



Forecasting without big data

a.k.a. how we stopped worrying and started loving small data

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- Small data requires big motivation
- You don't have to make something complex for it to be meaningful for the business
- Transparency towards users matters!

Background

About Ahold Delhaize

- 6,769 stores worldwide
- 372,000 associates
- 50 million customers/week



About Gall & Gall

- Dutch liquor store chain
- Founded in 1884
- 612 physical stores in The Netherlands
- Assortment of around 3500 products
- Growing e-commerce platform Gall.nl
- Around 60,000 daily visitors at Gall.nl
- Also available on bol.com & ah.nl



Using data at gall.nl: current priorities

- Continuous A/B-testing, from content pages to the check-out process
- Optimizing ROI of marketing channels through marketing mix models and attribution models
- Personalized offers to our customers through segmentation models and product recommendations
- Online sales forecasting for best customer experience

Motivation: why we need to forecast sales

Best customer experience



“Order before 10pm and get next day delivery”

Operational efficiency



- Order pickers
- Capacity delivery partners

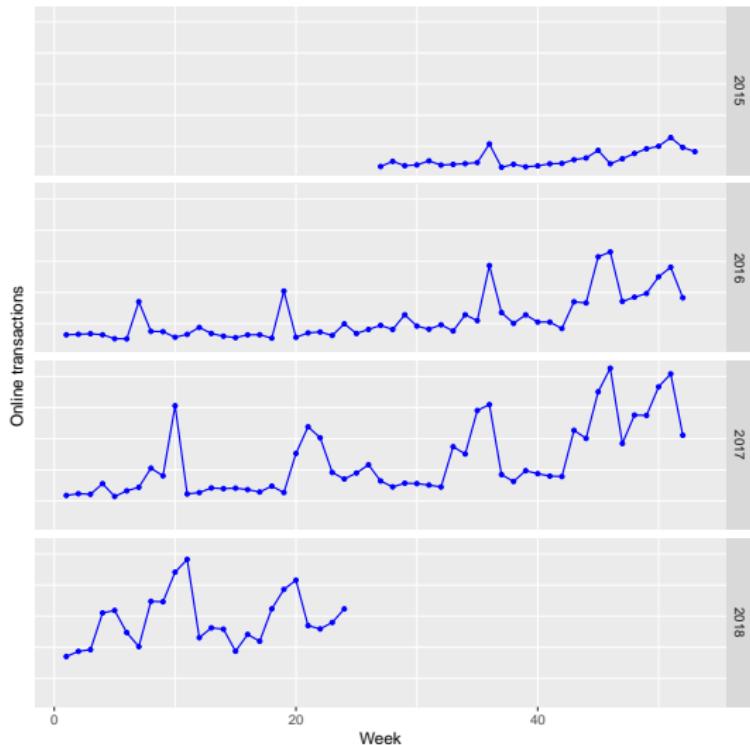
Improve current forecast of weekly online transactions

- Model performance measured by Mean Absolute Percentage Error (MAPE): $100 \times \text{average} \left(\left| \frac{y_t - \hat{y}_t}{y_t} \right| \right)$
- Current method is $\approx 12\%$
- Any new model is to be transparent and interpretable to the stakeholders

Data & Challenges

Weekly transactions

Time series of weekly online total transactions from 2015 to 2018



Increased promotions and marketing efforts since 2017

2015
2016
2017
2018



Our approach

Need for transparency

- Introducing new methods disrupts current ways of working
- Important to be mindful of users needs



ARIMA models

ARIMA: Auto-Regressive, Integrated, Moving Average

- Auto-regressive process (AR): series current values depend on its own previous values
- Integrated process: differencing of the time series to obtain stationarity
- Moving average process (MA): current deviation from the mean depends on previous deviations
- Perceived as basic yet powerful and interpretable

$$\hat{y}_t = \underbrace{\mu + \phi_1 y_{t-1} + \dots + \phi_p y_{t-p}}_{\text{AR terms lagged values}} + \underbrace{\theta_1 e_{t-1} + \dots + \theta_p e_{t-p}}_{\text{MA terms lagged errors}}$$

ARIMA as THE popular method

- Make predictions based on past observations at different points in time, for example, previous week
- Model trend, for instance, we expect the online transactions to grow steadily
- We also expect seasonality to play a role:
 - seasons and yearly events should have same patterns
 - promotions are also occurring in cycles (sometimes)

Available data



Sales
data



Marketing
campaigns



Offline
marketing



Digital
marketing

- 4 years of sales history
- 4 years of marketing campaigns
- 2 years offline marketing
- 2 years digital marketing

Available data



Sales data



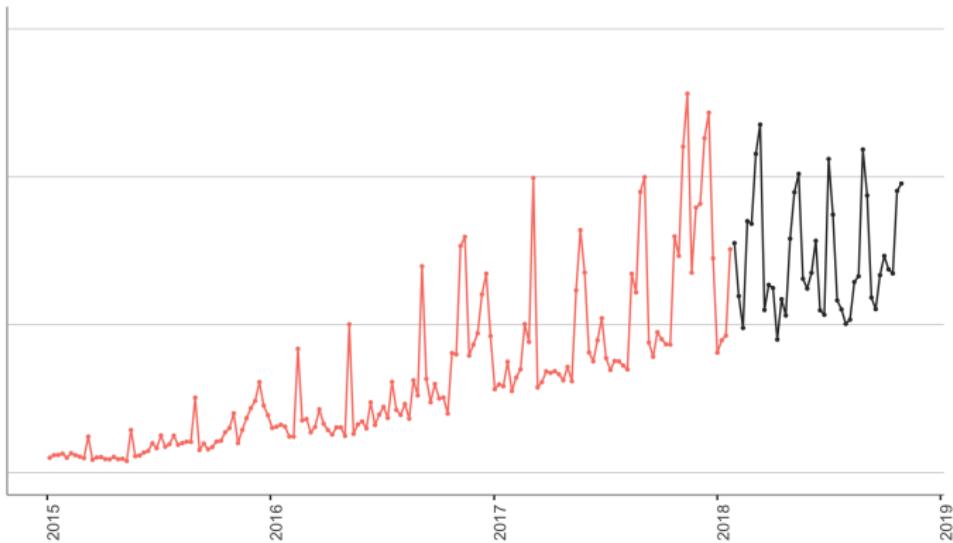
Marketing campaigns



Offline marketing

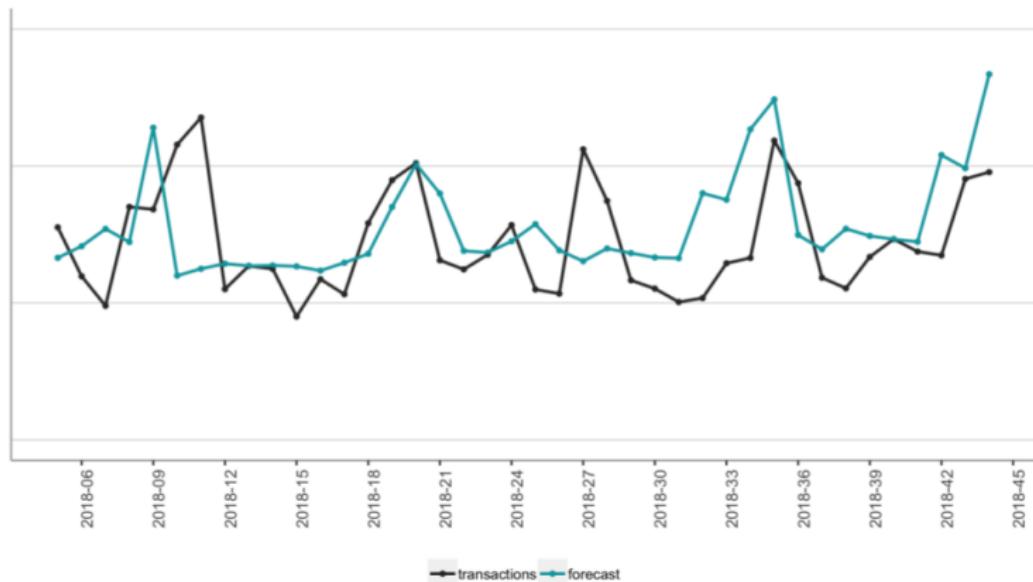


Digital marketing



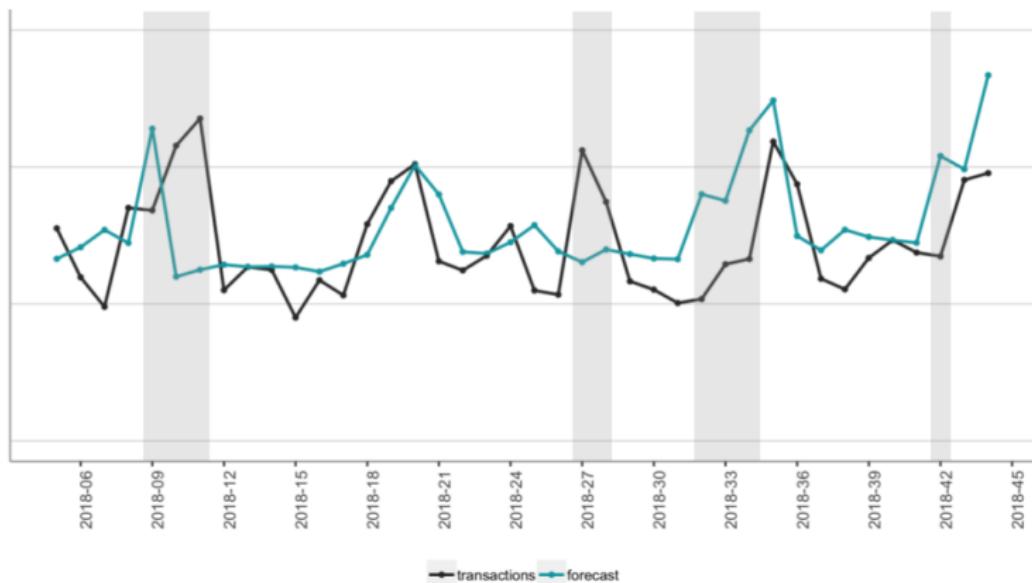
Understanding the data

- Peaks caused by marketing campaigns are handled as seasonal effects.
- The predicted growth trend is too high.



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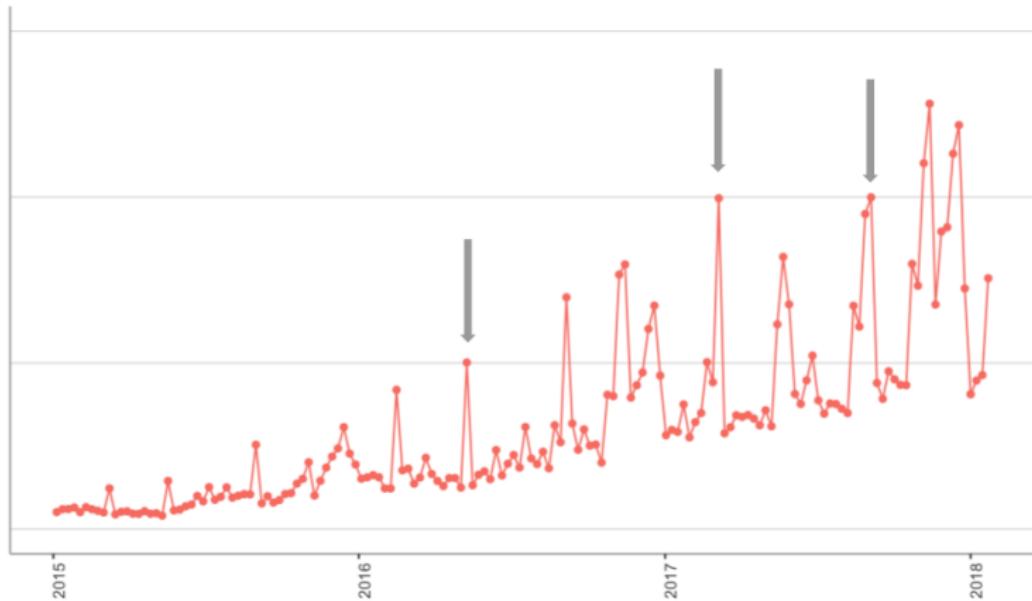
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- Which peaks are caused by marketing campaigns?
- On which level can we find the real growth trend?



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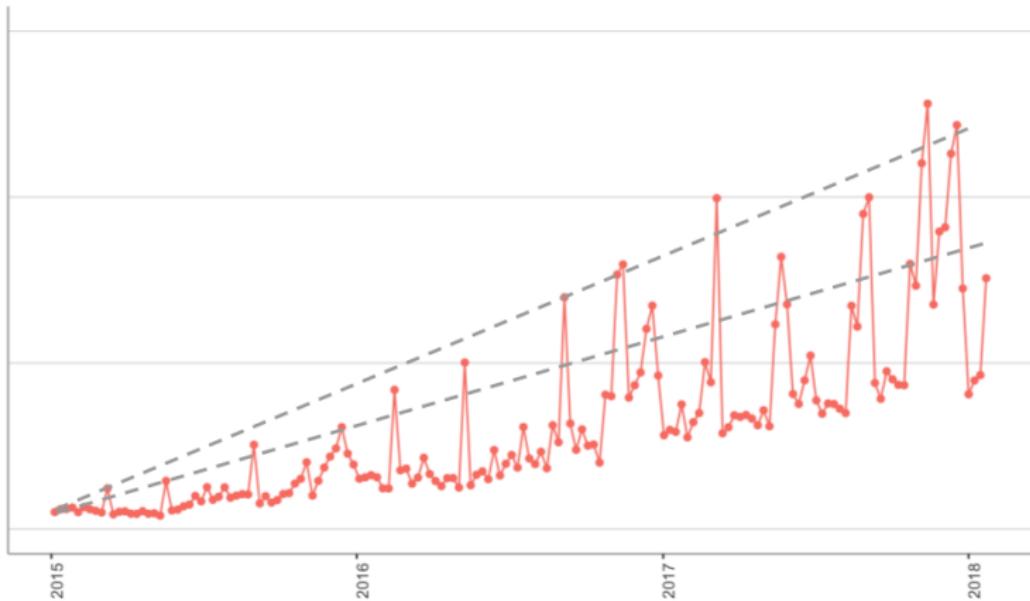
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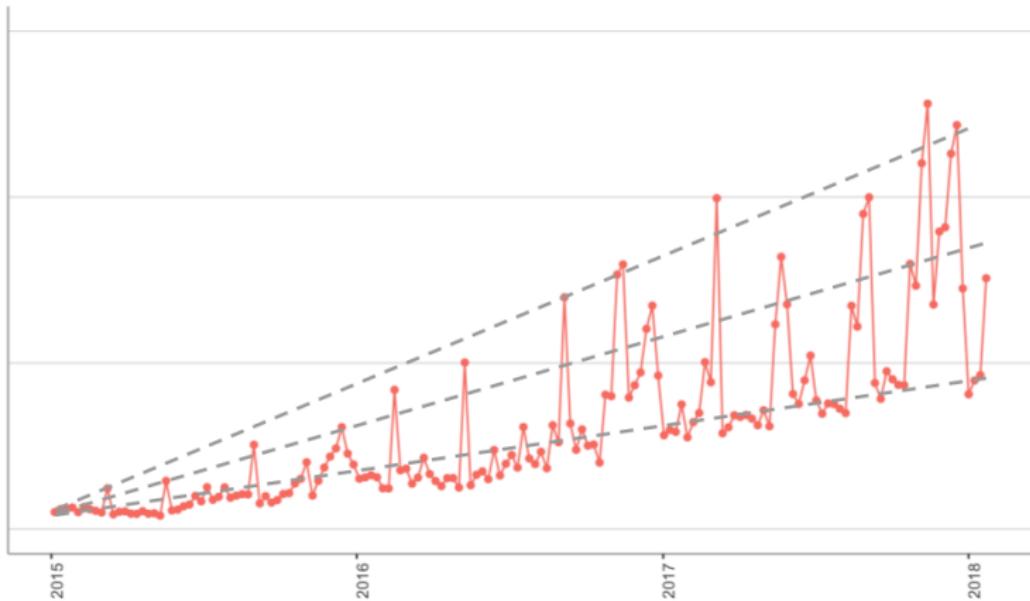
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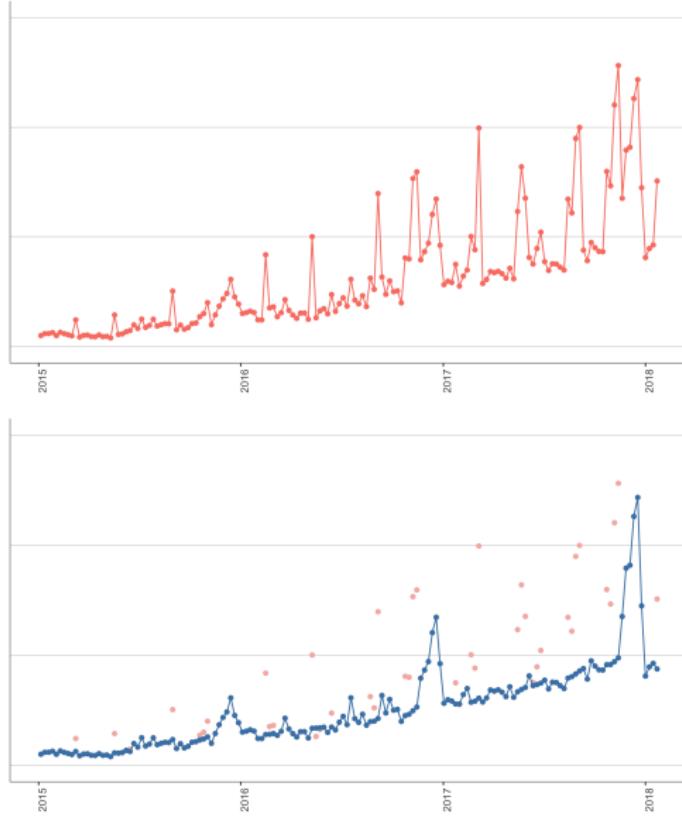


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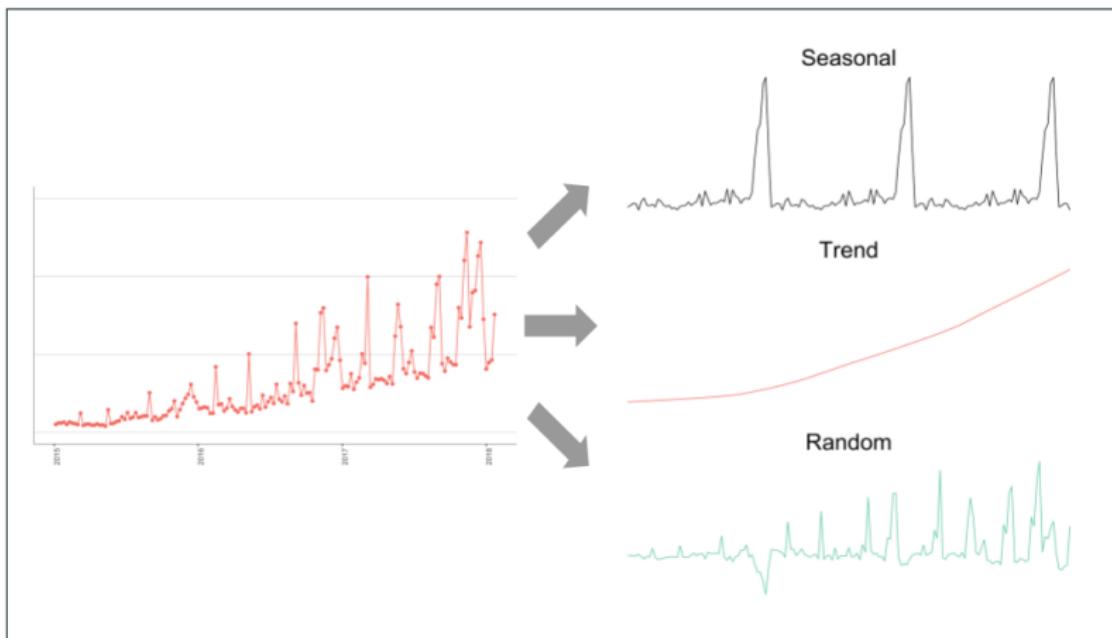
Define the baseline and use ARIMA to forecast



1. Non-seasonal peaks are corrected by a moving average
2. Non-seasonal peaks will be modeled separately
3. Growth trend has defined as the lowest baseline in our data

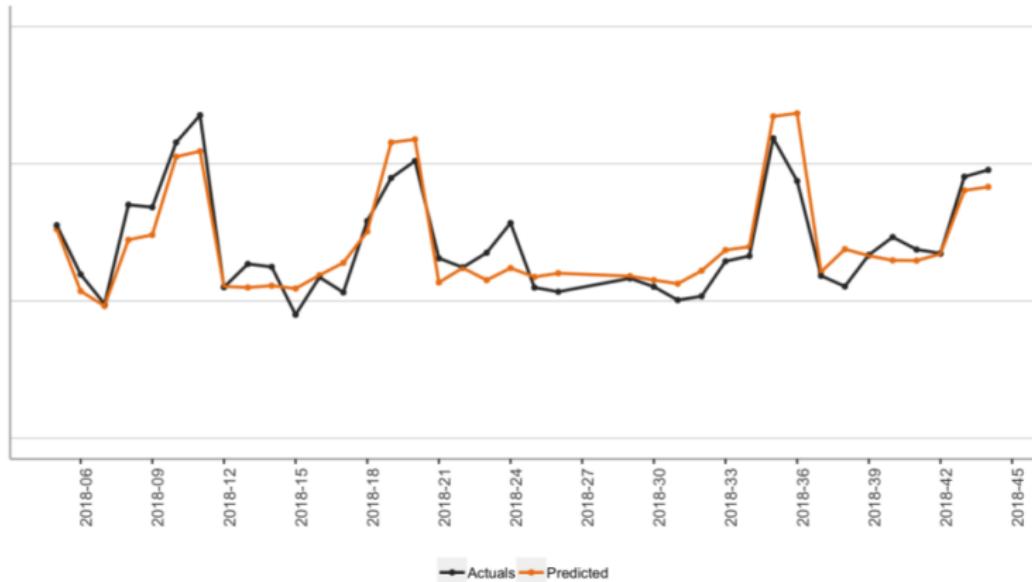
Now we can get a better understanding of our data

Use ARIMA - in combination with linear regression -to make a weekly order prediction.



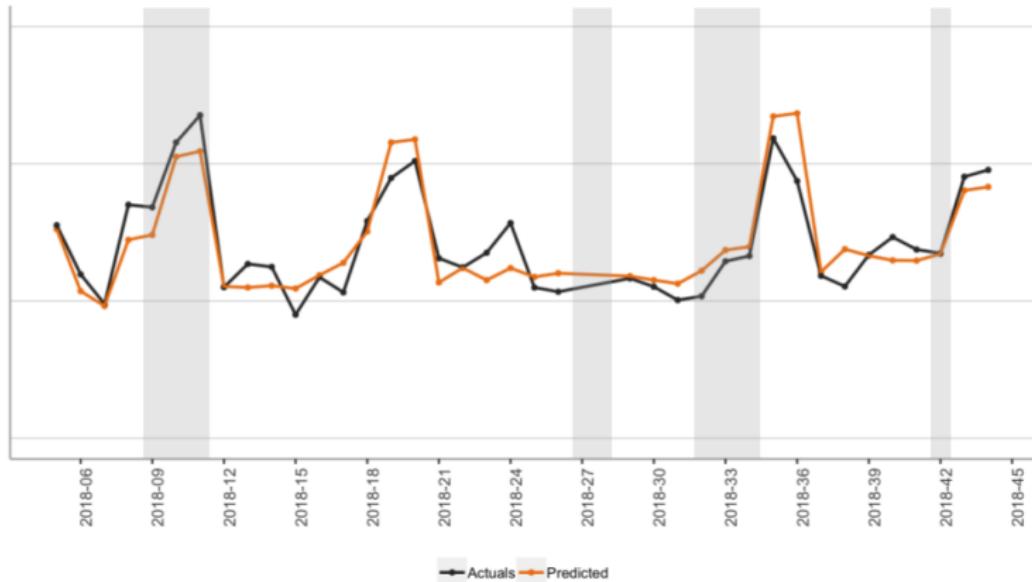
New forecast model shows an improved accuracy

- New model performs better: improved predictions of growth trend and marketing campaigns effects
- Mean Absolute Percentage Error (MAPE) went from 12.7% to 9.4%



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Benefits for the business

- MAPE drops from 12.7% to 9.4%
- 95% of the predictions are within an error rate of 20%
- Expected supply chain cost reduction of at least 4%

Conclusion

Future work

Keep on improving the new model!

- Understand the effects of promotions and marketing on online sales
- Explore how model performance can be balanced out with interpretability
- Expand to offline sales forecasts and to a product-level sales prediction

Take home messages

How to start forecasting without big(ger) data?

- Don't wait for all data but just start with the data that you have!
- Ask stakeholders for advice
- Try to look for a model that will help you with interpretability, instead of a black box as a first model,
- Try to calculate the business values of the predictions, for example in cost benefits or revenue increase.

Thank you!



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APR

Friday, April 12, 2019

Fair and transparent machine learning

Hosted by [Hinda Haned](#)From [Innovation Center for Artificial Intelligence Meetup](#)Public group 

Details

15:00-15:05 - Welcome

15:05-15:15 - Introduction - Why Ahold Delhaize cares about fair and transparent AI?, Jan Ernst de Groot (Ahold Delhaize)

15:15-15:45 - Opening the black box of user profiles in content-based recommender systems, David Graus (FD mediagroep)

15:45-16:15 - Impact of transparency in automated genre classification, Aysenur Bilgin (CWI)

16:15-16:45 - Fair and transparent machine learning at Ahold Delhaize: challenges and research directions, Hinda Haned & Bart Voorn

Appendix

Tools

- R forecast package
- Hyndman- Khandakar algorithm for automatic time series forecasting