Topics that might be on the second examination on October 26 2022

A few time complexity and recurrence problems, since not everyone has
mastered them.

Be able to write pseudocode:
 1. Floyd Warshall algorithm.  W are the arc weights.

```
 For all i and all j V[i,j] = W[i,j], back[j] = i

 For all j
  For all i
   For all k
    { temp = V[i,j]+V[j,k]
      if(temp < V[i,k])
        V[i,k] = temp
back[i,k] = back[j,k]
    }
```

 2. Bellman Ford algorithm.  0 = source.

```
 For all i V[i] = W[0,i], back[i] = 0
 Repeat the following until there are no more changes
  {
   for all arcs (i,j)
    { temp = V[i]+W[i,j]
      if(temp < V[j])
        V[j] = temp
back[j] = i
    }
```

Be able to step through Dijkstra's algorithm for a small graph.

Johnson's algorithm.
 Given a figure showing a weighted directed graph with some negative weights,
 Update the weights on edges so that there are no negative weights.

What is the worst-case time complexity for each of those four algorithms?

Johnson's O(nm logn) Floyd Warshal Theta(n^3) Bellman Ford O(nm)
Dijkstra O(m logn)

Dynamic Programming, possibly with memoization.

Example problem: maximum sum contiguous subsequence. Given a sequence of numbers, each either positive or negative, find a contiguous subsequence of maximum total. As an example if the input sequence is 3,-4,8,-2,3,5,-1,6,-5 the output sequence is 8,-2,3,5,-1,6. There are several algorithms for this problem.

1. Dumb Brute Force: O(n^3) time.
2. Slightly Smarter Brute Force: O(n^2) time.
3. Divide and Conquer: O(log n) time.
4. Dynamic Programming: O(n) time.

BFPRT (median of medians) algorithm for Selection.
Explain how to obtain the recurrence for the time complexity, that is
T(n) <= T(n/5)+T(7n/10)+n.

It takes $O(1)$ time to find the median of all blocks of 5. That's $\Theta(n)$. Finding the median of those medians, to use as a pivot, takes $T(n/5)$ time. Using the pivot, we partion the set into two pieces. Each piece has at least 3n/10 items, hence each piece has no more than 7n/10 items.

Find components of an undirected graph using union/find.

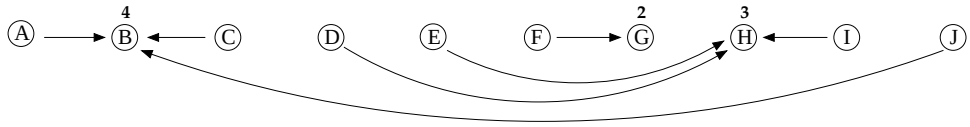
Here is an example. The graph is given to us as a list of edges. Let the vertices be Roman letters in the range A .. J. Let the list of edges be:

Work this example.

Each time you see an edge, you do find for both vertices, then union for both leaders if they are different.

The final diagram is shown below.

$\{A, B\}$
$\{E, H\}$
$\{F, G\}$
$\{C, B\}$
$\{D, E\}$
$\{A, J\}$
$\{D, I\}$
$\{D, H\}$
$\{B, J\}$
$\{C, J\}$
$\{E, H\}$




Heapsort. O(n log n) time. A sped up version of selection sort.