

### COT 4210 Homework #7: Classes P and NP

**Due Date: November 23, 2010 over WebCourses (check WebCourses for the time)**

- 1) Let  $\text{DOUBLE-SAT} = \{ \langle \phi \rangle \mid \phi \text{ has at least two satisfying assignments} \}$ . Show that DOUBLE-SAT is NP-Complete by giving a reduction from 3-SAT to DOUBLE-SAT.
- 2) Write a program that reads its input from the file "3sat.txt" and outputs to a file called "subsetsum.txt". The job of your program will be to convert a 3-SAT instance into a SUBSET-SUM instance such that the former is in 3-SAT iff the latter is in SUBSET-SUM. Make sure to hard-code the file names so your program can be immediately run without any user input. Make sure you match the sample shown below. Here are the file formats for both problems:

#### 3-SAT file format

The first line contains two positive integers,  $n$  and  $v$ , separated by a space.  $n$  is the number of clauses in the 3-SAT expression and  $v$  is the number of variables in the 3-SAT expression. The next  $n$  lines of the file will contain one clause of the 3-SAT expression each. Each line of these subsequent lines contains three integers separated by spaces. All integers will be either in between 1 and  $v$ , inclusive or  $-v$  and  $-1$ , inclusive. In particular, a positive integer  $k$  stands for the variable  $x_k$ , while the negative integer  $-k$  stands for the negation of the variable  $x_k$ . As an example, the clause:

$$(x_1 \vee \sim x_2 \vee x_3) \wedge (\sim x_1 \vee x_2 \vee x_3) \wedge (\sim x_1 \vee \sim x_2 \vee \sim x_3) \wedge (\sim x_1 \vee \sim x_2 \vee x_3)$$

would be stored in a file as follows:

```
4 3
1 -2 3
-1 2 3
-1 -2 -3
-1 -2 3
```

#### SUBSET-SUM file format

The first line contains two integers,  $n$  and  $t$ , where  $n$  is the number of integers in the subset and  $t$  is the target. The next line contains  $n$  integers that comprise the set, separated by spaces.

Here is a sample file, that corresponds to the 3-SAT file example above:

```
14 5631
4160 4117 1040 1093 337 260 64 64 16 16 4 4 1 1
```

**Note: Use the construction at the end of section 7.5, except determine the values of the numbers in base 4 instead of base 10.**