Learning Methods for Interferometers

Rana Adhikari
Caltech
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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?

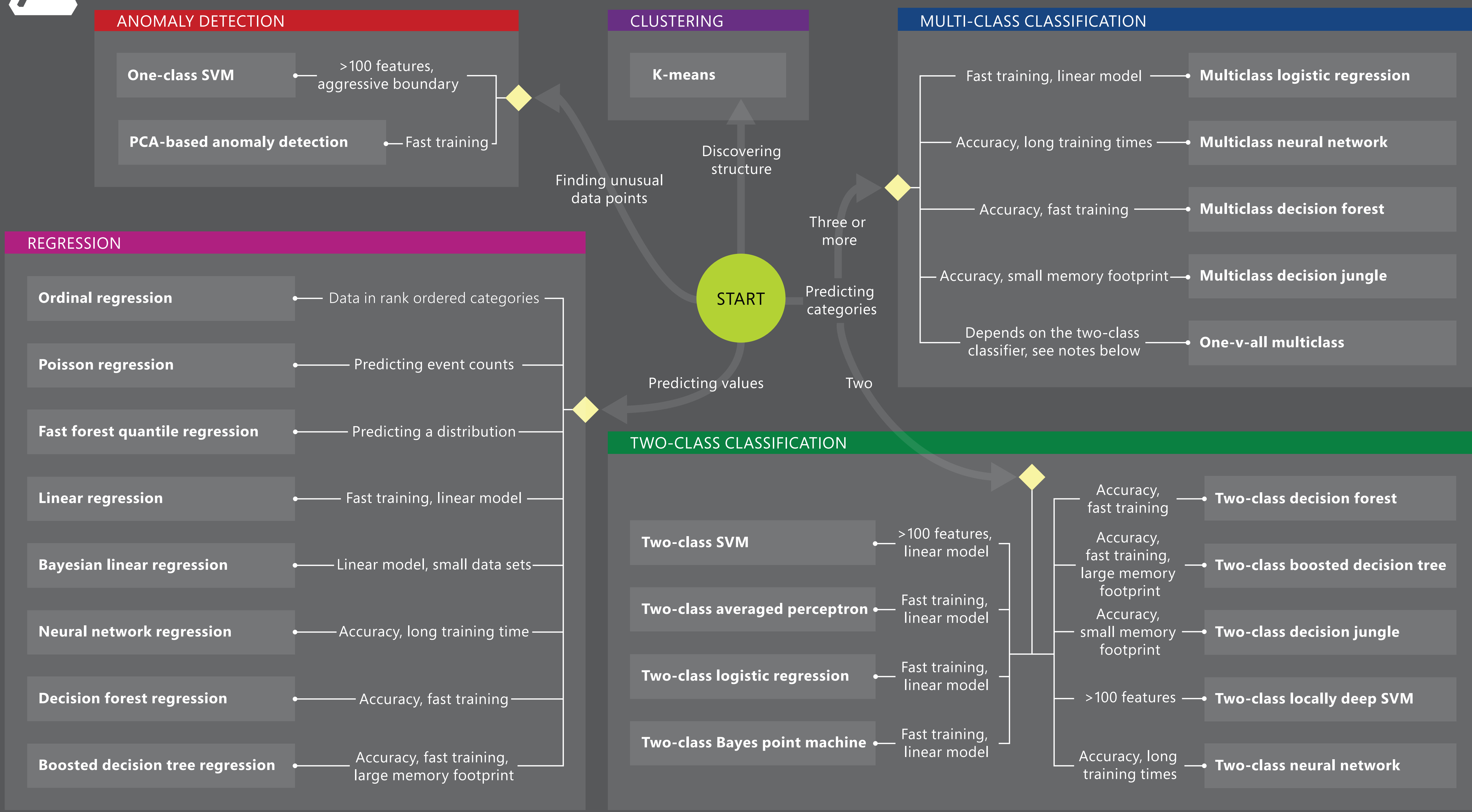

it RetRaces its steps.
r = sin θ
θ = π/3
θ = π/6
y = A + B cos 2x
r = cos θ for 0 ≤ θ ≤ π/2
(1, 0) = begin

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

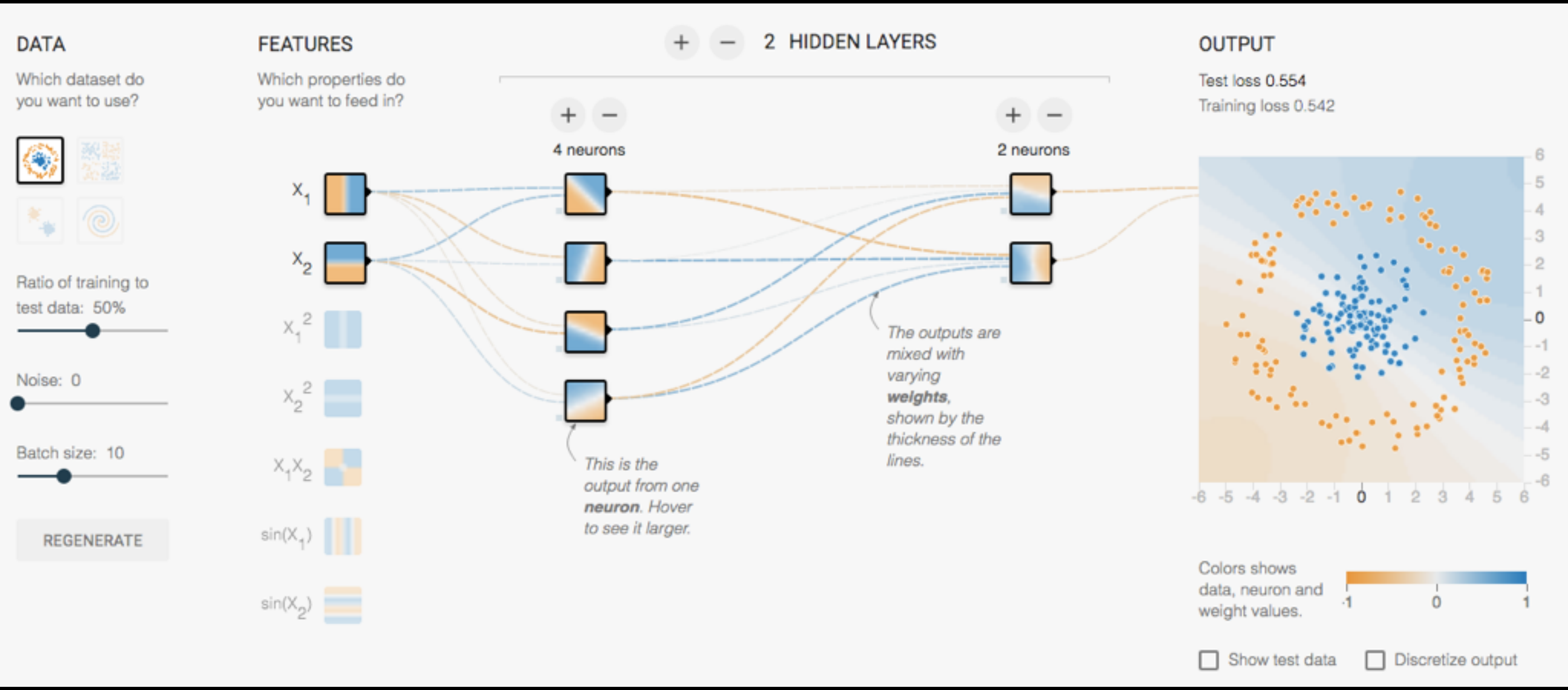
Microsoft Azure Machine Learning: Algorithm Cheat Sheet

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.



 Created by the Azure Machine Learning Team Email: AzurePoster@microsoft.com Download this poster: http://aka.ms/MLCheatSheet Microsoft

Google TensorFlow

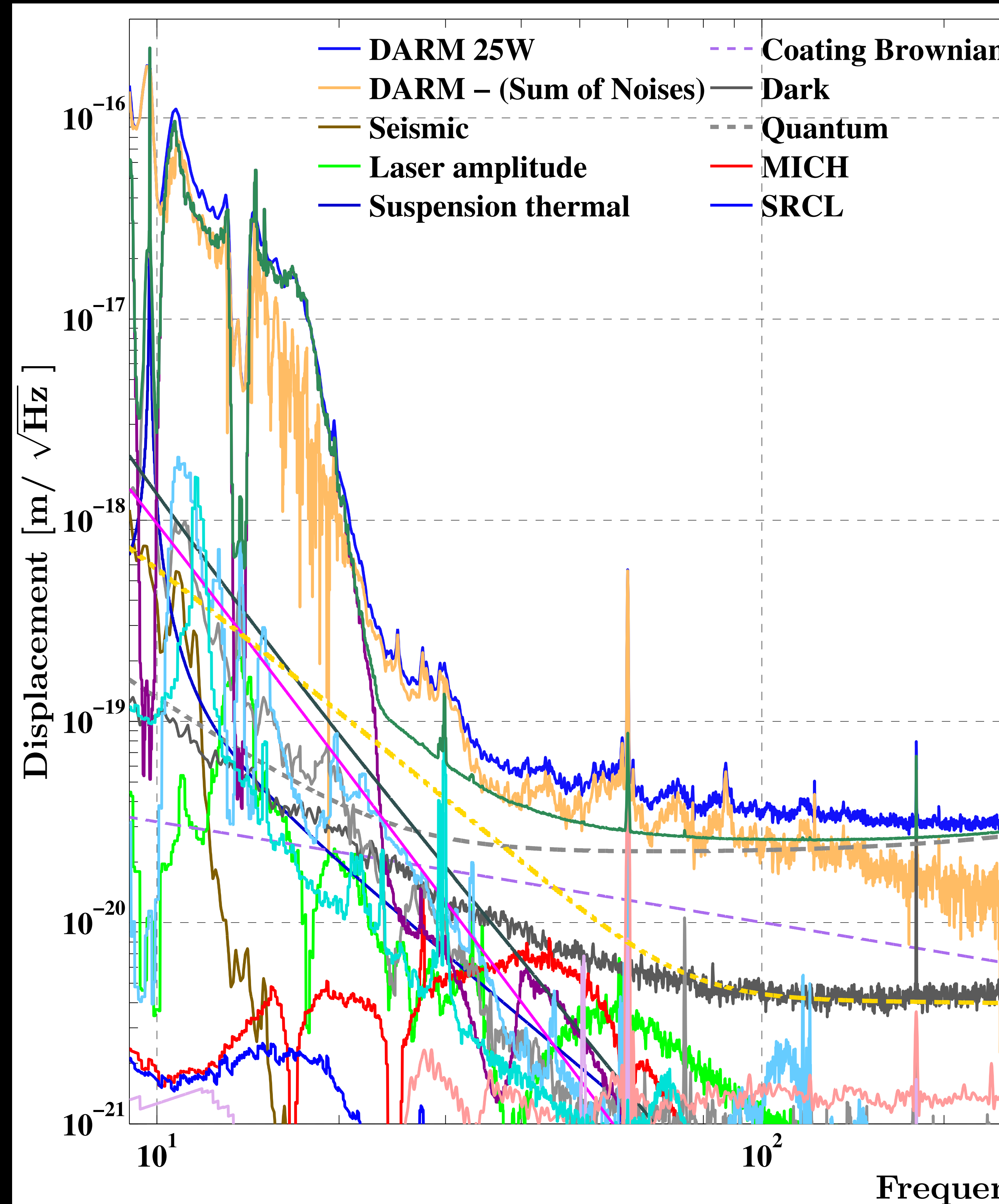


What ML techniques?

- 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

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Some Useful Links

- http://usblogs.pwc.com/emerging-technology/demystifying-machine-learning/
- https://www.udacity.com/course/machine-learning--ud262
- https://azure.microsoft.com/en-us/documentation/articles/machine-learning-algorithm-choice/
- http://openclassroom.stanford.edu/MainFolder/CoursePage.php?course=MachineLearning
- https://www.quora.com/What-is-the-difference-between-L1-and-L2-regularization