ASSIGNMENT # 1

PHYS-699

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Description Of The Problem:

The given problem is solvable by Krichhoff's Laws and the solution lies in solving a system of linear equations. We are able to solve this problem analytically provided the system of equations is small. A numerical solution saves us time regardless of the size of system of equations. For system of equations not huge, we use direct methods and iterative methods are adopted if the system of equation is enormously large.

Development of Algorithm:

For N nodes in a circuit, the solution lies in solving N-2 system of linear equations. We solved this problem using Crout's LU Decomposition Technique which is one of many direct methods available to us. To solve $A_{N-2,N-2}V_{N-2,1}=B_{N-2,1}$, we have to ensure that A is not a singular matrix.

We notice that resistors form a symmetric matrix of NxN with $R_{12}=R_{21}$, $R_{13}=R_{31}$ and so on. We take advantage of this symmetry and can read the entries of resistors from text files containing matrices of various dimensions into $RESISTOR_{N,N}$. Reading from file gives our code versatility. We make a matrix $ROH_{N,N}$ which contains the reciprocal values of resistors. This way, we get rid of handling inverse quantities in latter part of our algorithm.

We calculate $A_{N-2,N-2}$ and $B_{N-2,1}$ based on ROH, $V=V_1=1.0$ and $V_{N-2}=0.0$. Crout_LU_Decomposition function defined in our source code ensures that $A_{N-2,N-2}$ is not singular and decomposes $A_{N-2,N-2}$ into Lower Triangular Matrix and Unit Upper Triangular Matrix. Along with $B_{N-2,1}$, decomposed $A_{N-2,N-2}$ is then passed to Crout_LU_Solve which returns us the solution contained in $V_{N-2,1}$. We make our final loop to calculate total current drawn for the whole circuit.

At the moment, our code is capable of printing Nodes vs. Current Drawn in tabulated form (multiple runs enabled in one go) or we can run for any particular number of nodes in circuit to find out LU Decomposed Matrix and Voltage drop at each node besides calculating Total Current.

Results:

The produced algorithm is tested for up to 20 nodes. Our results are in good agreement with the solution provided for troubleshoot and debug purposes. We make $R_{ij}=|i-j|$Ohm and $V=V_1=1.0$Volts and $V_{N-2}=0.0$Volts. Total Current Drawn against Total Number Of Nodes is presented in Table 1.1 and Graph 1.1 is also plotted to represent the increasing trend of Current against Nodes.

# OF NODES	CURRENT IN CIRCUIT
3	1
4	1.04762
5	1.1
6	1.15038
7	1.19746
8	1.24117
9	1.28179
10	1.31965
11	1.35505
12	1.38828
13	1.41957
14	1.44913
15	1.47715
16	1.50377
17	1.52912
18	1.55333
19	1.57648
20	1.59868

Table 1.1: # of Nodes vs. Total Current Drawn By Kirchoff's Circuit.

Graph 1.1: Plot between Nodes and Total Current Drawn by Kirchoff's Circuit.