## Introduction

Chamber Crawler 3000 is a classic simplified rough-liked game. The only significant difference is CC3K does not update the terminal in real-time instead redraws the game board and other elements every turn.

The game has two parts of text display. The top part of the display consists current floor, chambers, player, enemies, items, stairway, passages, etc. The very bottom of the display shows player’s stats such as health, attack, defense, movement and floor level. The game grid consists of a board with 79 columns, 25 rows and 5 rows to display player stats.

Player is denoted as ‘@’ can go in 8 different directions and can collect gold when enemies is slayed. These actions work similar to the basic rouge like game. There are 5 different floor is available to the player and the goal of the game is to reach the highest floor by going through the stairways

## Overview

According to the Model-View-Control Model, the program can be divided into 4 main components.

Model

GridObjets

Updates

Manipulates

View

TextDisplay

Controller

Floor

Uses

Sees

Client

Main

Miannasd

Clients uses commands in Floor to manipulates the actual map in Grid Objects and update the actual map to the TextDisplay and display the map onto the screen.

## Main

Client executes a command and the game will perform it accordingly.

## Floor

Floor, as the controller, is responsible for linking all the elements of the game. It manages the lifecycle of the game and interact with the model and client. The class Floor is the basic setup and the core of the game. Floor contains a “map”, which is a two-dimension vector that contains a list of GridObjects’ shared pointers, on the current gird to keep track of all objects’ position. Map is a protected member in Floor since both player and enemy need to know where the items are and need to know the direction on the map when they take action during the game. In addition, TextDisplay is a private member in Floor class, which is a view model, when ever an action happens in the map during the game, map will update current stats through observer pattern (will be discussed later) to the display.

**Some of Floor’s responsibilities include:**

1. Setting up the “map” (grid).
2. Handling the randomness of spawning player, spawning enemies, spawning items and spawning cells.
3. Managing a uniform transition between levels.
4. Destroying all the objects and recreating new objects when restarting the game.

## GridObjects

The GridObjects represents the objects on the grid. It will have Player, Enemy, Item and cell, they are all abstractly modelled by GridObjects. Each kind of races of player or enemy is implemented with a single subclass. Each subclass in Character must define its stats (MaxHP, HP, Attack, Defense). For instance, Shade set it stats to MaxHp(125), HP(125), Attack, Defense(25). Each subclass will know it's own HP, Attack and Defense. Therefore, this makes it easier to add more races to Player and Enemy. Similarly, Potion and Gold are the subclasses of Item since each kind of potion and each kind of gold has different effects to player. Items is implemented with Decorator Pattern (See Design Section).

## TextDisplay

The display of the game only has text display. TextDisplay class represents the console display of the game and it is implemented with the Observer Pattern (See Design Section). It contains a two-dimension vector of char to store each symbol in the provided file.

**Some of TextDisplay’s responsibilities include:**

1. Client can virtually see the map on the screen by displaying the text map.
2. Notify observers and update itself when the actual map in GridObjects has changed (eg. Spawn objects on the map and character’s action during the game).
3. Display player’s current stat during the game.

## How the game works

1. ***Set up (Initialization and Spawning)***

Main will constantly be waiting client’s commands in the core game loop and initialized the game grid. Floor will set up properly as the init method get called. The map in the provided file. Objects will be spawn randomly in the following order on the map:

* Player
* Stairway
* 10 Potions 10 Gold
* 20 Enemies

1. ***Actions***

There are three actions that player can take in the entire game.

* Move

Player can move in eight different directions except there is an obstacle object is in that direction (i.e., Wall, Potion).

* Attack

Player can only attack in a range of one block radius.

* Pick up

Player can only pick up items within a range of one block radius. The exception for dragon hoard is player have to slay dragon in order to collect gold.

Whenever a player action is taken, it will notify enemies and text display.

1. ***Next floor***

Whenever the player character reaches the stairway of the current floor, the current floor and objects will be cleared out and memory will be properly freed. All temporary effects will be unwrapped from the player and permanent potion effects will stay on player. The objects on the next floor will be reinitialized and spawn randomly on the map. If the player reaches the 5th floor, then the player wins the game.

1. ***End***

The game will terminate whenever the player character is dead or client can execute the ‘r’ command to replay the game. All memory will be properly freed after the termination of the game.

## Design

## Coupling and Cohesion

## Design Pattern Highlights

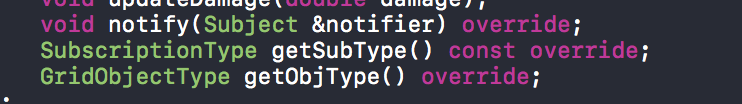
We employ the flowing Design Pattern:

* Observed Pattern

We can take the advantage of the Observer Pattern to implement text display and player’s/enemy’s move since objects on the grid and text display have an observer-subject relationship. Player is the main subject and text display are the subjects and observers of player. Once the player is created, all enemies will be attached to player’s observer list. Similarly, text display will be attach to each object’s observer list when an object is created.

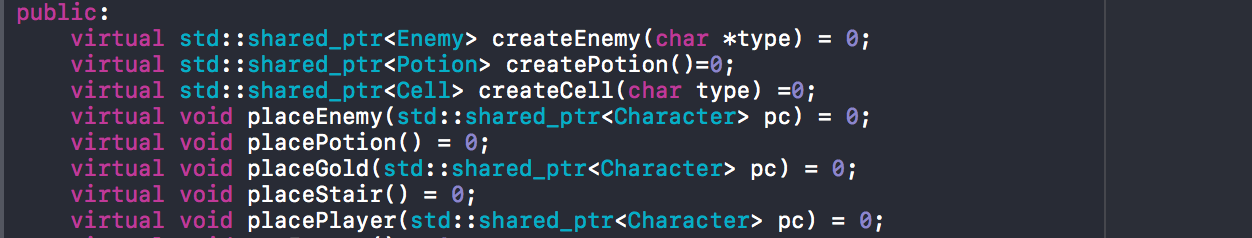
* Used to notify enemies and text display when player’s action is taken.

(For reference, visit Enemy.h)



* Used to notify text display when objects is been slayed or picked up.
* We use the enum as type to distinguishes which class to notify. For instance, it will notify ALL(text display and enemies) when player’s action is taken , it will notify display only when an item is picked up or when an enemy is killed.
* Factory Method Pattern

In our implementation, we take the advantages of Factory Method Pattern to create grid objects and allowing us to hide information of the subclass to the client. Level is the abstract class that have all pure virtual methods of creating objects and placing objects on the grid. Used in the Level class (can think as an abstract factory class) and floor is the concreate factory to implements all the creation of objects. (For reference, visit Floor.h).



* Visitor Pattern

The visitor pattern is helpful to construct polymorphism code. For instance, Player and Enemy are both inherited from the Character class, and when the attack method in the Enemy class is called, it will decide which method will be called in the subclass depending on the player’s race.(For reference, visit Enemy.h)

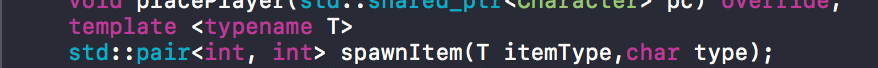


* Decorator Pattern

Decoration Pattern is very useful when attaching additional functionality to an object dynamically. Decorator pattern makes it easier when temporary potion’s effects is constructed on to the player with the potion decorator and permeant effects and different kinds of gold type can just set it on to player stat. Once player reaches the next level, temporary potion effects can be removed by iterating through the decorator and eventually reach the bottom of the decorator, which is the player.

For reference, you can see the code in potioneffects class.

* Template Function

We take the advantage of using Template function to reduce code rather than using the Template Method Pattern since potion and gold have similar code. (For reference, visit Floor.cc)

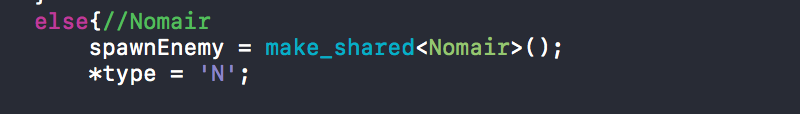
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## Resilience to change

***Additional Characters (Student and Nomair)***

Adding additional character races is not a significant change in our implementation. With Factory Design Pattern, we can just add another subclass for enemy/player and modify the method in the factory(Floor). Similarly, the attack action for new character race can implemented with the Visitor Pattern by modifying the attack method in Enemy.h/Player.h

An example of the flexibility of Factory Pattern,



Nomair is created. (For reference, visit Floor.cc)

***Additional Items(Weapons and Armors)***

## Questions:

Q1:How could your design your system so that each race could be easily generated?

Additionally, how difficult does such a solution make adding additional races?

Since all races have a common make () method, we can use the factory method pattern to generate the races and let the factory to decide which races is needed to be created.

Q2: How does your system handle generating different enemies? Is it different from how you generate the player character? Why or Why not?

In our final UML, you can see that Character is a superclass of both Player class and Enemy class since they have common fields. The way to spawn player and player is quite similar. Player character is generated when player has selected a race in GameGrid. In comparison generating enemies, we spawn enemies in the Level class. By using the Factory Method Pattern, Level itself is a factory and Floor is the concreate factory. Whenever the createEnemies() method is invoked in the floor class to spawn, each created enemy is attached to the player’s observers list.

Q3:

How could you implement the various abilities for the enemy characters? Do you use the same techniques as for the player character races? Explain.

We can use the visitor pattern for double dispatching. Implement overloading methods for each different combination of attack effects for player. Special attack abilities of enemies and player are implemented as virtual function.

Q4:

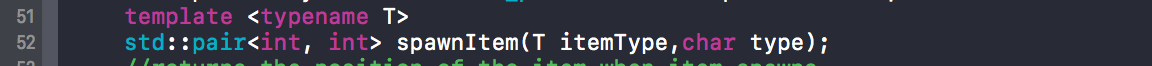
The Decorator and Strategy pattern are possible candidates to model the effects of potion, so we do not need to explicitly track with which potions the player character has consumed on any particular floor. In your opinion, which pattern would work better? Explain detail, by weighing the advantages/disadvantages of the two pattern.

In our opinion, Decorator Pattern is the best fit for adding potion effects to the player. Decorator Pattern allows you to add functionality to your object. In this case adding temporary potion’s effect to player. When a player uses the potion, potion can be a decorator and wrap it onto the player. When the player goes to the next floor, those temporary potions’ effects are gone. We could just simply unwarp that potion. According to the definition of Strategy Pattern in Wikipedia, Strategy pattern defines a family of algorithms and encapsulates each algorithms and allow algorithms to be interchanged at runtime. The disadvantage of using Strategy Pattern is we might have to add extract fields to the potions and we might have to explicitly track the potions that the player consumed.

Q5:

How could you generate items so the generation of Treasure and Potion reuses as much code as possible? That is, How would you structure your system so that the generation of a potion and the generation of treasure does not duplicate code?

Before Due Date 1, you can see that we use the Template Method pattern for code reusability on generating treasures and potions since the Item class is made up of Potion class and Item class. We use the template function instead of template method. As you can see in the Floor Class Line 51. The spawnItem can spawn both potion and gold by passing the them in itemtype.



## Extra Credit Features:

***WASD***

***Shared Pointers***

CC3k is written without using explicitly memory allocation and deallocation.

***AI for Enemy***

Enemies now have the ability to pursue player with in the range of 3 block radius.

## Final Questions:

Q1:

What lessons did this project teach you about developing software in teams? If you worked alone, what lessons did you learn about writing large programs?

Q2:

What would you have done differently if you had the chance to start over?