Week 13: Complexity Classes and Optimization

Day 22 (M 4/13): Backtracking and Enumeration

- **Video (21 min)**: Watch the following video on brute-force and backtracking algorithms.
`https://youtu.be/vDh_Y_ypMMA`

- **Exercise (10 min)**: In the subset sum problem, we are given a list of integer values and the goal is to find a subset of the list such that the entries in the subset sum to a given value T. For example, if the list is $[1, 3, 3, 4, 2]$ and the sum was $T = 6$ there would several possible subsets $(3, 3), (2, 4), (1, 3, 2)$. Explain how you would use backtracking to find a feasible solution to the subset sum problem.

- **Video (8 min):** Watch the following video on solving Sudoku with backtracking.
`https://youtu.be/bumjIv4qWfw`

Day 23 (R 4/16): P vs NP

- **Video (22 min)**: Watch the following video on complexity classes.
`https://youtu.be/jWlZOuVP_Sw`

- **Exercise (5 min)**: Show that the knapsack problem and sudoku problem are both in NP.

- **Video (5 min):** Watch the following video on the traveling salesman problem (TSP).
`https://youtu.be/zhKO7LjO2w0`

Day 24 (F 4/17): Intro to Heuristic Algorithms

- **Video (12 min)**: Watch the following video introducing heuristic algorithms.
`https://youtu.be/pXUUgDHlJ10`

- **Exercise (15 min)**: In the graph coloring problem, we are given an undirected graph $G = (V, E)$. The goal is to color the nodes of G using as few colors as possible such that for all edges $(u, v) \in E$ the nodes u and v are given different colors. Design a greedy heuristic algorithm to solve this problem. Can you find an instance in which your algorithm does not find the optimal solution (i.e. does not use the fewest number of colors)?

- **Video (11 min):** Watch the following video about local search algorithms. `https://youtu.be/GG9rAO5tYm8`
- **Exercise (15 min)**: Design a local search heuristic algorithm to solve this problem. Can you find an instance in which your algorithm does not find the optimal solution?

Extra Resources for the Week

- Backtracking: `http://www3.cs.stonybrook.edu/~skiena/373/videos/pdf/L15.pdf`
- NP: `http://www3.cs.stonybrook.edu/~skiena/373/videos/pdf/L19.pdf`
- Local Search: `https://www.cs.unc.edu/~lazebnik/fall10/lec06_local_search.pdf`
- TSP Heuristics: `http://160592857366.free.fr/joe/ebooks/ShareData/Heuristics%20for%20the%20Traveling%20Salesman%20Problem%20By%20Christian%20Nillson.pdf`