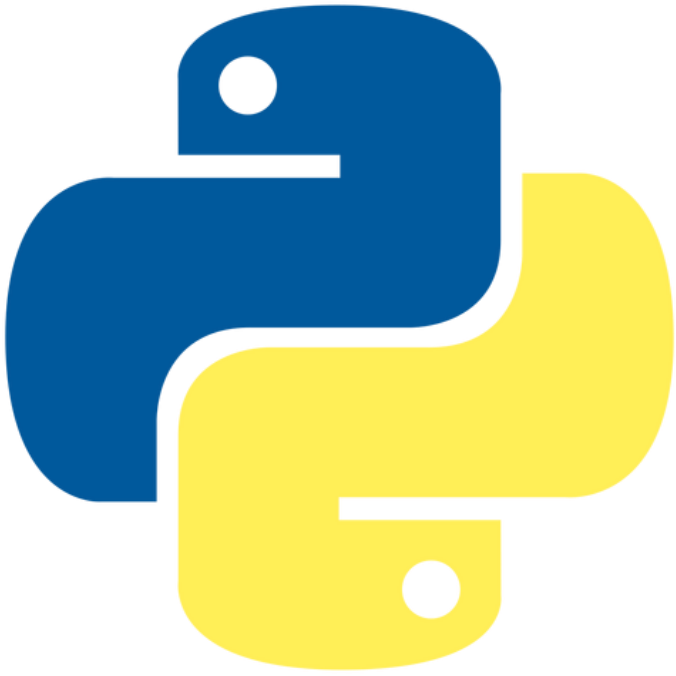
Revisions

- The original design proposal for the tower defense game was mostly correct in its descriptions of game mechanics and programming requirements, however their implementation could be made more clear/organised.
    - State management has been suggested in this design.
- Error Handling/testing was not present in the previous design proposal, which has been added in this proposal.
- Pseudocode and flow chart extract are included in this proposal to provide further detail on how the program should be designed and on logic flow.
- System architecture is included in this proposal to guide the organization of modules in the program.
- The original design proposal did not mention ethical/legal considerations, included in this proposal.

Ethical/Legal Considerations

- In the designing of my tower defense game I should ensure that all assets (e.g., images, music) used in the game are either original or properly licensed to avoid copyright infringement, and the ethical/legal consequences that follow.
- Fair gameplay should be prioritized by avoiding pay-to-win mechanics or manipulative design choices, to avoid associated ethical concerns.



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Pseudocode for checking grid tiles

- Demonstration of the 'check_tile' method inside the Grid class; checks the number (tile) at given coordinates inside a 2D array, returning a label (string) representing the tile type.

```
CLASS Grid:
  # Define constants for different tile types
  DEFINE FREE_TILE AS 0  # Represents a free (empty) tile
  DEFINE PATH AS 1       # Represents a path
  DEFINE TOWER AS 2      # Represents a tower

  METHOD __init__(grid):
    # Encapsulation: The grid is stored as a private attribute (data hiding)
    SET self._grid TO grid
  ENDMETHOD

  METHOD check_tile(grid_coords):
    # Abstraction: The method provides a meaningful string/label instead of raw numbers

    # Validation: Ensure the input format is valid
    IF grid_coords IS NOT a tuple OR LENGTH(grid_coords) IS NOT 2 THEN
      RETURN "Invalid input"  # Abstraction: Returns a user-friendly error message
    ENDIF

    # Extract x and y coordinates
    SET grid_x TO grid_coords[0]
    SET grid_y TO grid_coords[1]

    # Validation: Ensure coordinates are valid (not None)
    IF grid_x IS None OR grid_y IS None THEN
      RETURN "Invalid coordinates"
    ENDIF
```

```
    # Validation: Check if coordinates are within grid boundaries
    IF grid_x < 0 OR grid_x >= LENGTH(self._grid[0]) THEN
      RETURN "Out of bounds"  # Encapsulation: Prevents direct access to invalid memory
    ENDIF

    IF grid_y < 0 OR grid_y >= LENGTH(self._grid) THEN
      RETURN "Out of bounds"
    ENDIF

    # Retrieve the tile value from the grid
    SET tile_value TO self._grid[grid_y][grid_x]



    # Validation: Check tile value to ensure it's within expected types
    IF tile_value NOT IN {self.FREE_TILE, self.PATH, self.TOWER} THEN
      # Error handling: Prevents unexpected tile values from breaking the program
      THROW ERROR "Invalid tile value!"
    ENDIF

    # Determine the tile type and return a string
    IF tile_value == self.PATH THEN
      RETURN "path"  # Abstraction: Converts raw numbers into meaningful names
    ELSEIF tile_value == self.TOWER THEN
      RETURN "tower"
    ELSEIF tile_value == self.FREE_TILE THEN
      RETURN "free space"
    ENDIF
  ENDMETHOD
ENDCLASS
```

Testing Strategies/Error Handling

Error Handling:

- Invalid User Inputs: Validate inputs (e.g., coordinates for tower placement) and provide clear error messages for invalid actions.
- File I/O Errors: Handle file-related issues (e.g., loading/saving game data) using try-except blocks to prevent crashes.
- Runtime Exceptions: Use try-except to catch unexpected errors (e.g., out-of-bounds grid access) and provide fallback error messages.
- General Error Feedback: Provide user-friendly error messages and log errors for easier debugging.

Testing Strategies:

- Unit Tests: Test individual components (e.g., tower placement, enemy movement) using Pytest to ensure correct behaviour.
- Integration Tests: Test interactions between components (e.g., placing towers, enemy movement) with Pytest to ensure seamless functionality.
- System Tests: Test the entire game flow (e.g., start-to-finish gameplay) to ensure the game works wholly.

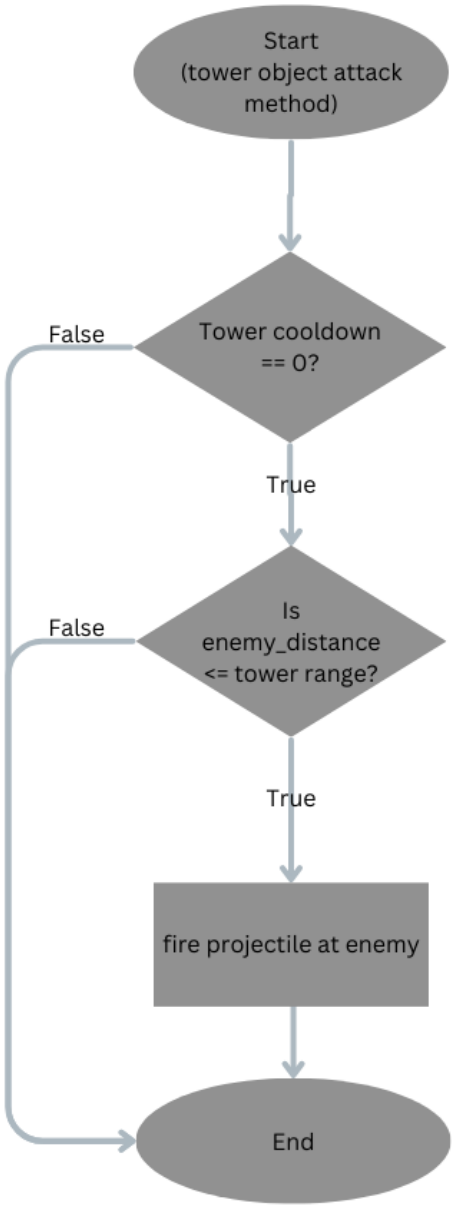
Justification:

- Error Handling ensures a smooth user experience and prevents crashes.
- Testing (unit, integration, system) ensures functionality, reliability, and performance, making the game maintainable and bug-free.

```python
from Game.grid import Grid

def test_grid_check_tile():

    grid = Grid([
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 2, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
            [0, 0, 0, 0, 0, 0, 0, 0, 0, 0],
        ])

    grid_coords = (5,4)
    grid.check_tile(grid_coords)
    print("Checking grid check_tile method")
    assert grid.check_tile(grid_coords) == "tower", 'Tile at (5,4) should be "tower"'
```

For example, this function ensures that the check_tile method (as shown in pseudocode earlier) works as expected; i.e. it correctly returns that at the given grid and coordinates, a tower is present.

Flowchart



- This is the attack method inside the base_tower class.
- It checks for if:
  - The tower's cooldown is 0 (meaning it can shoot)
  - The enemy_distance is smaller than/equal to (within) the tower's range, meaning the tower can reach it.
- If both conditions are satisfied, the tower will shoot (shoot is another method within the base_tower class). Otherwise, the method ends there.
- This method is called every frame within the games update loop (in game_state class; through update(self, events) → tower.update(self.enemies) → **self.attack(enemies)**)

System Architecture

```
/tower_defense_game
  /Assets                # Folder for all static assets used in the game
    /Maps                # Contains map files or configurations
    /sprites             # Holds image files for characters, enemies, and UI elements
    /ui                  # UI-related assets like button graphics, menu backgrounds, etc.

  /Constants             # Folder for constants that manage the configuration of the game
    /config              # Game configuration settings like screen size, difficulty, etc.
    /sprites             # Sprite constants like default dimensions, asset paths, etc.

  /Entities              # Folder for game entities (objects and entities in the game world)
    /enemies             # Contains enemy-related classes and behaviours
      /base_enemy        # Base class for all enemies, contains common enemy properties and methods
    /towers              # Contains tower-related classes and behaviours
      /base_tower        # Base class for all towers, contains common tower properties and methods

  /Game                  # Folder for core game logic, classes, and mechanics
    /game                # Contains core game engine logic, managing game state, and looping
    /map                 # Class or files related to the map generation and management
    /grid                # Grid class for handling the 2D grid of the tower defence map
    /maps                # Specific map files or map configurations for each level
    /mouse               # Handling mouse input and interactions within the game

  /States                # Folder for various game states that control the flow of the game
    /base_state          # Base class for game states (used for common state behaviour)
    /game_state          # Class representing the game state (active gameplay)
    /menu_state          # Class representing the menu state (menu navigation)
    /pause_state         # Class for the pause state when the game is paused
    /state_manager       # Manages state transitions (switching between states)

  /UI                    # Folder for user interface components and layout
    /Menus               # Folder for menu-related UI components and screens
      /menu              # General menu components (buttons, titles, etc.)
      /mainmenu          # Main menu components
      /optionsmenu       # Options menu components (audio, graphics settings, etc.)
      /pausemenu         # Pause menu components (resume game, restart, etc.)
    /button              # Classes or components for rendering buttons in the UI
    /tower_selection_panel   # Panel for selecting and placing towers in the UI
    /game_buttons        # Buttons that are part of the in-game interface (e.g., pause, quit)

  main.py                # Main entry point of the game, initializes and runs the game
  README.md              # Documentation file with game details, installation instructions, and more
```

Refined Class Diagrams

Class Diagram for Game_state and related classes