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16 mei 2019

scientific computing
predictions
complex data
algorithm
cybersecurity
digital finance
data systems
quantum software
machine learning
societal relevance
neuroscience
blockchain
AI

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SMART BUILDINGS

Nanda Piersma
Lector Urban Analytics

Predicting building occupancy

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UvA HvA WiFi network

Hogeschool van Amsterdam – Universiteit van Amsterdam

75 buildings

One WiFi HvA-UvA-netwerk for approx. 90.000 users,

Normal day use: 40.000+ simultaneous wifi-connections.

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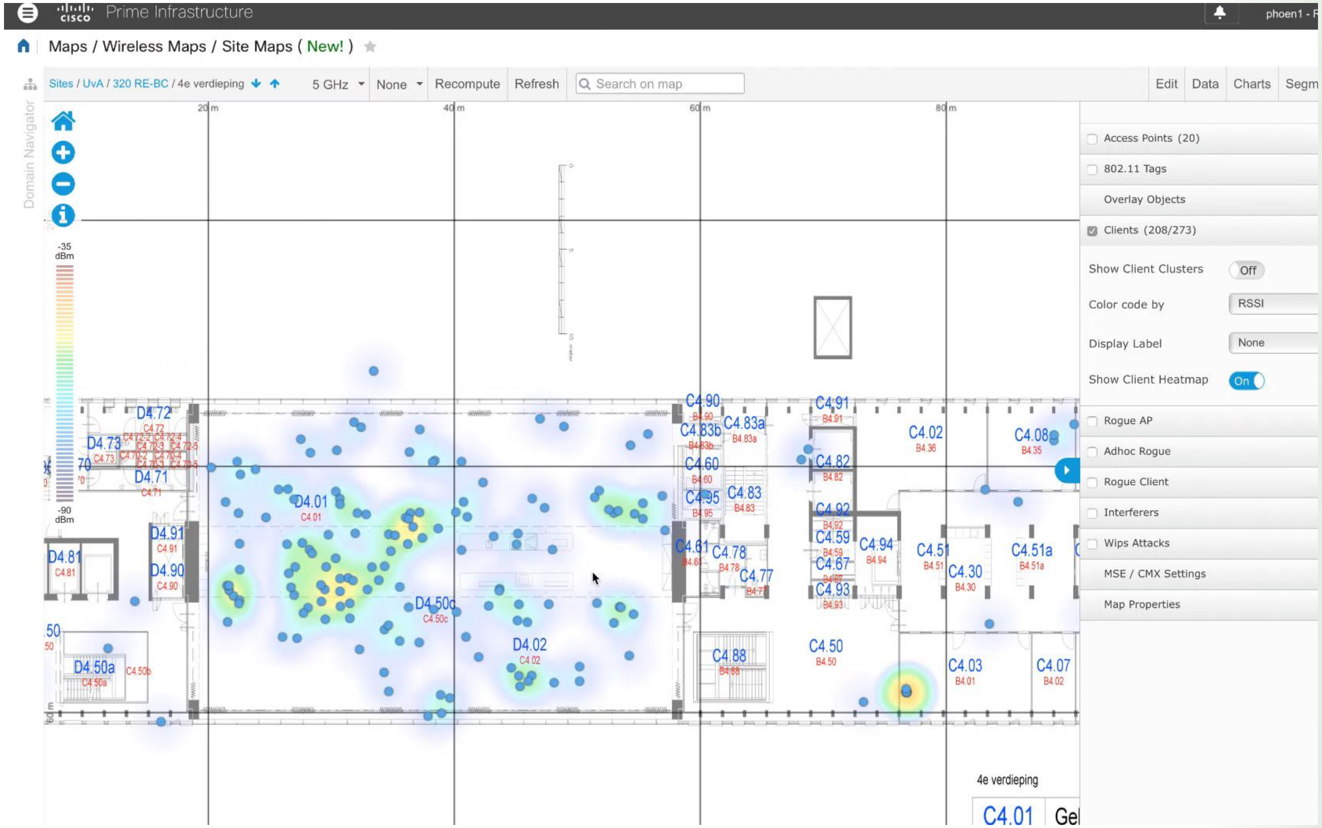
WiFi Data use: monitoring



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WiFi Data use: communication

https://uva.mapiq.net/

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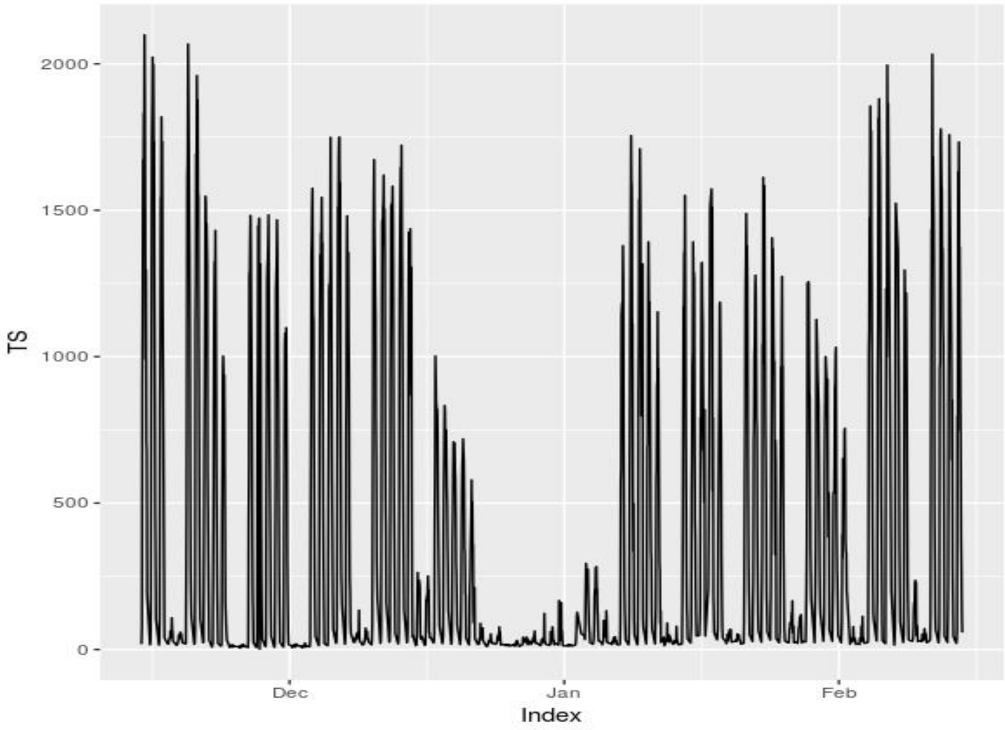
WiFi data use: predicting occupancy

How many connections per hour tomorrow?



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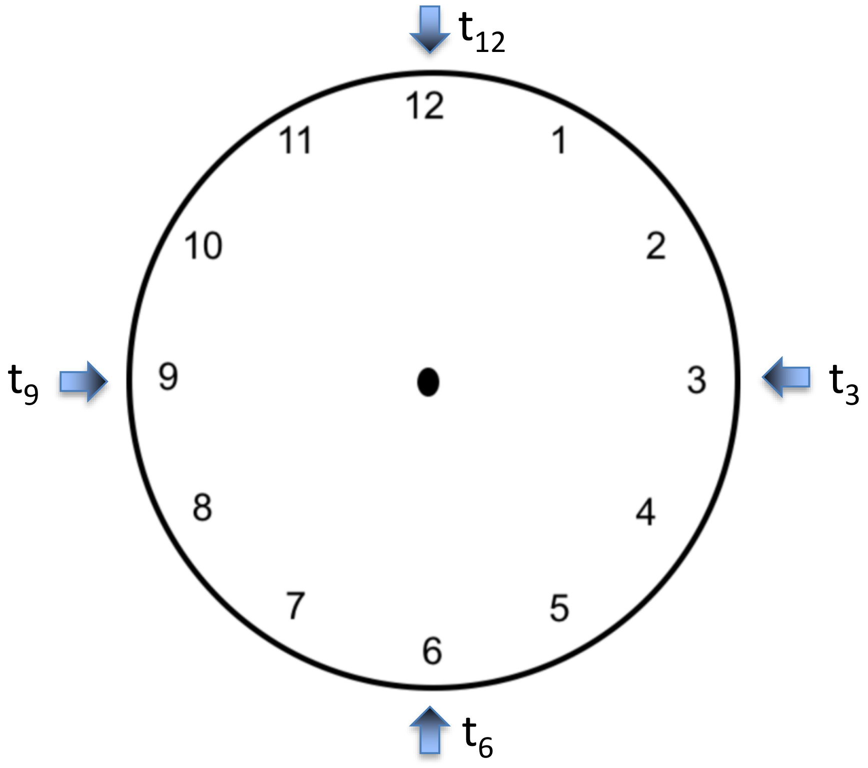
WiFi data use: no history is available

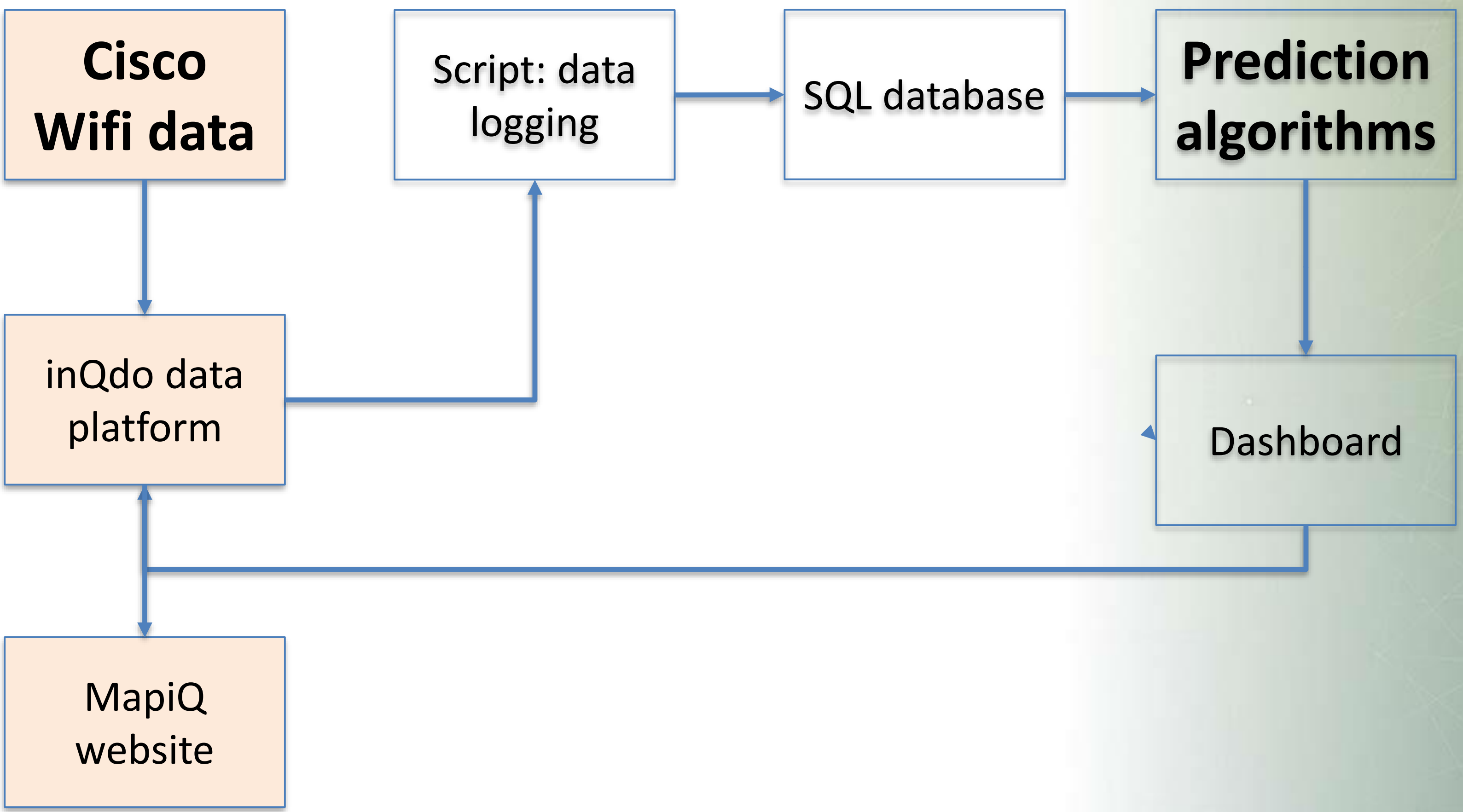
Project involves collection of data over a sufficient long time period



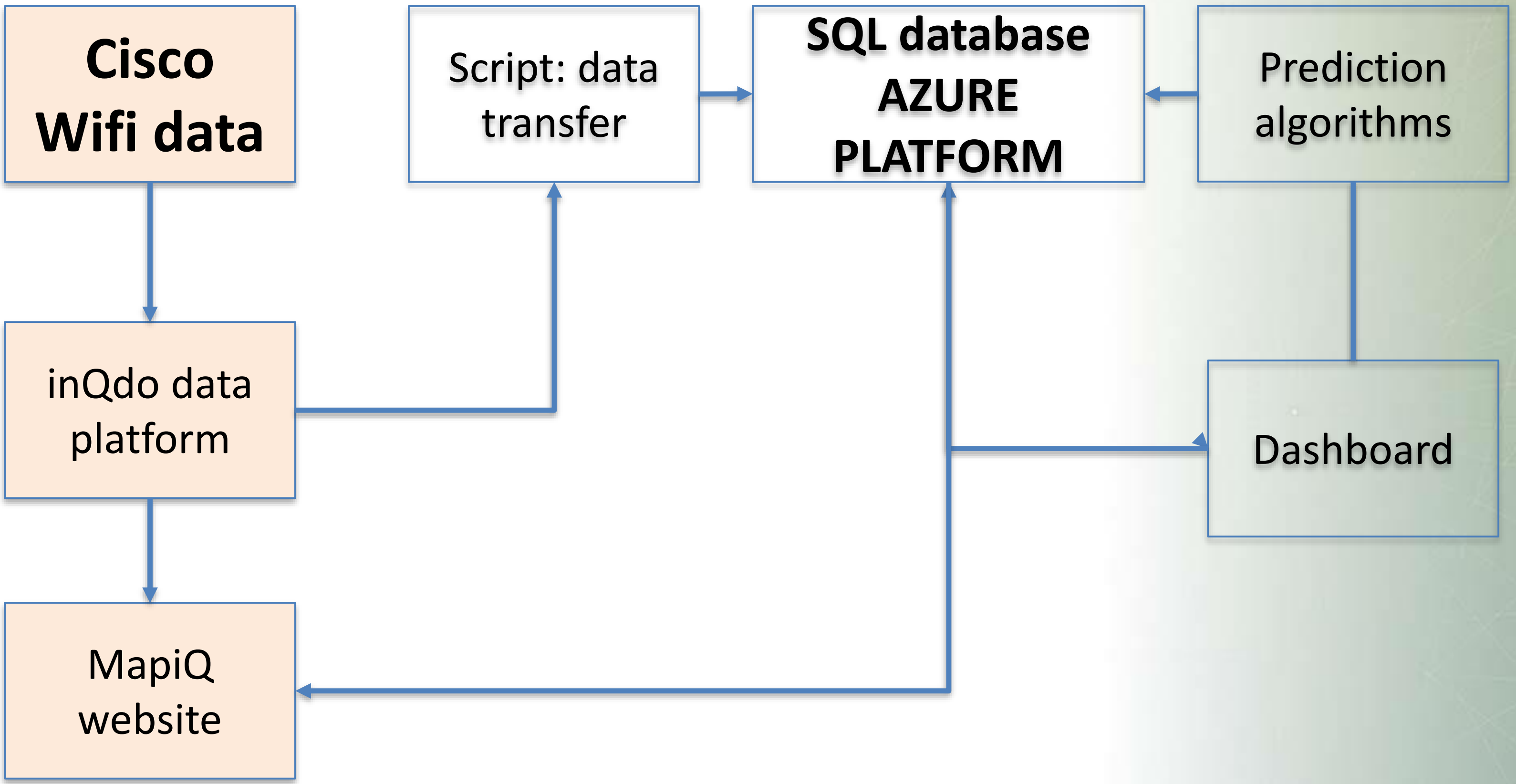
$$n_h = ¼ \, (t_{12}+t_3+t_6+t_9)$$

h	n_h
15-11-2018 06:00	16
15-11-2018 07:00	21
15-11-2018 08:00	70
15-11-2018 09:00	627
15-11-2018 10:00	1094
15-11-2018 11:00	1753
15-11-2018 12:00	1845
15-11-2018 13:00	2023
15-11-2018 14:00	1897
15-11-2018 15:00	1998
15-11-2018 16:00	1739
15-11-2018 17:00	1733
15-11-2018 18:00	1231
15-11-2018 19:00	949
15-11-2018 20:00	484
15-11-2018 21:00	313
15-11-2018 22:00	104

WiFi data use project: occupancy prediction

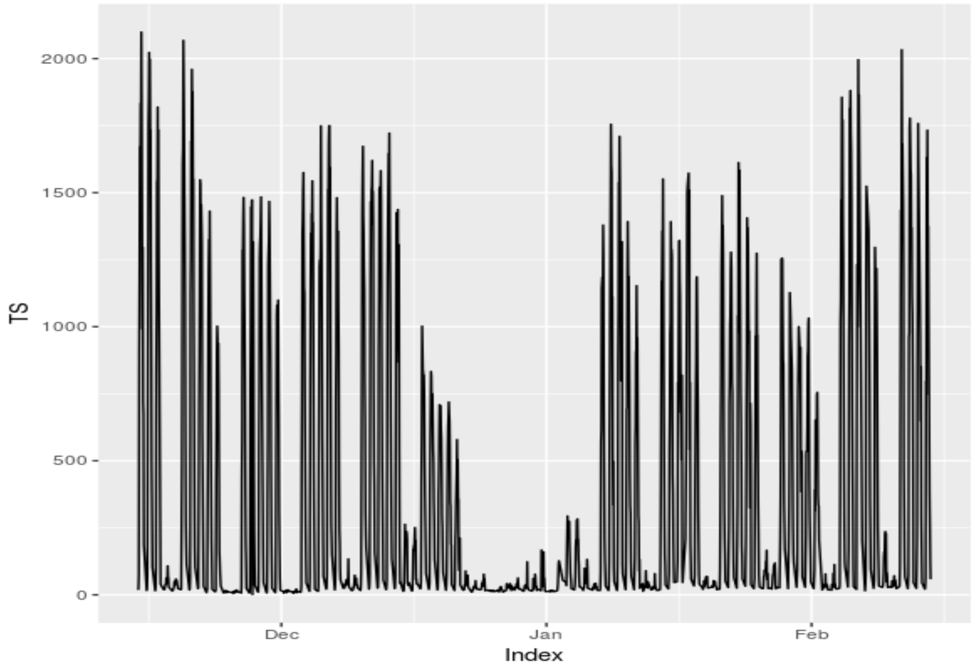


WiFi data use project: cloud version

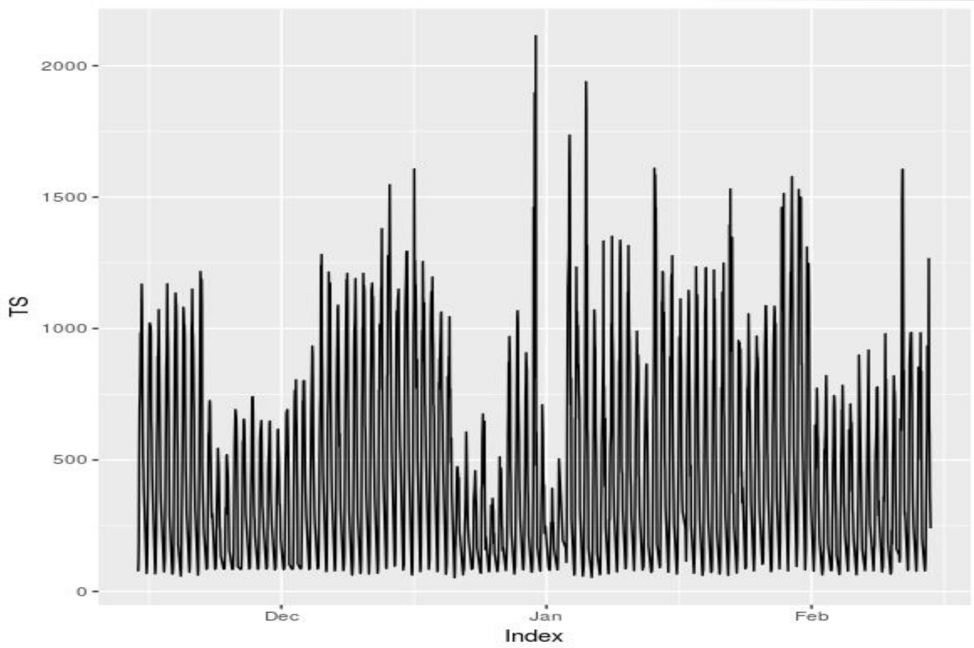


Use cases: UB en REC

Time series



REC



UB

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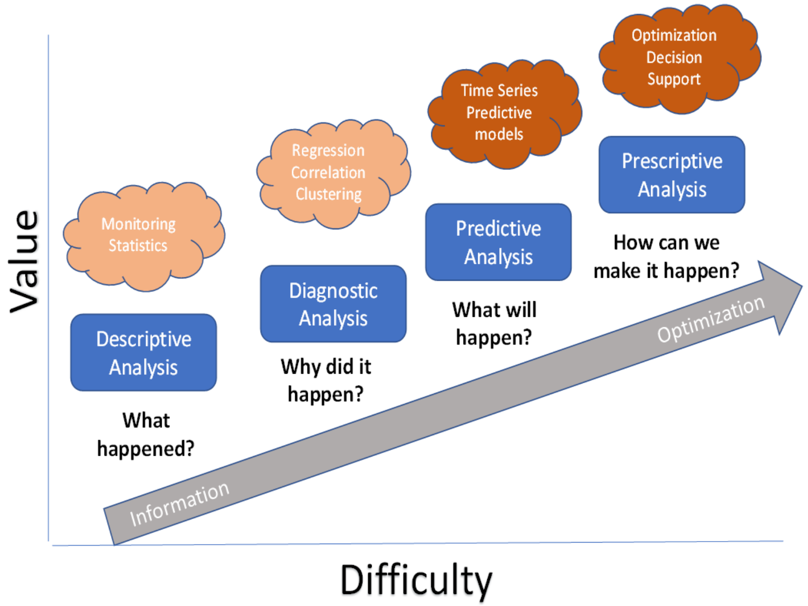
Mathematics 4 predicting occupancy

Linear regression

Neural network

Time series modelling



Linear regression

$Y = \alpha + \beta X + \varepsilon$

Y	regressor	(# WiFi connections per hour)
X	explainable variables	(?)
α	constant	
ε	error	

Traditional X values:

building schedules

special events

etc

Linear regression

$Y = \alpha + \beta X + \varepsilon$

Y	regressor	(# WiFi connections per hour)
X	explainable variables	(?)
α	constant	
ε	error	

<u>We used base line explainable variables:</u>

holiday	(yes/no)
day of the week	(Monday, …, Sunday)
hour of the day	(0,1,2,…,23)

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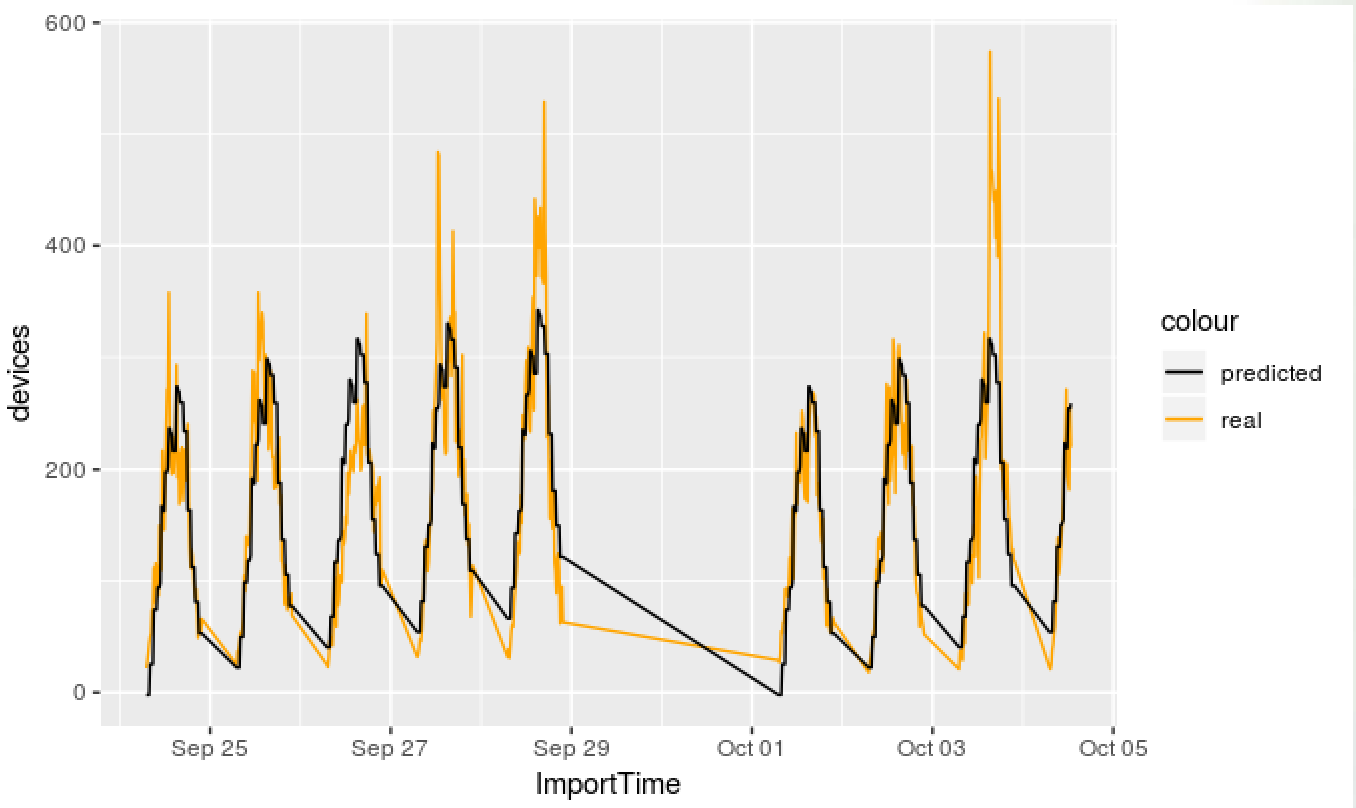
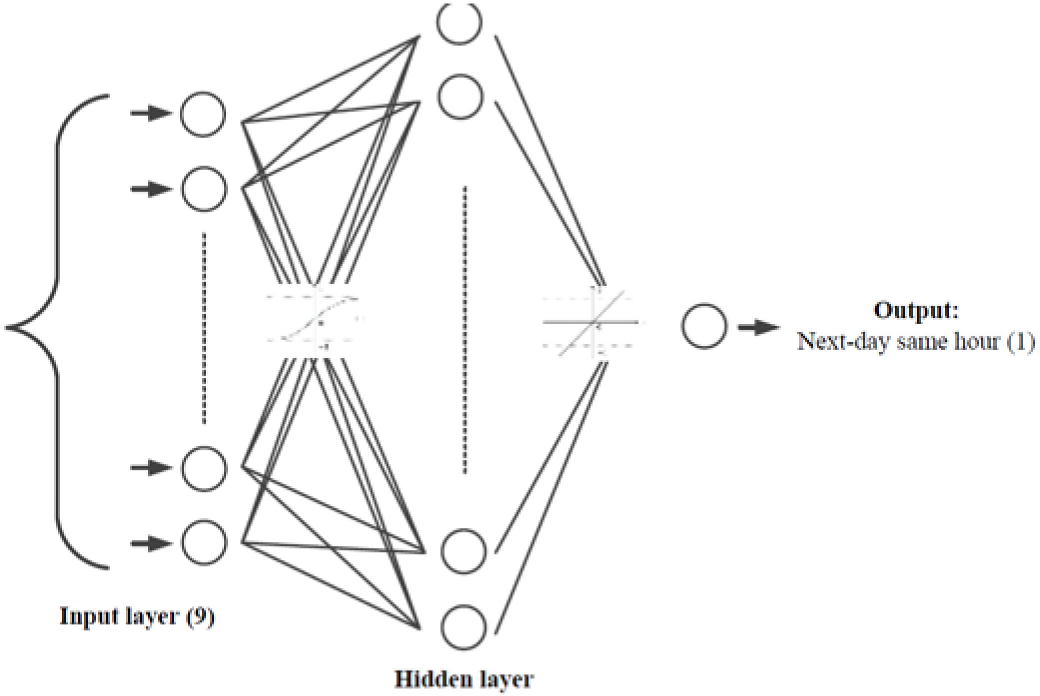
Results linear regression (REC)



Neural network non linear relation input and output



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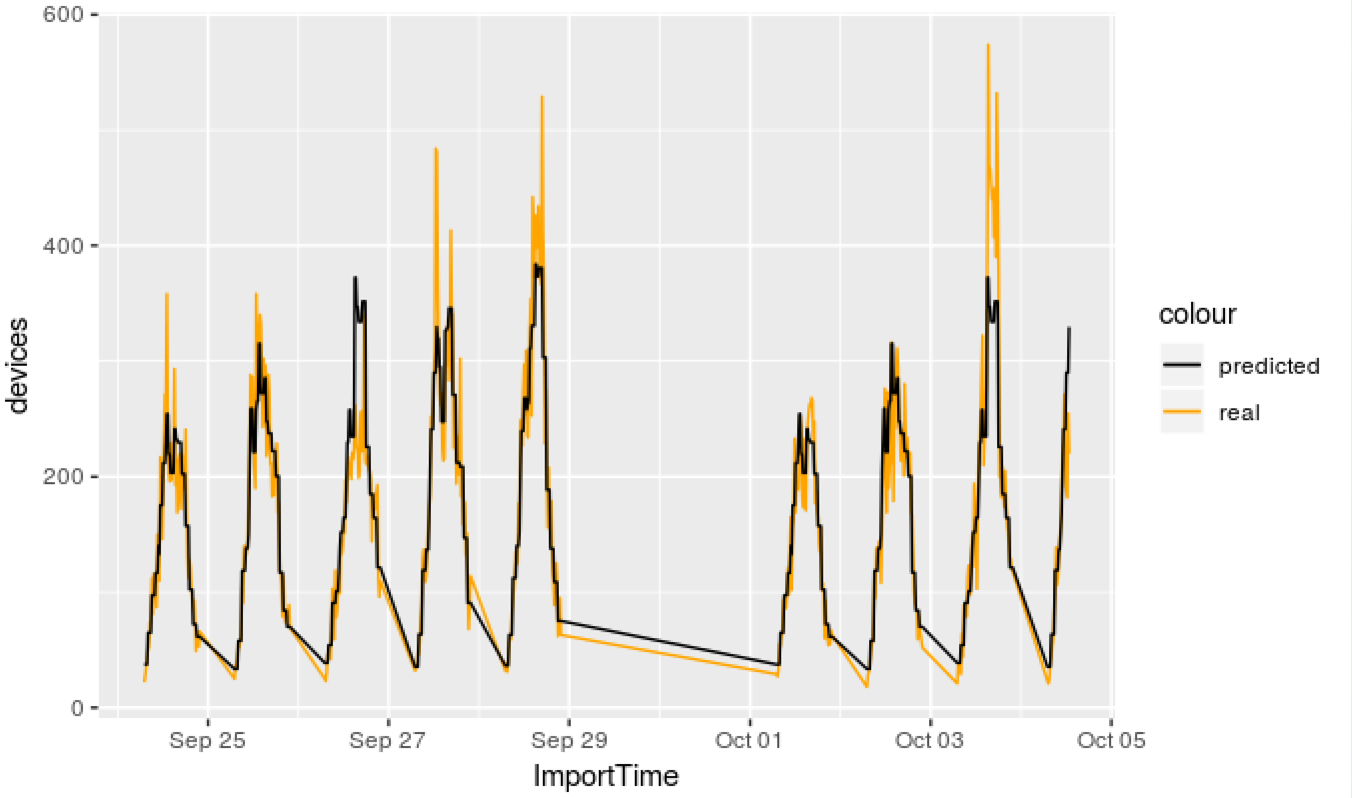
Results recurrent neural network (REC)



Time series modelling

Linear regression $Y = \alpha + \beta X + \varepsilon$

R-Sarima $Y_t = \alpha + \beta X_t + \eta_t$

with

$$\eta_t = \frac{\Theta_Q(LS)\Theta_q(L)}{\Phi_P(LS)\psi_p(L)\Delta_S{}^D\Delta^d}\,\varepsilon_t$$

Models seasonality, regularity patterns and white noise

L Lag (how far back do we need to look)

S Seasonality

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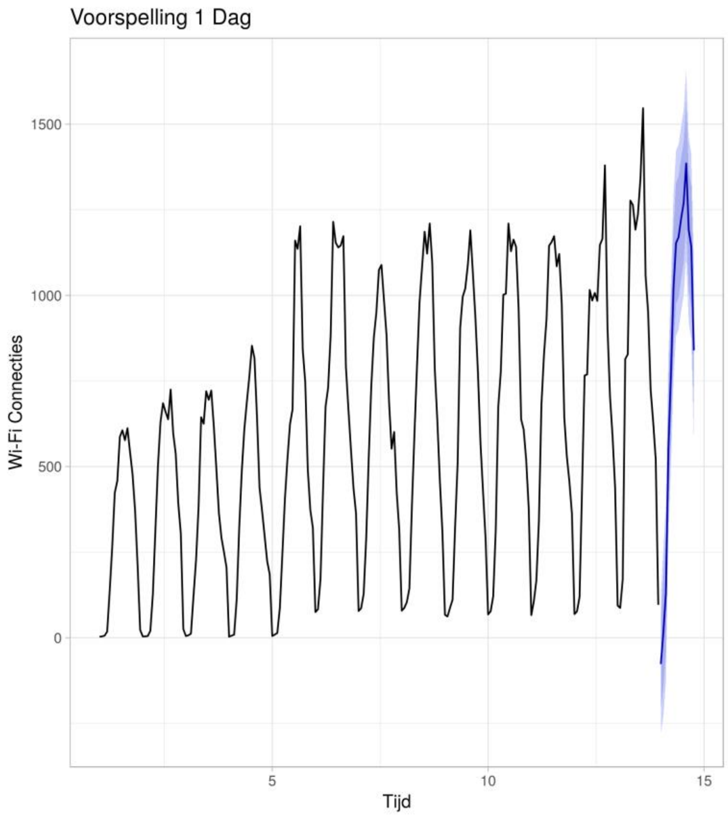
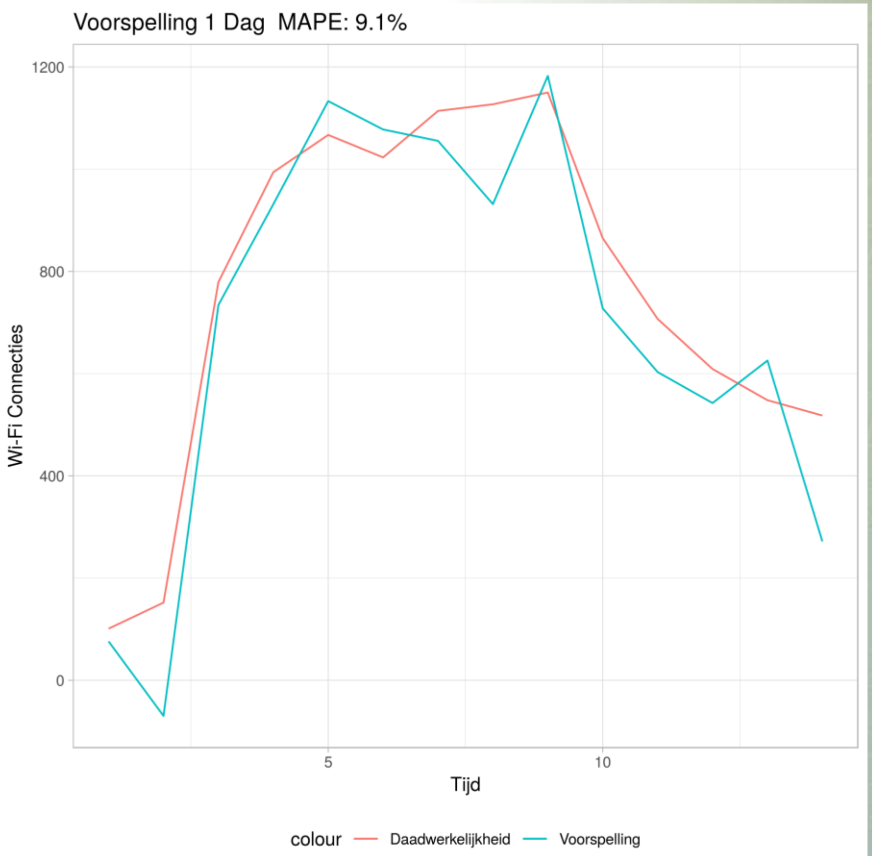
Results (REC)





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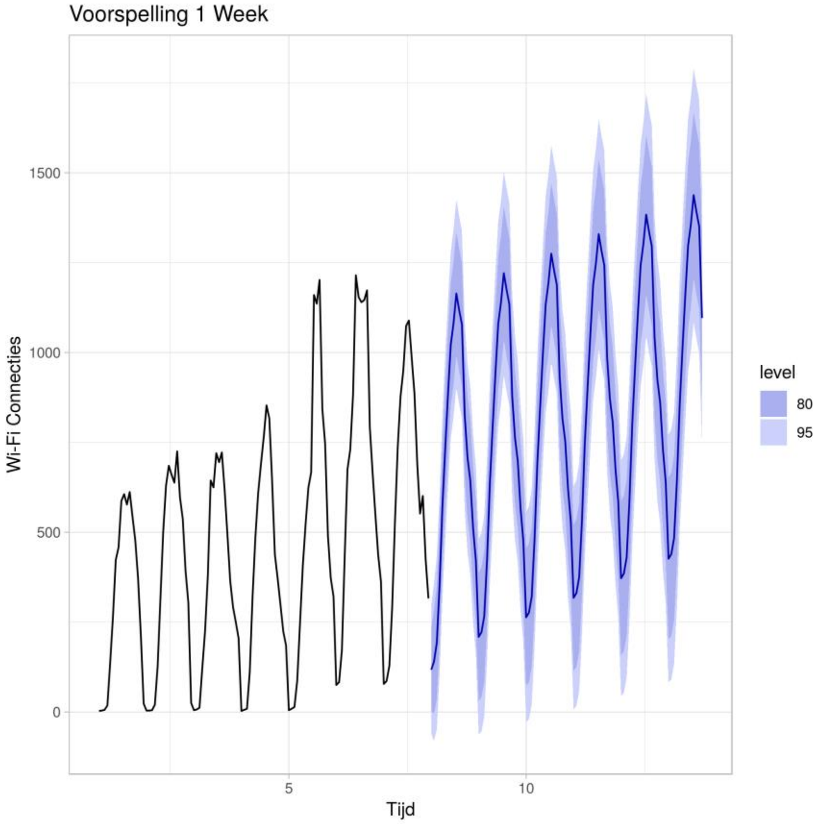
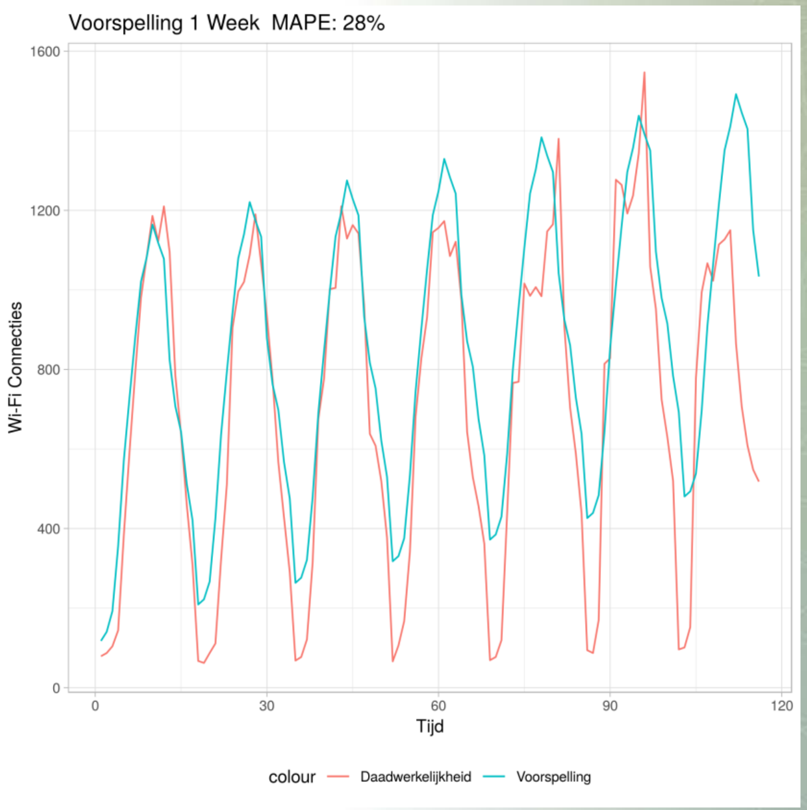
Results





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Rolling window time series approach

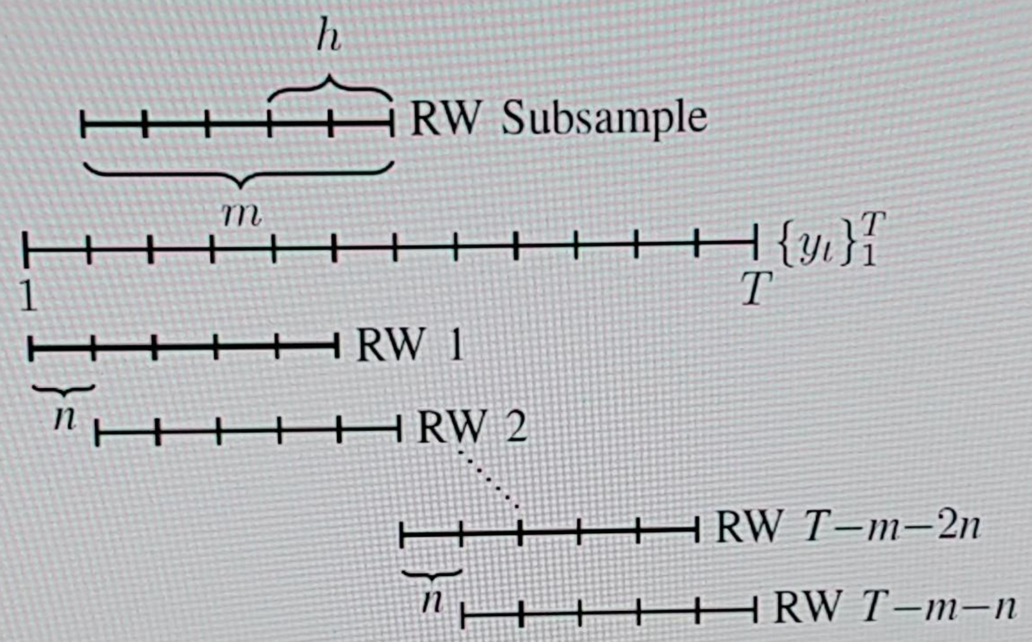

Fig. 2. Rolling Window Forecast Partitions

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Conclusion

Data logging is important

Stable data connections real time monitoring systems to data platforms are needed

Simple models don't work (if you have one data source)

Use better models (CWI)

Use extra data sources

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Use of modelling 1: Smart (HVAC) systems

REAL TIME connection to HVAC systems

- Shut down airco in under-used areas
- Decrease heat in busy areas
- ….

PREDICTED values for slow responding systems

USE of modelling: smart communication

Real time communication (current busy areas)

Forward communication (tomorrow is expected to be busy)

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USE of modelling: Smart service planning

Planning of cleaning services

Planning of maintenance

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TRANSFER of METHODOLOGY

Aggregation level: room, are, floor, building

TRANSFER OF METHODOLOGY

Aggregation level: room, are, floor, building

SENSOR TECHNIQUES

TRANSFER OF METHODOLOGY

Aggregation level: room, are, floor, building

SENSOR TECHNIQUES

OTHER OCCUPANCY modelling:

- bikes in the street,
- cars in carparks,
- ….

WHY CWI?

INTELLIGENT

NEW

MODELLING

SYSTEMS

STATE OF THE ART

COMPLEX

NEXT GENERATION

SMART

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Tot ziens!