

A photograph of a street scene in an urban area. On the right side, there is a row of two-story buildings with red-tiled roofs. A sign for "GOURMET PLUS" is visible on one of the buildings. The street is lined with numerous cars parked along the curb, indicating a high density of vehicles. A white van is parked in the foreground on the right. The overall scene suggests a study of car park overspill in a densely populated area.

# Car Park Overspill Study

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# Project Background

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LTA issued a Parking Study involving 65 locations,

- ❖ 30 retail malls
- ❖ 15 F&B clusters
- ❖ 10 hawker centres
- ❖ 10 community centres

Media Research Consultant (MRC) undertakes the Study, aiming to

- ❖ Help authority understand current parking situation
- ❖ Provide advice on transport and traffic-related matters

# Motivation

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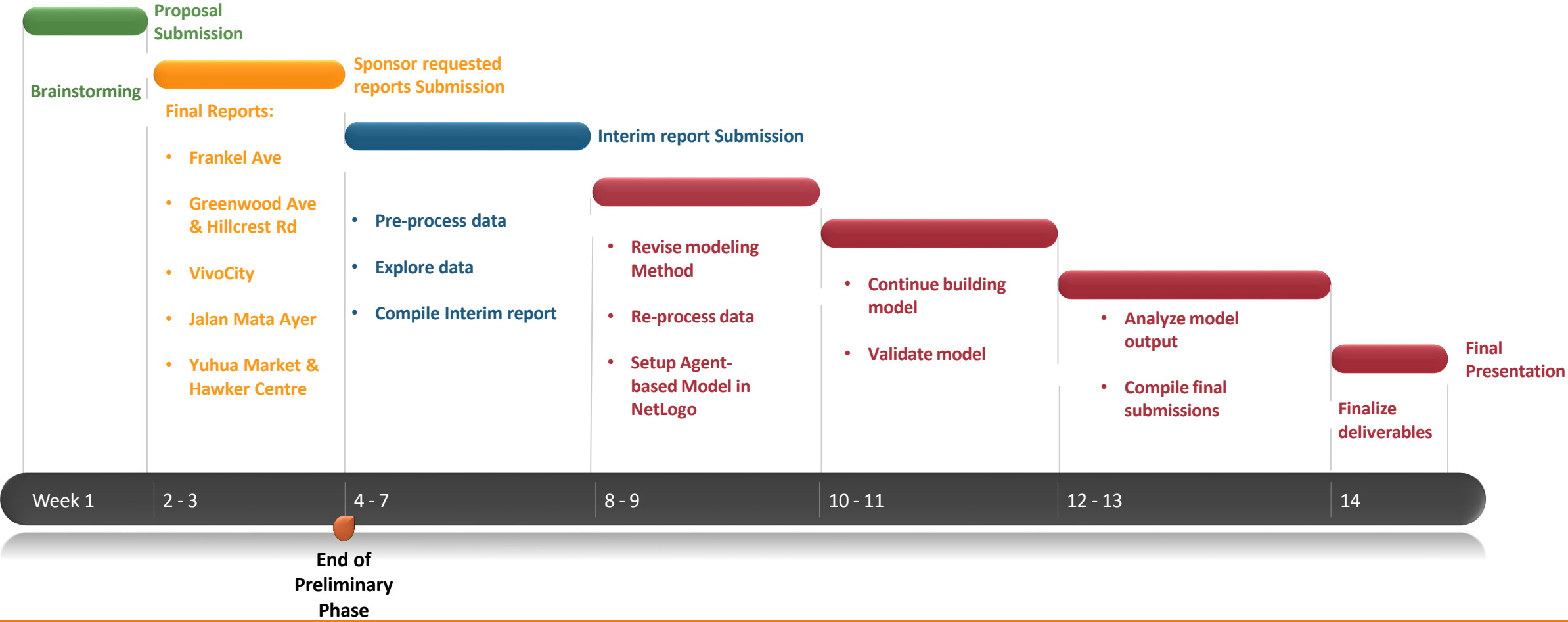
- ❖ To get to know industry practices in Analytics work
- ❖ To improve the efficiency in car park space planning
- ❖ To avoid of over spills in car park

# Objectives

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- ❖ Compile and deliver 5 site reports to project sponsor – Media Research Consultants
- ❖ Build an Agent-based Model in NetLogo
- ❖ Recommend car park space allocation plan

# Project Timeline and Milestones



# Preliminary Phase

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What we got from project sponsor

- ❖ Parking occupancy data
- ❖ Human traffic data
- ❖ On-site interview surveys

What we delivered to project sponsor

Report consists:

1. Executive Summary
2. Site Background
3. Site Characteristics
4. Site Assessment
5. Survey Findings
6. Conclusion

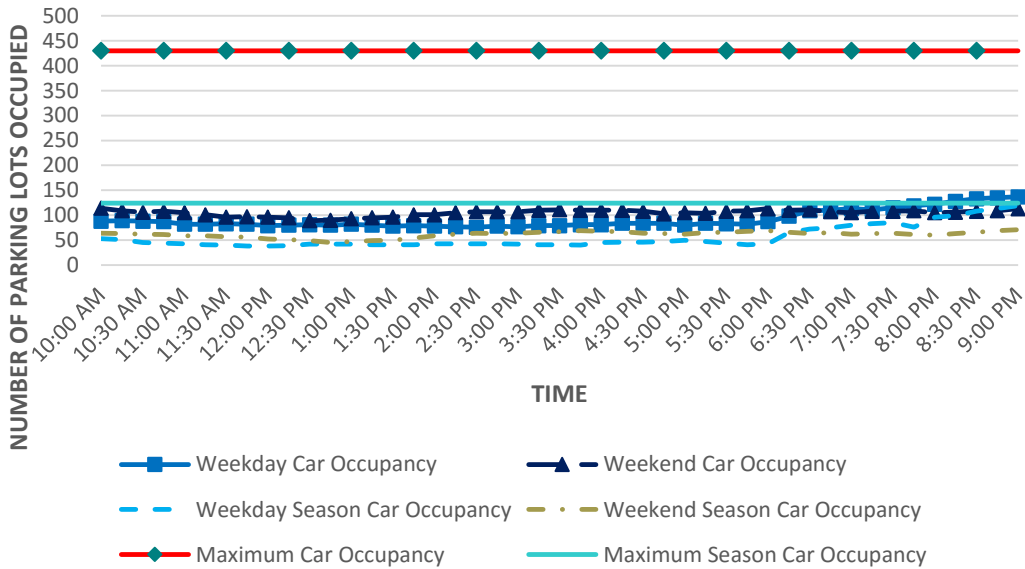
We finished:

- ❖ Final Report - Greenwood Ave & Hillcrest Rd
- ❖ Final Report - Vivocity
- ❖ Final Report - Frankel Ave
- ❖ Final Report - Jalan Mata Ayer
- ❖ Final Report - Yuhua Market & Hawker Centre

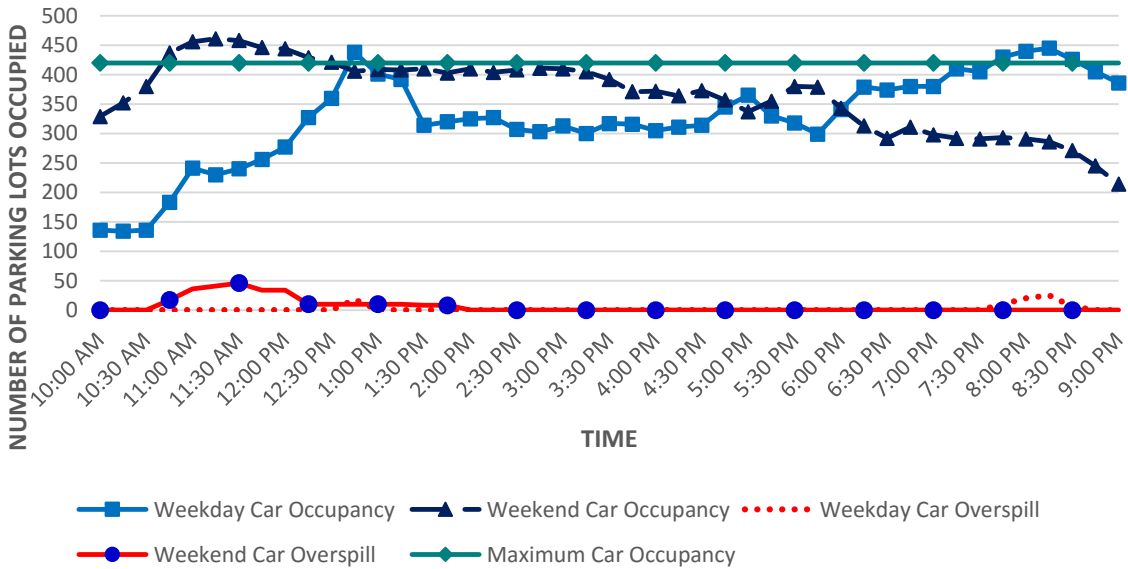
# Preliminary Phase Findings

❖ Oversupply or Overspills

Public Carpark (SK26) Car Occupancy at Compass Point



Development Carpark Car Occupancy at AMK Hub





# Phase 2 – Build a simulation tool



# Phase 2 – Build a simulation tool



# Data Preprocess



	AMK Hub	Boon Lay Shopping Centre	Changi City Point	...	...	West Mall
9:15am	17	29				16
9:30am	19	26	Row mean			23
			26			
:	:	:	:	:	:	:
:	:	:	:	:	:	:
10:00pm	20	21	Row mean			17

# Data Preprocess



	AMK Hub	Boon Lay Shopping Centre	Changi City Point	...	...	West Mall				
9:45am	17	29	8			16				
10:00am	19	26	15							
:	:	:	:							
:	:	:	:							
9:00pm	20	21	32	9:45am	241	784	77			347
				10:00am	310	1240	155			628
				:	:	:	:	:	:	:
				:	:	:	:	:	:	:
				9:00pm	2293	8873	365			750

Cumulative headcount in the site  
↓

↑ No. of cars arrival at site car park

# Data Preprocess



No. of cars arrival at site car park

MAX(Cumulative headcount in the site)

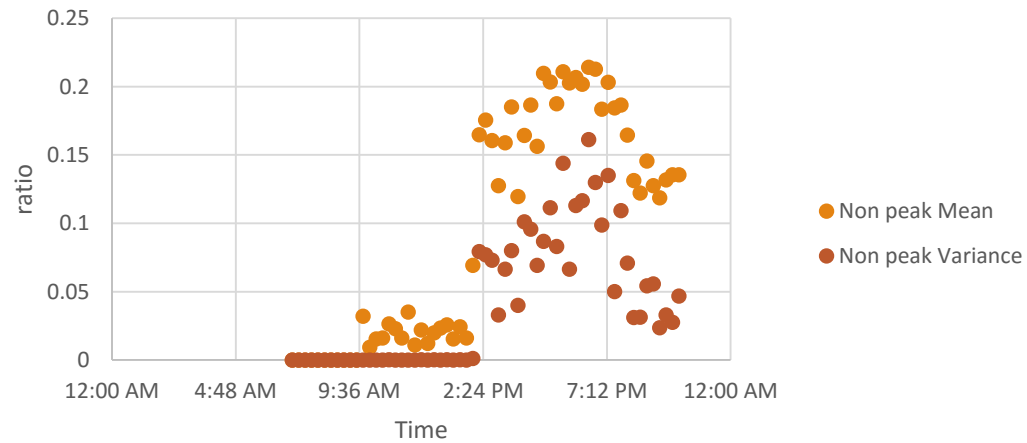
Mean          variance  
 0.01246292, 0.000156784  
 0.01246292, 0.000156784  
 ⋮  
 ⋮  
 0.01246292, 0.000156784

	AMK Hub	Boon Lay Shopping Centre	Changi City Point	...	...	West Mall
9:45am	0.007249467	0.003186113	0.009913259			0.009439528
10:00am	0.008102345	0.002856515	0.018587361			0.013569322
:	:	:	:	:	:	:
:	:	:	:	:	:	:
9:00pm	0.008528785	0.002307185	0.039653036			0.010029499

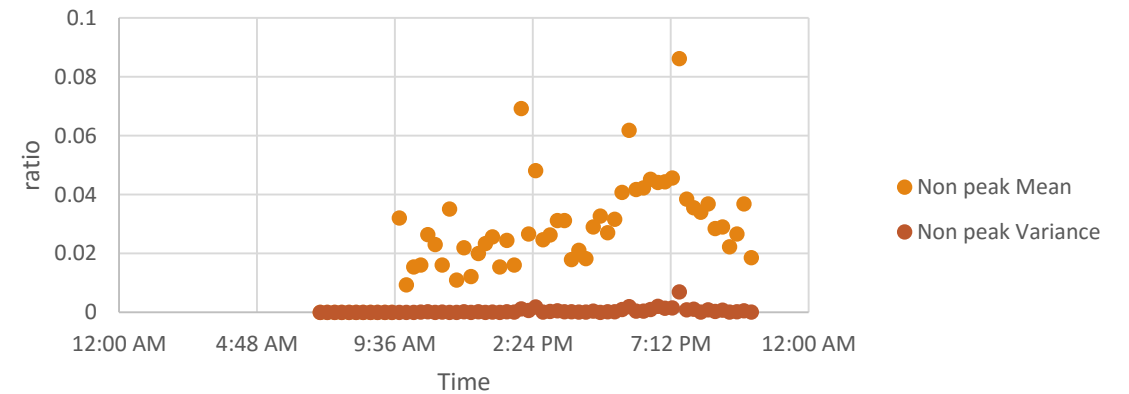
# Data Preprocess



Community Centre  
No. of car Arrivals/ Max. Human headcount



Community Centre  
No. of car Arrivals/ Max. Human headcount



# Data Preprocess

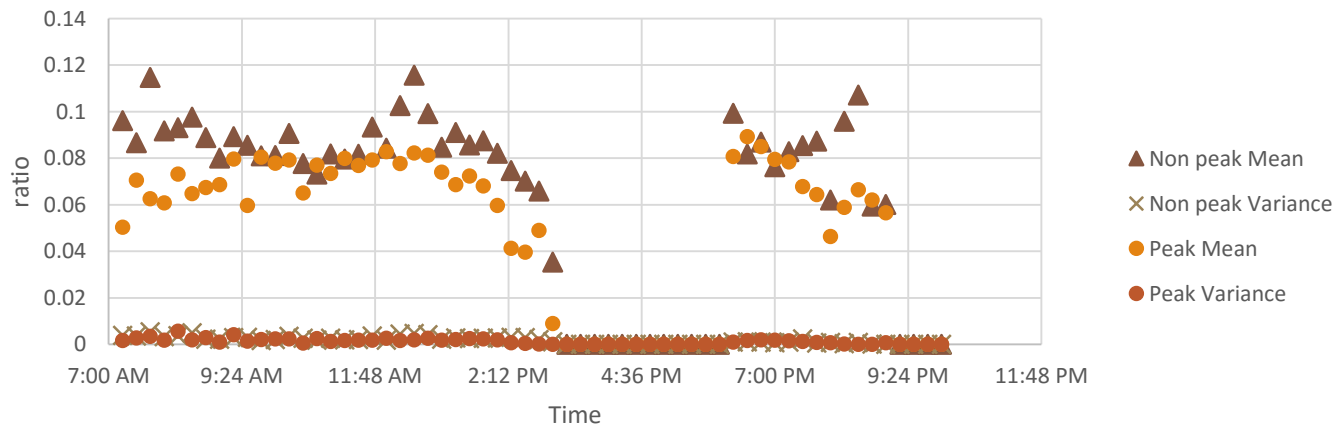
Data Cleaning

Find Car arriving pattern

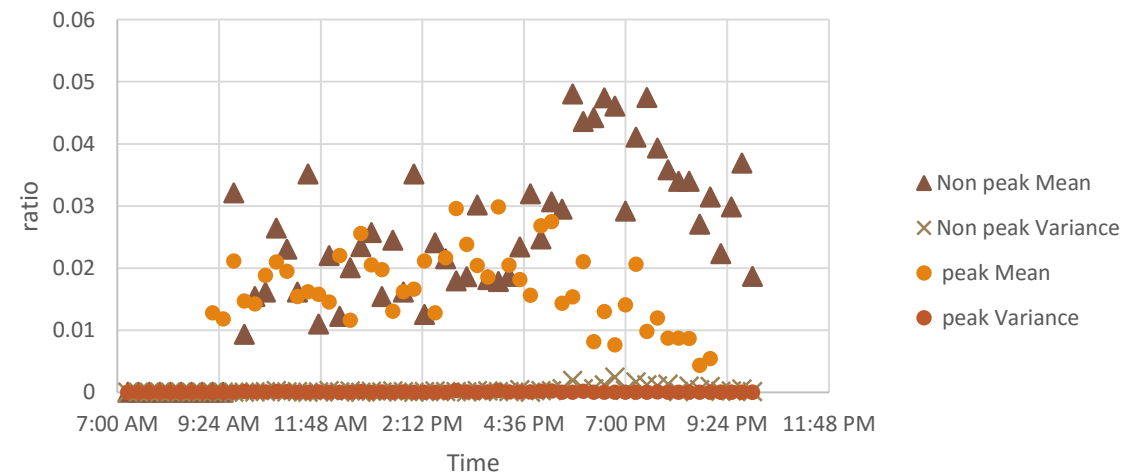
Remove outlier

Car arriving pattern for each site category

### Hawker Centre No. of car Arrivals/ Max. Human headcount



### Community Centre No. of car Arrivals/ Max. Human headcount



# Data Preprocess

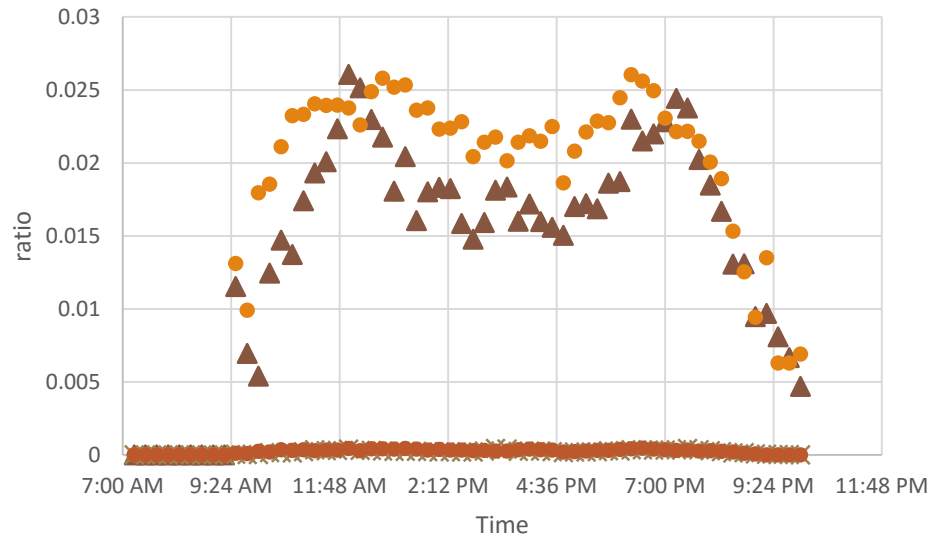
Data Cleaning

Find Car arriving pattern

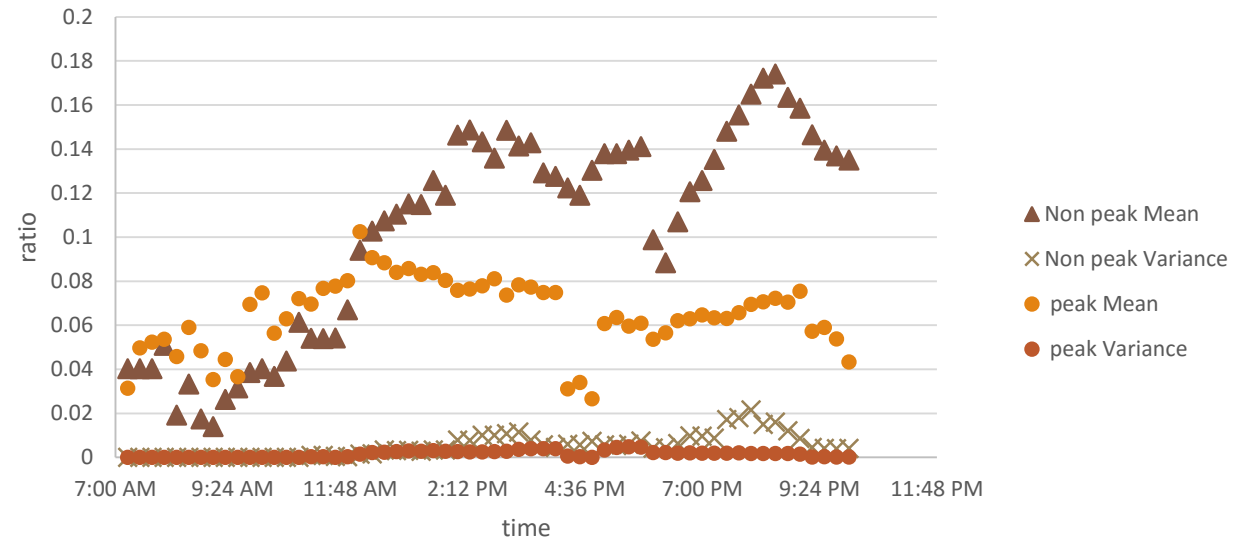
Remove outlier

Car arriving pattern for each site category

Shopping Mall  
No. of car Arrivals/ Max. Human headcount



F&B Cluster  
No. of car Arrivals/ Max. Human headcount





# Phase 2 – Build a simulation tool



# User Inputs & Parameters

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Development Site Type

Peak / Non-Peak



Maximum Head Count

X

Incoming Traffic /  
Head Count

=

Size of the Incoming  
Traffic

Number of Parking Space

# User Inputs & Parameters

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## Key User Inputs

Number_Of_Parking_Lots 200	Maximum-Capacity-Of-Site 3000
development-site-type shopping mall ▼	peak/non-peak non-peak ▼

Number of Parking Space

Maximum Head Count

Development Site Type

Peak / Non-Peak

# Agent & Patches

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Car



Road



Parking Space



Wall

# Agent & Patches

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Road

Entrance

Exit

Crossroad



Parking Space

Parked



Wall

# Agent & Patches

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Car

## Parameters

Patience

Normal Distribution

Stay Duration

Normal Distribution

Randomness

## Basic Behaviors

Follow basic traffic rules

Try to find optimal parking space until patience runs out

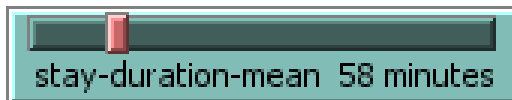
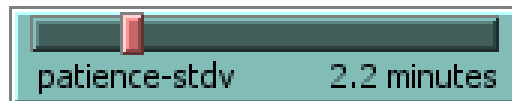
Leave the carpark when stay duration is reached

May not follow optimal solution

# Agent & Patches

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## Driver Behavior Variables



Randomness

Patience

Normal Distribution

Stay Duration

Normal Distribution

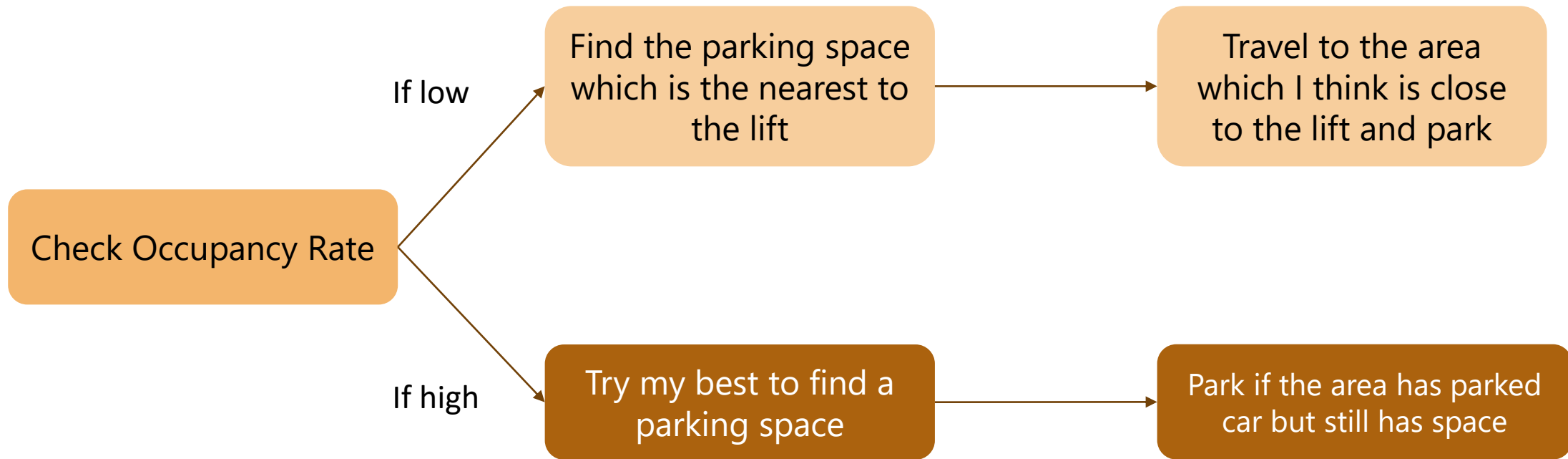
# Phase 2 – Build a simulation tool





# Parking Algorithm

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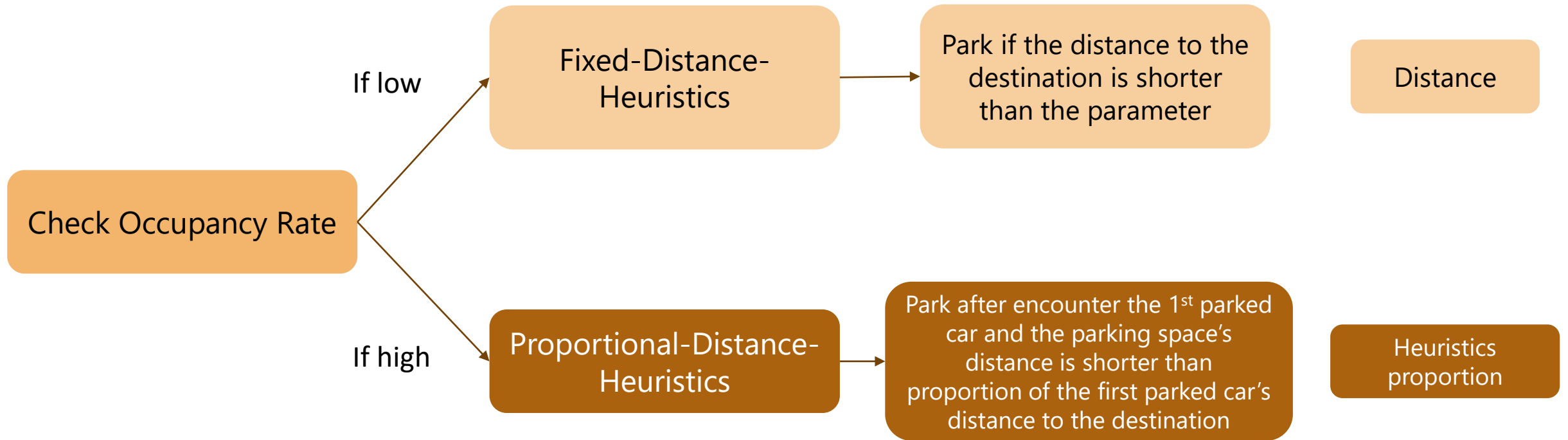


# Parking Algorithm

	Fixed-Distance-Heuristics	Proportional-Distance-Heuristics	Car-Count-Heuristics	Space-Count-Heuristics	Block-Count Heuristic	X-out-of-y-Heuristics
	Takes the first vacancy encountered within a fixed distance	The first vacancy after driving a proportion P of the distance between the first occupied place encountered and the destination	The first vacancy after passing C parked cars	The first space after reaching the first parked car and then passing S available spaces	The first space after passing a block of at least B parked cars without a space	If x or more parking places were occupied out of the last y places passed
Require Knowledge of Destination?	Yes	Yes	No	No	No	No
Suitable for Our Model?	Yes (if occupancy is low) May be affect by Carpark Size	Yes (if occupancy is high)	Yes (if occupancy is high) May be affect by Carpark Size	Yes (if occupancy is high) May be affect by Carpark Size	Yes (if occupancy is high) May be affect by Carpark Size	Yes (if occupancy is high) May be affect by Carpark Size

# Parking Algorithm

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# Parking Algorithm

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Parking Algorithm Variables

longest-distance-to-lift  
0

fixed-distance-heuristic-parameter 11.9

fixed-distance-heuristics-threshold 63.0

proportional-distance-heuristic-parameter 0.61

Distance

Reference to Occupancy Rate

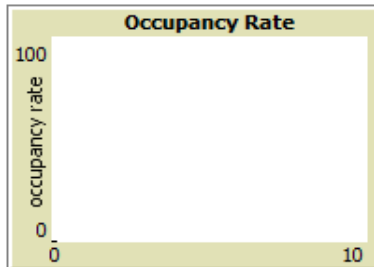
Heuristics proportion

# Phase 2 – Build a simulation tool



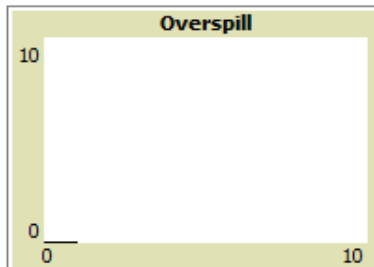
# Result Monitoring

Time  
9:30 AM



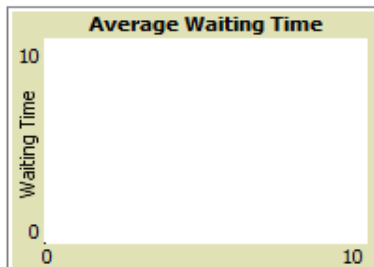
Occupancy Rate

$$\frac{\text{Number of Parked Car}}{\text{Number of Parking Space}}$$



Overspill

Number of Cars Waiting



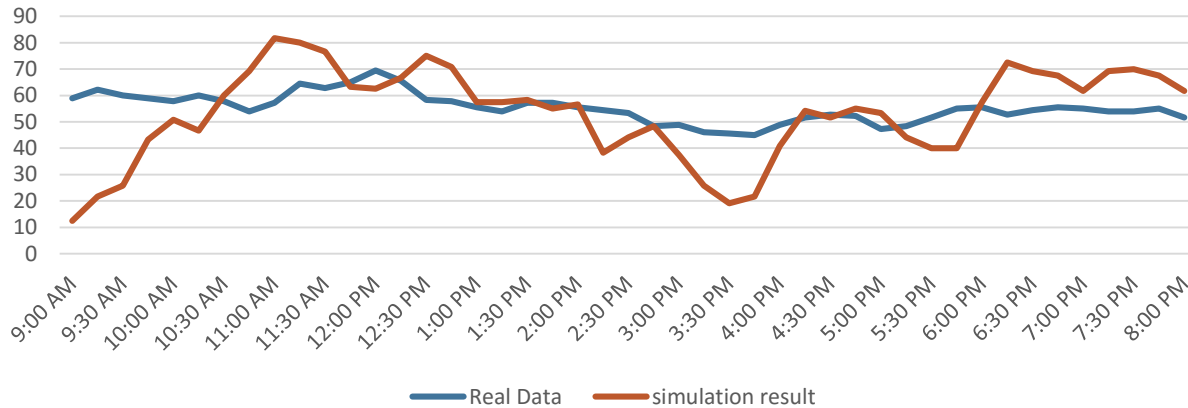
Average Waiting Time

Average of (waiting time of all cars which are waiting)

# Evaluation

## Pineer Mall Occupancy - Peak

Simulation Result vs. Real Data

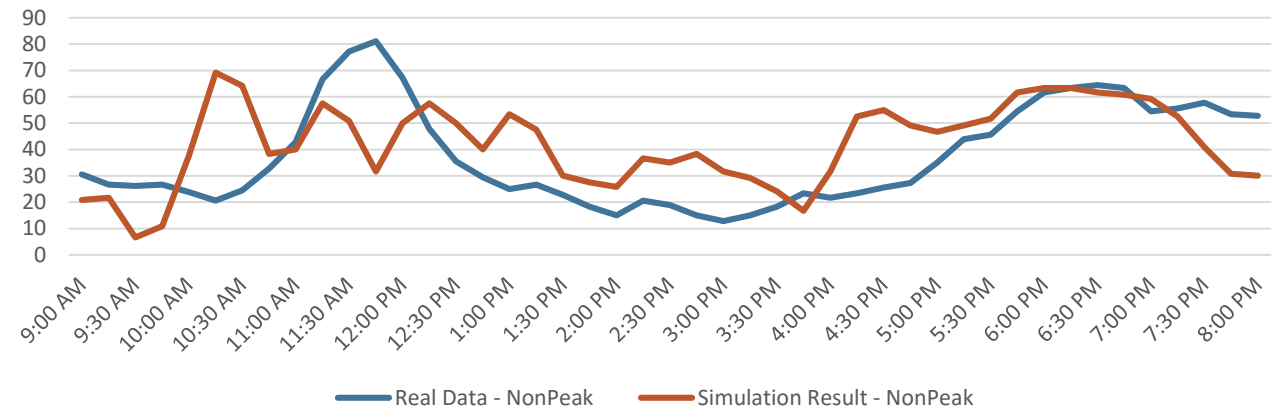


Error Rate 22.0%

Error Rate 30.7%

## Pineer Mall Occupancy Non-Peak

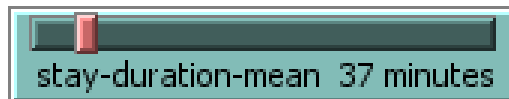
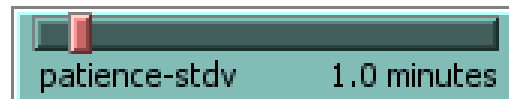
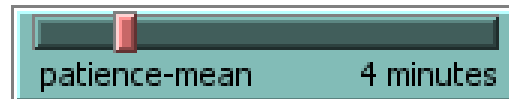
Simulation Result vs. Real Data



# Evaluation

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## Driver Behavior Variables





# Project Assumption & Limitations

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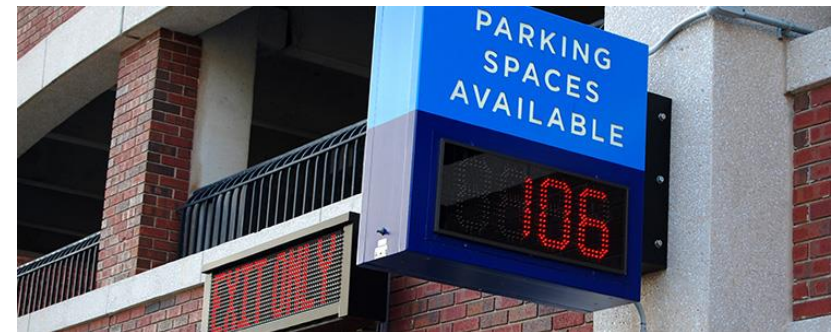
- ❖ Constant speed of cars
- ❖ No real data of parking duration
- ❖ Survey on drivers to better decide parking algorithm
- ❖ Pre-designed Carpark Shape
- ❖ Lack of details of driver behaviour (e.g. the enter, exit and parking action is instantaneous)

# Further Development

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The model can be more practical if:

- ❖ Map realistic car park layer into the model
- ❖ Collect data of parking duration
- ❖ More detailed and accurate behaviour of drivers



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**Thank you**

