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# TIME-VARIABLE ODE DISCOVERY FOR NON-STATIONARY TIME SERIES MODELING

**Голованев Яков** (Университет ИТМО)
**Научный руководитель –к.ф.-м.н., Хватов А.А. (**Университет ИТМО**)**

A modern class of continuous-time neural networks — neural ODE, showed impressive results in several areas, including time-series modeling problems. From the time-series models interpretability point of view, the latent neural ODE does not have many advantages over the classical machine learning methods. An alternative approach to classical machine learning models and neural ODEs is the differential equation discovery algorithms, working in the composite machine learning pipelines, that are making the model as interpretable as the underlying differential equations.

## Введение

We investigate time-variable ODE models, in which interpretable differential equations are extended and refined using neural networks to address the non-stationary time series modeling problem. Previously considering the linear neural ODE and replacing it with an explicit solution allowed us to improve the overall model performance, surpassing existing latent ODE model and LSTM networks. However, this approach is inapplicable when we cannot obtain a closed expression for the solution, which is true for most non-linear ODEs.

## Основная часть.

Instead of trying to find closed form solution for discovered ODE, we design and implement composite machine learning pipeline in form of differential equation model with coefficients defined by classical machine learning models, such as neural networks. We demonstrate automated training and optimization of the proposed model for several synthetic and physics-based datasets. The proposed model is then compared with existing models in various conditions. Apart from this, we conduct theoretical study of the proposed model and its representational capabilities using differential equations theory and demonstrative set of examples.

## Выводы.

While currently the proposed approach is on the prototype stage, we demonstrate that it can significantly increase the overall interpretability and quality of time series models using theoretical analysis and the set of experiments.

Голованев Я.С. (автор) Подпись

Хватов А.А. (научный руководитель) Подпись