Learning Structure for Computer Systems Management

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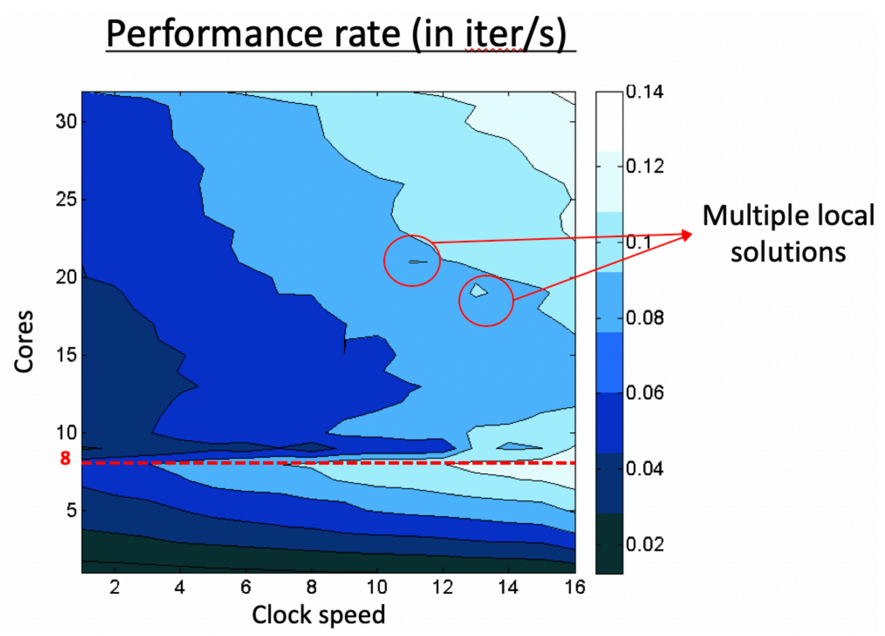
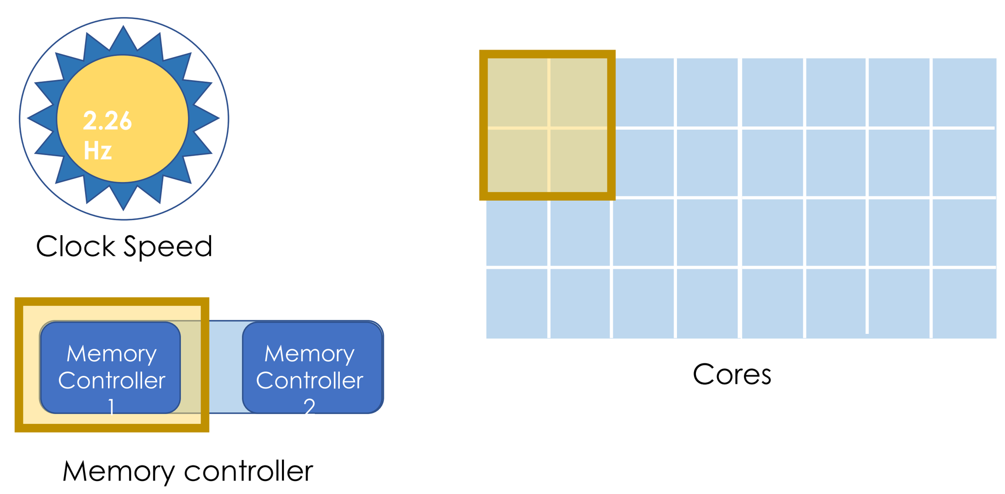
I. Introduction

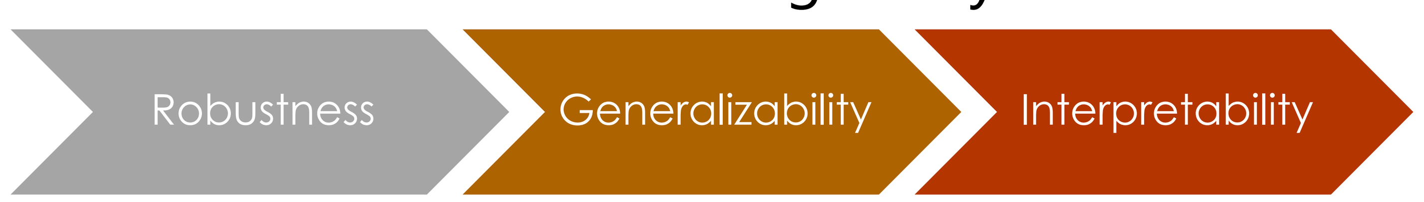
1. Complex Computer Systems



$\mathcal{C} \leftarrow$ {Core assignment} × {Clock speed assignment} × {Memory controller}



2. Machine Learning for Systems



3. My PhD Research

Key ideas:

- Understand system structure for robust and interpretable results

System structure
Single machine — Asymmetric benefits, Scarce data
Datacenter — Imbalanced data, Interpretability

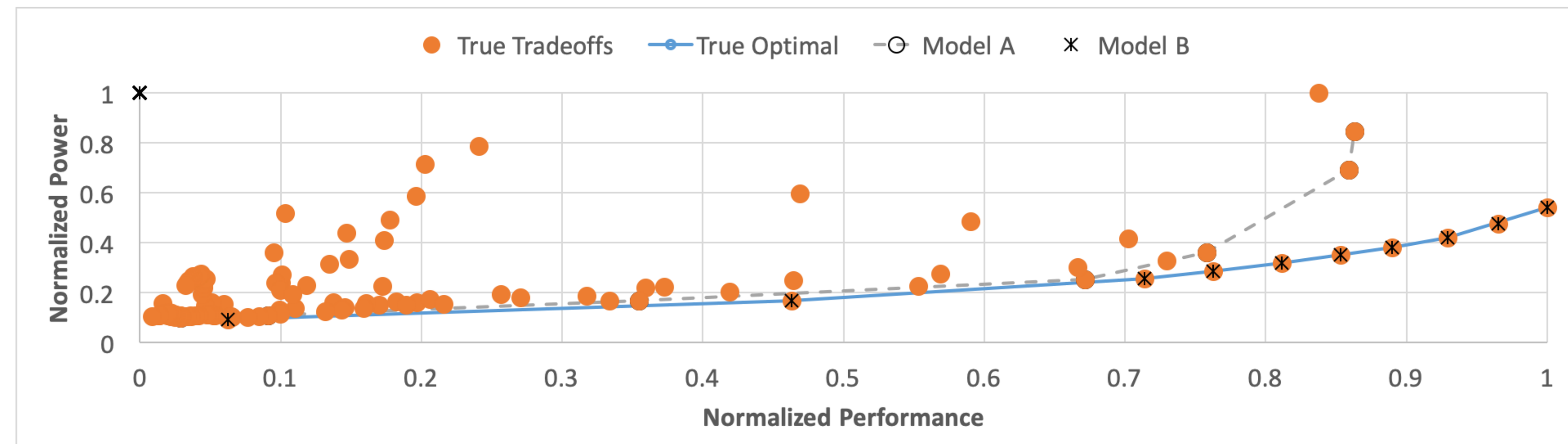
- Incorporate causal analysis to traditional ML methods

1. M. Gao, Y. Ding, B. Aragam. A Polynomial-time Algorithm for Learning Nonparametric Causal Graphs. NeurIPS, 2020.
2. Y. Ding, P. Toulis. Dynamical Systems Theory for Causal Inference with Application to Synthetic Control Methods. AISTATS, 2020.
3. Y. Ding, N. Mishra, H. Hoffmann. Generative and Multi–phase Learning for Computer Systems Optimization. ISCA, 2019.
4. Y. Ding, R. Kondor, J. Eskreis-Winkler. Multiresolution Kernel Approximation for Gaussian Process Regression. NeurIPS, 2017. (Spotlight)
5. Y. Ding, C. Liu, P. Zhao, S. C. Hoi. Large Scale Kernel Methods for Online AUC Maximization. ICDM, 2017. (Long Oral)
6. Y. Ding, P. Zhao, S. C. Hoi, Y. S. Ong. An Adaptive Gradient Method for Online AUC Maximization. AAAI, 2015. (Oral)

II. Learning for Systems Optimization with Scarce Data and System Structure (ISCA'19)

How to find the optimal system configurations?

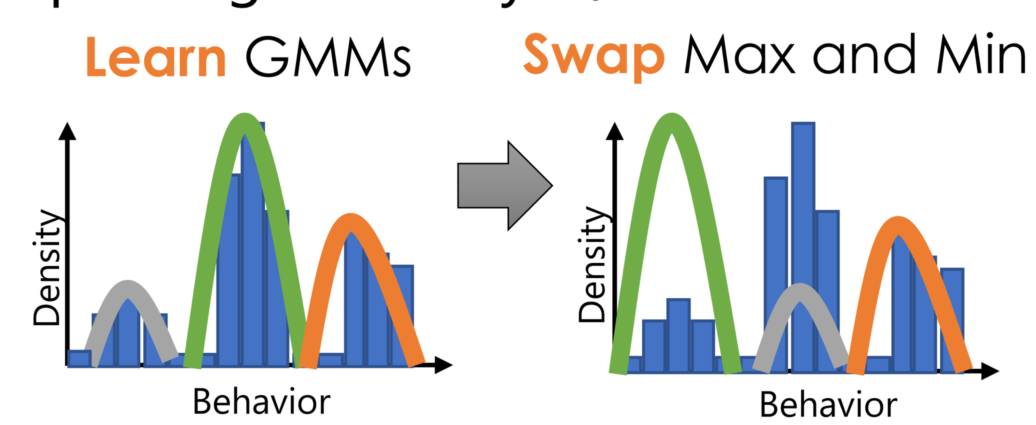
1. Motivational Example: SRAD on big.LITTLE system



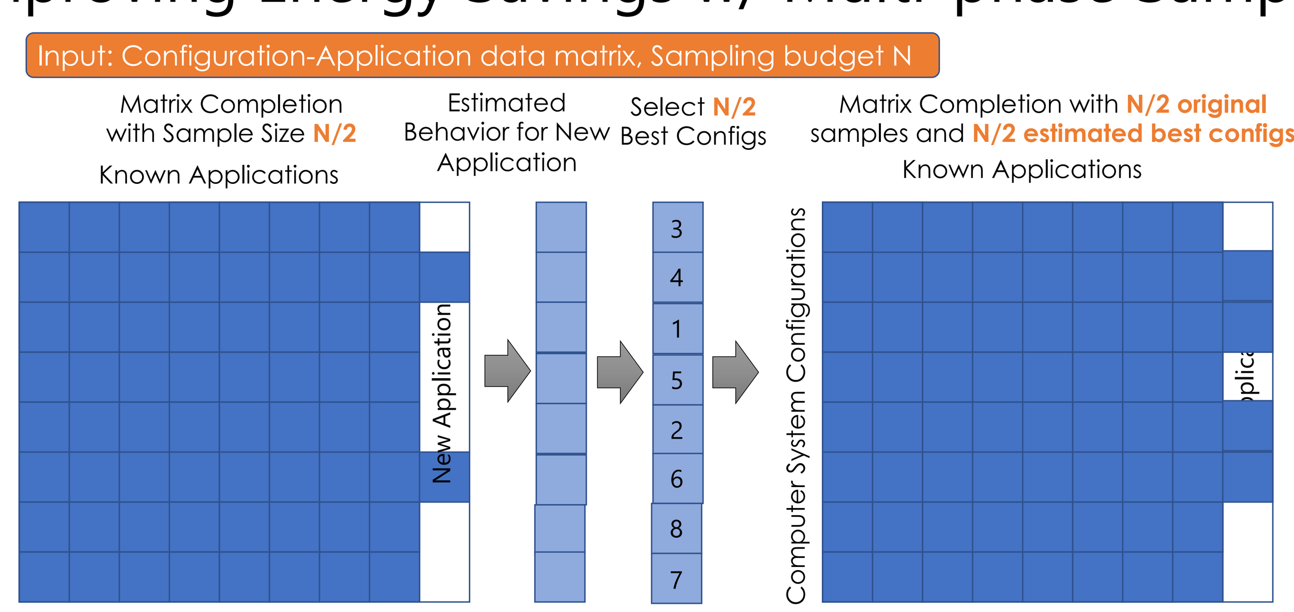
	Model A	Model B
Optimal points	Just far enough	True data
Non-optimal points	True data	Very far
Goodness of fit	99%	0
Energy over optimal	22% ❌	0 ✅

Key Insight:
High accuracy ≠ good system results

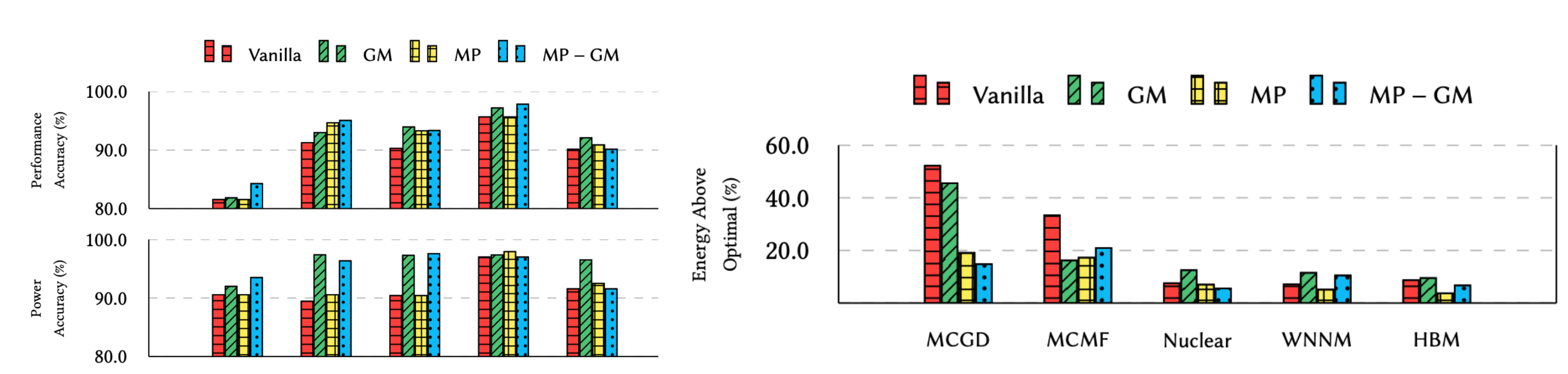
2. Improving Accuracy w/ Generative Model



3. Improving Energy Savings w/ Multi-phase Sampling



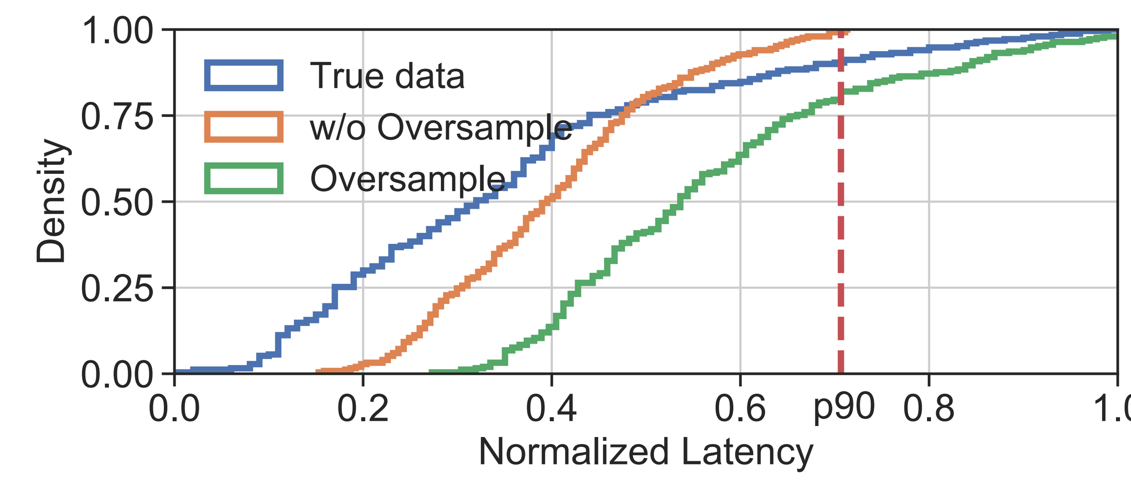
4. Experimental Results



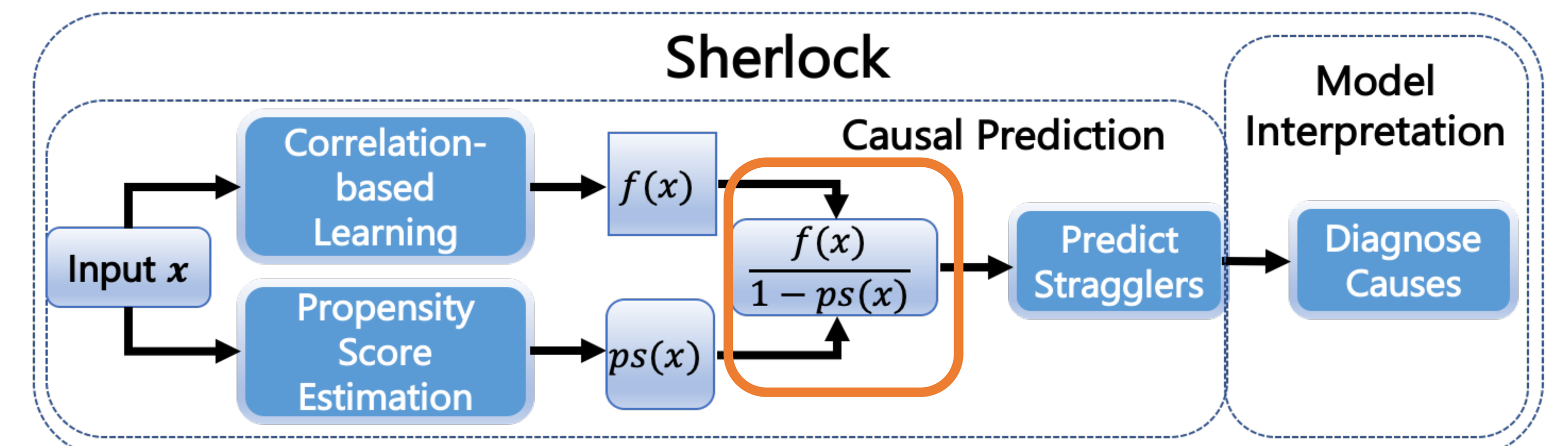
III. Learning for Straggler Prediction with Imbalanced Data

How to make early and accurate straggler prediction?

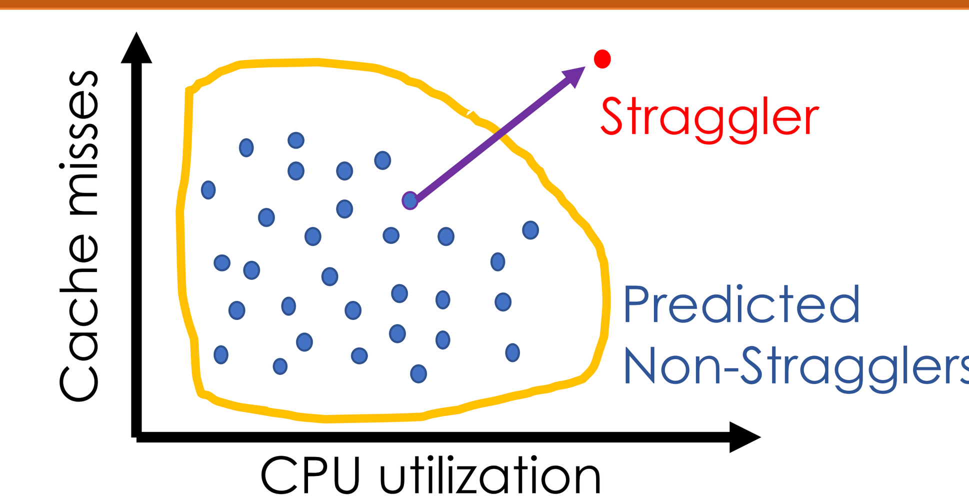
1. Limitations of Traditional ML for Straggler Prediction



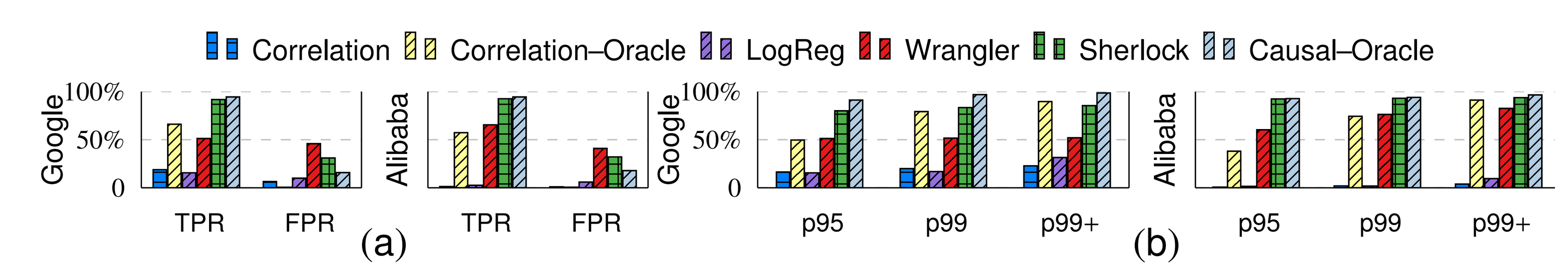
2. Our Solution: Sherlock

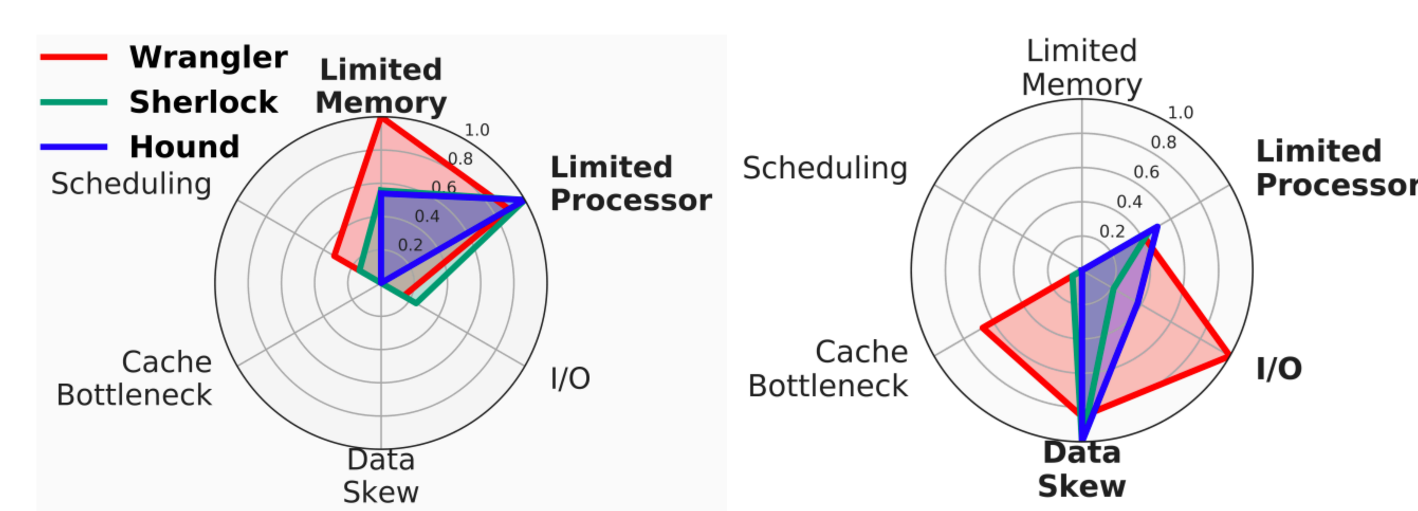


Key Insight:
Adjust predictions w/ propensity score



3. Experimental Results





(a) Job 6343946350 (b) Job 6308689702