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A Study of People Movement Index in Indonesia During Lebaran 2021

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Background

- Lebaran (Eid al-Fitr) is one of biggest national holidays in Indonesia
- People are driven to go visiting families and relatives around Lebaran.
- Covid-19 transmission depends on human interaction frequency.
- Movement of people also depends on their knowledge of Covid-19 status. (Low daily infections make people careless)
- An analysis is needed to Lebaran phenomena.

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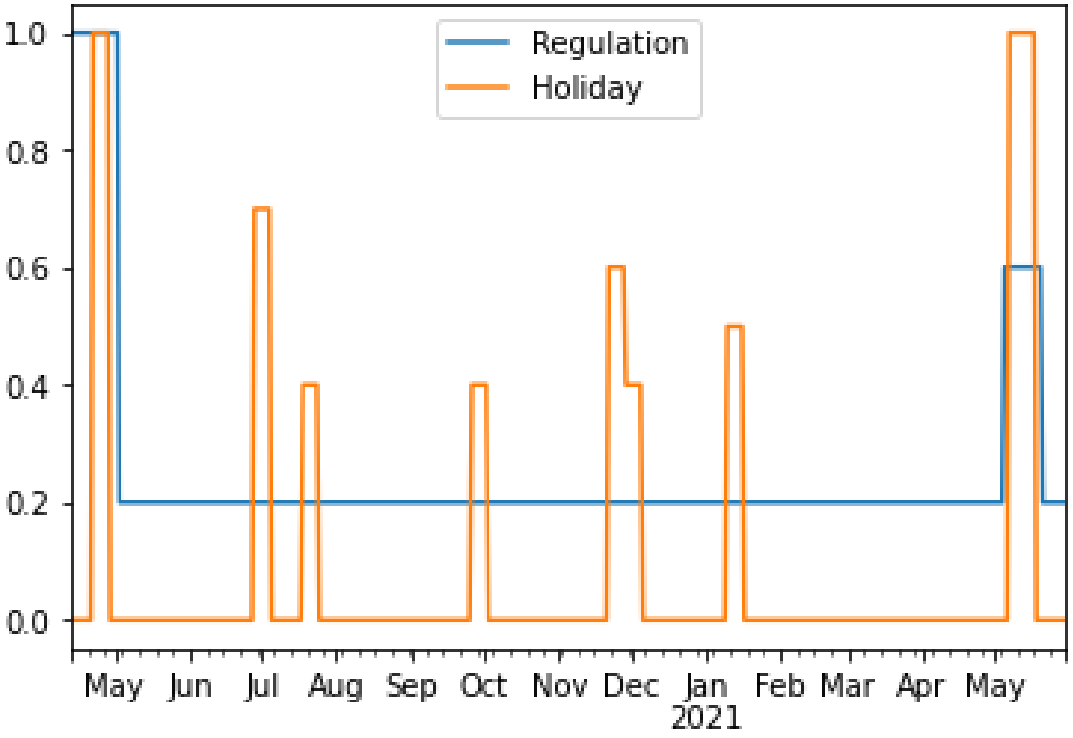
Methodology

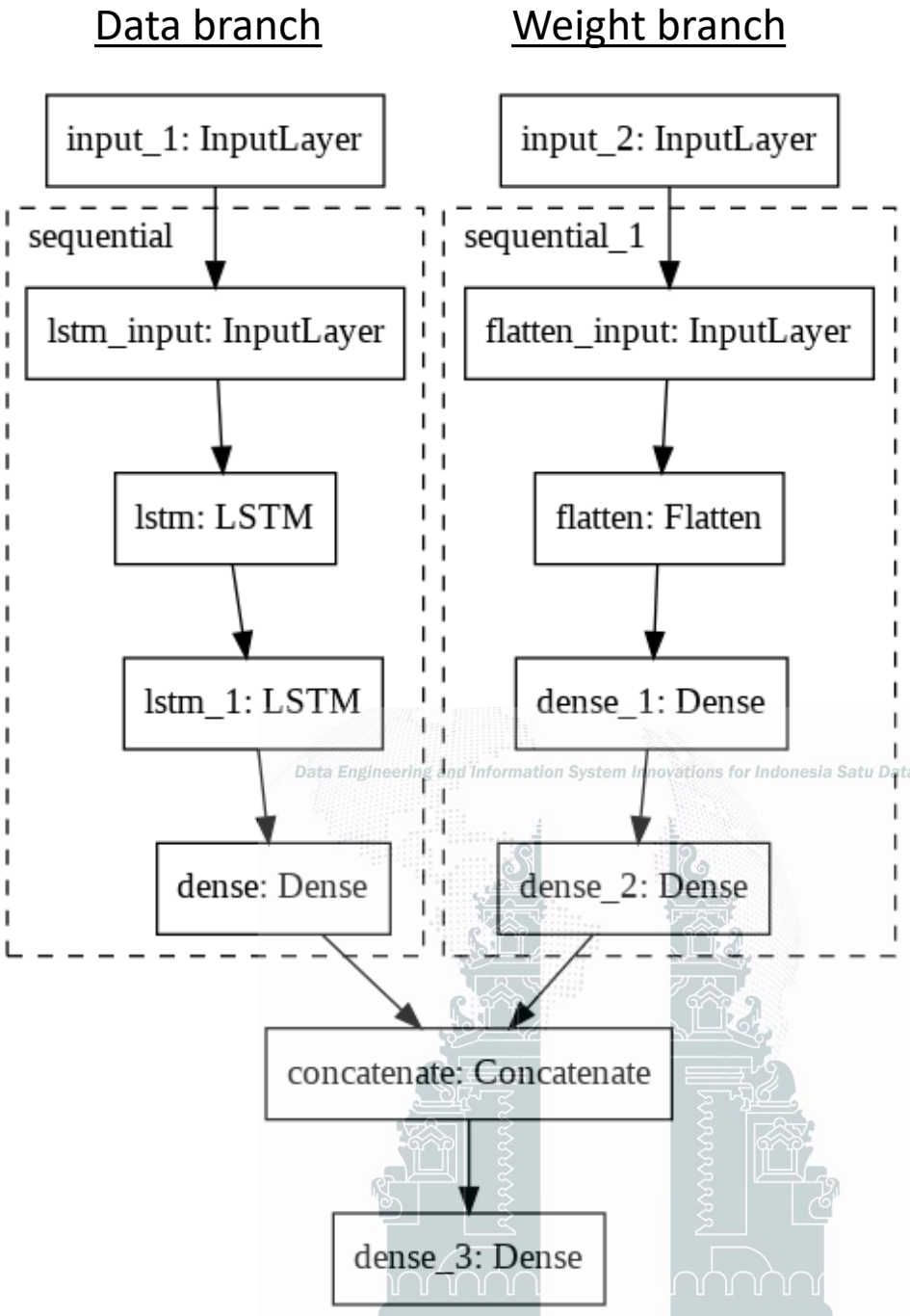
Neural Network, especially LSTM-cell RNN and 1-D CNN are used:

Model	Architecture	Feature	Step
A	LSTM	Single	Single
B	LSTM	Single	Multi
C	LSTM	Multi	Single
D	LSTM	Multi	Multi
E	CNN	Multi	Single
F	CNN	Multi	Multi

Methodology

Use of weight on holidays and regulation





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Data Used

- Data used: Facebook movement range data
- Two key features:
  - Relative daily movement $$M_{ch} = \frac{\overline{n_m}(U_{d,r}) - n_m^{baseline}}{n_m^{baseline}}$$
  - Stayput ratio $$S_r = \frac{n_s(U_{d,r})}{|U_{d,r}|}$$

where $U_{d,r}$ is the set of eligible users in region r on day d, $tiles(u)$ is number of tiles visited by user u, and

$$n_s(U_{d,r}) = \sum_{\substack{u \in U_{d,r} \\ tiles(u)=1}} 1 + L \qquad n_m(U_{d,r}) = \sum_{u \in U_{d,r}} \min_{u \in U_{d,r}} (tiles(u), 200) + L$$

Data Used

Range of Data:

- Training: March 20th, 2020 – February 10th, 2021
- Validation: February 11th, 2021 – May 2nd, 2021
- Testing: Around Lebaran 2021

Additional features:

- Covid-19 national daily infection
- Covid-19 national daily recovery

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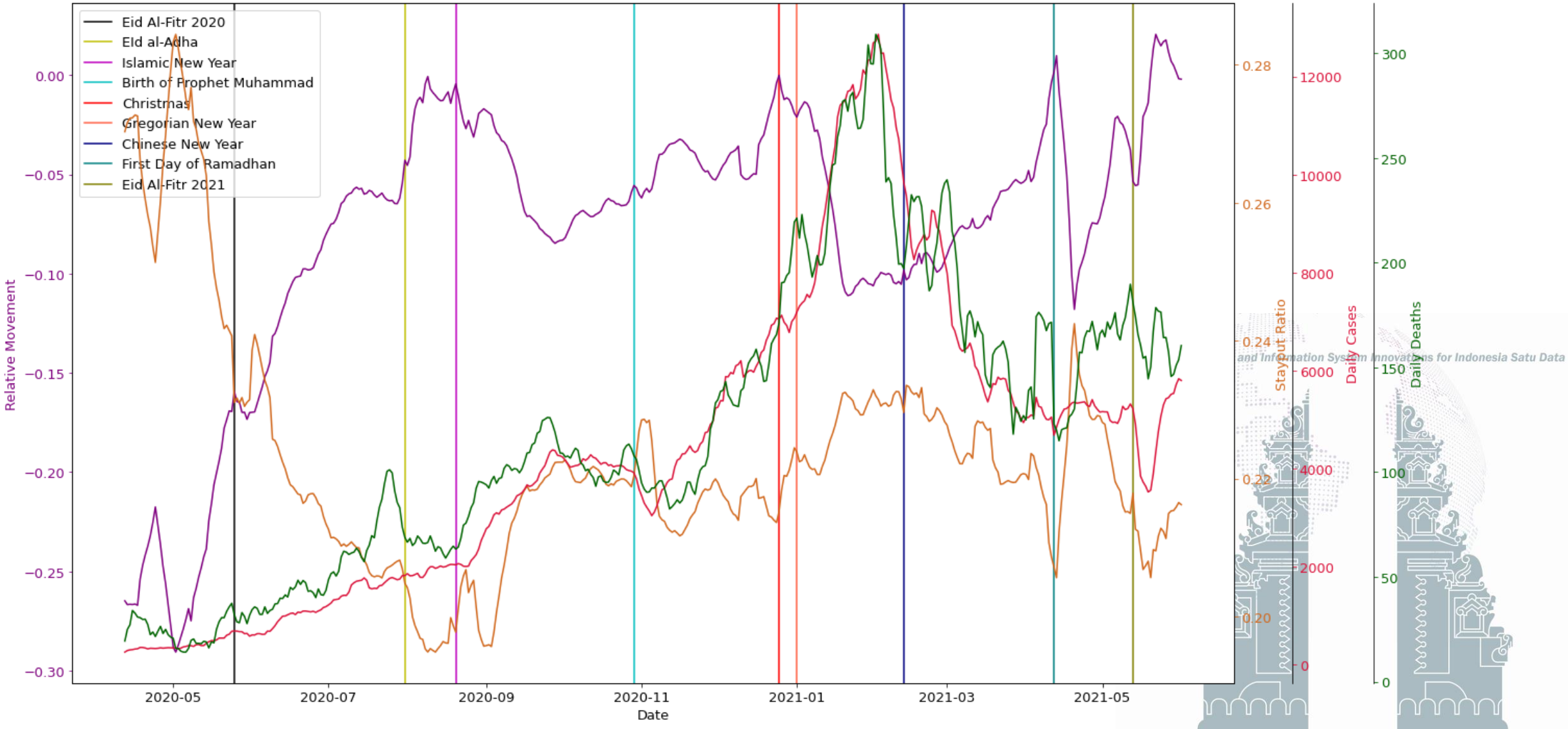
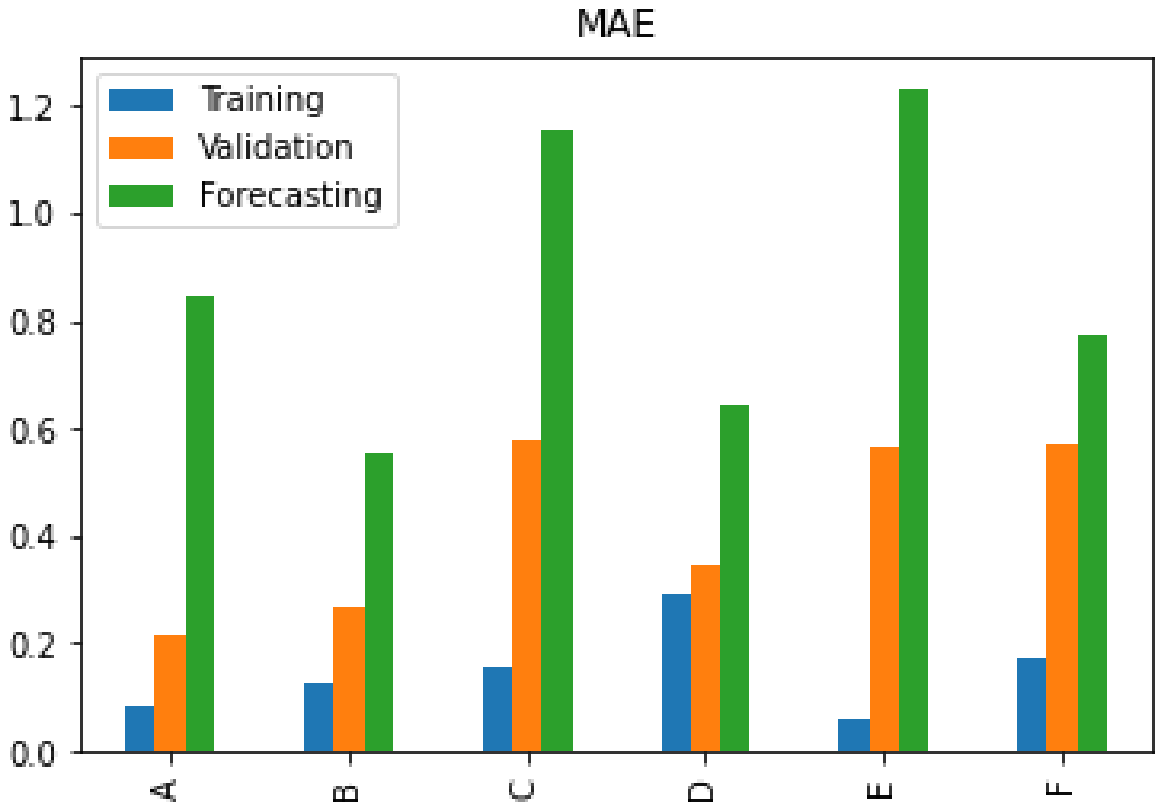
Results (Analysis of Trends)



Results (Series Forecasting)



- Multi-step model (B, D, F) obtained less MAE than single ones (A, C, E)
- Multi feature (C-F) obtained less MAE than single ones (A, B).
- LSTM and CNN gave similar performance, but CNN (E, F) is more susceptible to overfitting.

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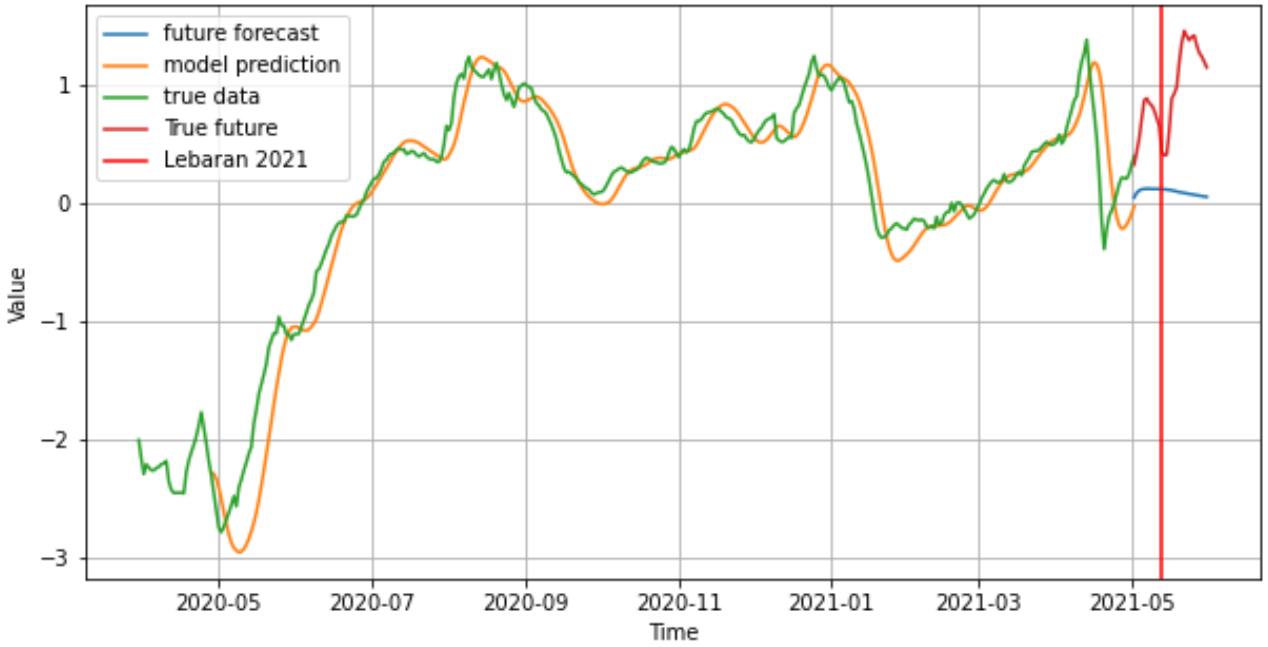
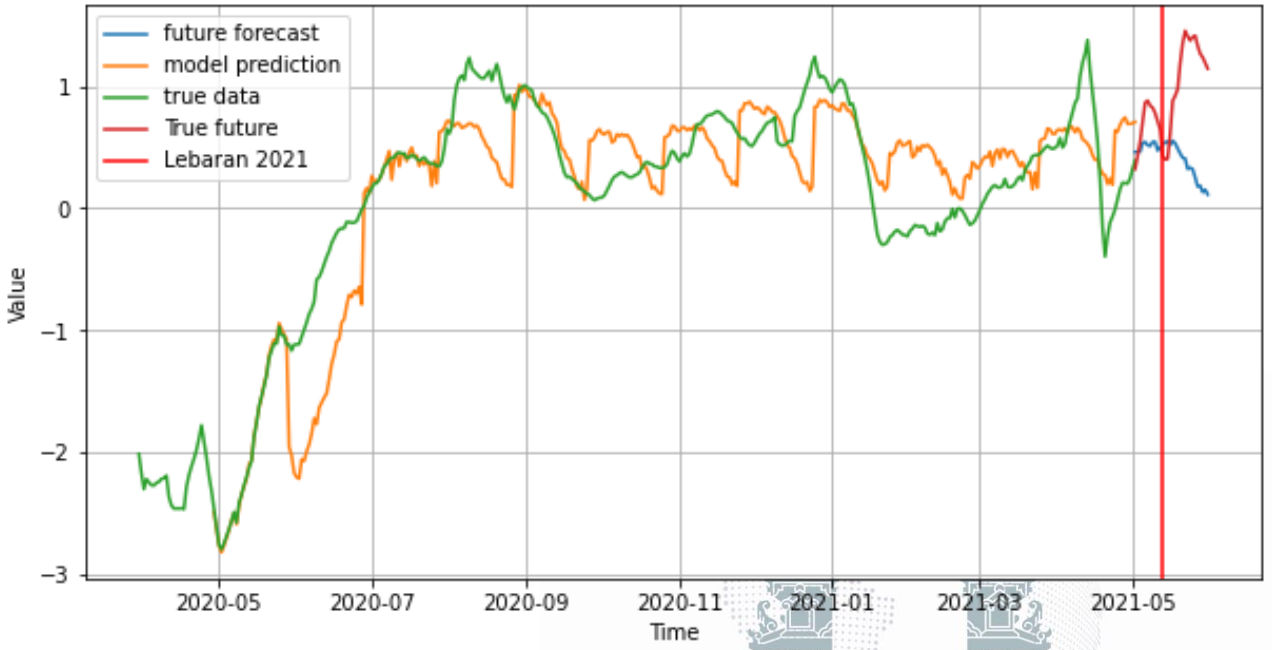
Results (Series Forecasting)



Model A
LSTM Single Feature Single Step



Model B
LSTM Single Feature Multi Step

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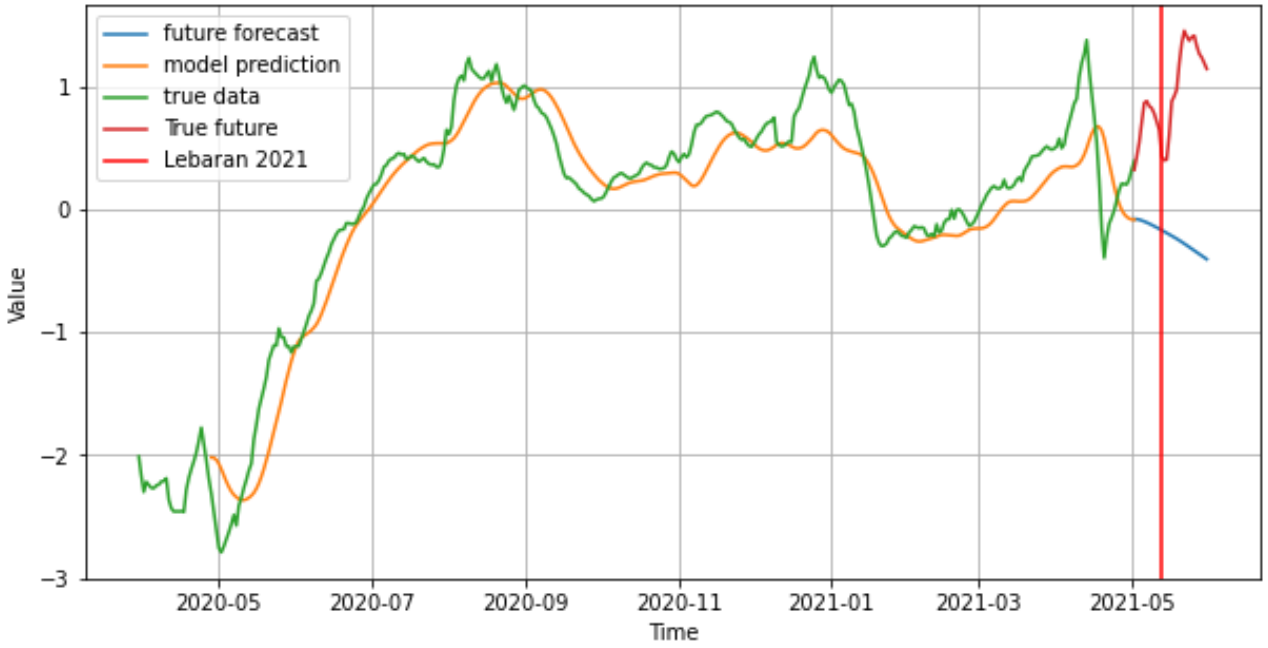
Results (Series Forecasting)



Model C
LSTM Multi Feature Single Step

Model D
LSTM Multi Feature Multi Step

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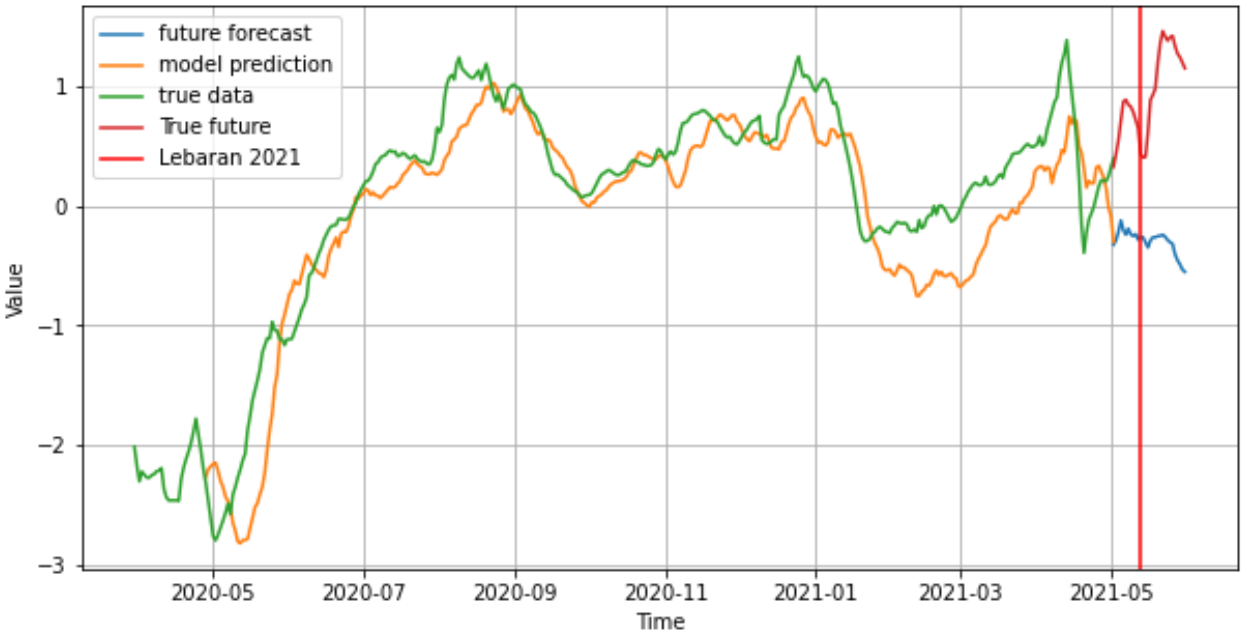
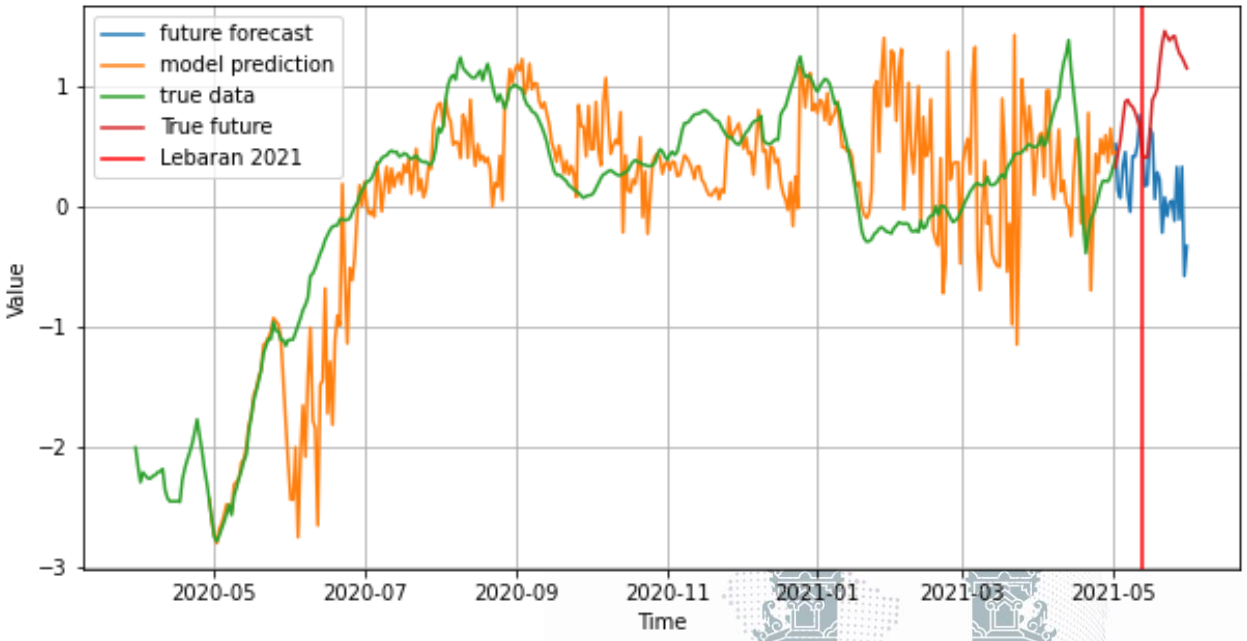
Results (Series Forecasting)



Model E
CNN Multi Feature Single Step



Model F
CNN Multi Feature Multi Step

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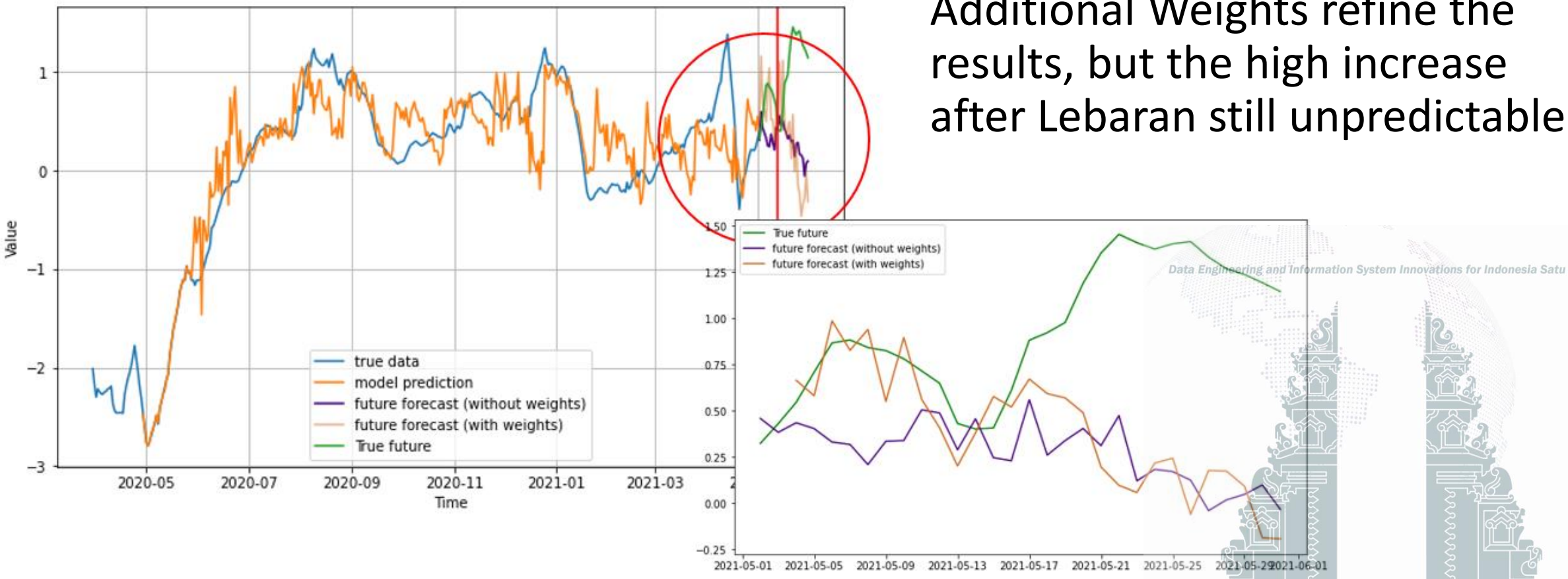
Results (Weights Effect)



Additional Weights refine the results, but the high increase after Lebaran still unpredictable

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Conclusion

- Both LSTM and CNN are effective on forecasting people movement.
- Multi features gives additional complexity to the model, makes it harder to fit the data. Multi step see farther to the future prediction, makes it gives better forecasting result.
- Regulations and holiday affects the people movements. Government Regulation is successfully hold people during Lebaran 2020.
- However, Lebaran 2021 gives anomaly. Because all model failed to anticipate its sudden increase.
- Inability to go home on previous Lebaran saturates people ability to hold their desire in mobility prevention, drives them to ignore regulations and Covid-19 status.