MIE1624 Final Exam Project

COVID19 in Canada

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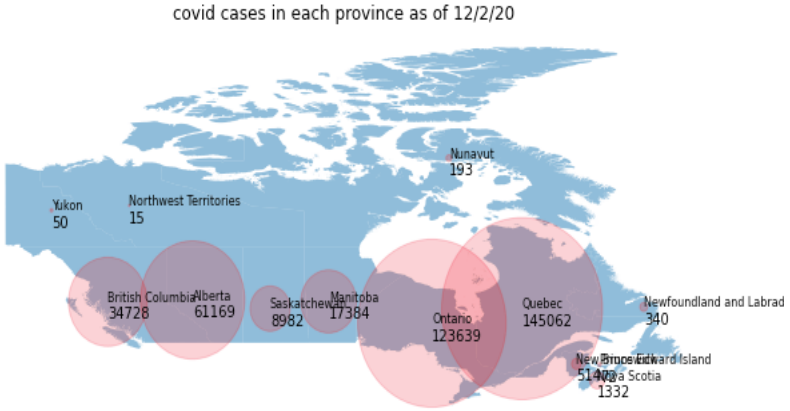
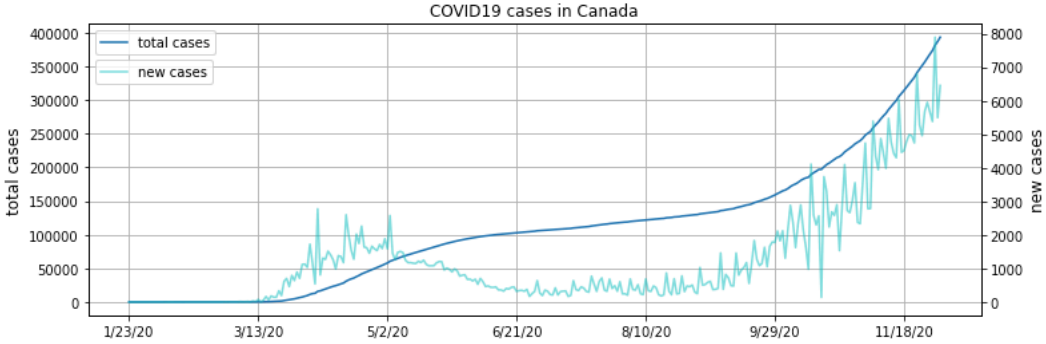
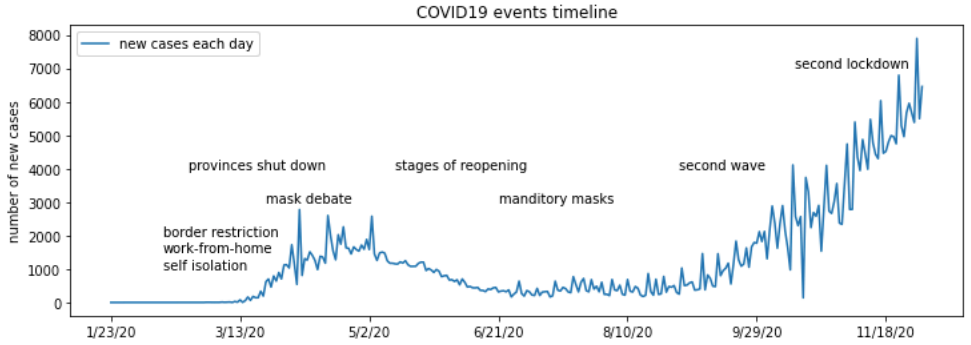
December 2020

Data Visualization







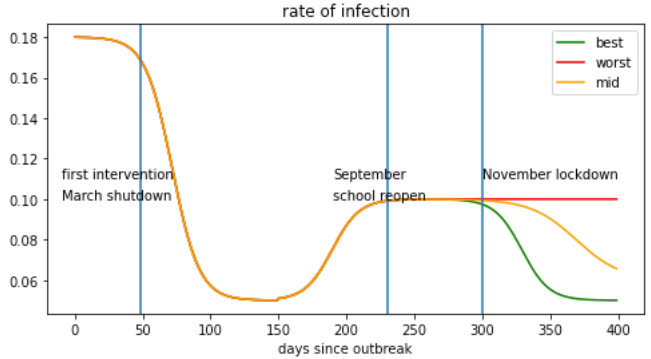
SIR Model

Uses a time dependent infection rate β(t) to model SIR: β is modeled with a piece-wise logistic function that reflects major events since the outbreak

$$\frac{dS}{dt} = -\beta(t) \cdot I \cdot \frac{S}{N}$$

$$\frac{dI}{dt} = -\beta(t) \cdot I \cdot \frac{S}{N} - \gamma \cdot I$$

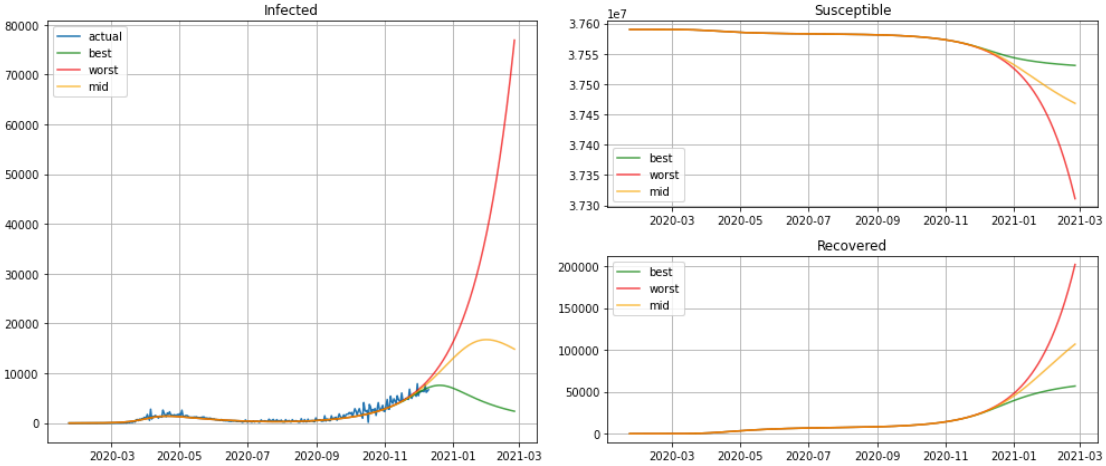
$$\frac{dR}{dt} = \gamma \cdot I$$



- β starts high and drops down after first intervention in March
- It remains low during the lockdown period
- Increase again as the country reopens
- Future prediction: three variations of β

Predicted outcomes of the three models:

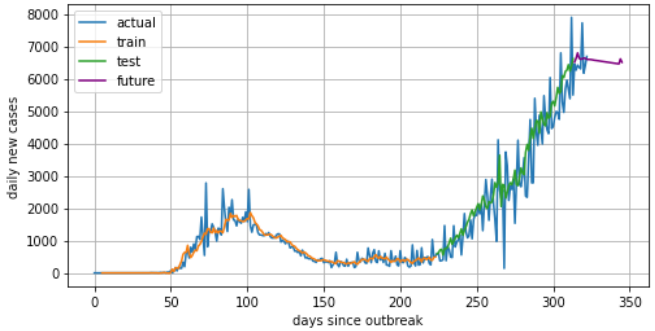
- Best case: immediate strong intervention to stop the second wave → the number of cases dives down quickly
- Worst case: no intervention is taken → the number of cases grows exponentially and out of control
- Middle case: delayed weaker intervention → the peak of new cases comes at a later time, resulting a longer and bigger second wave



normalized RMSE: 0.376

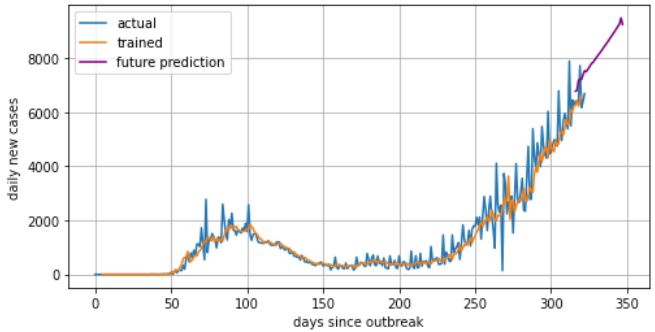
LSTM Model

- Predictions are made on a rolling basis: Past 5 days' numbers will be used to predict the next 3 days
- Since the model is only predicting 3 days head, a long term forecast is simulated by feeding the prediction output back into the model
- The long-term forecast accuracy may be impractical because input data are artificial, but the forecasted trend is still interesting to study to observe the direction of the curve
- Normalized RMSE (exclude future): Training 0.391, Test 0.231



Model A: 70% training set so model does not learn about second wave

The future prediction forecasts a drop of new cases. Intuitively, the training set (orange curve) only saw the first wave, it has learned that the number of new cases will eventually drop down, so it is predicting the same for the future (purple curve)



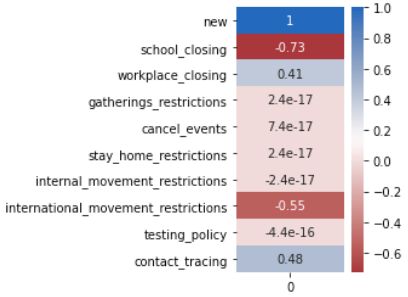
Model B: 100% training set to learn about the second wave

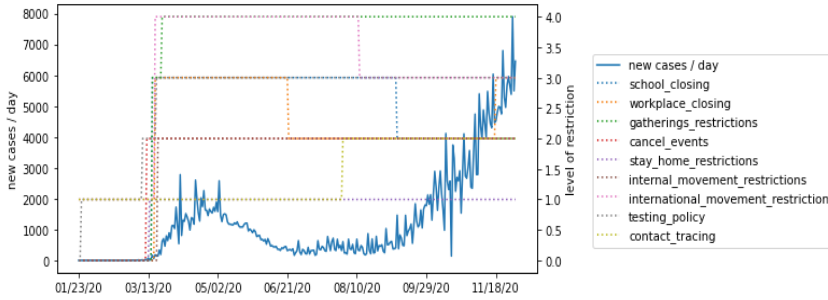
A spike of new cases is forecasted. The output can be explained as how the model predicts differently after learning that the number of cases can go up again

Relating to Other Datasets

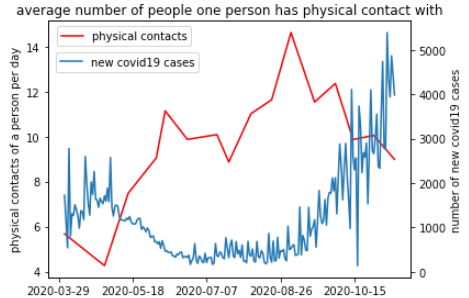
Most Correlated Government Policies

- School closing
  → The second wave came right after school reopens, resulting increase of contacts
- International movement restrictions
  → Border opened up in August for travelers from low risk regions, bringing in possible virus carriers

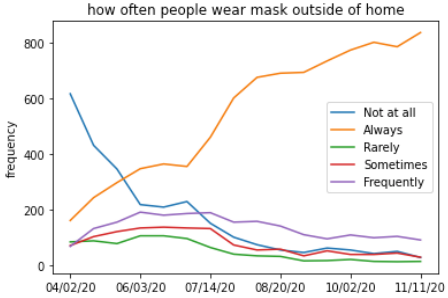




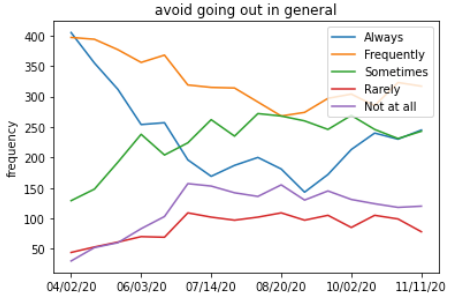
Correlations to People Behaviours



Trend in physical contacts is a leading indicators of new covid19 cases. Amount of social gathering impacts the severity of the pandemic



Consistent increase in mask use. No significant incident that linked mask to the occurrence of second wave.



Less cautious towards the virus.
More people going out increased chance of spreading

Insights to tackle the outbreak

1. School needs to remain closed
    - reverse the dominating cause of the second wave
    - reduce physical contacts and chances of cross infections
2. Keep people alerted, discourage people going out
    - increased engagement in social events increased chance of infections
    - offer more services online to decrease need of in-person activities
    - restrict number of people in a facility, encourage appointment, limit line ups
3. Implement absolute lockdown in severe areas
    - a hard lockdown that restrict travelling to other cities,
    - eliminate infection completely
4. Mandatory quarantine in designated facilities for people with confirmed positive tests
    - ensure infected people will not further spread the virus
5. Promote vaccines
    - media campaigns to reduce hesitancy and ensure vaccines' safety,
    - invite influential figures to take vaccines to encourage the public
    - solution to eliminate infection in the long run
6. Maintain other current policies
    - what has been done need to be maintained
    - people will continue to work from home, wear masks, and practice social distancing and self isolation, border will remain closed for foreign travelers