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Predicting Weather Inflicted Train Delays

Finnish Meteorological Institute

Roope Tervo
Laila Daniel

Photo by Kalevi Lehtonen 1955. Not published until Commons in 2014.
https://fi.wikipedia.org/wiki/Tiedosto:Finnish_class_Dm4_locomotive_number_1607_in_the_year_1955.jpg

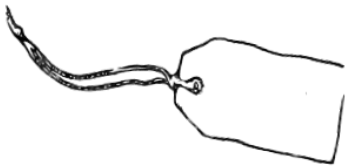
We aim to predict disruption of rail traffic caused by weather

Operation center can take several actions:

- Reduce train shifts
- Communicate

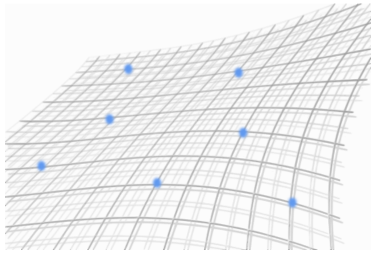
Project timeline: 01/2018-10/2018
Project partners: FMI, FTA, Trafi, VR
Area: Finland
Time range: 2 days ahead
Time step: 1 hour

Image: Solita Oy



Label data

+



Feature data

Method

Results

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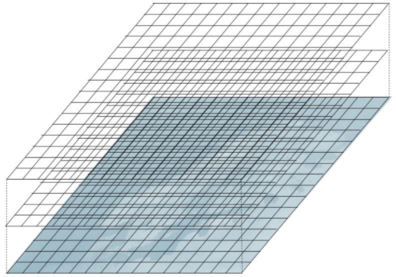
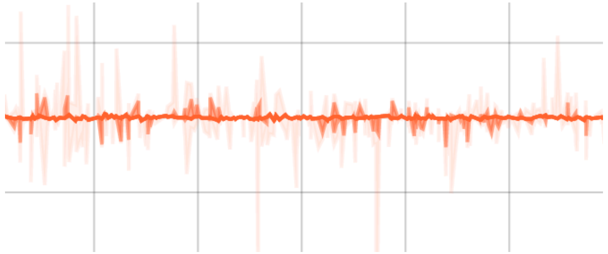


NWP

Method



Prediction

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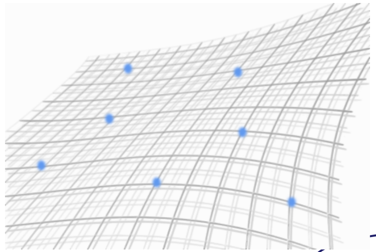
Data consist of train delays and corresponding weather observations

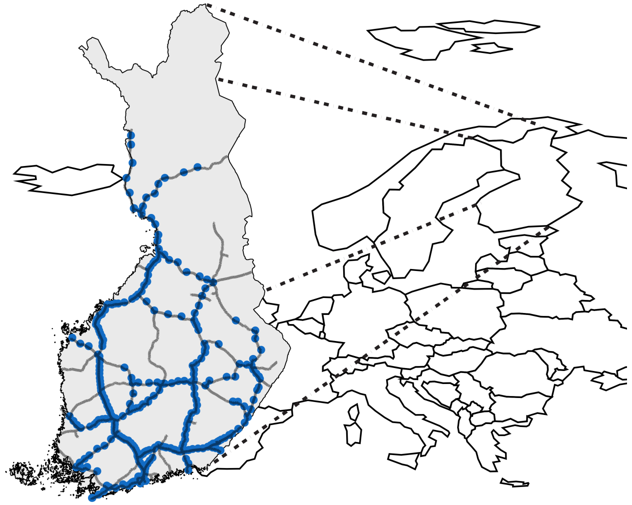
Delay between stations

- Passenger trains
- 514 stations

Weather observations

- 19 parameters





Data Liikennevirasto (CC4)

- Data from 2010 – 2018
- 30 M rows | 5.5 GB data

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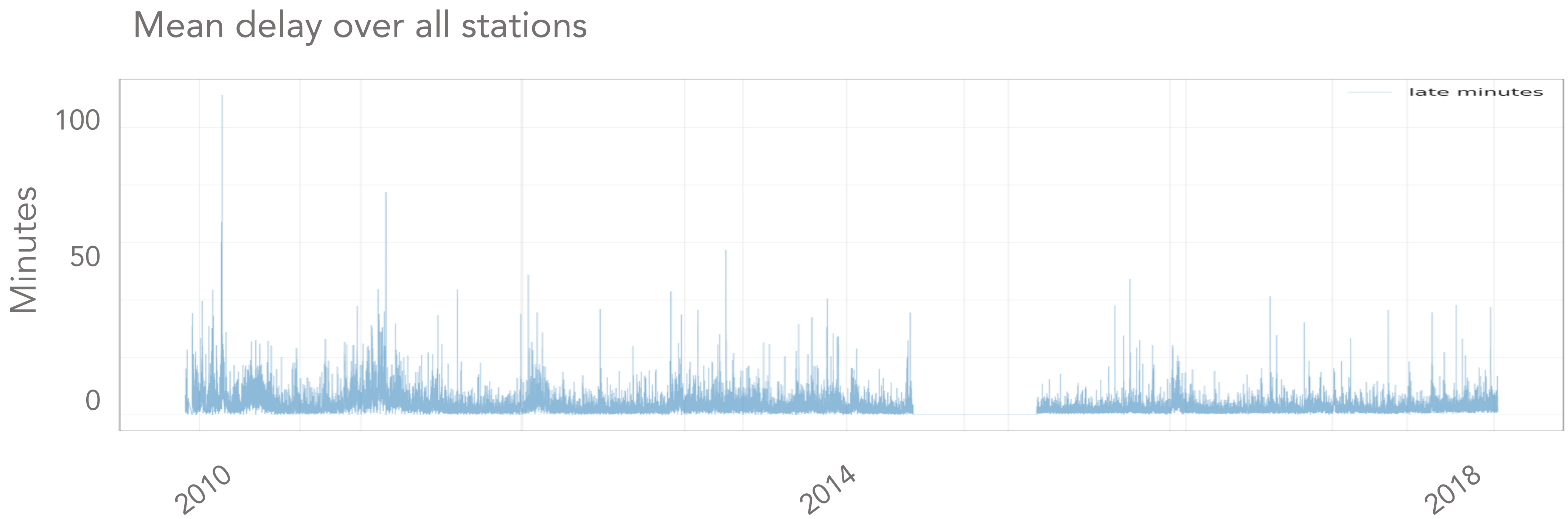
Most trains run in time



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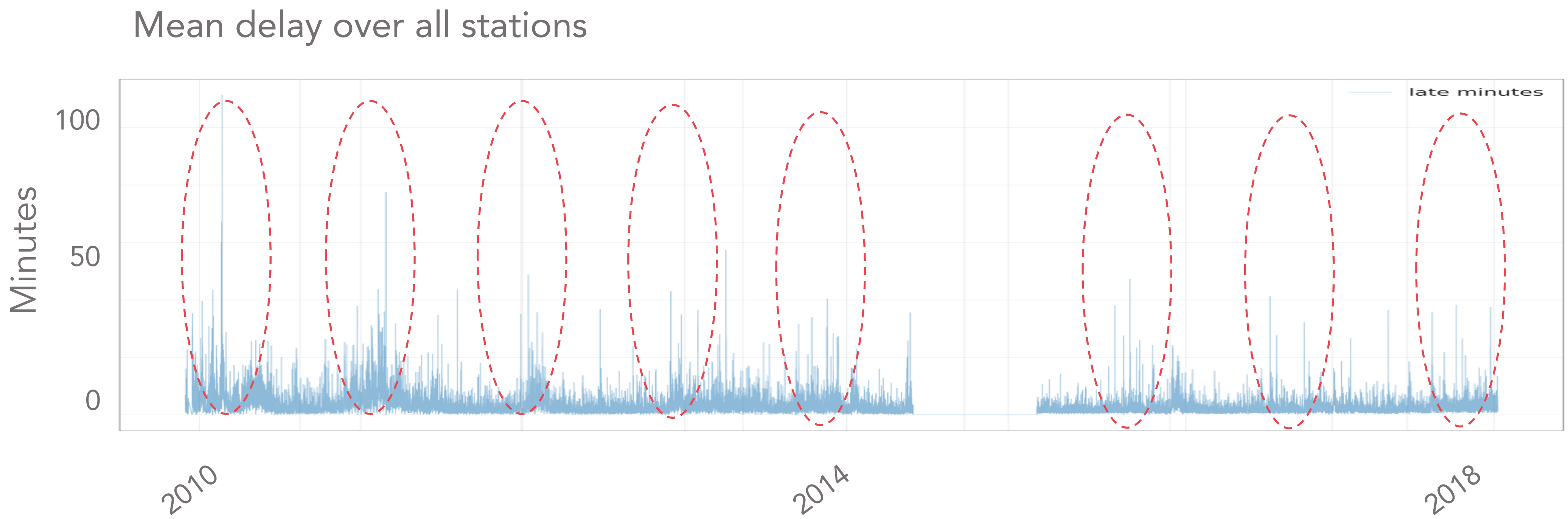
Most trains run in time



But severe delays happen quite regurarly every year

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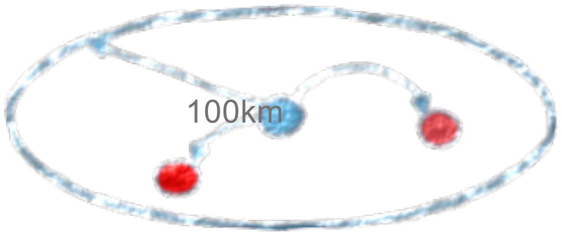
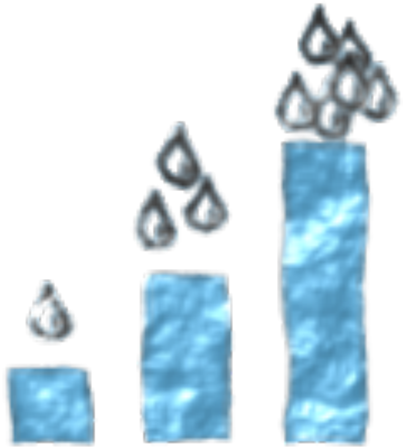
Various pre-processing methods used

Observations fetched with 100 km radius from train station using aggregation



Calculated 3h and 6h precipitation accumulation sums



Tried PCA, ICA and K-Means clustering

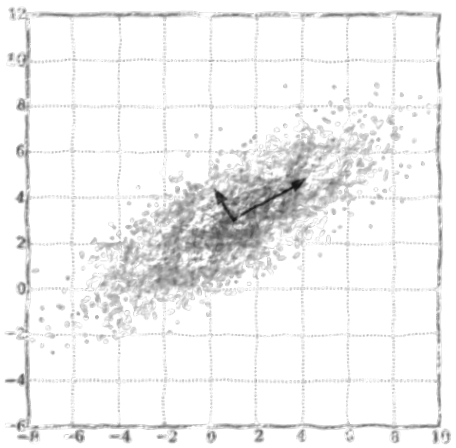


Image: Roope Tervo 2018.
Original image: Nicoguaro. License: CC4-BY.

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Three ML methods considered

LR

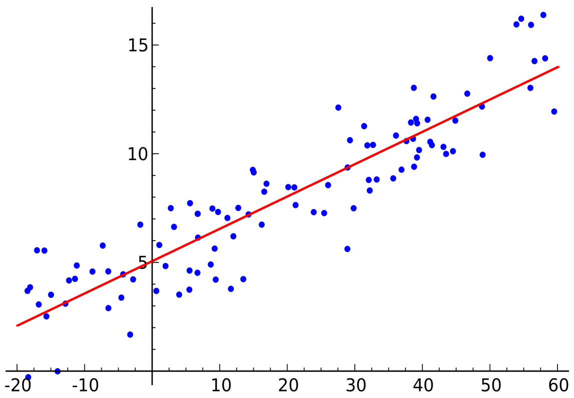


Image: CC0

RFR

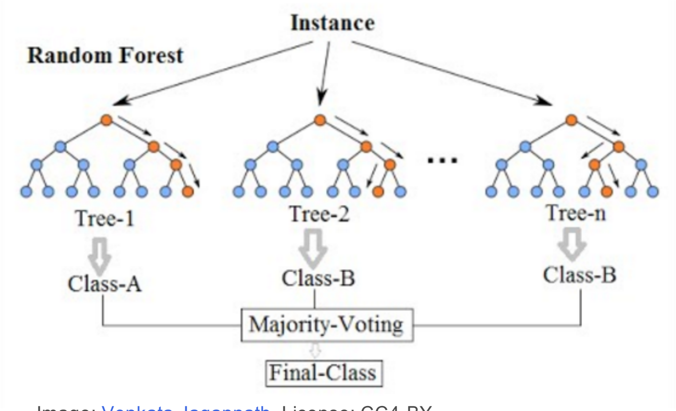
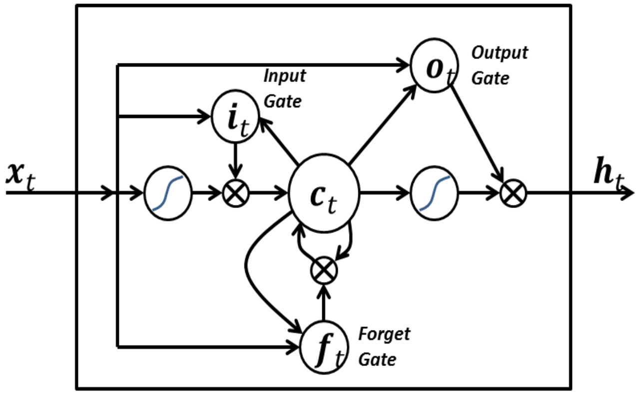


Image: Venkata Jagannath. License: CC4-BY

LSTM



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Random search used for finding optimal hyper parameters of LR and RFR

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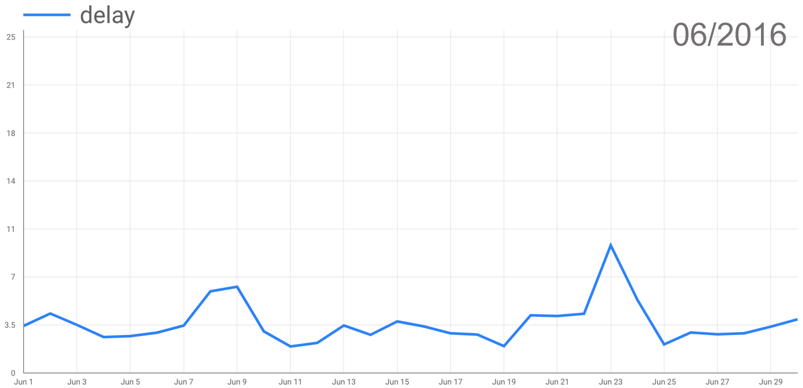
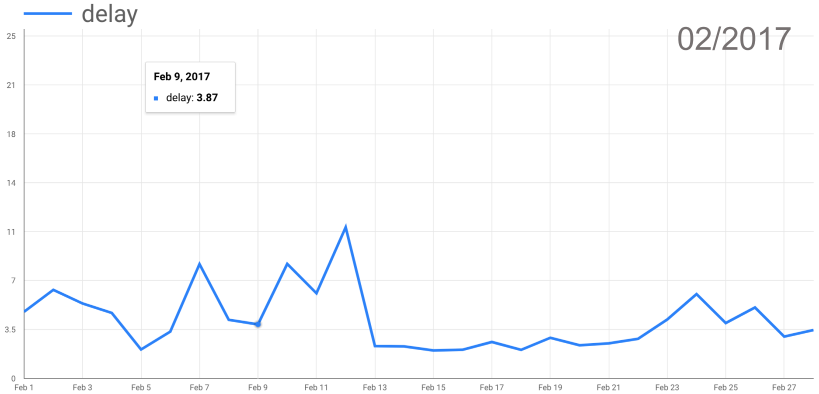
Three selected months picked out for testing performance





- Rest of the dataset splitted randomly to train and validation dataset with ratio 70/30 %

Results

LR

RMSE: 5.59
MAE: 3.11
BSS: 0.08

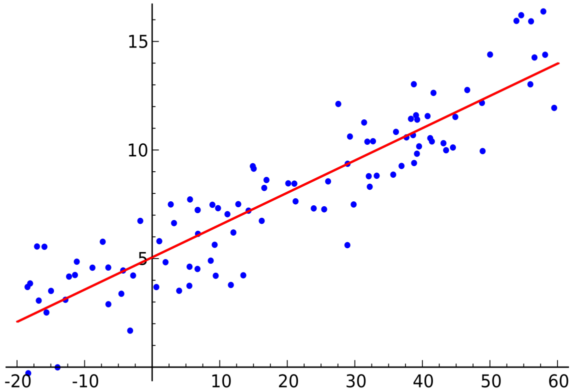
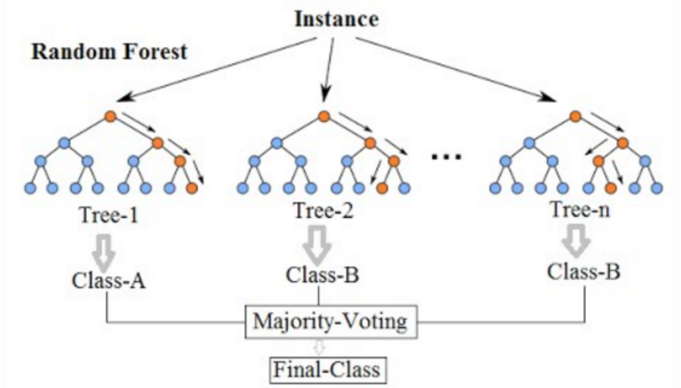


Image: CC0

RFR

RMSE: 5.37
MAE: 3.21
BSS: 0.11



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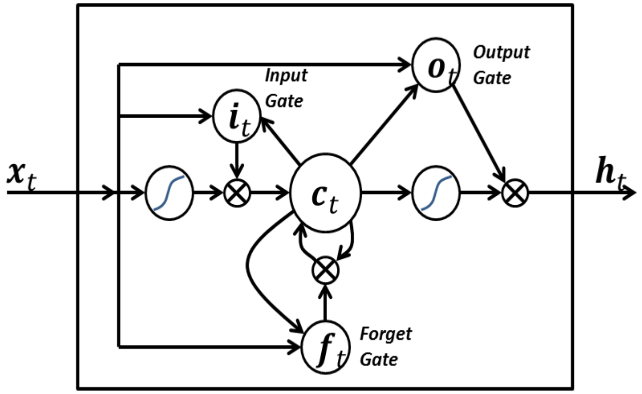
LSTM

RMSE: 4.35
MAE: 2.75
BSS: 0.01



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$$BSS = 1 - \frac{RMSE}{RMSE_{ref}},$$

where $RMSE_{ref}$ denotes root mean square error calculated with a mean value over the whole dataset

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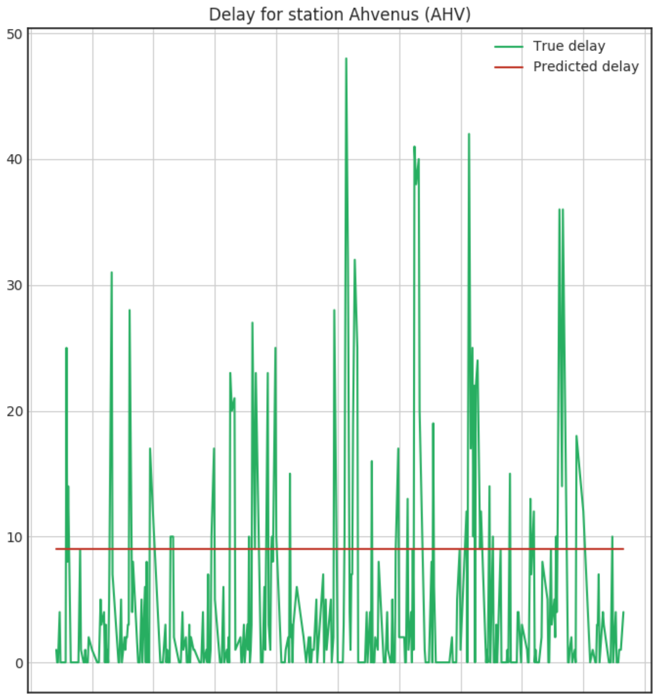
LSTM shows no real skill

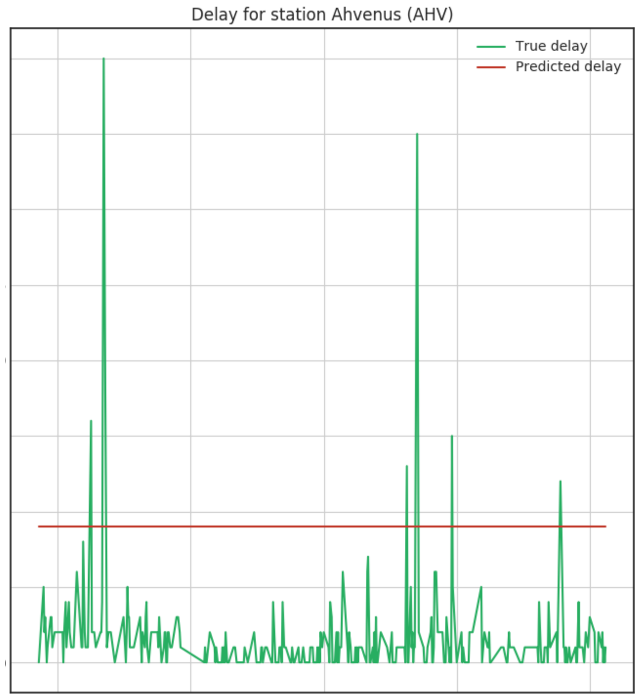
Predicted delay
True delay

Predicted vs. true delay, case Ahvenus

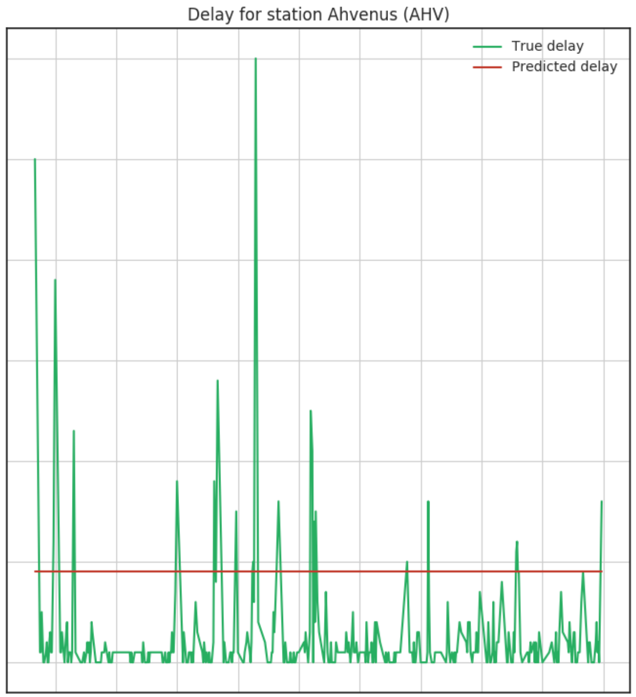
Delay (minutes)
50
25
0



Time
02/2011



Time
06/2016



Time
02/2017

RFR works relatively well

Predicted delay
True delay

Predicted vs. true delay, average over all stations

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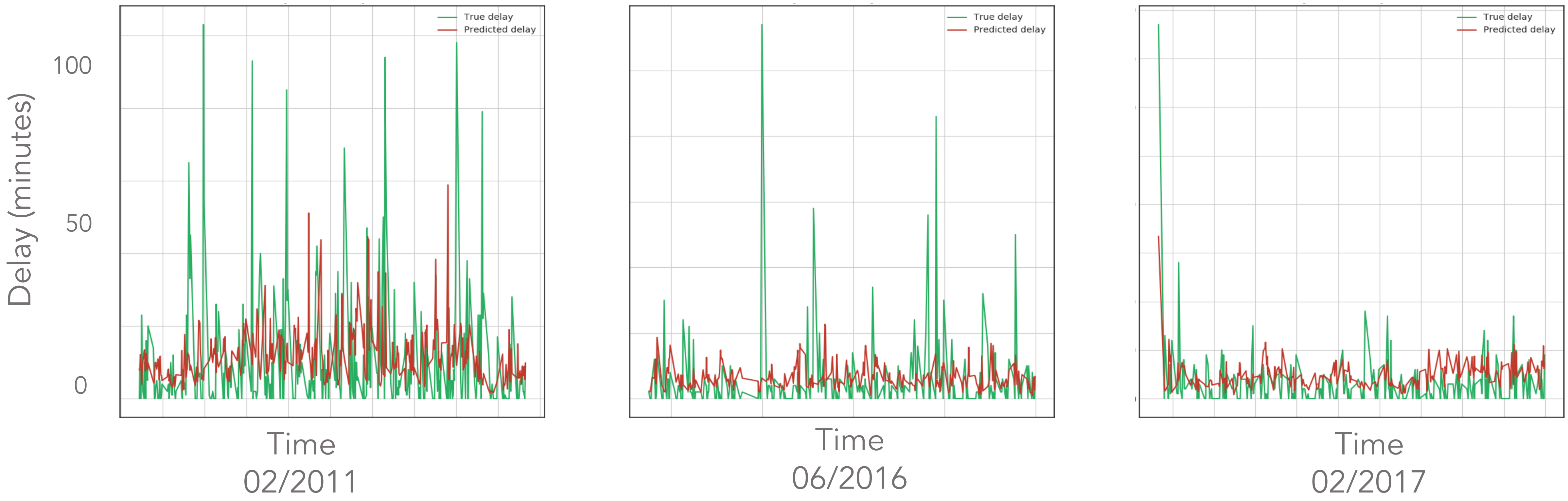
RFR works well for most individual stations

Predicted vs. true delay, case Kyrö

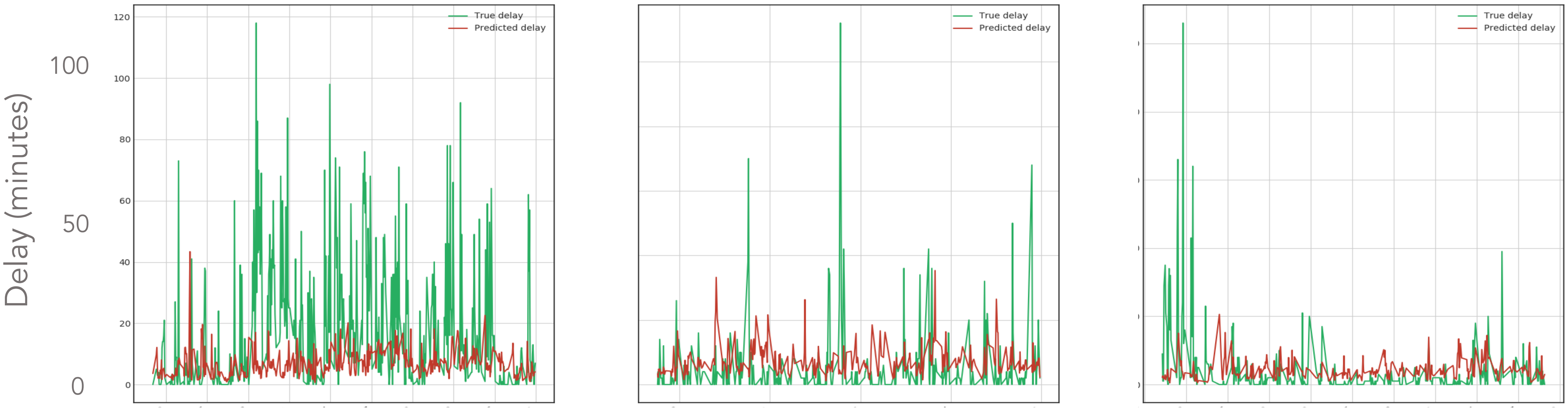


RFR don’t work for all cases

Predicted delay

True delay

Predicted vs. true delay, case Karjaa

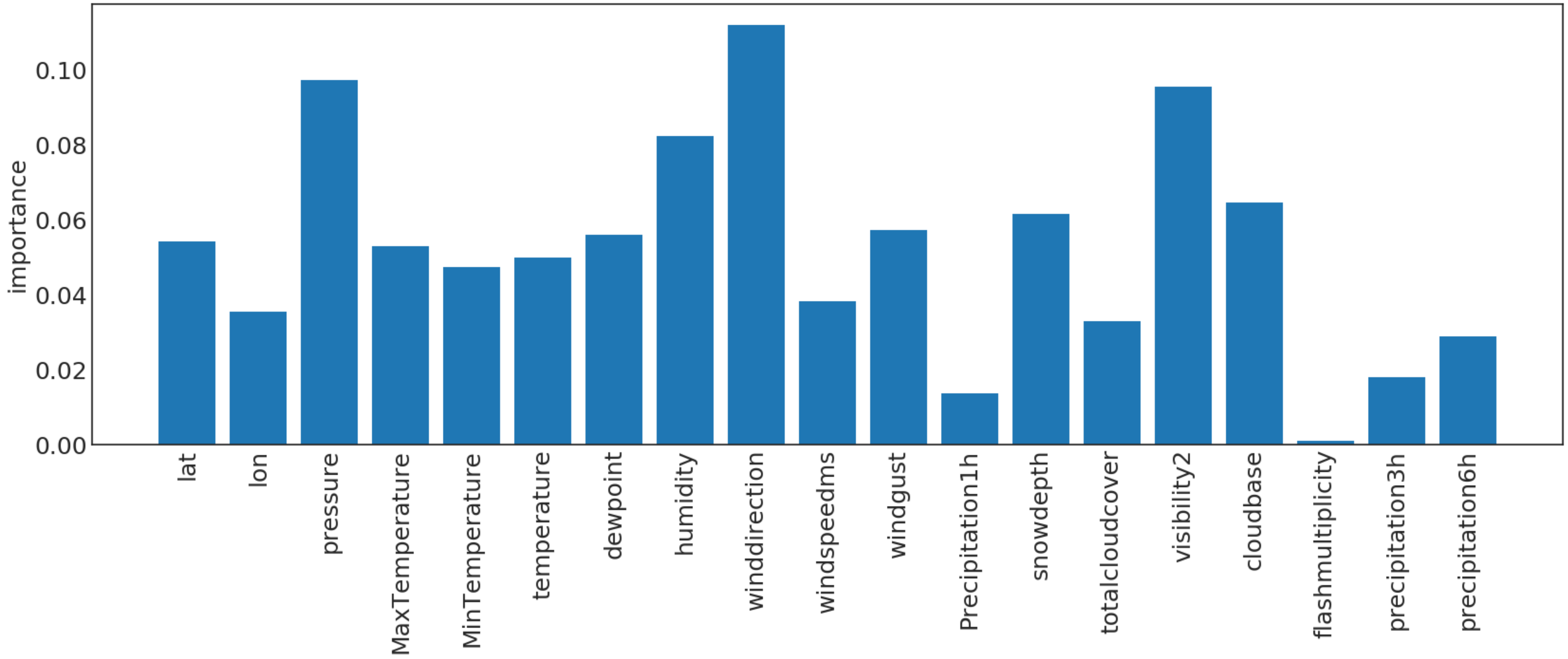


Time
02/2011

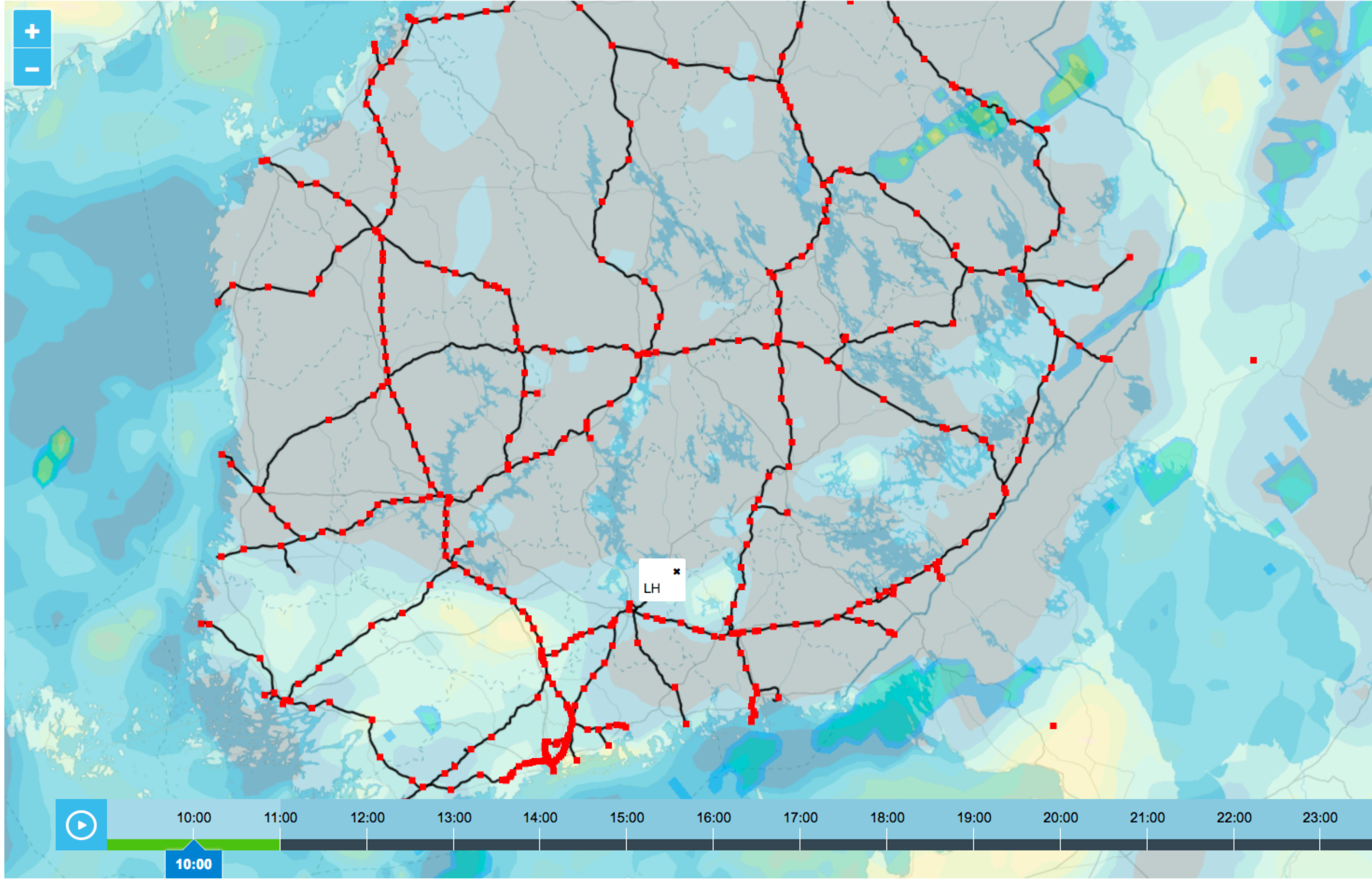
Time
06/2016

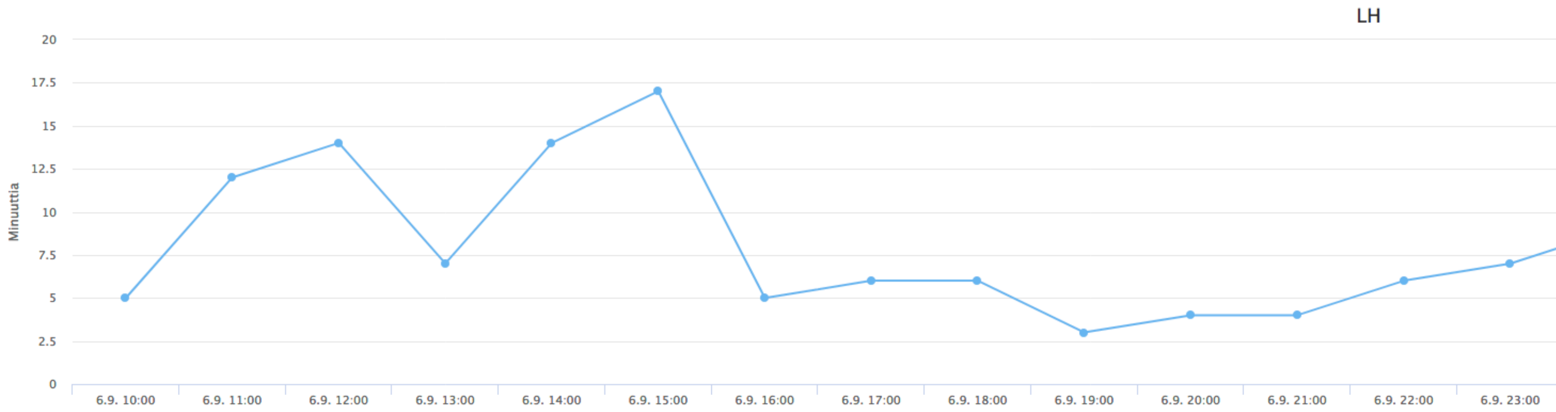
Time
02/2017

Wind direction, pressure and visibility are the most important features



Predictions are delivered to end users via web interface





Train delays can be predicted based on weather conditions

RFR gives the best average prediction

…although its performance is not steady

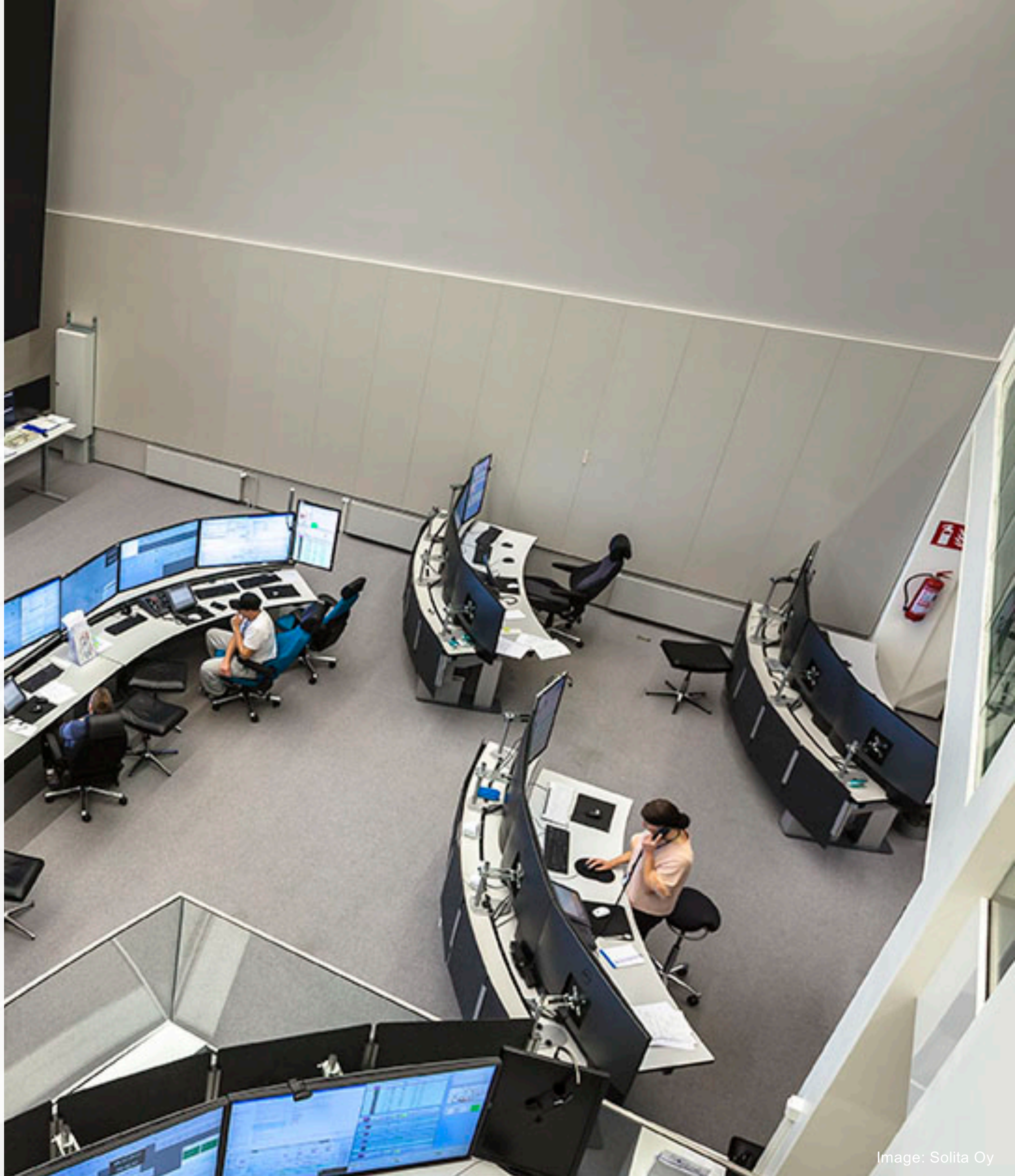


Image: Solita Oy

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Questions

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