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Homework 5 – New MST

CS 6515: Introduction to Graduate Algorithms

**Algorithm:**

- To find the MST of $G'$ we will utilize the DFS algorithm and the graph of $G'$.
- First, make a copy of MST $T$ and remove edge $e$ from it. Call this $T'$.
- Pass $T'$ into DFS, identifying the connected components in the graph using *ccnum[]*.
- Next, traverse graph $G'$ and find candidate edges that will connect the connected components in $T'$.
    - Meaning we only consider edges that form a path between vertices $(u,v)$ that are in different connected components in $T'$.
- Add the lowest weighted edge from the list of candidate edges to $T'$, and return $T'$.

**Correctness:**

- To find the MST of $G'$, we can utilize the existing MST $T$ with edge $e$ removed so that it does not need to be built from scratch.
- We pass $T'$ through DFS to identify the two connected components within the graph.
    - Since $T'$ is an MST, removing one edge from the graph will give us two connected components.
- We can then traverse $G'$ and create a candidate list of edges that would form a path between the two connected components in $T'$.
    - We only care about the edges from $G'$ that connect the two connected components in $T'$ so we can form a valid MST.
- We know from the Cut Property that any minimum edge across a cut is a part of some MST. So, we add the lowest weighted edge from our candidate list to $T'$ and return $T'$ as the MST of $G'$.

**Runtime:**

- Making a copy of $T$, running DFS as a blackbox on $T'$, and traversing $G'$ takes O(n + m) time each.
- Removing exactly one edge in $T'$ takes O(m) time.

- Overall runtime is O(n + m), which gets reduced to **O(m)** because we're running the algorithm on a connected graph.

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