

CS 3100 – Models of Computation – Fall 2011
Assignment 11 – Given 12/01/11 – version of 8:50am, 12/01/11
Due 12/09/11 11:59pm
100 points, 10% of assignment points

With respect to your class-project: Please cite *every source* in a bibliography.

The Final Exam is in-class, closed-notes, comprehensive, but emphasizes portions covered after the second midterm. It will be similar to both our midterms lots of simple questions that cover the basics; no tedious constructions. The final exam will not pertain to your projects.

Be sure to ask me to discuss these questions at the beginning of the lecture of 12/6

1. (20%) Write a proof, from first principles (by building the D function) for $Halt_{TM}$ being undecidable. $Halt_{TM} = \{\langle M, w \rangle \mid M \text{ is a TM that halts on } w\}$. Follow the structure of arguments given on Page 1 of <http://www.eng.utah.edu/~cs3100/lectures/127/notes27.pdf>.
2. (20%) Write a detailed mapping reduction proof from $Halt_{TM}$ to A_{TM} , showing details similar to those in Figure (a), Page 2, <http://www.eng.utah.edu/~cs3100/lectures/127/notes27.pdf>.
3. Explain what the sets A and B of Figure (b) are for these proofs. Write out the “if and only if” style proof “punchline” (e.g. $x \in A$ if and only if $f(x) \in B$; hence a solver for B would solve A) to make sure you understand what is going on. You can get ideas on how to write from Page 2.
 - (5%) $A_{TM} \leq_m PCP$.
 - (5%) $PCP \leq_m CFG_{amb}$. Here, CFG_{amb} is the language of CFG encodings that are ambiguous.
4. (40%) Encode the following Lewis Carroll puzzle using the DDCal tool and find a proof. You may have to strengthen the given conditions. Thoroughly explain how BDDs helped you solve this puzzle (one-page description).

I'll help you by giving a template, below.

```
# A puzzle by Lewis Carroll :
#
# From the premises
#
#(a)  None of the unnoticed things, met with at sea, are mermaids.
#
#(b)  Things entered in the log, as met with at sea, are sure to be worth remembering.
#
#(c)  I have never met with anything worth remembering, when on a voyage.
#
#(d)  Things met with at sea, that are noticed, are sure to be recorded in the log.
#
# Prove that I have never met with a mermaid at sea

# N = it is noticed, M = it is a mermaid, L = entered in log,
```

```

# R = worth remembering, I = I have met with it at sea, T = met at sea

# First specify the desired variable ordering. DDcal can later reorder
var = T*N*M*L*R*I

#(a)  None of the unnoticed things, met with at sea, are mermaids.
A1 = ?

#(b)  Things entered in the log, as met with at sea, are sure to be worth remembering.
A2 = ?

#(c)  I have never met with anything worth remembering, when on a voyage.
A3 = ?

#(d)  Things met with at sea, that are noticed, are sure to be recorded in the log.
A4 = ?

# Prove that I have never met with a mermaid at sea
proofGoal = ?

# Negate proof-goal and add it in
contra1 = A1 * A2 * A3 * A4 * proofGoal'

#Oops, need frame axiom: not met at sea => I have not met with it at sea
frame = ?

contra = contra1 * frame

[contra1 contra]

```

5. (10%) Write a one-page writeup on NP-completeness, Read about NP-complete problems in <http://en.wikipedia.org/wiki/NP-complete>. Mention some of the common NP-complete problems. Elaborate on some of the common misunderstandings about NP-complete problems that are listed there. You may survey other sources also - but **please cite every source you survey!**