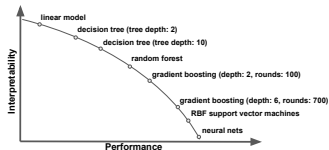# Interpretable Machine Learning

Introduction, Motivation, and History
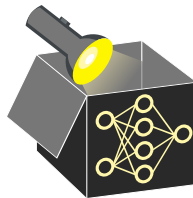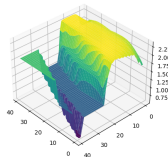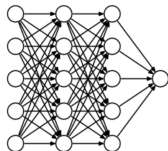

Learning goals

- Why interpretability?
- Developments until now?
- Use cases for interpretability

WHY INTERPRETABILITY?

- ML: huge potential to aid decision-making process due to its predictive performance
- ML models are black boxes, e.g., XGBoost, RBF SVM or DNNs $\leadsto$ too complex to be understood by humans
- Some applications are "learn to understand"
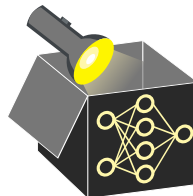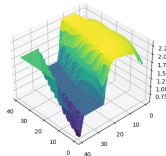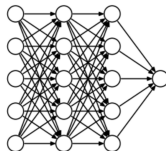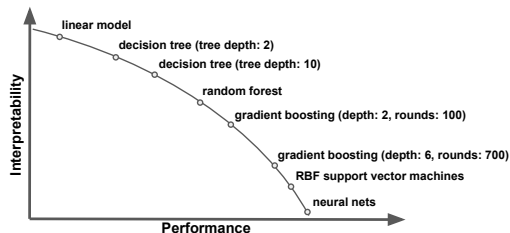
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- ML models are black boxes, e.g., XGBoost, RBF SVM or DNNs $\rightsquigarrow$ too complex to be understood by humans
- Some applications are "learn to understand"
- When deploying ML models, lack of explanations
  1. hurts trust
  2. creates barriers
- $\rightsquigarrow$ Many disciplines with required trust rely on traditional models, e.g., linear models, with less predictive performance

INTERPRETABILITY IN HIGH-STAKES DECISIONS

Examples of critical areas where decisions based on ML models can affect human life

- Credit scoring and insurance applications
  - ▸ Society of Actuaries
    - Reasons for not granting a loan
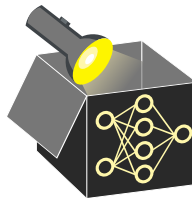   - Fraud detection in insurance claims

INTERPRETABILITY IN HIGH-STAKES DECISIONS

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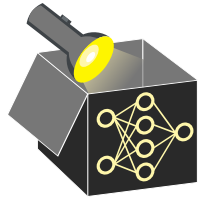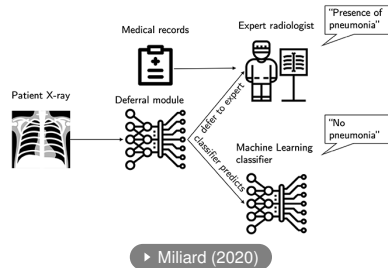 - ▶ Society of Actuaries
    - Reasons for not granting a loan
    - Fraud detection in insurance claims
- Medical applications
  - Identification of diseases
 - Recommendations of treatments
- . . .

▶ Miliard (2020)

NEED FOR INTERPRETABILITY

Need for interpretability becoming increasingly important from a legal perspective

- General Data Protection Regulation (GDPR) requires for some applications that models have to be explainable ▸ Goodman & Flaxman (2017)
  ↝ *EU Regulations on Algorithmic Decision-Making and a "Right to Explanation"*
- *Ethics guidelines for trustworthy AI* ▸ European Commission (2019)
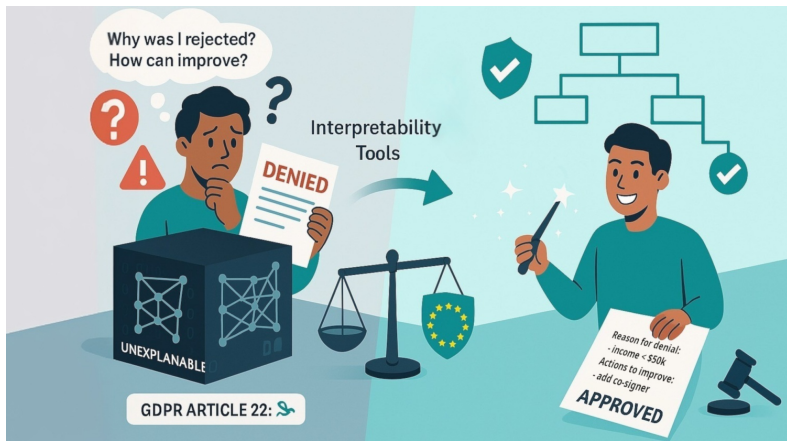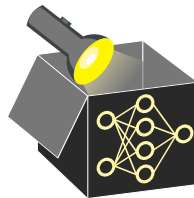
BRIEF HISTORY OF INTERPRETABILITY

- 18th and 19th century:
  Linear regression models (Gauss, Legendre, Quetelet)

- 1940s:
  Emergence of sensitivity analysis (SA)

- Middle of 20th century:
  Rule-based ML, incl. decision rules and decision trees

- 2001:
  Built-in feature importance measure of random forests

- >2010:
  Explainable AI (XAI) for deep learning

- >2015:
  IML as an independent field of research

▸ Carl Friedrich Gauss

▸ Wikipedia

Dataset

Majority Voting / Average

Final result