FEDERAL RESERVE BANK of ATLANTA

Some Regulatory Implications of Machine Learning

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Definitions

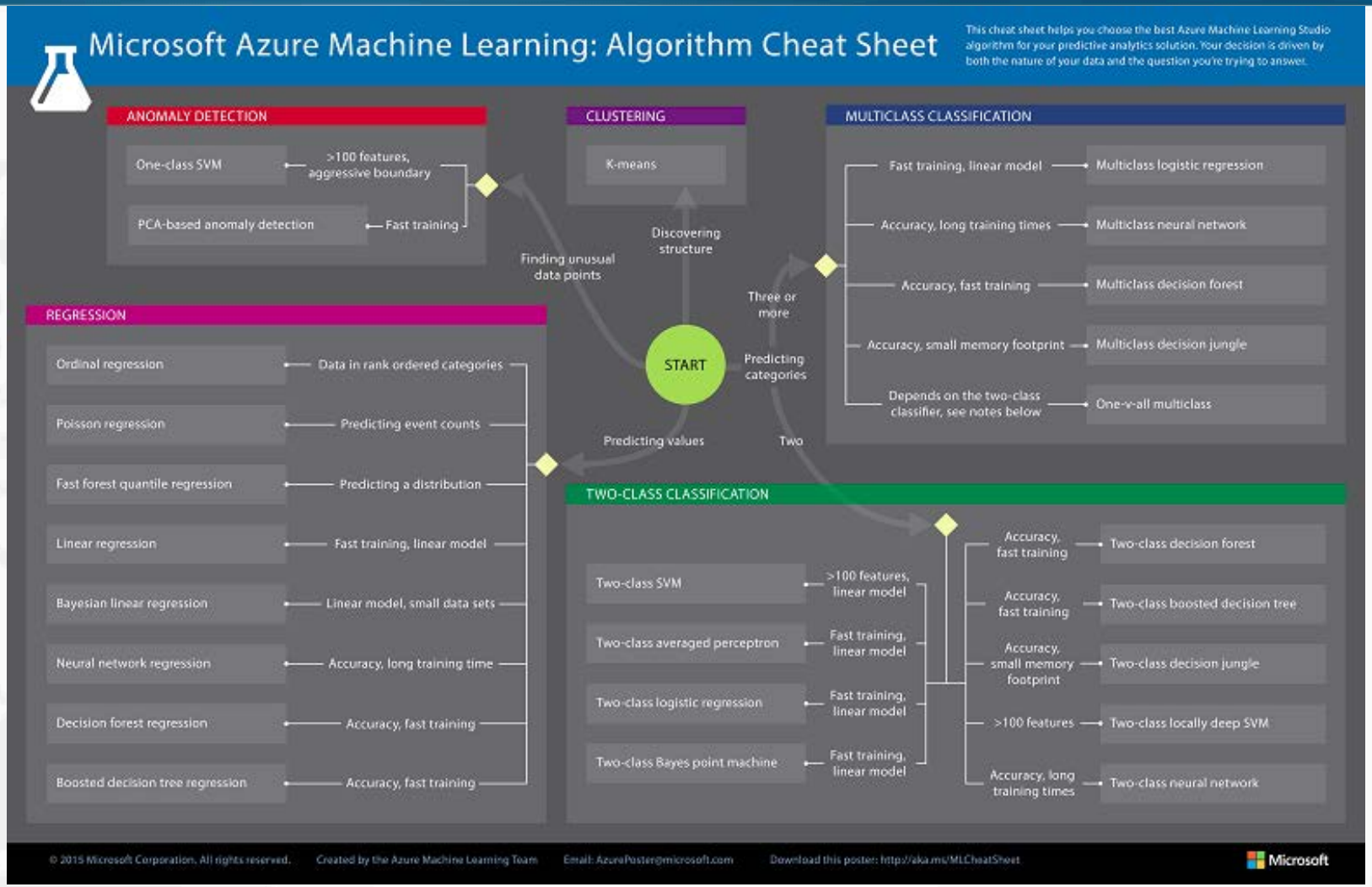
- **Artificial intelligence**: the theory and development of computer systems able to perform tasks that normally require human intelligence
- **Machine learning**: Machine learning is a type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed.
- **Deep Learning:** is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

Types of Machine Learning

- Three main types

1. Supervised learning
   - Classification
   - Predict value
2. Unsupervised learning – clustering
3. Reinforcement learning – algorithm makes a decision at each step.
   - Game playing
   - Opening a door

Multiple algorithms for individual goals



https://docs.microsoft.com/en-us/azure/machine-learning/machine-learning-algorithm-cheat-sheet

Relationship of statistics and machine learning

Wasserman on the differences between statistics and machine learning

- “The short answer is: None. They are both concerned with the same question: how do we learn from data?”
- “a more nuanced level there are differences due to historical and sociological reason.
  - “Statistics emphasizes formal statistical inference (confidence intervals, hypothesis tests, optimal estimators) in low dimensional problems. Machine Learning emphasizes high dimensional prediction problems.”
- https://normaldeviate.wordpress.com/2012/06/12/statistics-versus-machine-learning-5-2/

Observations on machine learning

- Potential advantages
  - Potentially superior pattern recognition
  - Potentially lower variable costs relative to humans
  - Consistency—never tired or distracted
- As a form of statistics, it imports the same set of issues
  - Machine learning focus on prediction means it is largely atheoretic but correlation is not equal to causation
    - In practice, ML usage is “Iterative and experimental”
  - Quality and consistency of the data are critical
  - …
- Deep learning is currently a black box in terms of how it makes its predictions

Some use cases of ML

- Improved marketing through customer segmentation
- Fraud detection
- Credit risk management
- Algorithmic trading
- Regulatory compliance
  - Know your customer / antimony laundering
  - Stress testing model development
  - Monitoring of behavior

Direct application to supervision and regulation

- Regulation versus supervision
  - Regulation is writing rules that must be obeyed
  - Supervision is inspection and examination of the firm
- Atheoretical analysis may uncover unanticipated relationships
  - “Iterative and experimental” could work for supervisors who can evaluate AI findings in a broader context
  - Need more caution with regulation,
    - Regulatees do not like being the subjects of experimentation
    - But could lead to better understanding of causal relationships that lead to better regulation

Limitations for regulation

- ML is a statistics
- David Rowe:

  "No amount of complex mathematical/statistical analysis can possibly squeeze more information from a data set than it contains initially.“
- This is a weakness in writing regulations to deal with two of the central problems of regulation

Limitations for regulation

1. Measuring the risk of failure and losses given failure
   - ML can help banks comply with regulatory stress testing requirements but it has limited ability to improve accuracy of forecasts of stress periods
   - Given large portfolios, individual assets regularly take large losses
   - But losses that cause failure requires large correlated losses in multiple asset classes which rarely happens
   - Need theory to link observable distribution of individual asset losses to large portfolio losses—
     - More loan level data from good times run through an atheoretical model is unlikely to contribute much

Limitations for regulation

2. Changes in regulation will change agents' behavior which may change the data generating process
   - Goal of regulation is change in behavior
   - Unintended changes possible by regulatees' and others'
   - Unlike Go or poker, new regulation can change the game's structure
   - ML & AI unlikely to predict structure changes
   - ML & AI may help regulators understand the current system leading to better predict responses to new regulation

Other implications of machine leaning

1. ML impact on bank profitability and risk through its impact on the rest of society
   - ML is producing big winners
   - But also big losers
     - Firms with obsolete business models
     - For workers

       "Fundamentally, human tasks break down in two categories: creative work and executional work. AI and machine learning threaten to replace all executional work, but fortunately for the humans, even at their best these systems are still terrible at the creative."

       - http://www.accountingweb.com/community/blogs/ryan-watson-cpa/machine-learning-isnt-the-end-for-accountants

Other implications of machine leaning

2. ML impact on structure of financial industry
   - Short to medium run: Explosion of competition
   - Longer run: Increasing gains from size suggests winner take (almost) all
     - Likely nearly linear processing costs from more data
     - Program development—nearly a fixed cost
     - Increasing product quality from having more data

Further discussion

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