**Parameters of the 7 problem instances for “A genetic algorithm with trip-adjustment strategy for multi-depot electric bus vehicle scheduling problem” by Liu et al.**

For each problem instance, one bus line has two CPs (CP1 and CP2), each of which involves a timetable. The data of each problem instance include the number of trips for a short (peak and long) block, the number of time points in a timetable, the capacity of each depot, the deadhead distance among depots and CPs (among different CPs). From the historical travel data of vehicles, the speed of deadhead trips (20km/h) is obtained. Thus, the deadhead travel time can be calculated by the deadhead distance divided by the speed.

# Number of trips in a short (peak and long) block for each problem instance

The two real-world problem instances (real-1 and real-2) are supplied by the public transportation companyin Qingdao city of China. Real-1 includes three bus lines (Lines 4, 59, and 60), and real-2 has five bus lines (Lines 4, 59, 60, 803 and k1). In the experience-based scheduling scheme, the average number of trips in a vehicle block is 6.2, 9.6, 9.3, 9.6 and 6.0 for Lines 4, 59, 60, 803 and k1, respectively. In GA-TAS, the number of trips in the short (peak) block is set to make vehicles perform the similar number of trips as in the experience-based scheme, thereby the comparison between GA-TAS and experience-based scheduling scheme is fair. The number of trips in the long block is set to make the departure time of the last trip in a vehicle block not exceed the last time point in the timetable.

Table 1 shows the settings of the number of trips (that is, the parameter *J* in Section 4 of the article) for real-1 and real-2. For all of the five random instances, the *J* of the short (peak and long) vehicle block of each bus line is set as 8 (8 and 14) by referring to the real-world problem instances and the travel time between the two CPs of one bus line. Besides, the number of trips in a block is set as even to ensure that vehicles depart and end at the same depot if vehicles do not perform deadhead trips from a CP of one bus line to a CP of another bus line.

**Table 1.** Number of trips in the short (peak and long) block for real-1 and real-2.

|  |  |  |  |
| --- | --- | --- | --- |
| Bus lines | Short block | Peak block | Long block |
| Line 4 | 6 | 6 | 10 |
| Line 59 | 10 | 10 | 14 |
| Line 60 | 8 | 8 | 12 |
| Line 803 | 10 | 10 | 14 |
| Line k1 | 6 | 6 | 10 |

# Parameters of two real-world problem instances

## Parameters of real-1

Real-1 consists of Lines 4, 59, and 60, and Lines 59 and 60 share the same CP, , and the same depot, Eb. The information of the three bus lines and the depots is shown in Table 2. The deadhead distance among different CPs, and the deadhead distance among depots and CPs are respectively shown in Tables 3 and 4.

**Table 2.** Information of the bus lines and depots of real-1.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Line 4 | Line 59 | Line 60 |
| CP1 |  |  |  |
| CP2 |  |  |  |
| Number of time points in the timetable of CP1 | 112 | 53 | 61 |
| Number of time points in the timetable of CP2 | 112 | 53 | 61 |
| Travel time between CP1 and CP2(unit: minutes) | 70 | 35 | 50 |
| Depot near CP1 | Ea | Eb | Eb |
| Depot near CP2 | Ec | Ed | Ee |
| Capacity of the depot near CP1 | 90 | 120 | 120 |
| Capacity of the depot near CP2 | 61 | 11 | 10 |

**Table 3.** Deadhead distance among CPs of real-1 (unit: km).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Bus lines and CPs | | Line 4 | | Line 59 | | Line 60 | |
|  |  |  |  |  |  |
| Line 4 |  | 0 | 24 | 6 | 19 | 6 | 26 |
|  | 24 | 0 | 17 | 4 | 17 | 3 |
| Line 59 |  | 6 | 17 | 0 | 11 | 0 | 19 |
|  | 19 | 4 | 11 | 0 | 11 | 7 |
| Line 60 |  | 6 | 17 | 0 | 11 | 0 | 19 |
|  | 26 | 3 | 19 | 7 | 19 | 0 |

**Table 4.** Deadhead distance among depots and CPs of real-1 (unit: km).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Depots | Line 4 | | Line 59 | | Line 60 | |
|  |  |  |  |  |  |
| Ea | 16 | 8 | 10 | 4 | 10 | 11 |
| Eb | 14 | 10 | 8 | 5 | 8 | 13 |
| Ec | 17 | 13 | 11 | 12 | 11 | 17 |
| Ed | 17 | 6 | 11 | 1 | 11 | 9 |
| Ee | 24 | 2 | 18 | 5 | 18 | 1 |

## Parameters of real-2

Real-2 has five bus lines in total. Apart from the Lines 4, 59, and 60, real-2 also includes Lines 803 and k1. Bus lines 4 and 803 share the same CP, , and the same depot, Ea. Lines 59, 60, and k1 share the same CP, , and the same depot, Eb. The information of the five bus lines and the depots is shown in Table 5. The deadhead distance among different CPs of the five bus lines, and the deadhead distance among depots and CPs of real-2 are respectively shown in Tables 6 and 7.

**Table 5.** Information of the five bus lines of real-2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Line 4 | Line 59 | Line 60 | Line 803 | Line k1 |
| CP1 |  |  |  |  |  |
| CP2 |  |  |  |  |  |
| Number of time points in the timetable of CP1 | 112 | 53 | 61 | 77 | 88 |
| Number of time points in the timetable of CP2 | 112 | 53 | 61 | 77 | 88 |
| Travel time between CP1 and CP2(unit: minutes) | 70 | 35 | 50 | 41 | 65 |
| Depot near CP1 | Ea | Eb | Eb | Ea | Eb |
| Depot near CP2 | Ec | Ed | Ee | Ef | Eg |
| Capacity of the depot near CP1 | 90 | 120 | 120 | 90 | 120 |
| Capacity of the depot near CP2 | 61 | 11 | 10 | 30 | 45 |

**Table 6.** Deadhead distance among CPs of real-2 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bus lines and CPs | | Line 4 | | Line 59 | | Line 60 | | Line 803 | | Line k1 | |
|  |  |  |  |  |  |  |  |  |  |
| Line 4 |  | 0 | 24 | 6 | 19 | 6 | 26 | 0 | 15 | 6 | 42 |
|  | 24 | 0 | 17 | 4 | 17 | 3 | 24 | 10 | 17 | 18 |
| Line 59 |  | 6 | 17 | 0 | 11 | 0 | 19 | 6 | 9 | 0 | 29 |
|  | 19 | 4 | 11 | 0 | 11 | 7 | 19 | 8 | 11 | 23 |
| Line 60 |  | 6 | 17 | 0 | 11 | 0 | 19 | 6 | 9 | 0 | 29 |
|  | 26 | 3 | 19 | 7 | 19 | 0 | 26 | 14 | 19 | 15 |
| Line 803 |  | 0 | 24 | 6 | 19 | 6 | 26 | 0 | 15 | 6 | 42 |
|  | 15 | 10 | 9 | 8 | 9 | 14 | 15 | 0 | 9 | 27 |
| Line k1 |  | 6 | 17 | 0 | 11 | 0 | 19 | 6 | 9 | 0 | 29 |
|  | 42 | 18 | 29 | 23 | 29 | 15 | 42 | 27 | 29 | 0 |

**Table 7.** Deadhead distance among depots and CPs of real-2 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Depots | Line 4 | | Line 59 | | Line 60 | | Line 803 | | Line k1 | |
|  |  |  |  |  |  |  |  |  |  |
| Ea | 16 | 8 | 10 | 4 | 10 | 11 | 16 | 9 | 10 | 27 |
| Eb | 14 | 10 | 8 | 5 | 8 | 13 | 14 | 9 | 8 | 29 |
| Ec | 17 | 13 | 11 | 12 | 11 | 17 | 17 | 4 | 11 | 29 |
| Ed | 17 | 6 | 11 | 1 | 11 | 9 | 17 | 7 | 11 | 25 |
| Ee | 24 | 2 | 18 | 5 | 18 | 1 | 24 | 12 | 18 | 17 |
| Ef | 12 | 10 | 29 | 6 | 29 | 14 | 12 | 6 | 29 | 6 |
| Eg | 13 | 12 | 7 | 9 | 7 | 16 | 13 | 2 | 7 | 29 |

# Parameters of five randomly generated problem instances

To observe the performance of GA-TAS on large scale problem instance, five random problem instances are generated in this article. The timetables of the five random instances are generated as follows. The operation time of a timetable is from 5:00 am to 22:30 pm. The timetable is divided into five time periods: morning off-peak period, morning peak period, midday off-peak period, evening peak period, and evening off-peak period (Gao et al. 2019; Ma, Li, and Yu 2020). An integer is randomly selected from [11, 13], [5, 7], and [8, 10] as the time interval of two adjacent time points in morning and evening off-peak periods, morning and evening peak periods, and midday off-peak period, respectively, to form a bus timetable. By this means, timetables for each instance are randomly generated.

The information of the bus lines and depots, the deadhead distance among CPs, the deadhead distance among depots and CPs for five random problem instances (rand-1, rand-2, rand-3, rand-4, and rand-5) are given as follows.

## Parameters of rand-1

Rand-1 includes four bus lines (Lines r1, r2, r3, and r4) and four depots (Er1, Er2, Er3, and Er4). Table 8 shows the information of the four bus lines and depots. Note that Lines r1 and r2 share the same CP, , and the same depot, Er1. Lines r1 and r4 share the same CP, , and the same depot, Er4. Lines r2 and r3 share the same CP, , and the same depot, Er2. Lines r3 and r4 share the same CP, , and the same depot, Er3. Table 9 gives the deadhead distance among different CPs. Table 10 gives the deadhead distance among depots and CPs.

**Table 8.** Information of the bus lines and depots in rand-1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Line r1 | Line r2 | Line r3 | Line r4 |
| CP1 |  |  |  |  |
| CP2 |  |  |  |  |
| Number of time points in the timetable of CP1 | 122 | 125 | 127 | 126 |
| Number of time points in the timetable of CP2 | 122 | 125 | 127 | 126 |
| Travel time between CP1 and CP2(unit: minutes) | 45 | 42 | 35 | 38 |
| Depot near CP1 | Er1 | Er1 | Er3 | Er3 |
| Depot near CP2 | Er4 | Er2 | Er2 | Er4 |
| Capacity of the depot near CP1 | 35 | 40 | 40 | 40 |
| Capacity of the depot near CP2 | 35 | 40 | 40 | 40 |

**Table 9.** Deadhead distance among CPs in rand-1 (unit: km).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bus lines and CPs | | Line r1 | | Line r2 | | Line r3 | | Line r4 | |
|  |  |  |  |  |  |  |  |
| Line r1 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 |
| Line r2 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 |
| Line r3 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 |
| Line r4 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 |

**Table 10.** Deadhead distance among depots and CPs in rand-1 (unit: km).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Depots | Line r1 | | Line r2 | | Line r3 | | Line r4 | |
|  |  |  |  |  |  |  |  |
| Er1 | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 |
| Er2 | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 |
| Er3 | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 |
| Er4 | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 |

## Parameters of rand-2

Rand-2 includes five bus lines (Lines r1, r2, r3, r4, and r5) and four depots (Er1, Er2, Er3, and Er4). Table 11 shows the information of the five bus lines and four depots. Note that Lines r1, r2, and r5 share the same CP, , and the same depot, Er1. Lines r1 and r4 share the same CP, , and the same depot, Er4. Lines r2 and r3 share the same CP, , and the same depot, Er2. Lines r3, r4, and r5 share the same CP, , and the same depot, Er3. Table 12 gives the deadhead distance among different CPs. Table 13 gives the deadhead distance among depots and CPs.

**Table 11.** Information of the bus lines and depots in rand-2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Line r1 | Line r2 | Line r3 | Line r4 | Line r5 |
| CP1 |  |  |  |  |  |
| CP2 |  |  |  |  |  |
| Number of time points in the timetable of CP1 | 125 | 123 | 120 | 120 | 112 |
| Number of time points in the timetable of CP2 | 125 | 123 | 120 | 120 | 112 |
| Travel time between CP1 and CP2(unit: minutes) | 45 | 42 | 35 | 38 | 45 |
| Depot near CP1 | Er1 | Er1 | Er3 | Er3 | Er1 |
| Depot near CP2 | Er4 | Er2 | Er2 | Er4 | Er3 |
| Capacity of the depot near CP1 | 70 | 70 | 70 | 70 | 70 |
| Capacity of the depot near CP2 | 40 | 40 | 40 | 40 | 70 |

**Table 12.** Deadhead distance among CPs in rand-2 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bus lines and CPs | | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | |
|  |  |  |  |  |  |  |  |  |  |
| Line r1 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 |
| Line r2 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 |
| Line r3 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 |
| Line r4 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 |
| Line r5 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 |
|  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 |

**Table 13.** Deadhead distance among depots and CPs in rand-2 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Depots | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | |
|  |  |  |  |  |  |  |  |  |  |
| Er1 | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 |
| Er2 | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 |
| Er3 | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 |
| Er4 | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 |

## Parameters of rand-3

Rand-3 includes six bus lines (Lines r1, r2, r3, r4, r5, and r6) and four depots (Er1, Er2, Er3, and Er4). Table 14 shows the information of the six bus lines and four depots. Note that Lines r1, r2, and r5 share the same CP, , and the same depot, Er1. Lines r1, r4, and r6 share the same CP, , and the same depot, Er4. Lines r2, r3, and r6 share the same CP, , and the same depot, Er2. Lines r3, r4, and r5 share the same CP, , and the same depot, Er3. Table 15 gives the deadhead distance among different CPs. Table 16 gives the deadhead distance among depots and CPs.

**Table 14.** Information of the bus lines and depots in rand-3.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Line r1 | Line r2 | Line r3 | Line r4 | Line r5 | Line r6 |
| CP1 |  |  |  |  |  |  |
| CP2 |  |  |  |  |  |  |
| Number of time points in the timetable of CP1 | 122 | 125 | 127 | 126 | 129 | 116 |
| Number of time points in the timetable of CP2 | 122 | 125 | 127 | 126 | 129 | 116 |
| Travel time between CP1 and CP2(unit: minutes) | 45 | 42 | 35 | 38 | 45 | 50 |
| Depot near CP1 | Er1 | Er1 | Er3 | Er3 | Er1 | Er4 |
| Depot near CP2 | Er4 | Er2 | Er2 | Er4 | Er3 | Er2 |
| Capacity of the depot near CP1 | 80 | 80 | 80 | 80 | 80 | 60 |
| Capacity of the depot near CP2 | 60 | 60 | 60 | 60 | 80 | 60 |

**Table 15.** Deadhead distance among CPs in rand-3 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bus lines and CPs | | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | | Line r6 | |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Line r1 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 |
| Line r2 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 |
| Line r3 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 |
| Line r4 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 |
| Line r5 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 |
|  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 |
| Line r6 |  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 |

**Table 16.** Deadhead distance among depots and CPs in rand-3 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Depots | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | | Line r6 | |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Er1 | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 |
| Er2 | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 |
| Er3 | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 |
| Er4 | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 |

## Parameters of rand-4

Rand-4 includes seven bus lines (Lines r1, r2, r3, r4, r5, r6, and r7) and five depots (Er1, Er2, Er3, Er4, and Er5). Table 17 shows the information of the seven bus lines and five depots. Note that Lines r1, r2, r5, and r7 share the same CP, , and the same depot, Er1. Lines r1, r4, and r6 share the same CP, , and the same depot, Er4. Lines r2, r3, and r6 share the same CP, , and the same depot, Er2. Lines r3, r4, and r5 share the same CP, , and the same depot, Er3. Table 18 gives the deadhead distance among depots and CPs. Table 19 gives the deadhead distance among different CPs.

**Table 17.** Information of the bus lines and depots in rand-4.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Line r1 | Line r2 | Line r3 | Line r4 | Line r5 | Line r6 | Line r7 |
| CP1 |  |  |  |  |  |  |  |
| CP2 |  |  |  |  |  |  |  |
| Number of time points in the timetable of CP1 | 126 | 126 | 120 | 125 | 125 | 116 | 112 |
| Number of time points in the timetable of CP2 | 126 | 126 | 120 | 125 | 125 | 116 | 112 |
| Travel time between CP1 and CP2(unit: minutes) | 45 | 42 | 35 | 38 | 45 | 50 | 50 |
| Depot near CP1 | Er1 | Er1 | Er3 | Er3 | Er1 | Er4 | Er1 |
| Depot near CP2 | Er4 | Er2 | Er2 | Er4 | Er3 | Er2 | Er7 |
| Capacity of the depot near CP1 | 100 | 100 | 80 | 80 | 100 | 60 | 100 |
| Capacity of the depot near CP2 | 60 | 60 | 60 | 60 | 80 | 60 | 40 |

**Table 18.** Deadhead distance among depots and CPs in rand-4 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Depots | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | | Line r6 | | Line r7 | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Er1 | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 0 | 12 |
| Er2 | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 19 | 11 |
| Er3 | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 11 | 13 |
| Er4 | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 22 | 15 |
| Er5 | 12 | 15 | 12 | 11 | 13 | 11 | 13 | 15 | 12 | 13 | 15 | 11 | 15 | 0 |

**Table 19.** Deadhead distance among CPs in rand-4 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bus lines and CPs | | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | | Line r6 | | Line r7 | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Line r1 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 22 | 12 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 |
| Line r2 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 22 | 12 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 17 | 11 |
| Line r3 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 12 | 13 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 17 | 11 |
| Line r4 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 12 | 13 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 |
| Line r5 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 22 | 12 |
|  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 12 | 13 |
| Line r6 |  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 17 | 11 |
| Line r7 |  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 |
|  | 12 | 15 | 12 | 11 | 13 | 11 | 13 | 15 | 12 | 13 | 15 | 11 | 15 | 0 |

## Parameters of rand-5

Rand-5 includes eight bus lines (Lines r1, r2, r3, r4, r5, r6, r7, and r8) and five depots (Er1, Er2, Er3, Er4, and Er5). Table 20 shows the information of the eight bus lines and five depots. Note that Lines r1, r2, r5, and r7 share the same CP, , and the same depot, Er1. Lines r1, r4, and r6 share the same CP, , and the same depot, Er4. Lines r2, r3, r6, and r8 share the same CP, , and the same depot, Er2. Lines r3, r4, and r5 share the same CP, , and the same depot, Er3. Lines r7 and r8 share the same CP, , and the same depot, Er7. Table 21 gives the deadhead distance among different CPs. Table 22 gives the deadhead distance among depots and CPs.

**Table 20.** Information of the bus lines and depots in rand-5.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Line r1 | Line r2 | Line r3 | Line r4 | Line r5 | Line r6 | Line r7 | Line r8 |
| CP1 |  |  |  |  |  |  |  |  |
| CP2 |  |  |  |  |  |  |  |  |
| Number of time points in the timetable of CP1 | 130 | 126 | 121 | 128 | 129 | 120 | 126 | 120 |
| Number of time points in the timetable of CP2 | 130 | 126 | 121 | 128 | 129 | 120 | 126 | 120 |
| Travel time between CP1 and CP2(unit: minutes) | 45 | 42 | 35 | 38 | 45 | 40 | 42 | 42 |
| Depot near CP1 | Er1 | Er1 | Er3 | Er3 | Er1 | Er4 | Er1 | Er2 |
| Depot near CP2 | Er4 | Er2 | Er2 | Er4 | Er3 | Er2 | Er7 | Er7 |
| Capacity of the depot near CP1 | 100 | 100 | 80 | 80 | 100 | 60 | 100 | 100 |
| Capacity of the depot near CP2 | 60 | 80 | 80 | 60 | 80 | 80 | 80 | 80 |

**Table 21.** Deadhead distance among CPs in rand-5 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bus lines and CPs | | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | | Line r6 | | Line r7 | | Line r8 | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Line r1 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 22 | 12 | 19 | 12 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 | 17 | 15 |
| Line r2 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 22 | 12 | 19 | 12 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 17 | 11 | 0 | 11 |
| Line r3 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 12 | 13 | 15 | 13 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 17 | 11 | 0 | 11 |
| Line r4 |  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 12 | 13 | 15 | 13 |
|  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 | 17 | 15 |
| Line r5 |  | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 22 | 12 | 19 | 12 |
|  | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 12 | 13 | 15 | 13 |
| Line r6 |  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 | 17 | 15 |
|  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 17 | 11 | 0 | 11 |
| Line r7 |  | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 0 | 15 | 17 | 15 |
|  | 12 | 15 | 12 | 11 | 13 | 11 | 13 | 15 | 12 | 13 | 15 | 11 | 15 | 0 | 11 | 0 |
| Line r8 |  | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 17 | 11 | 0 | 11 |
|  | 12 | 15 | 12 | 11 | 13 | 11 | 13 | 15 | 12 | 13 | 15 | 11 | 15 | 0 | 11 | 0 |

**Table 22.** Deadhead distance among depots and CPs in rand-5 (unit: km).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Depots | Line r1 | | Line r2 | | Line r3 | | Line r4 | | Line r5 | | Line r6 | | Line r7 | | Line r8 | |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Er1 | 0 | 22 | 0 | 19 | 11 | 19 | 11 | 22 | 0 | 11 | 22 | 19 | 0 | 12 | 19 | 12 |
| Er2 | 19 | 17 | 19 | 0 | 15 | 0 | 15 | 17 | 19 | 15 | 17 | 0 | 19 | 11 | 0 | 11 |
| Er3 | 11 | 12 | 11 | 15 | 0 | 15 | 0 | 12 | 11 | 0 | 12 | 15 | 11 | 13 | 15 | 13 |
| Er4 | 22 | 0 | 22 | 17 | 12 | 17 | 12 | 0 | 22 | 12 | 0 | 17 | 22 | 15 | 17 | 15 |
| Er5 | 12 | 15 | 12 | 11 | 13 | 11 | 13 | 15 | 12 | 13 | 15 | 11 | 15 | 0 | 11 | 0 |

# References

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