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Homework 7 – 3-Sol-SAT

CS 6515: Introduction to Graduate Algorithms

**NP Proof:**

* We can verify the *3-Sol-SAT* problem by traversing the CNF input formula, *f*, and verifying that three distinct assignments of n-variables satisfy *f*.
  + This is done by traversing the literals within each m-clause in O(nm) time.
* Validating that three distinct assignments of *n*-variables exist takes O(n) time.
* Overall runtime is O(nm), which is also polynomial.

**NP Complete Proof:**

**Reduction:** SAT -> 3-Sol-SAT (3SolSAT)

**I.T.:**

* Given the CNF input formula, *f*.
* Create *f'* by adding two new variables, *x* and *y*, and two additional tautology clauses to *f*.
  + One of the new clauses will contain a true and false literal of *x*, and the other with *y*.
    - Example: *(f) ^ (x V !x) ^ (y V !y)*.
  + This takes O(1) time.
* Pass *f'* to 3SolSAT in O(1) time.
* Overall runtime is O(1), which is polynomial.

**O.T.:**

* Return NO, if 3SolSAT returns NO in O(1) time.
* Return the solution of 3SolSAT, dropping the newly added *x* and *y* variables, returning one of the distinct truth assignments for the original variables in *f*.
  + This takes O(n) time.
* Overall runtime is O(n), which is polynomial.

**Correctness:**

* If 3SolSAT returns a solution, we have a solution for SAT by dropping the newly added *x* and *y* variables, resulting in satisfiable assignments to *f*.
* If SAT returns a solution, we have a solution for 3SolSAT by adding two new variables, *x* and *y*, and two tautology clauses, *(x V !x)* and *(y V !y)*, to *f*. Making it so 3SolSAT generates at least three distinct variable assignments from the new *x* and *y* variables alone.
* 3SolSAT has a satisfiable solution IFF the solution for SAT is satisfiable.

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