Homework 5: $\mathcal{A}x = b$: solving systems of linear equations using Gauss-Jordan, LU decomposition, and sparse algebra.

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2.1 Assignment

This homework assignment focuses on solving a system of linear equations using a matrix algebra approach. Here the problem will consist in finding the equivalent resistance of a network of identical resistances, connected as shown on the figure. The figure illustrates a 4×3 system but your code will be able to treat any system $n_x \times n_y$ of resistances.

To simplify the problem, all the resistances will be equal to 1Ω and the DC bias applied at the battery will be equal to 1 Volt.

Your job is:

1. To write a code that will build the matrix of resistances for any n_x and n_y.

2. To solve the system of equations for $n_x \leq 20$ and $n_y \leq 20$ and plot the equivalent resistance as a function of n_x and n_y.

3. To use both Gauss-Jordan elimination and LU decomposition and compare the execution times on a graph.

4. Where is the minimum local current?

5. Plot the potential drop across each resistance on a 2D map.

For 3 extra credits towards final project, you have the option to:

1. Solve the above problem using sparse algebra (1.5 credit)

2. Solve the above problem on GPUs (1.5 credit)

Make sure your report is self-contained with sufficient details and clear plots. Feel free to add listings of your code (or use pseudo-code). Collaborative work is allowed but each student will turn in an individual report.

Below is a suggestion for presentation. You can adapt it to your personal vision of the problem.

2.2 Algorithmic Considerations

2.3 Implementation

2.4 Results

2.5 Discussion

2.6 References (if any)

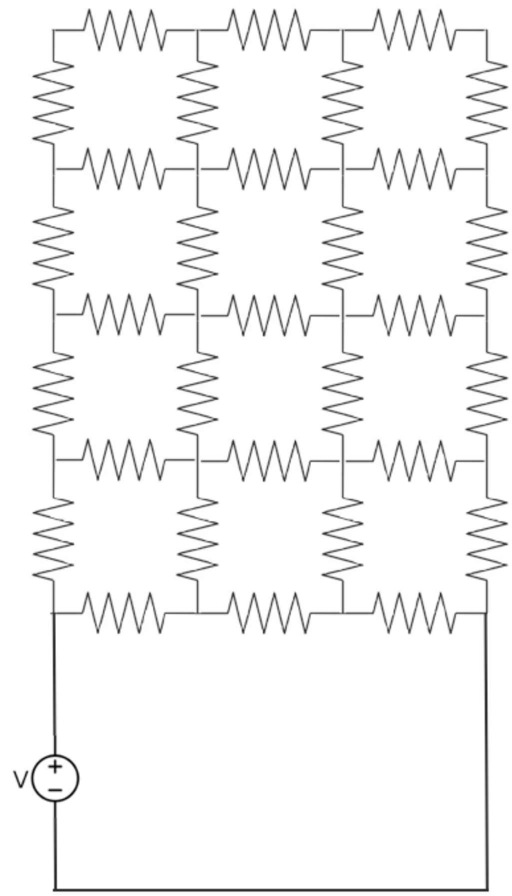

Figure 2.1: Example of a 4×3 network of resistances. Here, the equivalent resistance is found to be $1.60669R$. (Hint: Make sure your code reproduces this result!)