AI in Economics Seminar

Machine Learning and GenAI methods applied to economic forecasting

ECB – March 2024

Sandrine Lunven and Lea Dauphas

Programme for the ECB SPF 25-Year Anniversary Event (19th March 2024)

15:30: Welcome remarks from the President Christine Lagarde, European Central Bank

15:40: ECB staff presentation

On special survey on forecast processes and methodologies and on 25 years of SPF

ECB staff (Anastasia Allayioti, Rodolfo Arioli, Colm Bates, Vasco Botelho, Bruno Fagandini, Luis Fonseca, Peter Healy, Aidan Meyler, Ryan Minasian, Octavia Zahrt), European Central Bank

16:40: Panel discussion on current challenges for forecasting

Chair: Oscar Arce, ECB Director General Economics

Panellist: Léa Dauphas, TAC ECONOMICS

Panellist: Alexander Glas, Centre for European Economic Research (ZEW)

Panellist: Concepcion Sanz Gomez, Banco Santander

Panellist: Marco Valli, UniCredit Bank AG

18:00: Aperitif and seated dinner

Welcome remarks by Philip Lane, ECB chief economist

Informal dinner talk on value of micro data for understanding and analysis expectations by Ricardo Reis, London School of Economics and Political Science

Introduction to TAC ECONOMICS

AI-passionate Data
Scientists

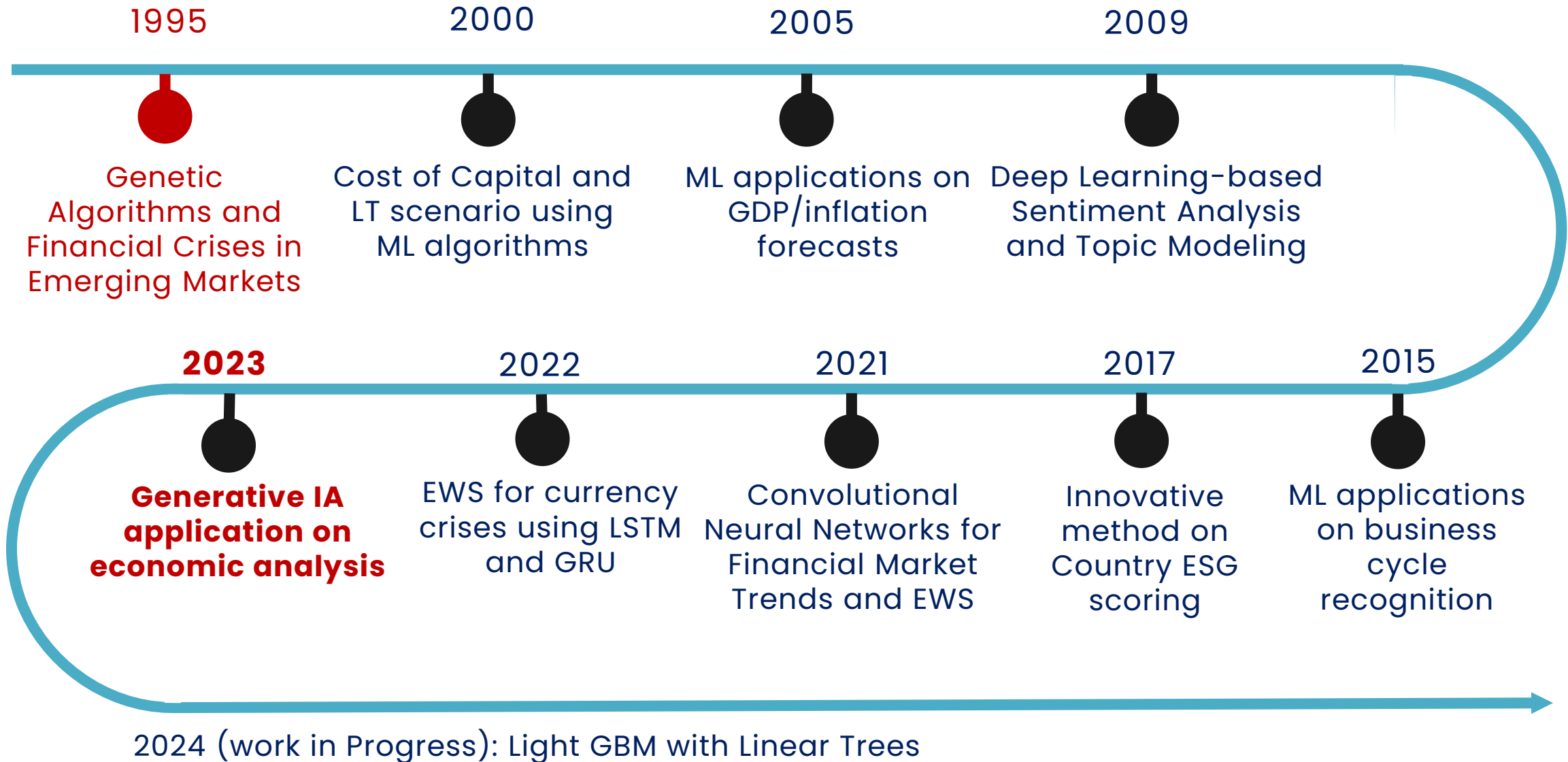Economic and financial
experts

Active in academia with
a taste for intellectual
challenge

- TAC ECONOMICS is a fully independent 35-year-old company focusing on economic and financial research with an operational focus.

- We combine an intensive use of quantitative data and models with in-depth analysis to deliver decision-oriented intelligence to large international companies (financial and industrial).
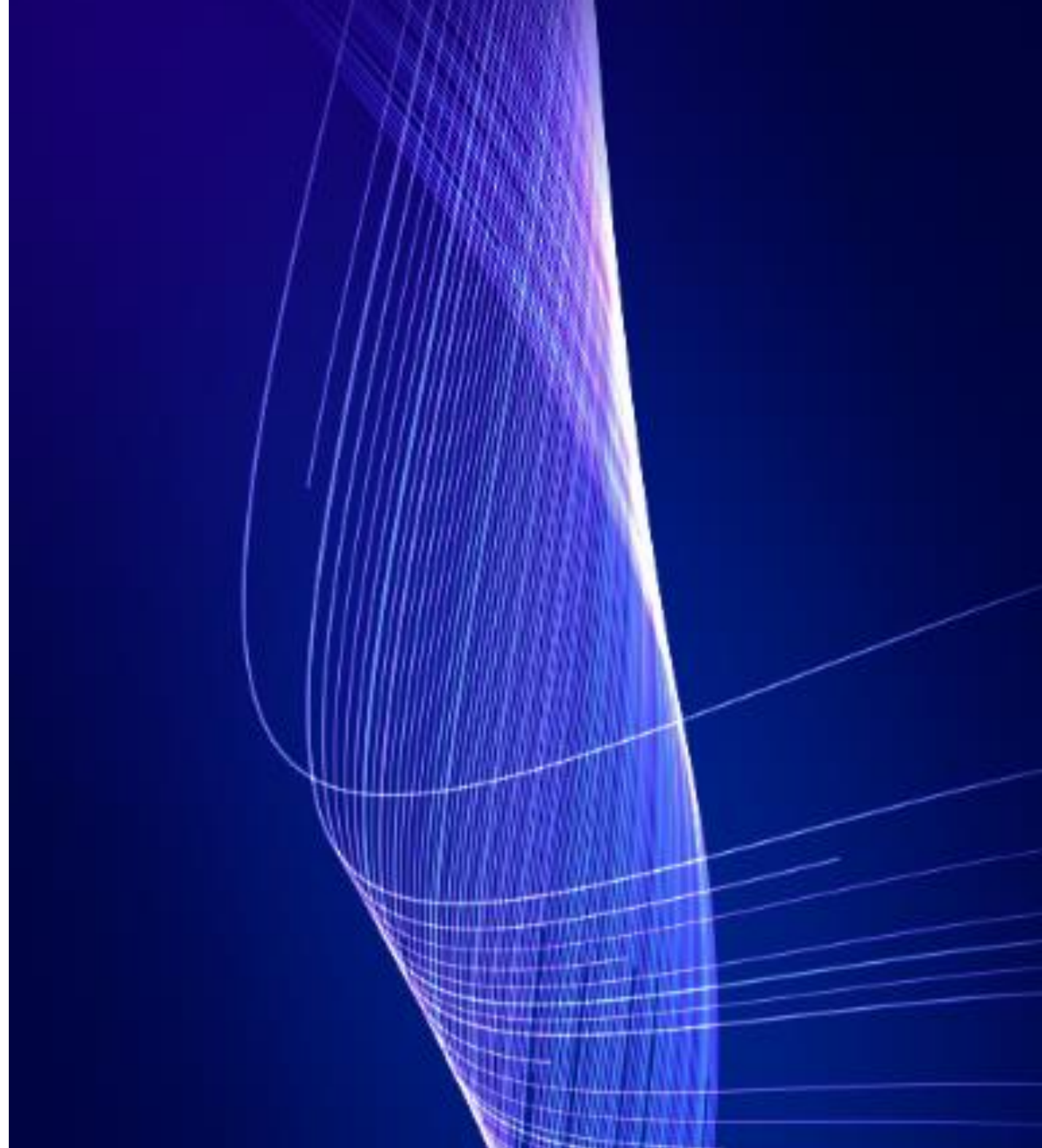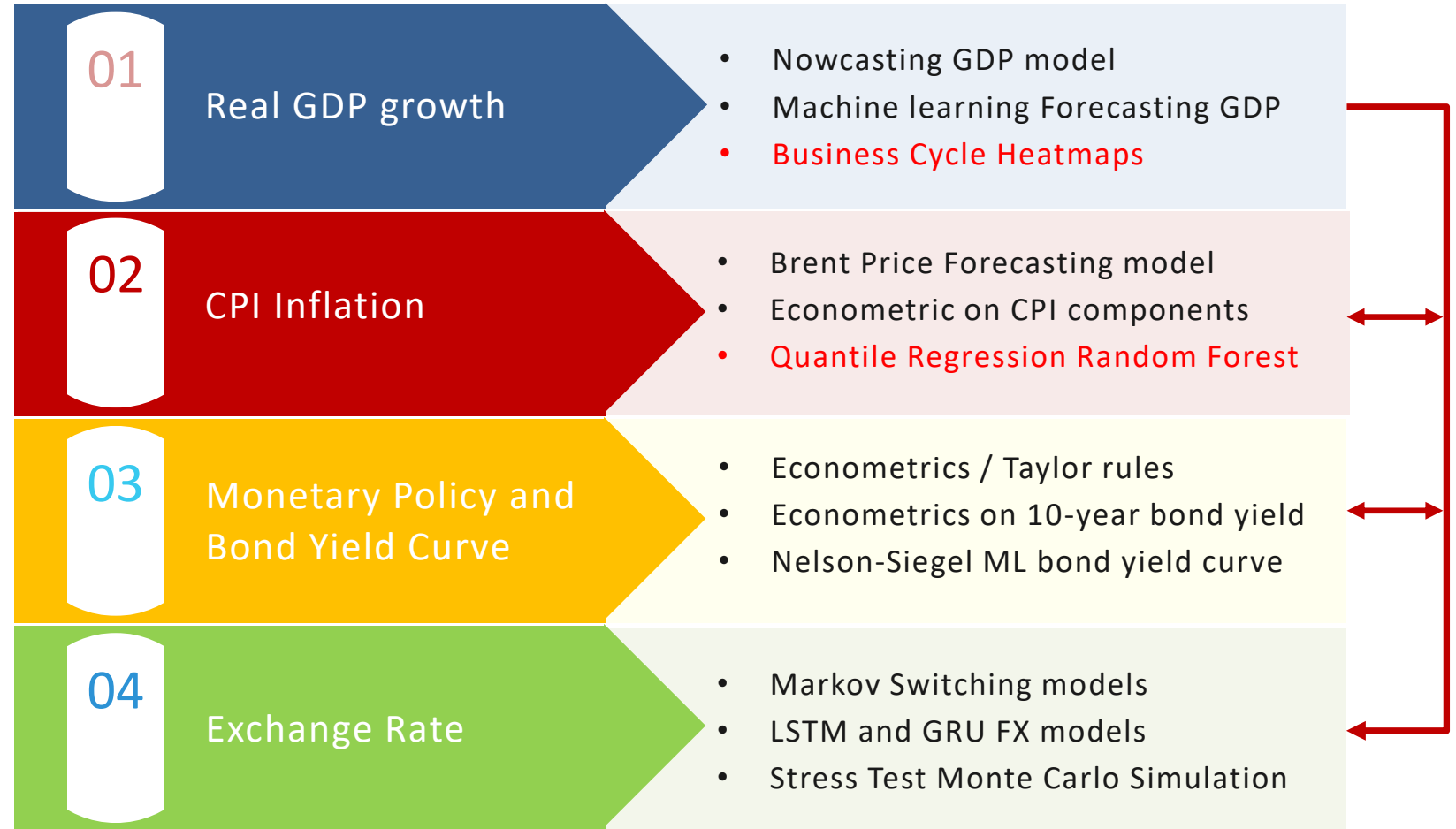
TAC ECONOMICS AI research in Economics

1995 — Genetic Algorithms and Financial Crises in Emerging Markets

2000 — Cost of Capital and LT scenario using ML algorithms

2005 — ML applications on GDP/inflation forecasts

2009 — Deep Learning-based Sentiment Analysis and Topic Modeling

2023 — Generative IA application on economic analysis

2022 — EWS for currency crises using LSTM and GRU

2021 — Convolutional Neural Networks for Financial Market Trends and EWS

2017 — Innovative method on Country ESG scoring

2015 — ML applications on business cycle recognition

2024 (work in Progress): Light GBM with Linear Trees

TAC ECONOMICS
Cyclical Forecasting Models

Cyclical Forecasting Models – Methodology

Combination of macro-fundamental model and AI methods

01 Real GDP growth
- Nowcasting GDP model
- Machine learning Forecasting GDP
- Business Cycle Heatmaps

02 CPI Inflation
- Brent Price Forecasting model
- Econometric on CPI components
- Quantile Regression Random Forest

03 Monetary Policy and Bond Yield Curve
- Econometrics / Taylor rules
- Econometrics on 10-year bond yield
- Nelson-Siegel ML bond yield curve

04 Exchange Rate
- Markov Switching models
- LSTM and GRU FX models
- Stress Test Monte Carlo Simulation

Development of an innovative method to identify business cycles in the Eurozone (initially developed for the United States)

- Quantitatively estimated (no judgment-based datation) using large number of macro and financial indicators

- Updated in "real time" (not with delay, using monthly indicators)

The method is developed into two steps:

- Construction of monthly "cyclical heatmaps" over the period 1990-2022 using large number of indicators

- Heatmap recognition based on K-means classification method to identify key historical archetypal heatmap reflecting the different phases of a business cycle

Step 1 – Construction of monthly « cyclical heatmaps »

- **Objective**: Translating the dynamic economic situation into "a picture" available at each month

- Over the period from January 2002 to February 2024 -> construction of 266 images

- Using mixed-frequency indicators (daily, weekly, monthly basis) converted to monthly basis (updated with no long delay).

- Gathering various information on the Eurozone economy into 5 broad categories: industrial activity, household sector, price, monetary and financial indicators

- Each indicator is normalized each 18-month window to highlight a deterioration or an improvement of the situation over each sub-period.

- Extracted from our Datalab, our aggregated database of economic and financial information https://app.taceconomics.com/

EUZ Cyclical situation over the past 18 months

Sep. 2022

Past 18 months

Feb. 2024

| 1 | 2 | 3 | 4 | 5 |
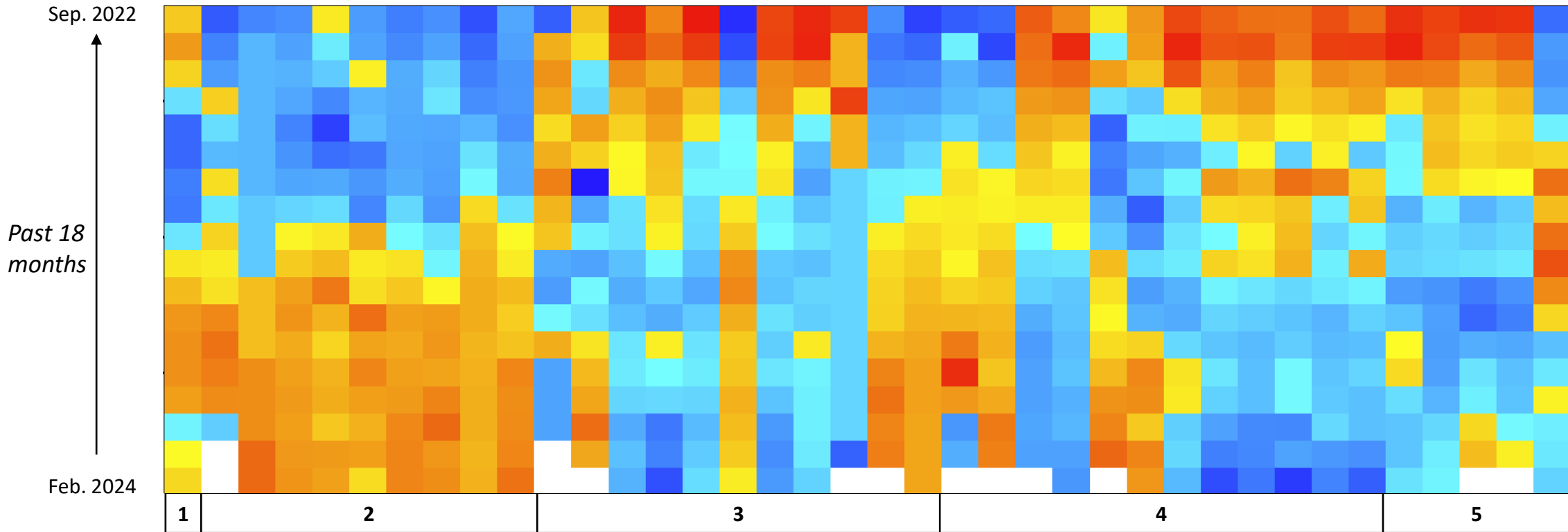
1 - Coincident economic index (ex: EC ESI)

2 - Industrial activity (production, capacity utilization, investment, confidence)

3 - Household sector (income, confidence, labor market, wages)

4 - Prices, monetary and financial markets (headline, core CPI, interest rates, financial conditions, market volatility)

5 - Oil prices and exchange rates

Step 2 – K-Means classification into 5 archetypal heatmaps

Top-cycle phase (5 – « peak »)
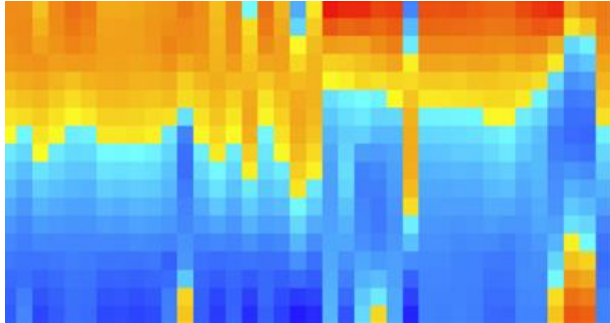
Cyclical reversal (3)
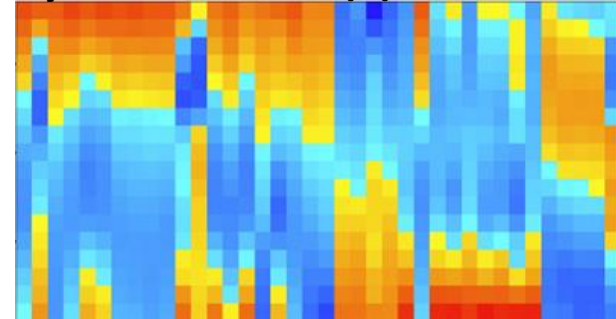
Recovery phase (4)

Cyclical weakness (2)

Peak
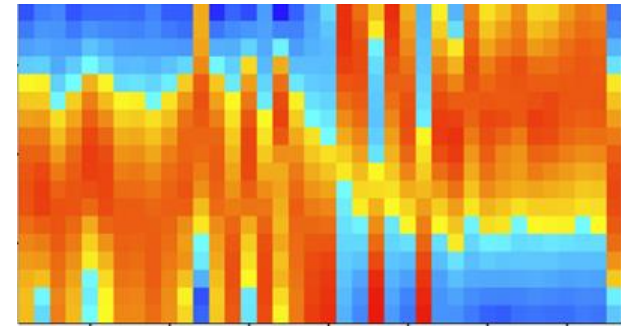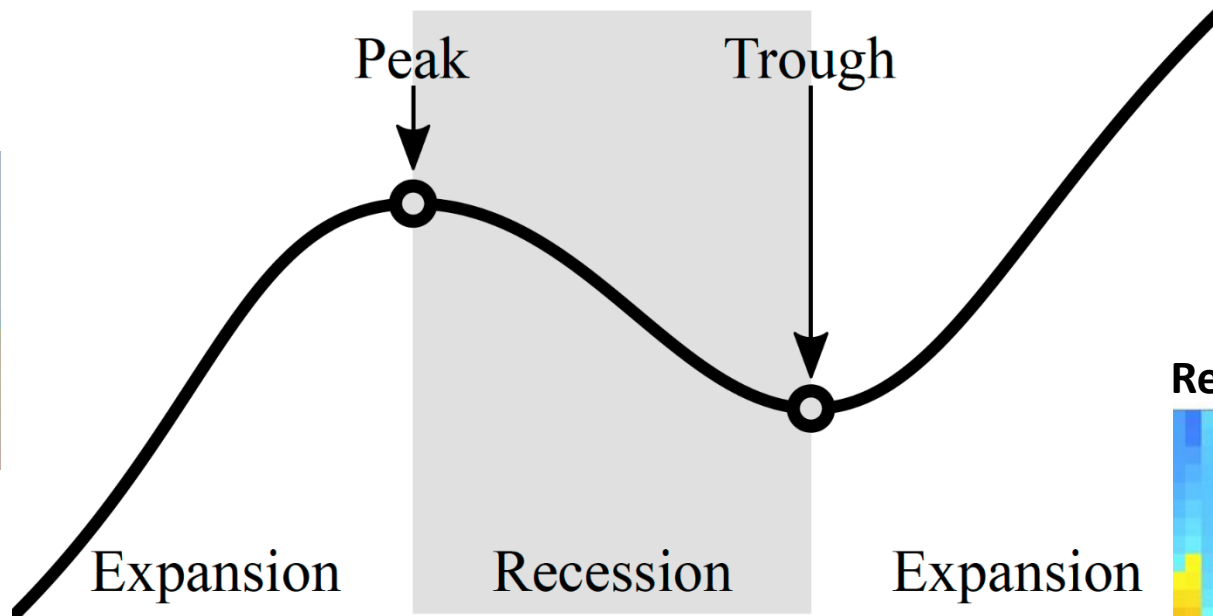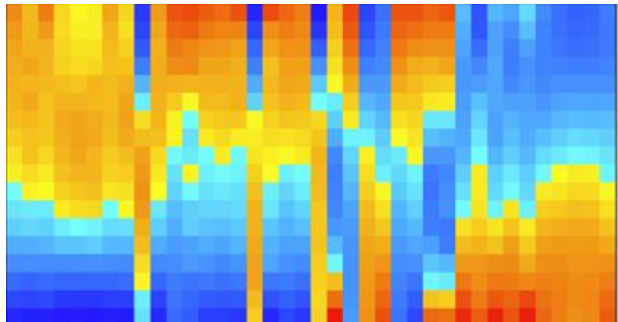
Trough

Recession phase (1 – « trough »)

Expansion

Recession

Expansion

Step 2 – K-Means classification into 5 archetypal heatmaps

Legend: CEPR recession — OECD based Recession Indicators from the Peak through the Trough — Heatmap cycle
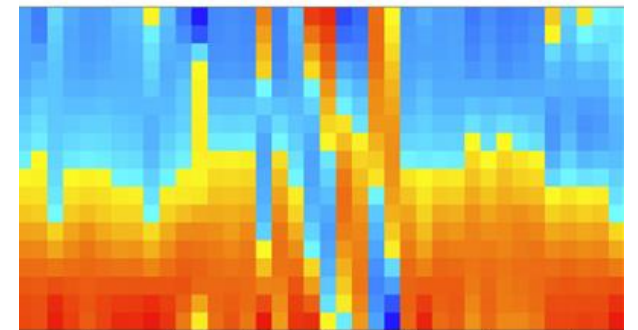
Step 3 – Interpretation and forecasting

Heatmap - Model 3 months: 81.4 %
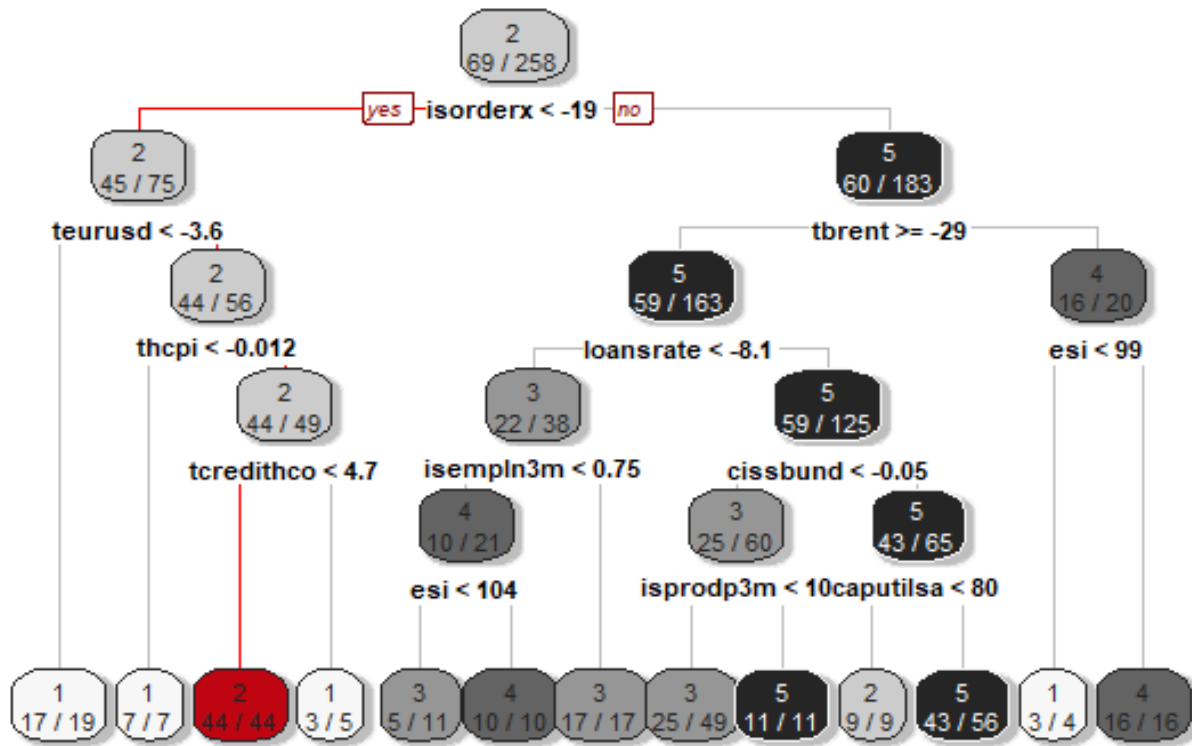
EUZ Cyclical situation over the past 18 months

Sources: TAC ECONOMICS Datalab

Machine Learning applied to inflation forecasts
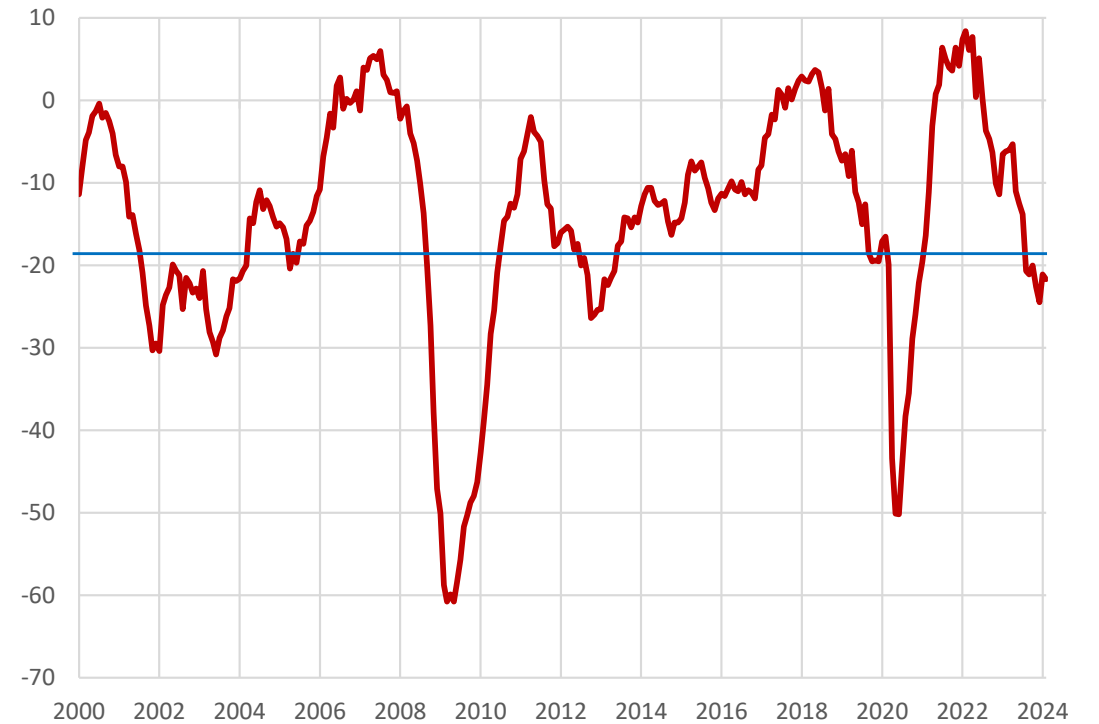
Brent prices projections – ML Method
USD/bl We

Legend:
- Brent estimate
- Brent
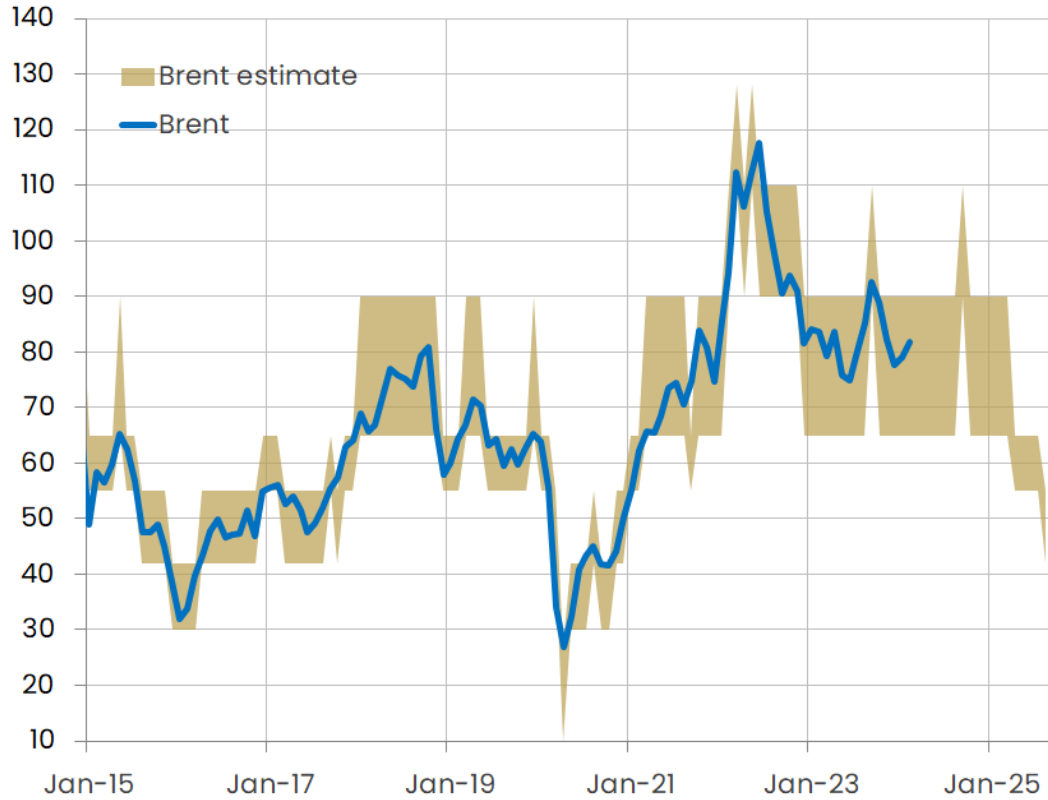
Sources: TAC ECONOMICS Datalab

EUZ HICP Projections by components
Y/Y in %, and pp

Legend: Goods — Services — Food — Energy — HICP -- Projections

Sources: TAC ECONOMICS Datalab

Machine Learning applied to inflation forecasts

EUZ HICP inflation forecasts

Legend: Inflation, q25, q50, q75

Feature importance

Feature importance ranking (top to bottom):
- Equity market realised volatility
- Raw materials price index inflation (WLD)
- General economic situation over next 12 months
- Industrial confidence indicator
- Manufacturing Confidence Indicator
- EUR/USD growth
- 10y bond yield DEU realised volatility
- US unemployment rate
- Assessment of order-book levels
- Brent inflation
- 10yr bond yield DEU
- Consumer confidence
- Employment expectations
- 10y bond yield EUZ
- 3m euribor
- Price trends over next 12 months
- Financial situation over next 12 months
- US core inflation
- Manufacturing Selling price expectations
- US inflation

Sources: TAC ECONOMICS Datalab

Quantile regression Random Forest at the 1-month to 24-months ahead based on around 40 indicators (activity, PPI, wages, inflation expectations, commodity prices, financial conditions)

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Conclusion

- TAC ECONOMICS has developed its own scientific methods for cyclical forecasting. It is based on a combination of macro-fundamental econometric models and machine/deep learning/AI models.

- The advantages of combining multiple quantitative methods are:

  - Econometrics: useful for applied theoretical aspects (Taylor rule, Okun law, Beveridge, expectation theories etc.) and to assess different assumptions (stress tests)

  - Machine Learning: use of large mixed-frequency data (leading indicators, soft data), to capture heterogeneities and non-linearities in complex environment.

- Finally, quantitative methods have both objectives of performance (best accuracy, useful alerts) and interpretation (reliability and indicators to monitor) in order to assist economists.

- *"The real test of knowledge is not truth, but utility" (Yuval Noah Harari)*

- *"All models are wrong, some are useful" (George Box)*

Gen AI applied to economic analysis
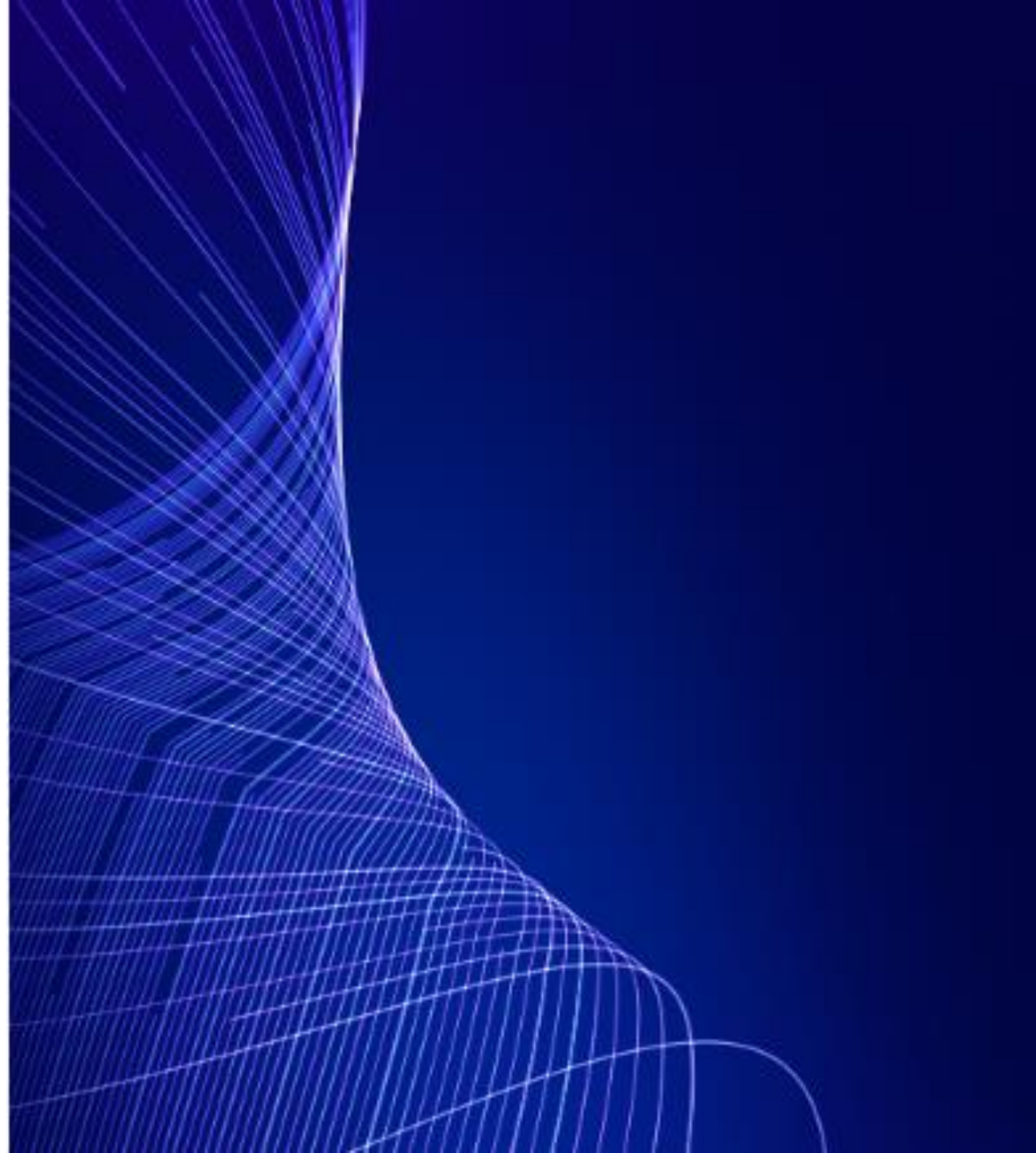
AI Generative Plateform applied to economic analysis

- ALBER is an acronym for **"Artificial Language for Boosting Economic Research"**

- **ALBER is a practical application of generative AI to economic analysis**, developed in collaboration with gwen**lake.** (www.gwenlake.com)

- Through a **user-friendly chat interface**, our clients can explore TAC ECONOMICS's extensive datasets and research, enabling them to uncover more comprehensive, insightful, and multifaceted analyses than ever before.

- With **more than 2 million analyses** and articles read per quarter, every economic question you ponder can be answered.

- **Ability to select specific dataset** (themes, sources) and/or specific reference documents (some of them in open data)

- Implementation of **recursive prompts** to reconstruct an economist's reasoning

- **Development of specific use-cases**: Review of literature, FX alert and analysis, Country Risk Monitoring, Cyclical analysis, ESG etc.

AI Generative Plateform applied to economic analysis
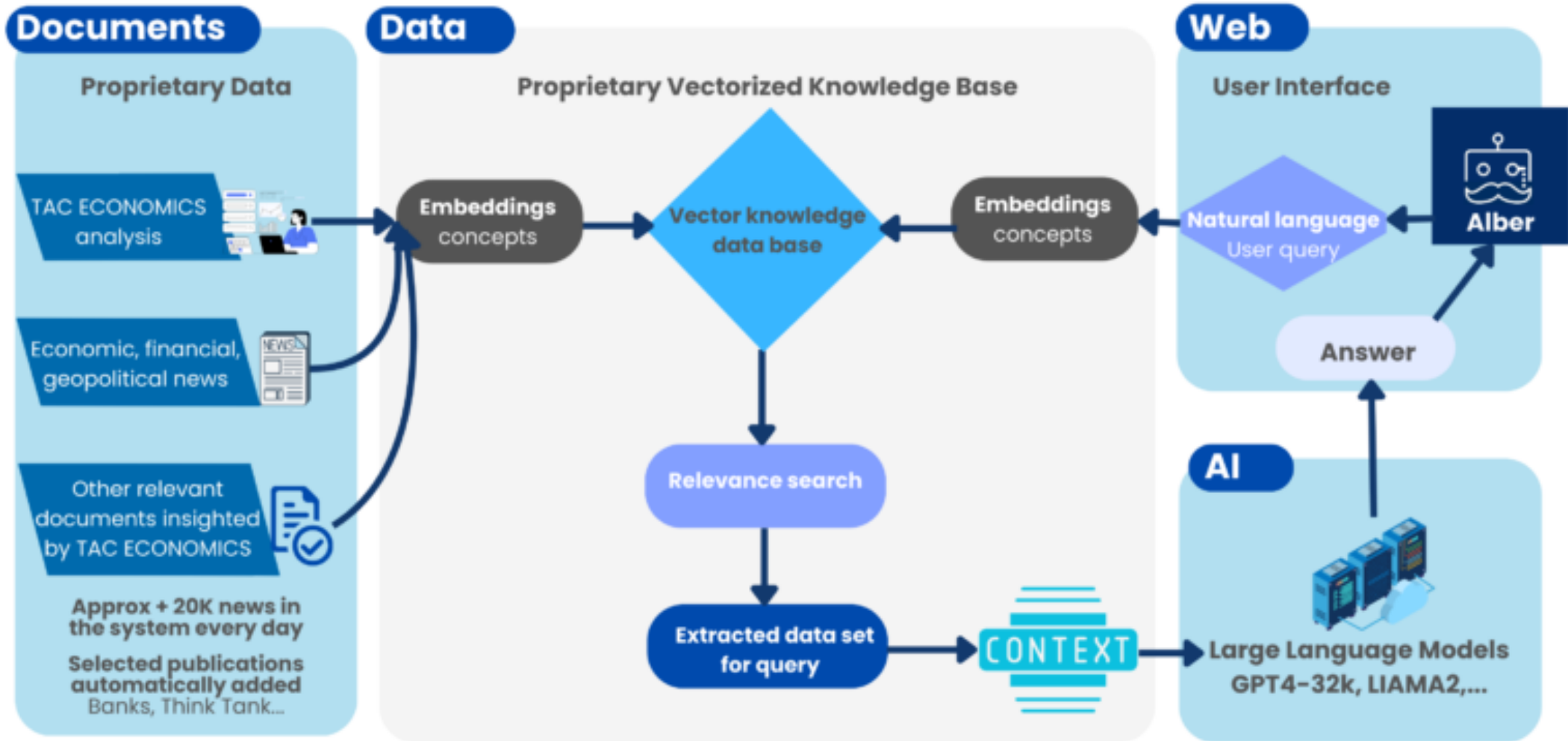
AI Generative Plateform applied to economic analysis

- **Automated digitization of documentation:** real-time news, TAC ECONOMICS analysis, academic research, reports from multilateral organisations, financial institutions, think tanks etc.

- **Automated chunks and embeddings:** Analysis of semantic concepts for document retrieval (100 languages)

- **Deployment of "elastic" and "vector" databases:** Queries and document research facilitation

- **Use of open source LLMs (Llama, MPT, GPTNeox):** Classification, summarization, structuring and chat on private LLMs or on the Gwenlake API

- **Hub:** Hub and Prompt Pipelines

- **RAG & RAG Fusion, conditional pipelines and graphs:** Deployment of private chats with RAG (hallucination reduction)

AI Generative Plateform applied to economic analysis

Contacts

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