

Deep Learning-based Business Process Prediction

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Business Process

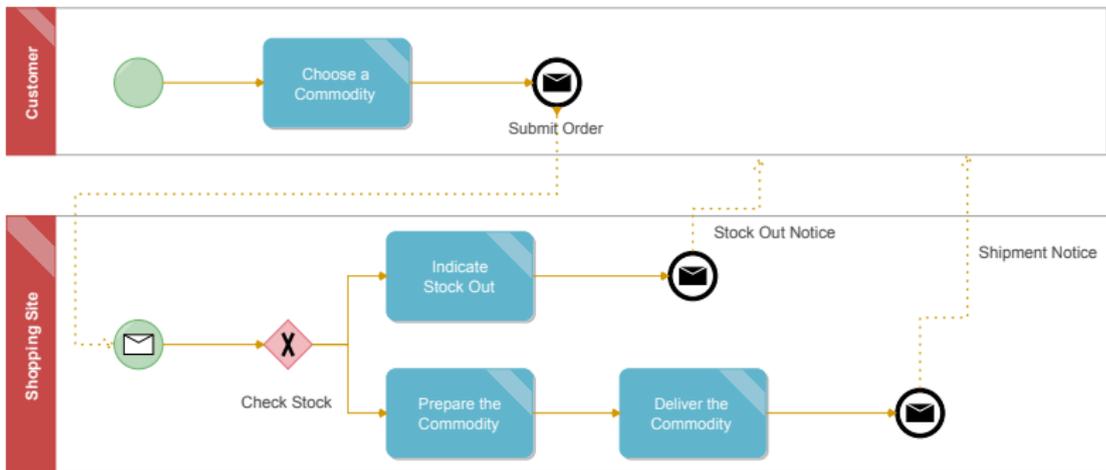


Figure 1: A part of business process models for online shopping.

Event Log

order number	activity	timestamp	user	product	quantity
9901	register order	22-1-2014@09.15	Sara Jones	iPhone5S	1
9902	register order	22-1-2014@09.18	Sara Jones	iPhone5S	2
9903	register order	22-1-2014@09.27	Sara Jones	iPhone4S	1
9901	check stock	22-1-2014@09.49	Pete Scott	iPhone5S	1
9901	ship order	22-1-2014@10.11	Sue Fox	iPhone5S	1
9903	check stock	22-1-2014@10.34	Pete Scott	iPhone4S	1
9901	handle payment	22-1-2014@10.41	Carol Hope	iPhone5S	1
9902	check stock	22-1-2014@10.57	Pete Scott	iPhone5S	2
9902	cancel order	22-1-2014@11.08	Carol Hope	iPhone5S	2
...

Figure 2: Toy example for an online shopping system.

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Predictive Process Analytics

Predictive Process Analytics (PPA), as a subfield of process mining,

- focus on analysing historical data to predict future state of a business process (Maggi et al., 2014)
- forecast multiple predictions, such as **next activity** (Teinemaa et al., 2019), **trace outcome** (Maggi et al., 2014), **remaining time** (Verenich et al., 2019), etc.
- apply approaches from both process science and data science

“Nowadays, deep learning has been widely applied to the predictive monitoring of business processes.” (Rama-Maneiro et al., 2021)

DL based PPA Frameworks

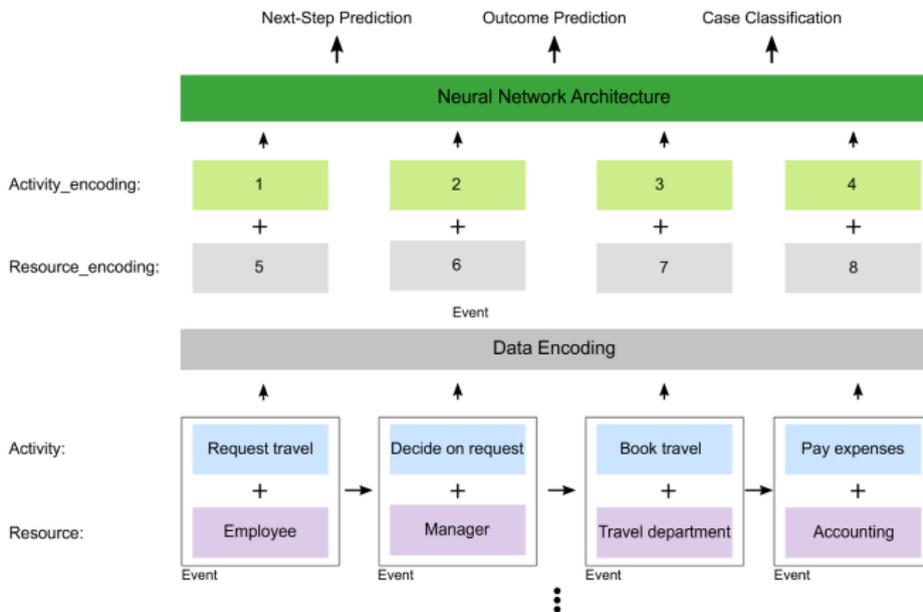


Figure 4: Deep learning based PPA framework (Neu et al., 2021).

DL Architectures

Two popular neural network architectures for handling sequential business process logs:

- **Long Short-Term Memory (LSTM)**: a special recurrent neural network (RNN) introduced by Evermann et al. (2017) from NLP and improved by Tax et al. (2017)
- **Transformer**: adapted from NLP (Bukhsh et al., 2021); Still a novel approach for PPA, but generally better than LSTM because of replacing RNN with attention layers

Encoding Methods

Two main encoding methods,

- **One-Hot**
- **Embedding**

only influence the final prediction performance in some extreme situations (Neu et al., 2021).

Event logs

A language usually have a fixed vocabulary group and the words in the dictionary would not change.

Comparing with languages, event logs have different characteristics:

- The number of unique activity are diverse in different dataset.
- The cases in event logs are limited .
- Event logs contain additional attributes.

The different event logs for the same DL architecture vary in performance. However, no research is concerned with analysing the effects of event logs for prediction performance.

My Research

Based on the above research gaps and limitations, the proposed research questions are:

***RQ1:** Which characteristics of an event log may impact on process prediction model performance?*

***RQ2:** How the event log characteristics (identified in RQ1) affect deep learning-based process prediction model performance?*

Current and Future

- Only next activity ->
Expanding to all predictions
- LSTM vs. Transformer ->
Comparing more DL Architectures
- DL Architecture Recommendation System

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Thanks!