Laboratory assignment

Component 5 & 6

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1 Conceptual Modelling

1.1 PAGES Model

Component	Description
P – Perception	*Player Agent*: – Ray-casting vision (obstacles, enemies, teammates) and the rays distances. *Moderator Agent*: – All agents' ray-casting information, positions, status (alive, death).
A – Actions	*Player Agent*: – Move forward – Rotate (left/right) – Shoot – Idle *Moderator Agent*: – Update blackboard – Idle (no real effect on environment)
G – Goals	*Player Agent*: – Win as a team (last team standing) – Eliminate enemies – Maximize cumulative reward (for RL agents) – Minimize received damage *Moderator*: – Message players from time to time about enemies.
E – Environment	– 2D grid with obstacles and open areas
S – State of Environment	– Static configuration of the map – Agent positions, directions, health – Projectiles in motion – Game status (ongoing/ended)

1.2 PEAS Description

Component	Description
P – Performance Measure	– Team survival – Enemy elimination – Action efficiency – Reward maximization
E – Environment	– Grid-based map – Obstacle and enemy dynamics – Discrete time evolution
A – Actuators	– Movement engine – Rotation control – Shooting mechanism – Blackboard interface
S – Sensors	– Ray-casting system – Blackboard reader – Health, position, direction state

1.3 Environment Properties

Property	Type	Explanation
Accessibility	Inaccessible	Partial vision through ray-casting only
Determinism	Non-Deterministic	Actions may have un-predictable effects
Episodic vs Sequential	Sequential	Current action influences future state
Static vs Dynamic	Dynamic	Other agents affect the state concurrently
Discrete vs Continuous	Continous	The position of the agent and some actions' details are floating numbers
Single vs Multiagent	Multiagent	Teams cooperate; opponents compete
Markovian	Assumed Markovian	The current state determines the next one

2 Design of the MAS

2.1 Agents' Role

- **Shooting Agents (Dummy, Heuristic, Learning)**
  - **Role:** Autonomous team-based combat agents.
  - **Goal:** Eliminate enemy agents and maximize survival.
  - **Perception:** Partial observation via ray-casting.
  - **Actions:** Move forward, rotate, shoot, idle.
  - **Types:**
    - *Dummy*: Takes random actions (purely reactive).
    - *Heuristic*: Uses rules to react to known patterns.
    - *Learning*: Uses reinforcement learning to improve performance.

- **Collaboration:** Reads teammate information from blackboard.

- **Moderator Agent**
  - **Role:** Non-acting agent providing indirect team communication.
  - **Functionality:**
    * Scans global state.
    * Writes helpful messages to the blackboard (e.g., enemy sightings).
  - Does **not** interact with the world directly.

2.2 Agents' Architecture

Agent Type	Architecture	Explanation
Dummy	Reactive	No memory or planning, reacts immediately and randomly.
Heuristic	Reactive	Rule-based decisions with simple conditional logic.
Learning	Hybrid	Uses internal state, learning, and planning (consequence to learning) for future steps.
Moderator	Reactive	Derives communication logic from global state, no direct actions.

2.3 Communication and Interaction Model

- **Communication Type:** Indirect via a *Blackboard System*.
- **Architecture:** Centralized communication, distributed control.
- **Access Model:**
  - Moderator: `write-only`
  - Shooting Agents: `read-only`
- **Use Case:**
  - Moderator sees that a Player Agent sees an Enemy and writes (or not, randomly) to each of its teammate that there's an enemy at a certain direction relative to the each teammate that should receive the message.
  - Teammates read and adjust behavior accordingly.
- **Coordination:**
  - **Intra-team:** Cooperative (blackboard usage).
  - **Inter-team:** Competitive (eliminate other teams).

2.4 Class Diagram

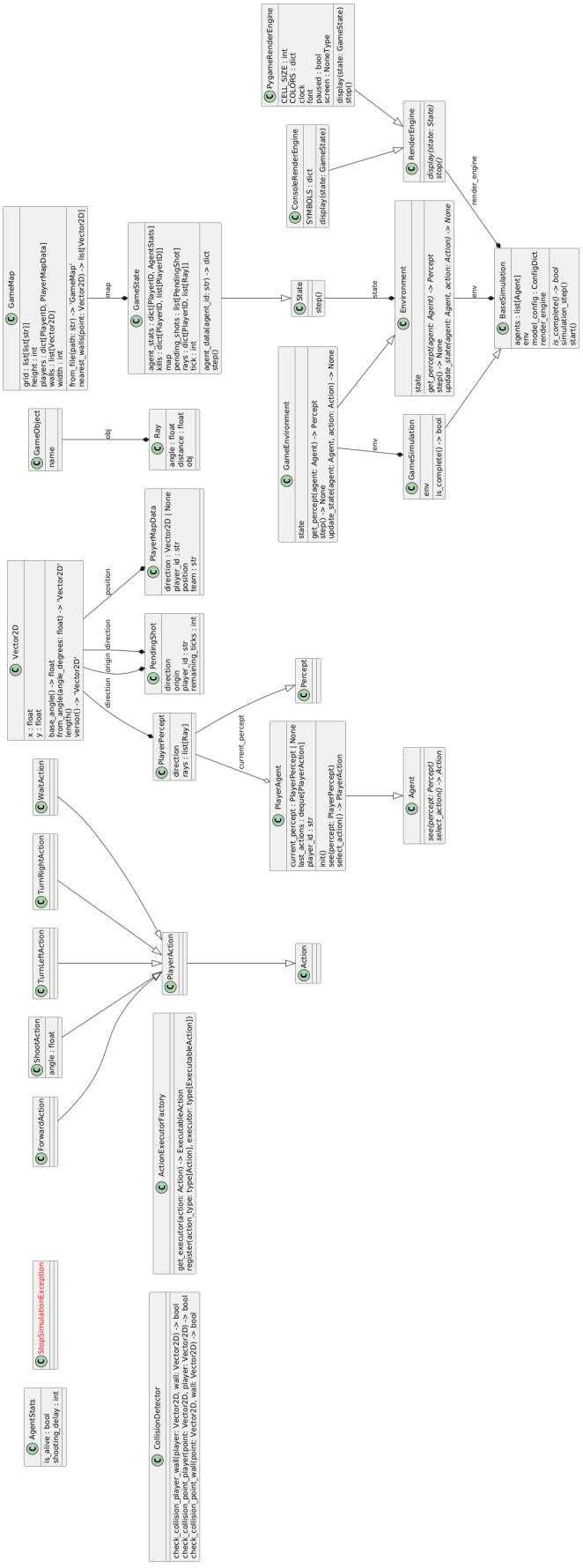

Figure 1: Class Diagram (1)

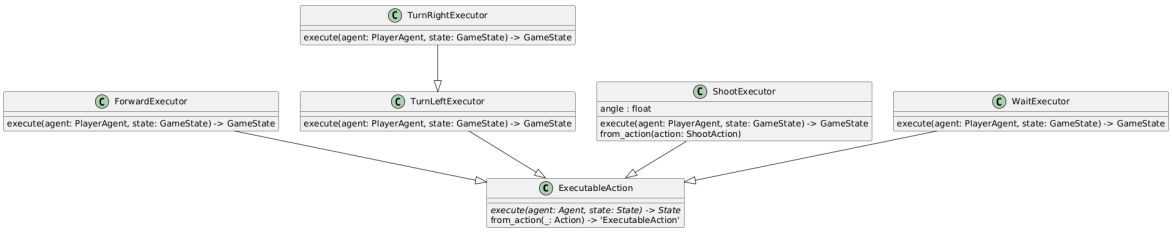

Figure 2: Class Diagram (2)