PREDICTING PURCHASE DAY IN B2B: FROM STATISTICAL METHODS TOWARDS LSTM NEURAL NETWORKS

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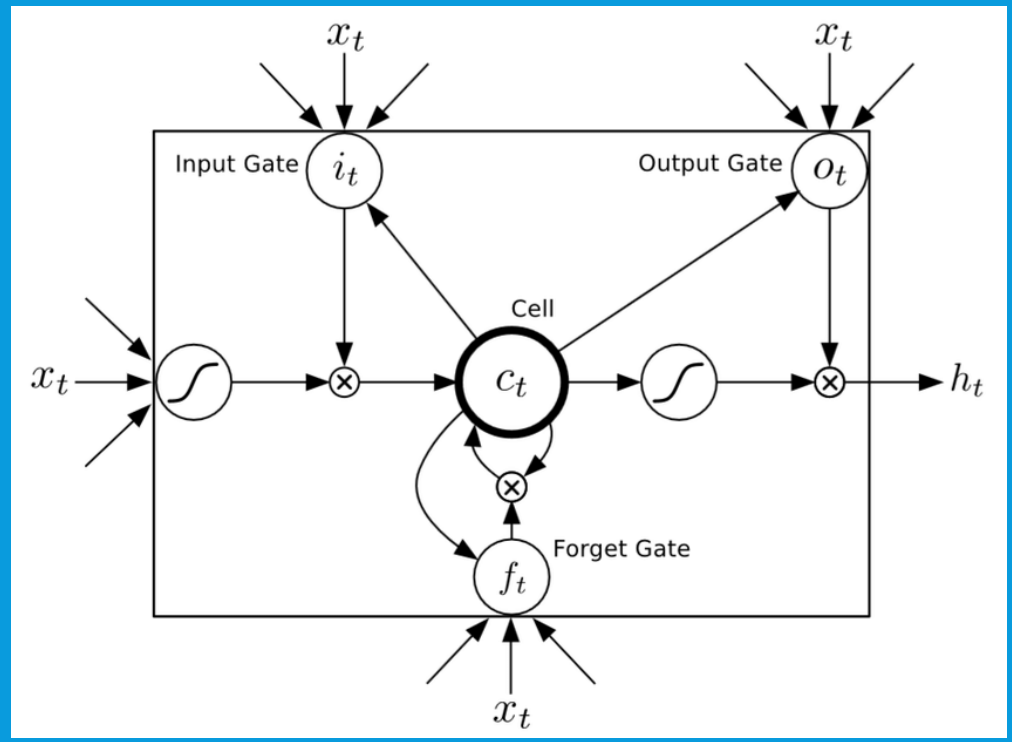
THE PROBLEM

- For businesses that are producing and/or selling products to customers production planning and product procurement is a very important task
- Predicting when will a customer make an order is a valuable information that can help the vendor in planning production but can also be used in direct advertising
- The goal was to try to predict if a specific customer will order a certain product in the following seven days
- The idea was that the prediction process would be executed each Sunday so that the vendor company would be able to perform some action during the following week based on the results
- The research was focused on B2B scenario where purchases are mainly done in bulk, in longer intervals, when it is needed and not impulsively, decisions are made rationally and by boards, not individuals

APPROACH

- Long Short-Term Memory (LSTM) Neural Networks have the ability to store long-term dependencies in data
- Each cell is essentially a memory block with three multiplicative gates: input gate, forget gate and output gate
- One LSTM neural network was trained for each customer-item pair
- Results were compared to a previous research focused on solving the same problem using statistical methods (ARIMA – Autoregressive Integrated Moving Model)



APPROACH

- Training and testing data consists of anonymized purchase records from a medical device manufacturer containing over three million purchases
- Due to the irregular nature of the time series, data was transformed to create a time series that consists of the number of days that passed since the last purchase of the same product by the same customer
- The input to the network consisted of 3 time steps, which meant that only customer-product pairs with at least 4 purchases could be used, which is why the 2+ purchases dataset was eliminated
- In order to make results comparable to ARIMA research, the output of LSTM neural networks was discretized to two classes: purchase expected in the following 7 days and purchase is not expected in the following 7 days

RESULTS

Comparison of next purchase prediction with LSTM and ARIMA

Dataset	LSTM		ARIMA	
	Precision	Recall	Precision	Recall
2+ purchases	-	-	20.44%	19.27%
6+ purchases	12.76%	43.27%	26.90%	12.87%
11+ purchases	15.89%	41.95%	38.88%	8.22%
16+ purchases	20.22%	46.79%	48.95%	5.70%
20+ purchases	23.49%	48.14%	57.77%	4.15%
50+ purchases	43.97%	69.92%	-	-
100+ purchases	62.20%	92.94%	-	-

LSTM: comparison for different predicted outcomes

Dataset	Predicted purchase		Predicted no purchase	
	Precision	Recall	Precision	Recall
6+ purchases	12.76%	43.27%	96.82%	85.37%
11+ purchases	15.89%	41.95%	94.93%	82.66%
16+ purchases	20.22%	46.79%	93.21%	79.82%
20+ purchases	23.49%	48.14%	91.37%	77.79%
50+ purchases	43.97%	69.92%	77.40%	53.62%
100+ purchases	62.20%	92.94%	70.00%	22.58%

CONCLUSION AND FURTHER WORK

- ARIMA has better precision, while LSTM neural networks has better recall on each subset dataset of the original data
- Depending on the agenda one or the other approach may be more suited
- For LSTM neural network, both precision and recall increased with each dataset containing a higher number of purchases per customer-product pair
- Customers tend to make group orders, i.e. order multiple products at one time, with each order consisting of some, but not all products
- Time series consisting of all purchases for a customer, regardless of the ordered product, might be more predictable and that is a research direction we will pursue in the future

THANK YOU FOR YOUR ATTENTION.