EURO^2

Industry use-cases
EuroCC-1 & -2 portfolio
Sorted by industry sectors

SHARK.AERO Shark

EURO²

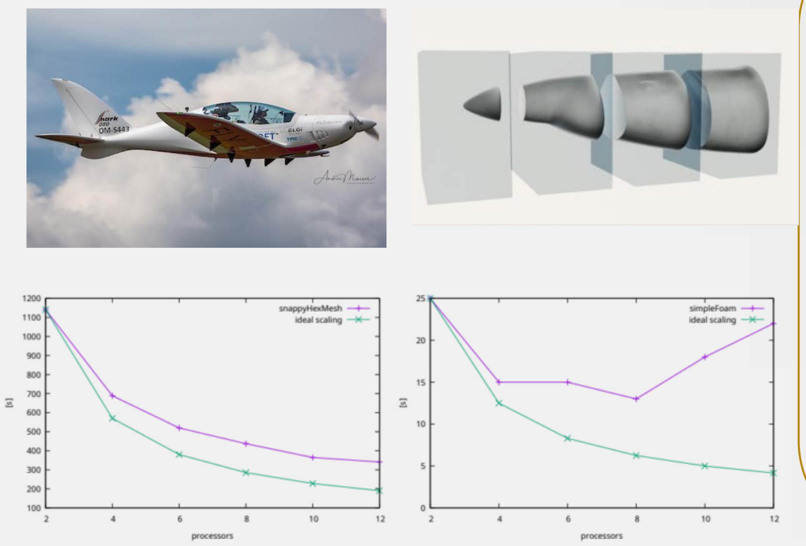
Transfer and optimization of CFD calculations workflow in HPC environment

Company

Shark Aero company designs and manufactures ultralight sport aircrafts with two-seat tandem cockpit. For design development they use popular open-source software package OpenFOAM.

Challenges & Solution

- The CFD (Computational Fluid Dynamics) simulations use the Finite Elements Method (FEM). Model created in Computer-Aided Design (CAD) software is divided into discrete cells, so called "mesh". Computational requirements scale with the 3rd power of the mesh density
- Workflow consist of enclosing mesh creation, mesh seg-mentation, model inclusion and CFD simulation itself. Model inclusion (using snappyHexMesh program) is the time-limiting step.
- Efficient parallelization (using Message Passing Interface) requires thorough design of the mesh division into domains, in order to minimized data transfer necessary for resolving boundary conditions.



From reality to model (top); parallel scaling of selected workflow steps (bottom)

Benefits

- ✓ 8x speed-up was achieved by migration to HPC. Aircraft parts design requires simulations of a relatively small models, but numerous times during the optimization.
- ✓ Higher speed-up is expected with increasing the problem size.

"Thanks to HPC we were not only able to run multiple simulations simultaneously, but we could also use much more refined mesh, which was not possible before due to memory limitations of our local computers."

Petr Sterba, Chief Engineer@SHARK.AERO, ltd.

Full story:

EURO SLOVAKIA

Lucia Demovičová, WPL EuroCC Slovakia, lucia.demovicova@nscc.sk

Finance & IT systems

DOXXbet™ CODIUM

EURO²

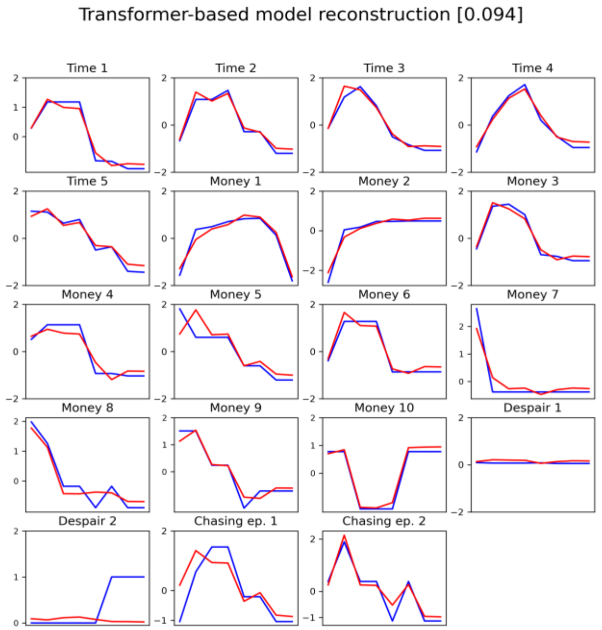
Anomaly Detection in Time Series: Gambling prevention using Deep Learning

Company

DOXXbet, ltd. – betting and online casino; Codium, ltd. – software developer of betting and iGaming platform, focused on enhancing customer service and players' engagement via identification and prevention of gambling behavior.

Challenges & Solution

- Unsupervised Transformer-based autoencoder (AE) model was used to detect anomalies in the dataset generated by online casino players.
- Data consists of time series of 19 derived features reflecting players' behavior, such as net loss / gain, cash deposits / withdrawals in a sliding time window, login frequency, etc.
- Alignment of AE's reconstruction error and the so called proxy indicators (selected manufactured descriptors, such as "chasing loss") enabled us to distinguish between data anomalies and potential problem gambling of players, thus decreasing the false positive rate.
- Training model with more than 100k trainable parameters and gigabytes of data greatly benefited from utilizing GPU-accelerated HPC facility.



Expected (blue) vs. predicted (red) values for each descriptor: single time window of a random player

Benefits

- ✓ Help betting and online casino providers mitigate negative consequences for players, which is in line with European trends in risk management.
- ✓ Real-time problem gambling detection using AI and Big Data thanks to HPC.

"The accelerated module of the HPC system Devana allowed us to test several approaches to prevention of pathological online gambling. Powerful GPU accelerators were of great value in training and fine-tuning of sophisticated AI models."

Martin Varmus, CEO@Codium, ltd.

Full story:

EURO SLOVAKIA

Lucia Demovičová, WPL EuroCC Slovakia, lucia.demovicova@nscc.sk

Finance & Insurance & IT systems

nettle[1] • ai.

EURO[2]

Named Entity Recognition for Address Extraction in Speech-to-Text Transcriptions Using Synthetic Data

Company

Nettle, ltd. –build AI driven conversational platforms that use Natural Language Processing (NLP) and Machine Learning (ML) to analyze, understand and derive meaning from unstructured text.

Challenges & Solution

- Extract municipality name, street name, house number, and postal code from speech-to-text data exclusively in Slovak language. There is currently no NER (Named Entity Recognition) model available for such task in Slovak language. Popular Large Language Models (LLMs), like GPT, are not suitable because of data privacy concerns and time delays caused by calls to (often slow) LLM cloud APIs.
- SlovakBERT LLM was fine-tunned for NER of desired entity types. Lack of real-world data for training was solved by generating synthetic samples using GPT-3.5-turbo OpenAI APIs in combination with prompt engineering.
- Training model with more than 124M trainable parameters, on tens of thousands samples greatly benefited from utilizing GPU-accelerated HPC facility.

Ground truth \ Predicted	O	B-Street	I-Street	B-Housenumber	I-Housenumber	B-Municipality	I-Municipality	B-Postcode	I-Postcode
O	53	6	10	1	1	2	0	0	0
B-Street	1	30	21	0	0	0	0	0	0
I-Street	0	1	10	0	0	0	0	0	0
B-Housenumber	2	1	0	69	0	0	0	0	0
I-Housenumber	0	0	0	1	18	0	0	0	0
B-Municipality	6	37	3	0	0	25	0	0	0
I-Municipality	1	0	9	0	0	0	8	0	0
B-Postcode	0	0	0	0	0	0	0	1	0
I-Postcode	0	0	0	0	0	0	0	0	0

Ground truth \ Predicted	O	B-Street	I-Street	B-Housenumber	I-Housenumber	B-Municipality	I-Municipality	B-Postcode	I-Postcode
O	61	1	1	0	0	5	4	1	0
B-Street	0	50	0	0	0	1	1	0	0
I-Street	0	0	10	0	0	0	1	0	0
B-Housenumber	0	0	0	72	0	0	0	0	0
I-Housenumber	0	0	0	0	19	0	0	0	0
B-Municipality	1	3	0	0	0	66	1	0	0
I-Municipality	0	0	1	0	0	1	16	0	0
B-Postcode	0	0	0	0	0	0	0	1	0
I-Postcode	0	0	0	0	0	0	0	0	0

Confusion matrix of the 1st (top) and the last (bottom) iteration model. Accuracy improved from 67.51 to 96.03%.

Benefits

- ✓ Improve the capacity of chatbots and voicebots to accurately enquire information from clients, e.g. update postal address. Companies can thus save significant resources of human-operated customer care systems.
- ✓ HPC enables noise reductions and improvement of recognition accuracy via computationally demanding fine-tuning of Large Langue Models.

Full story:

EURO SLOVAKIA

“We used the Devana supercomputer for training language models that assist us in extracting key entities from text. This helps us create chatbot and voicebot applications with a new level of user experience.”

Andrej Greguš, co-founder of Nettle.ai

Lucia Demovičová, WPL EuroCC Slovakia, lucia.demovicova@nscc.sk

Biotechnology & Chemical Science

POLYMER INSTITUTE SAS

Science is the future!

EURO²

Measurement of microcapsule structural parameters using artificial intelligence and machine learning

Company

Polymer institute of the Slovak Academy of Sciences (IP SAS) focuses research four major areas: synthesis and characterization of polymers, composite polymeric materials, polymeric biomaterials and molecular simulation of polymers.

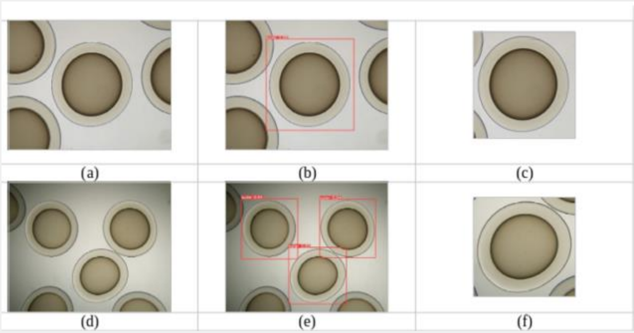
Challenges & Solution

- The goal was to design and implementation a pilot software solution for automatic processing of polymer microcapsules images using artificial intelligence (AI) and machine learning (ML) approach. The microcapsules consist of semi-permeable polymeric membrane developed at the IP SAV. Solution replaces error-prone and time-consuming manual measurement of microcapsule structural parameters.

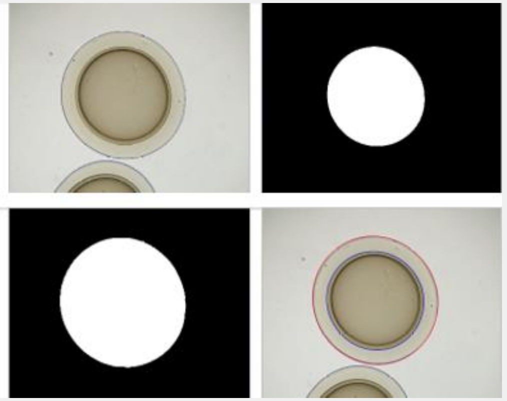
- Three step solution was developed. **Step 1**: Localization / detection of microcapsules using YOLOv5 model with pre-trained weights from COCO128 dataset. Training set consisted of 96 manually annotated images. **Step 2**: Detection of inner and outer microcapsule membrane using U-Net neural network (NN) architecture. Training set consisted of 140 manually generated binary masks. **Step 3**: Post-processing and structural parameters evaluation. Inferred binary masks of membranes are improved using "fill-holes" and "watershed" algorithms, subsequently, first and second principal axis of the fitted ellipse are used for the calculation of the structural parameters.

- Both YOLO and U-Net NN models greatly benefited from utilizing GPU-accelerated HPC facility.

- 98.5% of sample structural parameters were inferred within the desired accuracy / error bars of 0.05 mm.



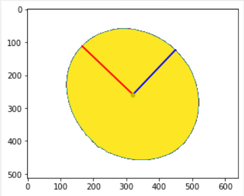
Step 1 – localization of microcapsules.



Step 2 – detection of inner and outer membranes

Benefits

- ✓ Automated detection and measurement of microcapsule membranes replaces time-consuming and error-prone human activity.
- ✓ HPC enables (continuous) improvement of computationally demanding neural network-based AI models and user-friendly deployment using Open OnDemand GUI



Step 3 – fitting and measurement

Full story:

EURO SLOVAKIA

Lucia Demovičová, WPL EuroCC Slovakia, lucia.demovicova@nscc.sk

EuroCC: Use cases portfolio

coordinated by CASTIEL2-WP4

EURO²

www.eurocc-access.eu/services/document-library/

EuroHPC
Joint Undertaking

This project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 951732. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Bulgaria, Austria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Lithuania, Latvia, Poland, Portugal, Romania, Slovenia, Spain, Sweden, United Kingdom, France, Netherlands, Belgium, Luxembourg, Slovakia, Norway, Switzerland, Turkey, Republic of North Macedonia, Iceland, Montenegro