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DELIVERABLE 1 – PROBLEM DESCRIPTION AND JUSTIFICATION

Overview

Game Chosen: *Tower Defense Game*
Target Audience: People who like classic, strategy, non-progression focused games.

Justification

Tower Defense Games are a popular and common genre of video games, where players place and upgrade **towers** to **defend** against incoming **enemies** from **reaching an endpoint**. The problem/challenge lies in designing an **engaging gameplay experience** that **balances** *difficulty*, *strategy*, and *resource management*.

I chose the tower defense genre because it has **creative freedom** and easy **expandability**, as well as a manageable scope. (simplicity) I have played and enjoyed them in the past (mostly from "Bloons TD6") and thus have elementary knowledge on how a tower defense game could be designed. To expand upon basic algorithmic logic (sequencing, selection, iteration, recursion etc. – additionally implementing the pygame library), the tower defense game choice further allows me to demonstrate **OOP elements** including:

- **Polymorphism** allowing for the creation of different enemy and tower types, introducing a wider range of attack strategies.
- **Inheritance** allowing for easy implementation of new enemy, tower and map types.
- **Encapsulation** and **Abstraction** by designing of classes that restrict unnecessary data access (private variables) and hide unnecessary internal details.

Game Requirements (summary):

- A Grid Based **Map**/coordinate **system**
- Different **enemy types**, perhaps with unique designs; *health*, *number*, *mechanics*. (e.g. impenetrable to certain tower types)
- **Wave-based enemy spawning** system, progressively increasing in difficulty.
- **Enemy** spawning and **pathfinding** mechanisms, allowing navigation for enemies from start to end points.
- Different **tower types** each with unique designs; *range*, *damage*, *attack patterns/types*; introduces *strategy* with choice of *distinct* and *unique* towers in different *scenarios*.
- **Resource management system**, enabling **purchasing** and **upgrading** of **towers**; introduces *strategy* with *resource management*.
- **Save System** – saves **progress**; *level completion*, *scores*, *settings*.

Programming Requirements:

- Using OOP (Object Oriented Programming) ensuring use of inheritance, polymorphism, encapsulation, abstraction to ensure code structure, maintainability, and scalability/extensibility.

Grid Based Map System

- The game world is represented using a 2D grid (2D array).
- Cells must store information such as walkable paths, tower placements, and obstacles.

Enemy Pathfinding & Movement

- Enemies must navigate from a start point to the goal using pathfinding algorithms

Tower Placement & Attacks

- Players must be able to place towers only on valid grid cells.
- Towers should have unique attack behaviors (e.g., single-target, splash damage, slow effect).
- Towers should fire projectiles that follow an enemy trajectory or apply area-of-effect (AoE) damage.

Enemy Spawning & Wave System

- Enemies spawn in waves, increasing in difficulty.
- Each enemy type has different stats (health, speed, resistance to damage types).

Resource & Upgrade System

- Players earn in-game currency for defeating enemies.
- Towers should be upgradable to enhance their damage, range, or special abilities.

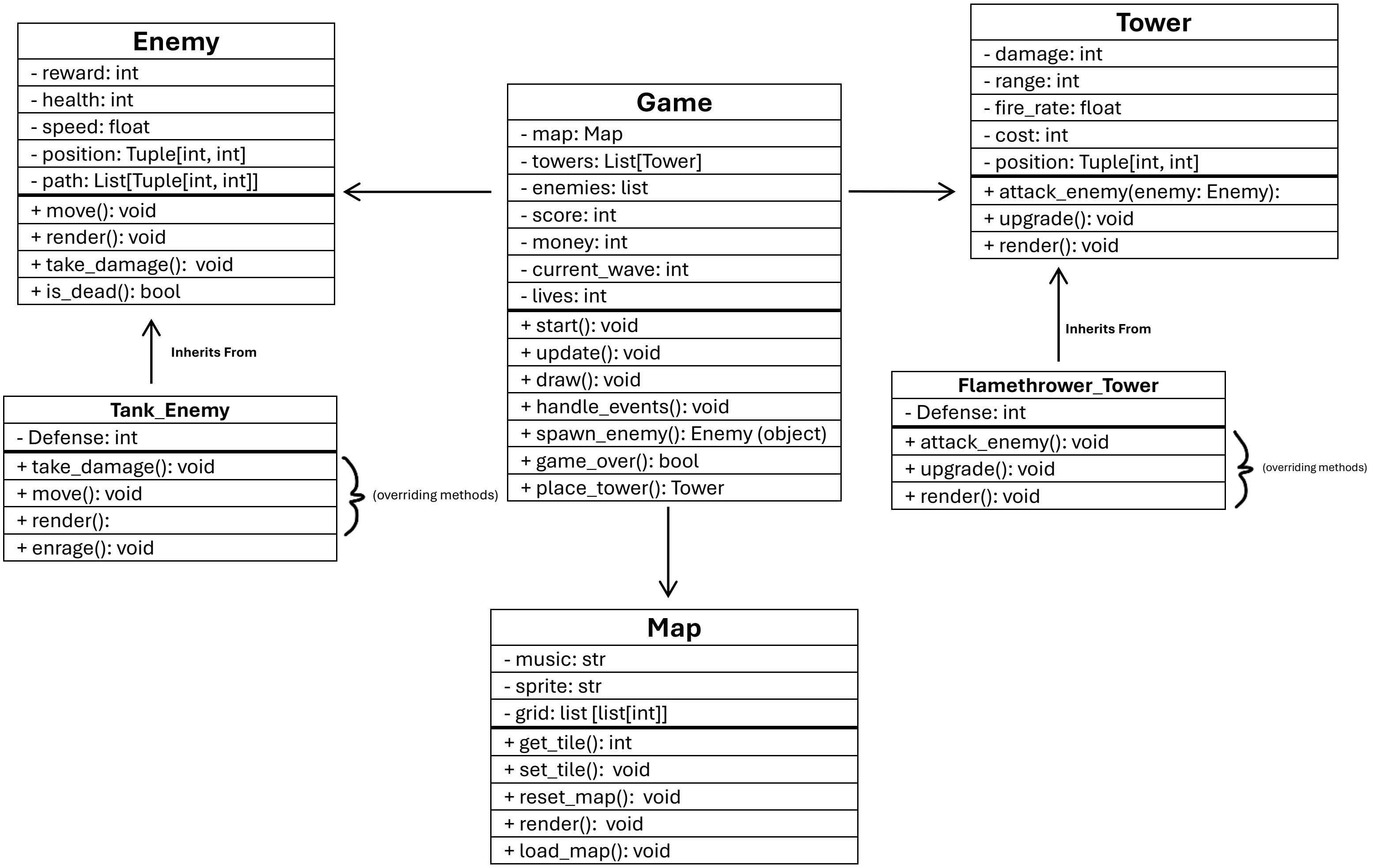
Game UI & Controls

- The game should have a main menu, start button, settings, and pause/resume controls.
- Players should receive real-time feedback (e.g., HP bars on enemies, damage numbers, notifications for invalid tower placement).

Title Screen & Level Management

- The title screen should allow players to start a new game, change settings, or exit.
- The game should support multiple levels/maps, each with unique enemy waves and layouts.

Example Class Diagrams:



Enemy
- reward: int
- health: int
- speed: float
- position: Tuple[int, int]
- path: List[Tuple[int, int]]
+ move(): void
+ render(): void
+ take_damage(): void
+ is_dead(): bool

Inherits From

Tank_Enemy
- Defense: int
+ take_damage(): void
+ move(): void
+ render():
+ enrage(): void

(overriding methods)

Game
- map: Map
- towers: List[Tower]
- enemies: list
- score: int
- money: int
- current_wave: int
- lives: int
+ start(): void
+ update(): void
+ draw(): void
+ handle_events(): void
+ spawn_enemy(): Enemy (object)
+ game_over(): bool
+ place_tower(): Tower

Tower
- damage: int
- range: int
- fire_rate: float
- cost: int
- position: Tuple[int, int]
+ attack_enemy(enemy: Enemy):
+ upgrade(): void
+ render(): void

Inherits From

Flamethrower_Tower
- Defense: int
+ attack_enemy(): void
+ upgrade(): void
+ render(): void

(overriding methods)

Map
- music: str
- sprite: str
- grid: list [list[int]]
+ get_tile(): int
+ set_tile(): void
+ reset_map(): void
+ render(): void
+ load_map(): void

Pseudocode Representation of example Tower Class and Flamethrower_Tower Subclass

```
CLASS Tower:

  METHOD Initialise(damage, range, fire_rate, cost, position):

    SET self.damage = damage
    SET self.range = range
    SET self.fire_rate = fire_rate
    SET self.cost = cost
    SET self.position = position

  ENDMETHOD

  METHOD attack_enemy(enemy):

    enemy.take_damage(self.damage)

  ENDMETHOD

  METHOD upgrade():

    Increase self.damage by 5
    Increase self.range by 1
    Decrease self.fire_rate by 10% (make it faster)

  ENDMETHOD

  METHOD render():

    #Render tower

  ENDMETHOD

ENDCLASS
```

```
CLASS Flamethrower_Tower Inherits Tower:

  METHOD Initialise(position):

    CALL parent constructor Initialise(damage=5, range=3, fire_rate=0.5, cost=200, position)
    SET self.damage = 5
    SET self.range = 3
    SET self.fire_rate = 0.5
    SET self.cost = 200
    SET self.position = position
    #Overridden tower stats

  ENDMETHOD

  METHOD attack_enemy(enemy):

    enemy.take_damage(self.damage)
    #Overridden attack method

  ENDMETHOD

  METHOD upgrade():

    Increase self.damage by 2
    Increase self.range by 0.5
    Decrease self.fire_rate by 15% (make it faster)
    #overridden upgrade stats

  ENDMETHOD

  METHOD render():

    #Render customized appearance/effects

  ENDMETHOD

ENDCLASS
```