

University of Nevada, Las Vegas Computer Science 477/677 Spring 2012

Examination, March 29, 2012

The entire examination is 225 points.

Name: _____

No books, notes, scratch paper, or calculators. Use pen or pencil, any color. Use the rest of this page and the backs of the pages for scratch paper. If you need more scratch paper, it will be provided.

1. True or False. If the answer is not known to science at this time, write "O" (for *open*). [5 points each]
 - (a) _____ $\mathcal{NP} = \mathcal{P}$
 - (b) _____ In open hashing, if the size of the hash table is less than the number of data items, every entry in the hash table will always have at least one item.
 - (c) _____ Greedy algorithms may be faster, but they should **never** be used if accuracy is important.
2. Fill in the blanks. [5 points each blank.]
 - (a) You can use _____ hashing if you know the exact data set in advance.
 - (b) No algorithm can find minimum weight paths in a directed weighted graph that has a _____
_____. [Two words.]
 - (c) The letter "N" in the name of the class $\mathcal{NP}$ stands for _____, while the letter "P" stands for _____.
 - (d) Each of the following two blanks contains either the word "top-down" or the word "bottom-up."
Dynamic programming algorithms are usually considered _____, while divide
and conquer algorithms are usually considered _____.
3. [15 points] Describe the standard desirable properties of a good hash function.

4. Solve the following recurrences, given the answer either using O , Ω , or Θ , whichever is most appropriate.
[10 points each]

(a) $F(n) \leq 4F(n/2) + n$

(b) $F(n) \geq F(n/3) + 1$

(c) $F(n) = F(n-1) + n^3$

(d) $F(n) = F(\sqrt{n}) + 1$

(e) $F(n) = \sqrt{n} F(\sqrt{n}) + n$

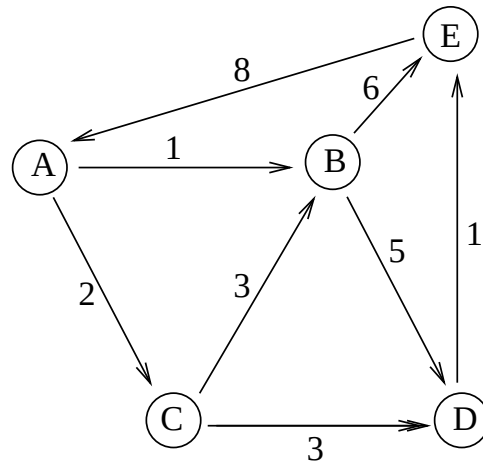
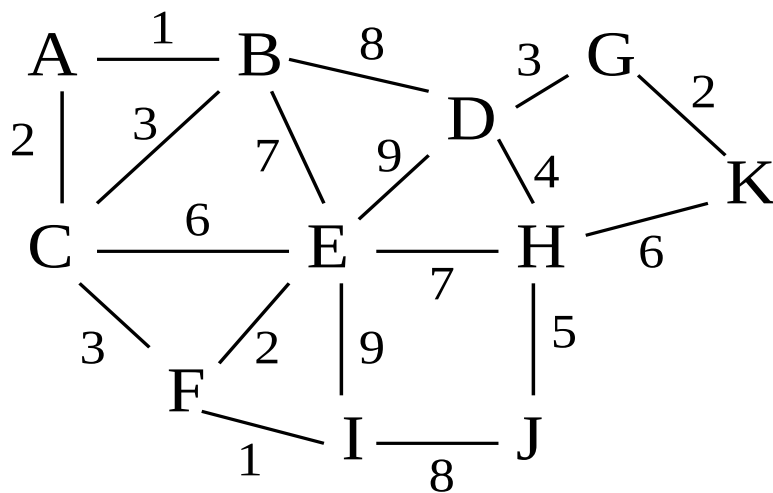


Figure 1: The weighted directed graph for Problem 5.

5. [30 points] Use Dijkstra's algorithm to solve the single-source minpath problem for the weighted directed graph shown in Figure 1, where the source vertex is A . Show all steps.

6. [30 points] Find a minimum spanning tree of the graph shown in the figure below. Use Kruskal's algorithm, using the implementation of Union/Find that we did in class. Show steps.

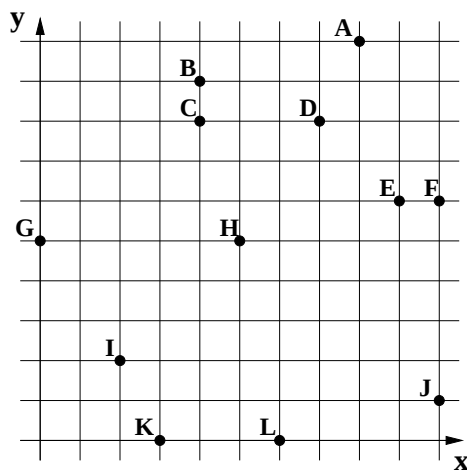
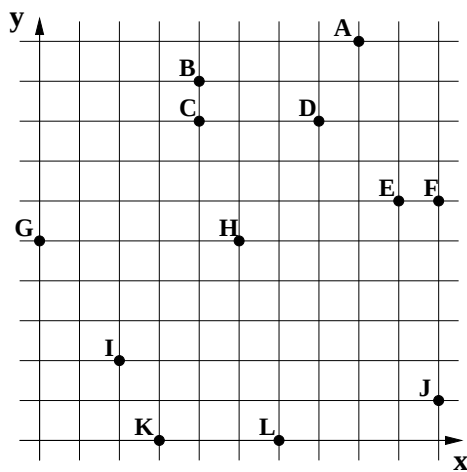
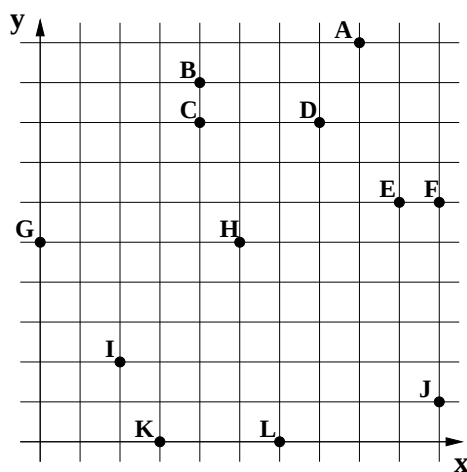
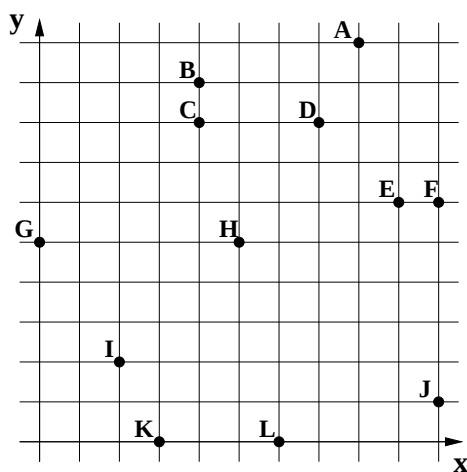


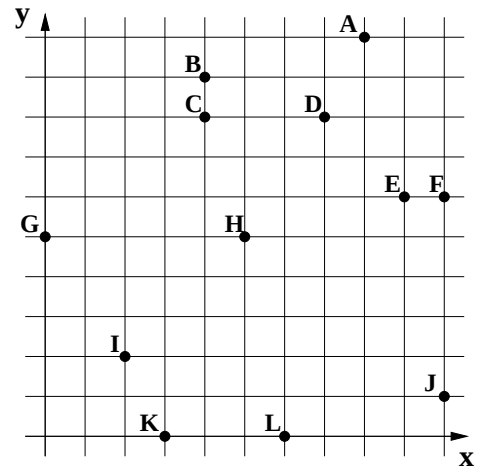
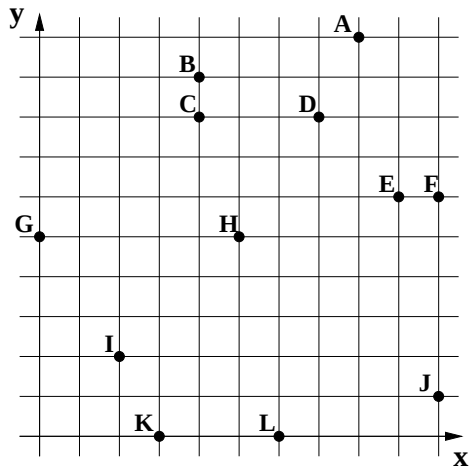
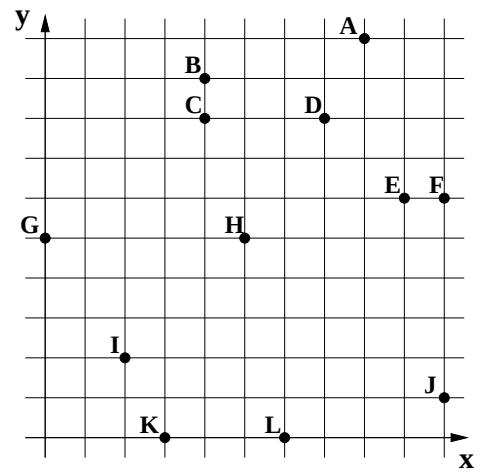
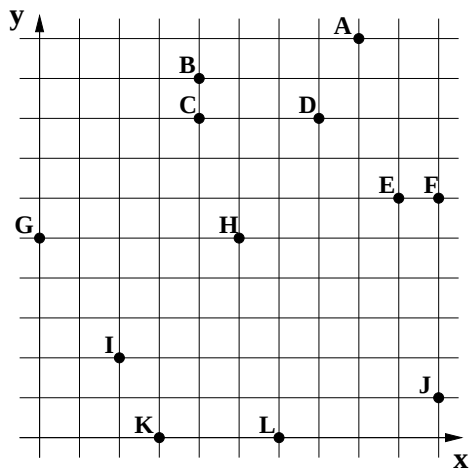
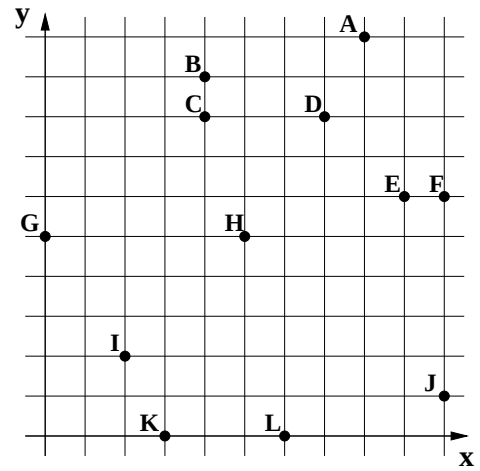
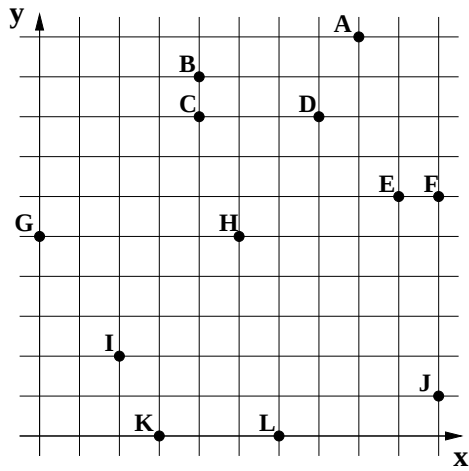
The weighted graph for Problem 6.

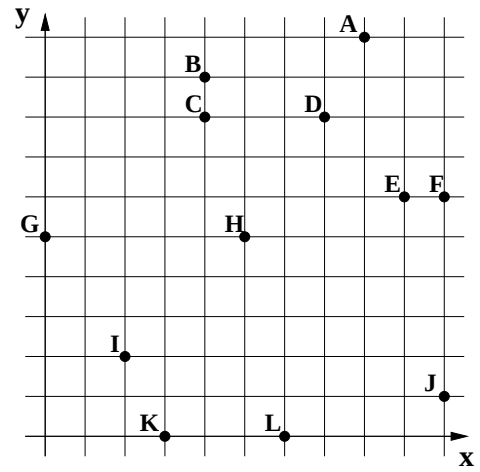
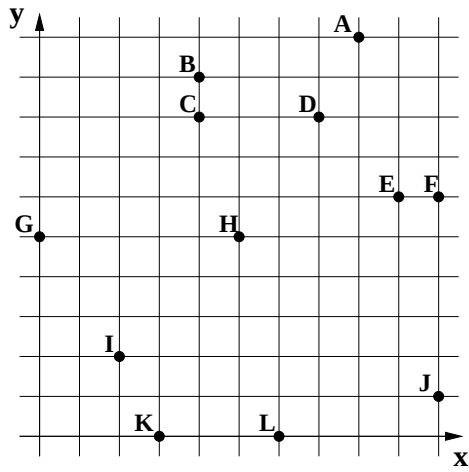
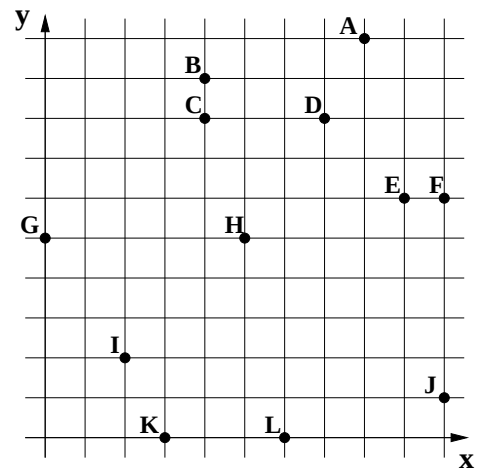
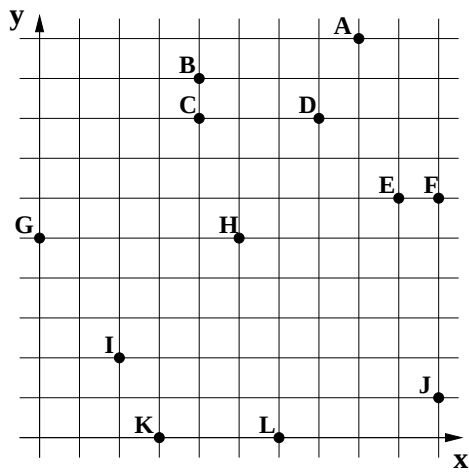
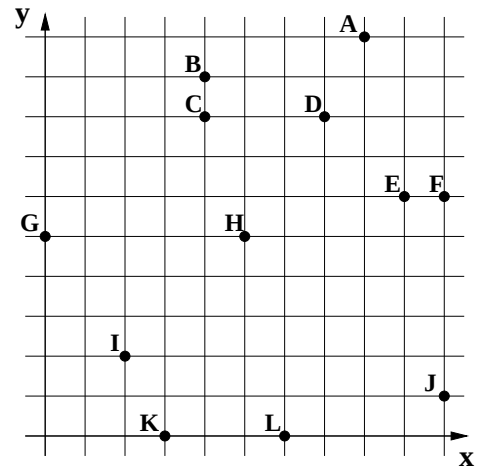
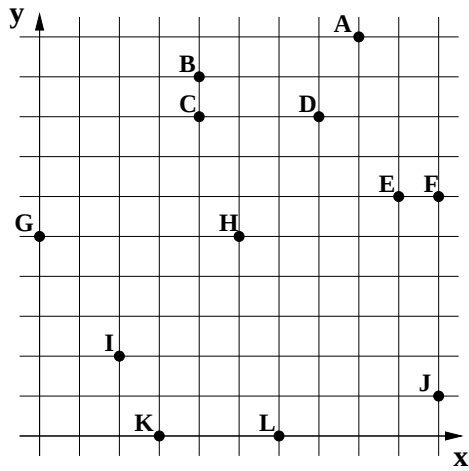
7. [30 points] A three dimensional $10 \times 8 \times 6$ array $\mathbf{X}$ is stored in row-major order. The indices range from 0 to 9, 1 to 8, and 0 to 5, respectively. Each item in the array occupies two addressable memory locations. The first item in the array, $\mathbf{X}[0,0,0]$, starts at address 1024. Where will the entry $\mathbf{X}[5,3,2]$ be stored?

8. [30 points]

Walk through Graham Scan to find the convex hull of the set of points $\{A, B, C, D, E, F, G, H, I, J, K, L\}$ in the plane, as shown in the figure. Use the space below, and as many copies of the figure as you need, to show the steps.







9. [20 points] A *complete graph* is a graph where there is an edge between any two nodes. The *Luce-Perry problem* is defined as follows:

“Given a graph G and an integer k , does G contain a complete subgraph consisting of k nodes?”

Using information I gave you in class about guide strings, or about non-deterministic programs, or both, convince me that the Luce-Perry problem is in the class $\mathcal{NP}$ -time.

If you simply tell me that it's well-known that it's $\mathcal{NP}$, and give me a reference, that will be worth no points.

Hint: It can be proved in only one line of text, although if you write more lines to “make sure,” that's ok.