Predicting Dengue Cases

Cheryl, Kit Fai, Mak & Eliza

Do you know?

Dengue is a common viral infection caused by mosquitoes that infects up to 400 million and kills 20,000 to 25,000 people in a year, making it a serious public health concern.

source:World Health Organisation

01

Our Objective

Develop a dengue forecasting model for the years 2019 and 2022 to predict potential dengue outbreak to implement preventive measures, enhance dengue surveillance and control.

Datasets Source

- NEA climate data
- Weekly google search trends data
- 2012 - 2022

Our Approach

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- Data gathering from publicly available datasets, journal papers, news articles, data cleaning; standardizing our units of scales, merging datasets for EDA and modeling
- Perform an EDA on our datasets; look for positive and inverse relationships, understanding trends, making sense of the quantitative data vis-a-vis our qualitative data
- Experiment with the different models to find one that best makes sense to us

02

What did our Research tell us?

Sources: PLOS Public Health Journal, NEA media releases, reputable news articles

In **1968**, Singapore launched a comprehensive vector control programme comprising:

- **Environmental** management
- Public health education thru **campaigns**
- **Surveillance** inspections and enforcement actions

Factor 1

The uniqueness of Singapore's **warm climate** lends to higher dengue cases providing an optimal breeding ground for mosquitoes to thrive. Climate scientist Winston Chow from the College of Integrative Studies at Singapore Management University says "We will not be able to eradicate dengue (because) the **constant weather extremes create the perfect breeding conditions for mosquitoes,"**

02

What did our Research tell us?

F**actor 2**

- **Urbanization** in a globalized world accounts for the rise in dengue cases. Singapore is a **densely populated nation** with 7810 persons per sqm as compared to Indonesia (which is one of the most populous nation) but has only 4383 persons per sqm.

F**actor 3**

- **Social distance policy** due to Covid-19 accounted for a significant rise of dengue cases in 2020, an all time high of 35,000 cases that year. With r**esidential places in naturally ventilated spaces** compared to air-conditioned office spaces invites more mosquitoes who are **day-biters** to bite people, leading to an increased rise of dengue cases.

02

What did our Research tell us?

F**actor 4**

- Singapore’s **low herd immunity** to denv3 is one of the leading causes of the sudden increase of dengue cases in 2020. Serological research studies show that Singapore’s exposure to denv3 compared to Indonesia is low. Singaporean kids **exposure to denv3 is below 10%** which is much lower to Indonesian kids who are 90% exposed to it which accounts for the low herd immunity to this new strain of dengue.

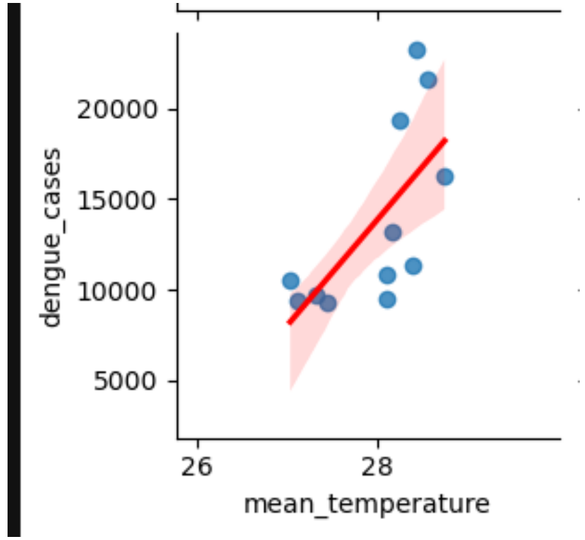
03a

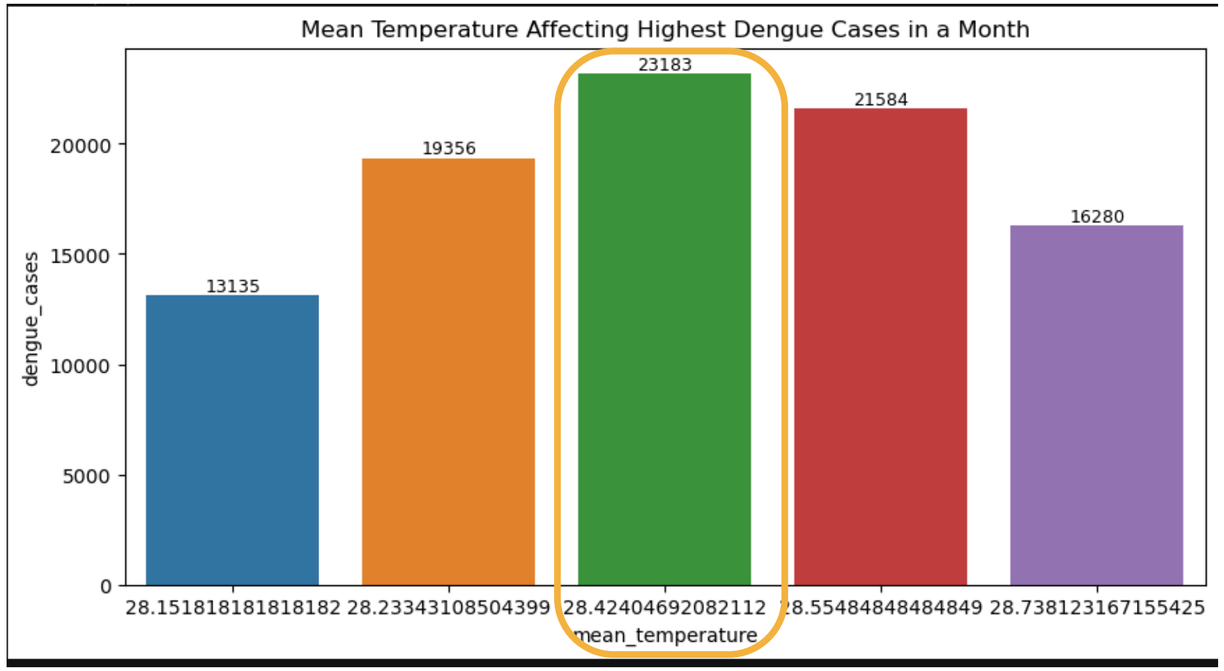
What do the data tell us?

1. **Warm climate** lends to higher dengue cases

2.Positive correlation between **temperature** and dengue cases

3.Dengue cases reached its peak when temperature is at 28.4





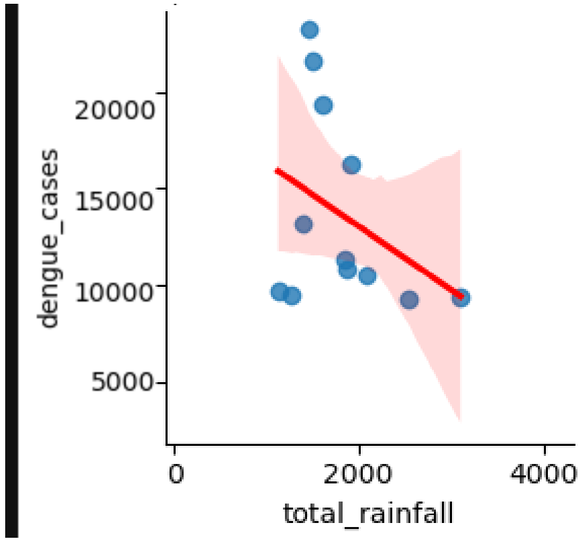
03b

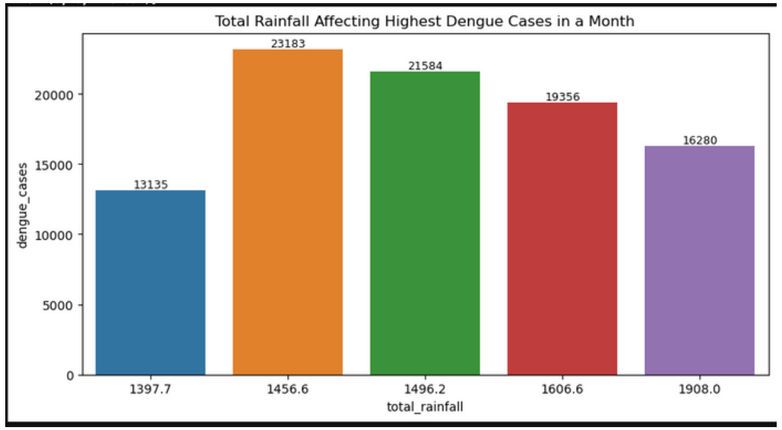
What do the data tell us?

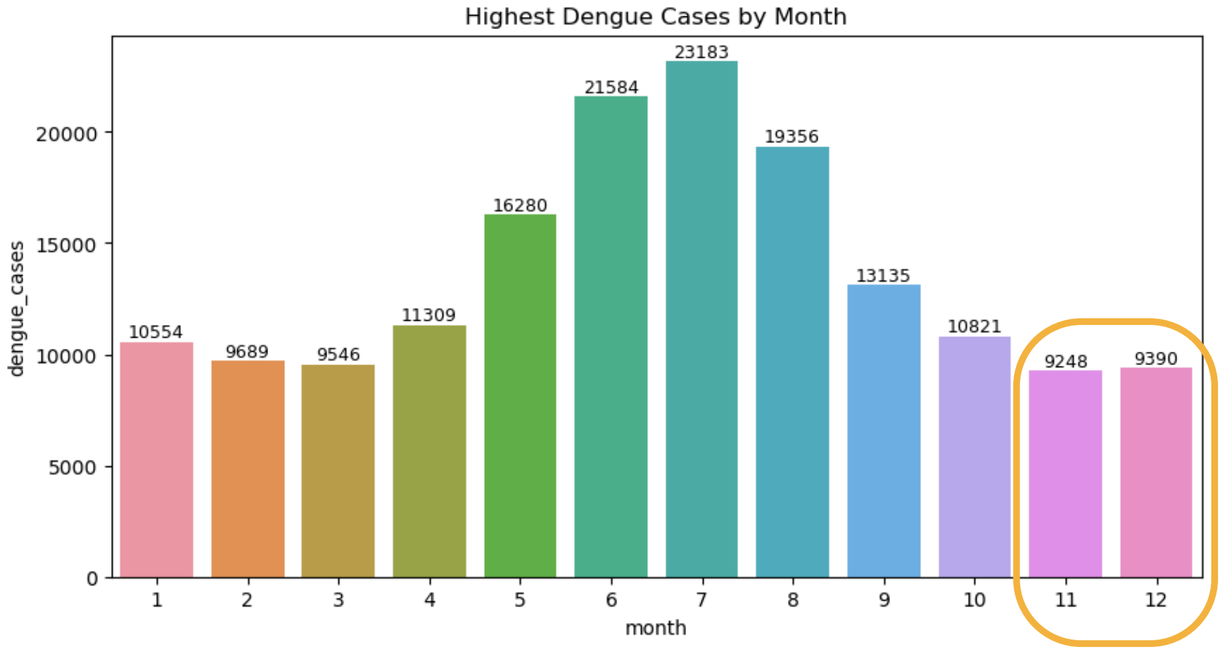
1. Negative correlation between dengue cases and total rainfall

2.Dengue cases are lower when **total rainfall** is more than 2000mm; flushing event that disrupts the reproductive cycle

3.Explains rainy months in Nov and Dec when dengue cases are lower







03c

What do the data tell us?

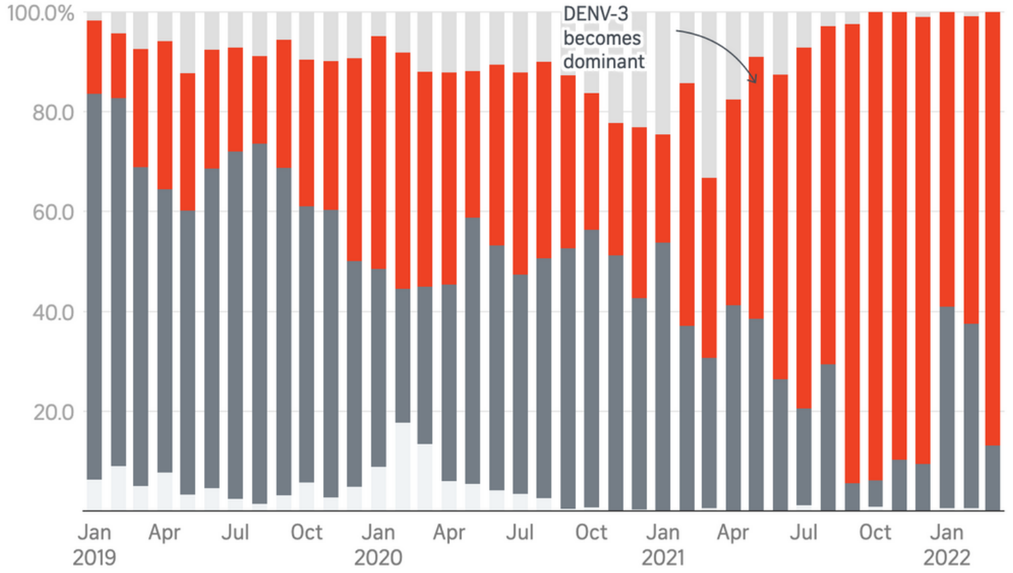
1.**Low herd immunity** due to exposure to new dengue strain i.e. denv3

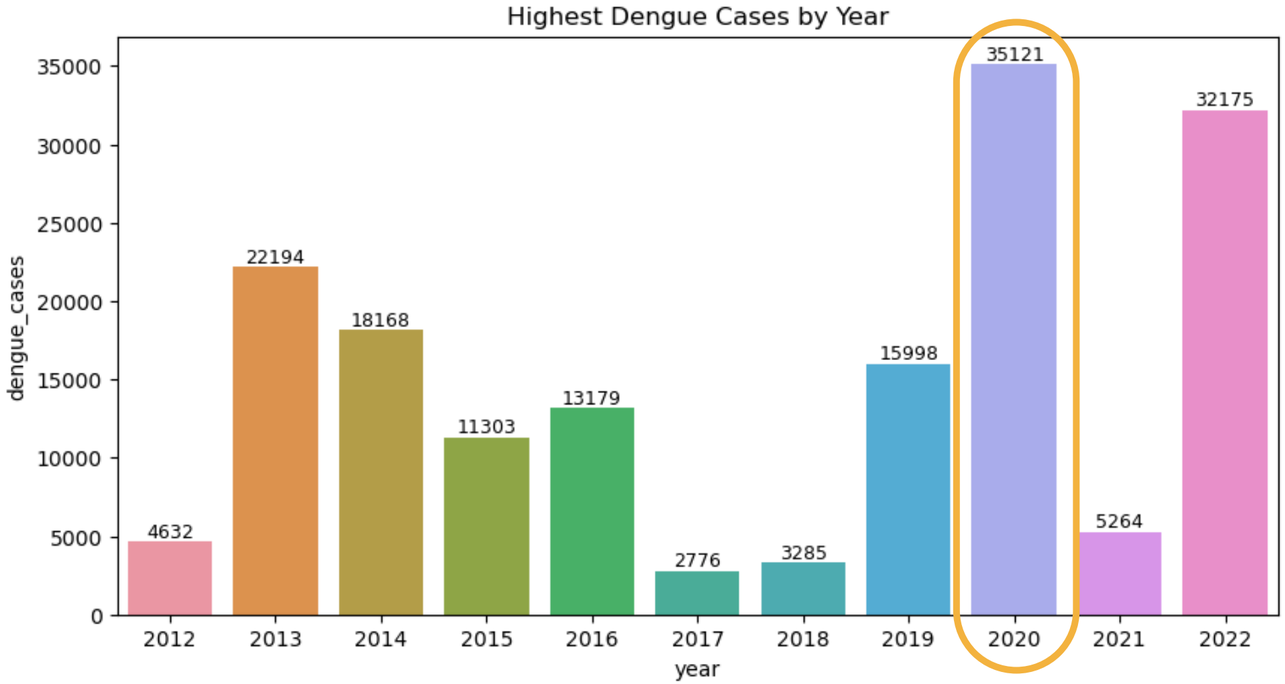
2.Dengue cases in 2013 and 2014 were driven by denv1

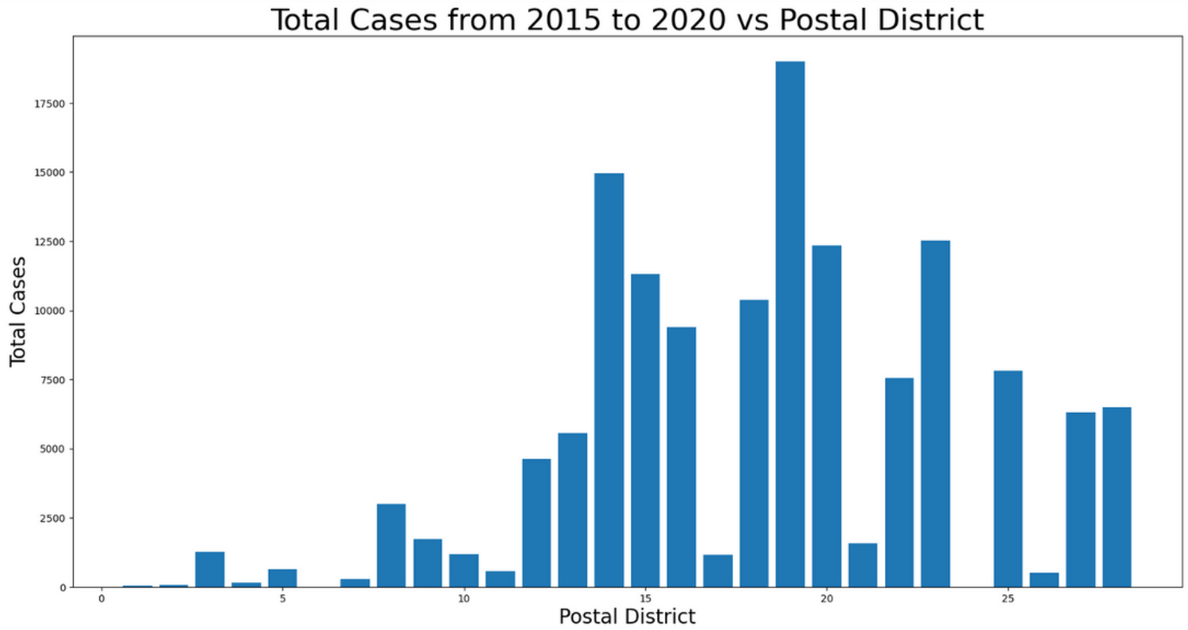
3.In 2015 - 2017 dengue cases were driven by denv2.

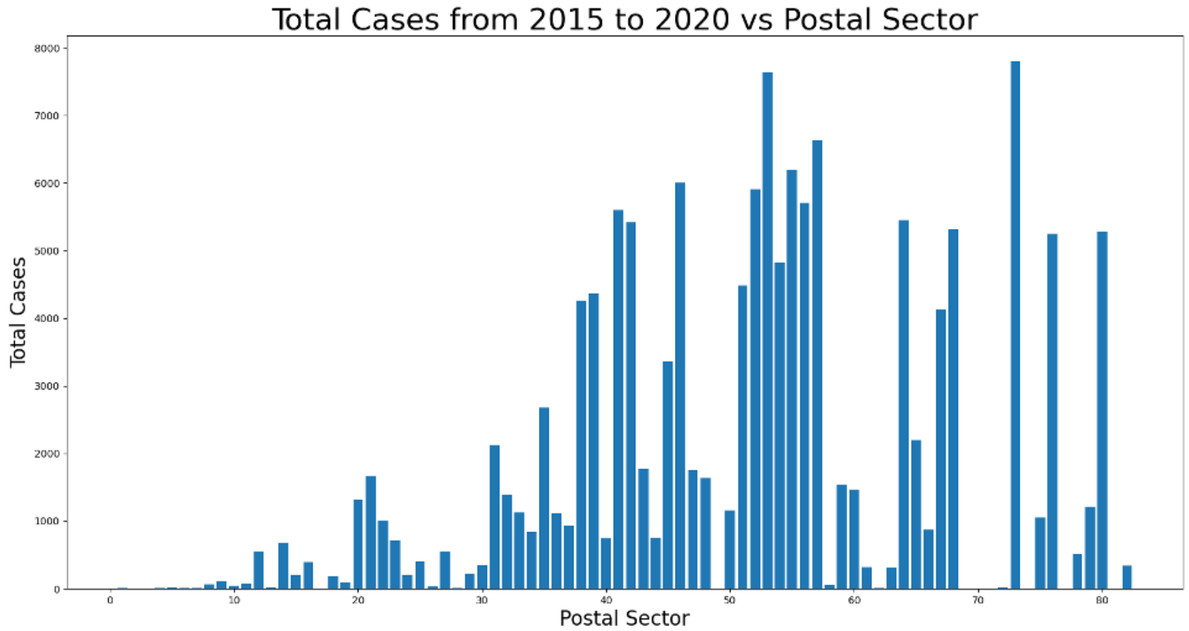
4. Thereafter from **2019 onwards denv3** were the predominant serotypes which could explain why there was a spike of dengue cases in 2019 from 2018.

5. Coupled with the **social distance policy**, in 2020 dengue cases exploded in Singapore reaching an all time high









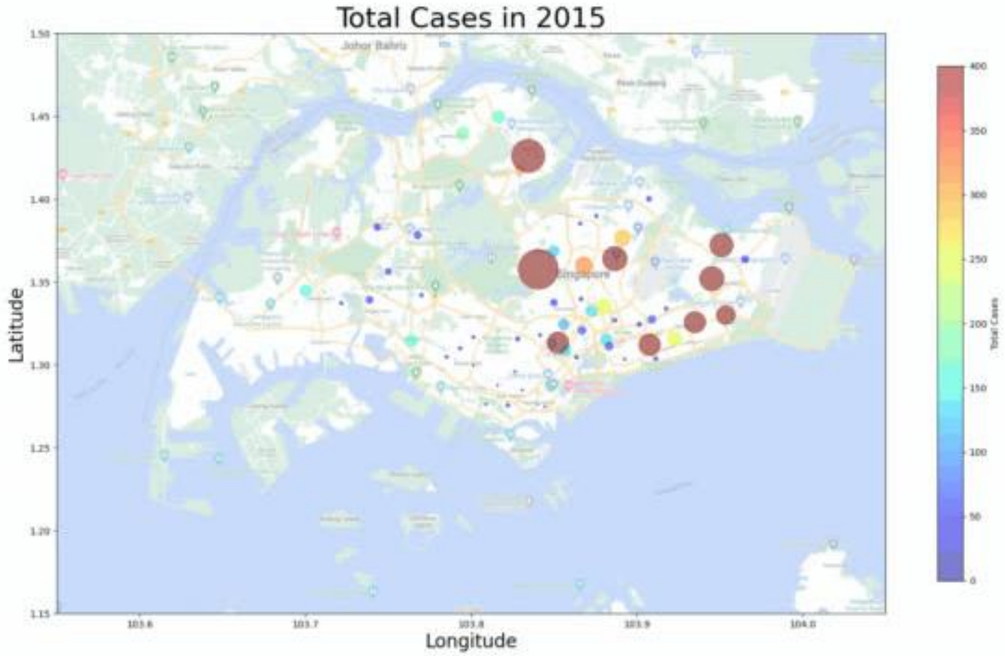
03e

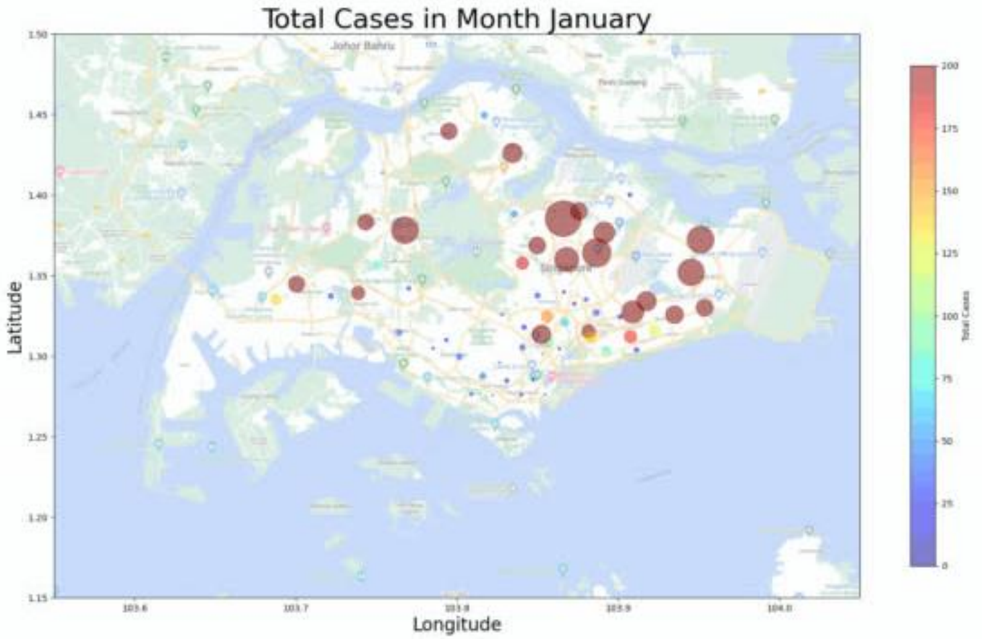
What do the data tell us?

1. Dengue cases are higher in Postal District 13~15 and Postal District 19~20, which are East and North East

2. Dengue cases are lower in Postal District 1~11 which are in the Western side of Singapore

3.The trend holds when subdivided into Postal Sectors





03f

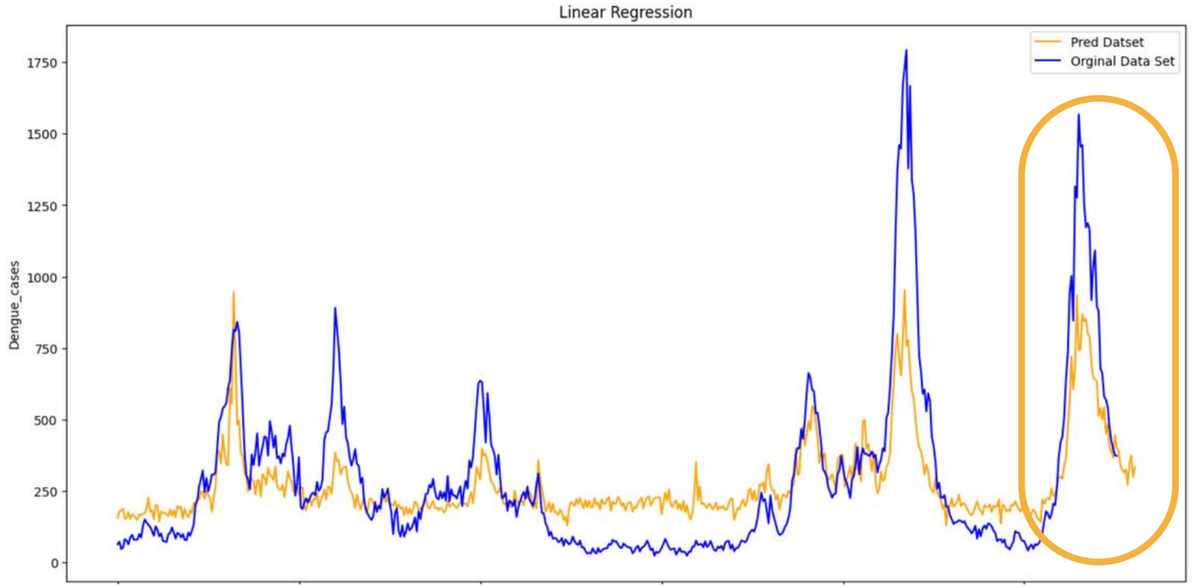
What do the data tell us?

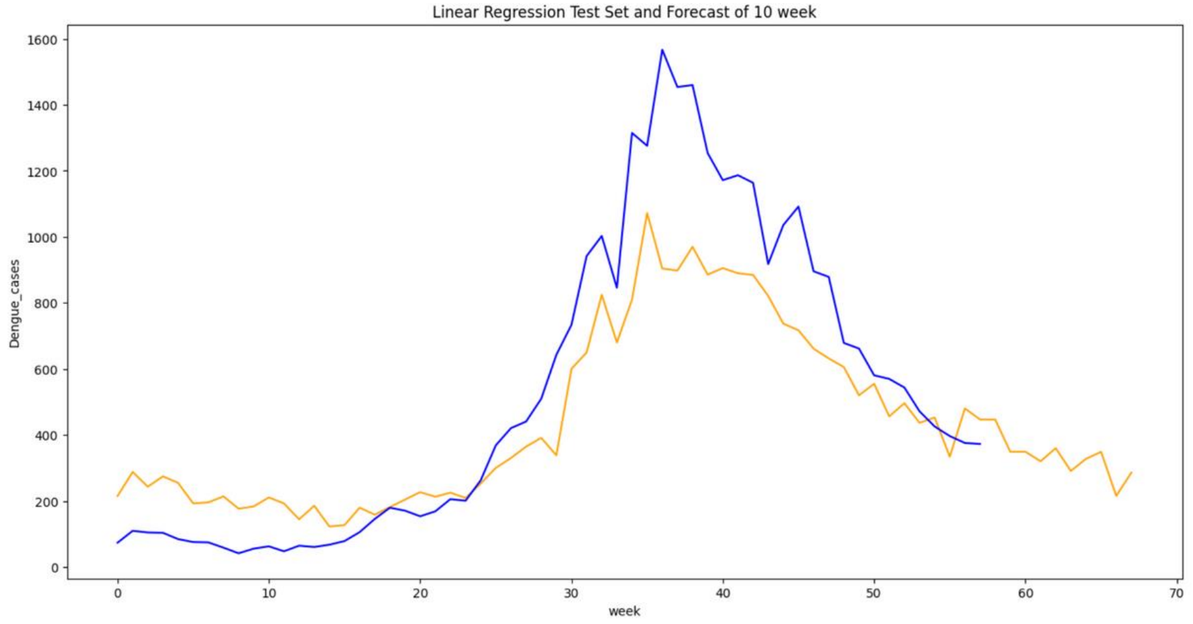
1. Over the years, indeed that the high number of cases are concentrated in areas like Woodlands, AMK-Bishan, Hougang, East Coast, and Tampines, which coincidentally are the large residential towns

2. We also can see the "slump" in dengue cases in 2017

Linear model prediction 10 week

04a



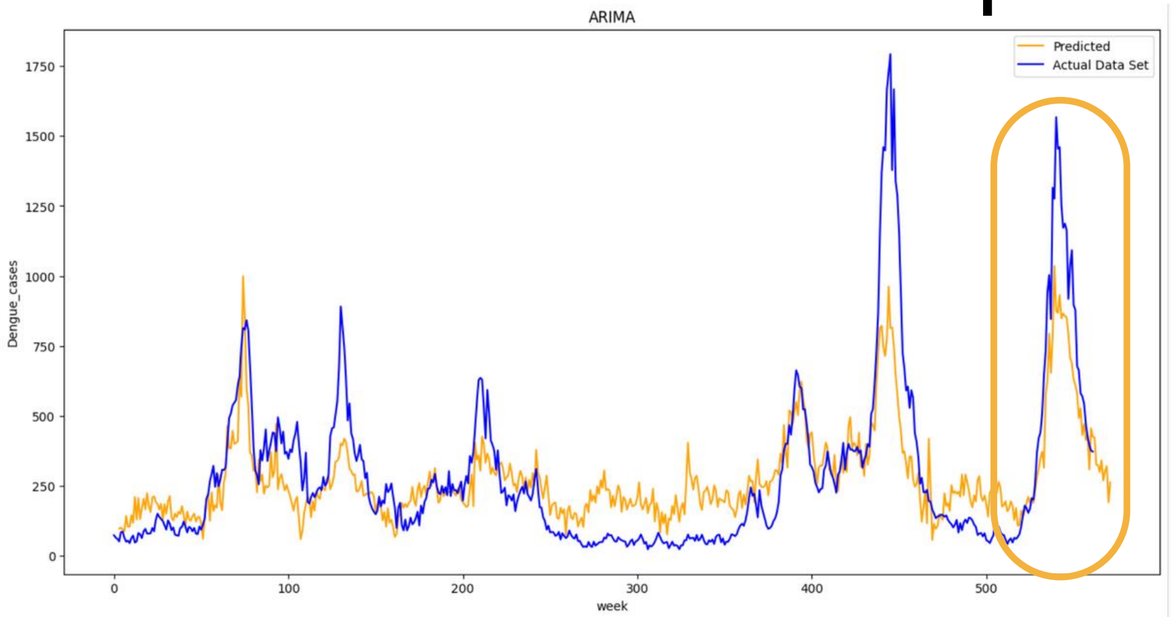


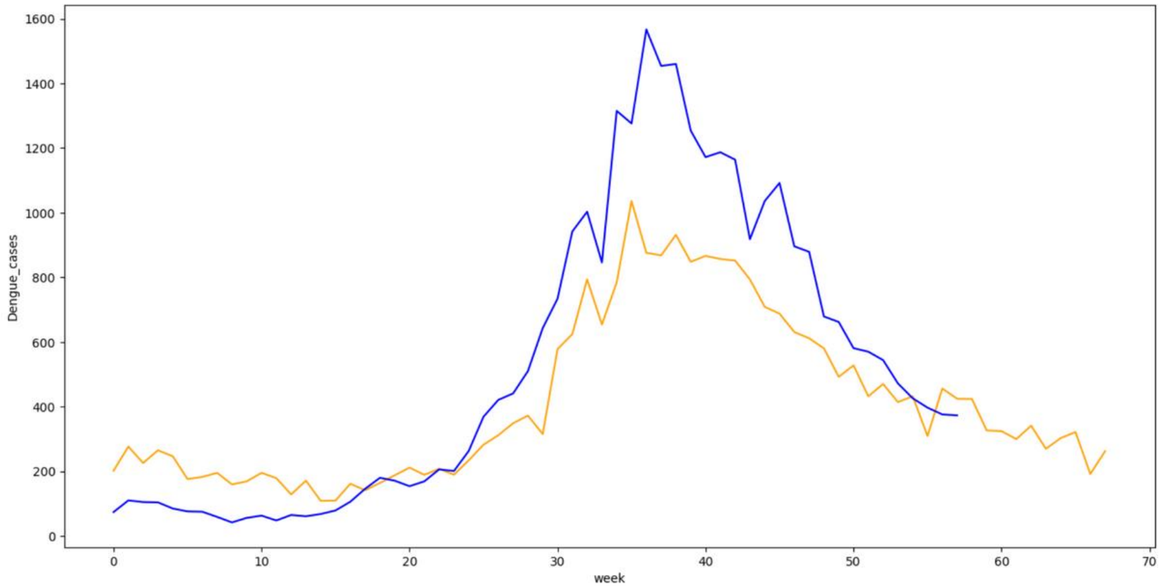
- Modelling Linear model using feature: Weekly Mean Temperature, Weekly Dengue Searches and Weekly Rainfall.
- Using Data from 10 week ago to predict current week, therefor model is able to forecast 10 week in advance. shift.() Method

Coef			
Feature	Linear	Lasso	Ridge
Weekly Mean Temperature	46.80	46.80	48.3
Weekly Dengue Searches	9.14	9.16	0.914
Weekly Rainfall	0.76	0.75	0.76
MSE & RMSE			
MSE	45923	45930	45919
RSME	214.29	214.31	214.28

ARIMA model prediction 10 week

04b





- there are no autoregressive terms, no moving average terms, and no differencing. Therefore, this model simply uses the mean of the time series to forecast future values.
- MSE: 45390
- RMSE: 385.37

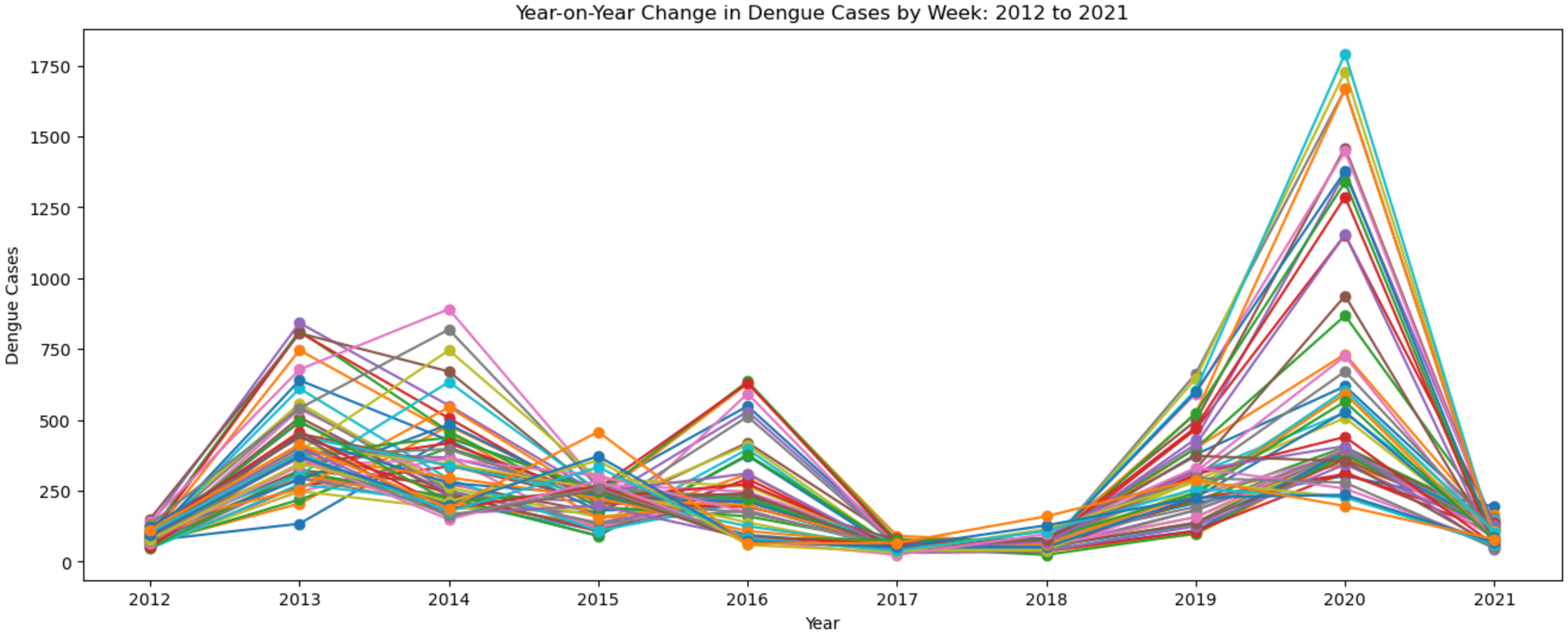
Predictor(s)

04c

DENGUE CASES

that's all!

Year-on-Year Weekly Patterns



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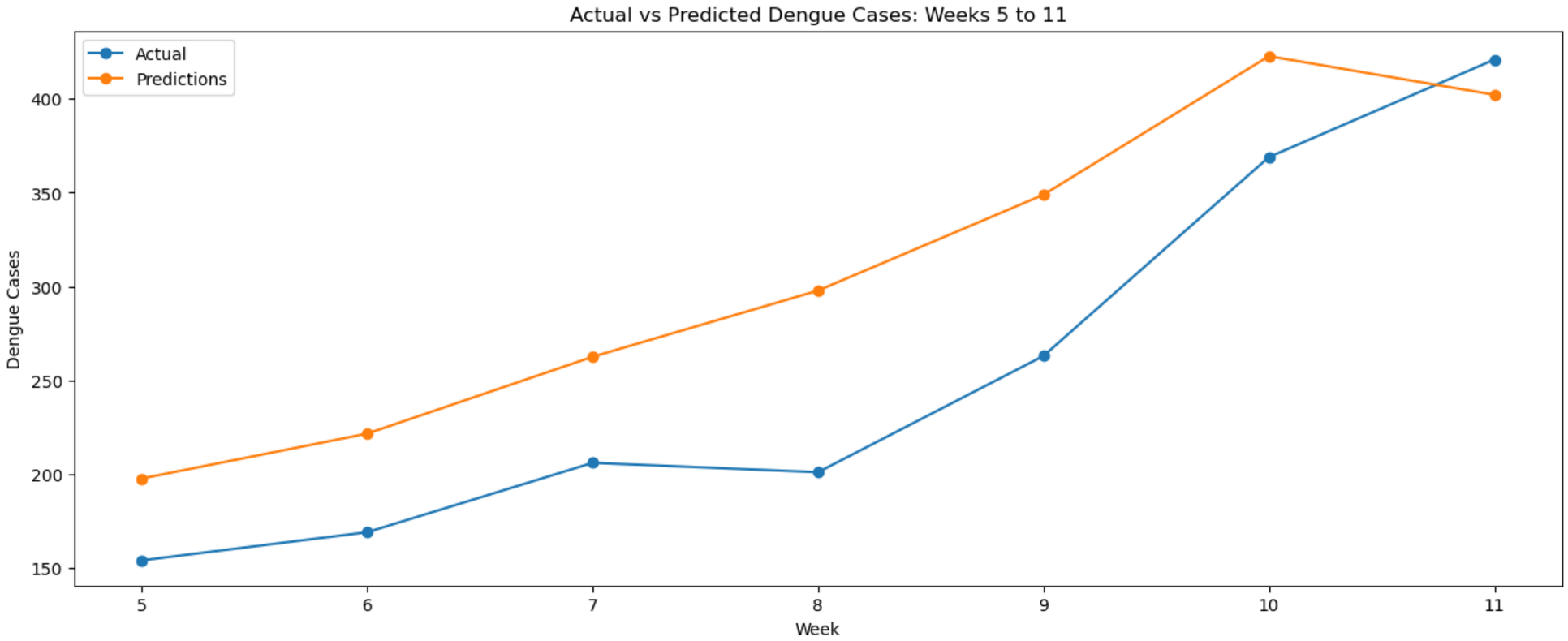
2022 W05 to W11



RMSE: 63
MAPE: 26.7%

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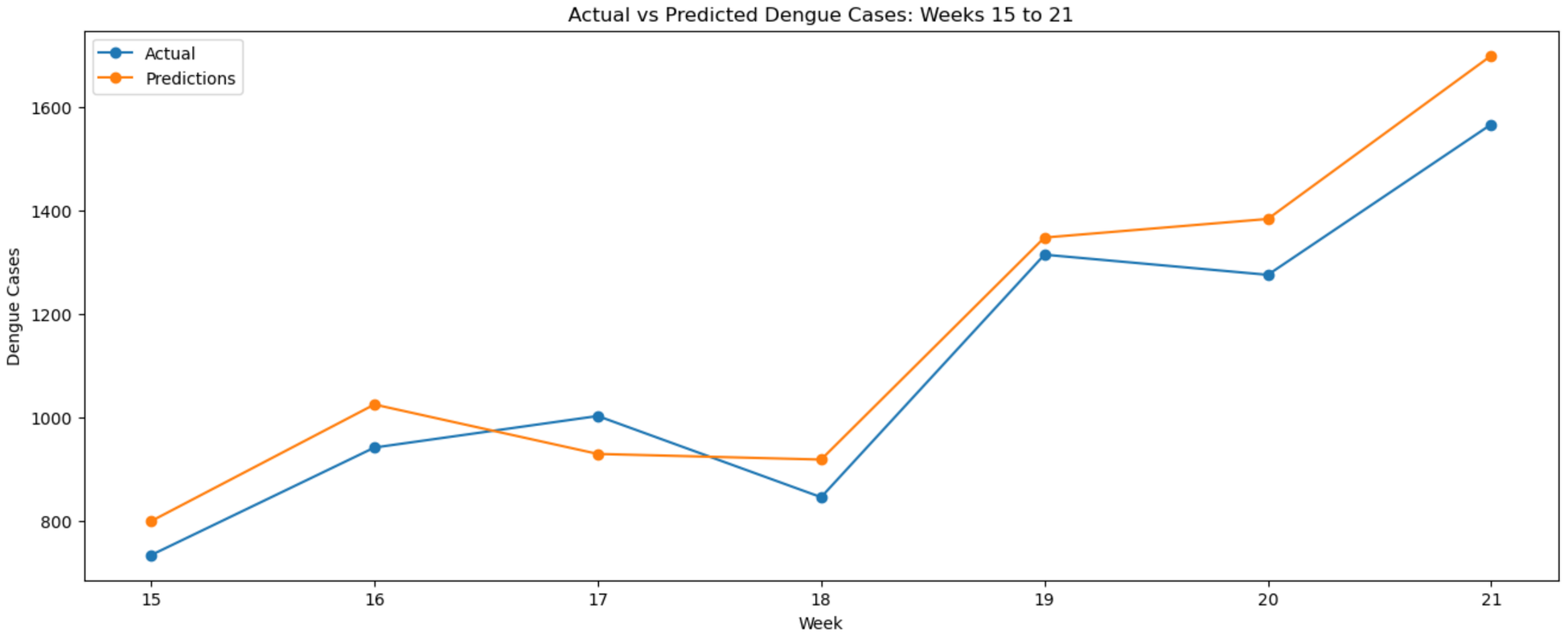
2022 W15 to W21



RMSE: 86
MAPE: 7.6%

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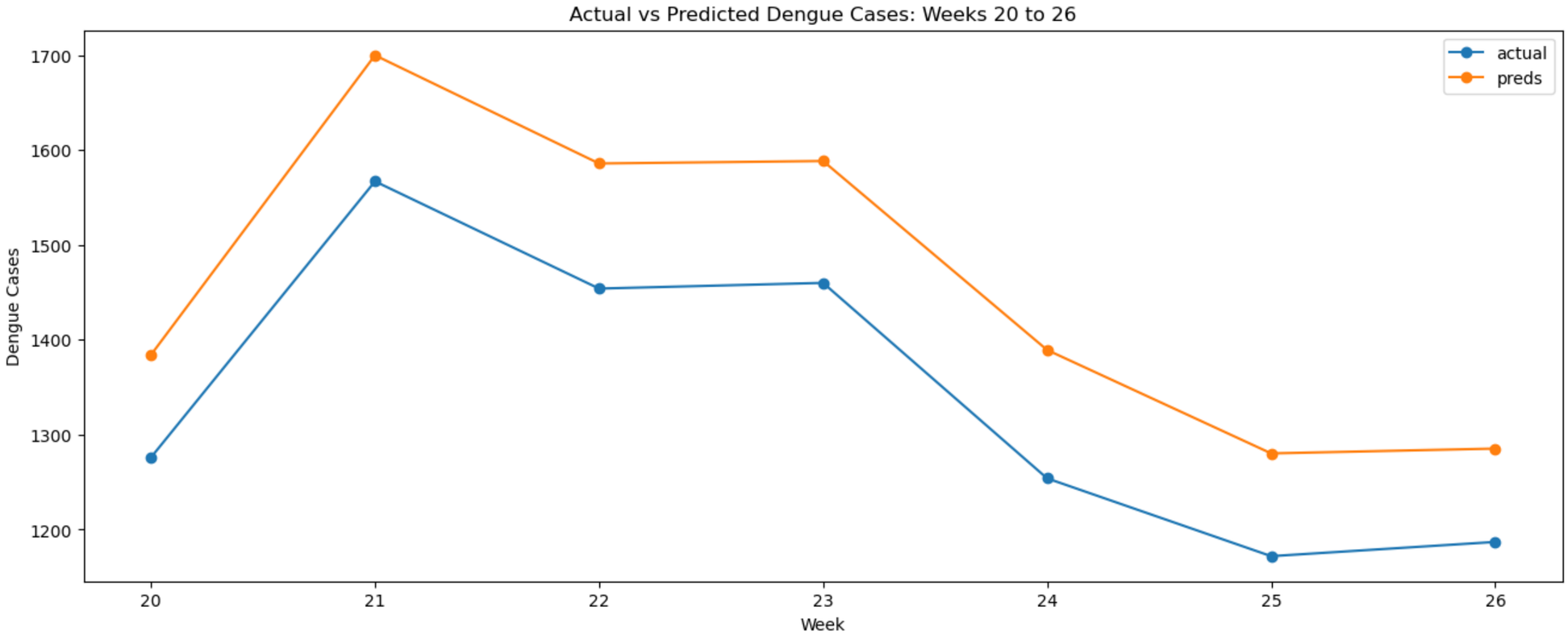
2022 W20 to W26



RMSE: 121
MAPE: 9.0%

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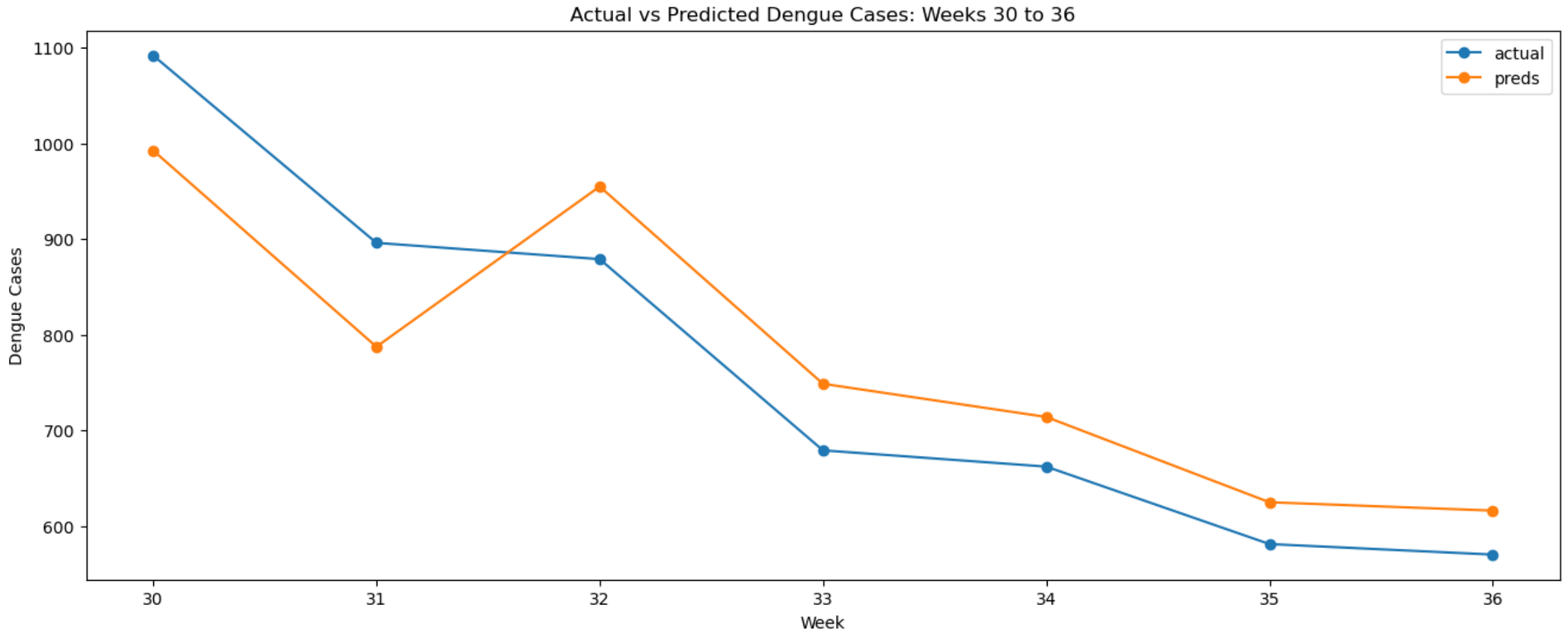
2022 W30 to W36



RMSE: 75
MAPE: 9.1%

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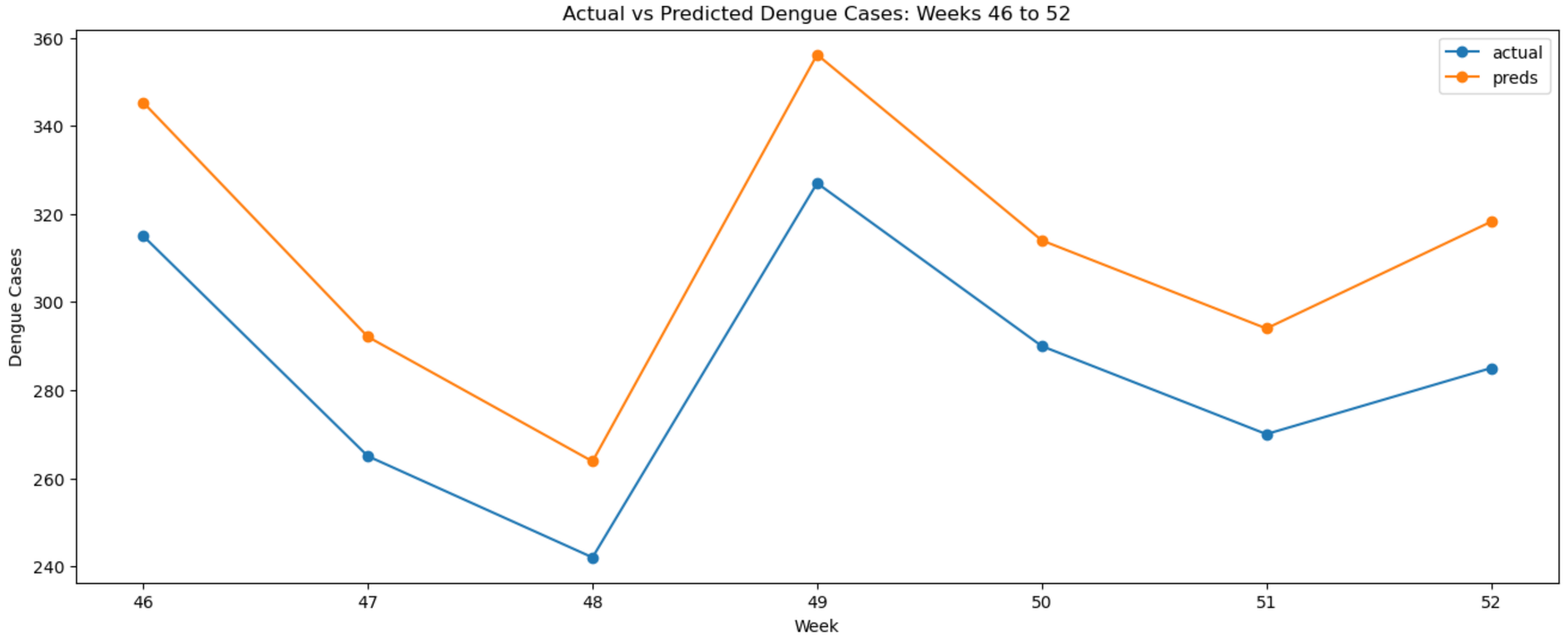
2022 W46 to W52



RMSE: 27
MAPE: 9.5%

04d

05a

Cost Effectiveness of Project Wolbachia

- Assuming an efficacy of 40%, for the first 42 weeks of 2022, we can reduce 11702 cases and economic cost of 41M$ With Project Wolbachia

	Forecast Cases (No intervention) 29255 cases	Project Wolbachia Intervention Cases 17553 cases
Direct Cost (Hospitalisation and Treatment @ 3500$ per person), A	102M$	61.5M$
Indirect Cost (Productivity Lost @ 3500$ per person), B	102M$	61.5M$
Project Wolbachia Cost, C	0M$	40M$
Total Cost (A + B + C)	204M$	163M$

Source: PLOS Journal - Economic impact of dengue in Singapore from 2010 to 2020 and the cost-effectiveness of Wolbachia interventions

06

Conclusions

1. Temperature and rainfall correlates strongly to dengue cases

2. Low herd immunity to new dengue strain

3. Singapore is densely populated

4. NEA Campaigns, Project Wolbachia are effective

Recommendations

1. NEA to spend more resources in vector control in East and North East

2. Consider climate change predictors into future model

3. Consider amount of Wolbachia Mosquito to be released, in the model

4.Model dengue outbreak by zone

The best way to prevent dengue is with S-A-W and B-L-O-C-K!

THANK YOU FOR LISTENING!