Information Technology Research - Take Home Assignment 2

Spring 2023

This assignment requires you to write code for the following goals.

As a general of the MIS kingdom, it is your duty to serve and protect it. Currently, the kingdom is under attack from an enemy, and the king has tasked you with an important mission - to plan the recruitment of a team of heroes that can help win the battle.

To help protect the kingdom, you need to accomplish the following three tasks:

1. **Compile a list of teams with heroes that could win against the enemy's team**
   A team could have three types of heroes: Spearman (S), Cavalry (C), and Archer (A). The hero matchups are as follows:
   - Spearman beats Cavalry
   - Cavalry beats Archer
   - Archer beats Spearman

   During the battle, the heroes fight in one-on-one combats. Therefore, your team will have the same number of heroes as in the enemy's team. A hero only fights an enemy in the same position.
   - Enemy's team = [Enemy 1, Enemy 2, …, Enemy k]
   - MIS kingdom's (your) team = [Hero 1, Hero 2, …, Hero k]
   - For k = 1 to n, a hero k will only fight enemy k.

   If one of your heroes wins, you receive one point. If one of your heroes loses, you lose one point. Draws do not add or subtract points. The remaining number of points after the battle is your grade. If the grade is greater than zero, your team wins the battle. For example, if the enemy's team is CCC and your team is SSA, your team's grade will be 1 (S>C: 1, S>C: 1, C>A: -1) and they will win the battle.

   Expected output: A list of all your potential hero teams that will win their battles.

2. **Compile a list of plans for recruiting each hero team with the shortest time**
   For each winning team, you need to find the shortest time to recruit the heroes in the team within the kingdom as a plan. The kingdom has a capital city with an id of 0, and several villages with ids of different numbers. Each village has a hero (A, S, or C) that could be recruited. A simple example of a kingdom is shown in Figure 1.

   To recruit heroes, you start from the capital city 0. The distance between two neighboring villages with a path is the same, each takes about one day of travel time. For example, to recruit the hero team ASC, you must recruit the heroes in the order of A, S,

and C. You could first take the path of 0 -> 1 -> 2 -> 3 -> 4 to recruit hero A at village 4 (Figure 2). Next, you could take the path 4 -> 3 -> 2 to recruit hero S at village 2 (Figure 3). Finally, you could take the path 2 -> 1 to recruit hero C at village 1. When you are passing through villages to recruit a hero, you cannot recruit heroes in those villages what happened to be on the way. For example, you cannot recruit hero S and hero C on the way to recruit hero A. The number of days to recruit these heroes will be 7 days, equal to the path length (0->1 -> 2 -> 3 -> 4 -> 3 -> 2 -> 1). Once a hero has been recruited from its village, the hero will not be available for recruiting anymore.

Expected output: A list of plans to recruit all your potential hero teams that could win the battle with their shortest recruitment times.

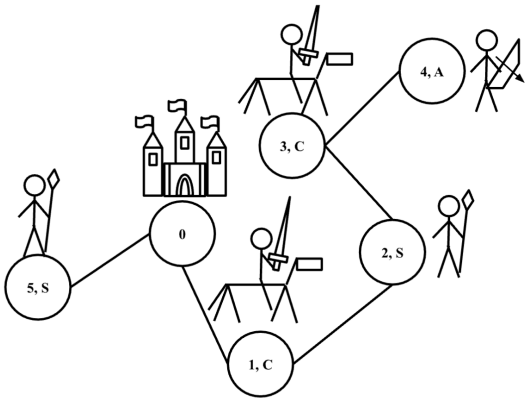

Figure 1

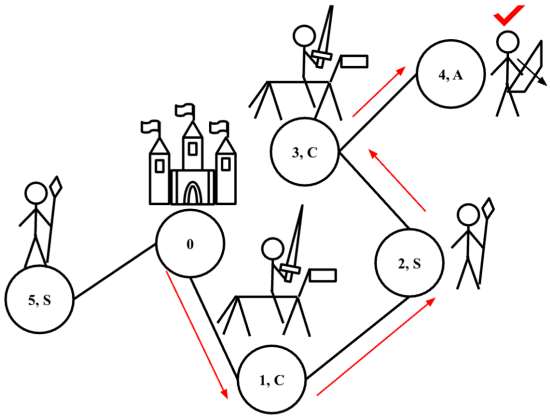

Figure 2

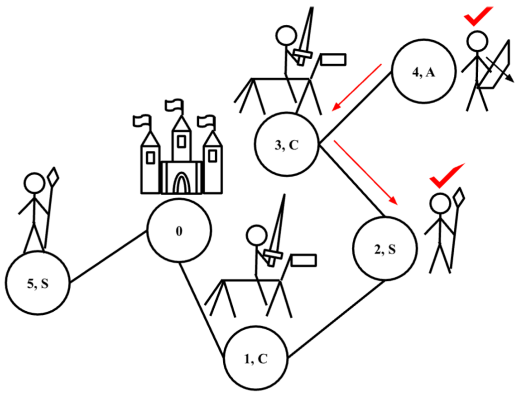

Figure 3

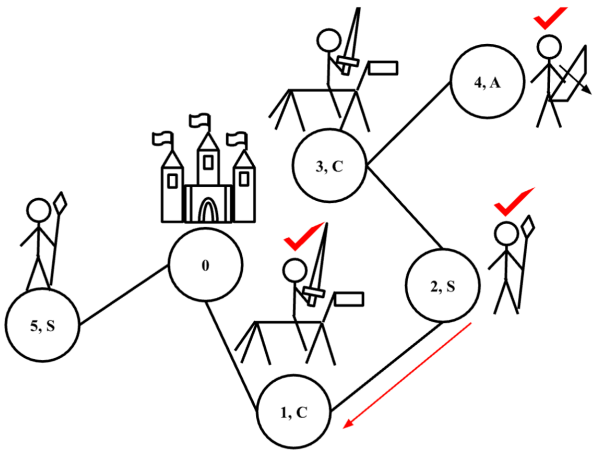

Figure 4

3. Recommend three best plans to recruit a winning hero team

To identify the best recruitment plan, you need to rank them. The grades used for ranking them first. The better the grade, the higher the ranking. When the grades are

the same, the shorter the recruitment time, the higher the ranking. If both the grade and the recruitment time are the same, the plans will be ranked in alphabetical order.

For example, better plans are higher in the list, the best 3 are underlined and are to be recommended:

- Team SCA, with a grade of 3 and a recruitment time of 5 days.
- Team SAA, with a grade of 2 and a recruitment time of 3 days.
- Team SCS, with a grade of 2 and a recruitment time of 7 days.
- Team ACA, with a grade of 1 and a recruitment time of 9 days.
- Team SSA, with a grade of 1 and a recruitment time of 9 days.
- …

Expected output: The recommended three best plans ordered by their rankings.

Due Date:

- 2023/05/23 (Tue) 9 pm

Requirements:

- Modify HW2.java which is posted in the online assignment of the course website.
- For the first task, complete the method *waysToWin* that takes the input of an enemy's heroes and returns a list of all your hero teams that could win the battle.
  e.g. waysToWin(["C", "A", "S"]) return[["S", "C", "A"], ["A", "C", "A"], …]
- For the second task, complete the method *findPlansForRecruitment* that takes in a Graph that represents the kingdom (e.g., Figure 1) and a list of winning hero teams and enemy order as inputs. The function should return plans for recruiting each hero team with the shortest time and about the teams in an array of *HeroRecruitment* objects.
  e.g. findPlansForRecruitment(graph,[["S", "C", "A"], ["A", "C", "A"], …, ["S", "C", "C"]) should return an array of *HeroRecruitment* objects.
  - The returned class *HeroRecruitment* includes the heroes in the team, days to recruit the heroes, villages you will recruit each hero in order, and the grade of the battle.
    e.g. *HeroRecruitment* object of the team SCA could be like:
    - Heroes of the team: ["S", "C", "A"]
    - Days to recruit the heroes: 5
    - Villages on path: [10, 5, 3]
    - Grade from battle: 3

For the third task, complete the *top3Plans* method that takes the plans for recruiting each hero team with the shortest time and about the teams in the input of an array of *HeroRecruitment* objects and returns the three best plans ordered by their rankings in an array of *HeroRecruitment* objects.
e.g. top3Plans([SCA, ACA, …]) should return an array of *HeroRecruitment* objects.

- The maximum number of villages in the kingdom is 25.
- The maximum number of heroes in an enemy's team is 20.
- Some expected outputs are commented on the main function of HW2.java.
- We will also test your code's correctness and robustness with other input and parameters (e.g., different kingdom maps, different enemy teams) that satisfy our requirement but are not provided in the main function.
- Write a comment for each key operation.
- You are only allowed to add or edit code inside the three methods: *waysToWin*, *findPlansForRecruitment*, *top3Plans*.

Deliverables:

- HW2.java
    - The java file needs to be uploaded to the course website.

Rules:

- THE ASSIGNMENT HAS TO BE WRITTEN INDEPENDENTLY BY YOU.
- You can discuss ideas with classmates and the TA if you cannot do it on your own, but make sure to credit the person who helped you in the comments.
- If you referenced an online source, also cite it in the comments.
- Late policy: this assignment will be docked 10% for every day late and will not be accepted 5 days after the due date.