ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ
UNIVERSITY OF PIRAEUS

ΤΜΗΜΑ ΨΗΦΙΑΚΩΝ ΣΥΣΤΗΜΑΤΩΝ

Π.Μ.Σ. ΤΕΧΝΗΤΗ ΝΟΗΜΟΣΥΝΗ

ΔΗΜΟΚΡΙΤΟΣ
DEMOKRITOS

ΙΝΣΤΙΤΟΥΤΟ ΠΛΗΡΟΦΟΡΙΚΗΣ ΚΑΙ ΤΗΛΕΠΙΚΟΙΝΩΝΙΩΝ

Προτεινόμενα Θέματα Διπλωματικής Εργασίας

Από

Ηλία Αλεβίζο

A. Neuro-symbolic complex event forecasting

Abstract:

In traditional machine learning, the goal is to "predict" the output of a function on previously unseen input data. The input data need not necessarily have a temporal dimension and the term "prediction" refers to the output of the learned function on a new data point. On the other hand, the task of forecasting is to predict the temporally future output of some function or the occurrence of an event. Time is thus a crucial component for forecasting. What makes forecasting particularly challenging is the fact that, from the (current) timepoint where a forecast is produced until the (future) timepoint for which we try to make a forecast, no data is available.

For this thesis, the candidate will have the opportunity to work with and/or develop a wide range of techniques (symbolic, statistical, machine learning) that can perform efficient event forecasting in real-time. Particular focus will be placed on combining deep learning and symbolic methods in order to develop a neuro-symbolic system for forecasting with the capacity to provide as its output forecasts that are not only accurate but also explainable and trustworthy. The developed system may be tested on a variety of application domains, from the analysis of biomedical data (epidemiological data, digital patients, evolution of patient trajectories) to the processing of moving objects trajectories and to the guidance of robotic swarms.

Bibliography:

Alevizos, E., Artikis, A. and Paliouras, G., 2022. Complex event forecasting with prediction suffix trees. The VLDB Journal, 31(1), pp.157-180.

Marra, G., Dumančić, S., Manhaeve, R. and De Raedt, L., 2024. From statistical relational to neurosymbolic artificial intelligence: A survey. Artificial Intelligence, p.104062.

Garza, A. and Mergenthaler-Canseco, M., 2023. TimeGPT-1. arXiv preprint arXiv:2310.03589.

B. **Unsupervised complex event forecasting**

Abstract:

In traditional machine learning, the goal is to “predict” the output of a function on previously unseen input data. The input data need not necessarily have a temporal dimension and the term "prediction" refers to the output of the learned function on a new data point. On the other hand, the task of forecasting is to predict the temporally future output of some function or the occurrence of an event. Time is thus a crucial component for forecasting. What makes forecasting particularly challenging is the fact that, from the (current) timepoint where a forecast is produced until the (future) timepoint for which we try to make a forecast, no data is available.

In particular, complex event forecasting assumes that we already have a pattern that we need to detect on event streams and that we need to then build a probabilistic model in order to forecasts occurrences of the pattern as well. For this thesis, the candidate will address the issue of unsupervised complex event forecasting, i.e., the situation where the pattern is unknown and the only available information concerns the labels of pattern occurrences. Another additional challenge is that current forecasting models are constructed based on “manually” provided features. The goal is to automate this process in order to discover the most important features through dimensionality reduction, feature extraction and feature selection techniques.

Bibliography:

Alevizos, E., Artikis, A. and Paliouras, G., 2022. Complex event forecasting with prediction suffix trees. The VLDB Journal, 31(1), pp.157-180.

Ghojogh, B., Samad, M.N., Mashhadi, S.A., Kapoor, T., Ali, W., Karray, F. and Crowley, M., 2019. Feature selection and feature extraction in pattern analysis: A literature review. *arXiv preprint arXiv:1905.02845*.

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