MATLAB EXPO

MATLAB을 이용한 eXplainable AI 모형의 금융자산 예측 적용

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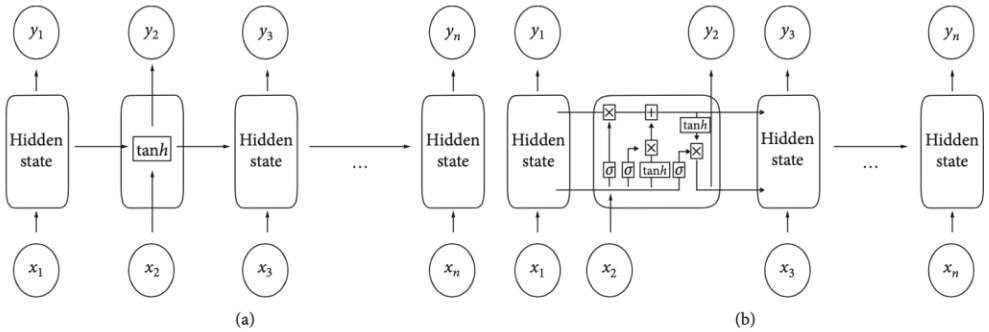
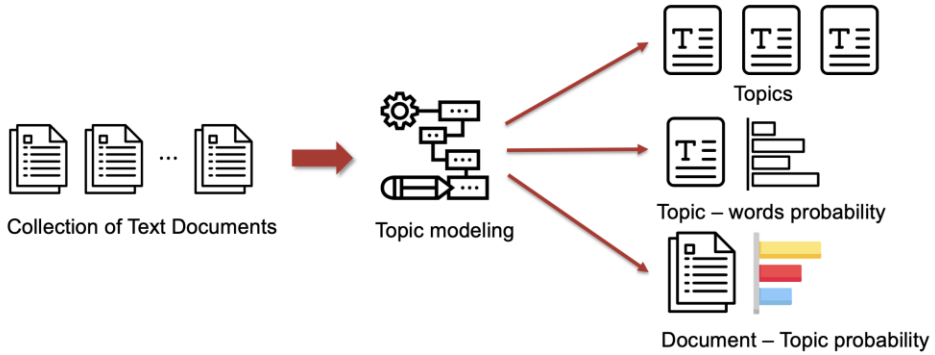
MathWorks

발표자 약력

- 가천대학교 금융수학과 (2018~)
- 주요경력
  - 삼성증권 금융공학팀
  - 포항공대 박사후 연구원
- 연구분야
  - 금융수학
  - 머신 러닝
  - 데이터 사이언스





Source : own elaboration

발표자 약력

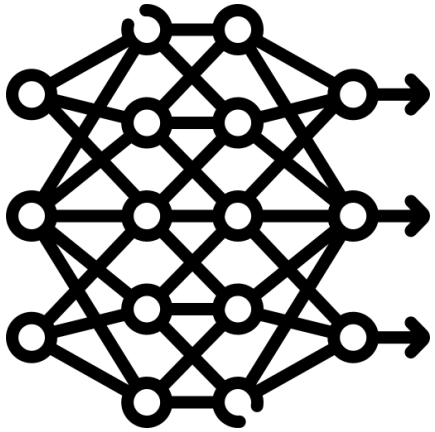
- “MATLAB을 활용한 금융 데이터 사이언스“ 2021년 12월
- Latent Dirichlet Allocation (LDA) model
- Lee, K. J., & Choi, S. Y. (2022). **Effects of Organizational Culture on Employer Attractiveness of Hotel Firms: Topic Modeling Approach**. Complexity, 2022.
- Lee, K. J., & Choi, S. Y. (2023). **Resourceful and demanding attributes of organisational culture, employee satisfaction, and organisational performance of large R&D intensive firms in the US**. *Technology Analysis & Strategic Management*, 1-14.

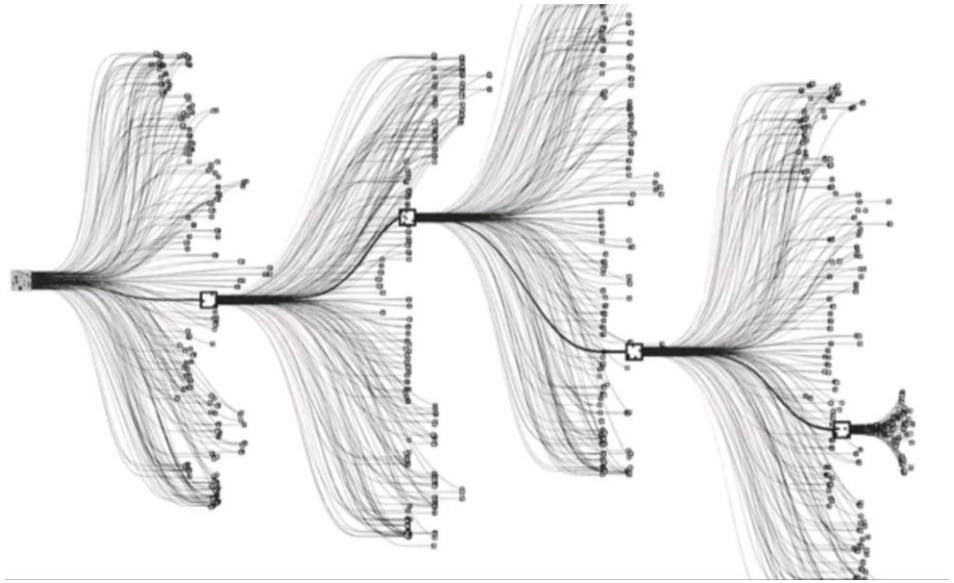
Contents

- eXplainable AI model
- Project Overview & Goals
- Solution by Mathworks
- Summary & Concluding Remarks

The tremendous success of deep learning.

- Deep learning has shown amazing performance in various tasks, whether it be text, time series or computer vision.

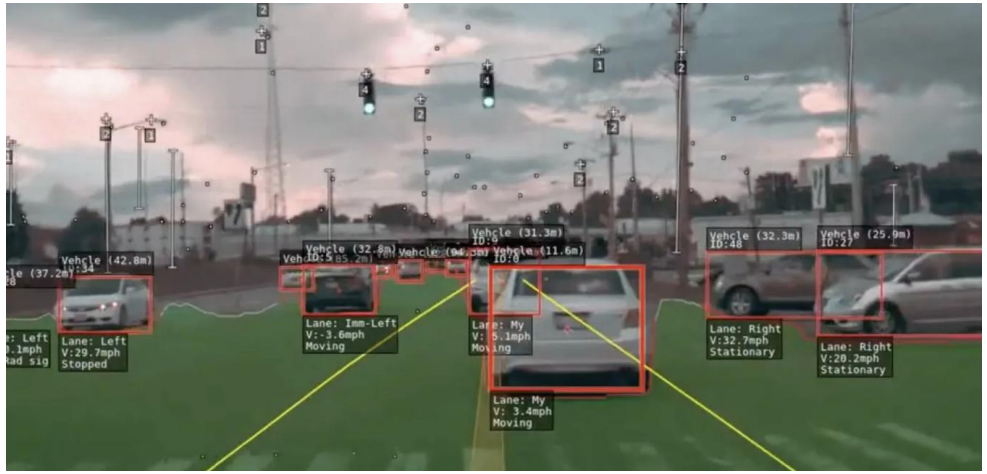




Source : https://www.quora.com/What-does-it-mean-that-AlphaGo-relied-on-Monte-Carlo-tree-search/answer/Kostis-Gourgoulias?ref=hackernoon.com

The tremendous success of deep learning. (cont.)

- Deep learning now used for many problems.
- EX) Image recognition, Speech Recognition, …

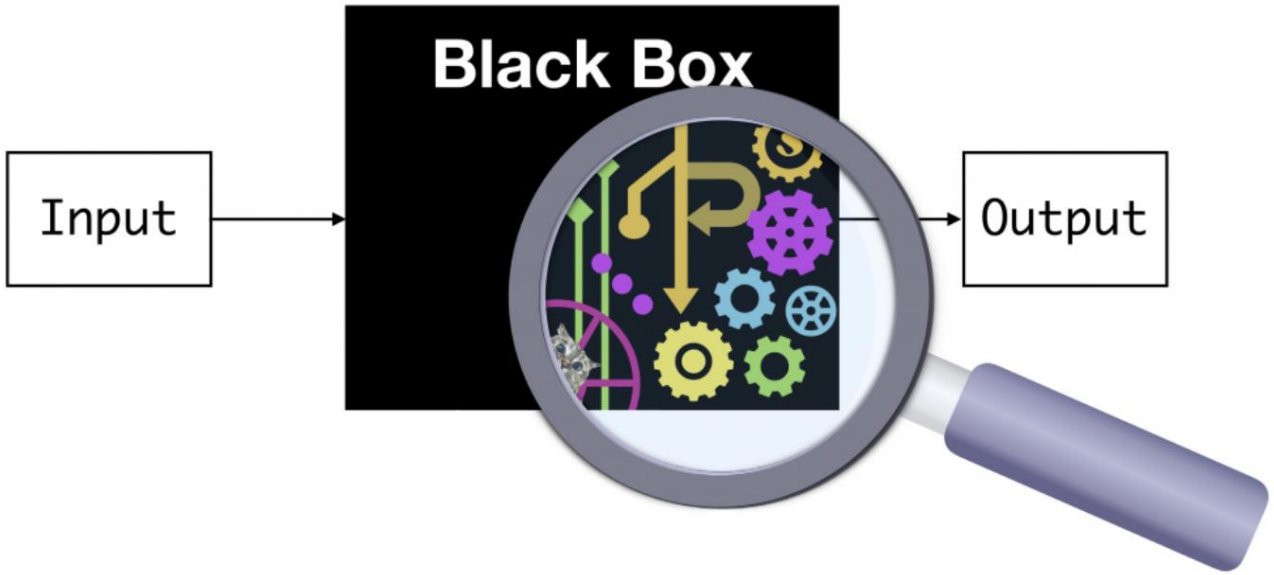


Source : https://electrek.co/2018/10/15/tesla-new-autopilot-neural-net-v9/

Source : https://www.apple.com/shop/buy-homepod/homepod

Deep learning : Black-Box models

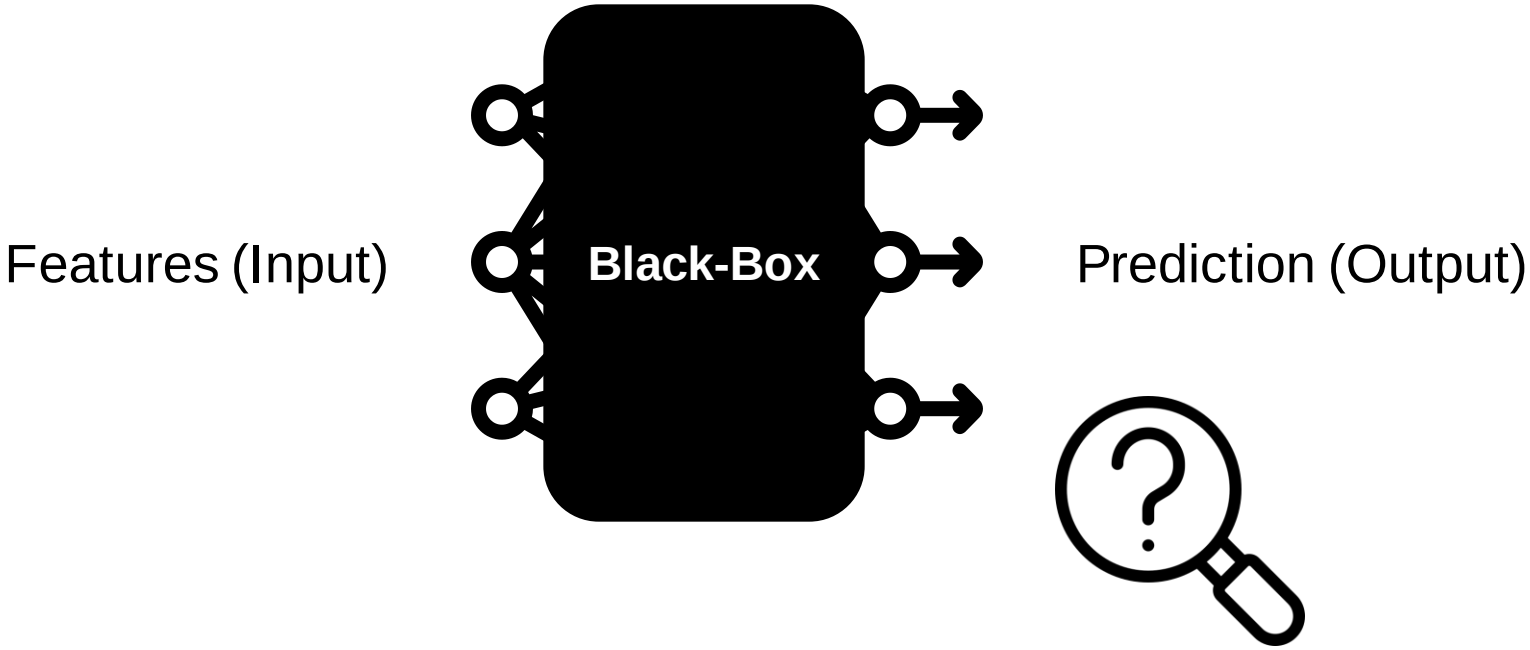
- Many of deep learning systems are black-box which means we don’t really understand how they work and why they reach such decisions.



Source : https://blog.ml.cmu.edu/2019/05/17/explaining-a-black-box-using-deep-variational-information-bottleneck-approach/

Deep learning : Black-Box models

- Accurately predicting outcomes is important
- The key question is **why**



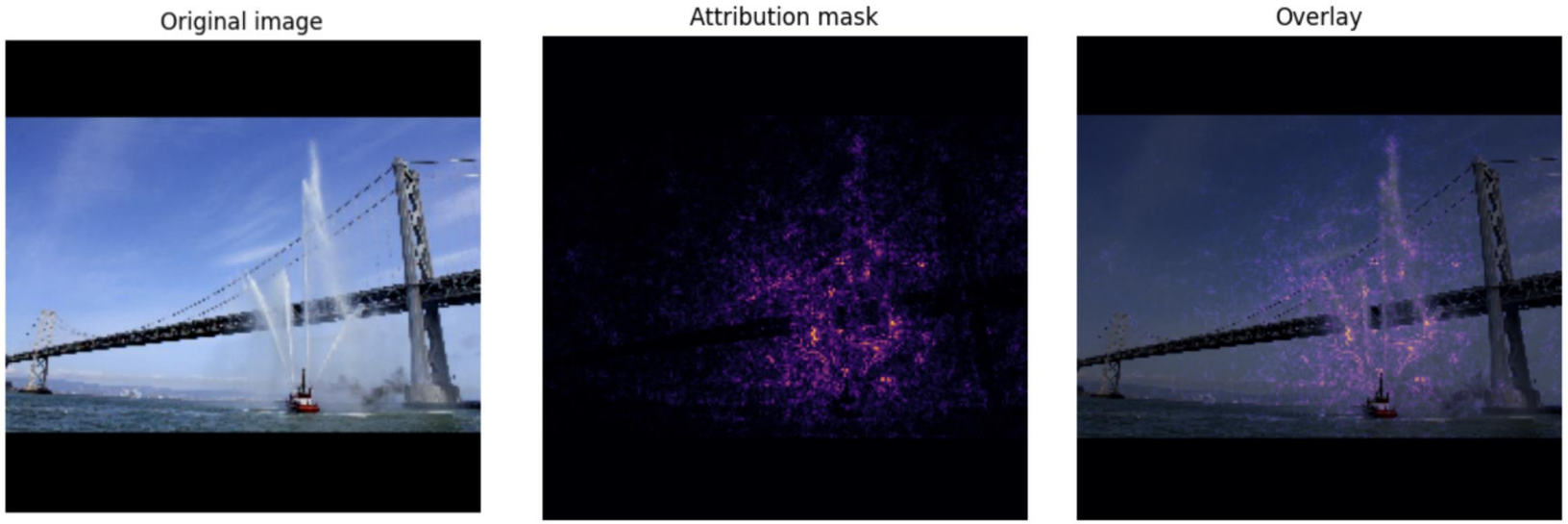
Need for explainability

- The need for explainability is especially urgent in fields, such as disease diagnosis and self-driving cars.
- Explainability can be as important as accuracy.
  - Which features contributed to a certain prediction and how?
  - How to learn or select features that are most informative?

Source：CSEP 590B: Explainable AI Ian Covert & Su-In Lee University of Washington

eXplainable AI(XAI) model

- Explainable AI (XAI) is a type of artificial intelligence that aims to provide transparency and interpretability in the decision-making process of AI models.



Source : https://www.tensorflow.org/tutorials/interpretability/integrated_gradients?hl=ko

eXplainable AI(XAI) model (cont.)

- An XAI model typically involves the use of algorithms and techniques that can explain the reasoning behind the decisions made by the AI system.
- This can include techniques such as decision trees, rule-based systems, and **model-agnostic** methods like LIME (Local Interpretable Model-agnostic Explanations) and SHAP (SHapley Additive exPlanations).

Project Overview & Goals

- Predict the forward and volatility of crude oil
- Examine how the forwards and volatilities of other financial assets affect on the crude oil
- Method : SHAP

Project Overview & Goals – Crude oil

- Crude oil is an important natural resource because it is a primary source of energy that is used to power vehicles, generate electricity, and fuel industrial processes.

- The global economy is highly dependent on crude oil, and fluctuations in its price can have significant impacts on the economies of individual countries and the world as a whole.

Project Overview & Goals – Crude oil (cont.)

- Choi, S. Y. (2022). Dynamic volatility spillovers between industries in the US stock market: Evidence from the COVID-19 pandemic and Black Monday. *The North American Journal of Economics and Finance*, *59*, 101614.

- Choi, S. Y. (2019). The influence of shock signals on the change in volatility term structure. *Economics Letters*, *183*, 108593.

Solution by Mathworks – SHAP

- The Shapley value (from game theory (1953))
- The Shapley value examines the weighted sum of the player's marginal contributions in the cooperative game.
- SHAP(SHapley Additive exPlanations) uses Shapely values to explain individual predictions. (Lundberg, S. M., & Lee, S. I. (2017). A unified approach to interpreting model predictions. *Advances in neural information processing systems*, *30*.)
- Features are considered as players and the prediction is total benefit.

Solution by Mathworks – SHAP (cont.)

- Description : The Shapley value of a feature for a query point explains the deviation of the prediction for the query point from the average prediction, due to the feature. For each query point, the sum of the Shapley values for all features corresponds to the total deviation of the prediction from the average.
- Use the Shapley values to explain the contribution of individual features to a prediction at the specified query point.

Syntax

```
explainer = shapley(blackbox)
```

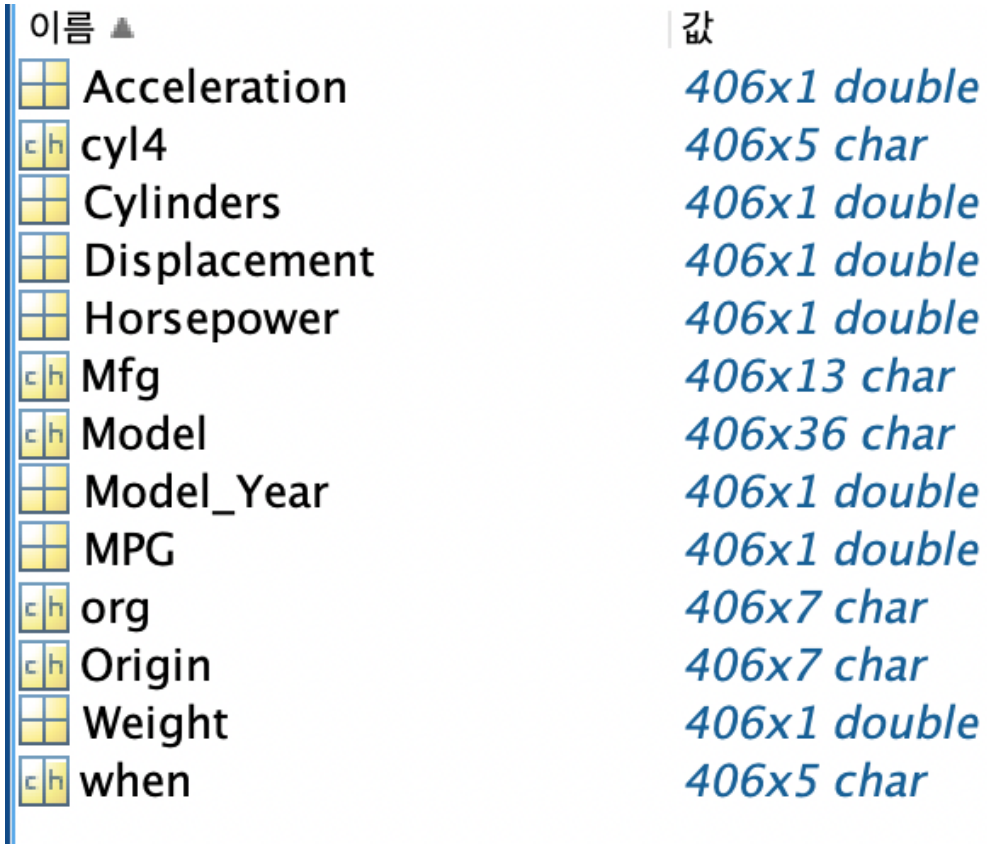
Solution by Mathworks – SHAP (cont.)

- The advantages of SHAP
- Individual feature importance: SHAP can explain the contribution of each feature in a prediction.
- Global feature importance: SHAP can provide a global view of the feature importance.
- Model agnostic: SHAP can be used with any machine learning model, including black box models such as neural networks.

Solution by Mathworks – SHAP ex)

- Ex) carbig set (measurements of cars made in the 1970s and early 1980s)
- MPG prediction
- Feature set

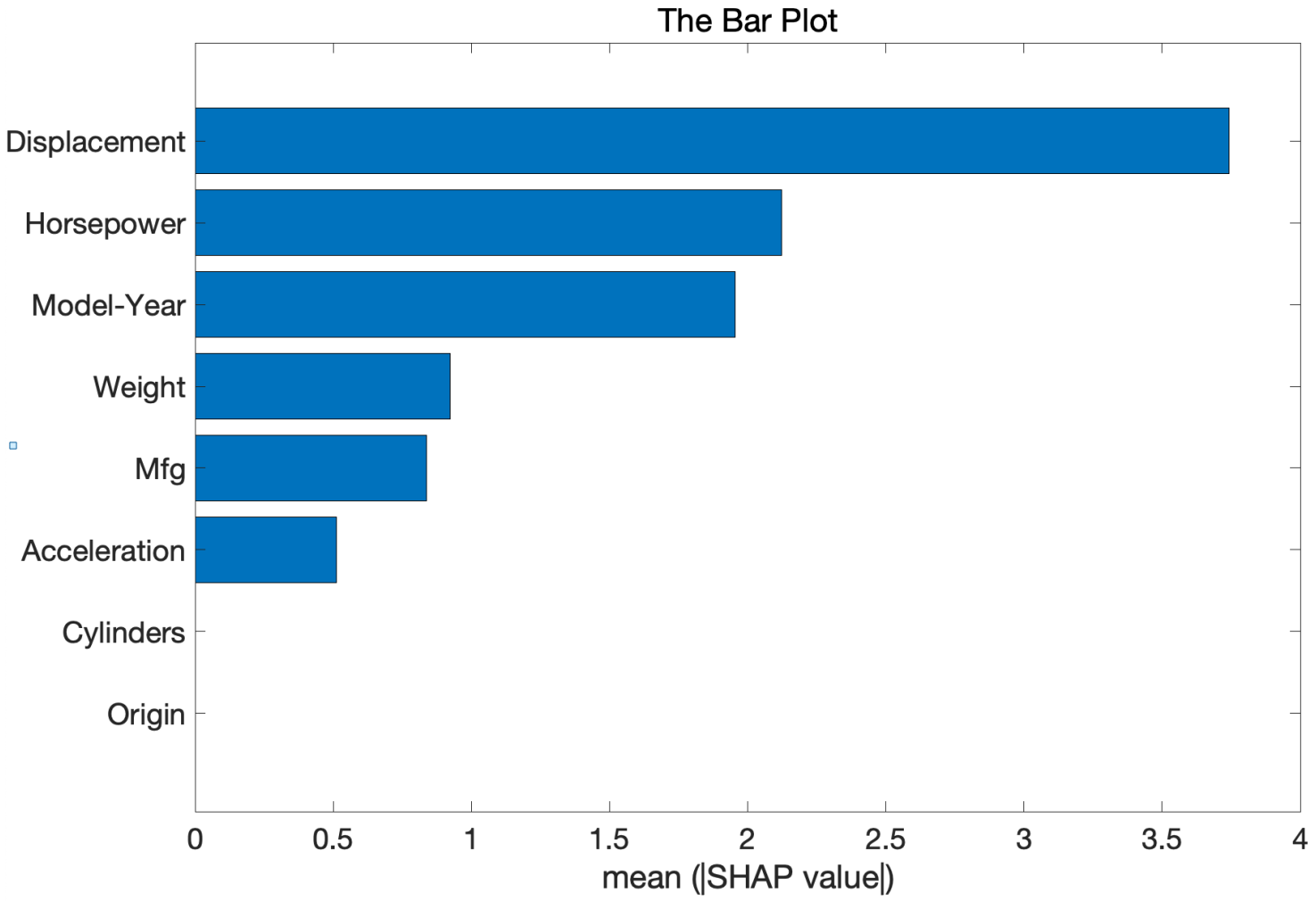
  (Origin, Cylinders, Displacement, Horsepower, Weight, Acceleration, Model_Year, Mfg)



Solution by Mathworks – SHAP ex)

- Global explanations

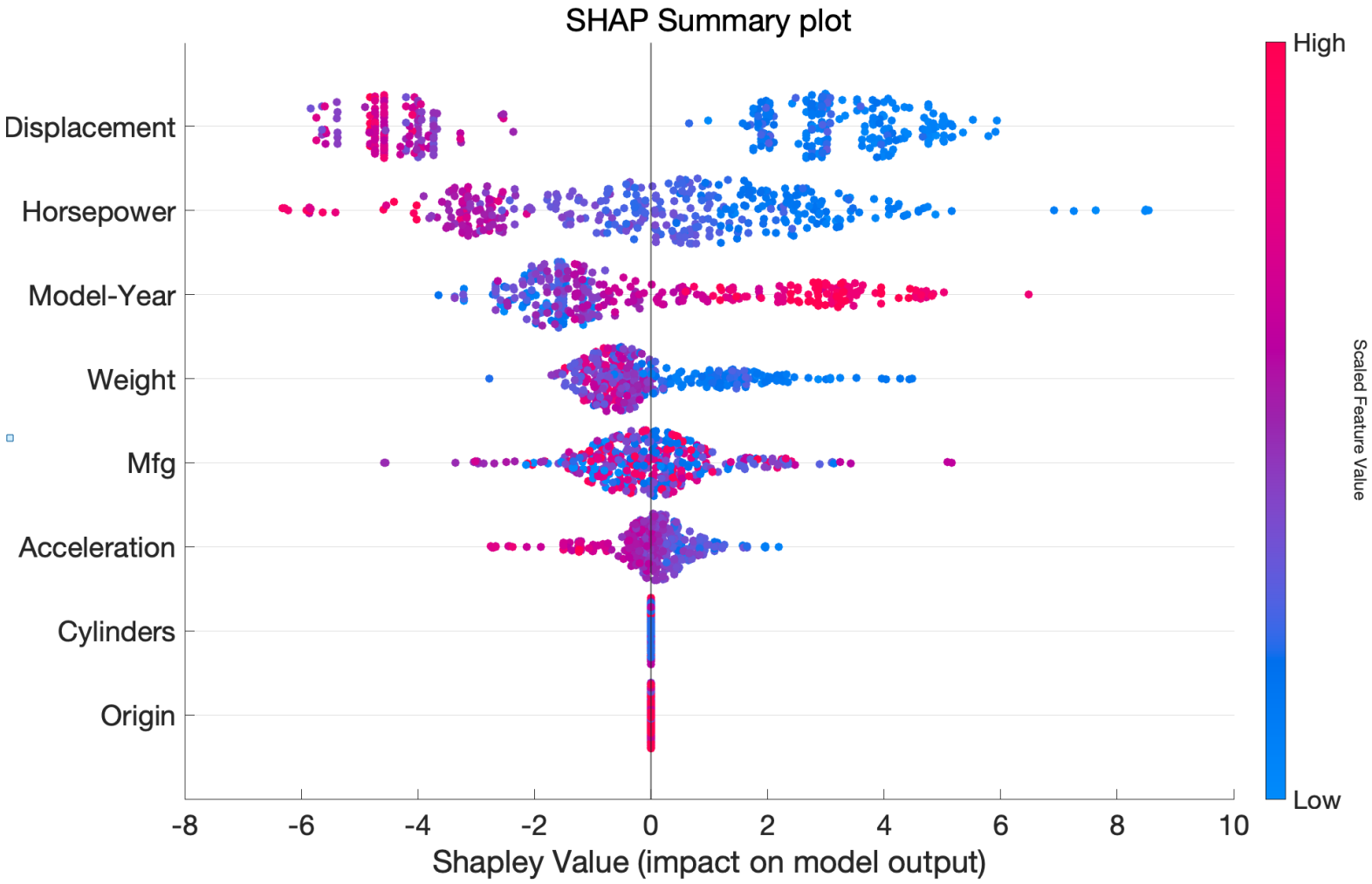
⇒ mean(|SHAP value|)



Solution by Mathworks – SHAP ex)

- Shapley value

⇒ Impact on model output



Solution by Mathworks – Results

- Input Data : forward and volatility of the major agricultural commodities(corn, wheat, and soybeans) and crude oil (2012.7.27 ~ 2022.8.16)

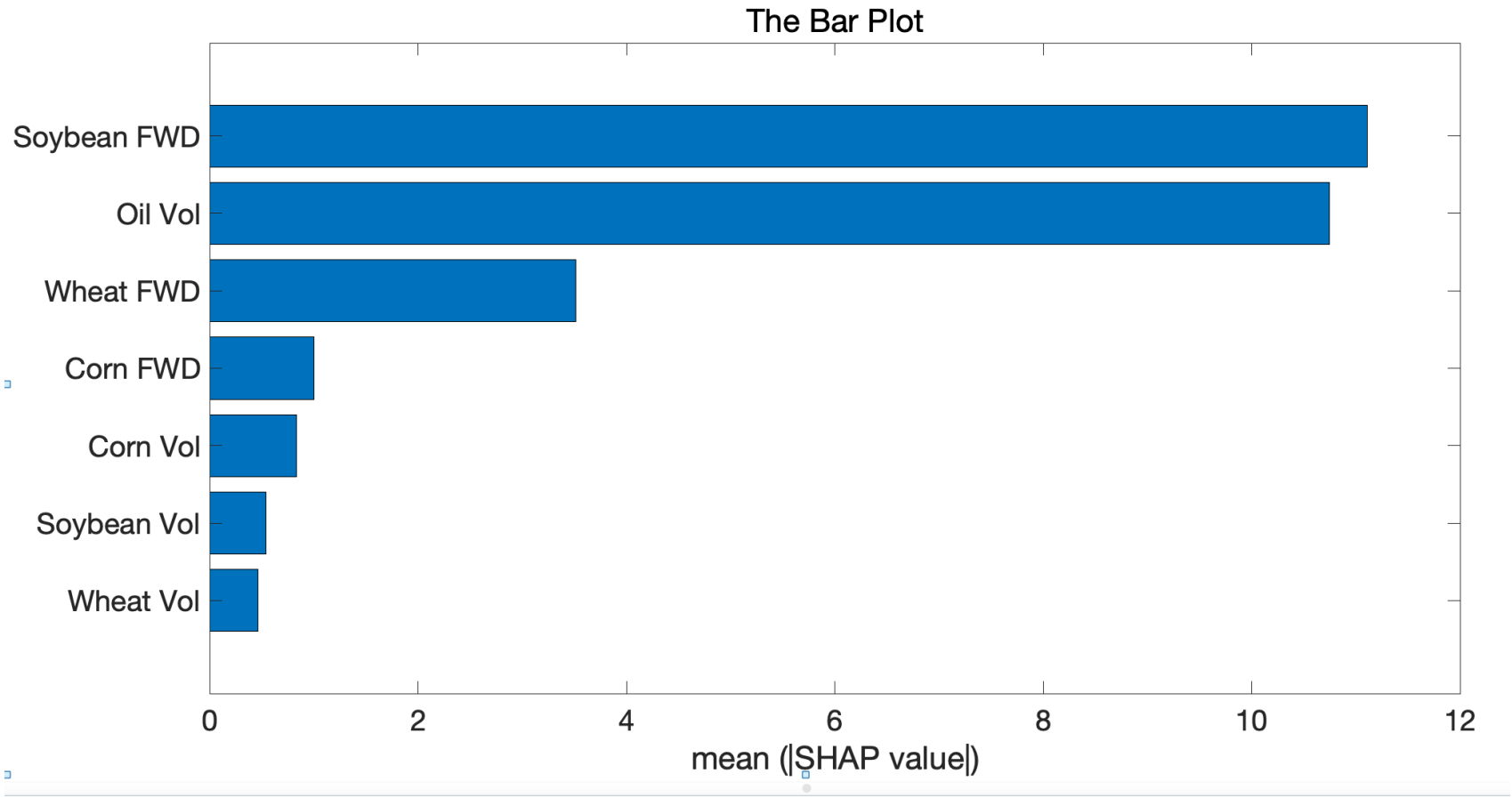
- Forecast the crude oil forward

⇒ Features set : the major agricultural commodities + crude oil volatility

- ML method : Least-Squares Boosting (‘LSBoost’)

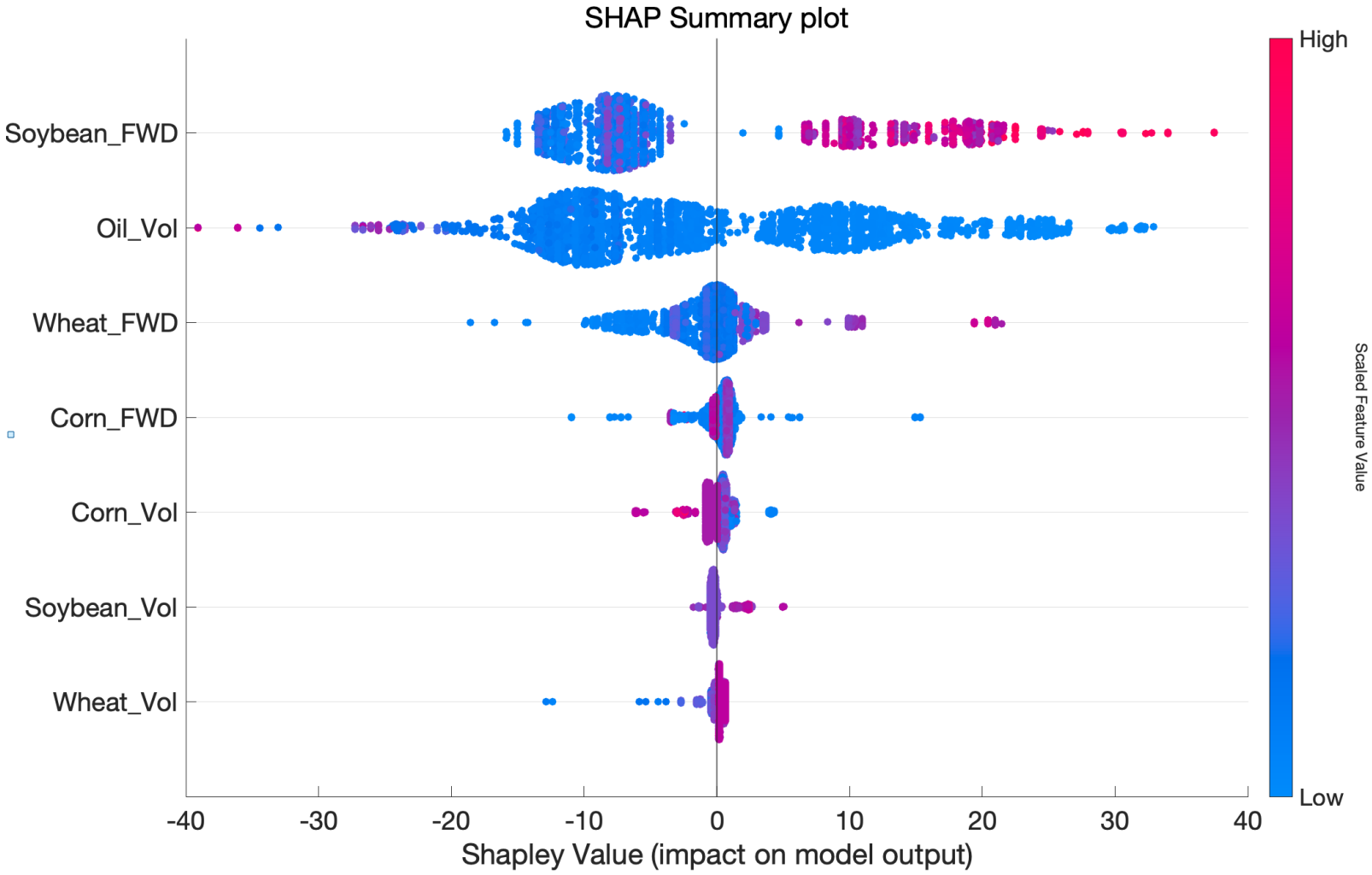
Solution by Mathworks – Results

- Global explanations



Solution by Mathworks – Results

- Summary plot



Summary & Concluding Remarks

- Predicting the forward and volatility of crude oil using SHAP, an XAI methodology

- Soybean forwards have a stronger predictive power than oil volatility in forecasting oil forward price.

- Transportation costs and soybean-based biodiesel

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Thank you

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