THE UNIVERSITY OF BRITISH COLUMBIA
CPSC 320 2016WT2: WEEKLY QUIZZES

Full Name: _____ Exam ID: ____

Signature: _____ UBC Student #: _____

Important notes about this examination

1. You have 25 minutes to complete this quiz.
2. **Answer all questions in PEN and write CLEARLY and LEGIBLY.**
3. You are allowed to bring up to (the equivalent of) a 3-inch 3-ring binder of notes and 3 textbooks, and nothing else. Justify all you answers.
4. Use the back of the pages for your notes, or if you need extra space for the answer to any question.
5. Good luck!

Student Conduct during Examinations

1. Each examination candidate must be prepared to produce, upon the request of the invigilator or examiner, his or her UBCcard for identification.
2. Examination candidates are not permitted to ask questions of the examiners or invigilators, except in cases of supposed errors or ambiguities in examination questions, illegible or missing material, or the like.
3. No examination candidate shall be permitted to enter the examination room after the expiration of one-half hour from the scheduled starting time, or to leave during the first half hour of the examination. Should the examination run forty-five (45) minutes or less, no examination candidate shall be permitted to enter the examination room once the examination has begun.
4. Examination candidates must conduct themselves honestly and in accordance with established rules for a given examination, which will be articulated by the examiner or invigilator prior to the examination commencing. Should dishonest behaviour be observed by the examiner(s) or invigilator(s), pleas of accident or forgetfulness shall not be received.
5. Examination candidates suspected of any of the following, or any other similar practices, may be immediately dismissed from the examination by the examiner/invigilator, and may be subject to disciplinary action:
   i. speaking or communicating with other examination candidates, unless otherwise authorized;
   ii. purposely exposing written papers to the view of other examination candidates or imaging devices;
   iii. purposely viewing the written papers of other examination candidates;
   iv. using or having visible at the place of writing any books, papers or other memory aid devices other than those authorized by the examiner(s); and,
   v. using or operating electronic devices including but not limited to telephones, calculators, computers, or similar devices other than those authorized by the examiner(s)—(electronic devices other than those authorized by the examiner(s) must be completely powered down if present at the place of writing).
6. Examination candidates must not destroy or damage any examination material, must hand in all examination papers, and must not take any examination material from the examination room without permission of the examiner or invigilator.
7. Notwithstanding the above, for any mode of examination that does not fall into the traditional, paper-based method, examination candidates shall adhere to any special rules for conduct as established and articulated by the examiner.
8. Examination candidates must follow any additional examination rules or directions communicated by the examiner(s) or invigilator(s).

Please do not write in this space:

Quiz Number:

Tutorial Section:

1 Cluedo Something to Me

The new game Clue II (CII, for short) is about a group of n people, each intent on stealing one of n objects. Each person moves about a mansion picking up and putting down objects but never holding the same object twice or holding any one object more than once. When they reach the object they want to steal, they pick it up and immediately flee the mansion with it, picking up no more objects.

Crucially, however, no one discovers anyone else has stolen anything. So, no one ever goes to pick up an object, only to find it missing.

As a player, you receive a list of clues, each of which is in one of two forms:

- "person" clues: person p_i was supposed to hold object o_j before object o_k (denoted (i, j, k) for short), and
- "object" clues: object o_i was supposed to be held by person p_j before person p_k (also denoted (i, j, k) for short)

(The clues describe what happens up to the point where a person steals an item; from that point on, the person picks up no more items, no matter what the clues say.)

So, an instance of the game is a value n, a list of person clues (i, j, k), and a list of object clues (i, j, k). No clue is repeated. No set of clues for a particular person (or a particular object) is inconsistent in the sense that it demands (directly or indirectly via a chain of clues) that person p_i hold o_j both before and after o_k (and similarly for object clues).

Your goal is to propose an item for each person to steal so that the thefts could have happened without anyone discovering that any other item was stolen.

For example, with the object clue "the candle was supposed to be held by Squirrel Girl before Koi Boy" and the person clue "Koi Boy was supposed to hold the candle before the pipe", it could **not** be the case that Squirrel Girl stole the candle and Koi Boy stole the pipe because:

- before Koi Boy can pick up and steal the pipe, Koi Boy must pick up the candle, and
- before Koi Boy can pick up the candle, Squirrel Girl (who held it first) must have already stolen it,
- but then Koi Boy would discover the theft of the candle.

You may use the topological sort algorithm (topo-sort) as needed in this problem. Topological sort takes a directed graph with no cycles (a directed, acyclic graph) and produces a left-to-right ordering of the vertices in the graph such that all edges point to the right. It runs in $O(m + n)$ time (where $m = |E|$ and $n = |V|$).

1.1 Instealbility

Here's a slight variant on the problem, which we'll call C3. Instead of receiving individual clues like "p_1 was supposed to hold o_1 before o_2", you receive a full list of the order that people are supposed to hold items and items are supposed to be held.

For example, with three people/items, you might be told for p_1 that "p_1 was supposed to hold o_1 before o_3 and o_3 before o_2" and for o_2 that "o_2 was supposed to be held by p_3 before p_2 and by p_2 before p_1".

So, a C3 instance is n, a planned ordering of objects for each person, and then a planned ordering of people for each object.

Give a correct reduction from C3 to SMP. Note that this means you have a correct solver for SMP and you use it as part of your reduction to solve C3.

FOR THE ASSIGNMENT ONLY: Sketch the key points in a proof that your reduction is correct. (That is, clearly explain why only an instability in SMP instance's solution could lead to the discovery of a theft in C3 instance/solution.)