On Fair Selection in the Presence of Implicit Variance

Emelianov, Gast, Gummadi, Loiseau (EC 2020)

Various fairness mechanisms have been proposed to mitigate discrimination

- Rooney rule: select at least one from underrepresented group
- 80%-rule: the selection rate for the underrepresented group be at least 80% of that for the overrepresented group
- Demographic Parity: the selection rates should be equal across the groups

Most literature show that fairness mechanisms introduce a quality/fairness tradeoff

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Kleinberg and Raghavan [ITCS'18] study the selection with implicit bias

estimate of quality

$$\text{quality } W \xrightarrow{A} \hat{W} = W/\beta \leftarrow \text{bias parameter}$$

$$W \xrightarrow[B]{} \hat{W} = W$$

They show that the Rooney rule improves the quality of selection

Selection with Implicit Variance

Our Model

estimate of quality

quality $W \xrightarrow{A} \hat{W} = W + \varepsilon \cdot \sigma_A$

$W \xrightarrow{B} \hat{W} = W + \varepsilon \cdot \sigma_B$

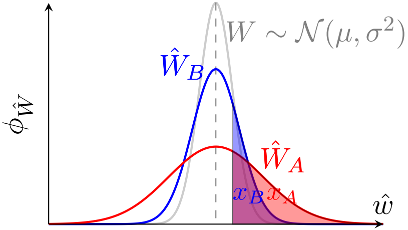
Selection Problem Setup

budget

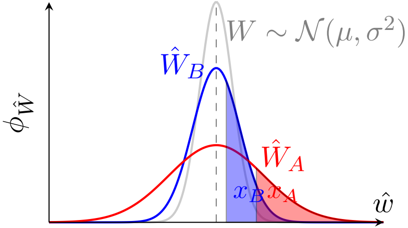
n candidates $\xrightarrow{\hat{W}_i}$ select αn

$n_A + n_B \qquad x_A n_A + x_B n_B$

We consider two natural selection algorithms



Group-Oblivious: select best irrespective of their group



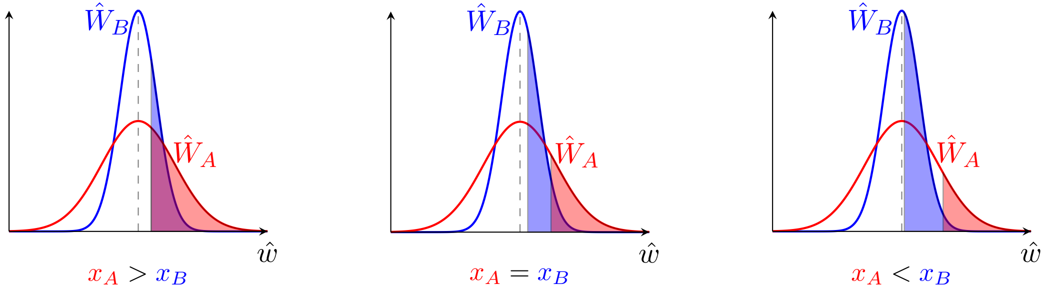
Group-Fair: select best from each group ($x_A \geq \gamma x_B$ and $x_B \geq \gamma x_A$)

Our main result is that fairness mechanisms improve the quality

Theorem
Assume that the quality distribution is group-independent $W \sim \mathcal{N}(\mu, \sigma^2)$. For any α and $\gamma < 1$:

$$\mathcal{U}^{\text{d.p.}} > \mathcal{U}^{\gamma\text{-fair}} \geq \mathcal{U}^{\text{g.obl.}}$$

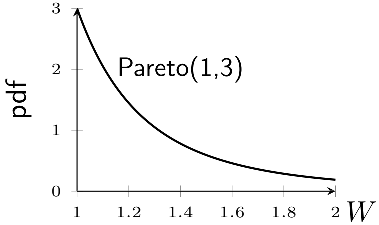
Proof Sketch

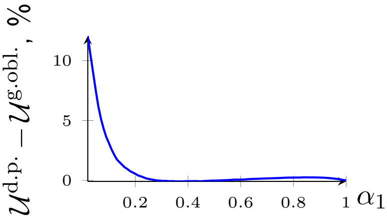


Group-Oblivious | Demographic Parity | Bayesian-Optimal

We also study the cases when our assumptions are not valid

Non-Gaussian Quality Distribution





Two-Stage Selection