Name: _____ USC ID: _____

Quiz 2: Matrix Multiplication using MapReduce (10 points), 15 minutes

Consider multiplying matrices A and B below using the (element-based) **2-phase** approach. Matrices are stored in a file in the sparse format (row index, column index, value) as shown in class.

$$A = \begin{bmatrix} 1 & 0 \\ 2 & 1 \\ 0 & 1 \end{bmatrix}, B = \begin{bmatrix} 1 & 0 \\ 1 & 2 \end{bmatrix}$$

1. [4 points] List all key-value pairs generated by the **Map** tasks of the **first** phase.

   A[i,j]: emit (j, ('A', i, A[i,j]))
   B[j,k]: emit (j, ('B', k, B[j,k]))
   (1, ('A', 1, 1)), (1, ('A', 2, 2)), (2, ('A', 2, 1)), (2, ('A', 3, 1)),
   (1, ('B', 1, 1)), (2, ('B', 1, 1)), (2, ('B', 2, 2))

   If all answers are wrong, you'll get 0 point
   If zero entries are not removed, deduct 0.5 point
   For every wrong key-value pair, deduct 0.5 point
   If key-value pair format is wrong, deduct 0.5 point

2. [3 points] List all key-value pairs generated by the Reduce tasks of the **first** phase.

   emit ((i,k), A[i,j] * B[j,k])
   j = 1: ((1, 1), 1), ((2, 1), 2)
   j = 2: ((2, 1), 1), ((2, 2), 2), ((3, 1), 1), ((3, 2), 2)

   If zero entries are not removed, deduct 0.5 point
   For every wrong key-value pair, deduct 0.5 point
   If key-value pair format is wrong, deduct 0.5 point

3. [3 points] List all key-value pairs generated by the Reduce tasks of the **second** phase.

   ((1, 1), 1), ((2, 1), 3), ((2, 2), 2), ((3, 1), 1), ((3, 2), 2)

   If zero entries are not removed, deduct 0.5 point
   For every wrong key-value pair, deduct 0.5 point
   If key-value pair format is wrong, deduct 0.5 point