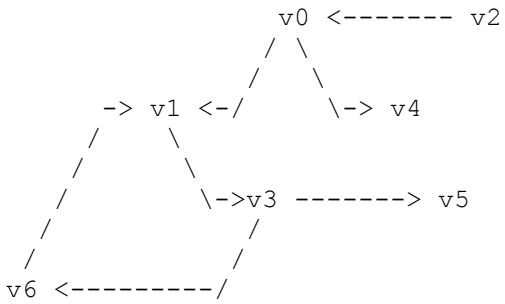
1. Draw a directed graph with five vertices and seven edges. Exactly one of the edges should be a loop, and do not have any multiple edges.
2. Draw an undirected graph with five edges and four vertices. The vertices should be called v1, v2, v3 and v4--and there must be a path of length three from v1 to v4. Draw a squiggly line along this path from v1 to v4.
3. Draw the directed graph that corresponds to this adjacency matrix:

```
       0       1       2       3
0  |  true    false   true    false  |
1  |  true    false   false   false  |
2  |  false   false   false   true   |
3  |  true    false   true    false  |
```

4. Draw the edge lists that correspond to the graph from the previous question.
5. Consider this graph:



   In what order are the vertices visited for a depth-first search that starts at v0? In what order are the vertices visited for a breadth-first search that starts at v0?

Multiple Choice

1. Which of the following statements is true?
   - A. A graph can drawn on paper in only one way.
   - B. Graph vertices may be linked in any manner.
   - C. A graph must have at least one vertex.
   - D. A graph must have at least one edge.
2. Suppose you have a game with 5 coins in a row and each coin can be heads or tails. What number of vertices might you expect to find in the state graph?
   - A. 7
   - B. 10
   - C. 25
   - D. 32
3. Why is the state graph for tic-tac-toe a directed graph rather than an undirected graph?
   - A. Once a move is made, it cannot be unmade.
   - B. There is an odd number of vertices.
   - C. There is an odd number of edges.

- D. There is more than one player in the game.

4. A simple graph has no loops. What other property must a simple graph have?
   - A. It must be directed.
   - B. It must be undirected.
   - C. It must have at least one vertex.
   - D. It must have no multiple edges.
5. Suppose you have a directed graph representing all the flights that an airline flies. What algorithm might be used to find the best sequence of connections from one city to another?
   - A. Breadth first search.
   - B. Depth first search.
   - C. A cycle-finding algorithm.
   - D. A shortest-path algorithm.
6. If G is an directed graph with 20 vertices, how many boolean values will be needed to represent G using an adjacency matrix?
   - A. 20
   - B. 40
   - C. 200
   - D. 400
7. How many linked lists are used to represent a graph with n nodes and m edges, when using an edge list representation,
   - A. m
   - B. n
   - C. m + n
   - D. m*n
8. How are loops represented in an edge-list representation of a graph?
   - A. A vertex will be on its own edge-list.
   - B. The edge-list will be a circular linked list.
   - C. The edge-list will be empty for that particular vertex.
   - D. The edge-list will be full for that particular vertex.

   Which graph representation allows the most efficient determination of the existence of a particular edge in a graph?

   - A. An adjacency matrix.
   - B. Edge lists.
9. What is the expected number of operations needed to loop through all the edges terminating at a particular vertex given an adjacency matrix representation of the graph? (Assume n vertices are in the graph and m edges terminate at the desired node.)
   - A. O(m)
   - B. O(n)
   - C. $O(m^2)$
   - D. $O(n^2)$

10. What graph traversal algorithm uses a queue to keep track of vertices which need to be processed?
    - A. Breadth-first search.
    - B. Depth-first search.