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:

Pipelines

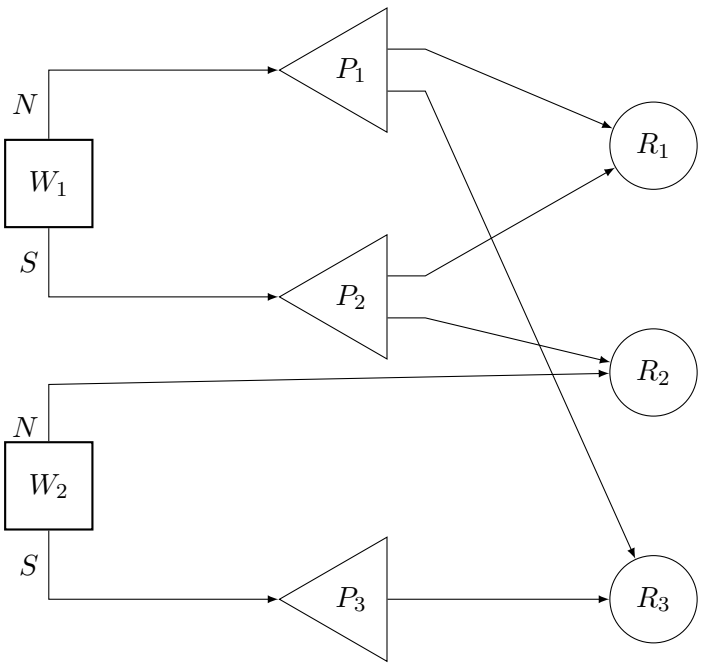
March 28, 2017

In the PIPELINE problem, you're given a network of pipelines which can be represented as a directed, acyclic graph (DAG) with three types of nodes:

- "Oil well" nodes that produce oil. They have **no** pipelines coming in and two pipelines going out labeled "N(orth)" and "S(outh)". They also have a switch. If the switch is in the "N" position, then the oil flows into the northern pipeline. If the switch is in the "S" position, then oil flows into the southern pipeline.
- "Pump station" nodes can have one pipeline coming in (which may or may not carry oil depending on the configuration of oil well switches) and any number of pipelines going out. If the pipeline coming in carries oil, then all pipelines going out also carry oil. Otherwise, none of the pipelines carries oil.
- "Refinery" nodes require oil supply to produce other products. They have one or more pipelines coming in and none going out. If any pipeline coming in carries oil, the refinery is operational. Otherwise, it is not.

The solution to an PIPELINE instance is YES if some configuration of the oil well switches supplies oil to all refineries; otherwise, it's NO.

Here is an example of a PIPELINE instance:



Oil well nodes are labeled W, pump station nodes P, and refinery nodes R.

1 Reduction from SAT to PIPELINE

1. List all configurations of the oil well switches in the network on the previous page that supply oil to all refineries.

2. Give a reduction from SAT to PIPELINE.

   Hint: Consider that a variable can be positive or negated, the positive (or negated) literal can appear in many clauses, and each clause needs at least one true literal in it.

   You don't need to prove correctness of your reduction!