AI for Financial Time Series Forecasting and Dynamic Assets Portfolio Optimisation
AGENDA

- The Story - why AI for finance now
- General solution architecture
- Financial time series forecasting
- MCTS neural networks - portfolio optimization
- Application of the latest machine learning methods to finance
THE AI STORY
The birth of AI

Alan Turing publishes “Computing Machinery and Intelligence”.

Alan Turing creates his Turing Test to determine whether or not a computer has human-like intelligence.

The term AI was used later - in 1955 by John McCarthy.
Deep learning

Geoffrey Hinton coins the term **deep learning**, to explain new algorithms that empower computers to distinguish objects, images and video.
Convolutional neural network

A convolutional neural network designed by researchers at the University of Toronto achieves an error rate of only 16% in the ImageNet Large Scale Visual Recognition Challenge, a significant improvement over the 25% error rate achieved by the best entry the year before.
Deep fake

The side effect of so good efficiency in analysis and generating images and videos are so called “deep fakes”, using AI for creating realistic images and videos.
AlphaGo

The biggest success story of the year was AlphaGo by DeepMind, a Reinforcement Learning agent that beats the world’s best Go player Kie Je.
AlphaZero

Revolutionary reinforcement learning method which could achieve super human level performance in GO, chess and shoggi without human knowledge.
Transformer

New, human attention based architecture which achieves extraordinary results in natural language translation.
Science-fiction

Never send human to do AI machine job
It's time to send AI to do investing

CEO AI Investments
AI INVESTMENTS SOLUTION
Algorithmic transaction systems

MACD

Moving averages

Price actions

Breakout

Stochastic

RSI

Chaos theory

MA+Boillingers Band
Based on the data, AI will learn both - the method and patterns of the transaction system.
Algorithmic systems - the method and system parameters are selected by human and therefore are deterministic.

AI – the system recognizes patterns, selects the method and determines the parameters all by itself.
Analyst - Portfolio manager - Trader

Analyst

Financial time series forecasting

Portfolio manager

Trading strategies
Portfolio optimization
Monte Carlo Tree Search with neural networks

Trader

Trade execution on over 200 markets, integration with 2 brokers
FINANCIAL TIME SERIES FORECASTING
Time series - definitions

- **Time series** - ordered in time list of values of given attribute
- **Time series forecasting** - forecasting of future, not known values of time series
- **Hybrid time series forecasting methods** - methods of time series forecasting based on combination of machine learning and statistical methods
Review of fundamental statistical forecasting methods

- Regression: linear, logistic, polynomial
- ARMA, ARIMA and different variants
- ARCH/GARCH - and different variants
- Exponential smoothing - Holt-Winters
- Theta method
- Ensemble of methods
M4 Competition - breakthrough in forecasting

• M Competition - most prestigious and scientifically backed competition in time series forecasting
• Organised by University of Nicosia and prof. Spyros Makridakis
• First and second place was won by hybrid methods

☑️ In the latest edition, M4 Competition was won by hybrid methods - combination of statistical and machine learning methods. Accuracy has been evaluated on 100 000 of different time series.
ES Hybrid Method - winning method from M4

- Data preprocessing - Exponential Smoothing
- Neural networks: LSTM - residual, dilated, attentions
- Model’s ensembling
- Parameters of preprocessing per each series, shared models

Data preprocessing and neural network LSTM in one dynamic computational graph. Parameters of Exponential Smoothing are trained with neural networks weight together.
ES Hybrid Method - winning method from M4

(1,2)-(4,8) Std
Quarterly

(1-3-6-12) Residual à la Kim
Monthly

(1,6),NL
Yearly, Pred. Intervals

Source: https://eng.uber.com/m4-forecasting-competition/
ES Hybrid Method - practical usage
Tsetlin Machines

- Unique and innovative approach for forecasting
- Stochastic Learning Automata algorithm for forecasting
- Dynamically managed probabilistic distributions
- Model’s ensembling

✔ Dynamically learnt probabilistic distributions.
Echo State Networks

- Chaotic time series forecasting
- Random reservoir of neurons
- Input/output layers weights are only trained
- Neurons are connected together - no layers

Being trained is only input/output layer based on the random reservoir.
Echo State Networks

Source: https://tex.stackexchange.com/questions/190914/drawing-an-echo-state-network
Hybrid methods - ones of the most advanced class of forecasting methods.

For financial time series accuracy over 60% for long term
Forecasting - applications to finance

• Forecasting risk of credit exposure
• Forecasting prices of assets
• Forecasting of macroeconomic values (GDP, inflation, unemployment, …)
• Forecasting demand for credit and saving
• Forecasting of customer behaviour
• ...and many more

Many areas of application and potential improvements.
FUTURE PORTFOLIO OPTIMIZATION

MONTE CARLO TREE SEARCH WITH NEURAL NETWORKS
Portfolio management and exposure

- Reinforcement learning - self-learning algorithms
- Managing the exposure for instruments
- Managing the risk exposure
- Optimization based on future probabilities instead of now casting

☑ Investing with AI tools is the future of financial markets.
Application to finance domain

- Optimization of capital usage
- Optimization of exposure
- Optimization of assets portfolio
- ...and many more

☑️ Advanced possibilities of the future cast optimization
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**Model Training**
## Ensembling

### Results


- **Create time**: 2019-10-12T07:44:37
- **Ensemble plan id**: 49
- **Selector type**: OffCEEL
- **Loss function**: STEP_FUNCTION
- **Evaluator Type**: CumulativeHardness
- **Population size**: 10
- **Generation size**: 1000
- **Weight Importance factor**: 1
- **Maps**: 100
- **MRSE population**: MRSE generation

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Results
34 weeks live results

Period: 2018.10 - 2019.06 - 34 weeks, Return in period: 34%
Complete development and research process of building AI applications for finance

Requirements gathering & analysis for AI projects

Development, research & fine tuning models

Building & deployment of the complete solution into multicloud
7bulls.com Group

We create, integrate and deploy software for over 25 years

- 150 staff members
- two offices: Warsaw, Torun (Poland, EU)
- strong growth: 25% per year on average
- pure self-service revenue stream
- certified R&D organisation in Poland & France
Summary

- AI in finance - real, measurable benefits
- Latest forecasting & optimization methods are the real breakthrough
- Super human performance is possible for selected areas

AI become reality in finance!
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