CSC196: Great Ideas in Computing

Tutorial 5

16th November 2022

Assignment 3

- Deadline: Wednesday, November 18, 8 AM EST
- Please try to export your solutions to .pdf before submitting, it makes grading easier
- Assignment created on MarkUs with 48 hours penalty decay of 0.5% per hour
- You have one week from the deadline to ask for re-grading
  - You will get the assignment grades within 4 days from the deadline

Q1

- Write search engine query to get some "complex" information
    - "Complex" information is a mixture of multiple "simple" information
        - "Simple" information: List of countries in the world
        - "Complex" information: List of executive leaders in the European Union
    - You will probably not get the desired result in the first time
    - Refine query **if necessary** and try again
    - Use incognito mode so that search information is not cached

Q1 (cont.)

- Record the following for each query:
  - Search Engine of choice (Google, DuckDuckGo etc...)
  - Query string ("Who is the president of South Africa")
  - Is this a refined query? If so, how?
  - Time at which search was executed
  - $max(k, 10)$ titles, where k is the number of results, ignore sponsored results and subtitles
- Repeat the same set of queries after a day
  - Use incognito mode so that search information is not cached
  - Search engines might learn to produce different (e.g. more relevant) results

Q1 (cont.)

- Are the titles recorded the same for each query? If it is different, then why is it the case?
  - Is it more relevant or less?
  - Are the sources more authentic than before?
  - These are some of the questions you can ask yourselves
  - Again, there are no right or wrong answers here
- **To the point answers are appreciated, don't write a long essay to get more marks.**

Q2

- Find allocations for each agent based on their value density function
  - Allocation A_1 for agent 1 is a range of rational numbers
  - $A_1 = [a, b] \subset [0, 1]$ such that $a, b \in Q$
  - Value function v_1 for agent 1 maps allocation A_1 to value y_1
  - $v_1(A_1) = y_1$
- Show that allocations are **equitable** and **envy-free**
  - Equitable: $y_1 = y_2 = y_3$
  - Envy-Free: $v_i(A_i) > v_i(A_j) \forall i, j \in [1, 2, 3]$
- Hint: **Use symmetry of the given value density functions**

Q3

- Assume $P \neq NP$
- It is a proven fact that 3-coloring problem is NP-complete
  - NP-complete: cannot be decided in polynomial time
- For graph $G = (V, E)$, whether the following languages are decidable in polynomial time? Justify.
  - $\mathcal{L}_1$: Is graph G, 100 colorable?
  - $\mathcal{L}_2$: Is graph G, $|V| - 1$ colorable?
  - $\mathcal{L}_3$: Is graph G, $|V|/2$ colorable such that $|V|$ is even?

Q3 (cont.)

- If a NP-complete problem A can be reduced in polynomial time to problem B, then B is NP-complete
- Come up with a transformation to reduce 3-coloring problem to 100-coloring problem?
  - Use a graph G which is 3 colorable and has |V'| vertices, then transform it
  - Hint: Clique k_n has n vertices and it is n-colorable
- What should be the size of the clique to reduce 3-coloring problem to $|V|/2$ colorable problem?
  - Here $|V|$ is the number of vertices in the transformed graph
  - Use a graph G which is 3 colorable and has $|V'|$ vertices, then transform it

Q3 (cont.)

- What about $|V| - 1$ colorable problem?
  - Every graph is $|V| - 1$ colorable if it is not a clique, **why**?
  - You can't use above transformations for this problem, **why**?

Best of luck for the quiz on 25th November!

- If you want to prove a problem A is NP, either show
  - Some NP problem B is reducible to A, note the direction of reducibility
  - Show exponential time solution and show that there is no better solution
- Polynomial vs Exponential
  - n^k for constant k is polynomial
  - n^k where $k = f(n)$ is exponential
- Revise previous assignments