EEE 488
Numerical Optimization Techniques
and Computer Applications

Optimal Resource Allocation with Node and Link Capacity Constraints in Complex Networks

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Overview

- INTRODUCTION
- PROBLEM FORMULATION
- ALGORITHM
- RESULTS
- CHALLENGES
- WORK DIVISON
- Q/A SESSION

Introduction

- Internet traffic congestion
- Increasing network capacity is expensive
- Use optimization theory
- Consider both node and link capacities
- Optimization of flow rate

Problem Formulation

The main optimization problem

$$\max_{x_s \in I_s, C_l \geq 0, D_n \geq 0} \quad \sum_s U_s(x_s) \tag{1a}$$

$$\text{subject to} \quad \sum_{s \in F(n)} x_s \leq D_n, n = 1, 2, ..., N \tag{1b}$$

$$\sum_{s \in F(l)} x_s \leq C_l, l = 1, 2, ..., L, \tag{1c}$$

$$\sum_n D_n == M. \tag{1d}$$

N-number of nodes, L-number of links, S-number of flows

Problem Formulation

Rewritten form of optimization problem

$$C_{l_{mn}} = T_{mn}\alpha(D_m + D_n)$$

$$\max_{x_s \in I_s, D_n \geq 0} \quad \sum_s U_s(x_s)$$

$$\text{subject to} \quad \sum_{s \in F(n)} x_s \leq D_n, n = 1, 2, ..., N$$

$$\sum_{s \in F(l_{mn})} x_s \leq T_{mn}\alpha(D_m + D_n), m, n = 1, 2, ..., N,$$

$$\sum_n D_n == M.$$

Algorithm

- We designed two network models with Tmn adjacency matrix and selected S pairs of nodes, where shortest path between pairs are not zero.
- We created set V(s), which represents the set of nodes flow s goes through, while two consecutive elements of arrays in V(s) refers to one of the links L.
- To determine F(n), we created empty cell array with size (N,1), then by iterating through elements in each array in V(s), we added s to F(element).
- To obtain F(l), we created empty cell array with size (N,N), then by iterating through elements in each array in V(s), we added s to F(element,element+1).
- Using CVX package of MATLAB, we solved optimization problem, plotted figures for $\sum_s U_s(x_s)$ and $\sum_s x_s$, where $U_s(x_s) = \frac{-1}{d_s^2 x_s}$

Results

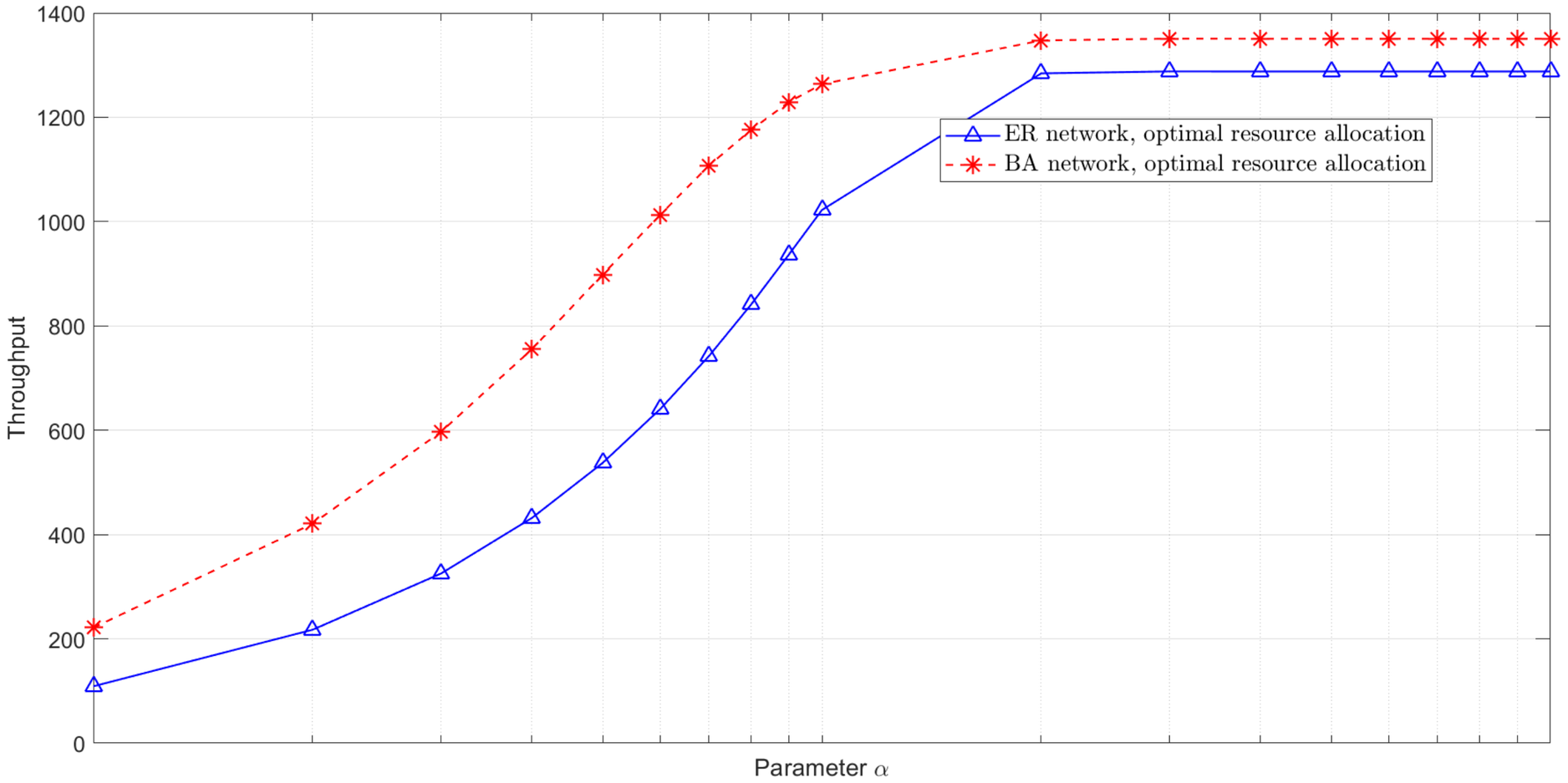

Figure 1. Relationship of throughput of the network and parameter α

Results

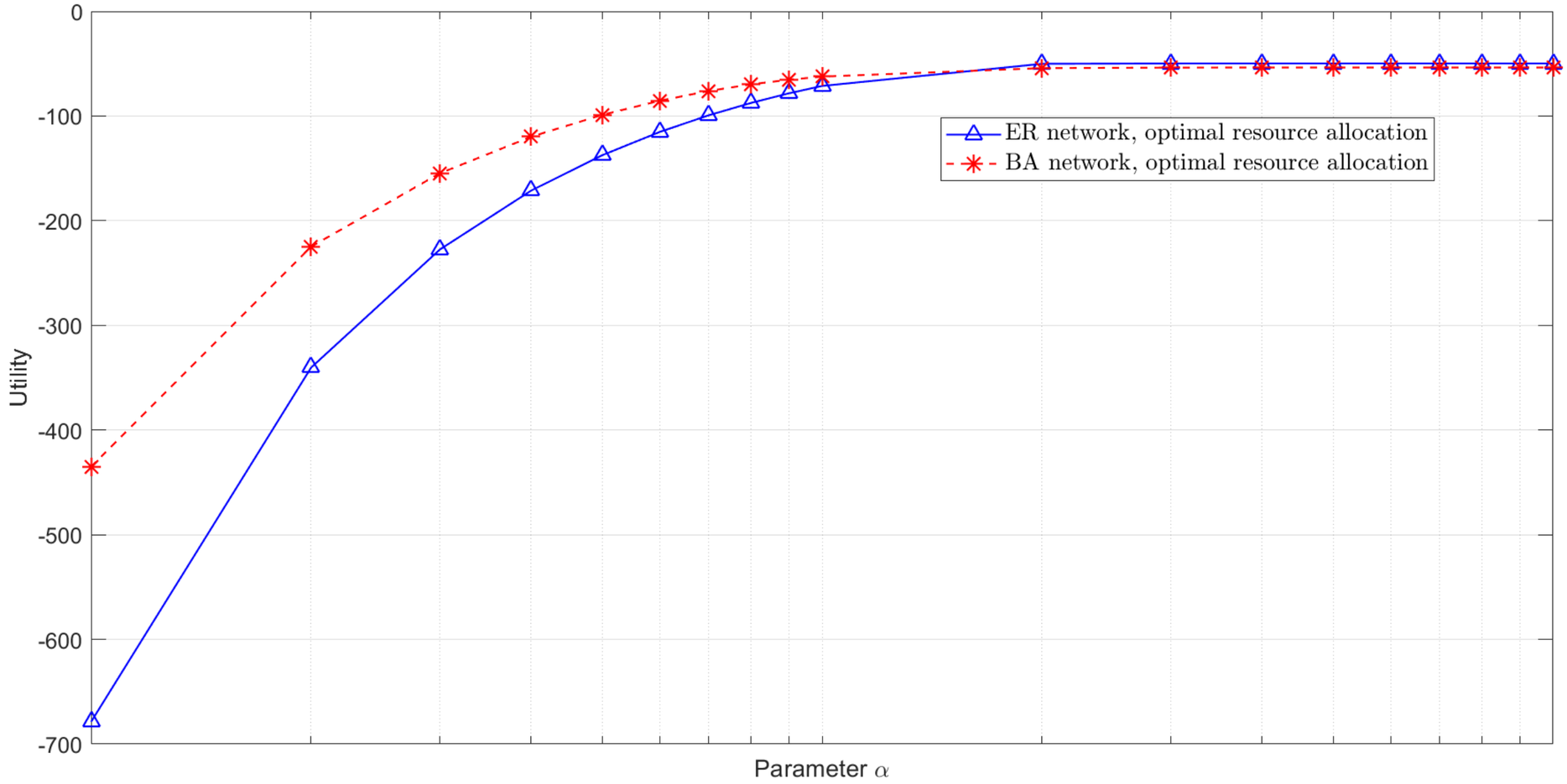

Figure 2. Relationship of utility of the network and parameter α

Results

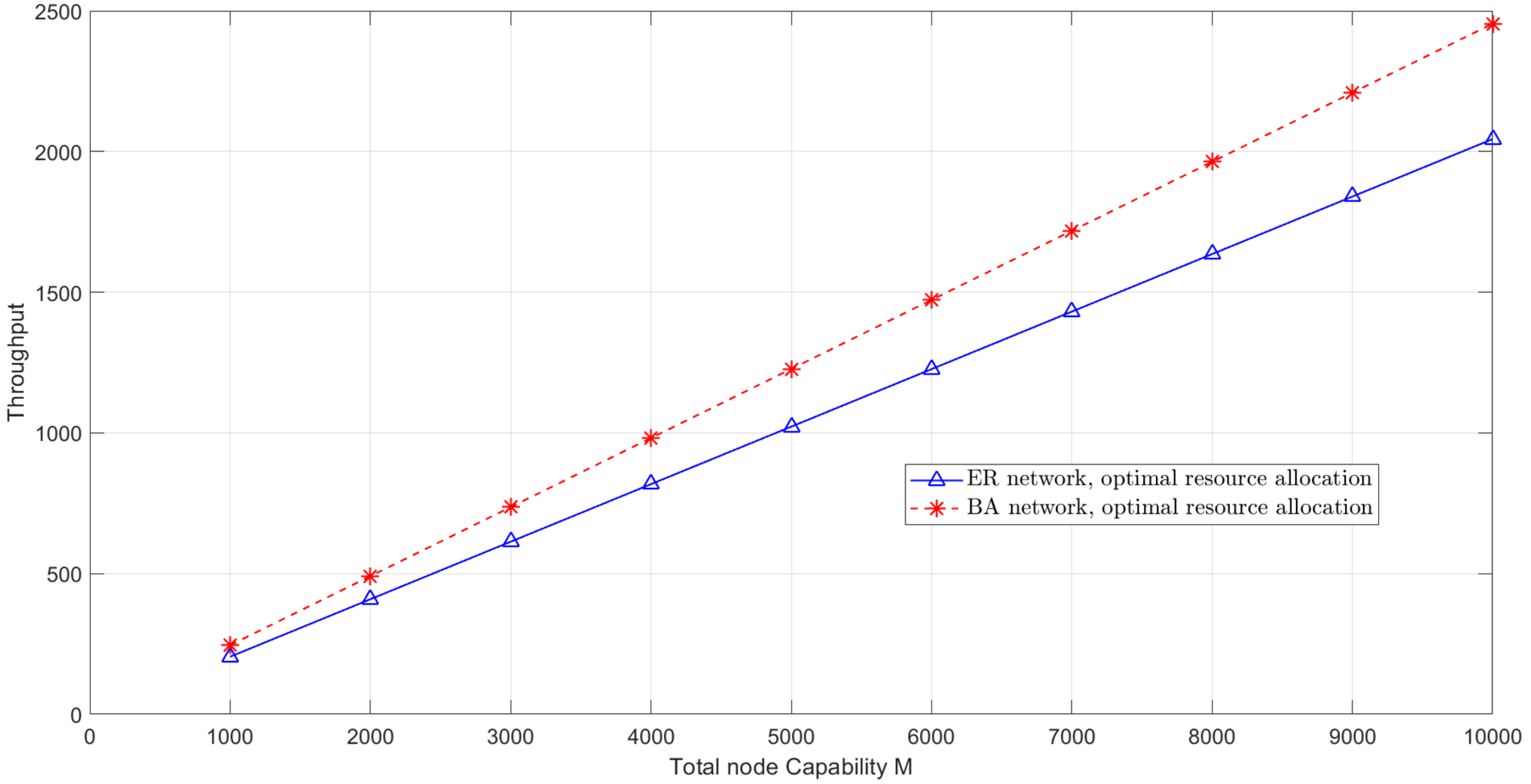

Figure 3. Relationship of throughput of the network and total node capacity M.

Results

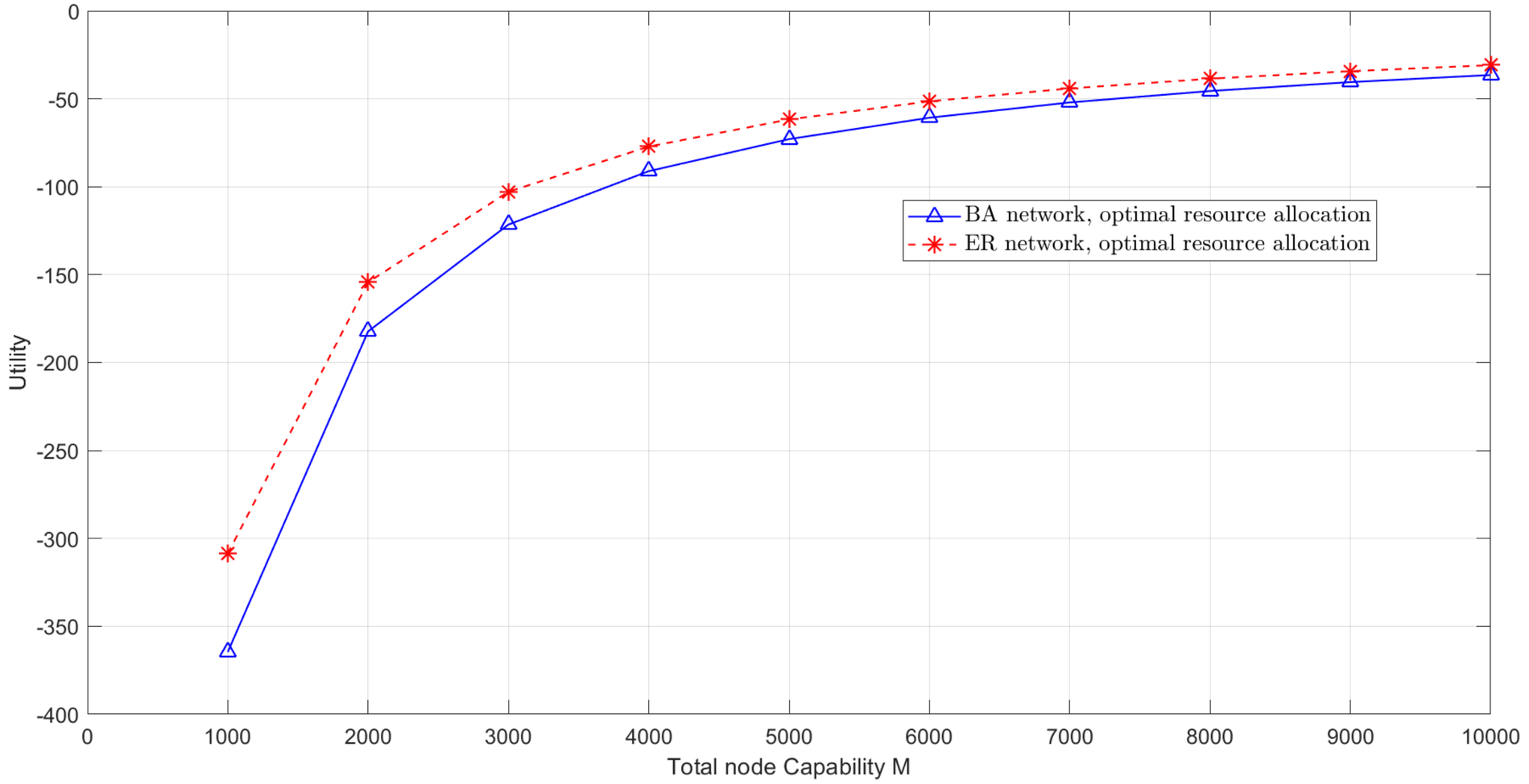

Figure 4. Relationship of utility of the network and total node capacity M.

Challenges

- Understanding the main concept
- NUP + flow control algorithm
- Distributed algorithm
- Running time

Adlet

- Creation of CVX part of the code with all constraints.
- Figure 1 and 2

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- Creation of F(n), F(l), V(s) sets and vector ds
- Figure 3 and 4

Q/A

Session

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