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Design & Analysis of Algorithms
CS575 Fall 2023

Theory Assignment - 3.3

1]

a] Design a greedy algorithm to solve the above problem, i.e, to minimize the number of stops for gas.

→ Algorithm:-

```
MinimizeStops {
    // initializing variables.
    NumberOfStops = 0 ;
    mileageLeft = m ;
    position = 0 ;

    // Using "while" loop to change position.
while ( position != cityB) {
maxDistance = position + mileageLeft ;
nextStop = -10 ;          // using -10 to keep it as flag.

    // Using for loop to iterate gas stations.
    for ( int i = 0 ; i < numberOfStations ; i++) {
        distanceToStation = stations [i] - position;
       if ( distanceToStation > mileageLeft ){
            break
       }Else{
            nextStop = stations [i];
       }     // End of "else" loop.
}          // End of for loop
```

```
if (nextStop == -1 || nextStop == position){
        print("unable to reach city B")
        return -1;
} // End of "if" loop.

NumberOfStops ++;
position = nextStop;
distanceCovered = position - stations[0];
mileageLeft = mileageLeft - distanceCovered;
} // end of while loop.

return NumberOfStops;
} // End of Algorithm.
```

b]

- The above algorithm uses a greedy approach at each stage to find the best local solution.
- In the above example we are finding the farthest gas station possible which can be reached with the available mileage and fuel.
- Greedy choice :- This algorithm chooses the gas station which is farthest and which can reached with the available fuel of the vehicle without refilling till that station.
- This choice allows to minimize the number of stops required for refilling the fuel.
- This choosing of gas station is a local step it and is performed without considering the entire route at once.
- The decision making is independent of the previous decisions made and chooses the farthest gas station locally.
- All these characteristics shows that the algorithm has the greedy choice property.

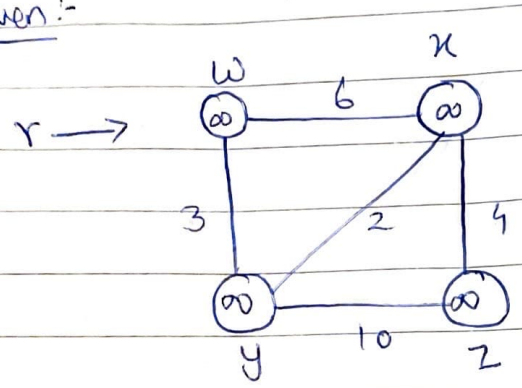
- We can also prove this by contradiction :-
Lets assume there exists an optimal solution which is different from our greedy approach, If there were such a solution which yeilds better output i.e minimizes the number of stops and provides a value which is smaller than greedy algorithm's solution.
- Then it implies that at some point, the optimal solution deviates from the farthest gas station.
- However if this happens that means it ~~contradicts~~ contradicts that the algorithm always selects the best local choice.
- Therefore we can say that the greedy algorithm's ~~solution~~ solution is optimal.

c] TC

We have 2 loops, while loop and for loop.
In the ~~worst~~ first case scenario the for loop which is present inside will iterate all the gas station i.e the distance would be less than the mileage and we would reach the city B.
So the time complexity would be O(n)
Considering second case scenario where the distance of two gas station is close to mileage i.e the car can only travel to one gas station and would not be able to skip any gas station. So the inner for loop will run for 2 times and the outer while loop will run for n times.
So we can say that the time complexity is O(n)

Q2)

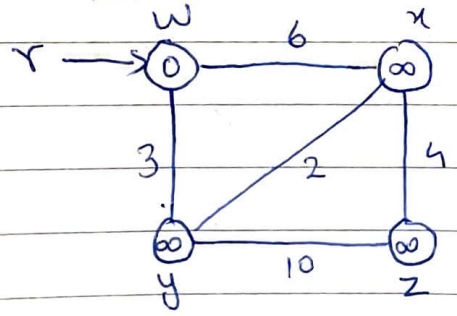
Soln Given:-



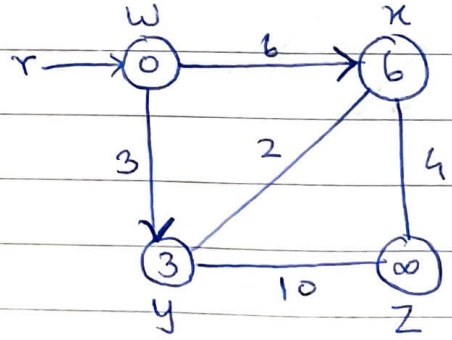
→

Set S	w	y	z	x	
{}	0/nil	∞/nil	∞/nil	∞/nil	→ Iteration 1
w		3/w	∞/nil	6/w	→ Iteration 2
w, y			10/y	2/y	→ Iteration 3
w, y, x			4/x		→ Iteration 4.

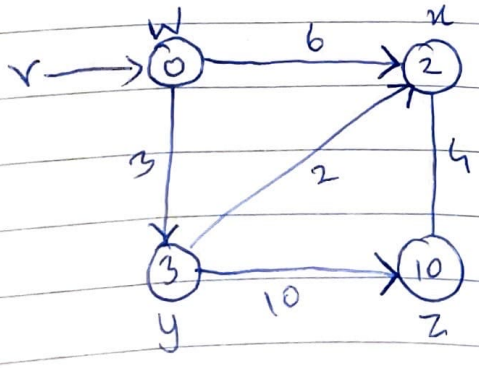
Iteration 1



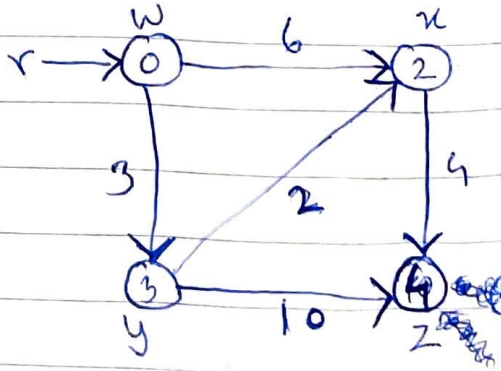
Iteration 2



Iteration 3

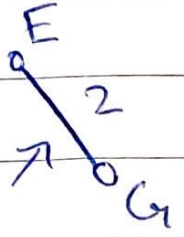


Iteration 4.

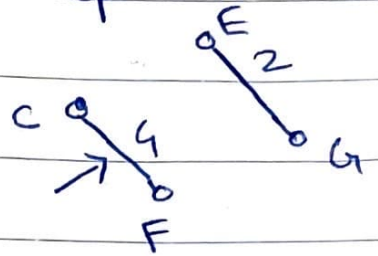


Q3]

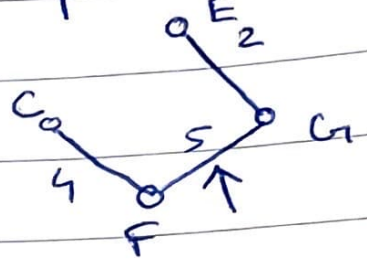
Step 1:-



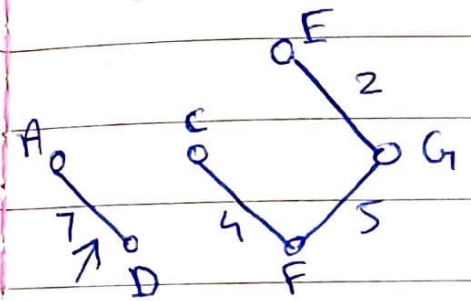
Step 2:-



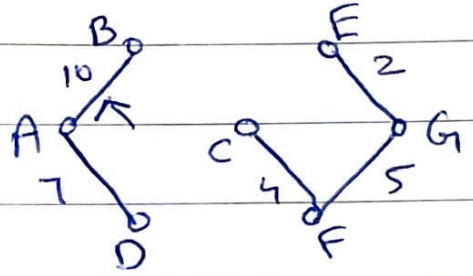
Step 3:-



Step 4:-



Step 5:-



Step 6:-