Using Hash Tables to run (an) Army(ies) for Real Time Strategy

Intro & Philosophy:

Working with a data multiset to create the basis to store something viable for a game, I chose to work with the idea of a real time strategy game (RTS). I want to keep army unit maintenance inside a hash table<string, unsigned int>. For this project, I will need the system to be able to flexibly alter unit status to include upgrades, damage taken, health points, cost to build, and unit value (e.g. a Marine may be worth one while a Tank can be worth 6.) As units are damaged and killed I need them removed from the table. I need to implement this for the production company RipRTSOff so that the program can manage its units inside the game environment for an end user gamer.

Core Operations:

The core operations of this bag should work as follows (somewhat previously explained): damage progression/ability, unit cost (both monetary and time), unit army value, total army count, and unit position. This will likely need to be a hash table of hash tables. Most operations should be O(1) as one can, " The indexes of the array are computed using a hash function. hash table structures have a remarkable property: most of their operations are (amortized, average, etc.) constant time, that is, their theoretical complexity is □(1)."[1] For example, first determine the type of unit to be attacked, like a tank. Then, from that hash table find the specific ID of the one being attacked and alter the unit as needed. Problems may occur when 8 units attack at the same time one unit and do way more damage than the total health of the unit being attacked. Also, the unit could already be dead when the damage vector is on route. However, there is one factor that will be O(N), that is the total army count (if counting the whole army each time.) this can be mitigated with a increment/decrement upon each unit creation and deletion.

Example Pseudo-code

```
Function Initialize Army Tracker(listOfAllUnitTypes)

    armyTracker.tableUnits = new HashTable<unitGenID, unitTypeAndData>()
    set unit count to 0
    set supply to 0

    For every unitGenID in listOfAllUnitTypes
        new_unitTypeTable = new HashTable<unitID, unitObj>
        Add the unit Table to the Army Table

Function Create Unit(unitGeneratorID, unitGeneratorLocation)

    Assign Serialized ID
    Create UnitItem
    Load Standard values
    Set at map location (TBD by buildings and their Locations in the future)
    Load the specifics (for example actual starting health, energy, shields {if any})

    Insert the Unit

    return serialized ID
```

Set Operations:

There are several different set operations that may be of use. For example in many games one can creat specific subsets of units in one's army. Also, to compare different strengths, one must also be able to compare where the army's intersect and where they have difference It is also useful to determine what upgrades one army may have that the other does not. For example if there is a scenario where the enemy is supposed to achieve final victory no matter what the player does, the difference one will reveal weaknesses for further unit generation to wipe out the player.

Extension Feature:

In order for game play to be satisfying to the player, there needs to pleasing mecanics, dynamics, and aesthetics. As described in "MDA: A Formal Approach to Game Design and Game Research":

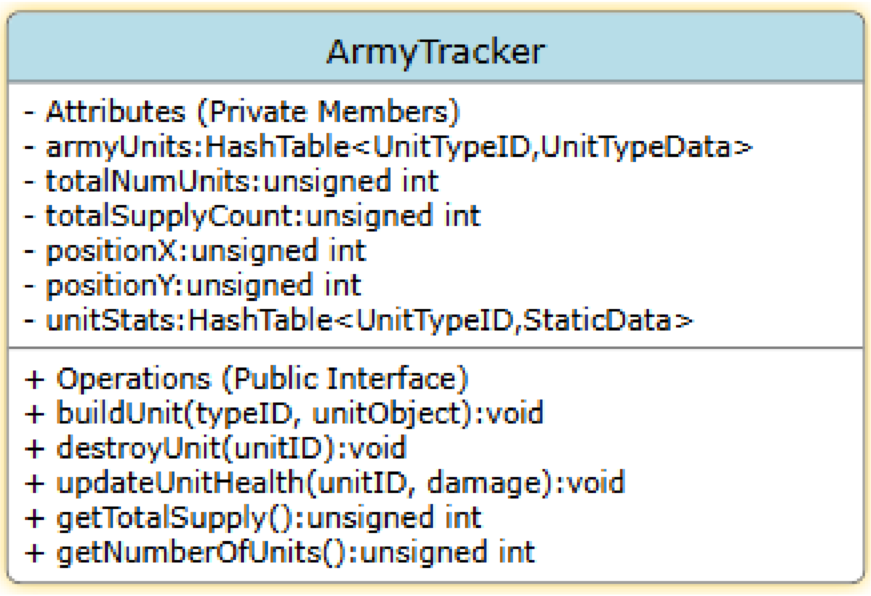
> Aesthetics What makes a game "fun"? How do we know a specific type of fun when we see it?...Dynamics work to create aesthetic experiences. For example, challenge is created by things like time pressure and opponent play. Fellowship can be encouraged by sharing information across certain members of a session (a team) or supplying winning conditions that are more difficult to achieve alone (such as capturing an enemy base)...Mechanics are the various actions, behaviors and control mechanisms afforded to the player within a game context. Together with the gameís content (levels, assets and so on) the mechanics support overall gameplay dynamics.[2]

Using one unit and another with the addition of an appropriate amount of time, there can be two separate units that merge into a single better unit. For example, if the player has a marine and robotic "AI" armor, the two units could merge to form the "starship trooper ape unit or at least a differently named facsimile of one. With this action, it gives another avenue for the player to progress in power without the creation of new units when unit capped for total supply. With the addition of more types of armies, this ability can be added in different versions to each. For example, one could be available early in the game to an army, but it would not have as much added strength as that for the army(ies) that have to wait longer to gain the ability.

Trade-off Analysis:

Sequence	AVLTree
Description This is basically an array. Each Item is stored individually and one must iterate through the whole list every single time you have to add subtract or find and given item. **Why is this a problem?** As the army increases for each player, there are ever more items to run through. Even with a sequence of sequences the whole proces is complicated and cumberson in relation to being able to just go to a bucket to find the type and then a bucket in the sub hash table to get to the specific unit.	**Description** An AVLTree is a for of tree search structure and a very effective way to search through for numeric values, especially when they are unique. **Why is this a problem?** As the army increases for each player, there's continual additions to the tree. This is not quite so problematic though as there is still the possibility of num type that subtrees but it is much easier to serialize and subtable as the tree best case scenario is $\log_2 N$.

In summary while both are able to be used and traited, neither of them are quite so efficient



ArmyTracker
- Attributes (Private Members)
- armyUnits:HashTable<UnitTypeID,UnitTypeData>
- totalNumUnits:unsigned int
- totalSupplyCount:unsigned int
- positionX:unsigned int
- positionY:unsigned int
- unitStats:HashTable<UnitTypeID,StaticData>
+ Operations (Public Interface)
+ buildUnit(typeID, unitObject):void
+ destroyUnit(unitID):void
+ updateUnitHealth(unitID, damage):void
+ getTotalSupply():unsigned int
+ getNumberOfUnits():unsigned int

Figure 1: img_1.png

as a hash table that can be run as O(1). Further, it feels easier to think about the traits inside the hash table bucket vis-à-vis the node structure or the list style of the sequence. Were the structure that was being worked on a crafting from inventory type, I would choose the Sequence type as all one needs to do is find first occurrence of limited types of object, remove it and then output the crafted item.

Alternative design sketch:

AVLTree

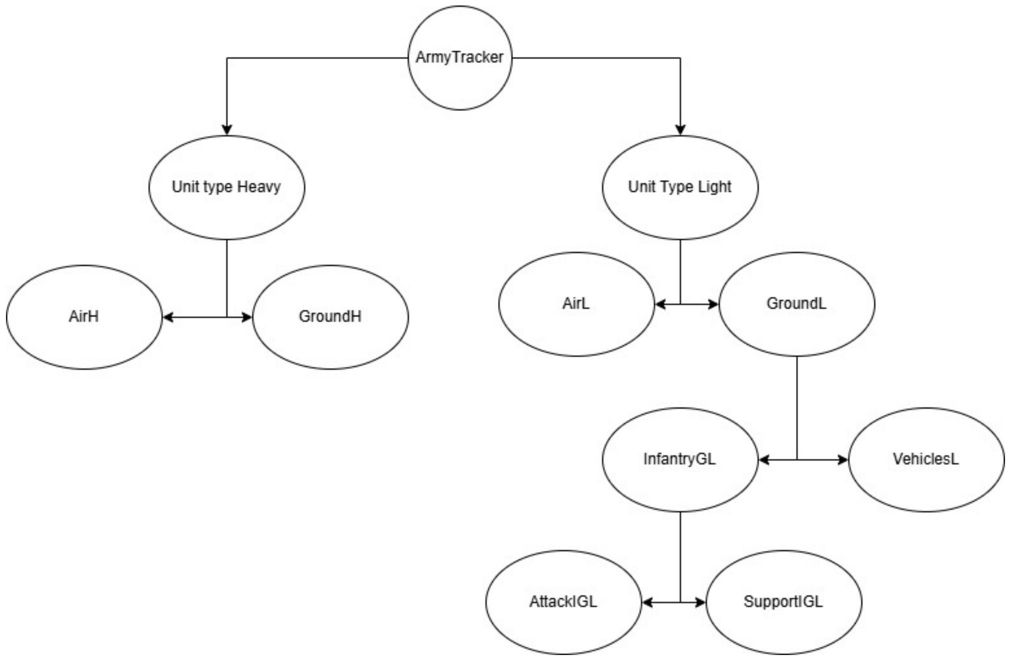


Figure 2: Alternative design sketch - AVLTree

The above flow chart is jus the start of what would need to be done to start out fleshing out what would be necessary to complete a flow chart just to start getting to the units. Although log2 N is not long it is still far longer than O(1) that a hash table would require to find the location of the hashed unit type. (See Below)

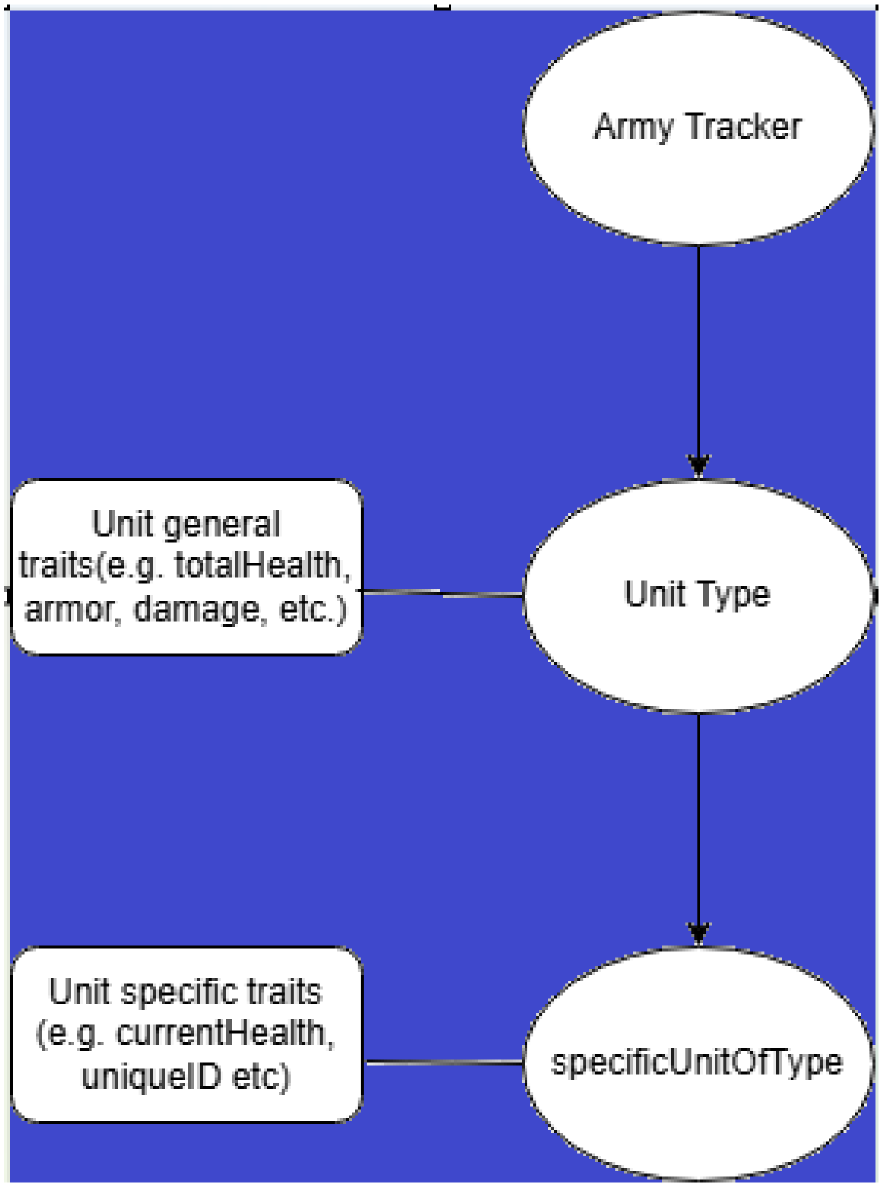

Army Tracker
Unit general traits(e.g. totalHealth, armor, damage, etc.)
Unit Type
Unit specific traits (e.g. currentHealth, uniqueID etc)
specificUnitOfType

Figure 3: Alternative design sketch - Hash Table

Evaluation Plan

I would test this format by first running through a debug program like we have through our projects. I would start with testing each variable through input validation and then standardized names to see what was returned and if it worked properly in the context of a hash table. After I would add the sub-variables to each general type, I would also verify that each of those returned the proper values. Next, I would test the hash table's hashtable for the individual values. one all those returned properly through try catch debugging, I would then link the tables properly with the secondary unit specific tables subservient to the primary tables.

Conclusion

[1] S. Tapia-Fernández, D. García-García, and P. García-Hernandez, “Key Concepts, Weakness and Benchmark on Hash Table Data Structures,” Algorithms, vol. 15, no. 3, p. 100, Mar. 2022

[2]R. Hunicke, M. LeBlanc, and R. Zubek, “MDA: A Formal Approach to Game Design and Game Research,” in Proceedings of the AAAI Workshop on Challenges in Game AI, San Jose, CA, USA, Jul. 2004, vol. 4, no. 1, p. 4