GROUP X

A Consult System for HDB Carpark

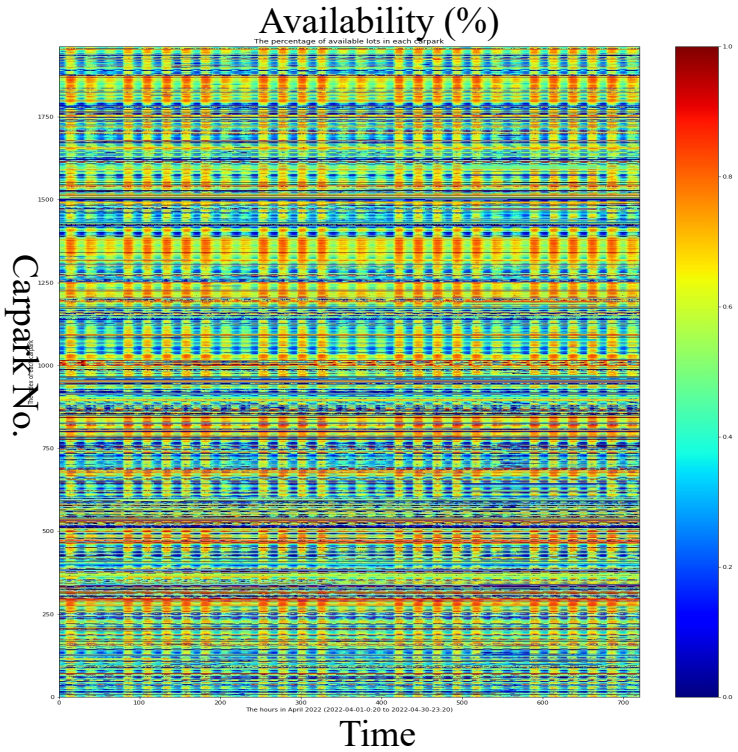
Outline

- Problems statement
- System design and Data collection
- New carpark construction suggestion
- Carpark available rate prediction
- Real-time carpark suggestion for drivers
- Conclusion

Problems Statement

Hard to find a proper parking lot which is:

- ✓ Available lots are enough,
- ✓ Close to your destination,
- ✓ Still available after driving away and coming back.



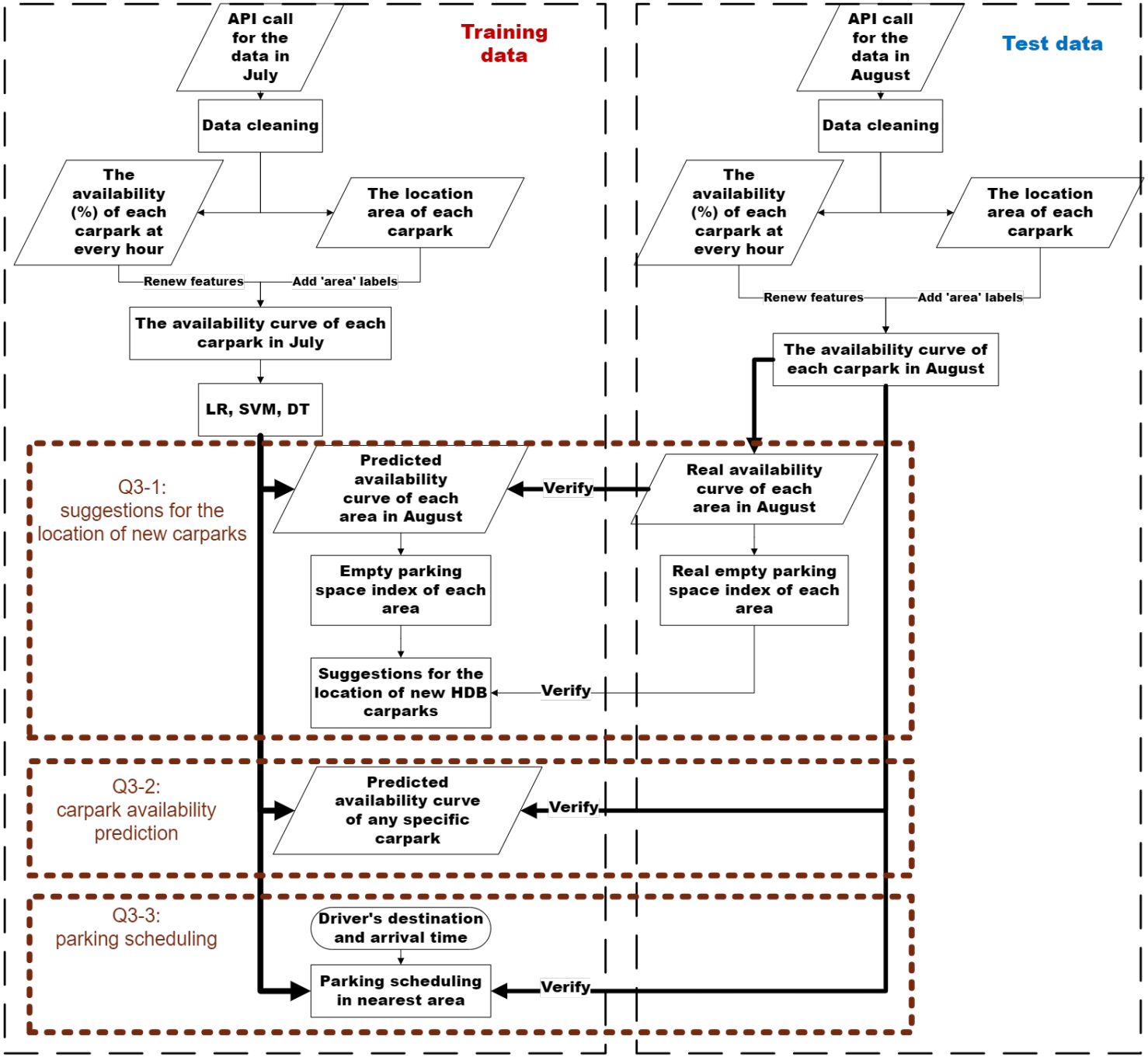
Three researches using the HDB parking lots dataset after area classification:

① **Suggestions** for the location of **new HDB carparks**.

② Carparks **availability prediction**.

③ Parking **scheduling** at the nearest area.

System design and Data collection



System design and Data collection

The parking problem is more severe in some area than in other areas! So, we classify the parking lots into different area.

From https://data.gov.sg/, there is information about HDB carparks such as car park numbers and locations.

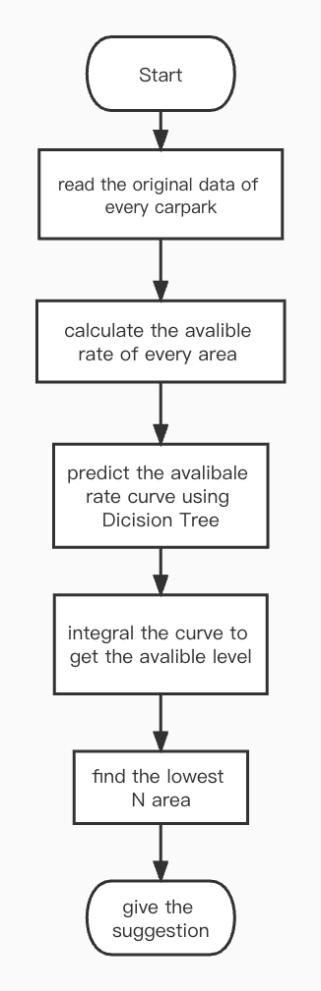
car_park_no	address
AM19	BLK 260 ANG MO KIO ST 21
AM20	BLK 309B ANG MO KIO ST 31
AM22	BLK 316B ANG MO KIO STREET 31
AM32	BLK 255A ANG MO KIO ST 21
AM43	BLK 455 ANG MO KIO ST 44
AM46	BLK 588 ANG MO KIO STREET 52
AM51	BLK 700 ANG MO KIO AVE 6
AM64	BLK 590 ANG MO KIO ST 51
AM79	BLK 596 ANG MO KIO STREEET 52
AM80	BLK 130A ANG MO KIO ST 12
AM81	BLK 132A ANG MO KIO ST 12
AM96	BLK 352A ANG MO KIO STREET 32
AR1L	3 AND 5 DOVER ROAD
AR1M	BLK 2A DOVER ROAD
AR2L	BLK 26 AND 27 DOVER CRESCENT
AR2M	BLK 28 DOVER CRESCENT
AR5M	BLK 19A DOVER CRESCENT
AR7L	12 TO 14 DOVER CLOSE EAST
AR7M	BLK 12A DOVER CLOSE EAST
AR9	BLK 20/22/23 DOVER CRESCENT
AV1	BLK 120/120A/121-127 ALEXANDRA VILLAGE
AV2	BLK 1001/1010 BUKIT MERAH LANE 1/3
B10	BLK 404/413 BEDOK NORTH AVENUE 3
B10M	BLK 431 BEDOK NORTH ROAD
B11	BLK 416/418 BEDOK NORTH AVENUE 2
B12	BLK 420/421 BEDOK NORTH STREET 1
B13	BLK 414/425 BEDOK NORTH ROAD
B14	BLK 412/413 BEDOK NORTH AVENUE 2
B16	BLKS 59, 62-65 NEW UPPER CHANGI ROAD
B17	BLK 52/57 NEW UPPER CHANGI ROAD
B19	BLK 36-44, 60 BEDOK SOUTH ROAD
B20	BLK 67/73 BEDOK SOUTH ROAD
B21	BLK 74/82 BEDOK NORTH ROAD
B23M	BLK 187 BEDOK NORTH ST 4
B24	BLK 84/89 BEDOK NORTH AVENUE 4

area	carpark_number	2022_7_1 (	2022_7_1 :	2022_7_1 :	2022_7_1 :	2022_7_1 ‹	2022_7_1 !	2022_7_1 (	(2022_7_1
12	AM19	0.357143	0.342262	0.33631	0.339286	0.33631	0.333333	0.360119	0.529762
12	AM20	0.576923	0.569527	0.568047	0.569527	0.573964	0.576923	0.58284	0.661243
12	AM22	0.304498	0.304498	0.304498	0.301038	0.297578	0.287197	0.297578	0.380623
12	AM32	0	0	0	0.021978	0.043956	0.043956	0.098901	0.252747
12	AM43	0.380645	0.365591	0.36129	0.36129	0.36129	0.363441	0.374194	0.492473
12	AM46	0.154412	0.137255	0.122549	0.102941	0.102941	0.098039	0.142157	0.392157
12	AM51	0.475836	0.464684	0.460967	0.457249	0.449814	0.453532	0.483271	0.598513
12	AM64	0.565217	0.565217	0.557971	0.554348	0.550725	0.557971	0.572464	0.639493
12	AM79	0.489407	0.478814	0.476695	0.485169	0.485169	0.489407	0.514831	0.627119
12	AM80	0.246073	0.209424	0.183246	0.183246	0.188482	0.204188	0.225131	0.329843
12	AM81	0.490991	0.486486	0.481982	0.472973	0.463964	0.459459	0.5	0.603604
12	AM96	0.447619	0.438095	0.434286	0.455238	0.449524	0.451429	0.457143	0.554286
13	AR1L	0	0	0	0	0	0	0	0
13	AR1M	0.586735	0.596939	0.607143	0.591837	0.581633	0.591837	0.607143	0.627551
13	AR2L	0	0	0	0	0	0	0	0
13	AR2M	0.399425	0.393678	0.382184	0.380747	0.373563	0.375	0.389368	0.520115
13	AR5M	0.527446	0.527446	0.527446	0.527446	0.527446	0.527446	0.527446	0.527446
13	AR7L	0.5	0.75	0.75	0.75	0.75	0.75	0.5	0.5
13	AR7M	0.39322	0.389831	0.386441	0.386441	0.386441	0.39661	0.40678	0.474576
13	AR9	0.03125	0.03125	0.03125	0.03125	0.03125	0.03125	0.03125	0.03125
14	AV1	0.714801	0.707581	0.707581	0.718412	0.711191	0.700361	0.67509	0.494585
20	B10	0.304264	0.30814	0.302326	0.306202	0.312016	0.306202	0.331395	0.424419
20	B10M	0.990536	0.993691	0.974763	0.962145	0.968454	0.968454	0.981073	0.990536
20	B11	0.380811	0.378833	0.405539	0.400593	0.403561	0.407517	0.432245	0.523244
20	B14	0.293269	0.293269	0.293269	0.293269	0.293269	0.293269	0.293269	0.293269
20	B16	0.480769	0.46978	0.464286	0.475275	0.456044	0.414835	0.406593	0.373626
20	B17	0.379221	0.379221	0.374026	0.368831	0.335065	0.301299	0.257143	0.249351
20	B19	0.516279	0.506977	0.495349	0.489535	0.488372	0.487209	0.516279	0.598837
20	B20	0.231169	0.207792	0.207792	0.233766	0.231169	0.241558	0.267532	0.371429
20	B21	0.311712	0.299099	0.293694	0.282883	0.277477	0.29009	0.333333	0.482883
20	B23M	0.554398	0.546296	0.538194	0.527778	0.528935	0.52662	0.538194	0.637731
20	B23T	1	1	1	1	1	1	1	1
20	B24	0.08	0.306667	0.353333	0.34	0.373333	0.253333	0.146667	0

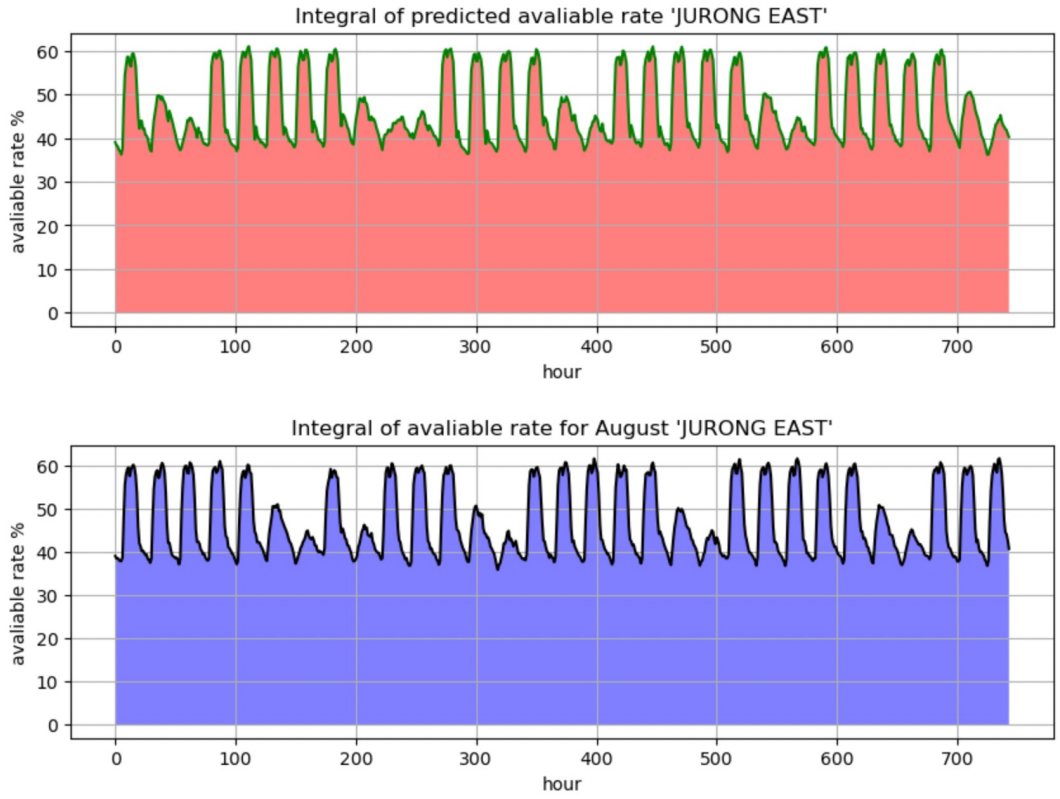
Adding ‘area’ labels

New carpark construction suggestion

- **Algorithm Design**



The workflow of the suggestion algorithm.



The integral of the available rate in 'Jurong East' area.

New carpark construction suggestion

- **Result**

```
Need to build more park in :
44
62
101
```

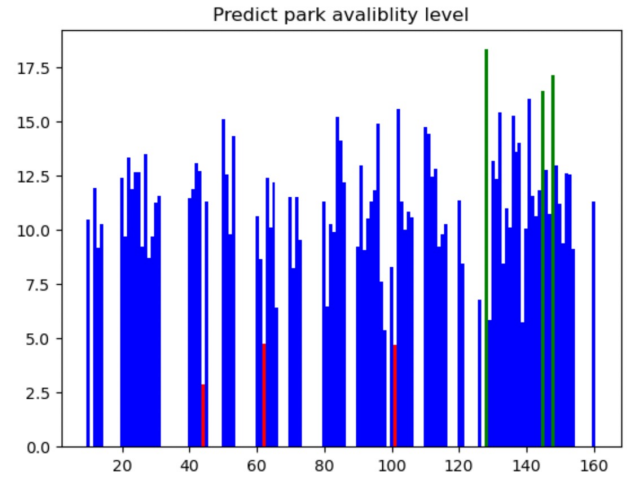


Fig 1. Predicted available level

The 3 areas with most crowded carparks are:

44	Around Beach road
62	Around Everton
101	Around Mei Lin St

```
Need to build more park in :
44
62
101
```

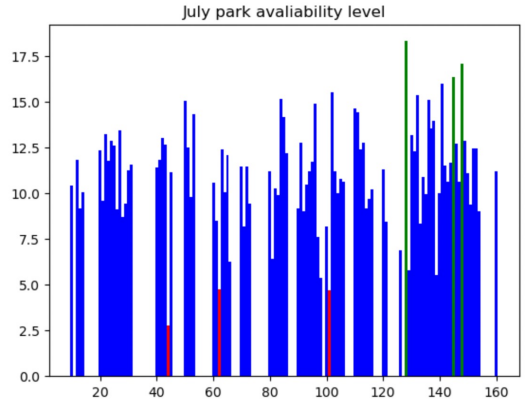


Fig 1. July available level

```
Need to build more park in :
44
62
101
```

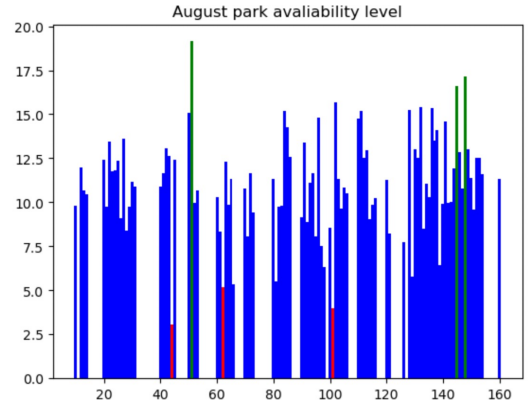
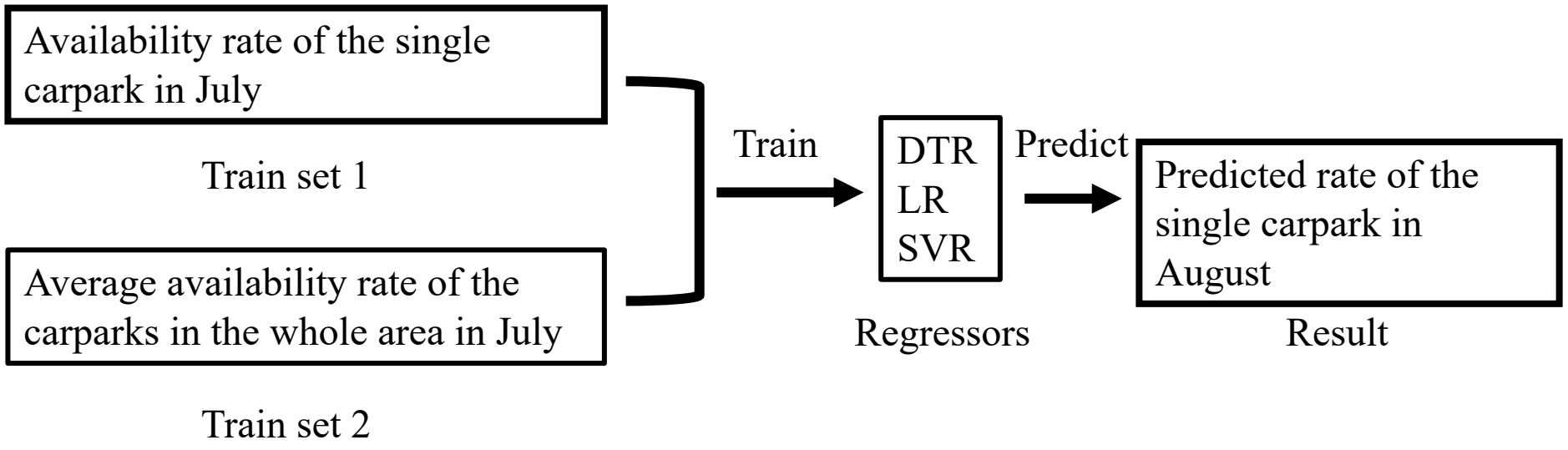


Fig 1. August available level

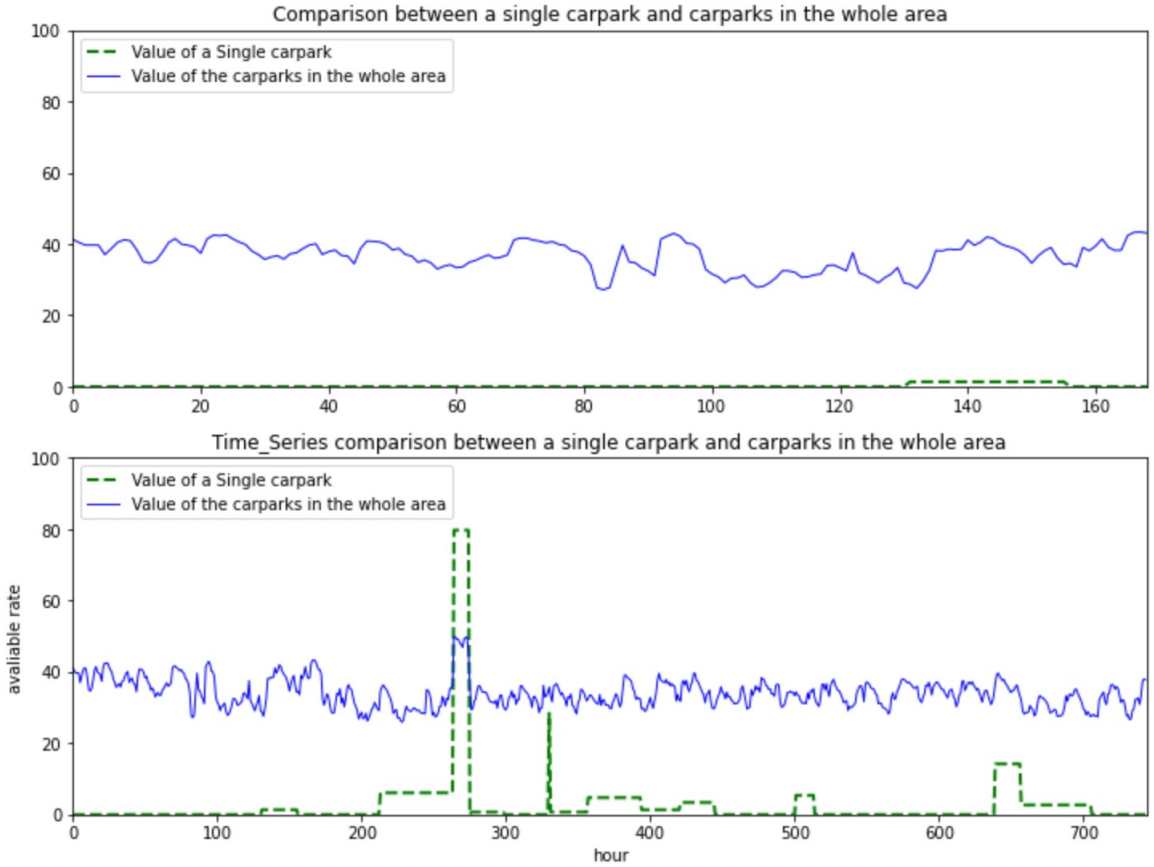
Carpark available rate prediction

- **Algorithm Design**



Carpark available rate prediction

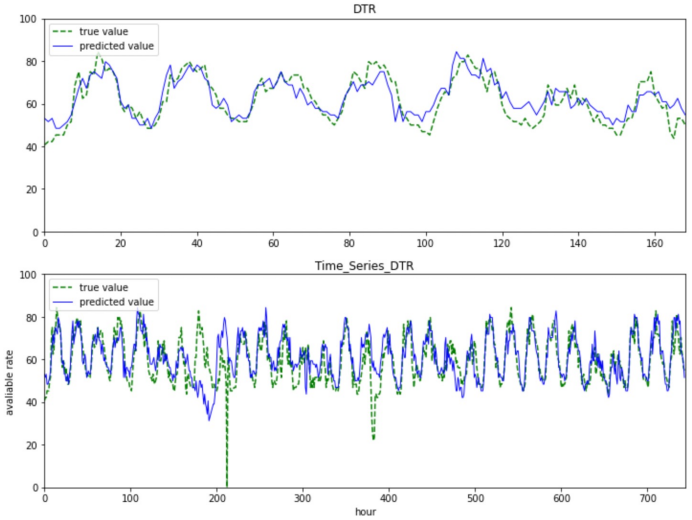
- **Result using the average availability rate of the carparks in the whole area**

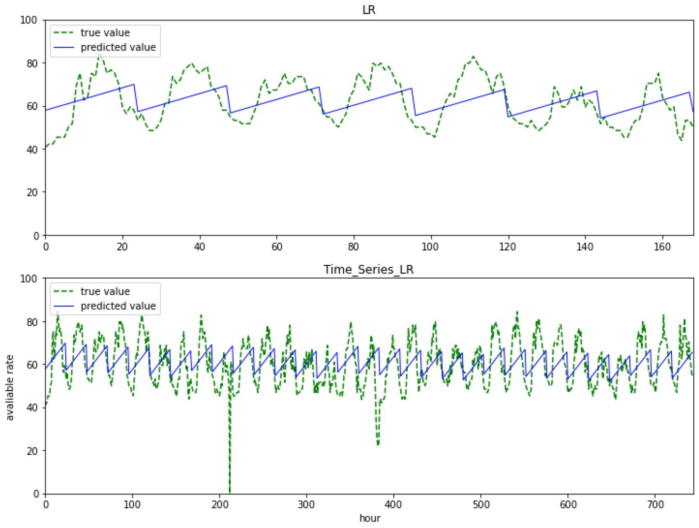


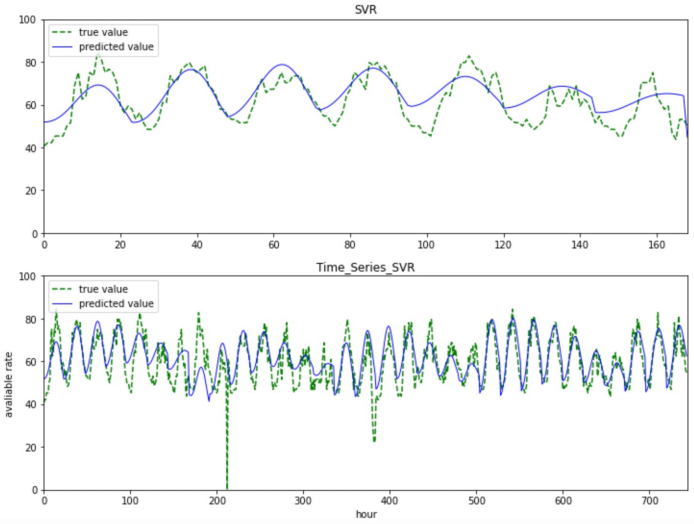
Carpark available rate prediction

- **Result using the availability rate of the single carpark**

Root Mean Squared Error:
DTR: 0.0836
LR: 0.0979
SVR: 0.0736







Real-time carpark suggestion for driver

➢ Algorithm Design:

- **1. Process Dataset:** concatenate July and August Data

1490

	area	carpark_number	2022_7_1_0_20_0	2022_7_1_1_20_0	2022_7_1_2_20_0	2022_7_1_3_20_0	2022_7_1_4_20_0	2022_7_1_5_20_0	2022_7_1_6_20_0
0	10	0	0.406250	0.359375	0.328125	0.328125	0.328125	0.328125	0.359375
1	10	1	0.562500	0.546875	0.546875	0.515625	0.562500	0.562500	0.593750
2	10	2	0.364130	0.358696	0.347826	0.339674	0.345109	0.315217	0.296196
3	10	3	0.429268	0.424390	0.419512	0.424390	0.424390	0.414634	0.458537
4	10	4	0.462312	0.452261	0.452261	0.472362	0.447236	0.467337	0.467337

- **2. GUI input:**
  - car parking lot number and arrival time, based on the input car parking lot, find the area it belongs to.
  - **Y_train.shape: (N*M,1), X_train.shape: (N*M,5)**
    - where N equals to row_numbers, M equals to column numbers before the input time
    - 5 corresponds to carpark_number, month,day, hour, minute respectively.

- **3. Use Decision Tree Regression to predict the available rate at test date**
  - If the predicted available rate for the parking lot the user want to go is above 60%, then we may suggest the user can go to the lot directly
  - else: We may predict other possible parking lots in the same area and recommend the nearby free parking lots to the users based on the predicted result.

Real-time carpark suggestion for driver

➢ Result and summary :

GUI Function:

```
In [46]: select_parklot()

please select the parking lot you wanna go, like A10:  B15
the parking lot doesn't exist, please reinput: B16
please choose the day of August you want to depature:  8
please choose the hour you may arrive in the day: 11
mean_squared_error: 0.0003
the parking lots is a little crowded, the available rate now is :0.41
In your destination Area:20,recommend the nearby parking lots B10M and B11 to park,B10M parking lot  has available rate: 0.99,
B11 parking lot has available rate:0.62

In [ ]:
```

1. Robust

2. Accurate

Conclusion

- Design a consult system for HDB carpark
  - ① given Suggestions for the location of new HDB carparks.
  - ② finished Carparks availability prediction.
  - ③ accomplished real-time Parking scheduling for driver at the nearest area.

- The system shows both robustness when input changes and high- accuracy according to the low-enough mean square error.

NUS National University of Singapore

Thank You!

A Consult System for HDB Carpark

Group X

2022.11.13