

## CS 172 Spring 2007 — Discussion Handout 9

### 1. What's the 'N' in NP?

Much as we'd like the 'N' to mean *not*, it actually means *nondeterministic*. Thus, NP is the class of all languages recognizable by a nondeterministic Turing machine in polynomial time. Prove that this definition is equivalent to the one given in class (the class of all languages which have polynomial time verifiable proofs of membership).

### 2. The complements of NP languages

Define  $coNP$  to be the class of languages  $L$  such that  $\bar{L} \in NP$ , where  $\bar{L}$  is the complement of  $L$ .

Prove that  $NP = coNP$  if and only if there is an NP-complete problem in  $coNP$ .

### 3. Unchanged by 'stardom'

(a) Prove that  $NP$  is closed under the star operation.

(b) Prove that  $P$  is closed under the star operation.

### 4. And how about NP-Complete problems?

(Now a part of HW7)

Let  $A$  and  $B$  be two NP-Complete languages. Show that  $A \cup B$  and  $A \cap B$  are not necessarily NP Complete.