INTERNATIONAL CONFERENCE ON PARALLEL PROCESSING
ICPP/2021/CHICAGO/USA
acm In-Cooperation
sighpc
AUGUST 9-12, 2021

FIFL: A Fair Incentive Mechanism for Federated Learning

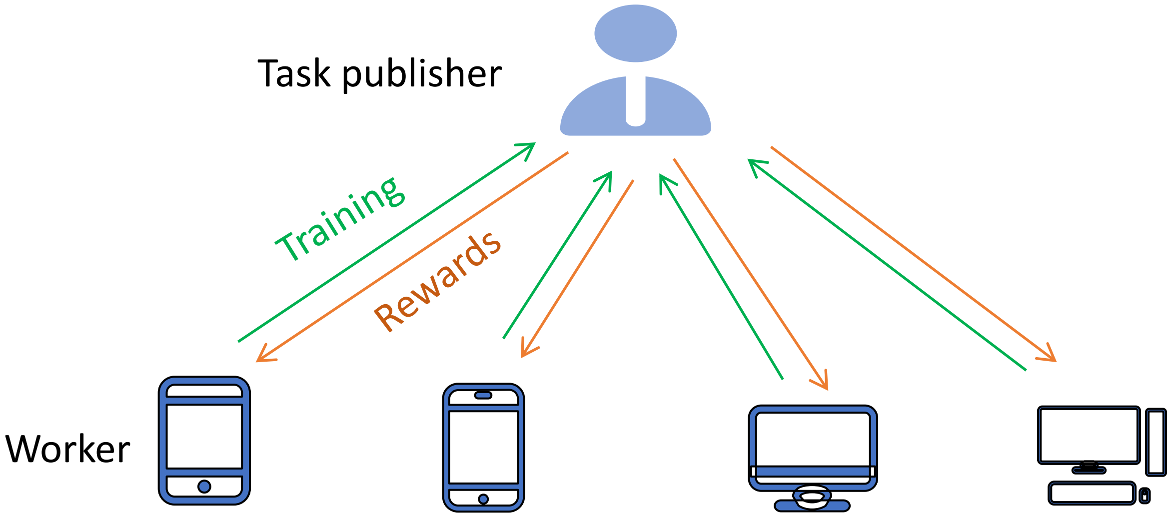
Liang Gao, National University of Defense Technology
Li Li, State Key Laboratory of IoTSC, University of Macau
Yingwen Chen, National University of Defense Technology
Wenli Zheng, Shanghai Jiaotong University
ChengZhong Xu, State Key Laboratory of IoTSC, University of Macau
Ming Xu, National University of Defense Technology

Agenda

- Background and challenge
- The proposed FIFL mechanism
- Experiments and results
- Conclusion

Background

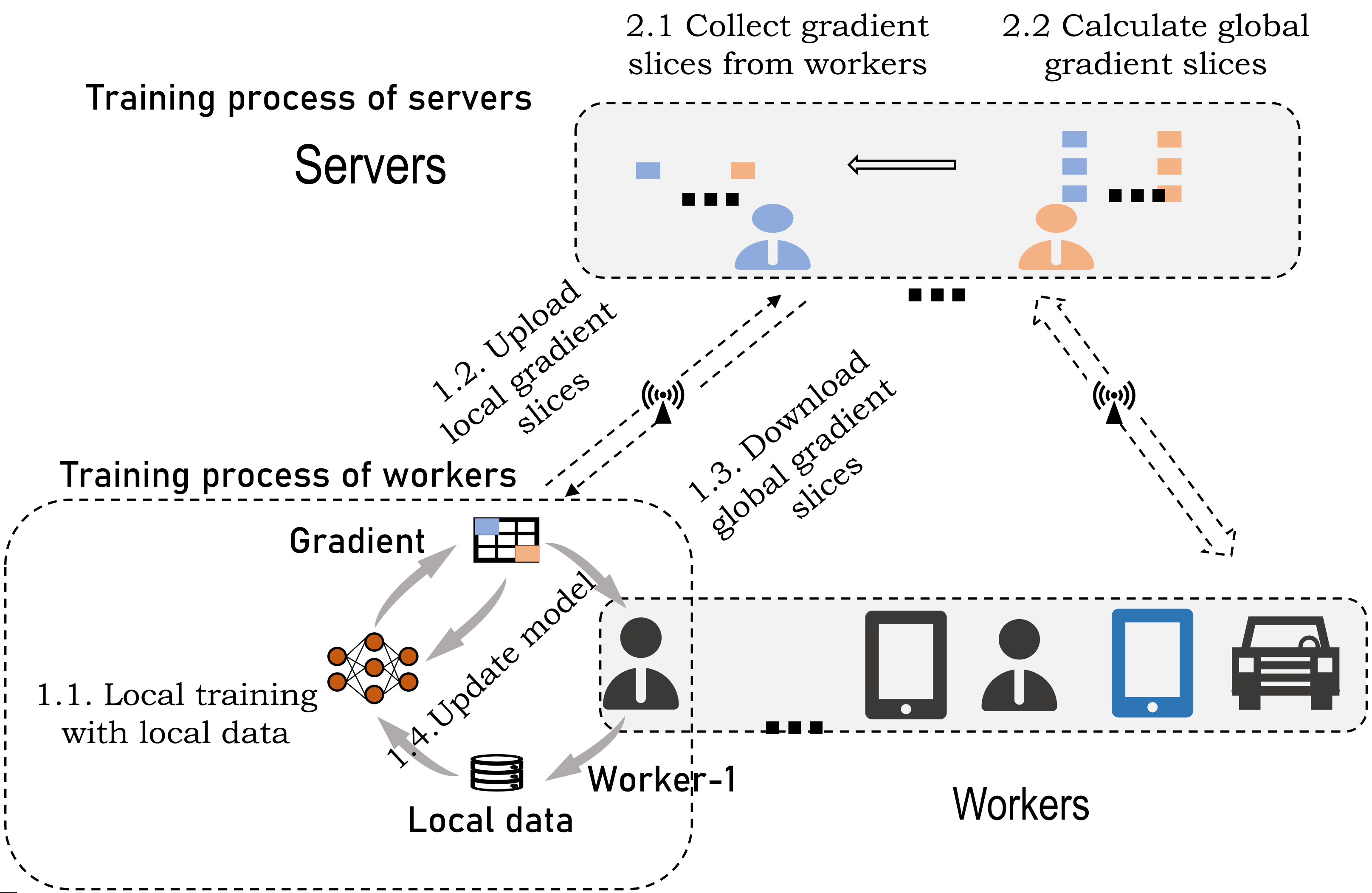
- Federated Learning, in which multiple devices collaboratively can train models by exchanging their model parameters instead of raw data.
- Crowdsourcing computing, the task publisher shares profit with workers to utilize workers' data and computing resources.



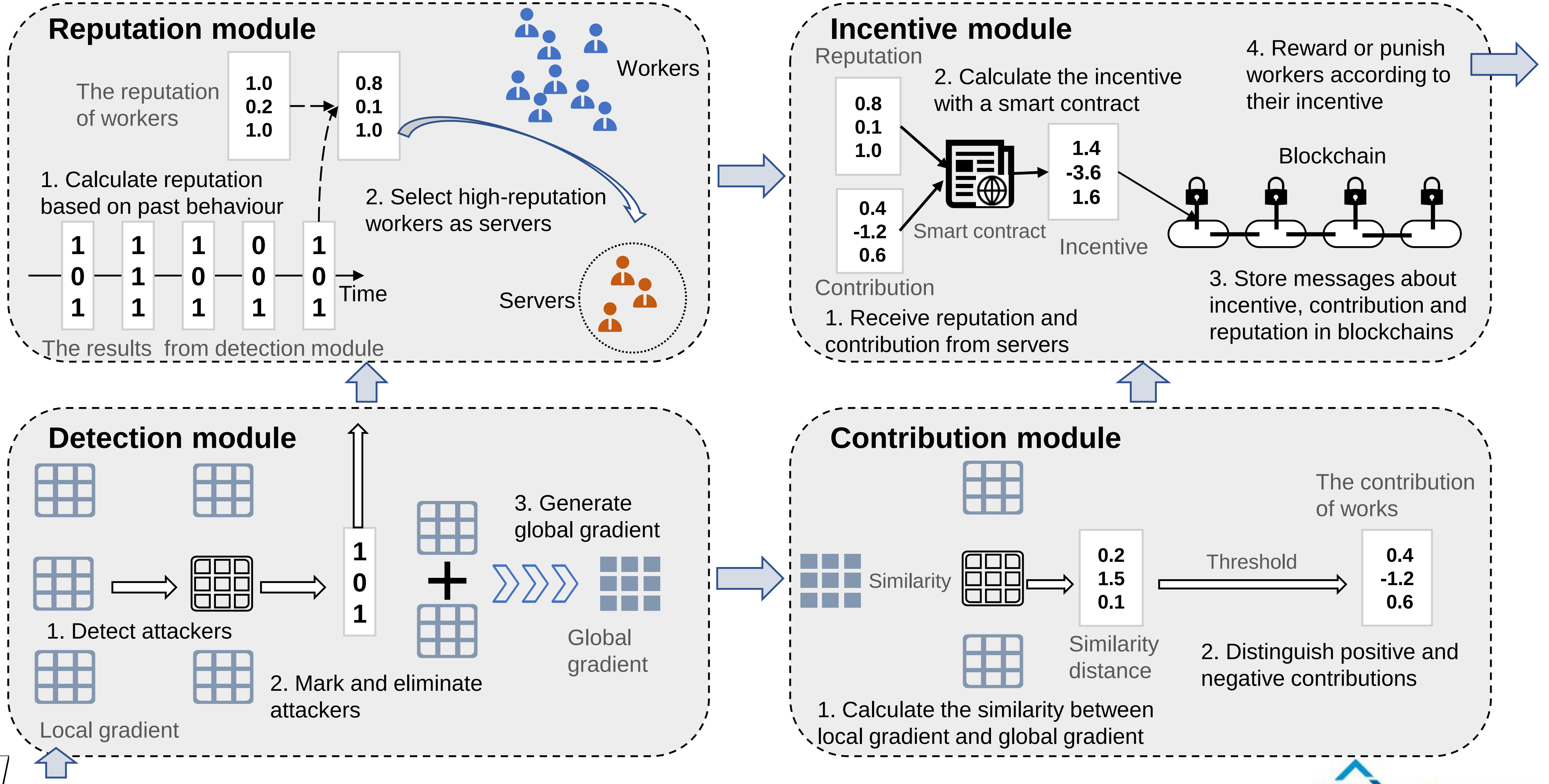
Challenges

- How to accurately and efficiently identify the workers' utilities in the incentive mechanism?
- How to ensure fairness and reliability of the incentive mechanism under attacks and deceptions?

A case: Federated learning



Mechanism



Reputation module
The reputation of workers
1.0 0.2 1.0
0.8 0.1 1.0
Workers
1. Calculate reputation based on past behaviour
2. Select high-reputation workers as servers
1 0 1
1 1 1
1 0 1
0 0 1
1 0 1
Time
Servers
The results from detection module
Incentive module
Reputation
0.8 0.1 1.0
2. Calculate the incentive with a smart contract
4. Reward or punish workers according to their incentive
1.4 -3.6 1.6
Blockchain
0.4 -1.2 0.6
Smart contract
Incentive
Contribution
3. Store messages about incentive, contribution and reputation in blockchains
1. Receive reputation and contribution from servers
Detection module
1 0 1
3. Generate global gradient
1. Detect attackers
Global gradient
2. Mark and eliminate attackers
Local gradient
Contribution module
The contribution of works
Threshold
Similarity
0.2 1.5 0.1
0.4 -1.2 0.6
Similarity distance
2. Distinguish positive and negative contributions
1. Calculate the similarity between local gradient and global gradient

Mechanism

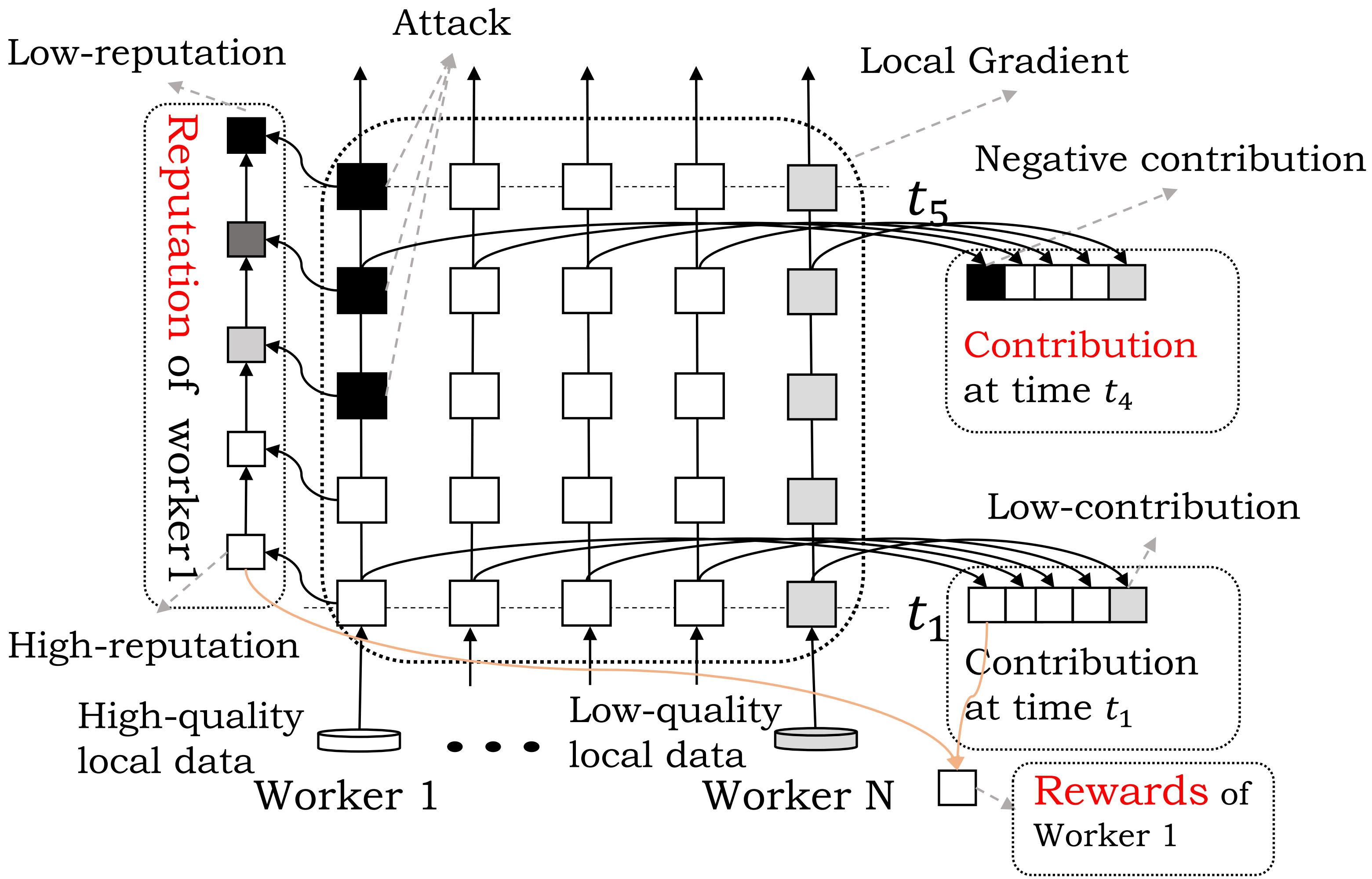
Gradient

Attack detect

Normal or Abnormal

Update

Contribution and Reputation



Experiment and results

Worker settings

- Honest workers
- Sign-flipping attackers
- Data-poison attackers

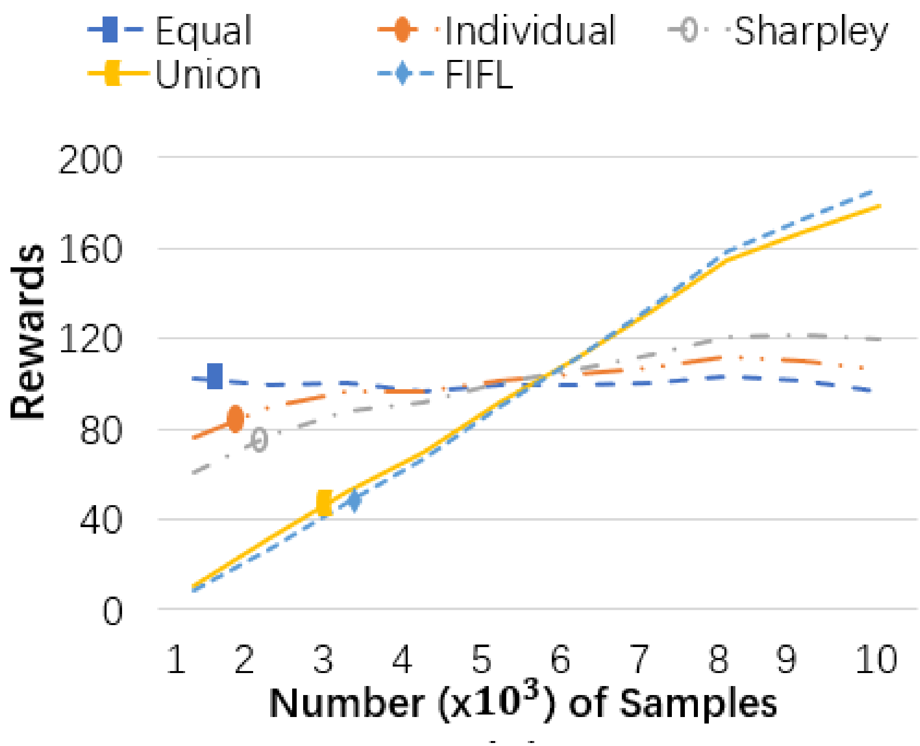
Experiment and results

Baselines

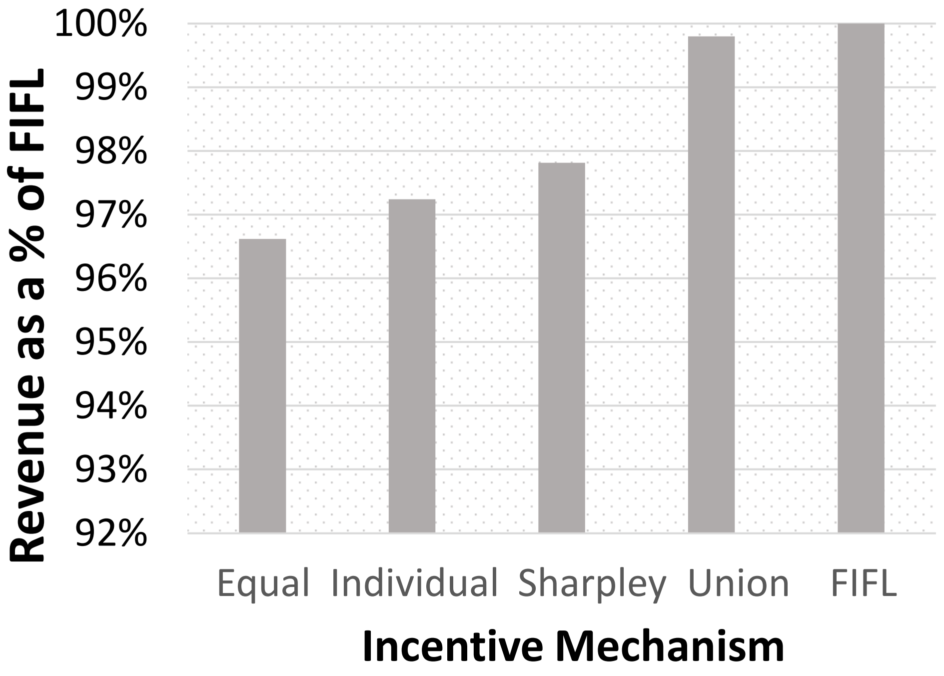
- Individual
- Equal
- Union
- Shapley

Experiment and results

Rewards distribution of workers

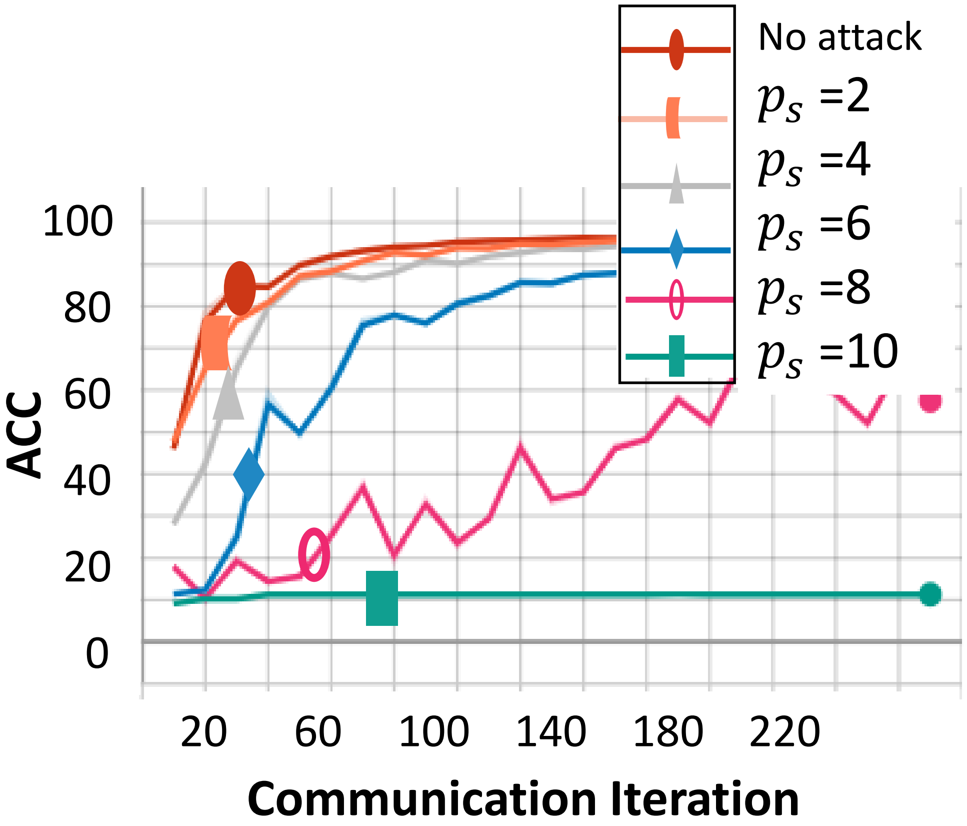


System revenue of different incentive mechanisms

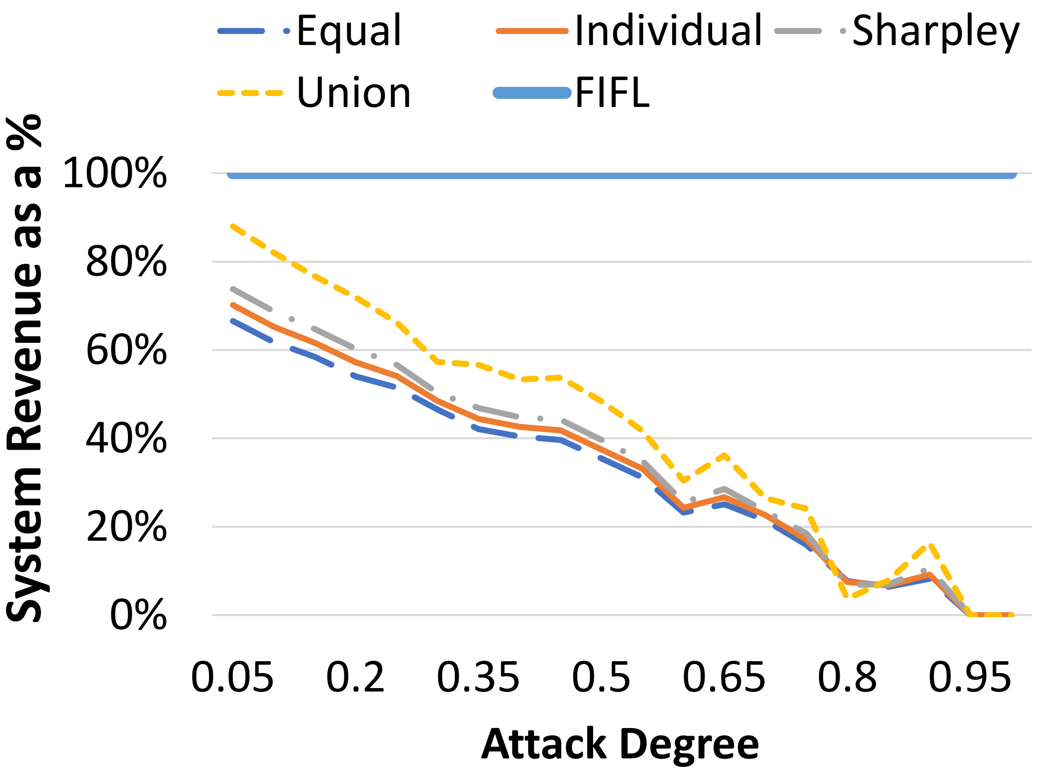


Experiment and results

Attackers' damage

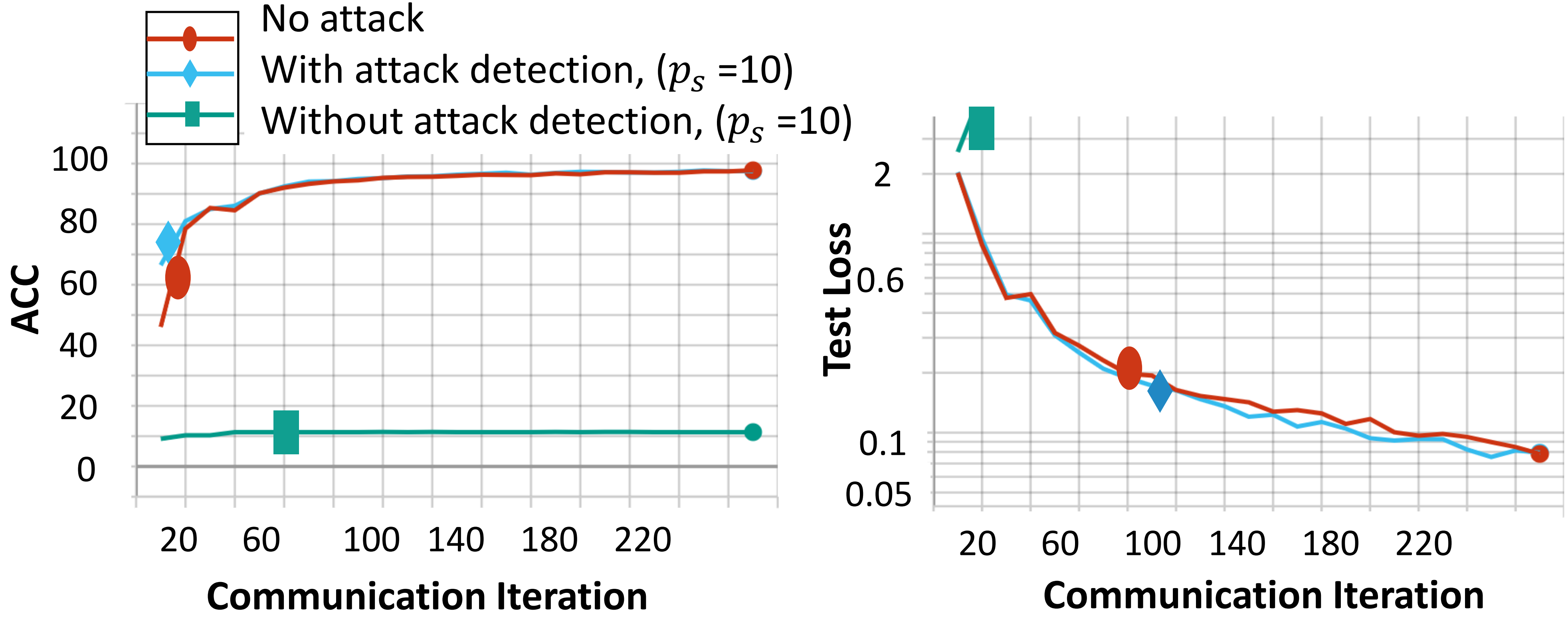


Effectiveness of FIFL in unreliable scenario



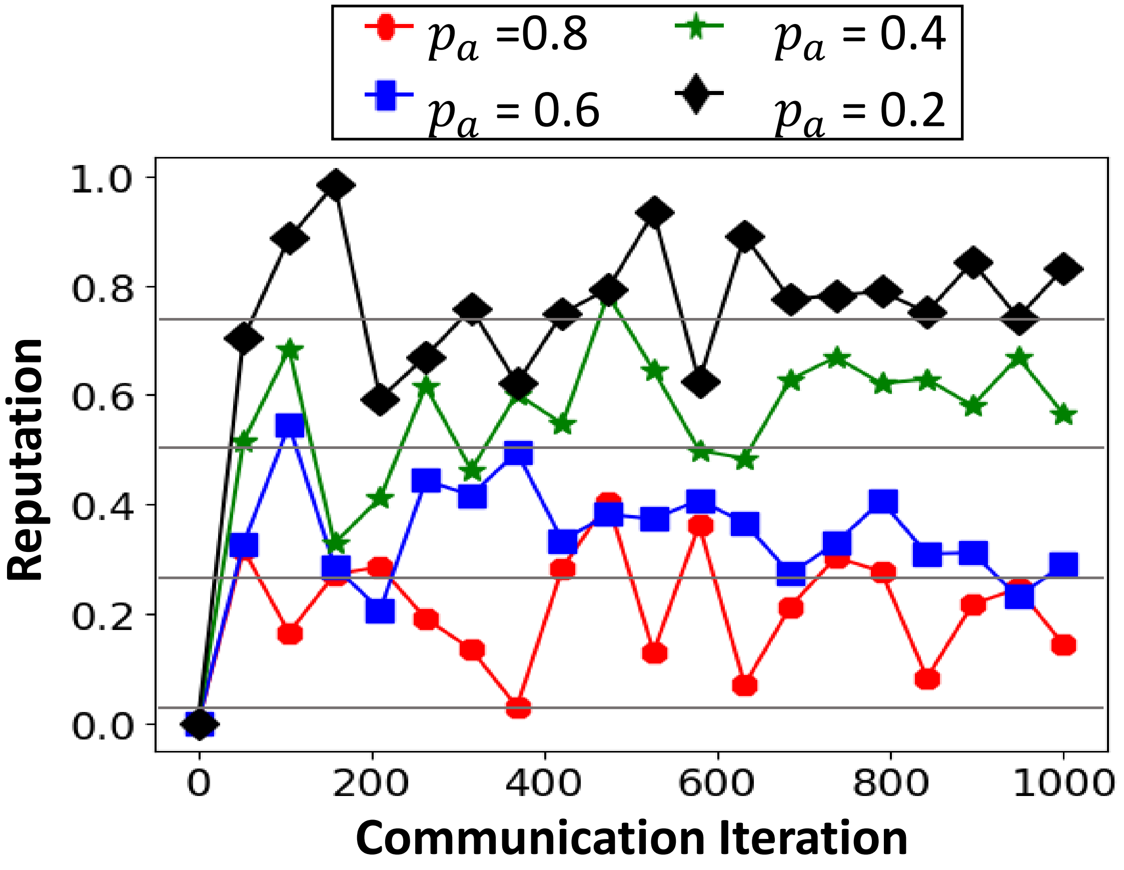
Experiment and results

Effectiveness of attack detection module

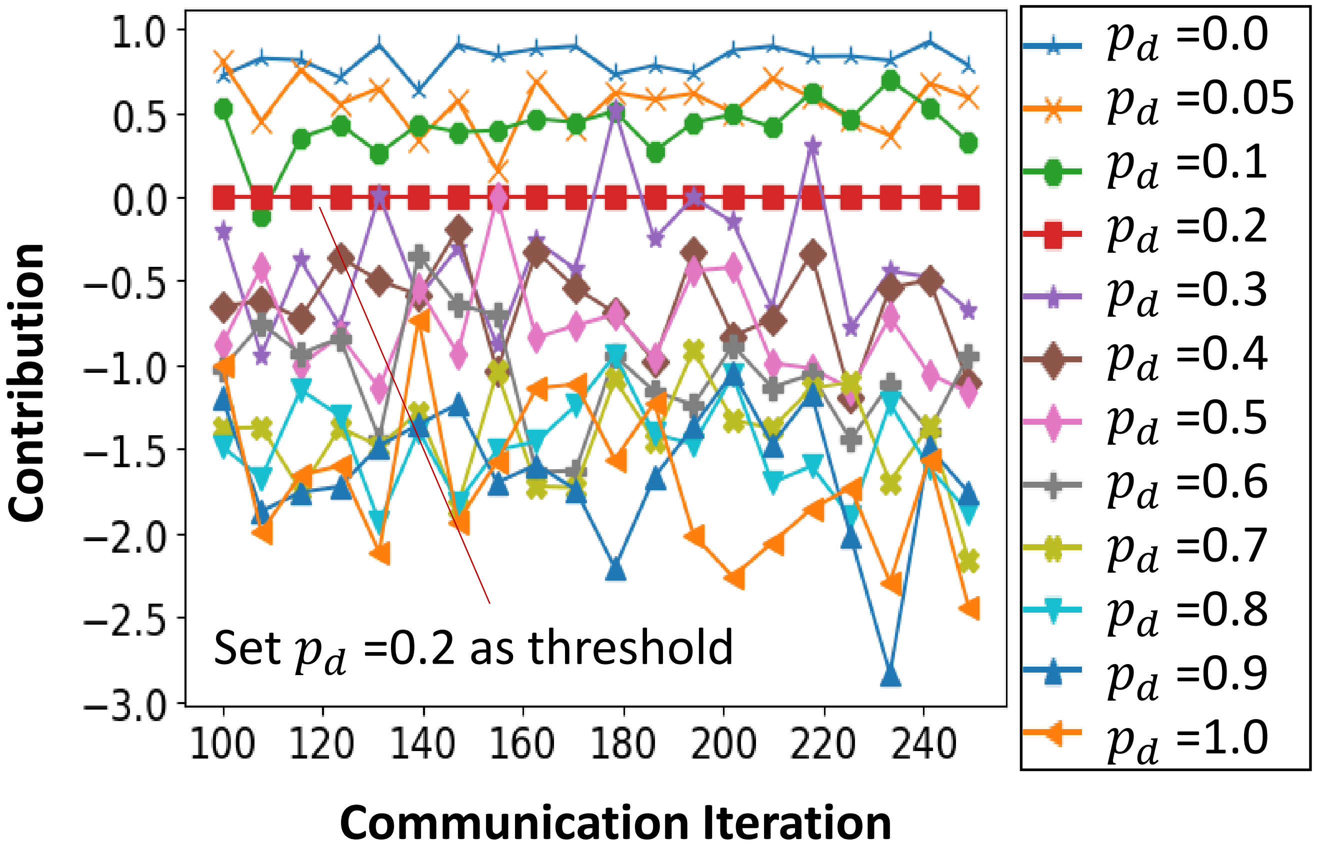


Experiment and results

Effectiveness of reputation module



Effectiveness of contribution module

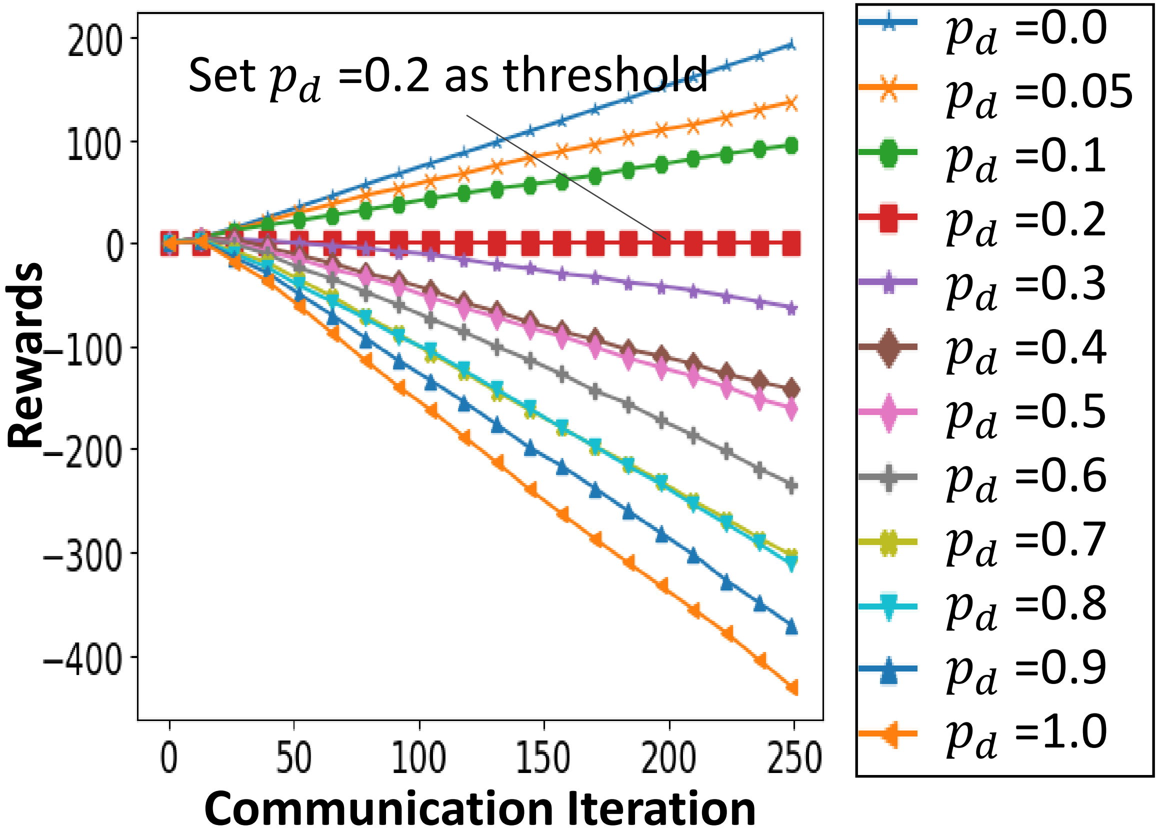


INTERNATIONAL CONFERENCE ON PARALLEL PROCESSING

acm In-Cooperation sighpc

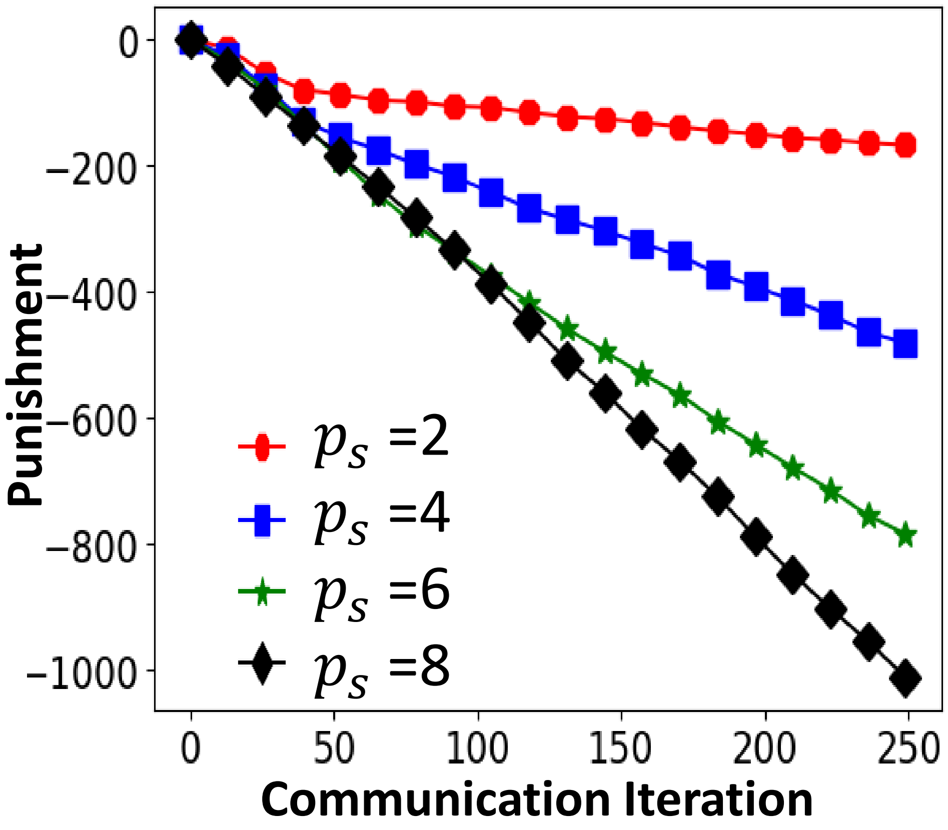
Experiment and results

Effectiveness of incentive module for data-poison attacker



(a)

Effectiveness of incentive module for sign-flipping attacker



(b)

Conclusion

- Attack resilience
- Fairness incentive
- Higher system revenue

Thanks for Listening!

- *Liang Gao (gaoliang.gl@outlook.com)*