
Advances in AI/ML and Mathematics for Economics Modelling and Analysis
Progrès en matière d'IA/ML et de modélisation et d'analyse économiques
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AJIT DESAI, Bank of Canada

Machine Learning Framework for Pattern Recognition and Anomaly Detection in Payments Systems

High-value payment systems (HVPS) are a central piece of the financial infrastructure in a country. We propose an novel machine learning (ML) framework for real-time transaction monitoring in such systems. Our framework uses a layered approach. First, we train an ML model based on supervised learning to serve as a payments-classifier to predict the submission time of individual interbank payments. The correctly classified payments are then used in the second layer to study participants' usual payment patterns, while the misclassified payments are analyzed using an unsupervised learning model for the purpose of detecting anomalies. We test our set of models on the payments data from the Canadian HVPS and artificially manipulated transactions. Our results suggest that the layered approach lets us systematically decompose large datasets into usual and unusual payments. This, in turn, allows for transaction-level anomaly detection, which, so far, has been difficult, due to the large size of payments datasets and the scarcity of anomalies. Our gradient boosting-based payments classifier outperforms traditional models by up to 35%, with a detection rate of 93% for artificially manipulated transactions. Moreover, we show that our framework can be applied to different types of payment systems and that it can be extended with additional algorithms to further improve its robustness.

XINFEN HAN, Bank of Canada

More Than Words: Fed Chairs' Communication During Congressional Testimonies

Abstract

We study soft information contained in congressional testimonies by the Federal Reserve Chairs and analyze its effects on financial markets. Using machine learning, we construct high-frequency measures of Fed Chair's and Congress members' emotions expressed via their words, voice and face. Increases in the Chair's text-, voice-, or face-emotion indices during the testimony generally raise the S&P500 index and lower the VIX. Stock prices are particularly sensitive to the Fed Chair's answers to questions directly related to monetary policy. The effects during the testimony add up and propagate after the testimony, reaching magnitudes comparable to those after a policy rate cut. Our findings resonate with the view in psychology that communication is much more than words and underscore the need for a holistic approach to central bank communication.

PANEL DISCUSSION,

CRISTIÁN BRAVO ROMAN, Western University

Multi-Modal Deep Learning for Midcap Credit Rating Prediction Using Text and Numerical Data

The credit rating of a company is a critical factor in determining its financial health and assessing its ability to meet its financial obligations. In this talk, we present a fusion of deep learning models for predicting company credit rating classes

using structured and unstructured datasets of different types. The structured datasets used in the model include market, bond, financial ratios, and previous rating information as covariates. An unstructured dataset consisting of earning call transcripts is used to capture additional information that might not be present in the structured data. The models combine different fusion strategies with well-known deep learning models such as Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), and Bidirectional Encoder Representations from Transformers (BERT). We apply data fusion strategies in terms of levels and techniques, including early and intermediate levels, concatenation, and cross-attention techniques. Our results show that a CNN-based multi-modal model with two fusion strategies outperforms other multi-modal techniques. Furthermore, comparing simple architectures with more complicated ones, we find that the more complex deep learning models do not necessarily have the highest performance given the structure of the text data modality. Finally, we compare the impact of different rating agencies on short/medium/long-term performance and find which rating companies have the better performance when predicting future rating movements. The findings of this paper highlight the importance of incorporating unstructured data into credit rating models and provide insights into the effectiveness of different fusion strategies and rating agencies in predicting credit rating classes.

PIERRE SIKLOS, Wilfrid Laurier University

How Machine Learning Helps Us Understand Central Bank Communication: Some Illustrations

I draw upon ongoing research with colleagues to illustrate how LLM and topic modelling developments have impacted how economists interpret what central banks communicate. In particular, I summarize relevant contributions from: “Emotion in Euro Area Monetary Policy Communication and Bond Yields: The Draghi Era” (with D. Kanelis); “A New Sentiment Indicator for the Euro Area” (with D. Kanelis) “One Money, One Voice? Evaluating Ideological Positions of Euro Area Central Banks” (with P. Hofmarcher, M. Feldkircher). Versions are available from SSRN.

VLADIMIR SKAVYSH, Bank of Canada

Transformer NLP Models and Quantum Computing for Classification of Receipts Data

Automated categorization of goods and services is vital to data analysis of consumer behavior, as well as calculating strategic indices for policy-making. One of the key data sources is the scanner data coming directly from points of sale, where millions of entries containing product descriptions as well as prices are logged in a relatively short period of time. We manually annotate such a dataset, the USDA food product dataset with North American Product Classification System (NAPCS) codes. Then, we propose the use of state-of-the-art neural network transformer models with multi-class softmax layers as well as one-vs-all objectives to train efficient and accurate product description classifiers. Since the data is highly imbalanced, we also experiment in using a generative pretrained language model (GPT2) to perform data augmentation for underrepresented classes and show that this indeed improves weighted accuracy. We further investigate the use of quantum computing as means to improve results in the future.