

# Project 6 - MultiSet Design

## Data Structure and Algorithm

November 30, 2025

### Abstract

## 1 Introduction

Based on what I understand from description of project 6, I had two options: an RPG game or a tower defense game. An RPG game is about a hero's journey, while Tower Defense is about strategic defense. I decided to go with the "Tower Defense" game. I like this kind of game more. This design will propose a class named "DefenseTower", a multiset data structure for core logic of Tower Defense game system. The player will manages defense strategies and structures to stop the incoming enemies. As mentioned in the project pdf, multiset (DefenseTower) will support multiple instances of same item e.g. a player likes to have 5 cannons and 2 towers to attack. As mentioned in Table 1, the comparison between Hash Table and AVL Tree bring me to the decision of choosing Hash Table (HashMap)(jstring, unsigned int).

Comparison Criteria	Hash Table	AVL Tree
Search Time Complexity	$O(1)$	$O(\log n)$
Insertion Time Complexity	$O(1)$	$O(\log n)$
Deletion Time Complexity	$O(1)$	$O(\log n)$
Memory Overhead	High	Low
Range Searches	Requires special implementation	Efficient
Re-balancing	Not necessary	Required
Recursion	Not Inherently RS	RS
Implementation	Mostly relies on Libraries	Easily Customizable
Suitability for Small Data Sets	Less suitable due to memory overhead	More suitable

Table 1: Comparison of HahsTable vs AVL-Tree[Gee]

Hash Table for game design is perfect because it will check the inventory (game loop Figure 1) thousands of times in a simple game. A Hash Table is the only structure fast enough to do this instantly ( $O(1)$ ) so the game doesn't lag/stutter.

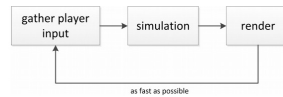


Figure 1: Simple game loop[VCF16]



Figure 2: This frog was uploaded via the file-tree menu.

Item	Quantity
Widgets	42
Gadgets	13

Table 2: An example table.

## 1.1 Design Philosophy

# 2 Some examples to get started

## 2.1 How to create Sections and Subsections

Simply use the section and subsection commands, as in this example document! With Overleaf, all the formatting and numbering is handled automatically according to the template you’ve chosen. If you’re using the Visual Editor, you can also create new section and subsections via the buttons in the editor toolbar.

## 2.2 How to include Figures

First you have to upload the image file from your computer using the upload link in the file-tree menu. Then use the `includegraphics` command to include it in your document. Use the figure environment and the caption command to add a number and a caption to your figure. See the code for Figure 2 in this section for an example.

Note that your figure will automatically be placed in the most appropriate place for it, given the surrounding text and taking into account other figures or tables that may be close by. You can find out more about adding images to your documents in this help article on [including images on Overleaf](#).

## 2.3 How to add Tables

Use the `table` and `tabular` environments for basic tables — see Table 2, for example. For more information, please see this help article on [tables](#).

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## 2.5 How to add Lists

You can make lists with automatic numbering ...

1. Like this,
2. and like this.

...or bullet points ...

- Like this,
- and like this.

## 2.6 How to write Mathematics

L<sup>A</sup>T<sub>E</sub>X is great at typesetting mathematics. Let  $X_1, X_2, \dots, X_n$  be a sequence of independent and identically distributed random variables with  $E[X_i] = \mu$  and  $\text{Var}[X_i] = \sigma^2 < \infty$ , and let

$$S_n = \frac{X_1 + X_2 + \dots + X_n}{n} = \frac{1}{n} \sum_i^n X_i$$

denote their mean. Then as  $n$  approaches infinity, the random variables  $\sqrt{n}(S_n - \mu)$  converge in distribution to a normal  $\mathcal{N}(0, \sigma^2)$ .

## 2.7 How to change the margins and paper size

Usually the template you're using will have the page margins and paper size set correctly for that use-case. For example, if you're using a journal article template provided by the journal publisher, that template will be formatted according to their requirements. In these cases, it's best not to alter the margins directly.

If however you're using a more general template, such as this one, and would like to alter the margins, a common way to do so is via the geometry package. You can find the geometry package loaded in the preamble at the top of this example file, and if you'd like to learn more about how to adjust the settings, please visit this help article on [page size and margins](#).

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To change the spell check language, simply open the Overleaf menu at the top left of the editor window, scroll down to the spell check setting, and adjust accordingly.

## 2.9 How to add Citations and a References List

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## 2.10 Good luck!

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## References

- [Gee]     GeeksforGeeks. Advantages of bst over hash table. <https://www.geeksforgeeks.org/dsa/advantages-of-bst-over-hash-table/>. Accessed: 2025-11-30.
- [Gre93]   George D. Greenwade.   The Comprehensive Tex Archive Network (CTAN).   *TUGBoat*, 14(3):342–351, 1993.
- [VCF16]   Luis Valente, Aura Conci, and Bruno Feijo. Game loop model properties and characteristics on multi-core cpu and gpu games. In *Proceedings of SBGames*, 2016.