All problems on the quiz involve the following problem:
AbstractWordSearch: Given a directed graph $G$ where each vertex has degree at most $d$, and each vertex $v$ is labelled by a symbol $\ell(v)$, a start vertex $v_1$, and a sequence of symbols $w_1..w_k$, is there a path in $G$ starting from $v_1$, $v_1..v_k$, so that $\ell(v_1)\ell(v_2)\ldots\ell(v_k) = w_1..w_k$? Note that the path might not be simple.

1. (5 points) Here is a recursive back-tracking algorithm that solves AbstractWordSearch:
   $$BTAWS(G, v, w_1..w_k).$$
   (a) IF $\ell(v) \neq w_1$ return False
   (b) IF $k = 1$ return True
   (c) FOR $u \in N(v)$ do:
   (d) IF $BTAWS(G, u, w_2..w_k) == True$ THEN return True
   (e) Return False

Illustrate the tree of recursive calls the above algorithm makes on the input (Note: The starting vertex $v$ is vertex 2, and $w_1..w_6 = BANANA)$:
2. (5 points) Give an upper bound on the number of total recursive calls the above procedure makes.

3. (5 points) Characterize the different subproblems that arise in the BT algorithm above.

4. (5 points) Define an array or matrix based on the sub-problem characterization of part 3.
5. (10 points) Compose the base cases of your array and express your array entries recursively. (give a brief justification of why your recursion works.)
6. (5 points) Convert the above backtracking algorithm into a dynamic programming algorithm.

7. (5 points) Analyze the running time of your dp algorithm.