the objective function values increase because the solution does not satisfy the constraints, as shown in the penalty function values on the right-hand side. The objective functions reach stationary points, and the penalty function decreases to zero (i.e., converges to a feasible solution) within 134 iterations. Fig. 4 depicts the convergent behaviors of  $\phi_{\lambda}(X)$  the CNO-CC algorithm on the ten datasets, where the red envelopes depict the augmented objective functions of group-best solutions  $X^*$ . It shows that the augmented objective function values monotonically decrease, and CNO-CC converges within 600 iterations.

## D. Performance Comparisons

To make fair comparisons, the same stop criterion is used among the competing algorithms; i.e., M in CNO-CC is set according to the stop criterion. Fig. 5 shows the resulting clusters using the CNO-CC algorithm on the ten datasets. Note that the shapes of some clusters are irregular due to the existence of capacity constraints. Tables III–V records the mean values and standard deviations of 21 internal cluster validity criteria resulting from the seven competing algorithms over 20 runs with random initialization on the ten datasets. The results show that the CNO-CC algorithm achieves the best results among the ten methods in 126 out of the 168 cases (75%) in terms of the mean values.

# VI. CONCLUSION

This paper presents a capacitated clustering algorithm based on CNO. The proposed objective function with fractional functional terms empowers to measure cluster compactness naturally. The surrogate function used to represent the objective function leads to the iteratively reweighted quadratic unconstrained binary optimization problem formulation in a majorization-minimization framework, facilitating the subsequent development of the clustering algorithm. The proposed capacitated clustering algorithm leverages the hill-climbing local search capability of BMs in scattered searches. The proposed algorithm statistically outperforms the baselines owing to the combined use of a more reasonable objective function for measuring cluster compactness and a more effective optimizer driven by collaborative neurodynamics. Further investigations may aim at the efficiency and scalability improvements of the neurodynamics-driven capacitated clustering algorithm. Further investigations may also include the robustness analysis of neurodynamics-driven constrained clustering as in noise-tolerant neural networks [112], [113].

## REFERENCES

- A. Banerjee and J. Ghosh, "Frequency-sensitive competitive learning for scalable balanced clustering on high-dimensional hyperspheres," *IEEE Trans. Neural Netw.*, vol. 15, no. 3, pp. 702–719, May 2004.
- [2] H. Liu, J. Han, F. Nie, and X. Li, "Balanced clustering with least square regression," in *Proc. 31st AAAI Conf. Artif. Intell.*, 2017, pp. 2231–2237.

IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS

- [3] J. Han, H. Liu, and F. Nie, "A local and global discriminative framework and optimization for balanced clustering," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 30, no. 10, pp. 3059–3071, Oct. 2019.
- [4] Z. Li, F. Nie, X. Chang, Z. Ma, and Y. Yang, "Balanced clustering via exclusive lasso: A pragmatic approach," in *Proc. AAAI Conf. Artif. Intell.*, vol. 32, no. 1, 2018, pp. 3596–3601.
- [5] S. Ding, L. Cong, Q. Hu, H. Jia, and Z. Shi, "A multiway p-spectral clustering algorithm," *Knowl-Based Syst.*, vol. 164, pp. 371–377, Jan. 2019.
- [6] P. Zhou, J. Chen, M. Fan, L. Du, Y.-D. Shen, and X. Li, "Unsupervised feature selection for balanced clustering," *Knowl.-Based Syst.*, vol. 193, Apr. 2020, Art. no. 105417.
- [7] P. Li, H. Zhao, and H. Liu, "Deep fair clustering for visual learning," in *Proc. IEEE/CVF Conf. Comput. Vis. Pattern Recognit. (CVPR)*, Jun. 2020, pp. 9070–9079.
- [8] L. E. Caraballo, J.-M. Díaz-Báñez, and N. Kroher, "A polynomial algorithm for balanced clustering via graph partitioning," *Eur. J. Oper. Res.*, vol. 289, no. 2, pp. 456–469, Mar. 2021.
- [9] J. M. Mulvey and M. P. Beck, "Solving capacitated clustering problems," *Eur. J. Oper. Res.*, vol. 18, pp. 339–348, Dec. 1984.
- [10] V. Maniezzo, A. Mingozzi, and R. Baldacci, "A bionomic approach to the capacitated p-median problem," *J. Heuristics*, vol. 4, no. 3, pp. 263–280, 1998.
- [11] S. Ahmadi and I. H. Osman, "Greedy random adaptive memory programming search for the capacitated clustering problem," *Eur. J. Oper. Res.*, vol. 162, no. 1, pp. 30–44, 2005.
- [12] S. Scheuerer and R. Wendolsky, "A scatter search heuristic for the capacitated clustering problem," *Eur. J. Oper. Res.*, vol. 169, no. 2, pp. 533–547, Mar. 2006.
- [13] K. Fleszar and K. S. Hindi, "An effective VNS for the capacitated p-median problem," *Eur. J. Oper. Res.*, vol. 191, no. 3, pp. 612–622, Dec. 2008.
- [14] D. Rodney, A. J. Soper, and C. Walshaw, "Multilevel approaches applied to the capacitated clustering problem," in *Proc. Int. Conf. Sci. Comput.*, 2008, pp. 271–277.
- [15] A. A. Chaves and L. A. N. Lorena, "Clustering search algorithm for the capacitated centered clustering problem," *Comput. Oper. Res.*, vol. 37, no. 3, pp. 552–558, Mar. 2010.
- [16] Y. Deng and J. F. Bard, "A reactive GRASP with path relinking for capacitated clustering," *J. Heuristics*, vol. 17, no. 2, pp. 119–152, Apr. 2011.
- [17] Z. Yang, H. Chen, and F. Chu, "A Lagrangian relaxation approach for a large scale new variant of capacitated clustering problem," *Comput. Ind. Eng.*, vol. 61, no. 2, pp. 430–435, Sep. 2011.
- [18] M. Gallego, M. Laguna, R. Martí, and A. Duarte, "Tabu search with strategic oscillation for the maximally diverse grouping problem," *J. Oper. Res. Soc.*, vol. 64, no. 5, pp. 724–734, 2013.
- [19] M. Lewis, H. Wang, and G. Kochenberger, "Exact solutions to the capacitated clustering problem: A comparison of two models," *Ann. Data Sci.*, vol. 1, no. 1, pp. 15–23, Mar. 2014.
- [20] A. Martínez-Gavara, V. Campos, M. Gallego, M. Laguna, and R. Martí, "Tabu search and GRASP for the capacitated clustering problem," *Comput. Optim. Appl.*, vol. 62, no. 2, pp. 589–607, Nov. 2015.
- [21] X. Lai and J.-K. Hao, "Iterated variable neighborhood search for the capacitated clustering problem," *Eng. Appl. Artif. Intell.*, vol. 56, pp. 102–120, Nov. 2016.
- [22] A. A. Chaves, J. F. Gonçalves, and L. A. N. Lorena, "Adaptive biased random-key genetic algorithm with local search for the capacitated centered clustering problem," *Comput. Ind. Eng.*, vol. 124, pp. 331–346, Oct. 2018.
- [23] F. Mai, M. J. Fry, and J. W. Ohlmann, "Model-based capacitated clustering with posterior regularization," *Eur. J. Oper. Res.*, vol. 271, no. 2, pp. 594–605, Dec. 2018.
- [24] Q. Zhou, U. Benlic, Q. Wu, and J.-K. Hao, "Heuristic search to the capacitated clustering problem," *Eur. J. Oper. Res.*, vol. 273, no. 2, pp. 464–487, Mar. 2019.
- [25] J. Brimberg, N. Mladenović, R. Todosijević, and D. Urošević, "Solving the capacitated clustering problem with variable neighborhood search," *Ann. Oper. Res.*, vol. 272, nos. 1–2, pp. 289–321, Jan. 2019.
- [26] X. Lai, J.-K. Hao, Z.-H. Fu, and D. Yue, "Neighborhood decompositiondriven variable neighborhood search for capacitated clustering," *Comput. Oper. Res.*, vol. 134, May 2021, Art. no. 105362.
- [27] K. Wagstaff and C. Cardie, "Clustering with instance-level constraints," in *Proc. AAAI/IAAI*, vol. 1097, Jun. 2000, pp. 577–584.
- [28] Y. Jia, J. Hou, and S. Kwong, "Constrained clustering with dissimilarity propagation-guided graph-Laplacian PCA," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 32, no. 9, pp. 3985–3997, Sep. 2021.

LI AND WANG: CAPACITATED CLUSTERING VIA MAJORIZATION-MINIMIZATION AND CNO

- [29] Z. Li, F. Nie, X. Chang, L. Nie, H. Zhang, and Y. Yang, "Rankconstrained spectral clustering with flexible embedding," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 29, no. 12, pp. 6073–6082, Dec. 2018.
- [30] Y. A. Koskosidis and W. B. Powell, "Clustering algorithms for consolidation of customer orders into vehicle shipments," *Transp. Res. B, Methodol.*, vol. 26, no. 5, pp. 365–379, Oct. 1992.
- [31] H. Ewbank, P. Wanke, and A. Hadi-Vencheh, "An unsupervised fuzzy clustering approach to the capacitated vehicle routing problem," *Neural Comput. Appl.*, vol. 27, no. 4, pp. 857–867, May 2016.
- [32] F. Alesiani, G. Ermis, and K. Gkiotsalitis, "Constrained clustering for the capacitated vehicle routing problem (CC-CVRP)," *Appl. Artif. Intell.*, vol. 36, no. 1, pp. 1–25, Dec. 2022.
- [33] Z. Donovan, K. Subramani, and V. Mkrtchyan, "Analyzing clustering and partitioning problems in selected VLSI models," *Theory Comput. Syst.*, vol. 64, no. 7, pp. 1242–1272, Oct. 2020.
- [34] J. F. Bard and A. I. Jarrah, "Large-scale constrained clustering for rationalizing pickup and delivery operations," *Transp. Res. B, Methodol.*, vol. 43, no. 5, pp. 542–561, Jun. 2009.
- [35] C.-A. Chou, W. A. Chaovalitwongse, T. Y. Berger-Wolf, B. DasGupta, and M. V. Ashley, "Capacitated clustering problem in computational biology: Combinatorial and statistical approach for sibling reconstruction," *Comput. Oper. Res.*, vol. 39, no. 3, pp. 609–619, Mar. 2012.
- [36] A. Martínez-Gavara, D. Landa-Silva, V. Campos, and R. Martí, "Randomized heuristics for the capacitated clustering problem," *Inf. Sci.*, vol. 417, pp. 154–168, Nov. 2017.
- [37] K. Liao and D. Guo, "A clustering-based approach to the capacitated facility location problem," *Trans. GIS*, vol. 12, no. 3, pp. 323–339, Jun. 2008.
- [38] M. J. Negreiros, N. Maculan, P. L. Batista, J. A. Rodrigues, and A. W. Palhano, "Capacitated clustering problems applied to the layout of IT-teams in software factories," *Ann. Oper. Res.*, vol. 316, pp. 1157–1185, Sep. 2020.
- [39] Y. Chen, Z.-P. Fan, J. Ma, and S. Zeng, "A hybrid grouping genetic algorithm for reviewer group construction problem," *Expert Syst. Appl.*, vol. 38, no. 3, pp. 2401–2411, Mar. 2011.
- [40] Y. Bejerano, "Efficient integration of multihop wireless and wired networks with QoS constraints," *IEEE/ACM Trans. Netw.*, vol. 12, no. 6, pp. 1064–1078, Dec. 2004.
- [41] R. Zhang, H. Li, and J. Wang, "Index tracking based on dynamic time warping and constrained k-medoids clustering," in *Proc. 11th Int. Conf. Intell. Control Inf. Process. (ICICIP)*, Dec. 2021, pp. 352–359.
- [42] M. R. Garey and D. S. Johnson, Comput. Intractability: A Guide to Theory NP-Completeness, vol. 174. San Francisco, CA, USA: Freeman, 1979.
- [43] J. J. Hopfield and D. W. Tank, "Computing with neural circuits—A model," *Science*, vol. 233, no. 4764, pp. 625–633, 1986.
- [44] Z. Yan, J. Wang, and G. Li, "A collective neurodynamic optimization approach to bound-constrained nonconvex optimization," *Neural Netw.*, vol. 55, pp. 20–29, Jul. 2014.
- [45] Z. Yan, J. Fan, and J. Wang, "A collective neurodynamic approach to constrained global optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 28, no. 5, pp. 1206–1215, May 2017.
- [46] H. Che and J. Wang, "A collaborative neurodynamic approach to global and combinatorial optimization," *Neural Netw.*, vol. 114, pp. 15–27, Jun. 2019.
- [47] H. Che and J. Wang, "A two-timescale duplex neurodynamic approach to biconvex optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 30, no. 8, pp. 2503–2514, Aug. 2019.
- [48] H. Che and J. Wang, "A two-timescale duplex neurodynamic approach to mixed-integer optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 32, no. 1, pp. 36–48, Jan. 2021.
- [49] J. J. Hopfield, "Neural networks and physical systems with emergent collective computational abilities," *Proc. Nat. Acad. Sci. USA*, vol. 79, no. 8, pp. 2554–2558, 1982.
- [50] Y. Takefuji and K. C. Lee, "A near-optimum parallel planarization algorithm," *Science*, vol. 245, no. 4923, pp. 1221–1223, 1989.
- [51] Y. Takefuji and K. C. Lee, "Artificial neural networks for four-coloring map problems and K-colorability problems," *IEEE Trans. Circuits Syst.*, vol. 38, no. 3, pp. 326–333, Mar. 1991.
- [52] G. Galan-Marin and J. Munoz-Perez, "Design and analysis of maximum Hopfield networks," *IEEE Trans. Neural Netw.*, vol. 12, no. 2, pp. 329–339, Mar. 2001.
- [53] Y. Takefuji and L. Chen, "Parallel algorithms for finding a nearmaximum independent set of a circle graph," *IEEE Trans. Neural Netw.*, vol. 1, no. 3, p. 263, 1990.

- [54] Y. Takefuji and K.-C. Lee, "A parallel algorithm for tiling problems," *IEEE Trans. Neural Netw.*, vol. 1, no. 1, pp. 143–145, Mar. 1990.
- [55] Y. Takefuji and K.-C. Lee, "A super-parallel sorting algorithm based on neural networks," *IEEE Trans. Circuits Syst.*, vol. 37, no. 11, pp. 1425–1429, Nov. 1990.
- [56] Y. Takefuji, T. Tanaka, and K. C. Lee, "A parallel string search algorithm," *IEEE Trans. Syst., Man, Cybern.*, vol. 22, no. 2, pp. 332–336, Mar. 1992.
- [57] N. Funabikiy and Y. Takefuji, "A neural network parallel algorithm for channel assignment problems in cellular radio networks," *IEEE Trans. Veh. Technol.*, vol. 41, no. 4, pp. 430–437, Nov. 1992.
- [58] S. C. Amartur, D. Piraino, and Y. Takefuji, "Optimization neural networks for the segmentation of magnetic resonance images," *IEEE Trans. Med. Imag.*, vol. 11, no. 2, pp. 215–220, Jun. 1992.
- [59] K. C. Lee, N. Funabikiy, and Y. Takefuji, "A parallel improvement algorithm for the bipartite subgraph problem," *IEEE Trans. Neural Netw.*, vol. 3, no. 1, pp. 139–145, Jan. 1992.
- [60] N. Funabikiy and Y. Takefuji, "A parallel algorithm for broadcast scheduling problems in packet radio networks," *IEEE Trans. Commun.*, vol. 41, no. 6, pp. 828–831, Jun. 1993.
- [61] K. Tsuchiya, S. Bharitkar, and Y. Takefuji, "A neural network approach to facility layout problems," *Eur. J. Oper. Res.*, vol. 89, no. 3, pp. 556–563, Mar. 1996.
- [62] N. Funabiki and S. Nishikawa, "A neural network model for multilayer topological via minimization in a switchbox," *IEEE Trans. Comput.-Aided Design Integr.*, vol. 15, no. 8, pp. 1012–1020, Aug. 1996.
- [63] K. Tsuchiya and Y. Takefuji, "A neural network approach to PLA folding problems," *IEEE Trans. Comput.-Aided Design Integr.*, vol. 15, no. 10, pp. 1299–1305, Oct. 1996.
- [64] S. Bharitkar, K. Tsuchiya, and Y. Takefuji, "Microcode optimization with neural networks," *IEEE Trans. Neural Netw.*, vol. 10, no. 3, pp. 698–703, May 1999.
- [65] G. E. Hinton and T. J. Sejnowski, "Optimal perceptual inference," in *Proc. IEEE Conf. Comput. Vis. Pattern Recognit.*, Jun. 1983, pp. 448–453.
- [66] E. H. L. Aarts and J. H. M. Korst, "Boltzmann machines as a model for parallel annealing," *Algorithmica*, vol. 6, nos. 1–6, pp. 437–465, Jun. 1991.
- [67] S. Kirkpatrick, C. D. Gelatt, and M. P. Vecchi, "Optimization by simulated annealing," *Science*, vol. 220, no. 4598, pp. 671–680, 1983.
- [68] J. H. M. Korst and E. H. L. Aarts, "Combinatorial optimization on a Boltzmann machine," *J. Parallel Distrib. Comput.*, vol. 6, no. 2, pp. 331–357, Apr. 1989.
- [69] E. H. L. Aarts and J. H. M. Korst, "Boltzmann machines for travelling salesman problems," *Eur. J. Oper. Res.*, vol. 39, no. 1, pp. 79–95, Mar. 1989.
- [70] Q. Liu, S. Yang, and J. Wang, "A collective neurodynamic approach to distributed constrained optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 28, no. 8, pp. 1747–1758, Aug. 2017.
- [71] S. Yang, Q. Liu, and J. Wang, "A collaborative neurodynamic approach to multiple-objective distributed optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 29, no. 4, pp. 981–992, Apr. 2018.
- [72] M.-F. Leung and J. Wang, "A collaborative neurodynamic approach to multiobjective optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 29, no. 11, pp. 5738–5748, Nov. 2018.
- [73] H. Che, J. Wang, and A. Cichocki, "Bicriteria sparse nonnegative matrix factorization via two-timescale duplex neurodynamic optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, early access, Nov. 17, 2021, doi: 10.1109/TNNLS.2021.3125457.
- [74] J. Wang, J. Wang, and H. Che, "Task assignment for multivehicle systems based on collaborative neurodynamic optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 31, no. 4, pp. 1145–1154, Apr. 2020.
- [75] J. Wang, J. Wang, and Q.-L. Han, "Multivehicle task assignment based on collaborative neurodynamic optimization with discrete Hopfield networks," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 32, no. 12, pp. 5274–5286, Dec. 2021.
- [76] M.-F. Leung and J. Wang, "Minimax and biobjective portfolio selection based on collaborative neurodynamic optimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 32, no. 7, pp. 2825–2836, Jul. 2021.
- [77] J. Zhao, J. Yang, J. Wang, and W. Wu, "Spiking neural network regularization with fixed and adaptive drop-keep probabilities," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 33, no. 8, pp. 4096–4109, Aug. 2022.
- [78] X. Li, J. Wang, and S. Kwong, "Hash bit selection via collaborative neurodynamic optimization with discrete Hopfield networks," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 33, no. 10, pp. 5116–5124, 2022.

IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS

- [79] W. Zhou, H.-T. Zhang, and J. Wang, "Sparse Bayesian learning based on collaborative neurodynamic optimization," *IEEE Trans. Cybern.*, early access, Jul. 14, 2021, doi: 10.1109/TCYB.2021.3090204.
- [80] J. Kennedy and R. C. Eberhart, "A discrete binary version of the particle swarm algorithm," in *Proc. IEEE Int. Conf. Syst., Man, Cybern. Comput. Simulation*, vol. 5, Oct. 1997, pp. 4104–4108.
- [81] D. R. Hunter and K. Lange, "A tutorial on MM algorithms," Amer. Statist., vol. 58, no. 1, pp. 30–37, 2004.
- [82] C. Lu, J. Feng, S. Yan, and Z. Lin, "A unified alternating direction method of multipliers by majorization minimization," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 40, no. 3, pp. 527–541, Mar. 2018.
- [83] Y. Sun, P. Babu, and D. Palomar, "Majorization-minimization algorithms in signal processing, communications, and machine learning," *IEEE Trans. Signal Process.*, vol. 65, no. 3, pp. 794–816, Feb. 2016.
- [84] Z. Lin, C. Xu, and H. Zha, "Robust matrix factorization by majorization minimization," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 40, no. 1, pp. 208–220, Jan. 2017.
- [85] F. Nie, Z. Wang, L. Tian, R. Wang, and X. Li, "Subspace sparse discriminative feature selection," *IEEE Trans. Cybern.*, vol. 52, no. 6, pp. 4221–4233, Jun. 2022.
- [86] G. Kochenberger et al., "The unconstrained binary quadratic programming problem: A survey," J. Combinat. Optim., vol. 28, no. 1, pp. 58–81, Jul. 2014.
- [87] M. Negreiros and A. Palhano, "The capacitated centred clustering problem," *Comput. Oper. Res.*, vol. 33, no. 6, pp. 1639–1663, Jun. 2006.
- [88] A. A. Chaves and L. A. N. Lorena, "Hybrid evolutionary algorithm for the capacitated centered clustering problem," *Expert Syst. Appl.*, vol. 38, no. 5, pp. 5013–5018, May 2011.
- [89] F. Stefanello, O. C. B. de Arújo, and F. M. Müller, "Matheuristics for the capacitated p-median problem," *Int. Trans. Oper. Res.*, vol. 22, pp. 149–167, Jan. 2015.
- [90] S.-O. Caballero-Morales, E. Barojas-Payan, D. Sanchez-Partida, and J.-L. Martinez-Flores, "Extended GRASP-capacitated K-means clustering algorithm to establish humanitarian support centers in large regions at risk in Mexico," J. Optim., vol. 2018, pp. 1–14, Dec. 2018.
- [91] A. E. F. Muritiba, M. J. N. Gomes, M. F. de Souza, and H. L. G. Oriá, "Path-relinking with Tabu search for the capacitated centered clustering problem," *Expert Syst. Appl.*, vol. 198, Jul. 2022, Art. no. 116766.
- [92] Y. Xu, P. Guo, and Y. Zeng, "An iterative neighborhood local search algorithm for capacitated centered clustering problem," *IEEE Access*, vol. 10, pp. 34497–34510, 2022.
- [93] J. O. McClain and V. R. Rao, "CLUSTISz: A program to test for the quality of clustering of a set of objects," *J. Marketing Res.*, vol. 12, no. 4, pp. 456–460, 1975.
- [94] F. J. Rohlf, "Methods of comparing classifications," Annu. Rev. Ecology Systematics, vol. 5, no. 1, pp. 101–113, Nov. 1974.
- [95] F. B. Baker and L. J. Hubert, "Measuring the power of hierarchical cluster analysis," J. Amer. Stat. Assoc., vol. 70, no. 349, pp. 31–38, Mar. 1975.
- [96] L. Hubert and J. Schultz, "Quadratic assignment as a general data analysis strategy," *Brit. J. Math. Stat. Psychol.*, vol. 29, no. 2, pp. 190–241, Nov. 1976.
- [97] B. Desgraupes, "Clustering indices," Univ. Paris Ouest-Lab Modal'X, Nanterre, France, Tech. Rep., 2013, p. 34, vol. 1.
- [98] J. C. Bezdek and N. R. Pal, "Some new indexes of cluster validity," *IEEE Trans. Syst., Man, Cybern. B. Cybern.*, vol. 28, no. 3, pp. 301–315, Jun. 1998.
- [99] D. Ratkowsky and G. Lance, "Criterion for determining the number of groups in a classification," *Austral. Comput. J.*, vol. 10, no. 3, pp. 115–117, 1978.
- [100] T. Caliński and J. Harabasz, "A dendrite method for cluster analysis," *Commun. Stat., Theory Methods*, vol. 3, no. 1, pp. 1–27, 1974.
- [101] S. Ray and R. H. Turi, "Determination of number of clusters in k-means clustering and application in colour image segmentation," in *Proc. 4th Int. Conf. Adv. Pattern Recognit. Digit. Techn.*, 1999, pp. 137–143.
- [102] J. C. Dunn, "Well-separated clusters and optimal fuzzy partitions," J. Cybern., vol. 4, no. 1, pp. 95–104, 2008.
- [103] H. P. Friedman and J. Rubin, "On some invariant criteria for grouping data," J. Amer. Statist. Assoc., vol. 62, no. 320, pp. 1159–1178, 1967.
- [104] G. Ball and D. Hall, A Novel Method of data analysis and Pattern Classification. Menlo Park, CA, USA: SRI International, 1965.
- [105] G. W. Milligan, "A Monte Carlo study of thirty internal criterion measures for cluster analysis," *Psychometrika*, vol. 46, no. 2, pp. 187–199, Jun. 1981.

- [106] X. L. Xie and G. Beni, "A validity measure for fuzzy clustering," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 13, no. 8, pp. 841–847, Aug. 1991.
- [107] D. L. Davies and D. W. Bouldin, "A cluster separation measure," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. PAMI-1, no. 2, pp. 224–227, Apr. 1979.
- [108] Å. J. Scott and M. J. Symons, "Clustering methods based on likelihood ratio criteria," *Biometrics*, vol. 27, no. 2, pp. 387–397, 1971.
- [109] F. H. C. Marriott, "Practical problems in a method of cluster analysis," *Biometrics*, vol. 27, no. 3, pp. 501–514, 1971.
- [110] J. A. Hartigan, *Clustering Algorithms*. Hoboken, NJ, USA: Wiley, 1975.
- [111] A. W. Edwards and L. L. Cavalli-Sforza, "A method for cluster analysis," *Biometrics*, vol. 21, no. 2, pp. 362–375, 1965.
- [112] L. Xiao, J. Dai, R. Lu, S. Li, J. Li, and S. Wang, "Design and comprehensive analysis of a noise-tolerant ZNN model with limited-time convergence for time-dependent nonlinear minimization," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 31, no. 12, pp. 5339–5348, Dec. 2020.
- [113] L. Xiao, Y. He, J. Dai, X. Liu, B. Liao, and H. Tan, "A variableparameter noise-tolerant zeroing neural network for time-variant matrix inversion with guaranteed robustness," *IEEE Trans. Neural Netw. Learn. Syst.*, vol. 33, no. 4, pp. 1535–1545, Apr. 2022.



Hongzong Li received the B.E. degree in automation from Northeastern University, Shenyang, Liaoning, China, in 2020. He is currently pursuing the Ph.D. degree in computer science with the Department of Computer Science, City University of Hong Kong, Hong Kong.

His current research interests include optimization, computational intelligence, and clustering.



Jun Wang (Life Fellow, IEEE) received the B.S. and M.S. degrees from Dalian University of Technology, Dalian, China, in 1982 and 1985, respectively, and the Ph.D. degree from Case Western Reserve University, Cleveland, OH, USA, in 1991. He held various academic positions at Dalian University of Technology, Case Western Reserve University, University of North Dakota, Grand Forks, ND, USA, and The Chinese University of Hong Kong, Hong Kong. He also held various short-term or part-time visiting positions at the U.S.

Air Force Armstrong Laboratory, Dayton, OH, USA, RIKEN Brain Science Institute, Tokyo, Japan, the Huazhong University of Science and Technology, Wuhan, China, Shanghai Jiao Tong University, Shanghai, China, and Dalian University of Technology. He is currently a Chair Professor with the City University of Hong Kong, Hong Kong.

Dr. Wang was a Distinguished Lecturer of the IEEE Computational Intelligence Society from 2010 to 2012 and from 2014 to 2016. He is an IEEE Systems, Man, and Cybernetics Society Distinguished Lecturer from 2017 to 2022. He was a recipient of several awards, such as the Research Excellence Award from the Chinese University of Hong Kong for 2008–2009, the Outstanding Achievement Award from the Asia–Pacific Neural Network Assembly in 2011, the IEEE TRANSACTIONS ON NEURAL NETWORKS Outstanding Paper Award in 2011, the Neural Networks Pioneer Award from the IEEE Computational Intelligence Society in 2014, and the Norbert Wiener Award from the IEEE Systems, Man, and Cybernetics Society in 2019. He served as the General Chair for the 13th and 25th International Conference on Neural Information Processing in 2006 and 2018, respectively, and the IEEE World Congress on Computational Intelligence in 2008. He was the Editor-in-Chief of the IEEE TRANSACTIONS ON CYBERNETICS from 2014 to 2019.