CSE 200 Final Exam
Due Wed. June 11 at 6 AM

Answer four out of five questions with a complete proof. You may be informal, if you are precise. You may not discuss this exam with anyone except myself and Kirill, whether taking the course or not. Each question has equal weight. You may cite without proof any result from the text or proved in class. In particular, you can use without proof the NP-completeness of any problem proved NP-complete in class, in the Sipser text, or on the homeworks, including: SAT, 3-SAT, Independent Set, Clique, Vertex Covering, 3-coloring, Hamiltonian Circuit, and Subset Sum.

Computability and circuit complexity Prove that there is a language L so that $L \notin REC$ but $L \in P/poly$, i.e., that is not computable but has a polynomial sized circuit C_n for each fixed length of input n.

NP-Completeness Consider the following two problems:

Equi-partition.

Instance: A list of n non-negative integers, $a_1, ..a_n$

Solution format: A subset of the indices 1...n, $S \subset \{1, ..n\}$.

Constraint: $\sum_{i \in S} a_i = \sum_{i \notin S} a_i$.

Problem: Decide whether such an equi-partition S exists.

Bin-filling.

Instance: A bin size $B > 0$ and a list of n non-negative integral item sizes, $a_1, ..a_n$, and a number F.

Solution format: An assignment $A[i]$ of each item i into a bin, where bins are described as integers in $\{1, ..F\}$.

Constraint: All bins $j \in \{1..F\}$ must be *full*, i.e. $\sum_{i, A[i]=j} a_i \geq B$.

Problem: Decide whether there is an assignment A that fills all F bins.

Prove that both the above problems are NP-complete.

NP completeness Let Independent Set Maximality (ISM) be the problem: Given a graph G and an independent set I in G, is there a larger independent set I' in G? Show that this problem is NP-complete.

NP and probabilistic computation Prove that, if $NP \subseteq BPP$, then $NP = RP$.

NP **and** $co - NP$ Consider the problem Greater Maximum Independent Set: Given G_1 and G_2, is the maximum independent set for G_1 strictly larger than that for G_2? Show that this problem is in NP if and only if $NP = co - NP$.