**GameLab Puzzle Game - Theory Q&A**

**What is the game?**

The game is a puzzle game based on the job-scheduling optimisation problem. The game is to arrange certain *jobs* on a *calendar.* The *jobs* are made up of *tasks*. The *job* is to build an equipment needed by your character in the story. Each equipment requires a sequence of tasks to build, which must be performed in a given order. The arrangement of the *task* on the calendar should be in such a manner that *tasks* do not overlap with each other. Also, the time taken to complete all the *tasks*, i.e., the days used on the *calendar*, is as low as possible.

**What does the game explain?**

The job-scheduling problem is an optimization challenge in engineering industries and computing systems. It involves efficiently assigning tasks or jobs to available resources while minimizing certain criteria such as completion time, cost, or resource utilization. Whether it's managing manufacturing processes, optimizing data center operations, or scheduling tasks on a computer processor, this problem seeks to find the most effective allocation of resources to maximize productivity and minimize delays. There are multiple ways to approach a job scheduling optimization problem. An intuitive approach is possible when dealing with small number of jobs and resources. But with larger data sets, optimisation algorithms play a crucial role in finding a satisfactory solution.

**How does the game explain this?**

The game tries to help the player (the student) understand a job scheduling problem by letting the player make decisions regarding the scheduling of a limited numbers of task and small number of resources. Naturally, a player without the knowledge of optimisation algorithms, would use a trial-and-error method to reach a solution. There is an external time limit implemented on the player to force them to make decisions quickly.

**How should a teacher use the game in a lecture?**

Once the timer runs out, the teacher then goes through the debrief questions which helps the player connect the concepts of optimisation algorithms to the decision they just made while playing the game. Even if the players reach the best possible solution without using any optimisation algorithms, the teacher can point out that the puzzle game has very limited number of variables. If there were a large number of variables involved, with an even shorter time window to find a solution, then a trial-and-error method would not be a reliable method for producing any useful result.

**Introduction of the game – mechanics wise – rules and restrictions:**

There are only three main rules that you need to keep in mind while playing the game.

1. No task for an equipment can be started until the previous task for that item is completed. Therefore, check the number on the game piece before placing it on the calendar.
2. A craftsperson can only work on one task at a time. Therefore, no overlapping of game pieces (tasks) on the calendar.
3. A task, once started, must run to completion. Therefore, do not sub-divide or cut the game pieces beyond the dotted lines (depicted in the game sheet).

**Introduction of the game – “story” wise – guide players into the game world:**

(story wise, this game is played after the other two optimisation games in the book.)

You have been on adventures around the kingdom of Kairasus. But now a new opportunity presents itself before you. The kingdom of Sakinara, in the far east, is in trouble. Multiple messengers from Sakinara have been travelling around the world to look for help. One such messenger meets you and asks you for help. The messenger is going to return to Sakinara in 15 days in a ship. The ship is going to set sail and you need to gather all your equipment before it leaves for the kingdom of Sakinara.

You plan to gather all your equipment which will help you in your new adventures ahead. These equipment are: a sword, a shield and a helmet. Each equipment requires a sequence of tasks to build, which must be performed in a given order. The tasks are performed by various craftsperson and artisans all over the town of Quendhur. Your goal is to get all the equipment made as soon as possible by carrying out all the tasks. But there are few limitations as to how the tasks can be scheduled. Be mindful of these constrains and limitations when you choose the right person for the job.

**Debrief – “story” wise – wrap up the game, end of game element:**

You were able to get all your equipment made and collected. You said your farewell to your friends and colleagues. You packed your bag for the new adventure that awaits you in the unknown land of Sakinara in the east.

On the other hand, if you could not get on the ship on time with all your equipment, you decided to spend more time in the town of Quendhur. You spend time perfecting your skills and preparing for the next opportunity whenever it would present itself.

**Debrief – theory wise – help players translate their learnings and experiences from the game to their real life and practical work:**

This game tries to capture the essence of a job scheduling optimization problem. Each equipment needed by your character in the game represents an individual ‘job’ of the optimization problem. Each job is composed of certain tasks which need to be completed by a specific craft person. Each of the craft person represents a machine which carries out the task.

There are five basic elements of an optimisation problem:

1. **Set**: A "set" in optimization refers to a collection or group of objects, elements, or variables. The group of craft persons and the group of equipment make up the sets of the puzzle game.
2. **Parameter**: Parameters are values that typically define characteristics of the elements within a set. They describe various aspects of the problem but do not change during the optimization process. For the puzzle game, the time span of an individual task is a parameter of the game.
3. **Objective**: The objective is a function that you want to optimize. It defines what you're trying to maximize or minimize in the problem. The objective function is typically expressed in terms of the decision variables and parameters. The aim is to minimize or maximize the output of the objective function. For the puzzle game, the goal is to minimize the time taken to complete all the tasks.
4. **Decision Variable**: Decision variables are used to change and control the outputs of the objective function. These variables represent the choices or decisions you make to achieve the best outcome. In job scheduling, choosing when and which tasks to complete are examples of decision variables.
5. **Constraints**: Constraints limit the range of possible solutions and define the boundaries within which the optimization must occur. These are conditions that must be satisfied for a solution to be considered feasible. Constraints can be equality constraints (e.g., production must meet demand) or inequality constraints (e.g., resource usage cannot exceed a certain limit). For the puzzle game the constraints are regarding the availability of the craft persons and the sequence of the tasks.

The following are the debrief questions that the teacher asks the students:

* *Were you able to find optimal solution?*
* *What was your approach to placing the game pieces on the calendar?*
* *Could you relate the game to a real-life experience?*
* *If you look at the game's mechanics, which elements do you recognize?*
* *Can you write down these elements in more generic terms?*
* *If you play the game again, all elements being the same, will you change your approach?*
* *Instead of three, if the game had more than ten equipment and more than six craftsperson, would you have the same approach?*
* *What sort of logic or code would you use if you wanted to make a program to do the job scheduling (i.e., placing the pieces on the calendar) in a manner that results in least time of competition of all the tasks?*