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5/14/23

COEN 239 HW 6

**Problem 1:** A CMST has to be generated for a configuration with the following parameters. The cost matrix $C$ is:

$$C = \begin{bmatrix} \infty & 6 & 3 & 4 & 5 \\ 6 & \infty & 3 & 5 & 7 \\ 3 & 3 & \infty & 3 & 5 \\ 4 & 5 & 3 & \infty & 3 \\ 5 & 7 & 5 & 3 & \infty \end{bmatrix}$$

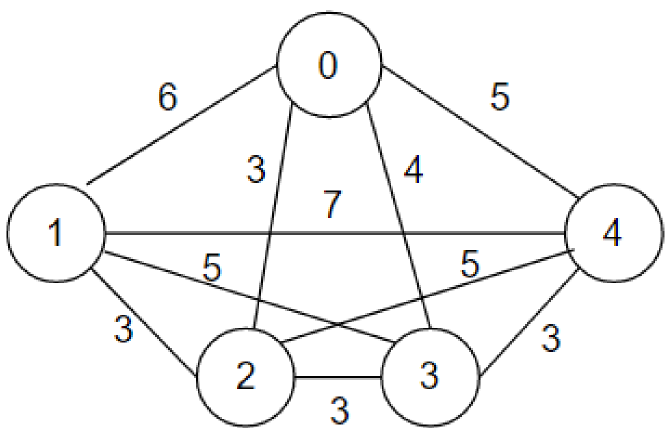
$N = 4, \beta = 10$, and $\rho = [5, 4, 3, 5]$. Use Esau-Williams algorithm.

This is only a paper & pencil exercise. Coding is not necessary.

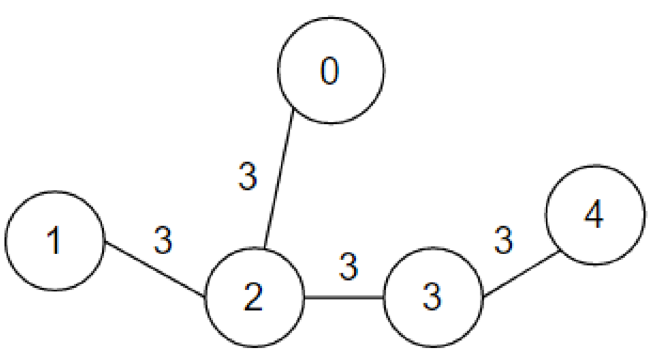
*To get full credit, show all your computations.*

**Solution:** $v_0$ = vertex used to denote the central-server. $v_i$ = vertex used to denote the $i$th workstation, $1 \leq i \leq 4$.

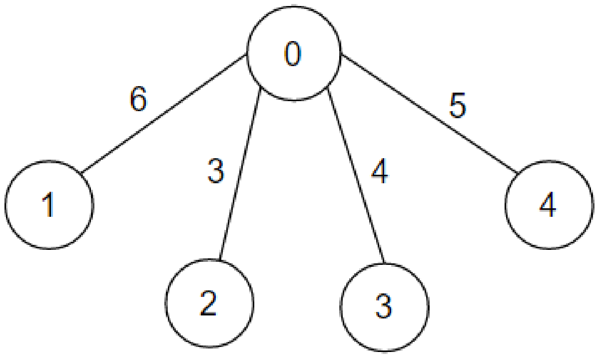
The links in the CMST are $\{(v_0, v_2), (v_2, v_1), (v_0, v_3), (v_3, v_4)\}$. The total cost of this tree is 13.




MST:



Initialization:
T1 = {1}; T2 = {2}; T3 = {3}; T4 = {4};
*T* = [5, 4, 3, 5]; W = [6, 3, 4, 5]

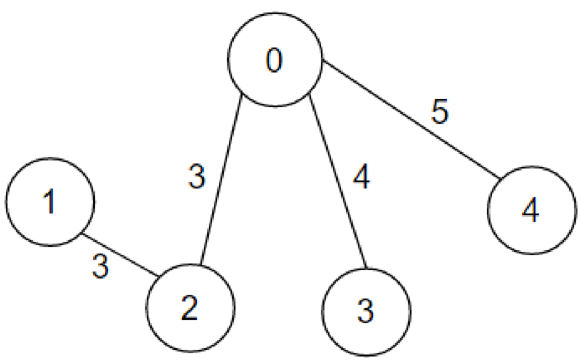



Step 1:

| | | | | |
|---|---|---|---|---|
| t = | [inf | -3 | -1 | 1] |
| | [0 | inf | 0 | 2] |
| | [1 | -1 | inf | -1] |
| | [2 | 0 | -2 | inf] |

min = -3 → i = 1, j = 2
*T*1 + *T*2 = 9 < *B* = 10

T1 = T2 = {1, 2}; T3 = {3}; T4 = {4};
*T* = [9, 9, 3, 5]; W1 ← W2 = 3; W = [3, 3, 4, 5];
$t_{12} = t_{21}$ = inf

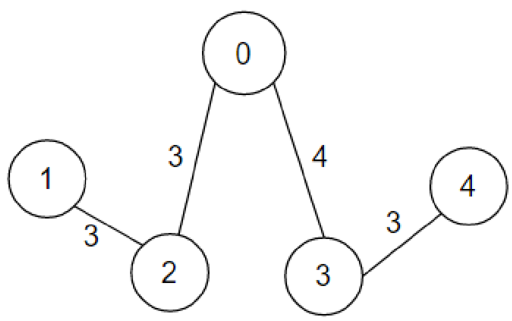



Step 2:

| | | | | |
|---|---|---|---|---|
| t = | [inf | inf | 2 | 4] |
| | [inf | inf | 0 | 2] |
| | [1 | -1 | inf | -1] |
| | [2 | 0 | -2 | inf] |

min = -2 → i = 4, j = 3
$T4 + T3 = 8 < B = 10$

T1 = T2 = {1, 2}; T3 = T4 = {3, 4};
$T$ = [9, 9, 8, 8]; W4 ← W3 = 4; W = [3, 3, 4, 4];
$t_{43} = t_{34}$ = inf




Step 3:

| | | | | |
|---|---|---|---|---|
| t = | [inf | inf | 2 | 4] |
| | [inf | inf | 0 | 2] |
| | [1 | -1 | inf | inf] |
| | [3 | 1 | inf | inf] |

min = -1 → i = 3, j = 2
$T3 + T2 = 17 > B = 10$

Step 4:

| | | | | |
|---|---|---|---|---|
| t = | [inf | inf | 2 | 4] |
| | [inf | inf | 0 | 2] |
| | [1 | inf | inf | inf] |
| | [3 | 1 | inf | inf] |

STOP

**Problem 2:** Read the paper: *Difficulties in Simulating the Internet*, by S. Floyd and V. Paxson. Write a one or two page summary of this paper.

Attempting to simulate the behavior of the internet is very difficult because of how diverse and constantly changing it is. The links between individuals, the protocols, the many different applications, and the large amount of traffic and users are all contributors to this. This article discusses two main strategies for creating high quality simulations despite these challenges: the search for invariants, and the exploration of the parameter space. To conclude, they take a look at a collaboration within the research community for developing a common network simulator.

They claim that simulation plays a huge role in representing the behavior of the internet in the present as well as possible effects if it were to change how it operates. However, it is not easy to do this. The article emphasizes how it doesn't intend to discourage simulation of the Internet, but instead to warn about the mistakes and danger of doing so. They also make sure to express the limitations so that they don't weaken the simulations by making preemptive strong claims about them before they are fully justified and proven.

They discuss the role of simulation in Internet research. They claim that because the internet is so large and ever-changing, measuring and analyzing results are not as obvious as they might be in other fields. Experiments constantly run into unforeseen complex issues, making them difficult to understand and interpret. Additionally, measurement and experimentation are limited from being able to explore the future internet, as the environments and architectures are currently unknown and unpredictable. There is even a concern of new functionality leaking too early and rapidly spreading before it is ready, such as HTTP. With simulation to accompany analysis, however, we can examine complicated scenarios and allow researchers to develop intuition about the internet. But, one main pitfall is that it is difficult to tell whether the simulator accurately implements the intended model. Thus, a good simulator would be one that not only proposed protocols for future internet architecture, but also included proposed protocols from other researchers too, calling for the need to publicize scripts.

The article then describes the internet as an immense moving target. The authors claim that the internet has three main properties that make it hard to simulate. Firstly, the IP protocol is great at unifying diverse networks to operate together successfully, but makes it difficult to understand the difference in how these networks behave. Secondly, the sheer size of the internet makes it extremely difficult to try to scale and simulate. Thirdly, the internet changes drastically over time, making it impossible to predict exactly how the internet will transform and thus simulate. Overall, the internet's high level of diversity, ever-growing, and ever-changing state makes it extremely difficult to simulate and gain expected results.