Numerical Analysis
Homework 3. Resistor Networks

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1. Objective

In this assignment, I will use LU decomposition to solve resistor networks and obtain the equivalent resistance and some node voltage.

2. Approach

First, I form the linear system for a resistor network.

Algorithm. System Equation for a Resistor Network

Let the unknown vector be all node voltages, x_i, $i = 1,\ldots,n$.

Create an $n \times n$ matrix A and an n-vector b and initialize both to 0.

for each node i not connecting to voltage sources,

for each resistor, with conductance $g_k = 1/r_k$, connecting node i and j,

$$A_{ii} = A_{ii} + g_k,$$

$$A_{ij} = A_{ij} - g_k.$$

for each node i connecting to a fixed voltage V_i,

$$A_{ii} = 1,$$

$$A_{ij} = 0, \quad j \neq i,$$

$$b_i = V_i.$$

Second, I use LU decomposition to solve the system equation and I can obtain node voltages vector.

3. Results

2 resistors per side	**20 resistors per side**
equivalent resistance: 1000	equivalent resistance: 229.423
v_ne: 0.75	v_ne: 0.622178
v_ea: 0.5	v_ea: 0.5
v_sw: 0.25	v_sw: 0.377822
# of nodes: 9	# of nodes: 441
time: 0	time: 1.9
4 resistors per side	**40 resistors per side**
equivalent resistance: 681.818	equivalent resistance: 136.043
v_ne: 0.7	v_ne: 0.603088
v_ea: 0.5	v_ea: 0.5
v_sw: 0.3	v_sw: 0.396912
# of nodes: 25	# of nodes: 1681
time: 0	time: 105.48
10 resistors per side	**50 resistors per side**
equivalent resistance: 376.009	equivalent resistance: 114.396
v_ne: 0.648693	v_ne: 0.598084
v_ea: 0.5	v_ea: 0.5
v_sw: 0.351307	v_sw: 0.401916
# of nodes: 121	# of nodes: 2601
time: 0.03	time: 386.83

Execution time grows exponentially with # of nodes: