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

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

\[
\begin{aligned}
\text{estimate of quality} & \quad \hat{W} = \frac{W}{\beta} \quad \text{bias parameter} \\
\text{quality} & \quad W \\
A & \quad \xrightarrow{W} \\
B & \quad \xrightarrow{\hat{W} = W}
\end{aligned}
\]

They show that the Rooney rule improves the quality of selection
Selection with Implicit Variance

**Our Model**

The estimate of quality is given by:

\[ \hat{W} = W + \epsilon \cdot \sigma_A \]

\[ \hat{W} = W + \epsilon \cdot \sigma_B \]

**Selection Problem Setup**

- **n candidates** \( \hat{W}_i \) \( \rightarrow \) select \( \alpha n \)

- \( n_A + n_B \) \( \xrightarrow{\uparrow} \)

- \( x_A n_A + x_B n_B \)

---

We consider two natural selection algorithms:

**Group-Oblivious:** select best irrespective of their group

**Group-Fair:** select best from each group \((x_A \geq \gamma x_B \text{ and } x_B \geq \gamma x_A)\)
Our main result is that fairness mechanisms improve the quality of the outcomes.

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

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

**Proof Sketch**
- Group-Oblivious: $x_A > x_B$
- Demographic Parity: $x_A = x_B$
- Bayesian-Optimal: $x_A < x_B$
We also study the cases when our assumptions are not valid.

**Non-Gaussian Quality Distribution**

Pareto(1,3)

**Two-Stage Selection**

\[
\hat{W}_i \quad \text{budget at 1st stage} \quad \text{select } \alpha_1 n \quad \text{budget at 2nd stage} \quad W_i
\]

\[
\alpha_1 = \alpha_2
\]