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Scientific Computing Assignment 2

1) Question 1
   a) Application of Sparse Matrices
      i) Pagerank algorithm to rank web pages for optimized web search.
      ii) Solving PDEs of different domains. (Especially Computational FLudi Dynamics)
   b) Read.
   c)

$$\begin{pmatrix} 1 & 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 4 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 8 & 0 & 0 & 16 \\ 0 & 32 & 0 & 0 & 64 \end{pmatrix}$$

      Matrix in CRS format
      Row_ptr = (0 2 3 3 5 7)
      Col_ind = (0 3 3 1 4 1 4)
      Values = (1 2 4 8 16 32 64)
   d) Generate Sparse Matrix
   e) Matrix to CRS format
   f) Get the (i,j)th element from CRS formatted Matrix
   g) Set and element in (i,j)th position
   h) CRS to CCS format Conversion
   i) Generate a Random Matrix, Convert to CSR format, Set Diagonals to 2016, and convert it to CCS format and print
   j) Matrix Vector Multiplication

Algorithm	N = 10	N = 50	N = 100	N = 500	N = 1000	N = 5000
Sparse (ms)	0.017405	0.197887	0.622034	9.5460415	43.410540	1288.798332
Dense (ms)	0.020980	0.438929	1.499176	27.653217	122.936249	3249.945402

k) Matrix Matrix Addition

Algorithm	N = 10	N = 50	N = 100	N = 500	N = 1000	N = 5000
Sparse (ms)	0.041485	0.808239	2.507210	45.750141	184.364796	4957.509041
Dense (ms)	0.043392	0.892162	2.872706	54.998636	221.481562	5891.148329

2) Question 2

a) -2 , -3 , 11

b) Normalized Power Iteration with initial vector $[0\ 0\ 1]^T$.

kth Iteration	X_k^T	$\|y_k\|_{Infinity}$
1	[0.5, 1.0, 0.25]	4.0
2	[0.5, 1.0, 0.8611]	9.0
3	[0.5, 1.0, 0.7306]	11.4444
4	[0.5, 1.0, 0.7536]	10.9224
5	[0.5, 1.0, 0.7493]	11.0144
6	[0.5, 1.0, 0.7501]	10.9972
7	[0.5, 1.0, 0.75]	11.000399999999999
8	[0.5, 1.0, 0.75]	11.0

c) Shifted Normalized Power Iteration. Matrix is shifted by -2

kth Iteration	X_k^T	$\|y_k\|_{Infinity}$
1	[-0.5, -1.0, -0.75]	7.0
2	[-0.5, -1.0, -0.75]	13.0

d) After the shift the convergence rate is increased hence the number of iterations are reduced from 8 to 2. The reason to choose -2 to as the shift is, -2 is the second highest eigenvalue of the matrix.

e) Pagerank Algorithm