AI in videogames

Videogames Technology
Asignatura transversal

Departamento de Automática

Universidad de Alcalá

Objectives

- Introduce the role of AI in videogames
- Describe the main AI methods used in videogames

Bibliography

Desarrollo de Videojuegos. Desarrollo de componentes. Capítulo 1. UCLM.

Table of Contents

Introduction (I)

What is AI?

AI is about making computers able to perform the thinking tasks that humans and animals are capable of.

I. Millington, "AI for games"

Human skill	AI field
Motion control	Robotics
Image reconition	Computer vision
Speech understanding	Natural Language Processing
Reasoning	Automatic reasoning
Plan	Planning & Scheduling
Learn	Machine Learning
Drive vehicles	Control
Play chess	Search

Introduction (II)

AI is a key component: Emotional stimulus

- AI provides a challenge
- Hard enough to be a challenge ...
- ... easy enough to avoid frustration

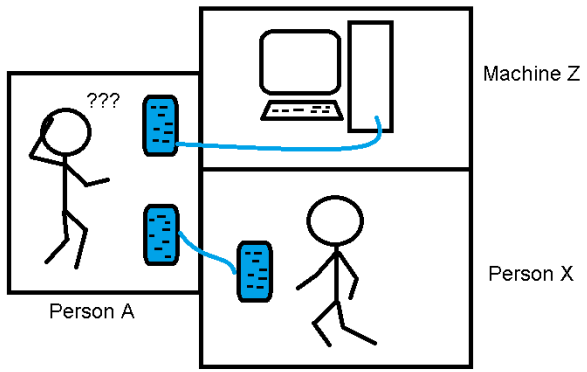
AI in videogames aims to give fun

- Classical AI seeks optimal solutions
- AI in videogames optimizes fun: Realistic behavior

Basic concepts

Turing test

Turing test: Is a person able to distinguish between another person and an AI?



Turing test in videogames

- Does an AI play like a human? Chess games, shooters, etc
- Does an AI design levels like a human?
- Does an AI design art like an human?

Better AI with more computational resources

- Computational resources are limited!

Basic concepts

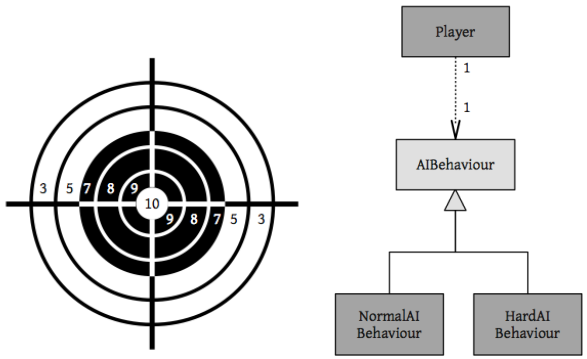
Intelligence illusion

Balance between intelligence and computational resources

- Intelligence, in videogames, is subjective
- AI in videogames seeks intelligence illusion

Many naïve (yet very useful) techniques

- Damage vs. impact point
- Modify NPC state: More life, stamina or speed



Basic concepts

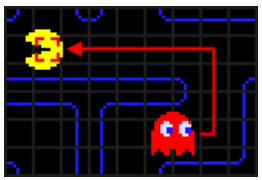
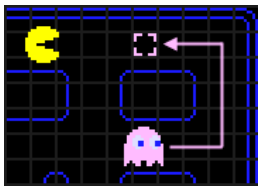
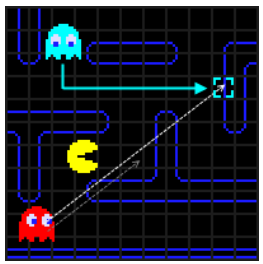
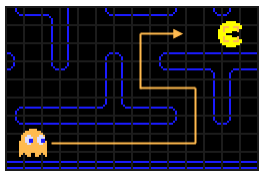
Complexity fallacy

Complex behaviors are better?

- Good AI matches the right behavior to the right algorithm
- KISS: Keep It Simple, Stupid!

Study case: Ghost behaviour in Pac-Mac

- Ghosts with two states: normal and frightened (FSM)
- In normal state ghosts move in a straight line
- When finds a junction semi-randomly chooses a route
  - Blinky (red): Follows Pac-Man (no path-planning)
  - Pinky (pink): Goes to four tiles ahead Pac-Man
  - Inky (blue): Takes Pac-Man and Blinky's positions
  - Clyde (orange): Random

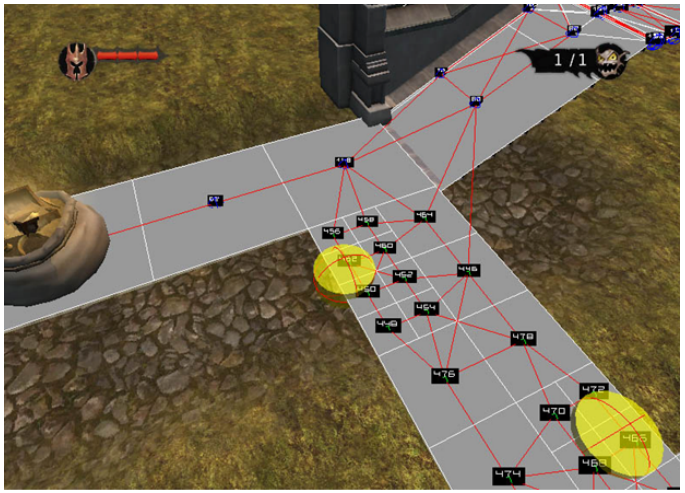





AI in videogames

Main AI applications

Main applications

- NPC control
- Path-planning (Demo)
- Search and planning



AI in videogames

Advanced AI applications

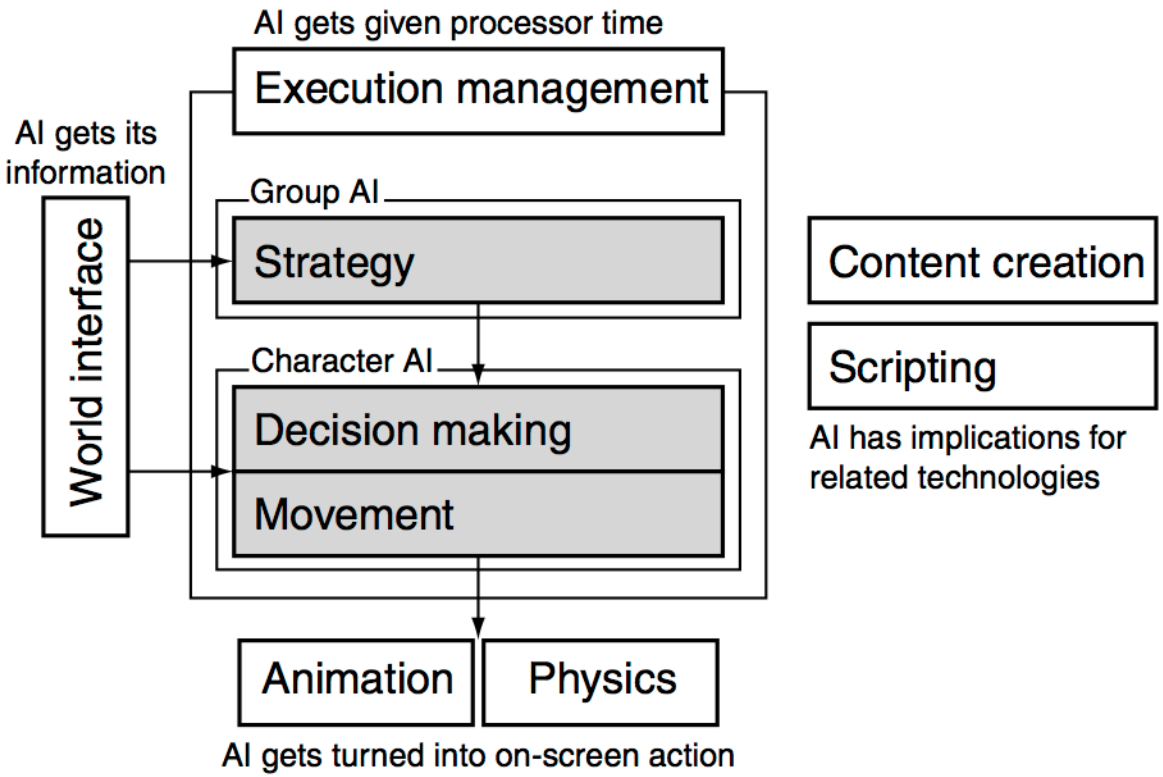
Advanced applications:

- NPC behavior learning
- Player modeling
- Games as AI benchmarks
- Procedural-content generation
- Computational narrative
- Believable agents
- AI-assisted game design

Model of AI

Overview

- Movement
- Decision making
- Strategy
- Infrastructure



Model of AI

Details

- **Movement**: Algorithms that turn decisions into motion
  - How to move from point A to point B?: Path-planning algorithms
- **Decision making**: What to do next?
  - Each NPC has a range of actions: Attacking, hiding, exploring, patroling, ...
  - Select the action
  - Implementation done with movement and animations
- **Strategy**: Team coordination
  - Group decision making ...
  - ... even though each individual makes its own decision
- **Infrastructure**: Support features
  - Perception, interfaces to animation and physics engine, etc
  - Resources management

Basic AI techniques in videogames

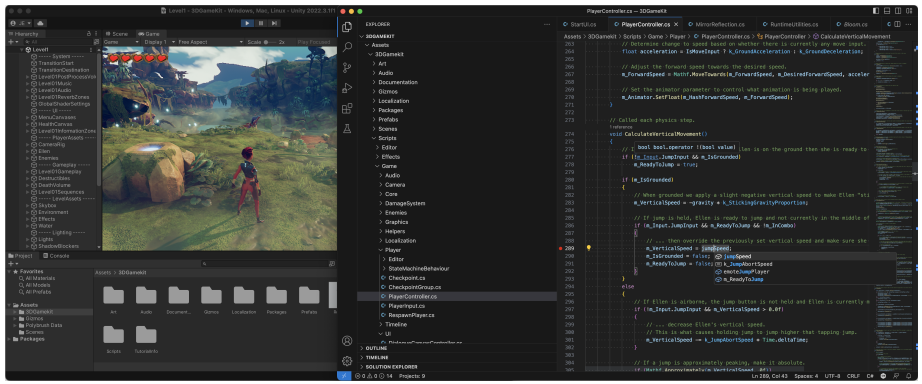
Overview

Basic techniques

- Heuristics (implemented as scripts in videogames)
- Behavior tree
- Classic search algorithms
- Finite State Machines

Advanced techniques

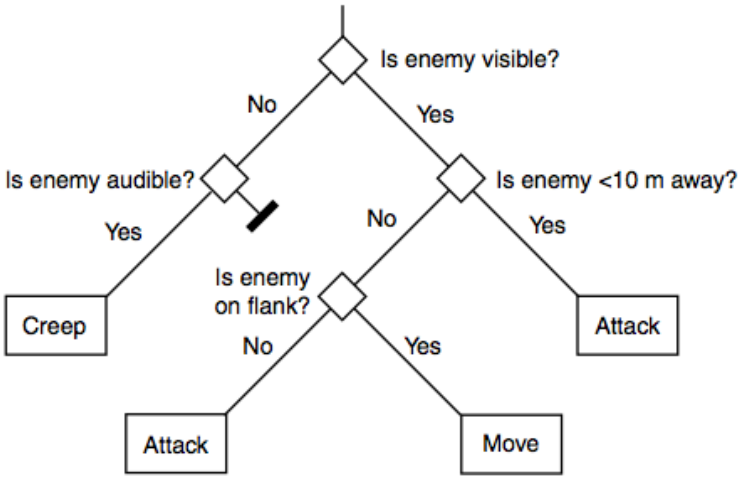
- Agents
- Fuzzy logic
- Artificial Neural Networks
- Genetic Algorithms

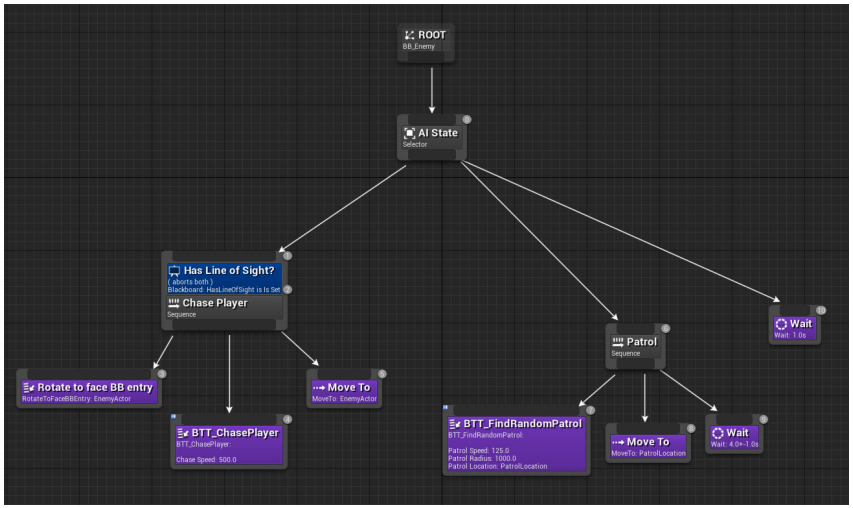


(Source)

Basic AI techniques in videogames

Behavior trees





AI techniques in videogames

Search algorithms (I)

Almost any problem in AI is a search problem

- Search the best path (i.e., **path-planning**)
- Search the best attack
- Search the best strategy
- Search the best move

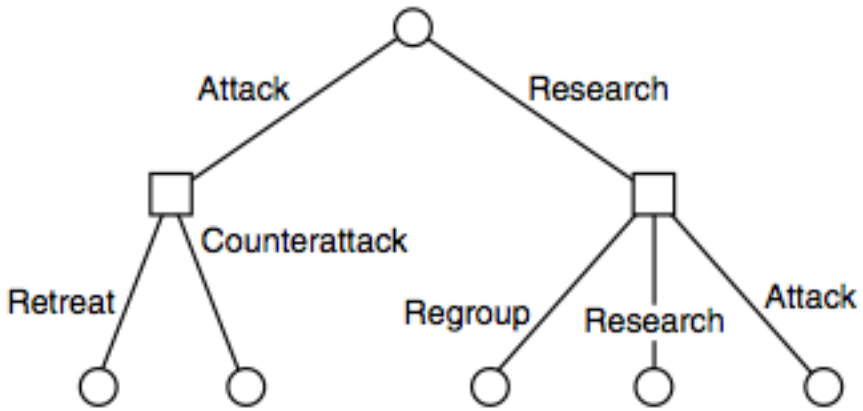
Any AI search algorithm can be used

- **A***, Minimax, Depth-first, Dijkstra, ...

The issue is to express the problem in terms of a search task

Basic AI techniques in videogames

Search algorithms (II)



Source: Ian Millington, John Funge. "Artificial Intelligence for Games". Ed. Morgan-Kaufmann. 2009.

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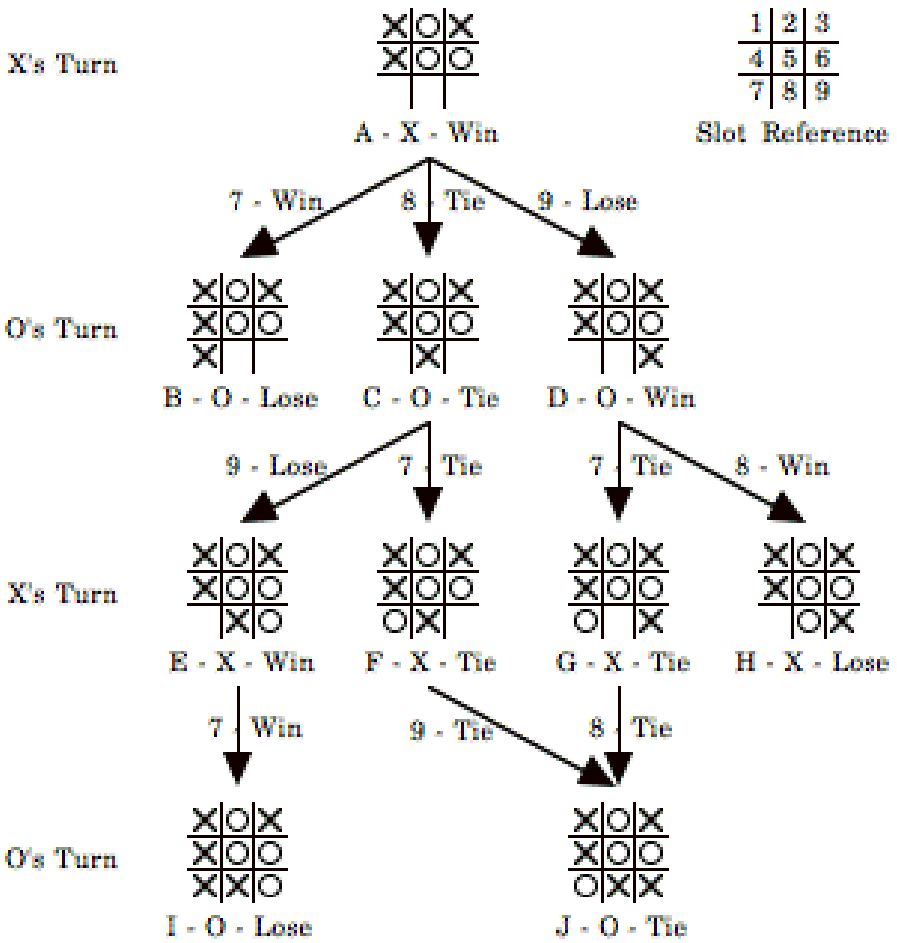
Search algorithms (III)



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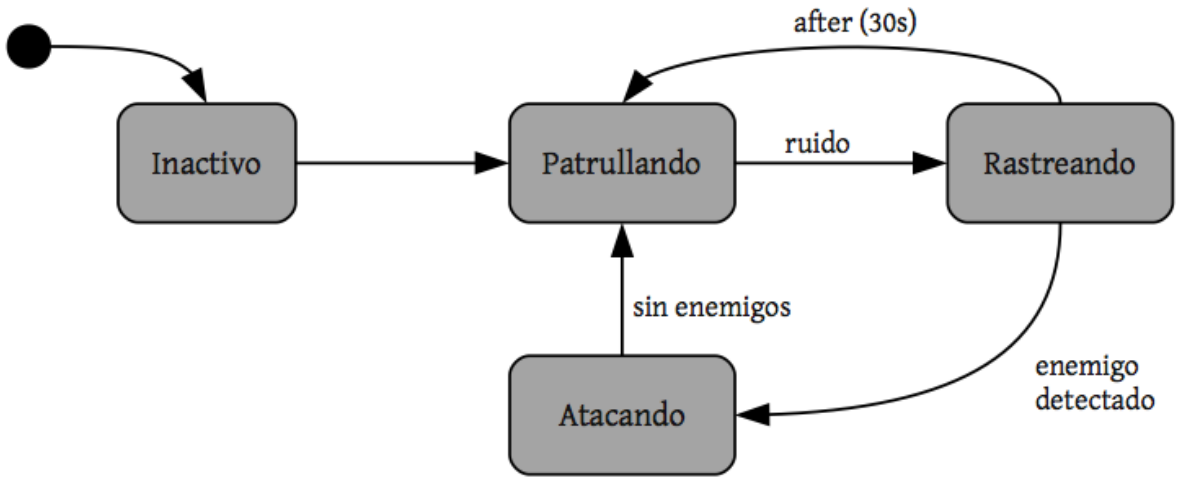
Finite State Machines (FSM) (I)

A FSM contains a set of states, transitions and triggering events that rules the transitions

Features:

- Easy and fast method
- Easy debugging
- Intuitive
- Flexible



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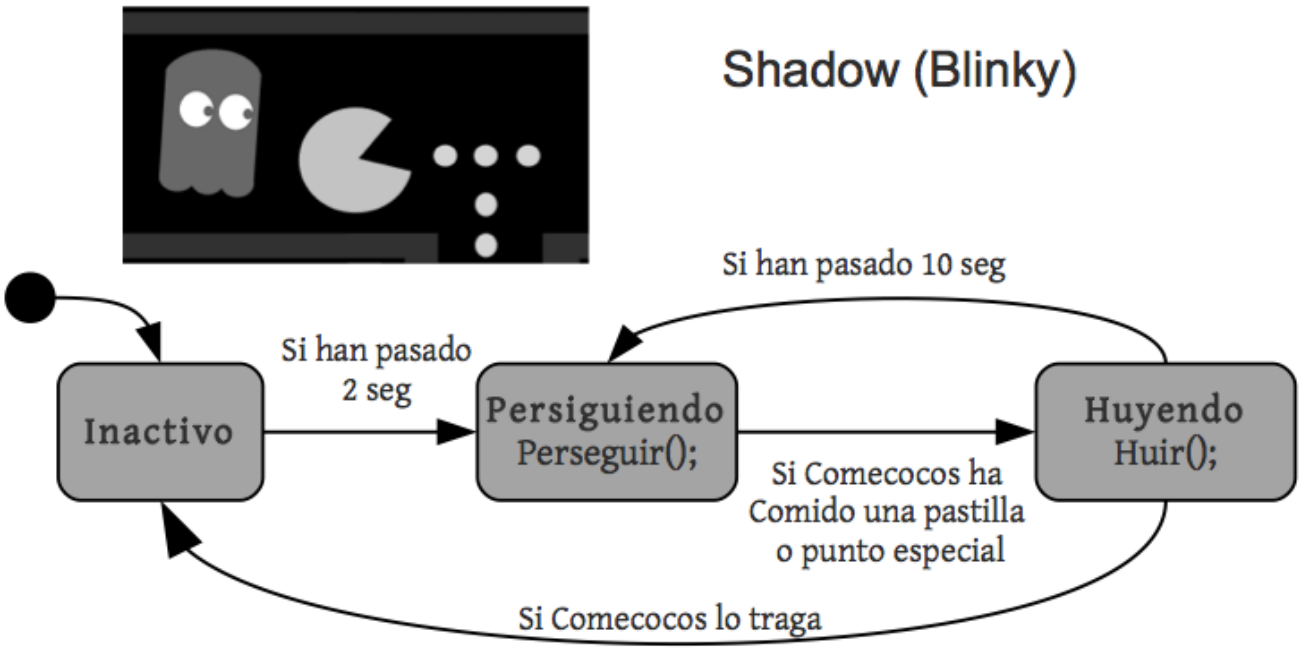
Finite State Machines (FSM) (II)



Advanced AI techniques in videogames

Agents

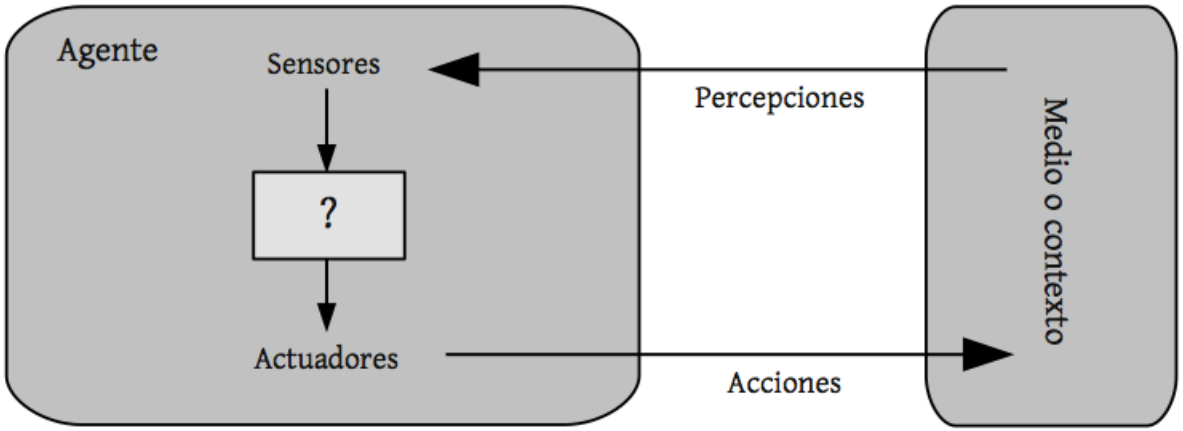
Agent definition

An agent is an goal-oriented entity able to perceive its environment and act on it

Agent properties

- Autonomy
- Social skills
- Reactivity
- Proactivity

Related concepts: Learning and reasoning



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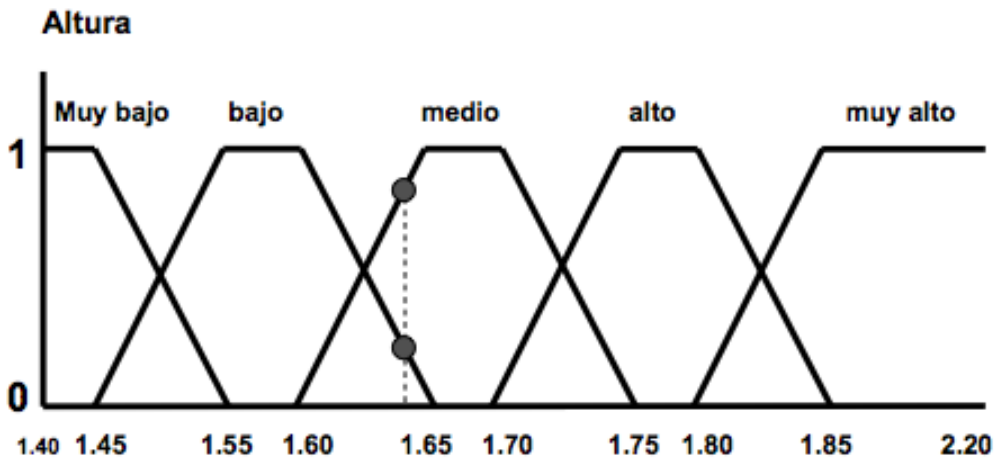
Fuzzy logic (I)

Fuzzy logic

Fuzzy logic, in opposition to digital logic, considers different levels of true values

Properties

- Closer to human reasoning
- A fact can be true and false
- Deals with imprecise linguistic terms



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Fuzzy logic (II)

Application examples

Fun control

```
IF temperature IS very cold THEN stop fan
IF temperature IS cold THEN turn down fan
IF temperature IS normal THEN maintain level
IF temperature IS hot THEN speed up fan
```

Game control

```
IF distance IS [very small, small] AND
enemy_strengh IS [low, regular] THEN attack
```

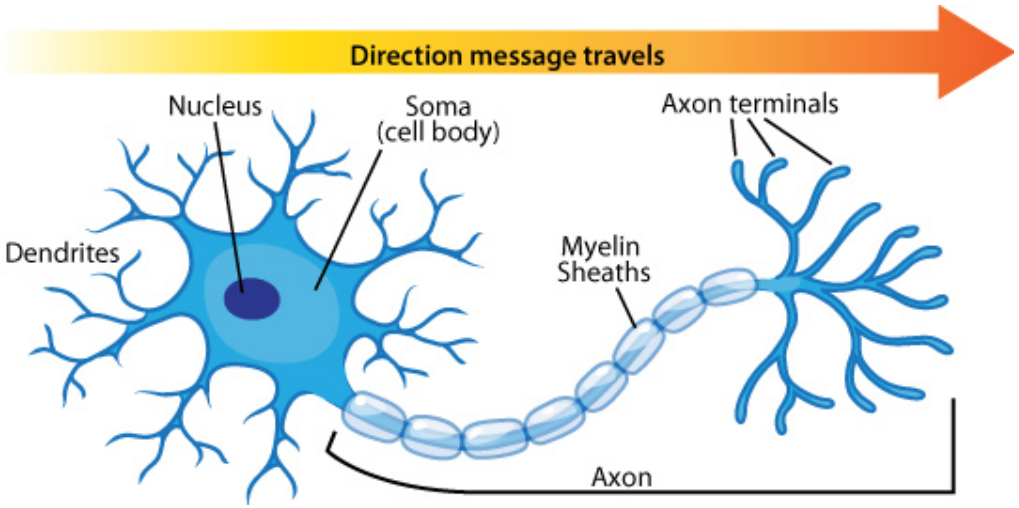
Advanced AI techniques in videogames

Artificial Neural Networks (I)

A neuron has a cell body ...

- ... a branching input structure (dendrite) and
- ... a branching output structure (axon)

Axons connect to dendrites via synapses



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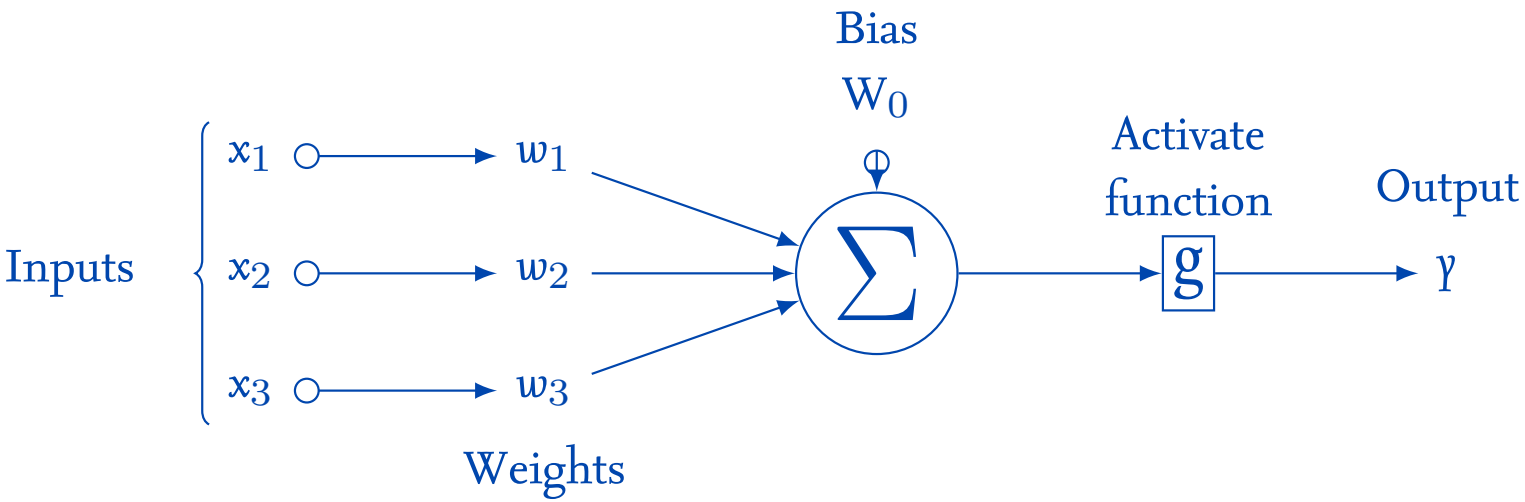
Artificial Neural Networks (II)



a_j Normalized input $(0 \leq a_j \leq 1)$

W_j Weight of input j $(0 \leq W_j \leq 1)$

W_0 Bias

g Activation function

Neuron model

$$a_i = g\left(\sum_{j=0}^{n} W_{j,i} a_j\right)$$

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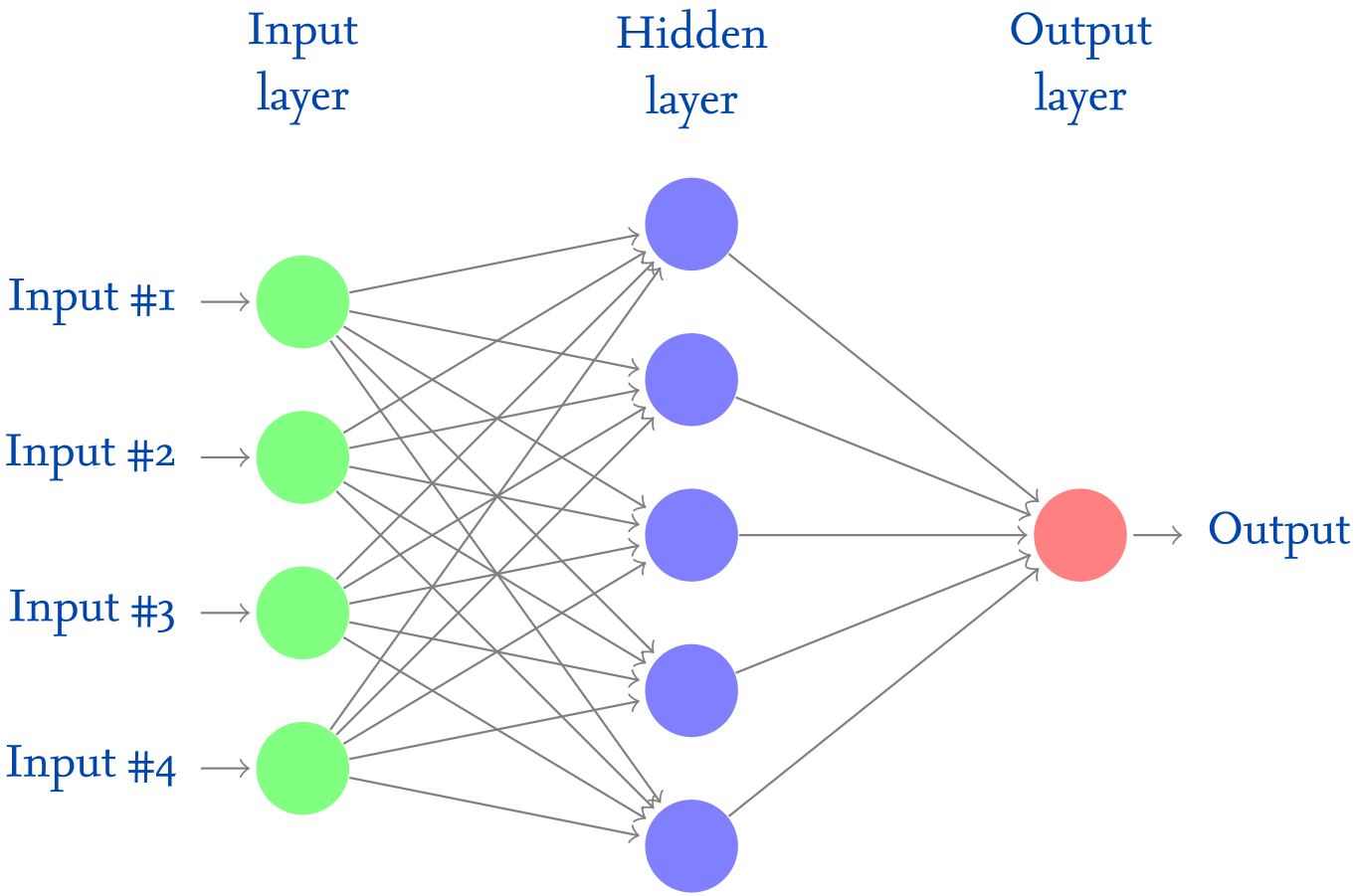
Artificial Neural Networks (III)



(Video Mario ANN)

Advanced AI techniques in videogames

Genetic Algorithms

Genetic Algorithms are used in *optimization* problems

- Usually in black-box problems
- They all imitate biological evolution
- Stochastic search (interesting for videogames)

They use a population

- Each individual represents a (potential) solution
- Population is modified: Mutation and crossover

Selection that imitates natural selection

- Based on a **fitness** function

Iterative process - generations

(Demo)