CS/ECE 374 A (Spring 2024)
List of Standard NP-Complete Problems

Here is a list of known standard NP-complete problems that you may use to reduce from, to prove that new problems are NP-complete. We will provide you this list for the final exam (so, no need to copy them for your cheat sheet). Sometimes, we explicitly ask you to use a specific known problem for the reduction; then you must follow our instructions to get full credit.

(Of course, the list is not exhaustive, as there are hundreds of known NP-complete problems, e.g., see this compendium. But the list contains some of the most commonly used ones. We didn't include general SAT, traveling salesman, or knapsack, for instance, because 3SAT, Hamiltonian cycle, or subset-sum are simpler counterparts and are thus more convenient for doing reductions. If we ask you to use a problem not in this list, we will define that problem precisely in the question.)

- 3SAT:

  Input: Boolean formula F in 3CNF form.

  Output: yes iff there exists an assignment that makes F evaluate to true.

- Vertex-Cover:

  Input: undirected graph $G = (V, E)$ and a number K.

  Output: yes iff there exists a vertex cover S of size (at most) K. (A vertex cover is a subset $S \subseteq V$ such that for every $uv \in E$, we have $u \in S$ or $v \in S$.)

- Independent-Set:

  Input: undirected graph $G = (V, E)$ and a number K.

  Output: yes iff there exists an independent set S of size (at least) K. (An independent set is a subset $S \subseteq V$ such that for every $u \in S$ and $v \in S$, we have $uv \notin E$.)

- Clique:

  Input: undirected graph $G = (V, E)$ and a number K.

  Output: yes iff there exists a clique S of size (at least) K. (A clique is a subset $S \subseteq V$ such that for every $u \in S$ and $v \in S$, we have $uv \in E$.)

- Hamiltonian-Cycle/Hamiltonian-Path:

  Input: undirected graph $G = (V, E)$.

  Output: yes iff there exists a Hamilonian cycle/path, i.e., a cycle/path that visits every vertex in V exactly once.

- 3-Coloring:

  Input: undirected graph $G = (V, E)$.

  Output: yes iff there exists a 3-coloring, i.e., a mapping $\varphi : V \to \{1, 2, 3\}$ such that for every $uv \in E$, we have $\varphi(u) \neq \varphi(v)$.

- Subset-Sum:

  Input: a set S of integers and a number W.
  Output: yes iff there exists a subset of S whose sum is exactly W.

- Set-Cover:

  Input: a set U of elements, a collection $\mathcal{C}$ of subsets of U, and a number K.
  Output: yes iff there exists a subcollection $\mathcal{S} \subseteq \mathcal{C}$ of (at most) K subsets such that the union of $\mathcal{S}$ is all of U.