Assignment 2
UAV Deployment Problem

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Problem Statement

Consider a UAV used to extend the coverage range of a base station (BS). Le there be N no.of users who wish to use the UAV for their uplink transmission and finally forward the data to the BS. In this context, let each user i require a bandwidth BW_i from the UAV and also has di amount of data to transmit to the UAV in the uplink. In this context, if the UAV has a constraint on the total bandwidth (BW) and total data storage capacity for all the users, then, suggest a method to maximize the number of users who could satisfactorily transmit data to the UAV?

Problem 1:To elaborate more: a user i who wishes to transmit data to the UAV needs 2 parameters (BW_I, and d_i) to be available at the UAV. Similarly, all users (), k .....) have similar type of requests. But, at the UAV, there is a constraint on the maximum BW (i.e. BW_i + BW_j + BW_k+.. etc) and also on the maximum capacity for data storage D (i.e. d_i+dj+d_kt... if the UAV admits users), k....etc. So, now we need to decide which users could be admitted without exceeding the capacity of the UAV (Le. how to maximize the no.of users ted). Think::: What type of problem is this?

Problem 2: If there are multiple UAVs around a BS and all of them (1 UAVs) have different BW and D values; how to maximize the no.of users admitted? (This is basically an extended version of problem 1; where we had only one UAV; but here we have multiple UAV with in the same context)

Think: What type of problem is this?

The solution we came with

1. Greedy Algorithms:

- Greedy 1: One possible greedy approach could be to prioritize users based on either their bandwidth requirement or data size, and admit them until the capacity limits are reached. For example, you could admit users with the smallest bandwidth requirements first, or users with the smallest amount of data to transmit.
- Greedy 2: Another greedy approach could involve a combination of bandwidth and data size. You could sort users based on a weighted combination of their bandwidth and data size requirements and admit users until the capacity limits are reached.

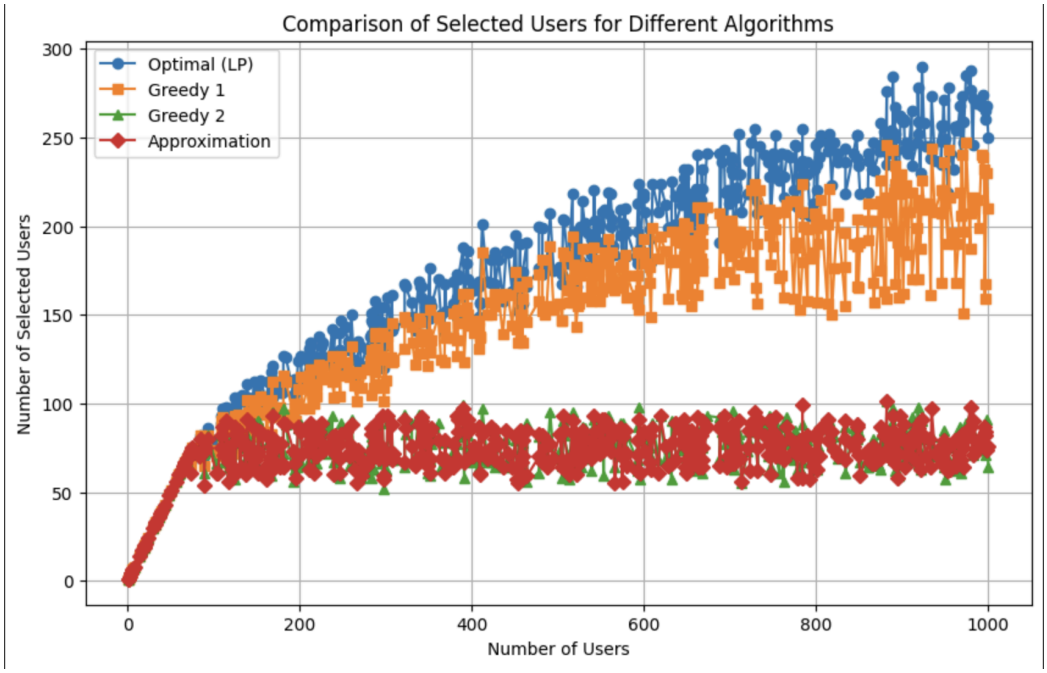
2. Optimal Algorithms:

- Finding the optimal solution to this problem may involve using dynamic programming techniques, which can be computationally expensive depending on the size of the problem. Dynamic programming can guarantee the optimal solution but may not be practical for large-scale problems due to its computational complexity.

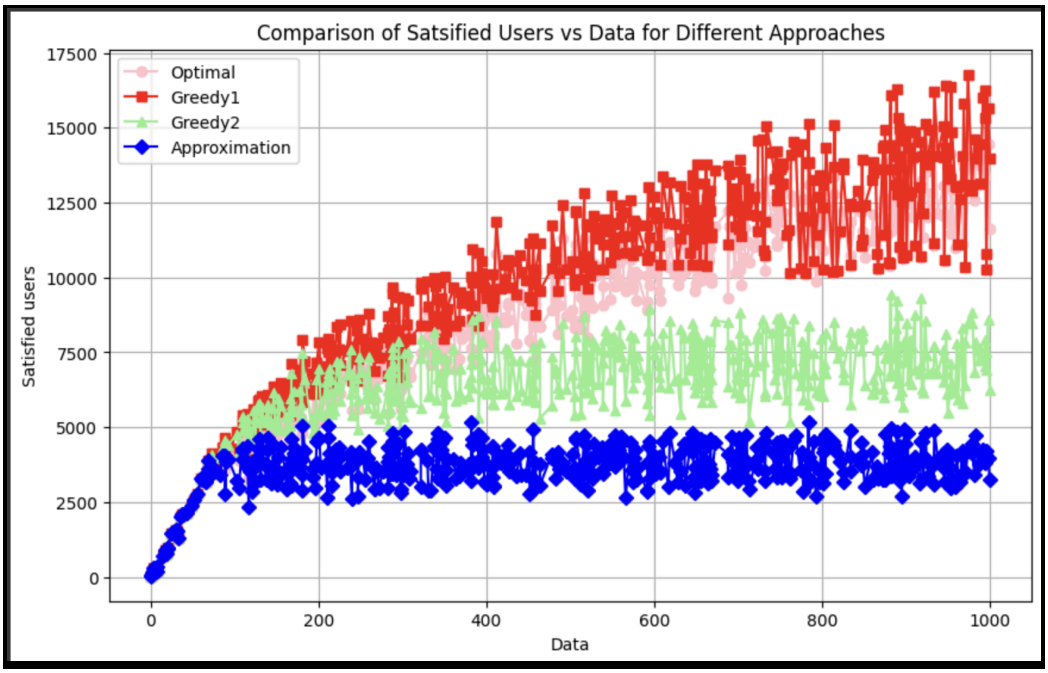
3. Approximation Algorithms:

- Since finding the optimal solution might be impractical for large instances of the problem, approximation algorithms can be used to find near-optimal solutions in a more efficient manner. These algorithms sacrifice optimality for efficiency.

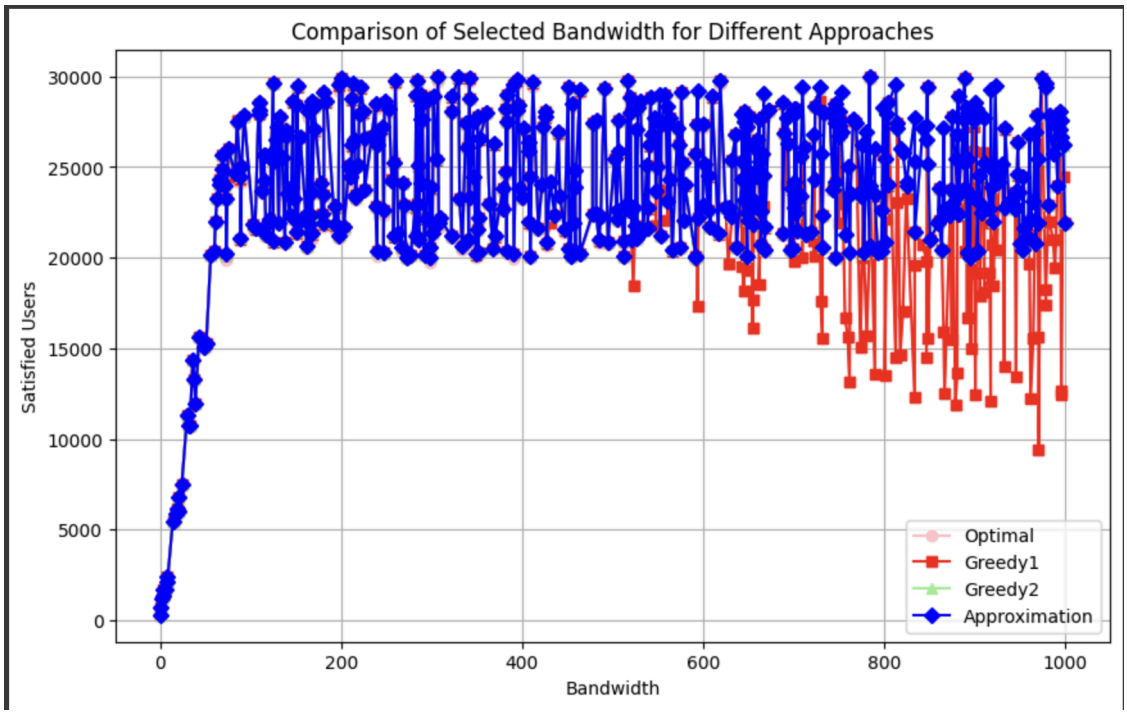
Plot 1: Users vs satisfied users



Plot 2: Data vs Satisfied users

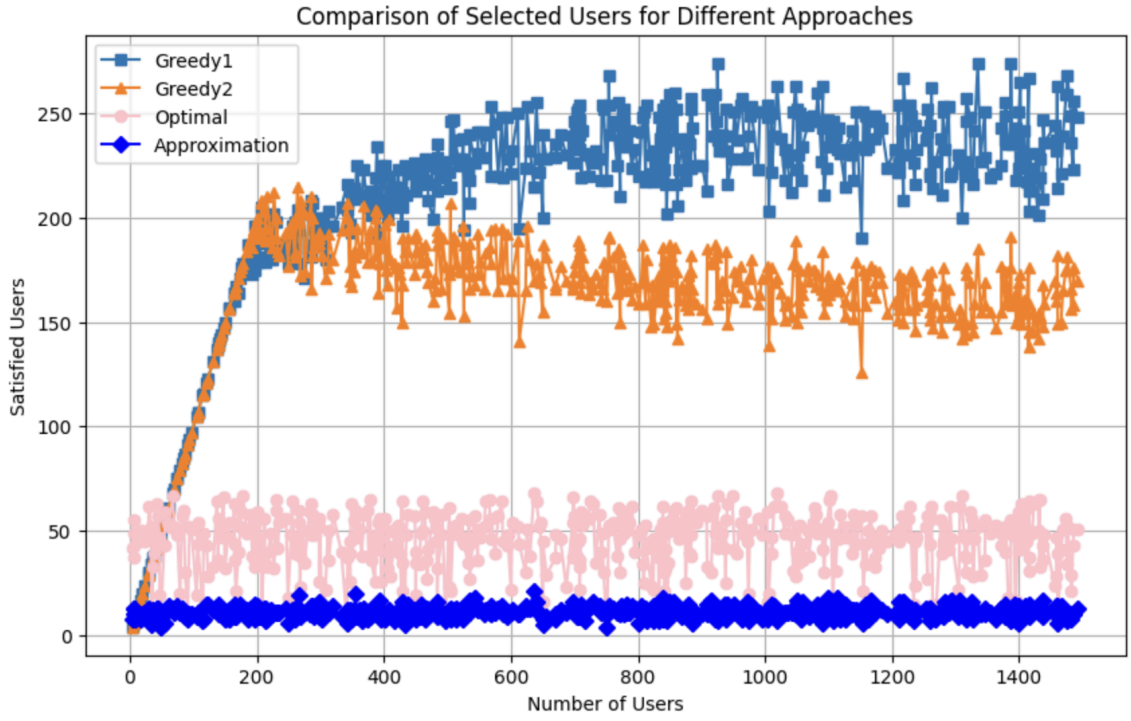


Plot 3: Satisfied users vs Bandwidth

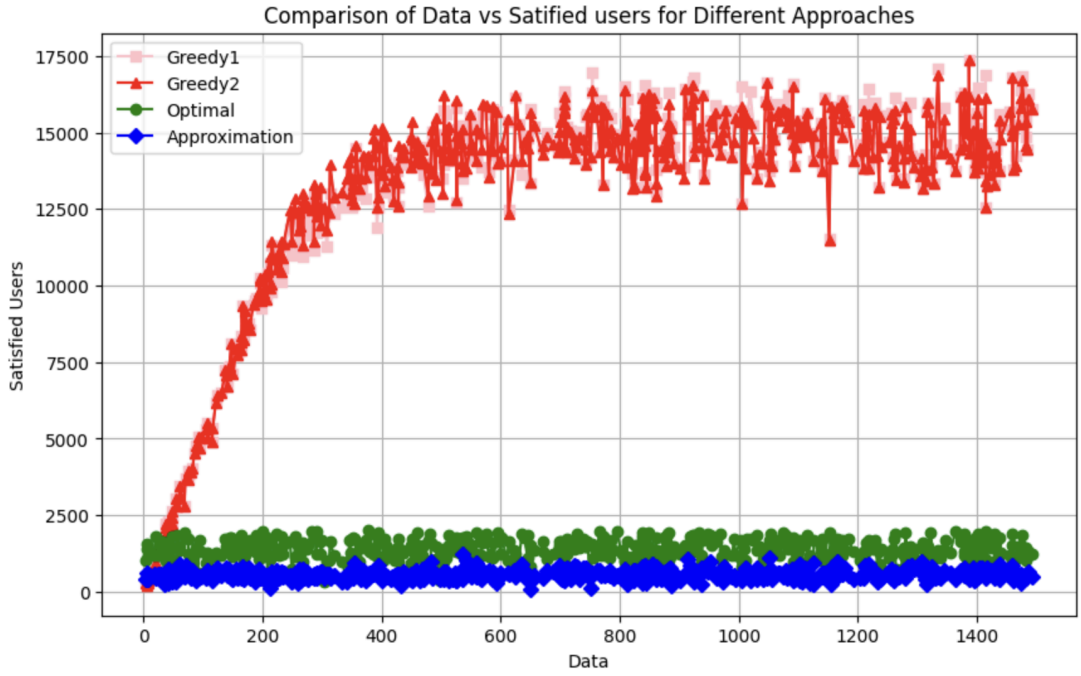


Multiple UAVs:

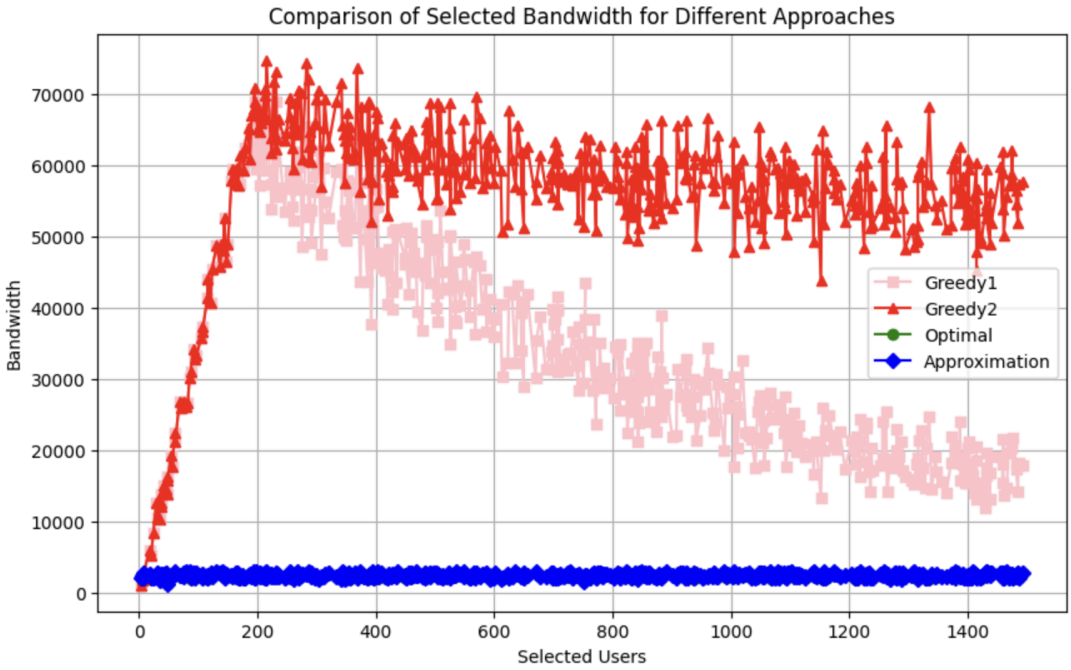
Plot 1: Users vs satisfied users



Plot 2: Data vs Satisfied users



Plot 3: Bandwidth vs Satisfied users



Conclusion:

After looking closely at how four different ways of deciding who gets to use the bandwidth in a UAV communication setup—Greedy1, Greedy2, Optimal, and Approximation—work, it's clear they each have their own strengths. Greedy1 tends to pick users with the most bandwidth, so it usually lets more users transmit their data. Greedy2 is similar but focuses on users with the highest data to send. However, the Optimal method is the best at picking users in a way that uses the most bandwidth overall. It's like finding the perfect balance. The Approximation method is good too, but not quite as precise as the Optimal one. So, if you want to make sure you're using as much bandwidth as possible and satisfying the most users, the Optimal method is your best bet.