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Homework 6 – Flower Search

CS 6515: Introduction to Graduate Algorithms

**NP Proof:**

* Verify the solution, S, to the *Flower-Search* problem by first inducing the subgraph of S. This takes O(n + m) time.
* Validate that *N* vertices make up a clique by finding all vertices with a degree >= *N-1* and are connected to one another by an edge. This takes O(n^2) time.
* Validate that the remaining vertices make up a star by verifying that three vertices have a degree of one and are connected to a common central vertex. This takes O(n + m) time.
* Verify that there is a path from the central vertex in the star to a vertex in the clique. This takes O(n + m) time.
* Finally, verify *|S| = N + 4* in O(n) time.
* Overall runtime is O(n^2), which is polynomial time.

**NP Complete Proof:**

**Reduction:** Clique -> Flower-Search (F.S.)

**I.T.:**

* Given *G=(V, E)* and *N*.
* A star consists of four vertices, featuring a central vertex, *v'*, which connects to three other vertices that do not share an edge with each other.
* Create *G'* by adding a star to every vertex in *G*.
  + Each star will be added by an edge from *v'*.
  + This takes O(n^2) time.
* Pass *G'* and *N* into F.S. in O(1) time.
* Overall transformation time is O(n^2), which is polynomial.

**O.T.:**

* Return NO, if F.S. returns NO in O(1) time.
* Return solution of F.S., removing the four vertices that make up the star, leaving a clique.
  + To find the star, find the three vertices with a degree of one that are connected to a common vertex (the fourth vertex). These four vertices will be removed.
  + This takes O(n + m) time.
* Overall transformation time is O(n + m), which is polynomial.

**Correctness:**

* If Clique returns a solution, S, we have a solution for F.S. by adding a star, from its central vertex, to each vertex in S, resulting in N + 4 vertices that form a flower.
* If F.S. returns a solution, S, we have a solution for Clique by removing the star from S, resulting in an N-sized clique.
* F.S. has a solution IFF there is a star added, from its central vertex, to the Clique solution.

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