Socially Optimal Flow in Routing Games

- Losses on each edge $e \in (y_e)$.
- Player $i$ routes one unit of flow from $s_i$ to $t_i$.

Main Assumption - Large Games

- Any player has a small $o(1)$ impact on the costs of others as $n \to \infty$.

Useful Tool - Joint Differential Privacy

- Controls the impact a single player has on the outcome for other players.
- No real “privacy” concerns here, but still useful!

Novel Technique - Private Gradient Descent

We need to solve the convex program in a way that is joint differentially private in data $s$.

\[
\min \quad \text{Total Cost of } x \\
\text{s.t.} \quad x \in \mathcal{F}(s)
\]

Conclusion

We construct a weak mediator $M$ in a Large Routing Game that adds tolls to induce optimal flow, with unknown player demands.

Open Problem

Can we make weak mediators in general large games?