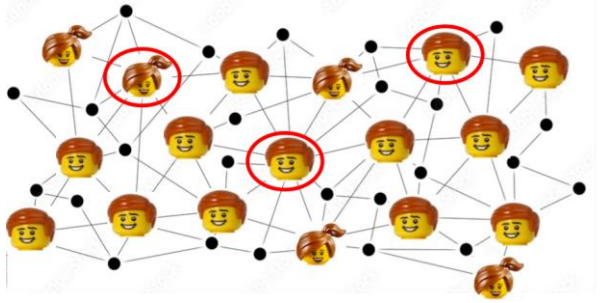
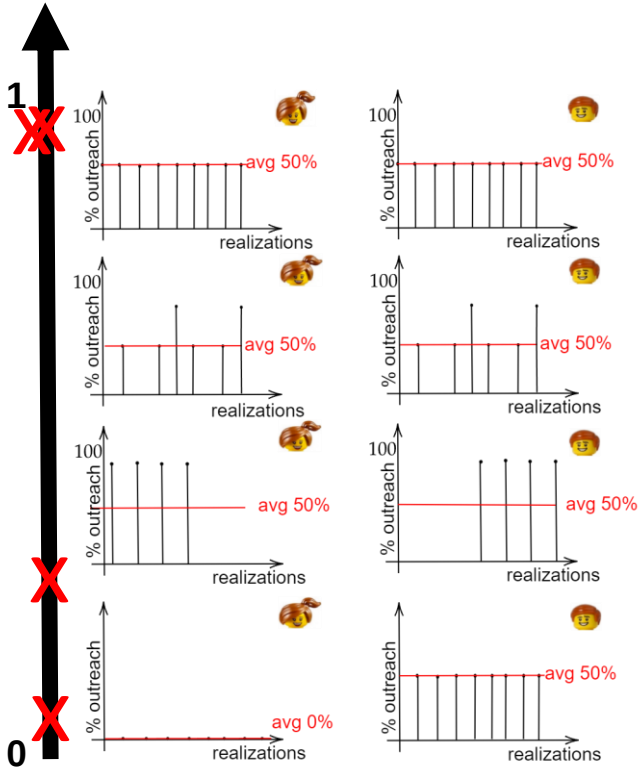
Fairness in Social Influence Maximization via Optimal Transport

Shubham Chowdhary, Giulia De Pasquale, Nicolas Lanzetti, Ana-Andreea Stoica, Florian Dörfler

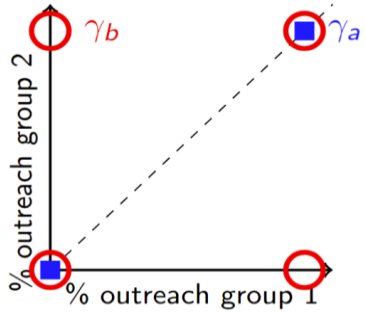
Fairness in Social Influence Maximization

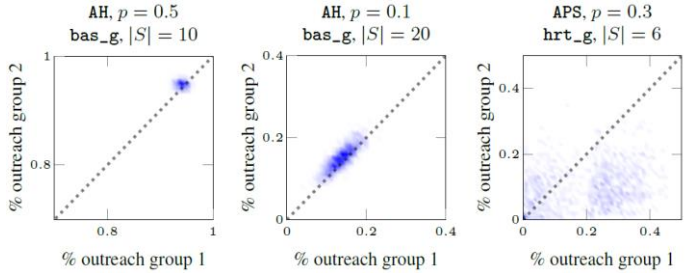


Fairness



Motivating Example – Which outcome is fair?

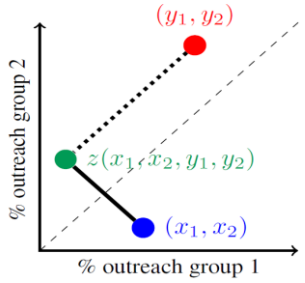




Fairness via Optimal Transport

Fairness = distance from an ideal distribution

$$W_c(\gamma_a, \gamma_b) = \min_{\pi \in \Pi(\gamma_a, \gamma_b)} \mathbb{E}_{(x_1,x_2),(y_1,y_2)\sim\gamma,}\,[c((x_1, x_2), (y_1, y_2))]$$



Ideal distributions = everyone always receives the information

$$\text{FAIRNESS}(\gamma) = 1 - \sqrt{2}W_c(\gamma, \gamma^*) = \mathbb{E}_{(x_1,x_2)\sim\gamma}\left[1 - |x_1 - x_2|\right]$$

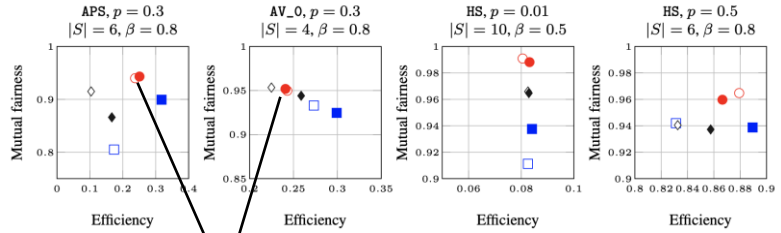
Fairness-improving algorithm

Algorithm 1 Stochastic Seedset Selection Descent

Input: Social Graph $G(V_G, E_G)$, initial seed set S_0, β fairness weight, ϵ-tolerance
Output: Optimal seedset S^*

$\mathcal{S}_0 \leftarrow \{\}$ ▷ collection of candidates
for k iterations **do** ▷ configurable k
  $V_{S_0} \leftarrow$ nodes reachable from S_0 via cascade, using SEEDSET_REACH routine
  $S \leftarrow \{\}$
  for $|S_0|$ iterations **do**
    $S \leftarrow S \cup \{v\} \mid v \sim V_S$
    $V_S \leftarrow$ nodes reachable from S in a fixed horizon, using SEEDSET_REACH
    $V_{S_0} \leftarrow V_{S_0} \setminus V_S$
  $E_{S_0} \leftarrow -\text{BETA\_FAIRNESS}(S_0, \beta)$
  $E_S \leftarrow -\text{BETA\_FAIRNESS}(S, \beta)$
  $p_{\text{accept}} \leftarrow \min\{1, e^{E_{S_0} - E_S}\}$ ▷ S_0 acceptance based on energy change
  if $x \sim \mathcal{B}(p_{\text{accept}})$ **then** ▷ Metropolis sampling in 12-18
    $S_0^+ \leftarrow S$ ▷ get a better seedset
  else
    if $x \sim \mathcal{B}(\epsilon)$ **then** ▷ for some small constant ϵ
      $S_0^+ \leftarrow \{v_i\}_{i=1}^{|S_0|} \overset{|S_0|}{\sim} V_G$ ▷ random seedset
    else
      $S_0^+ \leftarrow S_0$ ▷ retain existing choice
  $\mathcal{S}_0 \leftarrow \mathcal{S}_0 \cup \{S_0^+\}$
  $S_0 \leftarrow S_0^+$ ▷ for next iteration
$S_0^* \leftarrow S_0 \in \mathcal{S}_0 \mid \text{BETA\_FAIRNESS}(S_0, \beta)$ is maximum ▷ via S3D_ITERATE
return S_0^*

Performance



ours

NCCR Automation