Learning Methods for Interferometers
Deep Machine Learning?

- What problems do we want to solve which we cannot do yet?
  - Mystery noise, tilt-horizontal, angular noise,…
- What problems are already solvable but quite difficult?
  - Global feedback design, glitch classification
- Are there techniques out there?
Some Dreams

- Use the flashing time series to learn how to lock the interferometer. Multiple error signals linearized.

- Use PEM signals to predict glitches

- Array of accelerometers/microphones to synthesize the scattered light noise

- Diagnose noisy states of interferometer before the operators. Send SMS to appropriate scientist.

- Predict imminent failure of facility systems with PEM + HVAC sensors. (power lines, weather, HVAC vibrations)

- Slow trends in backscatter or other couplings indicate device failures. (e.g. photodiodes, DACs, wires, laser alignments)

- poor operating decisions indicate operator is getting tired
Microsoft Azure Machine Learning: Algorithm Cheat Sheet

ANOMALY DETECTION
- One-class SVM
- PCA-based anomaly detection

CLUSTERING
- K-means

MULTI-CLASS CLASSIFICATION
- Multiclass logistic regression
- Multiclass neural network
- Multiclass decision forest
- Multiclass decision jungle

REGRESSION
- Ordinal regression
- Poisson regression
- Fast forest quantile regression
- Linear regression
- Bayesian linear regression
- Neural network regression
- Decision forest regression
- Boosted decision tree regression

TWO-CLASS CLASSIFICATION
- Two-class SVM
- Two-class averaged perceptron
- Two-class logistic regression
- Two-class Bayes point machine
- Two-class decision forest
- Two-class boosted decision tree
- Two-class decision jungle
- Two-class locally deep SVM
- Two-class neural network

This cheat sheet helps you choose the best Azure Machine Learning Studio algorithm for your predictive analytics solution. Your decision is driven by both the nature of your data and the question you’re trying to answer.
Google TensorFlow
What ML techniques?

- Unsupervised Learning
  - only has input data (no target)
- Supervised Learning (includes all of MS Azure)
  - has both input and output (e.g. PEM & h(t))
- Reinforcement Learning
  - given knowledge of desired output states
  - algorithms learn how to move to desires based on inputs
Removing the Mystery Noise

- Many Noise problems eliminated
- All linear regression combinations checked
- Now testing some bilinear methods by brute force creation of pseudo channels
- Think we need more fully nonlinear estimator
Nonlinear Regression

- Volterra (1890) series representation; expanded by Wiener
- Beyond linear regression; includes ‘by-hand’ nonlinear terms (e.g. higher order polynomials)
- Kernel based methods, self generate basis
- L1 & L2 norms used to reduce complexity / sparseness
Early example of RL

Adaptive control of pulse phase in a chirped-pulse amplifier

Anatoly Efimov, Mark D. Moores, Nicole M. Beach, Jeffrey L. Krause, and David H. Reitze

Author Affiliations • Find other works by these authors
Some Useful Links

• http://usblogs.pwc.com/emerging-technology/demystifying-machine-learning/

• https://www.udacity.com/course/machine-learning--ud262


• http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=MachineLearning