1 Tour of Rome

You are a tour guide charged with coming up with an itinerary for some clients wishing to visit Rome, Italy. The clients will be in Rome starting Monday and finishing Friday (5 days). They can only see one site per day. They wish to see all 5 of the following sites:

- The Vatican
- The Colosseum
- The Appian Way
- The Trevi Fountain
- The Sistine Chapel

1. Formulate this problem as a CSP problem in which there is one variable per tourist site, stating the domains, and constraints. Constraints should be specified formally and precisely, but may be implicit rather than explicit.

2. Draw the constraint graph associated with your CSP.

3. Rate your constraint graph on a scale from “tree-structured” to “not tree-structured at all”. Based on that answer describe whether a tree-structured algorithm or a local search algorithm would be better suited for finding a solution. Justify why the algorithm you chose would work better.
You are a poet. For your next poem, you are needing a phrase that is 4 words long. The diagram above shows the words you can choose (note that this is not a constraint graph). The diagram also tells you which transitions are allowed between words. For example, the edge from “Clay” to “loves” means that “Clay” can be followed by “loves”. You want the last word in the phrase to be the word “today”.

You decide to model the problem using variables $X_i$ for each position $i$ in the sequence of words you are trying to generate, and domains equivalent to the set of possible words for that position.

1. State the binary and/or unary constraints for this CSP (either implicitly or explicitly).

2. Cross out the values from the domains of the variables that will be deleted in enforcing arc consistency.
3. According to MRV, which variable or variables could the solver assign first?

4. Assume that you also want the phrase to start with “Clay”. List all the solutions of this CSP or write none if no solutions exist.

3 Questions about CSPs

1. In arc consistency, arcs are processed one at a time for consistency, potentially pruning values from variable domains. True or False: the order in which arcs are considered will impact the set of values that remain when the arc consistency algorithm terminates? Briefly explain your answer.

2. For a CSP that has n variables, each of which has d possible values, what is the maximum number of steps a backtracking search algorithm could potentially have to backtrack (i.e., the number of the times it generates an assignment, partial or complete, that violates the constraints) before finding a solution or determining that there is not satisfying solution? (circle one). Briefly explain your answer.
   - $O(1)$
   - $O(nd^2)$
   - $O(n^2d^3)$
   - $O(d^n)$
   - $\infty$

3. What is the maximum number of steps a backtracking search algorithm could potentially have to backtrack for a CSP if it is running arc consistency and applying the MRV and LCV heuristics? (circle one). Briefly explain your answer.
   - $O(1)$
   - $O(nd^2)$
   - $O(n^2d^3)$
   - $O(d^n)$
   - $\infty$

4. Consider now that we are trying to solve a tree-structured CSP using a backtracking search algorithm with arc consistency and using an optimal variable ordering. What is the maximum number of steps we might have to backtrack? (circle one). Briefly explain your answer.
   - $O(1)$
   - $O(nd^2)$
   - $O(n^2d^3)$
   - $O(d^n)$
   - $\infty$
5. Constraint Graph Consider the following constraint graph:

In two sentences or less, describe a strategy for efficiently solving a CSP with this constraint structure.