

# AI in videogames

Videogames Technology

## 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.

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# Introduction

## 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"

AI is a key component in any videogame: **Emotional stimulus**

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

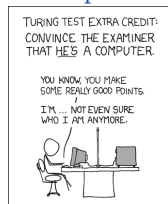
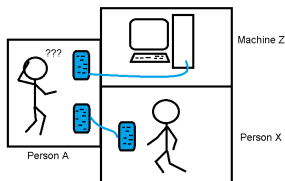
AI in videogames aims to give fun

- 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

Better AI with more computational resources

- Computational resources are limited

# Basic concepts

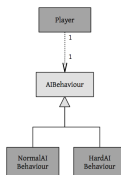
## Intelligence illusion

Balance between intelligence and computational resources

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

Many naïve (yet very useful) techniques

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



# Basic concepts

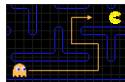
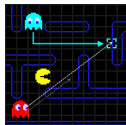
## Complexity fallacy

Complex behaviors are better?

- Good AI matches the right behavior to the right algorithm

Study case: Pac-Mac

- Ghosts with two states: normal and frightened (FSM)
- In normal state ghosts moves 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:

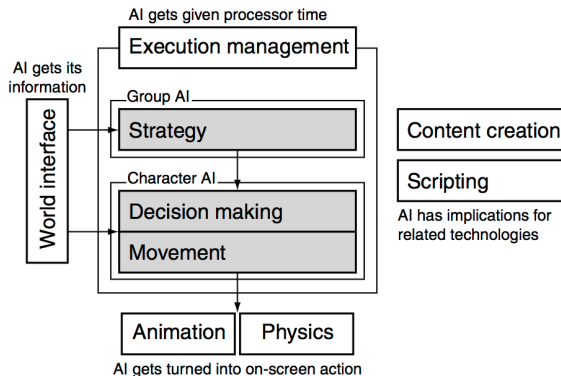
- NPC behavior learning
- Player modeling
- Games as AI benchmarks
- Procedural-content generation
- Computational narrative
- Believable agents
- AI-assisted game design



# 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, patrolling, ...
  - 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

- Classic search algorithms
- Finite State Machines

### Advanced techniques

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

# AI techniques in videogames

## Search algorithms (I)

Almost any problem in AI is a search problem

- Search the best path
- Search the best attack
- Search the best strategy
- Search the best move

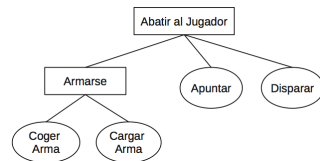
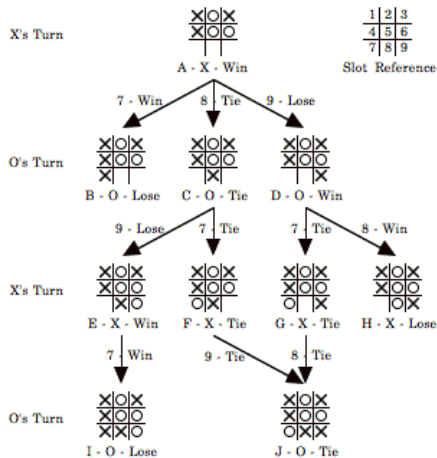
Any AI search algorithm can be used

- 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)



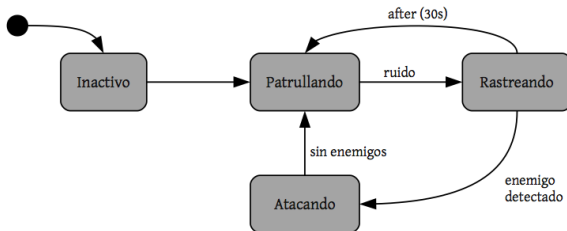
# Basic AI techniques in videogames

## Finite State Machines (FSM) (I)

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

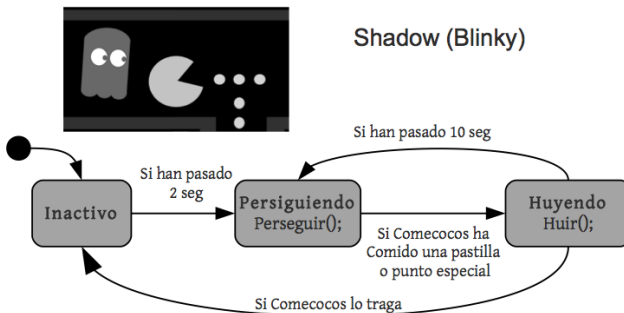
Features:

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



# Basic AI techniques in videogames

## Finite State Machines (FSM) (II)





# Advanced AI techniques in videogames

## Agents

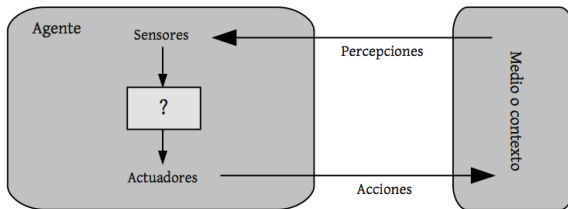
### Agent definition

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



# Advanced AI techniques in videogames

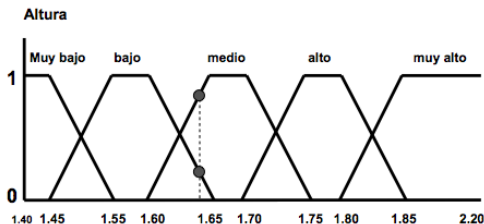
## Fuzzy logic (I)

### 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



# Advanced AI techniques in videogames

## 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\_strength IS [low, regular] THEN attack

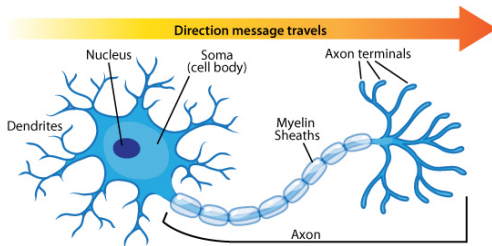
# Advanced AI techniques in videogames

## Artificial Neural Networks (I)

A neuron has a cell body ...

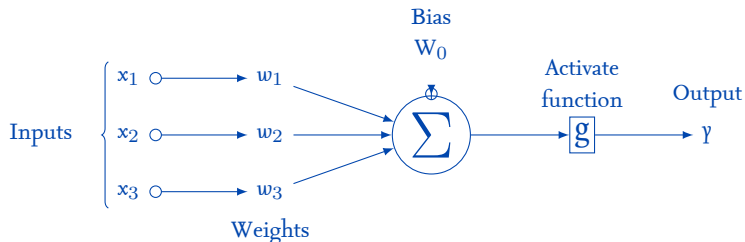
- ... a branching input structure (dendrite) and
- ... a branching output structure (axon)

Axons connect to dendrites via synapses



# Advanced AI techniques in videogames

## 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

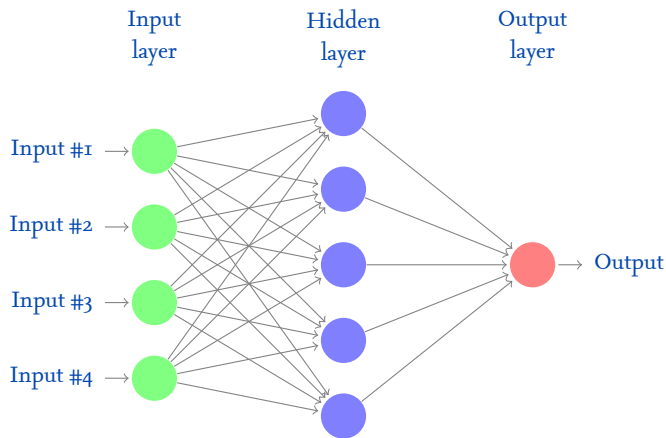
$g$  Activation function

Neuron model

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

# Advanced AI techniques in videogames

## Artificial Neural Networks (III)



(Video Mario ANN)

# Advanced AI techniques in videogames

## Genetic Algorithms (I)

Large number of Evolutionary Algorithms

- There is no ``canonical" algorithm
- 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

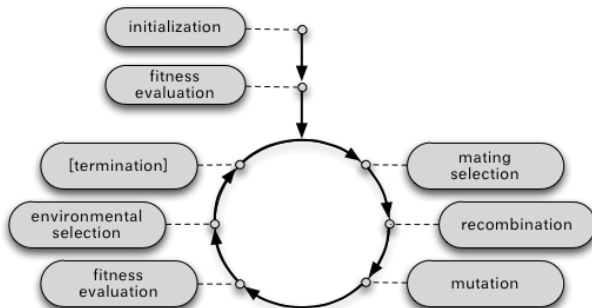
- Based on a **fitness** function

Iterative process

# Advanced AI techniques in videogames

## Genetic Algorithms (II)

### Possible basic algorithm



(Demo)