CECS 528, In Class Assignment 8, Friday March 27th, Spring 2026, Dr. Ebert

Turn in a single sheet of paper where students in your group take turns classifying the following problems as being in `P`, `NP`, or co-`NP` and writing a few sentences to justify the classification.

Problem

Classify each of the following problems as being in `P`, `NP`, or co-`NP`. For each problem determined to be in `P`, provide a good big-O estimate of the number of steps required to decide the problem. (4 points each plus 3 additional points for each `P` problem).

1. An instance of `One Million Subset Sum` is a set S of nonnegative integers, and the problem is to decide if there is a subset of S that sums to the value of 10^6.

2. An instance of `Incomplete Triples` consists of three sets A, B, and C, each having size n, along with a set S of triples of the form (a, b, c) where $a \in A$, $b \in B$, and $c \in C$. The problem is to decide if, for any chosen subset $T \subseteq S$ of n triples, some member of $A \cup B \cup C$ will be absent from T.

3. An instance of `Fallible` is a Boolean formula F. The problem is to decide if there an assignment that can be made to the variables of F so that F evaluates to 0.

4. An instance of `Small Cuts` is a simple graph $G = (V, E)$ and the problem is to decide if every cut of G has a size that does not exceed one percent of the total number of vertices of G, where a **cut** of G is defined to be a function $f : V \to \{\text{red,blue}\}$ that colors each vertex of G either red or blue, and the size of the cut is equal to the number of edges $e = (u, v)$ for which u and v are assigned different colors by f.

5. An instance of `Palindrome` is an array a of integers, and the problem is to decide if a reads the same forwards as backwards, meaning that, for all $i \in \{0, 1, \ldots, n-1\}$, $a[i] = a[n-1-i]$.

6. An instance of `Feedback Arc Set (FAS)` is a directed graph $G = (V, E)$ and a natural number $k \geq 0$. The problem is to decide if there is a set S of k vertices of G for which, when removing the vertices of S from G (and all edges incident with them) the resulting graph is acyclic.