

Wumpus: Network

Object Oriented Programming Assessment Task

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1. Overview

This document provides documentation for the Preliminary Object Oriented Programming Project. The appendixes provide external documentation and context useful for those studying the code.

1.1. Hunt the Wumpus: Background

Hunt the Wumpus is a classic computer game originally created in 1972 by Gregory Yob. The game is set in a series of interconnected caves, where the player must hunt a creature known as the Wumpus. The player navigates the cave system, avoiding hazards such as bottomless pits and super bats, while attempting to deduce the Wumpus's location and shoot it to win the game.

1.2. Wumpus: Network

Wumpus: Network is the result of this project. It is a game inspired by Hunt the Wumpus, adding original features. It is a graphical game with 3D and 4D levels, expanding the scope of the original game with more challenging and interesting levels.

2. Journal

2.1. 05/05/2025

git commit hash: 19c52af565583322ebfb73220f7fd8ead5119bbe

2.1.1. Progress

- Competed text based implementation of the game
- This implementation loads the game map from a JSON file
 - This is used to create the `Level` class, which holds the position of Caves and Hazards
 - Hazard has various subclasses for Wumpus, BottomlessPit and Superbats, which manipulate the `PlayerController` and `Level` on events such as `on_player_enter` (implemented as methods)
 - `PlayerController` has the actual player controlling functionality implemented in subclasses such as `TextPlayerController`
 - This will ease migration to a graphical implementation

2.1.2. Future improvements

- Add unit tests and documentation
- Change `Level` to an event-based system, where entities yield or return events that control the level, rather than having a tight coupling to the `Level` and `PlayerController`

2.2. 22/05/2025

git commit hash 854cebf7a5eb777694642c36225013d7dd866ef

2.2.1. Progress

- Added event based architecture
- This helped to decouple the Hazards from the `Level`
- Handling of player interaction with Hazards was also moved to `Level`.

2.3. 13/06/2025

git commit hash 9003447fea0d29cc30092adac94c328893a5294f

2.3.1. Progress

- Complete migration to event based architecture
- Separate text-based game completely from core logic
- Add automated black-box testing
- Fix various edge cases (eg: shooting to room not adjacent to current room)
- Install pygame to nix shell

2.3.2. Future tasks

- Create graphical package

2.4. 20/05/2025

git commit hash 6a933ba5beb2a14ae5db1195709b73e29b06c576

2.4.1. Progress

- Created graphical package
 - Has a stack of scenes (Main Menu, Level Select, How to Play, Playing, Paused)
 - Modal scenes can be pushed onto stack and pop'ed to preserve game state
- Used force directed graph drawing to draw level onto scene
 - However, force directed graph drawing prefers to have all edges same length
 - So level map converges onto a perspective-like map with crossings, rather than a flattened map

2.4.2. Future tasks

- I've decided against continuing with a flat 2D approach, rather using perspective projection of the actual polyhedral graph
- Hunt the Wumpus uses a dodechedral graph, so similar levels modelled after Platonic solids can be made

2.5. 20/07/2025

git commit hash 106c2d65c672cbe5ac7d59964eb6f37db517d4f2

2.5.1. Progress

- Playable graphical version
 - Uses Renderer class to draw level, Caves and Player are Drawable instances that get sorted by depth
 - Arbitrary dimension perspective projection allows for 3D and 4D levels (or potentially higher in the future)
 - Created 4 levels (3 3D levels and 1 4D)
 - Animations when moving player or shooting to rotate view – so the player doesn't constantly have to reposition the camera
 - Spinning level graphics on main menu
 - Death counter and screen tint to indicate player death
 - I do this since this game will take a few deaths to complete due to randomness
 - Deaths are a level statistic that players can try to optimise as a *high score*

2.5.2. Future tasks

- Scene transitions
- How to play
- Credits menu
- Win screen (with high score)
- Level 5
- Level unlocking
- Sound effects

2.6. 31/07/2025

git commit hash 0d256ab3988070b43b3bfdcdfaa36fc65c97d851

2.6.1. Progress

- How to play
- Win screen
- Level 5 completed
- Level unlocking

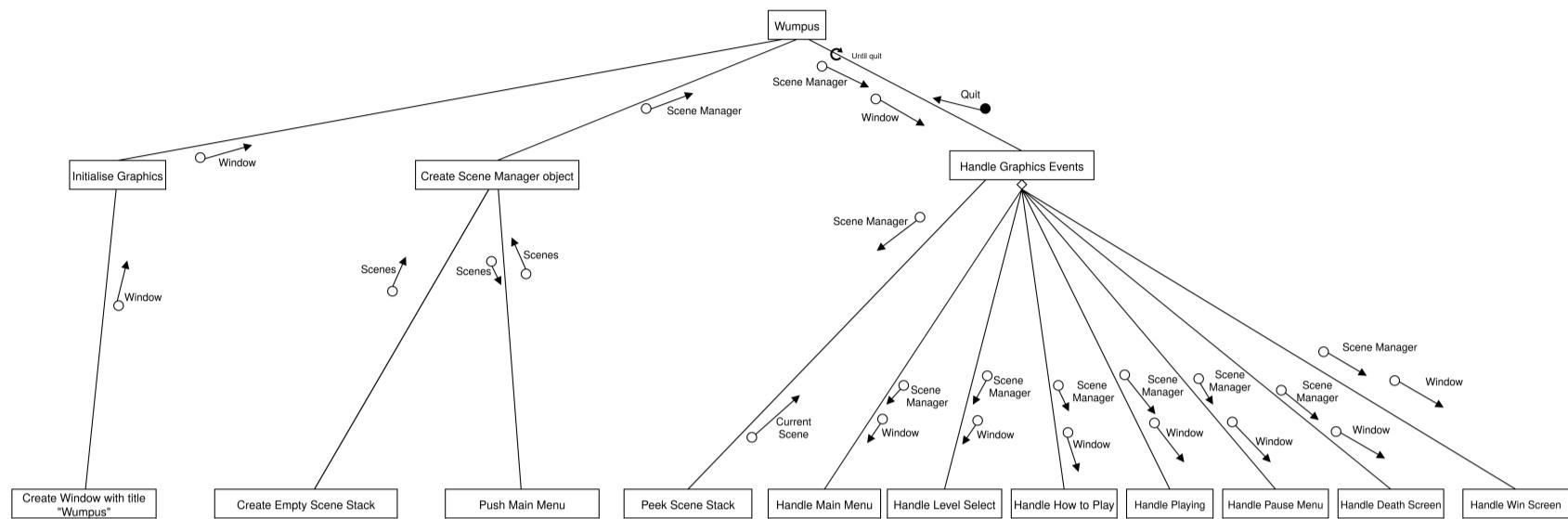
Due to time limitations I did not get to:

- Sound effects
- Credits menu (but I will include these in the folio)

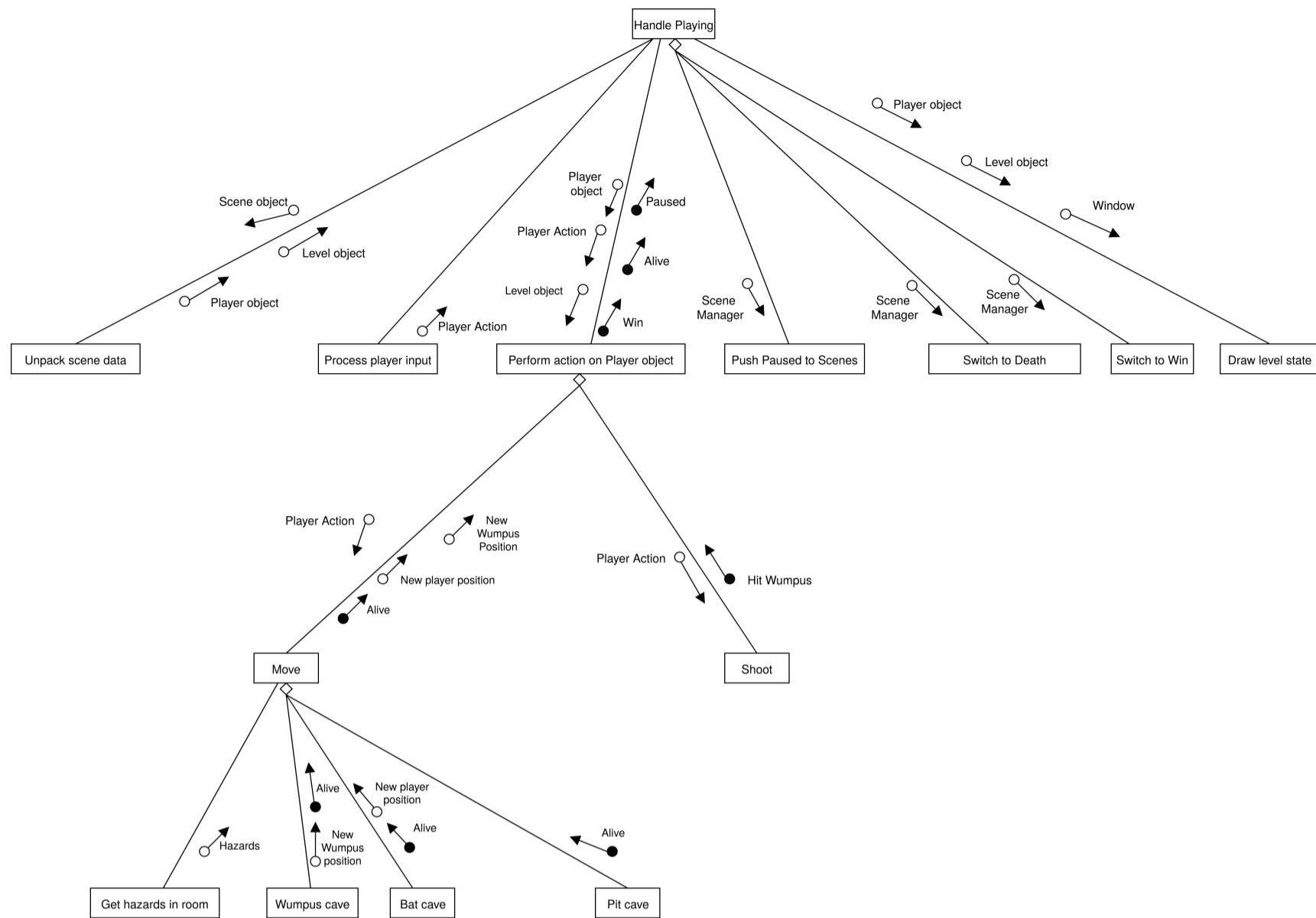
3. System Modelling

3.1. Structure Charts

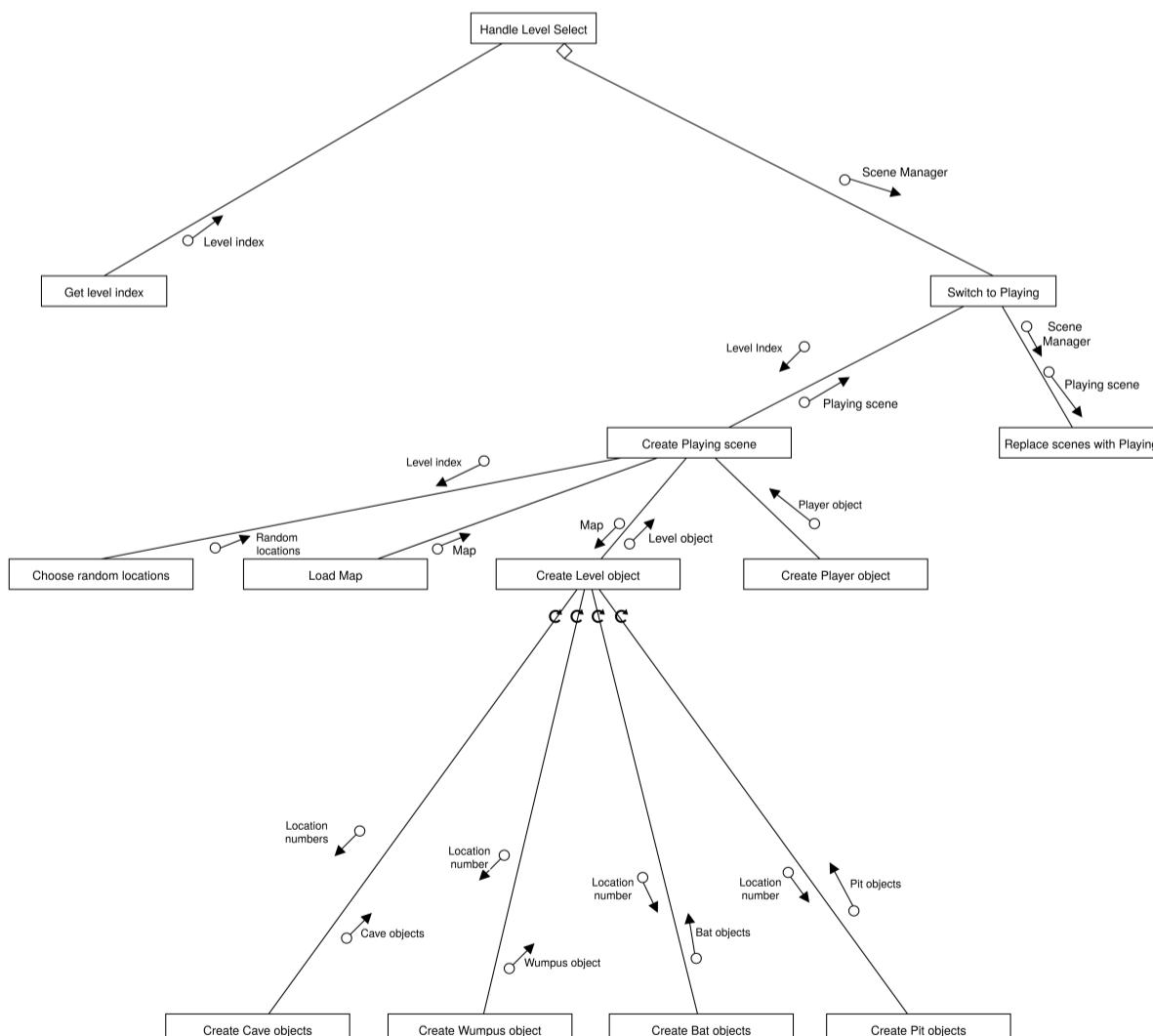
3.1.1. Wumpus



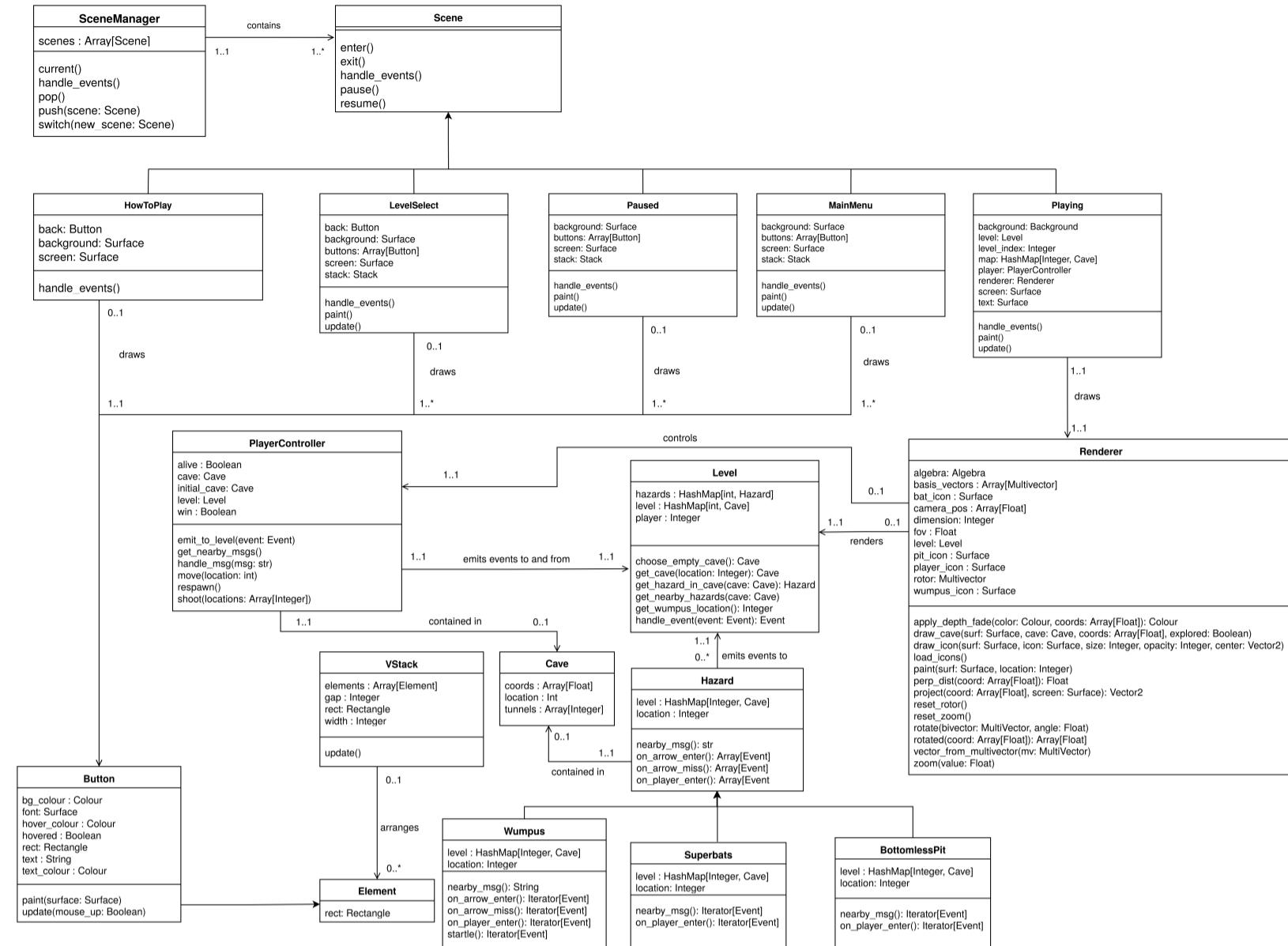
3.1.2. Handle Playing



3.1.3. Handle Level Select



3.2. Class Diagram



4. Data Dictionary

4.1. Internal representation

| Data Structure (type) | Attributes | Data type | Max length | Description |
|---------------------------|--------------|--------------|------------|---|
| PlayerController (object) | alive | Boolean | 1 | Whether the player is alive |
| | cave | Cave object | EOF | Current cave the player is in |
| | initial_cave | Cave object | EOF | Cave where the player first spawned in (used for respawn) |
| | level | Level object | EOF | Level object containing caves and hazards |
| | win | Boolean | 1 | Whether the player has won |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|-----------------------|------------|--|------------|---|
| Level (object) | hazards | Array of hazard objects | EOF | The hazard objects in the level |
| | level | HashMap of Integer to the Cave objects | EOF | Maps cave location number to cave objects |
| | player | Integer | 3 | Cave location number of the player |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|-----------------------|------------|-------------------|------------|--|
| Cave (object) | location | Integer | 3 | This cave's location number |
| | tunnels | Array of integers | EOF | Array of cave location numbers this cave connects to |
| | coords | Array of reals | EOF | 3D coordinates of cave |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|-----------------------------------|-------------------|---|
| Hazard (object) | level | Hashmap of Integer to Cave object | EOF | Maps cave location number to cave objects |
| | location | Integer | 3 | Hazard's location number |

4.2. Graphical

| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|------------------------|-------------------|--|
| SceneManager (object) | scenes | Array of Scene objects | EOF | A stack where the top scene is the one that is shown |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|-------------------------|-------------------|----------------------------------|
| MainMenu (Scene) | buttons | Array of Button objects | EOF | Buttons that are shown on screen |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|------------------|-------------------|--------------------------|
| HowToPlay (Scene) | back | Button object | EOF | Button to close the menu |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|-------------------------|-------------------|-------------------------------|
| LevelSelect (Scene) | buttons | Array of Button objects | EOF | Buttons to enter each menu |
| | back | Button object | EOF | Button to return to main menu |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|-------------------------|-------------------|---|
| Playing (Scene) | level | Level object | EOF | Level object containing caves and hazards (see above) |
| | player | PlayerController object | EOF | PlayerController to control actions of player (see above) |

| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|-------------------------|-------------------|----------------------------------|
| DeathMenu (Scene) | buttons | Array of Button objects | EOF | Buttons that are shown on screen |

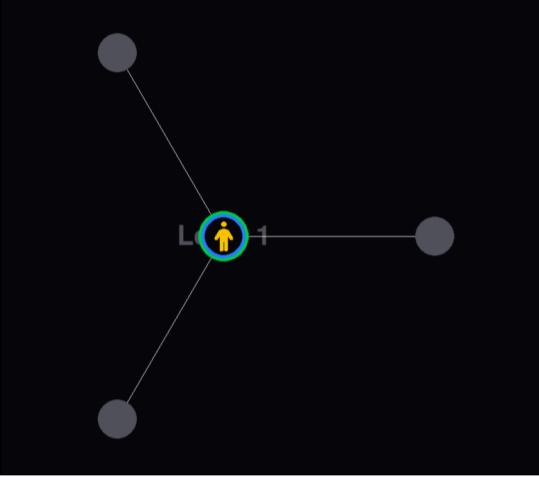
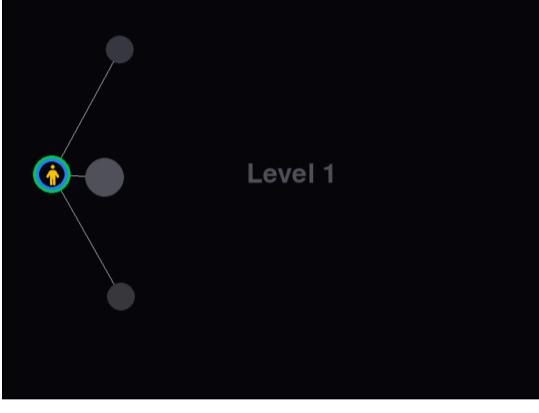
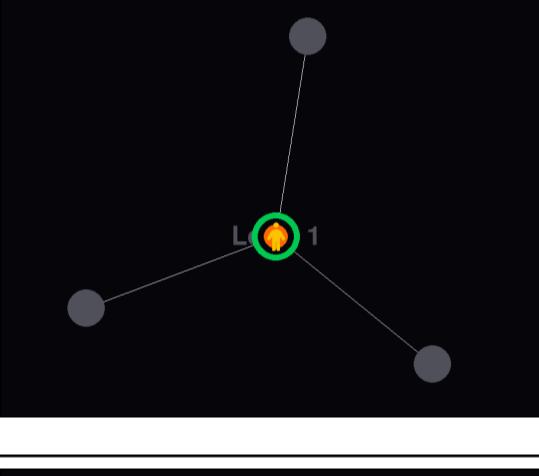
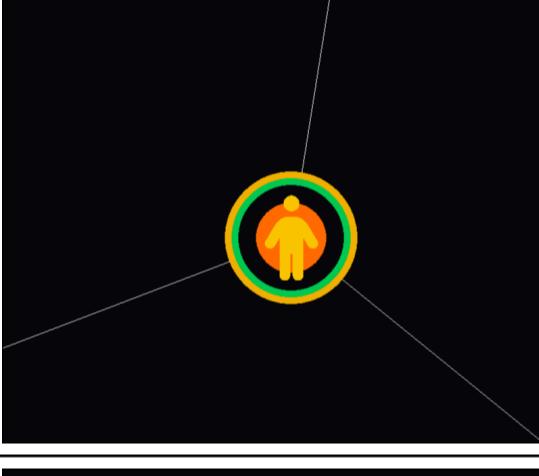
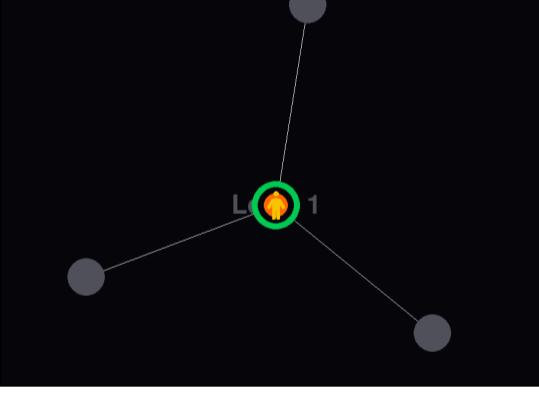
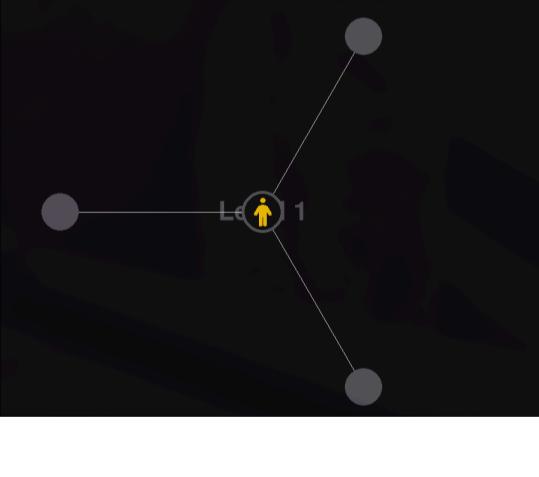
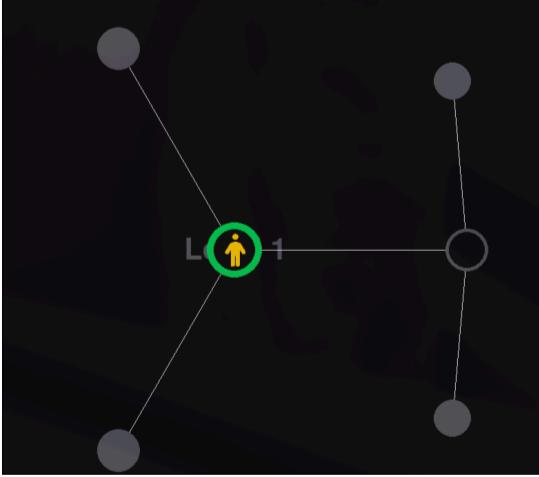
| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|-------------------------|-------------------|----------------------------------|
| WinMenu (Scene) | buttons | Array of Button objects | EOF | Buttons that are shown on screen |

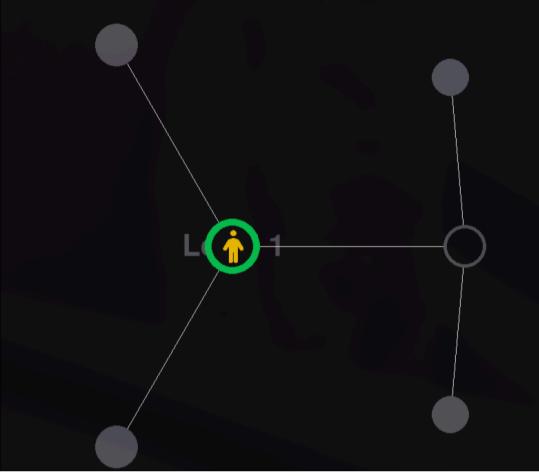
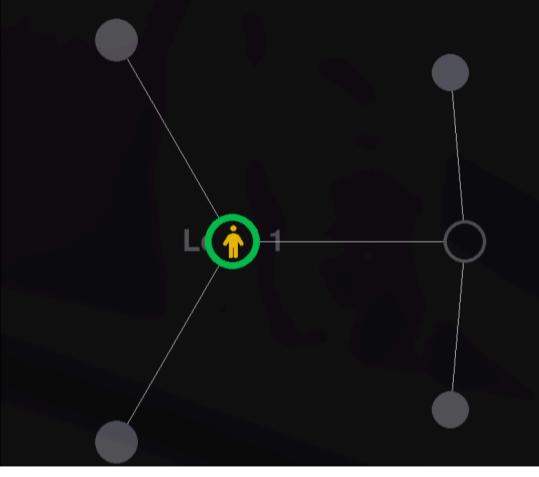
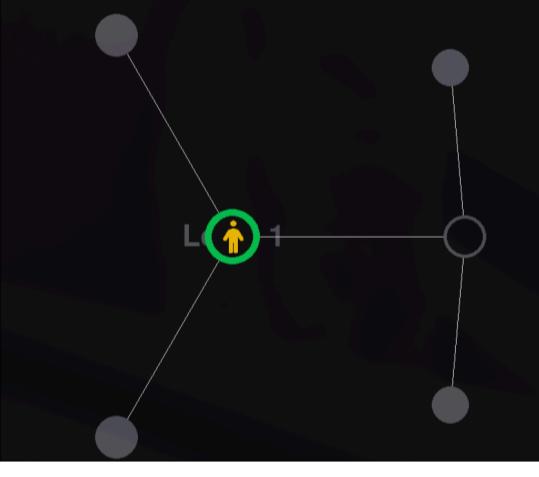
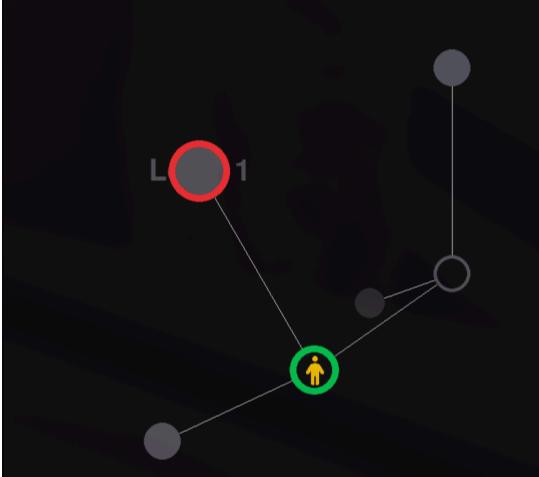
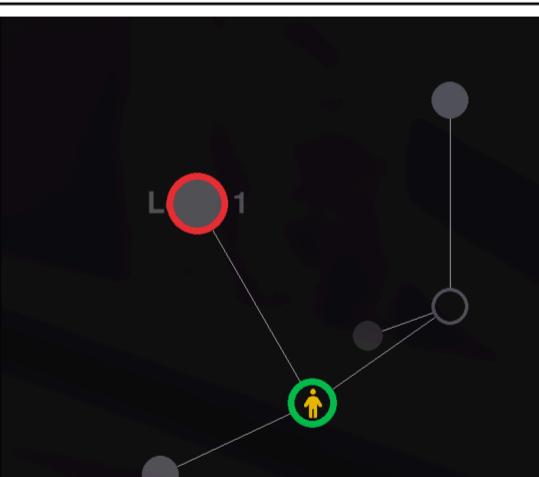
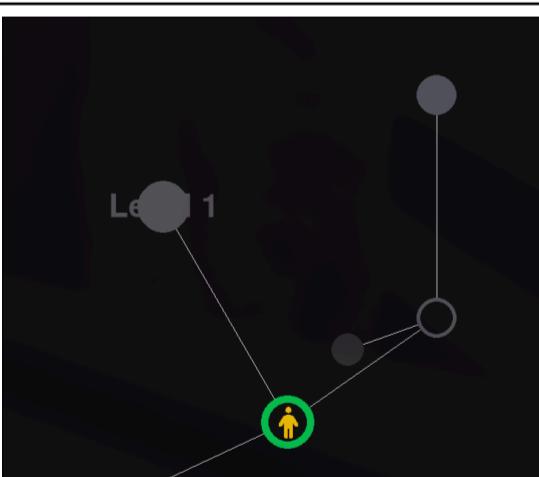
| Data Structure (type) | Attributes | Data type | Max length | Description |
|------------------------------|-------------------|------------------|-------------------|--|
| Button (Scene) | bg_colour | RGB colour | 6 | Background colour of button |
| | font | Font file | EOF | Font file to text |
| | hover_colour | RGB colour | 6 | Background colour of button when hovered |
| | hovered | Boolean | 1 | Whether the button is currently hovered |

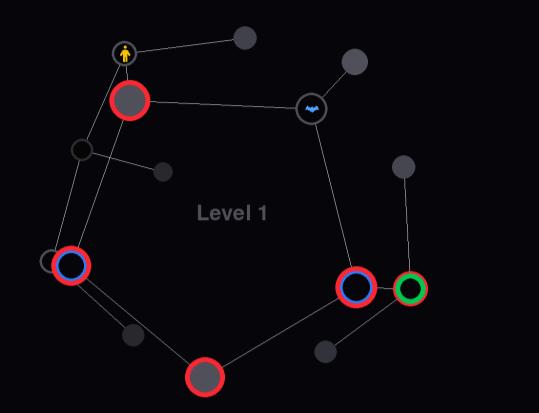
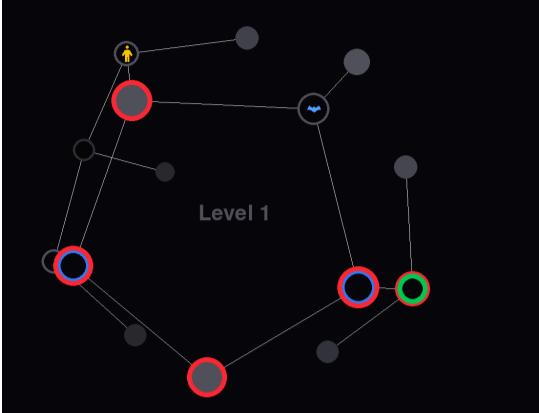
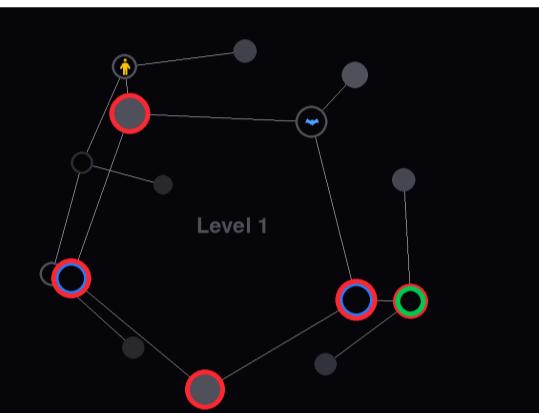
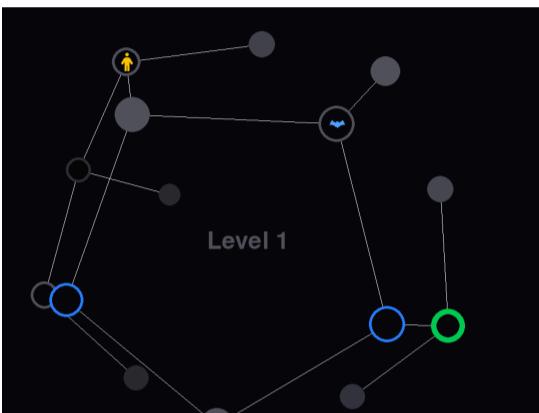
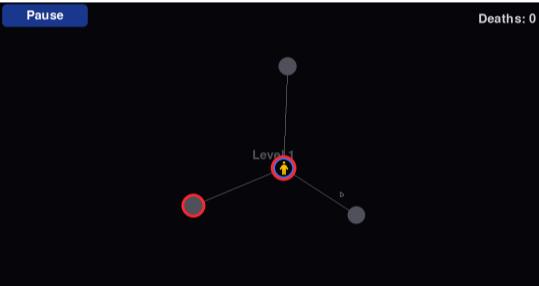
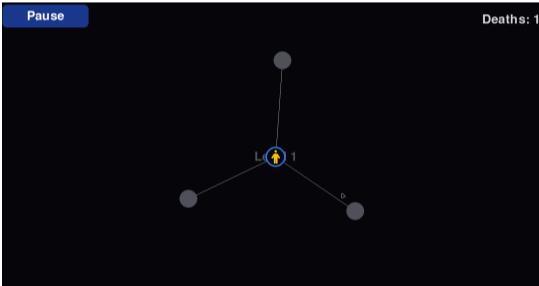
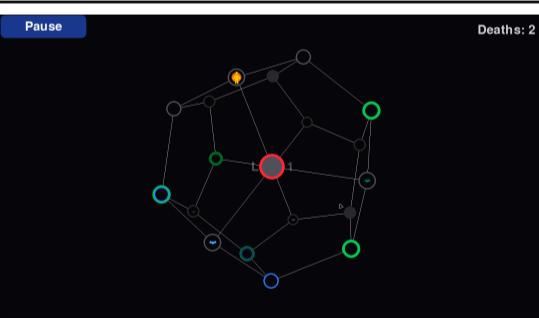
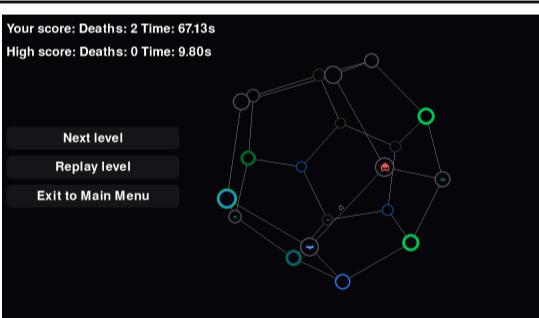
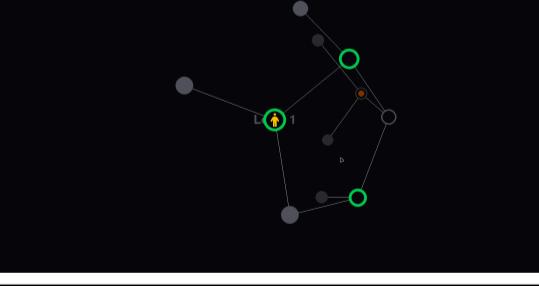
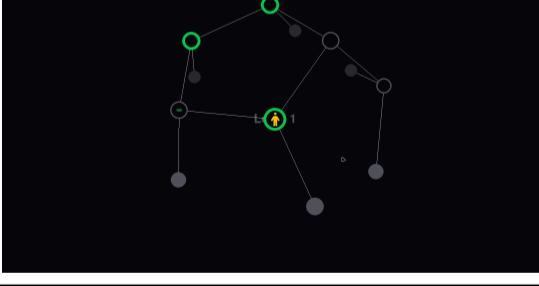
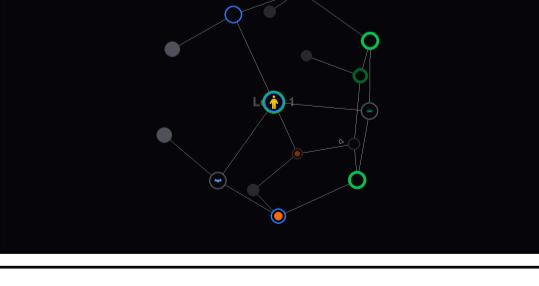
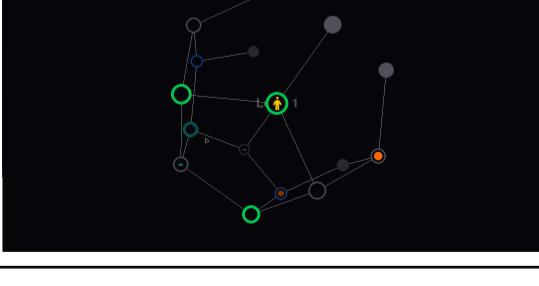
| | | | | |
|--|-------------|-------------------|-----|--|
| | rect | Array of integers | 4 | Top, left, width, height coordinates of button |
| | text | String | 100 | Label to show on the button |
| | text_colour | RGB colour | 6 | Colour to draw the text |

5. Testing Strategies

5.1. Main Game

| Initial state | User Action | Expected Output | Reason |
|---|---------------------------------------|---|--|
|  | Click and drag |  | Test rotating view |
|  | Scroll down |  | Test zooming in |
|  | Scroll up |  | Test zooming out |
|  | Left-click on cave adjacent to player |  | Clicking on a cave should cause the player to move to it |

| Initial state | User Action | Expected Output | Reason |
|---|--|--|---|
|  | Left-click on cave not adjacent to player | <i>no change</i> | Player can only move to an adjacent cave |
|  | Right-click on cave not adjacent to player | <i>no change</i> | Arrows cannot skip caves |
|  | Right-click on a cave adjacent to player |  | Right-clicking specifies a shooting path (highlighted in red) |
|  | Right-click on a cave not adjacent to end of shooting path |  <i>Shooting path has been reset</i> | Arrows cannot skip caves |

| Initial state | User Action | Expected Output | Reason |
|---|---|---|---|
|  <i>Notice the shooting path contains exactly 5 caves</i> | Right click on any cave |  <i>no change</i> | Arrows can travel a maximum of 5 caves |
|  | Press the 'c' key |  | Pressing the 'c' key after selecting a shooting path will reset it. |
|  <i>Notice that the player's cave is highlighted as part of the shooting path</i> | Shoot cave player is in (by pressing enter) |  | Shooting oneself leads to death and immediate respawning |
|  | Shoot cave Wumpus is in |  | Shooting the Wumpus completes the level |
|  | Moving into cave with pit |  | Pit leads to death and immediate respawning |
|  | Moving into cave with bat |  | Bats teleport player to random cave |

6. Evaluation

6.1. Implementation of Object Oriented Programming concepts

6.1.1. Encapsulation

Encapsulation is the bundling of attributes with methods to hide internal details about an object that other modules are not concerned with. An example of this is the **Facade pattern**.

The core Wumpus game logic is separated from the graphical package, as the graphical code is not concerned with it. Thus, I use the Facade pattern in PlayerController to provide a simplified external interface to the game logic.

```
class PlayerController:
    """
    Responsibility:
        - Emit events to level like PlayerMoved
        - Handle events such as PlayerKilled
    """

    def __init__(self, level: Level):
        self.level = level

        self.cave = level.choose_empty_cave()
        self.initial_cave = self.cave
        self.alive = True
        self.win = False

        list(self.emit_to_level(PlayerMoved(self.cave.location)))

    def move(self, location: int):
        list(self.emit_to_level(PlayerMoved(location)))

    def shoot(self, locations: list[int]):
        for location in locations:
            if any(
                [
                    isinstance(event, ArrowHit)
                    for event in self.emit_to_level(ArrowShot(location))
                ]
            ):
                return

        self.emit_to_level(ArrowMissed())

    def emit_to_level(self, event: Event) -> Iterator[ArrowHit]:
        ... # omitted for brevity

    def handle_msg(self, msg: str):
        pass

    def get_nearby_msgs(self):
        ... # omitted for brevity

    def respawn(self):
        ... # omitted for brevity
```

This class is an example of the Facade pattern, as the internal details of the event system is hidden from the other modules which use this class. Instead, other modules call the PlayerController's methods to perform actions on the player. For example:

```
player.move(7)
if not player.alive:
    player.respawn()
```

6.1.2. Inheritance

Inheritance allows for a child class to reuse the methods and attributes of its parent class, while only overriding behaviour that differs. Inheritance is used as a mechanism for code reuse in the inheritance between TextPlayerController and PlayerController.

```
class TextPlayerController(PlayerController):
    def play(self) -> bool:
        """Play the game, returns whether the game was won or lost."""
        while self.alive and not self.win:
            self.get_action()
        return self.win

    def get_action(self):
        ... # text handling omitted for brevity
```

```
def handle_msg(self, msg: str):
    print(msg)
```

This class demonstrates reuse of the core game logic defined in `PlayerController`, while adding additional functionality allowing it to be controlled using text.

6.1.2.1. Polymorphism

Inheritance is also used to achieve dynamic polymorphism, allowing multiple classes to share a common interface to implement different behaviours. This can be seen in the `Hazard` class and its subclasses.

```
class Hazard:
    """
    Hazards are located in a cave, they can affect the player's location or
    cause the player to lose.
    """

    def __init__(self, level: dict[int, Cave]):
        self.location: int | None = None
        self.level = level

    def on_arrow_miss(self) -> Iterator[Event]:
        """Called when an arrow does not hit any hazards that are not immune."""
        yield from []

    def on_arrow_enter(self) -> Iterator[Event]:
        """
        Called when an arrow hits the cave this hazard is in.

        Returns: Whether the arrow has considered to 'hit' the hazard.
        Most hazards are immune by arrows, so they should return False.
        """
        yield from []

    def on_player_enter(self) -> Iterator[Event]:
        """Called when the player enters the cave this hazard is in."""
        yield from []

    def nearby_msg(self) -> str:
        """Returns a message to be printed when a hazard is nearby."""
        return "Unknown hazard nearby."

class BottomlessPit(Hazard):
    """
    Kills the player when it enters the cave.
    """

    def nearby_msg(self):
        return "I feel a draft."

    def on_player_enter(self):
        yield "You fell into a bottomless pit."
        yield PlayerKilled()
```

Here, the `Hazard` parent class defines a common interface for hazards to define their interactions. It contains blank implementations of hazard reactions to different events. Thus, as seen in `BottomlessPit`, child classes only need to override functionality that they actually implement, while still allowing all hazards to be controlled in a unified way. This is considered polymorphism (meaning “many forms”), as objects of different classes can be used in the same way, without being concerned with what specific subclass is in use.

6.1.3. Evaluation of implementation of OOP concepts

This project demonstrates a strong implementation of OOP concepts, effectively using classes and methods to reuse functionality.

6.2. Functionality

6.2.1. Features

This project provides a complete, playable game with 5 different levels. Each level provides a unique map with randomly spawned hazards which can be interacted with. The game features menus including:

- Main Menu
- Level Select
- How to Play
- Pause Menu
- Win Menu

This game has a progress mechanism where levels are “locked”, until the level before it has been completed. This allows for a gradual increase in difficulty as the player completes the game. Furthermore, this game has a high score mechanism, which keeps track of the number of times the player has died in the level and how long the player takes to complete.

Within a level, my game implements features close to the original Hunt the Wumpus game. It includes the three original hazards: Wumpus, Bottomless Pit, Super bats and similar movement and shooting mechanics to the original game. Added functionality includes the ability to rotate the 3D view and zoom in and out (further explained in Appendix B.).

6.2.2. Polish

Polish refers to features which improve the player experience with subtle tweaks and refinements. Some examples of polish in this game:

- Camera rotation animation when clicking on a cave
- Brief red tint on screen which fades out to give an indication of player death
- Animations follow a more realistic easing curve – animations don't abruptly start and stop rather they speed up and slow down similar to real world objects
- When the mouse cursor is "hovered" over a clickable button, it changes colour subtly to indicate that it is clickable
- Borders on buttons are slightly rounded
- Important buttons like the pause button, back button or the next unplayed level in level select are a different colour for visual contrast to draw attention to them
- The Main Menu features a rotating Wumpus cave in the background for visual interest
- Upon completing a level, the entire shape of the level is revealed in a slowly rotating view

6.2.3. Possible improvements

There are some small features that could further improve player experience, but have not been implemented due to time:

- Sound effects
- Fade transitions between screens
- A settings menu to reset progress
- Text on screen to supplement visual indication of hazards
- Further levels could introduce novel hazards
- Credits in an in-game menu (see Appendix C.)

There is also a visual inconsistency in the way tunnels are rendered. The lines that represent tunnels will always render behind all caves, however sometimes this is incorrect. This is rarely noticeable but fixing this could improve player experience.

6.2.4. Evaluation of functionality

This is a complete and functional game, with a high degree of polish and additional features. While it does lack some features that would be recommended for a public release of a game, it is certainly in a **playable state** with multiple levels and menus.

6.3. Originality

This project provides an original interpretation of the Hunt the Wumpus game while staying true to the original intentions of the game. The original game was text-based, containing a single level. Hunt the Wumpus was created due to the **creator's frustrations with the multitude of "hide and seek computer game[s]" based on square grids**. Yob's innovation was creating a hide and seek game where the caves were a **non-grid pattern**. However, **graphical versions of the game present their levels on a square grid**, usually by "**flattening**" the caves network by forcing them to fit on a square grid. **This ultimately limits the complexity of levels in these games to those that fit on a grid**.

This game provides a different interpretation, **preserving the non-grid pattern of the original game**. It does this through arbitrary dimension perspective projection and rotation (described in Appendix B.). What this means is the game rendering logic can draw levels of any dimension greater than or equal to 3. To effectively explore these levels, this game provides **zoom and rotate functionality**. **There are 3 3D levels and 2 2D levels included**. The mechanisms and intuition for understanding higher dimensions than 3 are provided in Appendix B., but they are not necessary to be able to play the levels. The purpose of these levels is to present a **further challenge to the player** that would not be common in other video games.

6.3.1. Levels

All levels have cave structures based on different mathematically interesting shapes.

Level 1 Dodecahedron (3D) *This level was also used in the original textual Hunt the Wumpus, but here it is playable in 3D.*

Level 2 Icoahedron (3D)

Level 3 Möbius strip (3D)

Level 4 Tesseract (4D)

Level 5 24-cell (4D)

6.3.2. Evaluation of originality

Wumpus: Network is a highly original interpretation of **Hunt the Wumpus**, providing unique features that are rare even for video games in general. It does this while preserving the experience of playing the original game, by keeping the same core mechanic of deducing where hazards are based on the current cave. While my game does not add new hazards or interactions compared to the original version, it instead explores how this could be extended in more complex and challenging levels, as well as a novel interface.

This project implements a feature set significantly different provided in the support resource. Even without the graphical implementation, **this project implements key features of the textual Hunt the Wumpus not present in the guided walkthrough**, such as the ability for the Wumpus to move between caves, and randomly spawned hazards.

6.4. Documentation

This project has both internal and intrinsic documentation within the codebase.

6.4.1. Intrinsic

Intrinsic documentation makes the code more understandable by using clear structure and naming within the structures of the code itself.

Examples:

```
@dataclass
class Cave:
    location: int
    tunnels: list[int]
    coords: tuple[float, ...]
```

The class, attributes and type annotations within this code make the purpose and structure of the code clear.

```
class Superbats(Hazard):
    def nearby_msg(self):
        return "Bats nearby."

    def on_player_enter(self):
        yield "ZAP -- Super bat snatch! Elsewhereville for you!"
        yield PlayerMoved(choice(list(self.level.values()))).location)
```

The class and method names in this code make it clear what each hazard does.

```
class PlayerController:
    def __init__(self, level: Level):
        self.level = level
        self.cave = level.choose_empty_cave()
        self.initial_cave = self.cave
        self.alive = True
        self.win = False
```

The names of the attributes in this class make the player's initial state clear. The `level.choose_empty_cave()` method has a descriptive name to help readers of the code understand its purpose.

6.4.2. Internal

The need for internal documentation is reduced through intrinsic documentation, however it is still important to describe the purpose of code, or to clarify complex procedures.

In Python, internal documentation takes the form of “docstrings” (special comments tied to a specific method, function, class or module) or inline comments.

Examples:

```
class PlayerController:
    """
    Responsibility:
    - Emit events to level like PlayerMoved
    - Handle events such as PlayerKilled
    """

    ...
```

This class-level docstring explains the overall responsibility of the `PlayerController` class, making its role in the system clear.

```
class Hazard:
    """
    Hazards are located in a cave, they can affect the player's location or
    cause the player to lose.
    """

    ...

    def on_player_enter(self) -> Iterator[Event]:
        """Called when the player enters the cave this hazard is in."""
        yield from []
```

Here, both the class and method docstrings describe the purpose and expected behavior, clarifying how hazards interact with the player.

```
def emit_to_level(self, event: Event) -> Iterator[ArrowHit]:
    # This method sends an event to the level and yields any ArrowHit events in response.
    ...
```

This inline comment explains a non-obvious implementation detail about how events are handled and what is yielded.

```
def on_arrow_enter(self) -> Iterator[Event]:
    """
    Called when an arrow hits the cave this hazard is in.

    Should yield an ArrowHit event if the arrow has considered to 'hit' the hazard.
    Most hazards are immune by arrows, so they should not yield this event.
    """

    yield from []
```

This method-level docstring provides additional context about the method's purpose and its expected return value, especially clarifying the default behavior for most hazards.

```
class BottomlessPit(Hazard):
    """Kills the player when it enters the cave."""
    ...

```

A concise class docstring here makes the effect of the `BottomlessPit` hazard immediately clear to readers.

```
"""
Events are used to decouple the Hazards from the Level.
Instead of directly invoking methods on Level, Hazards yield Events, which
are dispatched to Level. This also prevents circular type imports between Level
and Hazards.
"""

```

This module level docstring, makes it clear the overall purpose of this section of code before readers go into specific classes or methods.

6.5. Evaluation of documentation

This project is thoroughly documented with both internal and intrinsic documentation.

Appendix A. Code structure

The use of LLMs was allowed in this project.

```
wumpus/
├── graphical/      # Graphical user interface: scenes, icons, GUI utilities
├── level_gen/     # Level generation logic and algorithms for different map types
├── text/          # Text-based interface and logic for terminal gameplay
└── wumpus/        # Core game logic: cave structure, events, hazards, player, levels

```

A.1. Commands

1.1.1. Running Unit Tests

```
python -m unittest

```

1.1.2. Playing graphical

```
python -m graphical

```

1.1.3. Playing text

```
python -m text

```

1.1.4. Exporting folio to pdf

```
cd folio
typst compile main.typ

```

Appendix B. Arbitrary Dimension Perspective Projection and Rotation

Appendix C. Credits

C.1. Graphics

- Wumpus icon – Hunt the Wumpus box art
- Bat by Gabriele Malaspina from “<https://thenounproject.com/browse/icons/term/bat/>” (CC BY 3.0)
- Icons – Font Awesome

C.2. Libraries

- Graphics – pygame
- Vector – numpy
- Geometric Algebra – kingdon