

Motivation

- There is growing awareness that AI and ML systems can in some cases learn to behave in unfair ways



J. Angwin et al., ProPublica, 2016

- AI community has invested a large amount of effort
- However, techniques for ensuring fairness have currently attained relatively little adoption in deployed AI systems
- Main barrier: **Fairness brings a cost in performance!**

"Big Tech refuses to prioritize solving these issues over their bottom line."

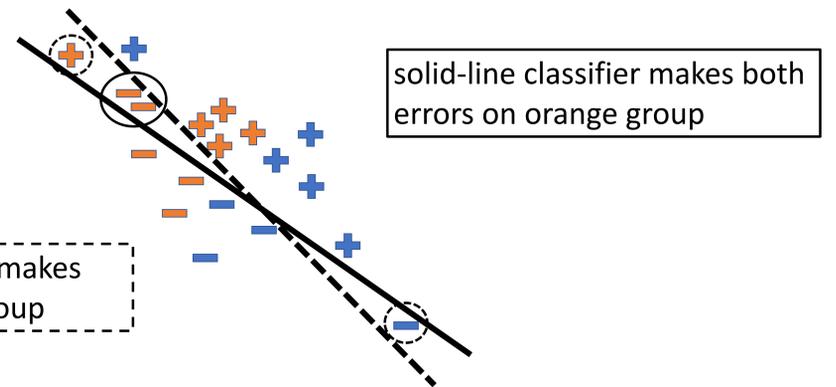
-- Kate Crawford. NYT, 2016

Our Research Questions?

- Clearly trade-offs exist, but are they inevitable?
 - Is it possible to obtain some degree of improvement in **fairness metrics for free**?
- Our study shows the answer is frequently yes!*

Fairness for Free

- We identify **two mechanisms** that can potentially lead to fairness for free:
 - The regularization benefits of fairness penalties**
 - It has potential to reduce overfitting
 - "Gerrymandering" the errors between protected groups**
 - Multiple classifiers can potentially obtain same or similar number of errors



Hyper-parameter Selection Strategy

- Full Hyper-parameter Search (FHS)**
 - our gold standard
 - Over all DNN hyper-parameters + λ
- Stage-wise Hyper-parameter Search (SHS)**
 - faster alternative
 - Over only the fairness trade-off λ

For both strategies, select the fair model with the best fairness metric, such that accuracy is at least as good as for best typical model (TM)

Fair Learning Algorithms

- Differential Fair Model (DFM)** J Foulds et al., ICDE, 2020

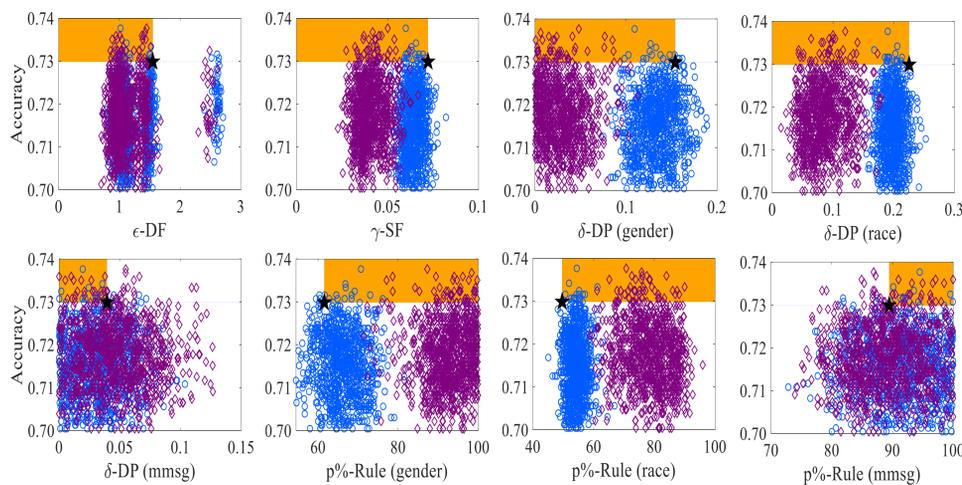
$$\min_{\theta} f(\mathbf{X}; \theta) \triangleq \frac{1}{N} \sum_{i=1}^N L(\mathbf{x}_i; \theta) + \lambda [\max(0, \epsilon(\mathbf{X}; \theta) - \epsilon_t)]$$
- Adversarial Debiasing Model (ADM)** Loupe et al., NeurIPS, 2017

$$\min_{\theta} \max_{\phi} f(\mathbf{X}; \theta, \phi) \triangleq \frac{1}{N} \sum_{i=1}^N L(\mathbf{x}_i; \theta) - \lambda L(\mathbf{X}; \theta, \phi)$$

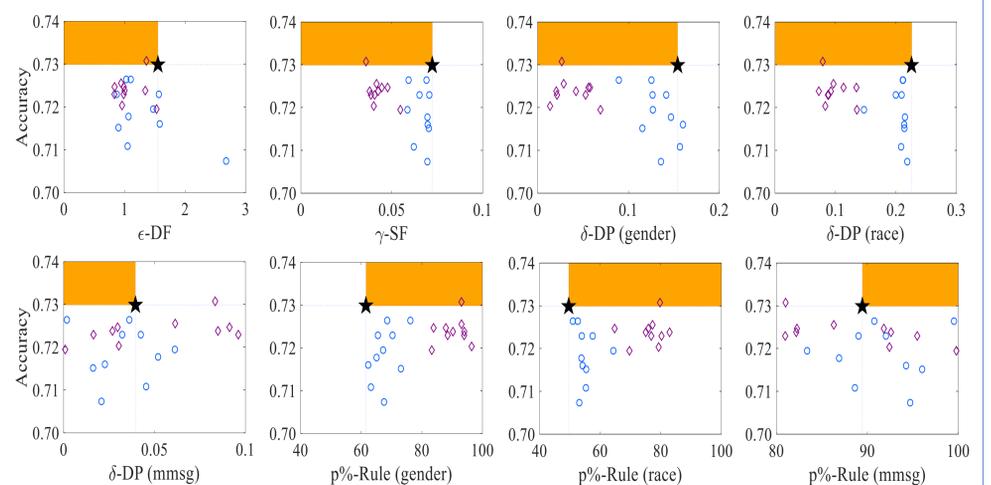
Analysis on Grid Search

★ TM ○ DFM ◇ ADM ■ Fairness for Free Region

FHS on COMPAS



SHS on COMPAS

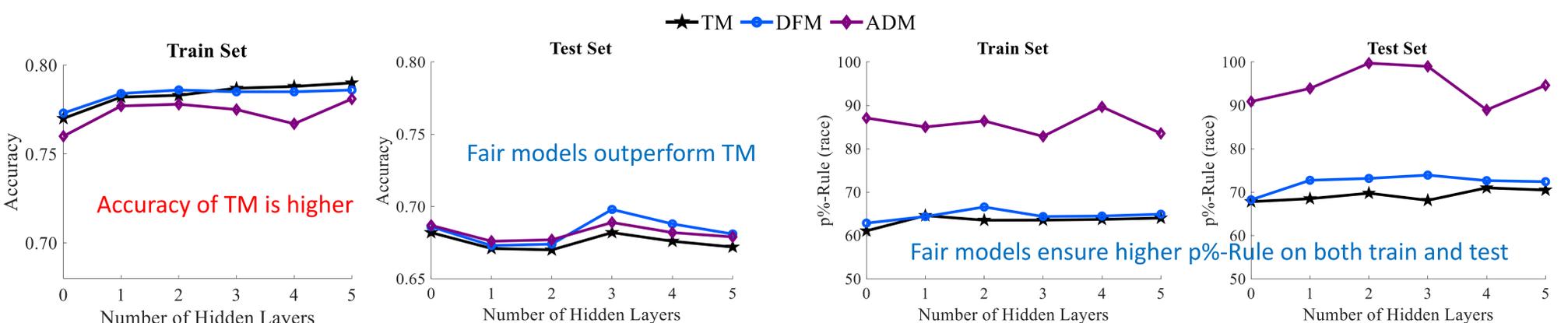


A large number of fair models satisfied the criteria of "fairness for free" in terms of all the fairness metrics

Only a single ADM satisfied our criteria of "fairness for free" for most of the fairness metrics

Similar results for FHS and SHS approach on other benchmark datasets: **Adult, Bank, and HHP** data

Case Study on Overfitting



Fair models reduce overfitting which helps to improve both accuracy and fairness

We demonstrate that it is possible to **improve fairness to some degree with no loss or even an improvement in accuracy** via a sensible hyper-parameter selection strategy

Our results reveal a pathway toward increasing the deployment of fairness techniques in real systems