

# PAC-MAN

Luis Moura

83808

Maria Lavoura

84681

Pedro Teixeira

84715

# Our Goals

Develop an Agent for Pac-Man that would:

Achieve a good score in the ranking

Be a real competitor in a more realist situation

Play with equal success any new level presented to it

Consider level completion speed

Consider survivability and strategy skills to outwit ghosts attempts of entrapment



# How we achieved our Goal

## Our Strategy Planners

The programming approach was to create a decision-making process in *layers*:

### Topographer

- Makes a topography analysis of the game map.
- Computes the information once for each game:
  - Pathways
    - Corridors
    - Crossroads
    - Corridor Adjacencies
  - Ghosts Den



### Strategy Advisor

- Before each Pac-Man's move, creates a picture of the game situation.
- Provides valuable information to future strategy plan:
  - Pac-Man Info
    - Crossroads
    - Accessible Crossroads
    - Crossroad Semaphores
    - Ghosts in pursuit at each corridor end
    - ...
  - Ghosts Info
    - Distance to Pac-Man
    - Path to Pac-Man
    - ...



### Strategy Analyst

- According to Advisor information.
- Chooses the best game plan and which Execution Agents to call and validates their advised move.



# Topographer & Strategy Advisor

## What is analyzed

### Ghosts Den

- Dynamically calculated.

### Pathways

- All non-wall coordinates.

### Corridors

- A list of adjacent pathways coordinates and two crossroads as ends.
- Can be:
  - **SAFE** – Has no ghosts;
  - **UNSAFE** – Has 1 or more ghosts.

### Corridor Adjacencies

- Pairs of adjacent corridors.

### Crossroads

- A coordinate that joins corridors.
- Belongs to all corridors it joins.
- A crossroad directly accessible to Pac-Man (the ends of its corridor) is classified with a semaphore like system:
  - **GREEN** – No ghosts in proximity;
  - **YELLOW** – There are ghosts at a dangerous distance of the crossroad. Pac-Man can escape if he goes directly through that crossroad;
  - **RED** – Considering that the ghosts are in pursuit of Pac-Man, it is impossible for Pac-Man to escape from that crossroad before a ghost gets to it (or a ghost is already inside Pac-Man's Corridor).



# Strategy Analyst | Execution Agents

## How they change Pac-Man behavior

### **Pursuit**

Focus on eating ghosts

Pac-Man is safe and there are zombie ghosts

### **Counter**

Focus on eating boosts

Pac-Man is almost surrounded

### **Eating**

Focus on eating energies

Pac-Man is safe

### **Flight**

Focus on finding alternative paths

Pac-Man is almost surrounded

### **Panic**

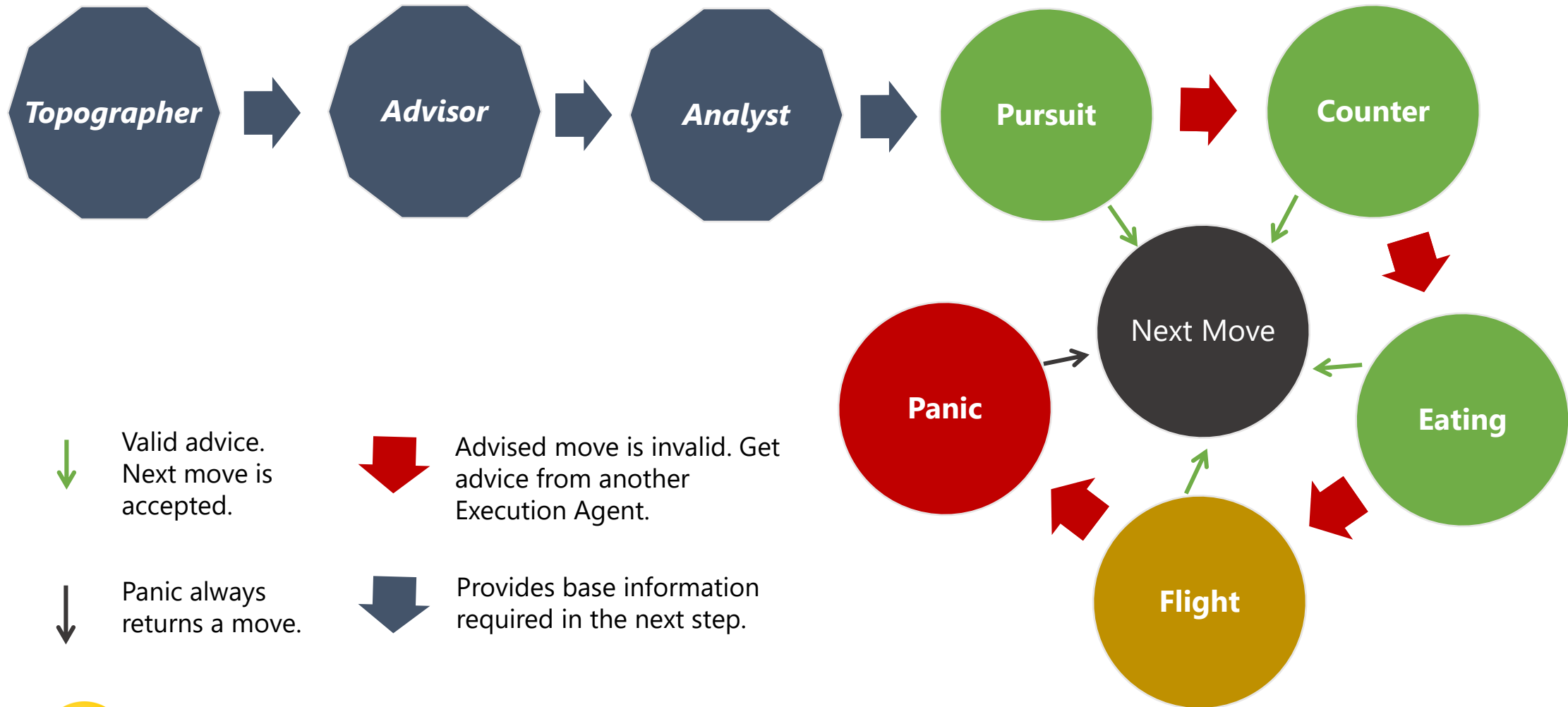
Focus on finding the closest safest corridor/position

No other mode was possible



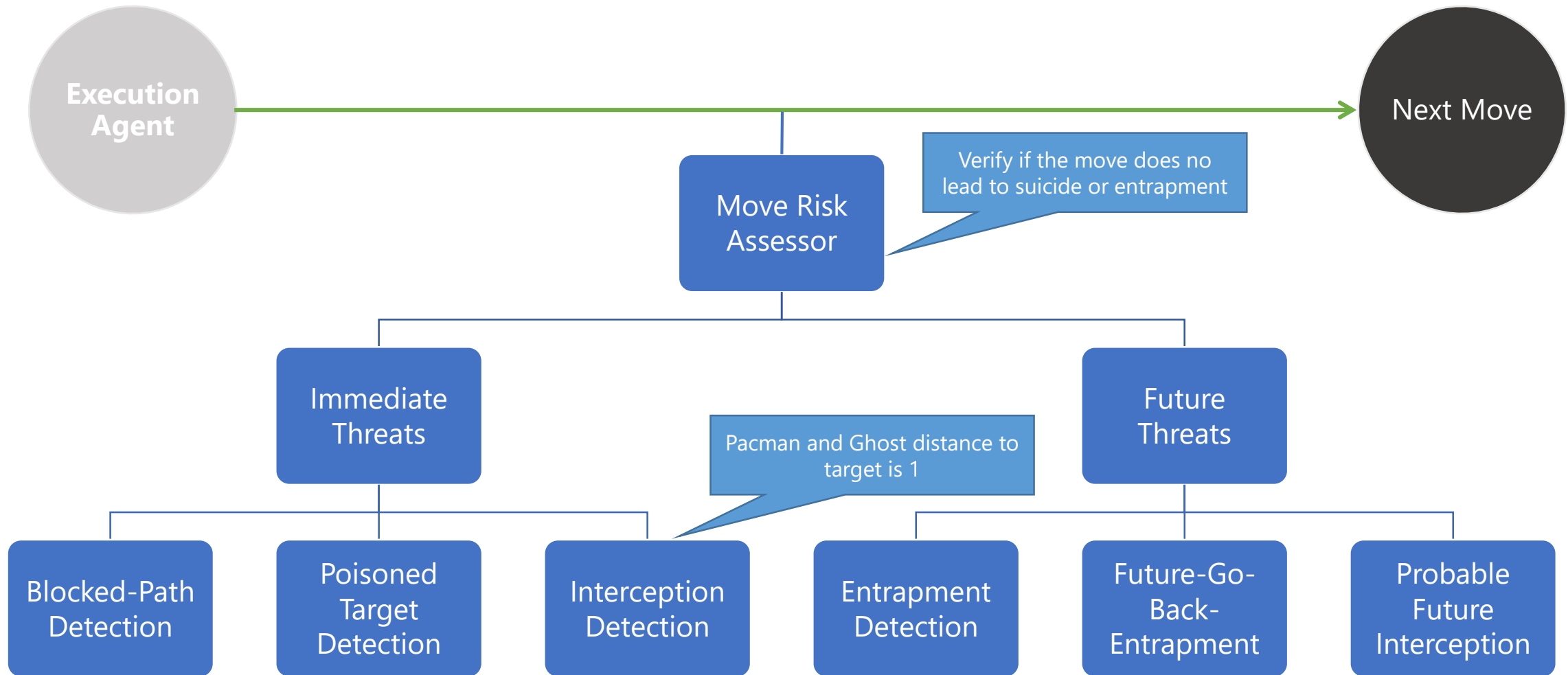
# Strategy Analyst | Execution Agents

## How the next move is computed



# Strategy Analyst | Execution Agents

## How the next move is validated



# Strategy Analyst | Execution Agents

## How Search Tree is used

### Type 1 Search

- Used by Strategy Advisor and some execution agents (Eating, Counter, Pursuit);
- Uses A\* algorithm with Manhattan Distance as heuristic;
- Search based on corridors (ie. Search Nodes are corridors);
- Returns the shortest path to the target.

### Type 2 Search

- Used by Flight execution agent;
- Uses A\* algorithm with Manhattan Distance as heuristic;
- Search based on corridors (ie. Search Nodes are corridors);
- Allows avoiding given coordinates;
- Returns  $n$  possible paths to the target.

### Type 3 Search

- Used by Panic execution agent;
- Uses a custom algorithm;
- Search based only on safety criteria of the immediately adjacent corridors;
- Returns next coordinate





# Game Constants

Game Constants are changeable and were tested

- 4 game constants can be changed
- Default values were decided by choosing the best average of a list of averages of 10 simulations each for the situations of Evaluation 2 -> combination of the 3 game constants.

Safe Distance to Crossroad

Minimum escape margin if Pac-Man is racing towards a crossroad against a ghost

Safe Distance to a Ghost

Distance (number of steps) at which a ghost probably isn't in pursuit of Pac-man

Pacman -> Ghost Pursuit Multiplier

Value from 0 to 1.

- 0 -> Pac-Man does not pursue the ghost
- 1 -> Pac-Man pursues any ghost in maximum range until the timeout of the ghost

Number of offensive ghosts

Number of ghosts at unsafe distance to prefer offensive strategy (counter first)



# Results

## Our Goals vs what was achieved

Achieve a good score in the ranking

With 4 ghosts averaged (with various configurations and maps) about

- 1200 points in level 2 (high score was 1482)
- 1100 points in level 3

Be a real competitor in a more realist situation

Survivability rate of 94% with 4 ghosts at level 2 and 90% with 4 ghosts at level 3

Play with equal success any new level presented to it

Averaged similar scores in both maps with the same conditions



# Work Percentages

Based on the amount of work and the contribution to the creation of the architecture of the solution, we agreed the following percentages of work per member:

- Luis Moura 40%
- Maria Lavoura 30%
- Pedro Teixeira 30%

