CSCE476/876 **Spring 2009**

Homework 7

Assigned on: Mon March 23, 2009.

Due: Friday, April 3, 2009.

You can choose to do either Section 1 (worth 110 points) or Sections 2 to 9 (with 110 points plus 20 bonus points). It is your decision. If you choose to do both options, you will receive the *maximum* of the grades of the two sections, not the sum.

1 Implementation: Solving SAT 110 points

Write a search algorithm to determine the satisfiability of a SAT instance. You can either write:

- A DPLL procedure (backtrack search),
- A local search procedure.

You must

- Clearly describe, in addition to your code, your data structures, how your search algorithm operates, and the improvements, if any, that you have included in your code.
- We recommend that you use the standard file for input files known as the 'simplified version of the DIMACS format':
  http://www.satcompetition.org/2009/format-benchmarks2009.html
- Test the performance of your algorithm on some non trivial uniform random instances taken from the SAT Competition. For example:
  http://www.cs.ubc.ca/~hoos/SATLIB/benchm.html

Alert: many implementations exist in the literature and on the web. We expect you to do your *own* implementation.

2 AIMA, Exercise 6.3, page 190. 10 points

3 AIMA, Exercise 7.2, page 236. 16 points

4 AIMA, Exercise 7.5, page 237. 6 points

Note that $A \Leftrightarrow B \Leftrightarrow C$ is equivalent to $A \Leftrightarrow B$ and $B \Leftrightarrow C$.

5 Truth Tables **8 points**

Use truth tables to show that each of the following is a tautology.

1. $(p \wedge q) \rightarrow \neg(\neg p \vee \neg q)$
2. $[Mary \wedge (Mary \rightarrow Susy)] \rightarrow Susy$
3. $\alpha \rightarrow [\beta \rightarrow (\alpha \wedge \beta)]$
4. $(a \rightarrow b) \rightarrow [(b \rightarrow c) \rightarrow (a \rightarrow c)]$

6 AIMA, Exercise 7.8, page 237. **16 points**

only c, d, e, f, g and h.

7 Logical Equivalences **8 points**

Using a method of your choice, verify:

1. $(\alpha \rightarrow \beta) \equiv (\neg\beta \rightarrow \neg\alpha)$ contraposition
2. $\neg(\alpha \wedge \beta) \equiv (\neg\alpha \vee \neg\beta)$ de Morgan
3. $(\alpha \wedge (\beta \vee \gamma)) \equiv ((\alpha \wedge \gamma) \vee (\alpha \wedge \beta))$ distributivity of $\wedge$ over $\vee$

8 Proofs **28 points**

Give the explantions of each step if the steps are given, and give both the explanation and step if they are not.

- If $q \wedge (r \wedge p), t \rightarrow v, v \rightarrow \neg p$, then $\neg t \wedge r$.

Proof	**Explanations**
1. $q \wedge (r \wedge p)$	Given
2. $t \rightarrow v$	Given
3. $v \rightarrow \neg p$	Given
4. $t \rightarrow \neg p$	
5. $(r \wedge p)$	
6. r	
7. p	
8. $\neg\neg p$	
9. $\neg t$	

10. $\neg t \wedge r$

- If $p \rightarrow (q \wedge r), q \rightarrow s$, and $r \rightarrow t$, then $p \rightarrow (s \wedge t)$.

  Proof **Explanations**

  1.
  2.
  3.
  4.
  5.
  6.
  7.

- **Prove by contradiction.**

  If $\neg(\neg p \wedge q), p \rightarrow (\neg t \vee r), q$, and t, then r.

Proof	**Explanations**
1. $\neg(\neg p \wedge q)$	Given
2. $p \rightarrow (\neg t \vee r)$	Given
3. q	Given
4. t	Given
5. $\neg r$	Negation of Conclusion
6.	
7.	
8.	
9.	
10.	
11.	
12.	

9 AIMA, Exercise 7.11, page 238. 18 points + 20 bonus

Parts a, b, and c are required. Parts d, e, and f are bonus.