A Deep Learning Approach to Maximising the Utility of 5G Mobile Backhaul Networks

THE UNIVERSITY of EDINBURGH informatics

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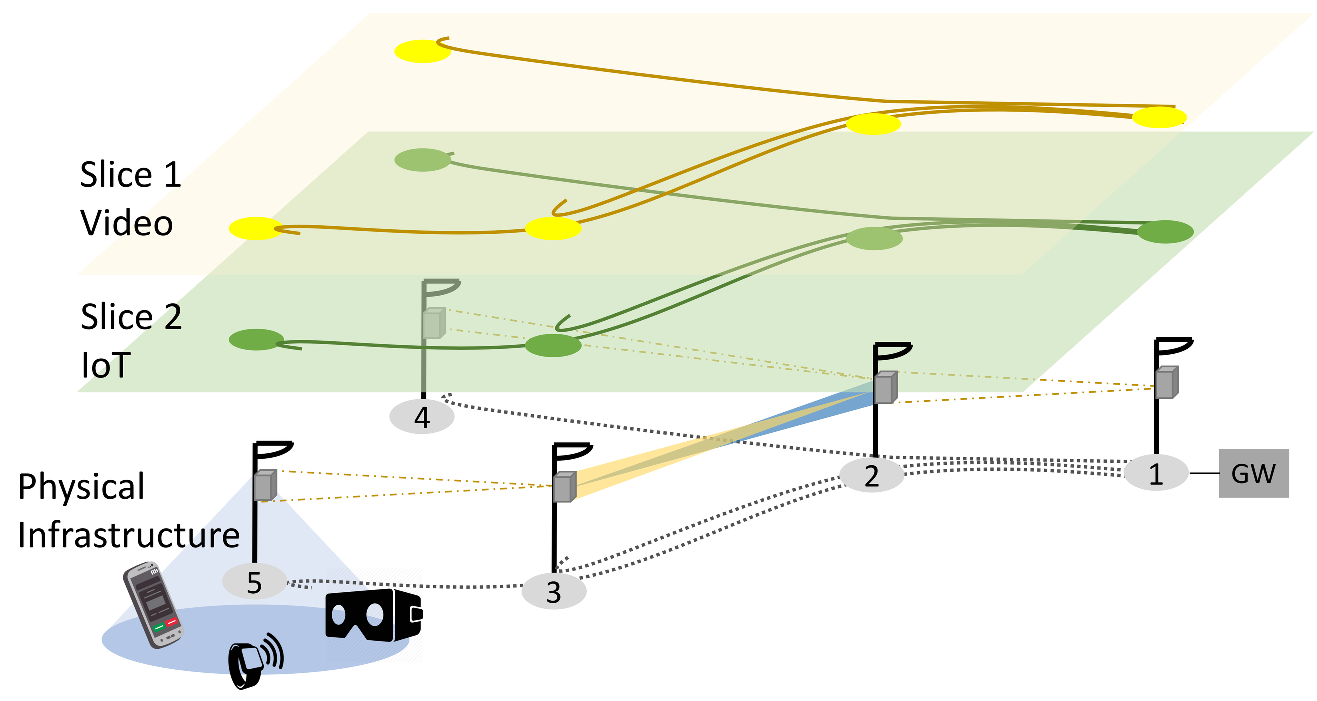
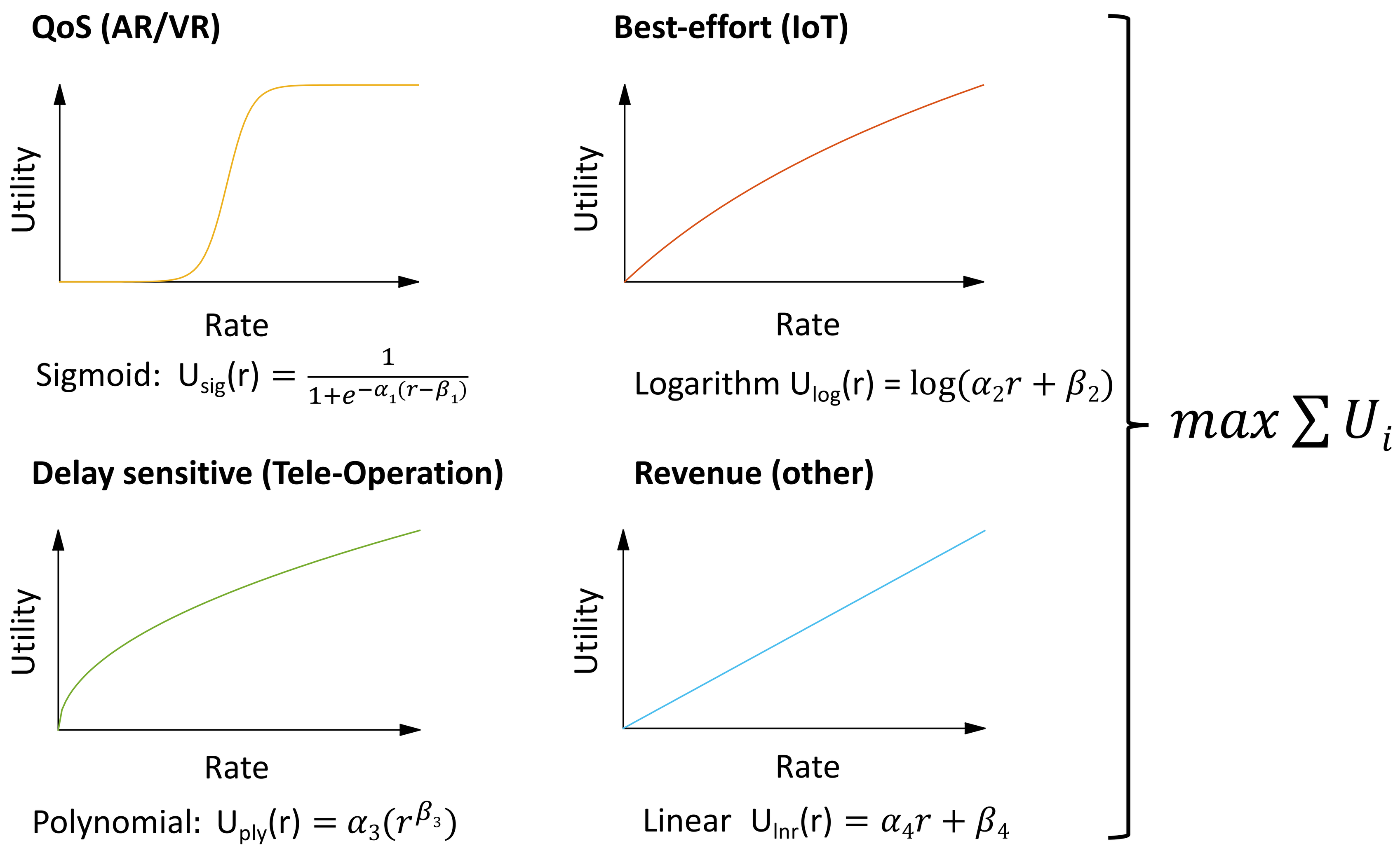
5G Networks

- Ramified use cases and distinct performance requirements
- Network virtualisation and densification
- Millimetre-wave (mm-wave) enables Multi-Gbps backhauls



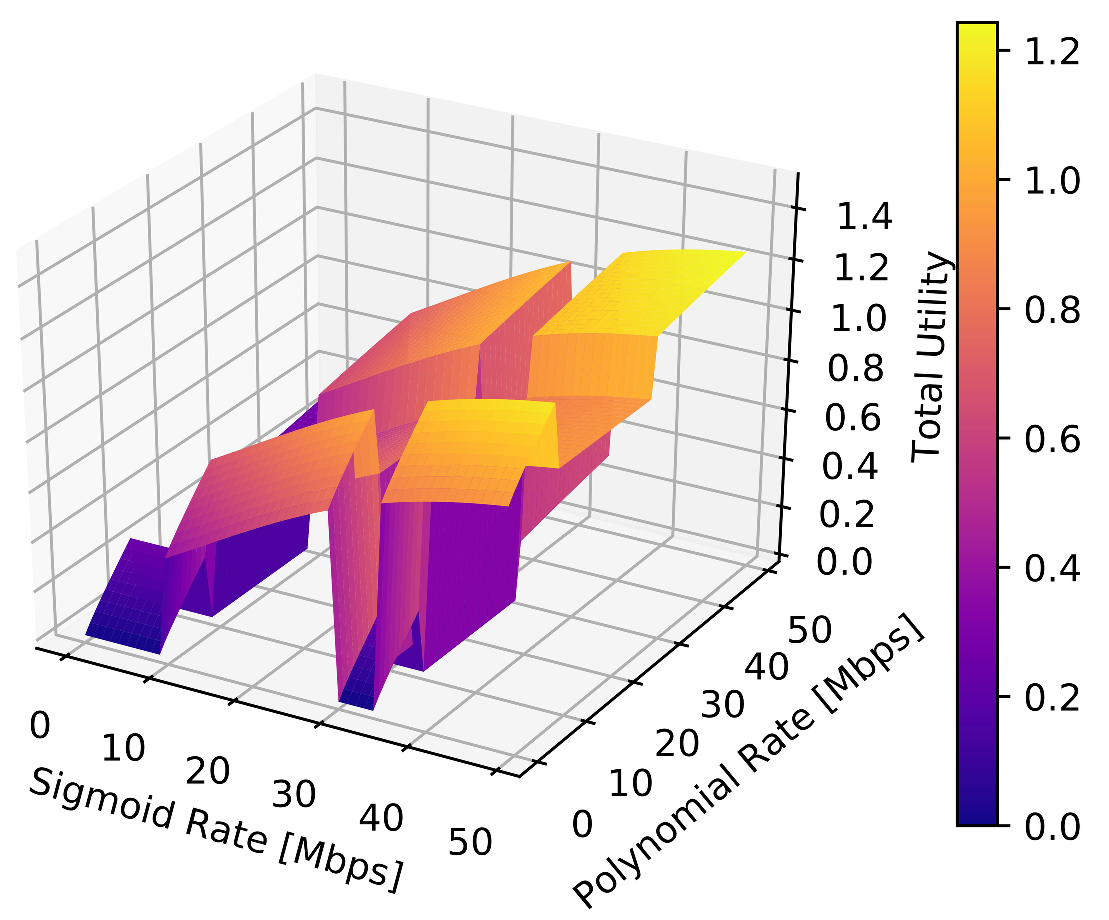
Utility Framework

- Application scenarios -> utility functions
- Combing all known types of utility functions



Finding the Optimal Rate Allocation

- High-dimensional highly non-convex problem
- Global search can be time consuming
- Heuristic method can solve but sub-optimal



The Deep Learning Approach

Supervised learning with convolutional neural network (CNN)

- 10 stacks of convolutional layers + batch normalisation + SeLU
- Input: Flow demands ($d_{i,j}$) and minimum service rates ($\delta_{i,j}$)
- Output: Predicted flow rate ($r_{i,j}$)

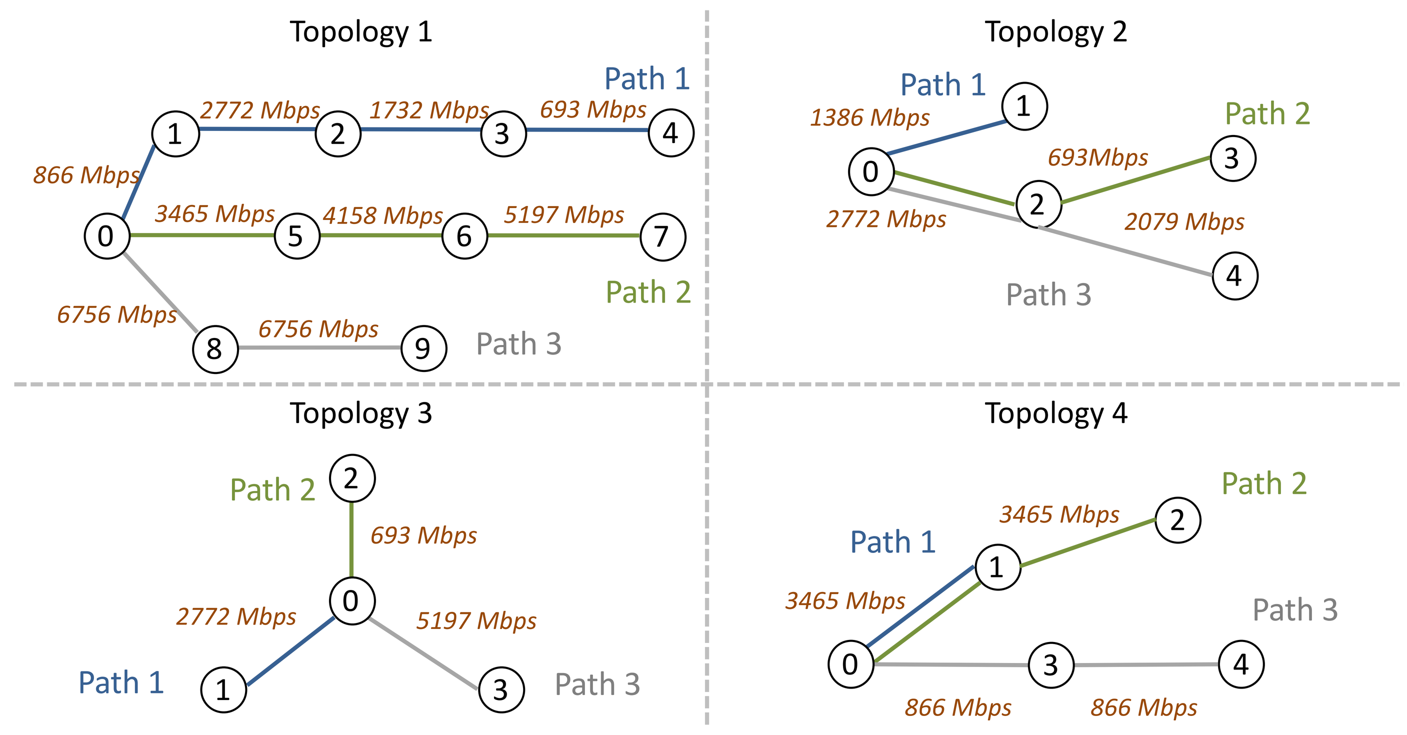
Acknowledgement: We gratefully acknowledge the support of NVIDIA Corporation with the donation of the Titan Xp GPU used for this research

Performance Evaluation

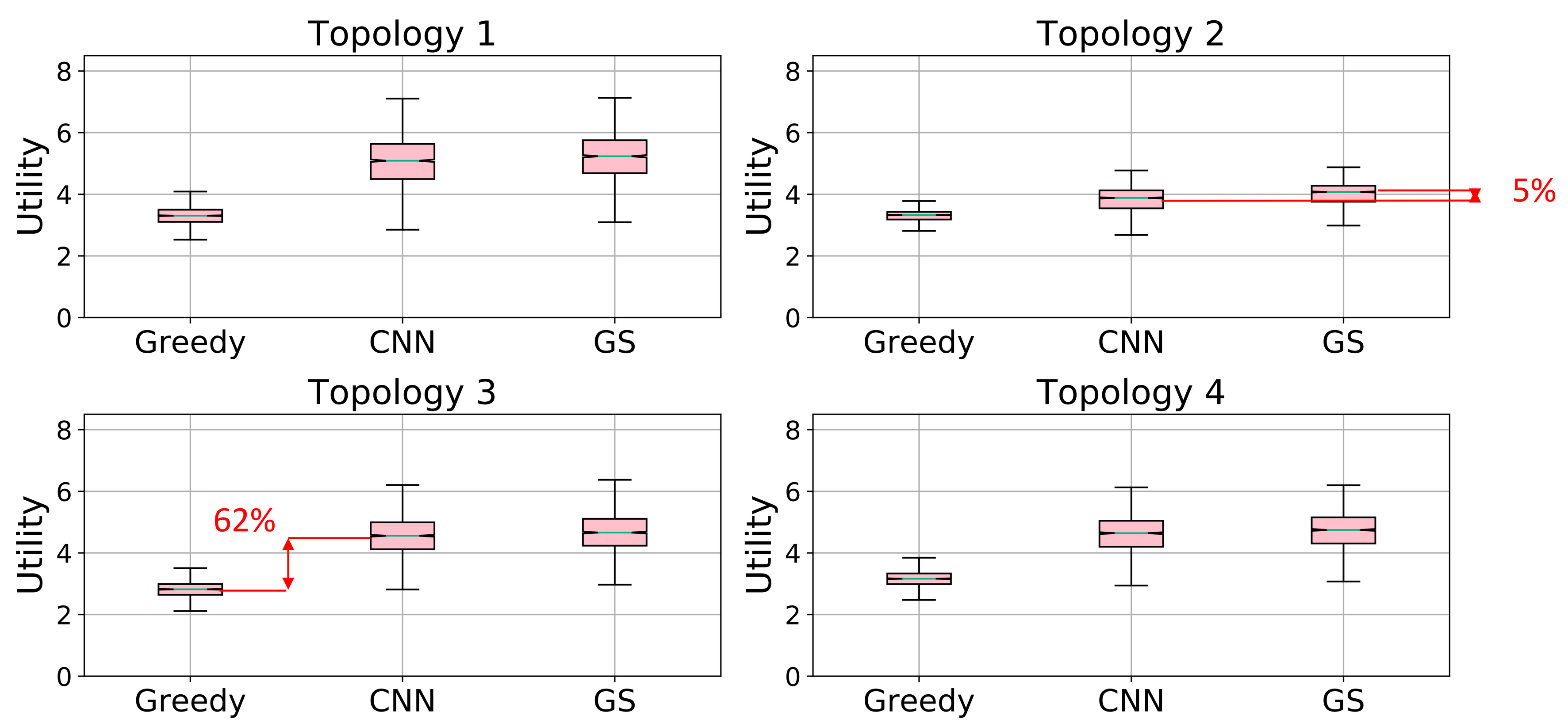
10,000 data points $\{d_{i,j}, \delta_{i,j}, r_{i,j}\}$

- Optimal solutions obtained from Global Search (GS)[1]
- Benchmark: Light-weight greedy solution

Topologies

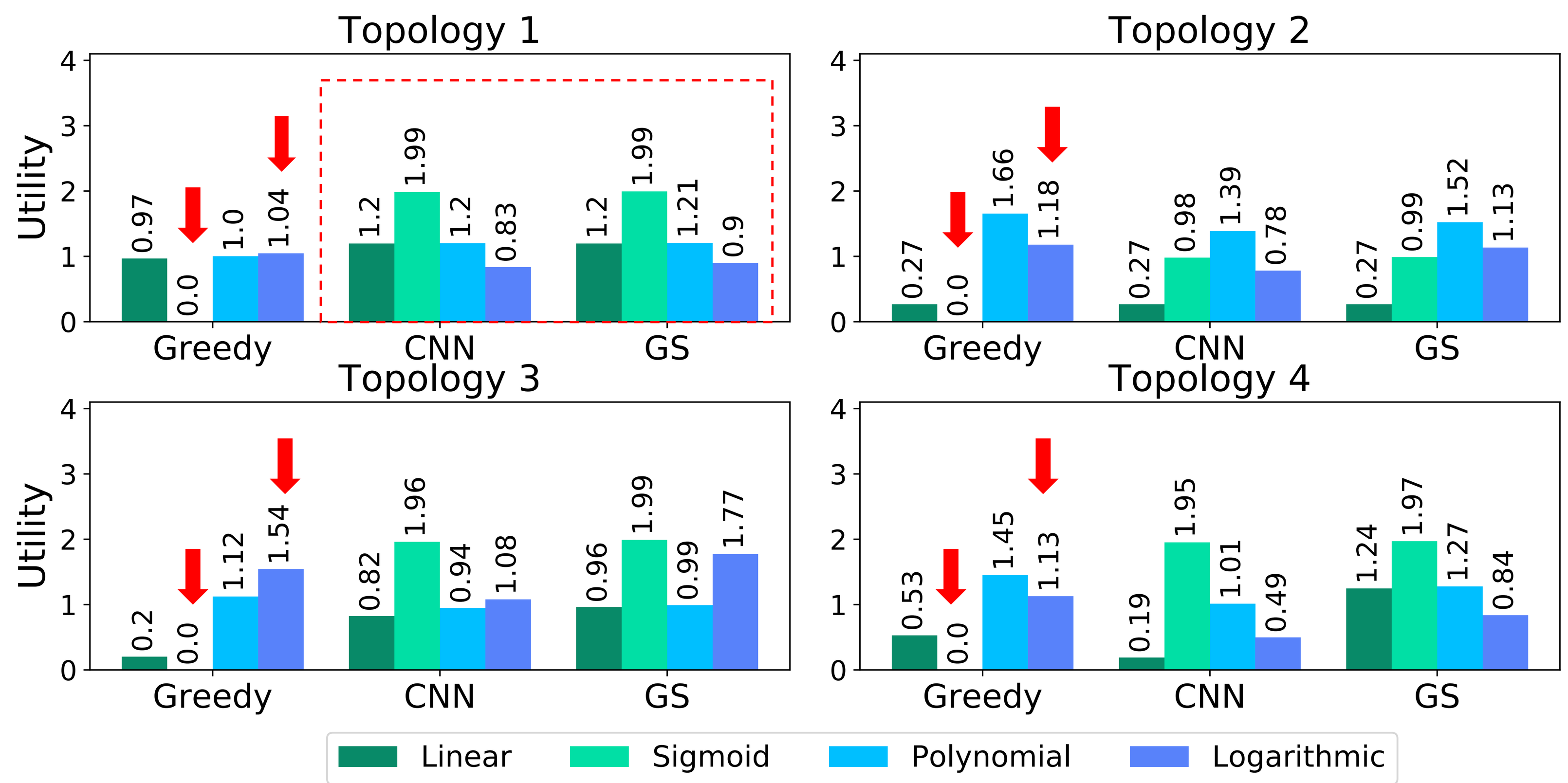


Total network utility distributions over 2k instances



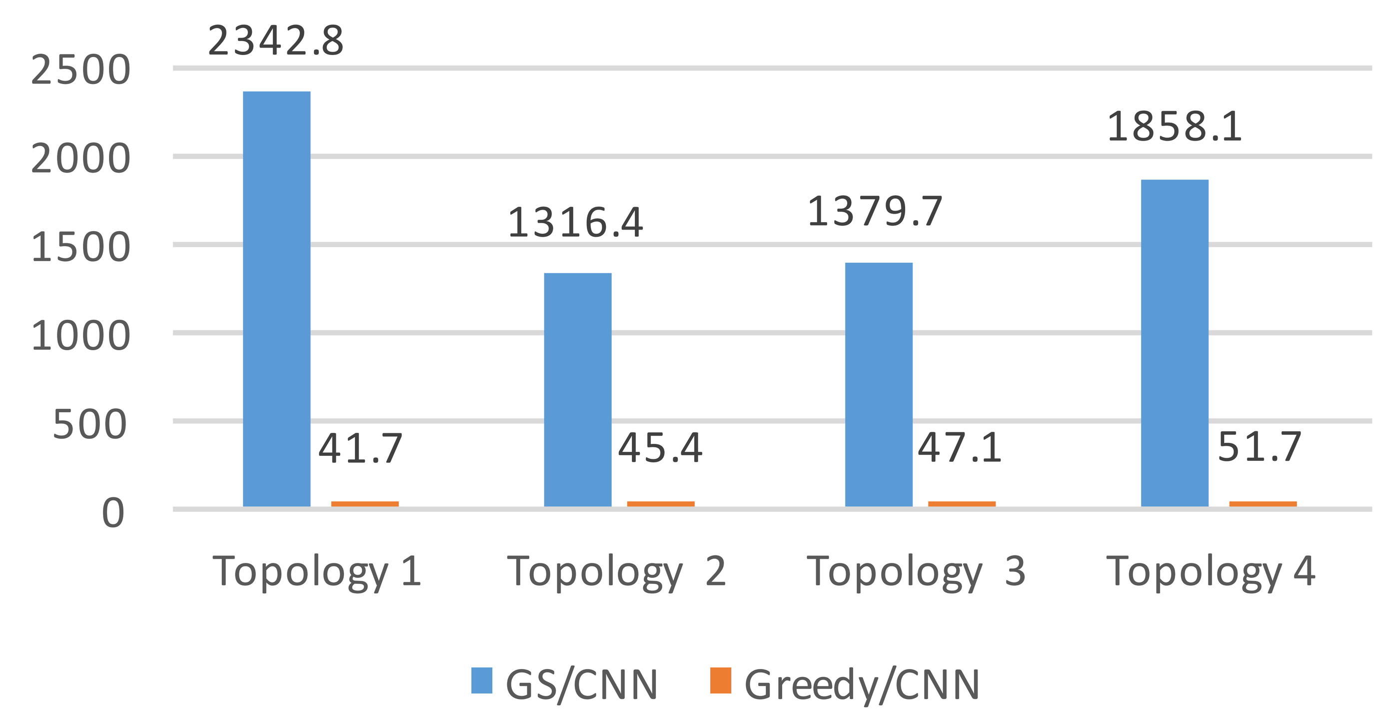
- CNN: close to optimal in terms of median, quartiles, etc.
- Achieves up to 62% total utility gain over greedy

Per type utility allocation in a single instance



- CNN attains close to optimal allocations
- Greedy tends to starve Sigmoidal utilities

Computation Time



- 2000x faster than GS and 50x faster than Greedy

[1] Optimality of GS is proven in Z. Ugray et al. Scatter search and local NLP solvers: *A multistart framework for global optimization*. Journal on Computing, 19(3), 2007.