CSE 30151 Theory of Computing: Homework 8
NP and Beyond

Version 1: Nov. 21, 2017

Instructions

- Unless otherwise specified, all problems from "the book" are from Version 3. When a problem in the International Edition is different from Version 3, the problem will be listed as V3:x.yy/IE:x.zz, where x.zz is the equivalent number. When Version 2 has a different number, it will be listed as V3:x.yy/V2:x.zz. If either IE or V2 does not have a matching number, the problem text will be duplicated.
- You can prepare your solutions however you like (handwriting, LaTeX, etc.), but you must submit them in **legible PDF**. You can scan written solutions in the library or using a smartphone (with a scanner app like CamScanner). It is up to you to ensure that submissions are legible. REMEMBER THAT IF WE CAN"T READ IT OR SCAN IS CUT OFF¡ YOU DON"T GET A GRADE FOR IT.
- Please give every PDF file a unique filename.
  - If you're making a complete submission (all problems), name your PDF file `netid-hw5.pdf`, where `netid` is replaced with your `NetID`.
  - If you're submitting some problems now and other problems later, name your file `netid-hw5-123.pdf`, where `123` is replaced with just the problems you are submitting now.
  - If you use the same filename twice, only the most recent version will be graded.
  - The time of submission is the time the most recent file was uploaded.
- If you use LaTeX and want to draw something like a state diagram, consider using the `tikz` package. A reference document is on the website under "Assignments".
- You may also find the website http://madebyevan.com/fsm/ a useful tool for drawing state diagrams via drop and drag. It will output both .png image files and latex in the tikz format.
- Submit your PDF file in Sakai. Don't forget to click the Submit (or Resubmit) button!

Practice Problems

These problems are from the book, and most have solutions listed for them. They are listed here for you to practice on as needed and any answers you generate **should not** be submitted. You are free to discuss these with others, but you are not allowed to post solutions to any public forum.

1. V3:7.16 Closure

Book Exercises

These problems are found in the text book and are to be answered and submitted by each student. You are to solve them yourself. Use of solution manuals from any source or shared solutions is a violation of the ND Honor Code. You are also not allowed to show your solutions to another student.

Note: for these problems "high level" descriptions of TMs that are decideers or recognizers aee fine (as in proofs of Theorem 4.2 on p. 195 or Theorem 4.3 on 196).

1. (10 points) V3:7.7, V2:7.6, IE:7.7 closure of NP under concatenation only.
2. (10 points) V3:7.12, V2:7.11, IE:7.12 Show language in NP. (Hint: consider a nondeterministic TM)
3. (10 points) V3:7.18, V2:7.17, not in IE. Show that if $P + NP$ then every language A that is in P, except the empty language or Σ^*, is also in NP-Complete.
4. (10 points) V3:7.22, V2:7.21, IE:7.49 Show language in NP-complete

Non-book Problems

The following problems are not found in the text book. You hare to solve them yourself. Use of any resource you used other than the text book or class notes must be cited. You are also not allowed to show your solutions to another student.

7. (10 points) Define $CIRCUIT = \{\langle C, x\rangle |$ C is a logic circuit with 1 output and n inputs such that there exists a set of input values that make the output equal the boolean value x $\}$. Show that CIRCUIT is not only in NP, but also is NP-Complete. You can assume what you learned from Logic Design about the ability to rewrite boolean expressions. Hint: Think about SAT.