

The Future of Gaming

Eike Falk Anderson

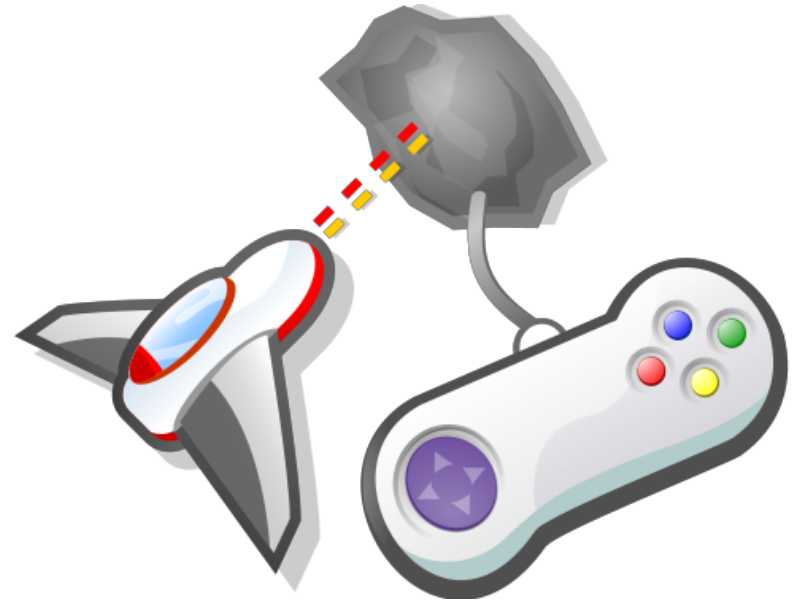
Fotis Liarokapis

Christopher Peters



Overview

- Game History
- Game Graphics
- Game World Creation
- Game AI & Behaviour
- Game Interfaces



What is a game?

Games have been a part of human life since the dawn of Humanity



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Just a few formal definitions:

- a structured or semi-structured, contrived activity (*Wikipedia*)
- a series of interesting choices (*Meier*)
- a closed formal system that represents a subset of reality (*Crawford*)



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A brief history of Computer Games

Over the past 60 years
we have gone from this



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we have gone from this



to this



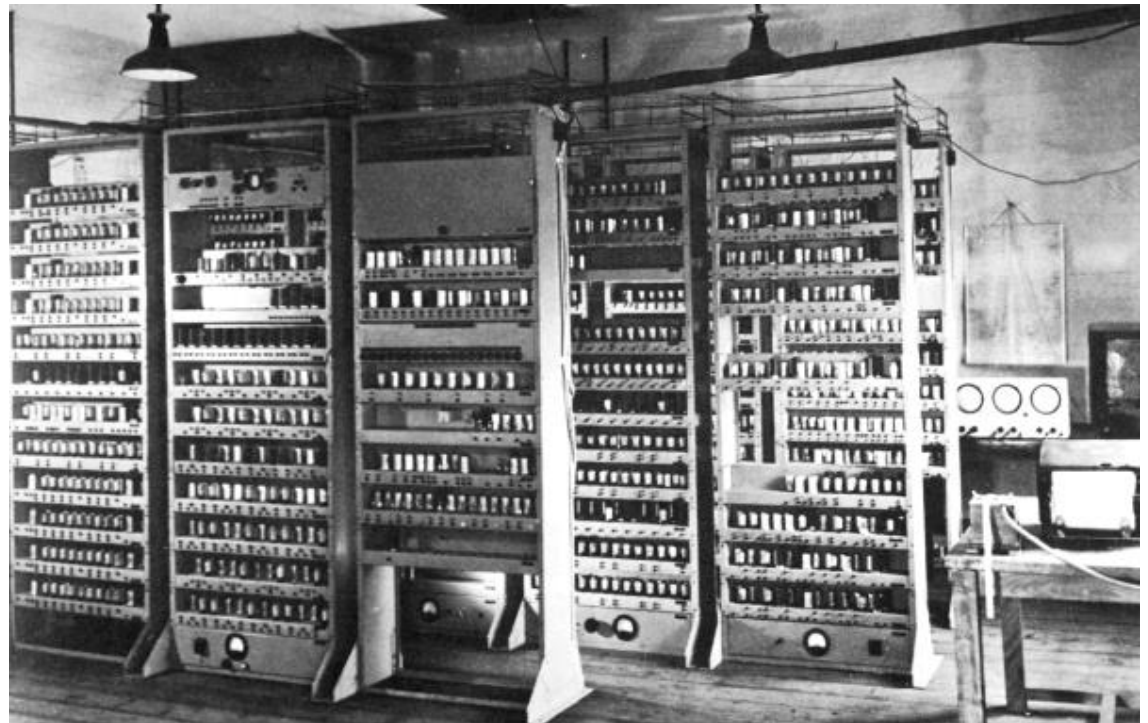
A brief history of Computer Games



1952 OXO (EDSAC)



- the first computer game: noughts & crosses on the EDSAC



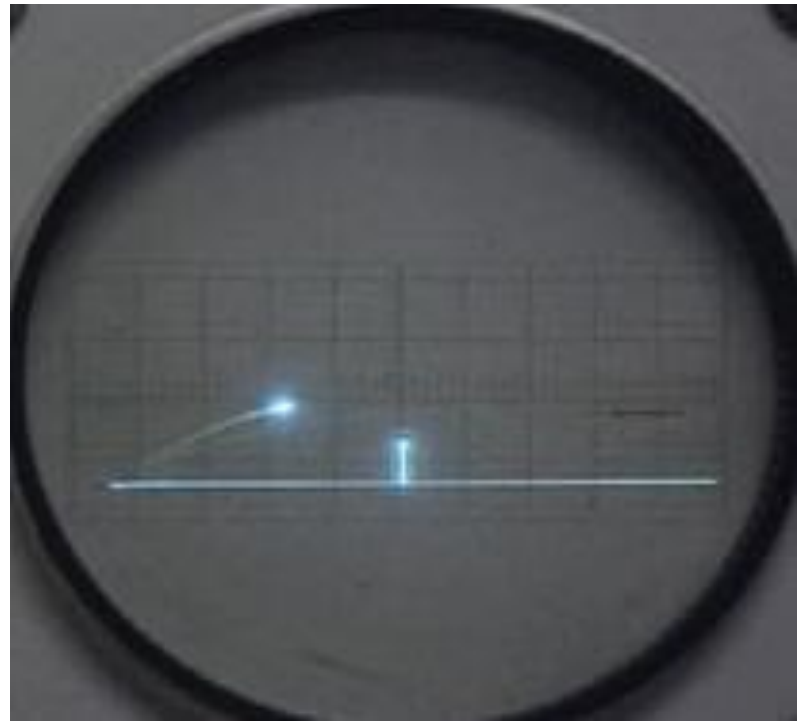
A brief history of Computer Games



1952 OXO (EDSAC)

1958 Tennis For Two

- created as an interactive demonstration of oscilloscopes
- not a computer game (almost a video game)
- real innovation were the handheld controllers



A brief history of Computer Games



1952 OXO (*EDSAC*)

1958 Tennis For Two

1962 Spacewar

- created by students at MIT to test the capabilities of the PDP-1 computer by DEC
- first computer game with real-time vector graphics
- inspired "Computer Space", the first arcade video game (1971)



A brief history of Computer Games



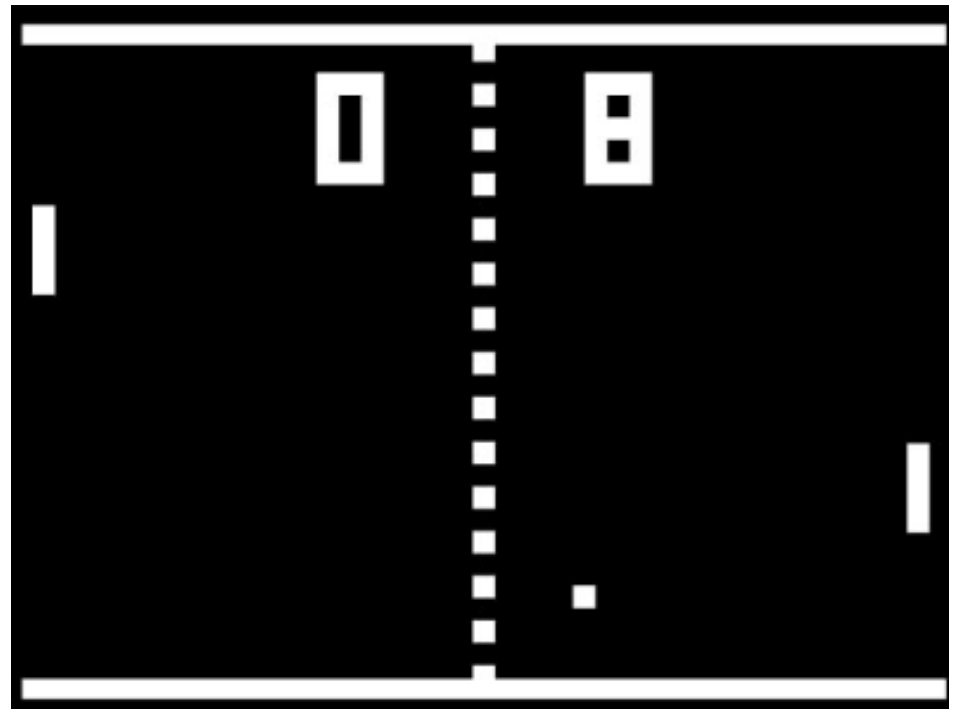
1952 OXO (*EDSAC*)

1958 Tennis For Two

1962 Spacewar

1972 Pong

- first arcade video game to enjoy widespread distribution & popularity
- a rehash of the “Tennis For Two” idea
- inspiration for games such as “Breakout”



A brief history of Computer Games



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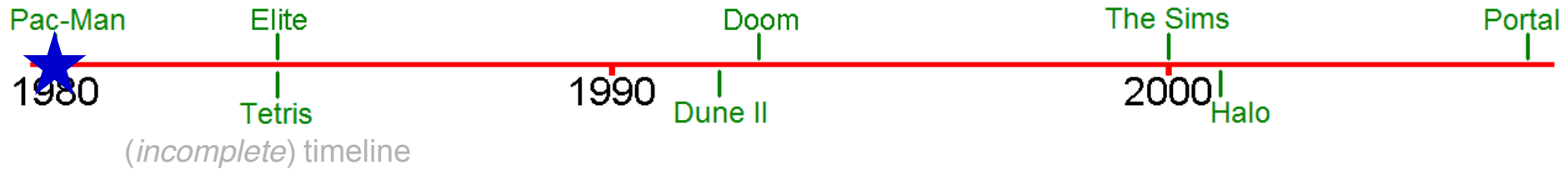
1972 Pong

1978 Space Invaders

- Japanese space shooter game inspired by “Breakout”
- colours created through overlays
- predates the game “Asteroids” by a year



A brief history of Computer Games

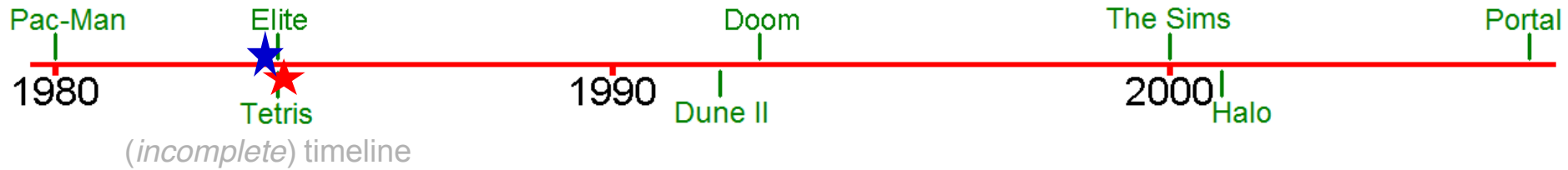


1980 Pac-Man

- an early attempt at “character design”
- meant to appeal to a wider audience



A brief history of Computer Games

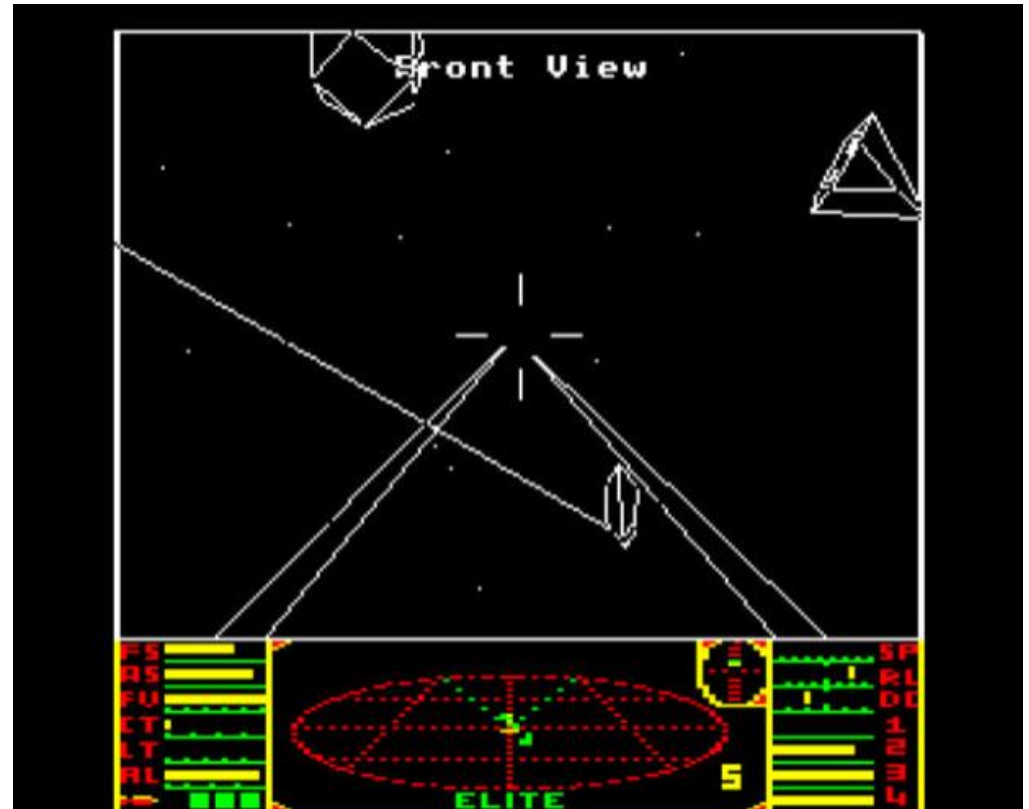


1980 Pac-Man

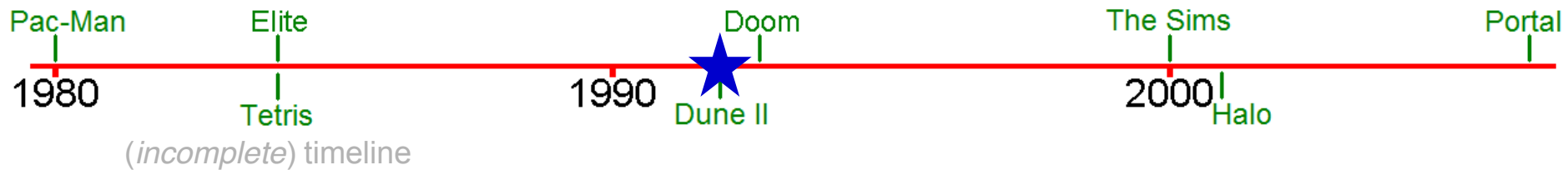
1984 Elite, Tetris

two widely different games:

- space exploration action game – one of the first games with 3D (vector) graphics
- puzzle game – at the heart of the launch of hand-held gaming devices



A brief history of Computer Games

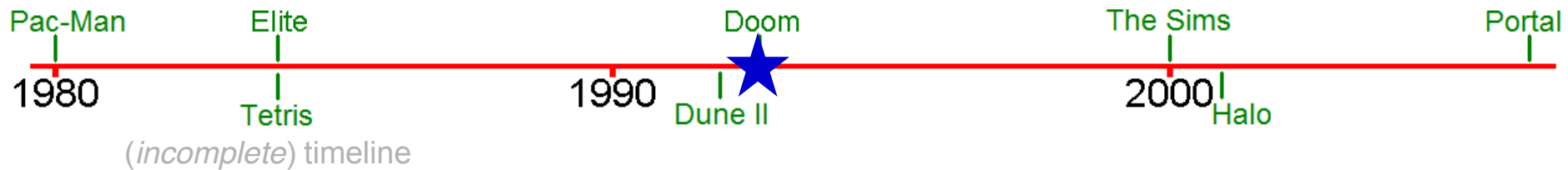


1980 Pac-Man
1984 Elite, Tetris
1992 Dune II

- one of the first real-time strategy games
- established many of the elements of the RTS game genre



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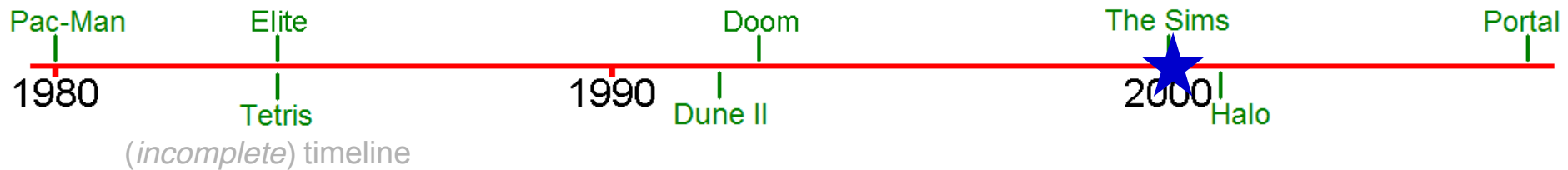


1980 Pac-Man
1984 Elite, Tetris
1992 Dune II
1993 Doom

- one of the first 3D first-person shooter games
- established many of the elements of the FPS game genre



A brief history of Computer Games

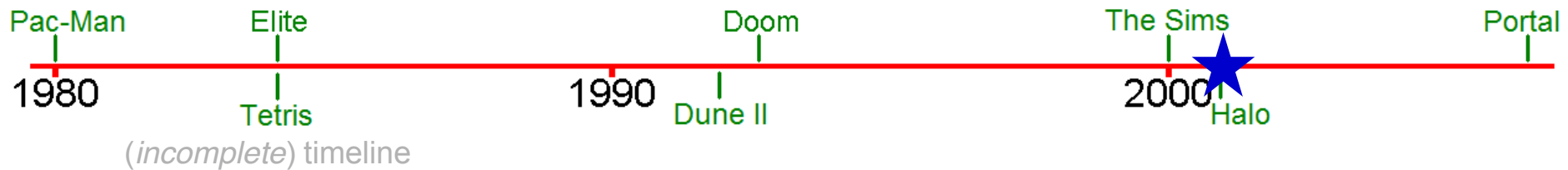


1980 Pac-Man
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1993 Doom
2000 The Sims

- god-game that pioneered novel game character behaviour models
- setting greatly expanded the player demographic



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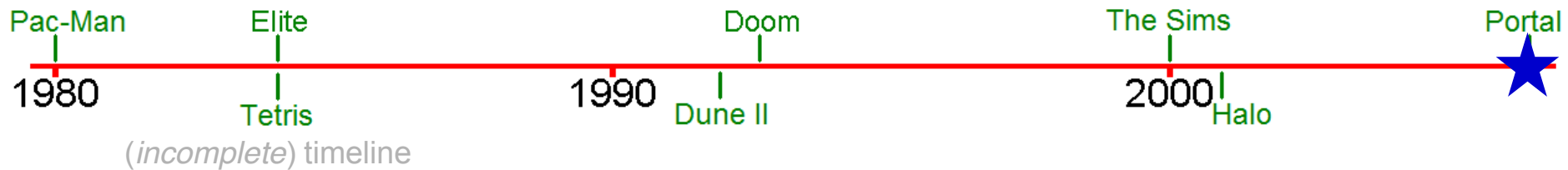


1980 Pac-Man
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2001 Halo

- exclusive launch title for the Xbox console
- lacked support for on-line multiplayer (but allowed up to 16 players in LAN) games



A brief history of Computer Games



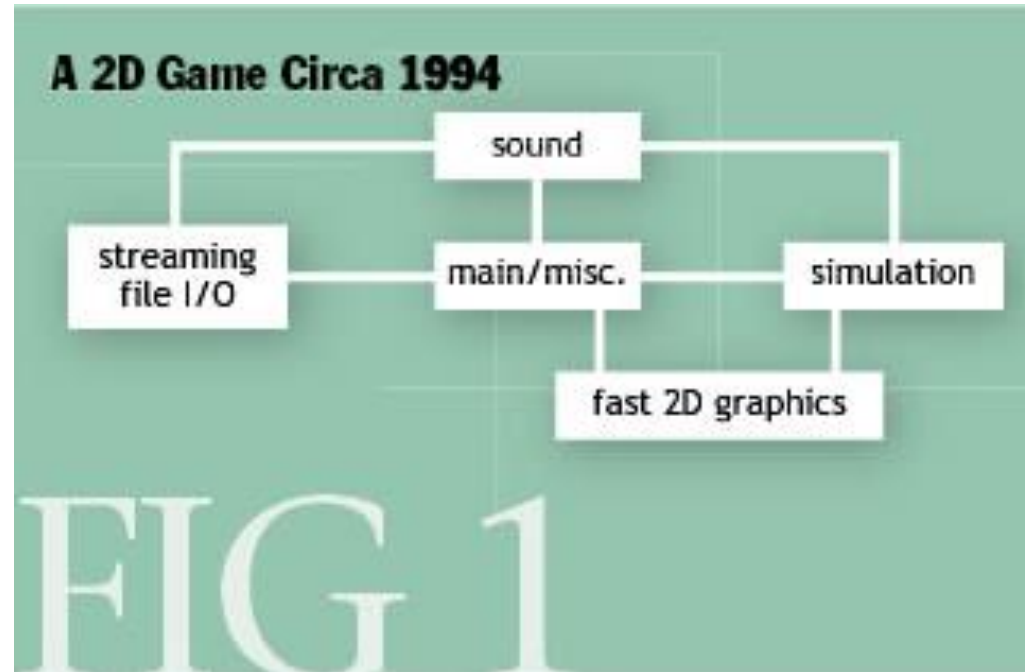
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2007 Portal

- novel puzzle game
- violence directed at the player only



Rapid Growth of Complexity

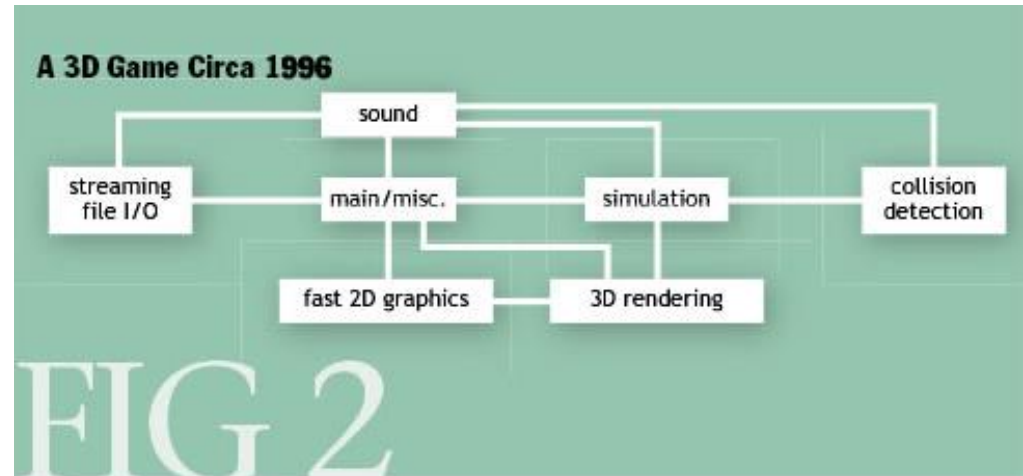
- game infrastructure started simple



Blow, J. (2004). Game Development: Harder than you think, ACM Queue 1(10)

Rapid Growth of Complexity

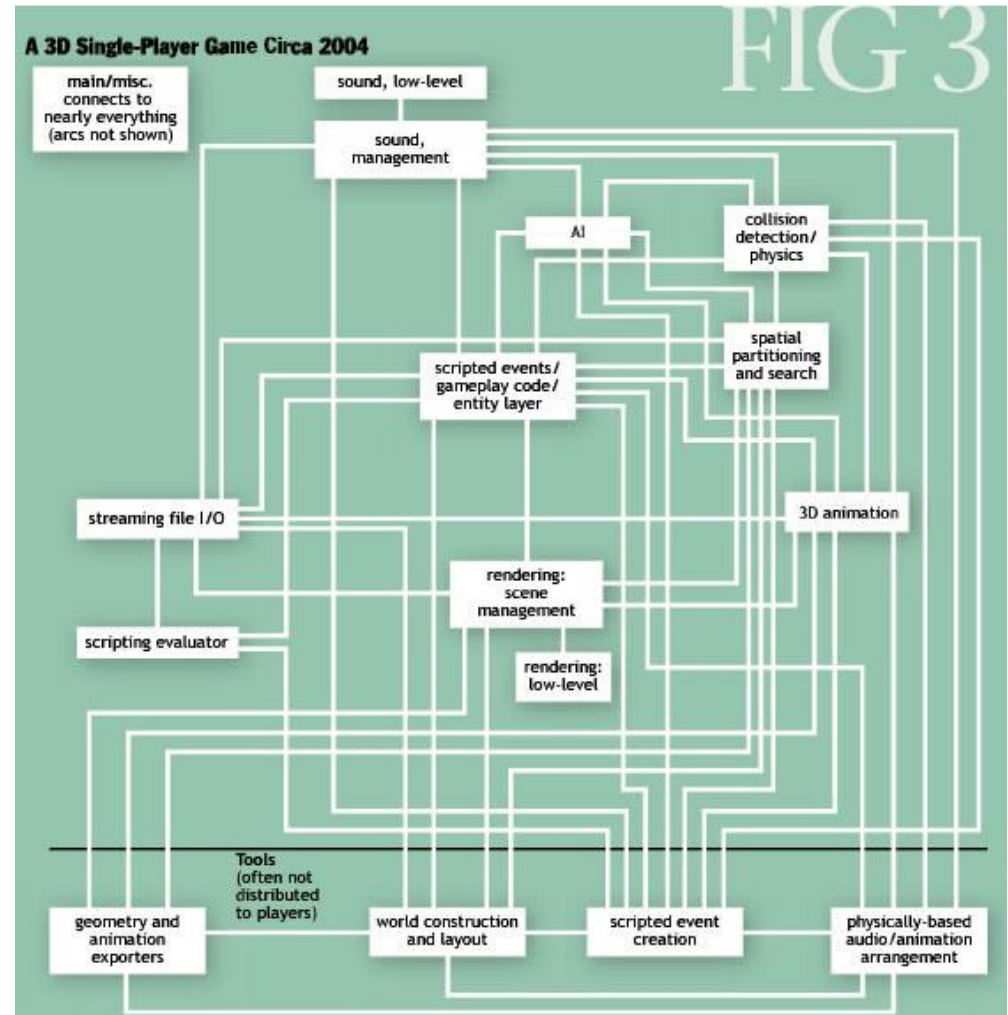
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- the switch to 3D games quickly increased complexity



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Rapid Growth of Complexity

- game infrastructure started simple
- the switch to 3D games quickly increased complexity
- modern games are among the most complex software systems available



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The Future of Gaming is...

Light & Materials

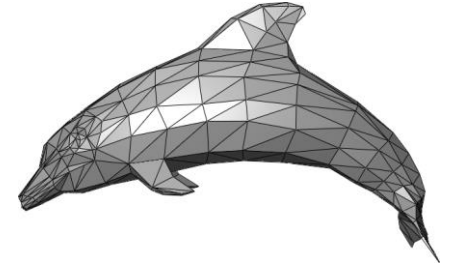
Accurately simulated Virtual Environments



Unreal Engine 4 – “Elemental” Tech Demo

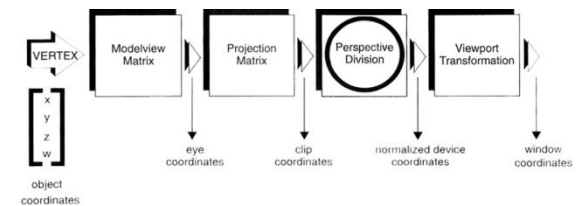
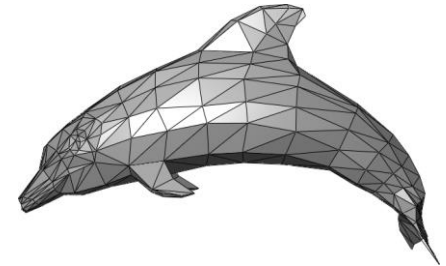
3D Computer Graphics

- for each vertex (corner point of a polygon) of a polygonal mesh



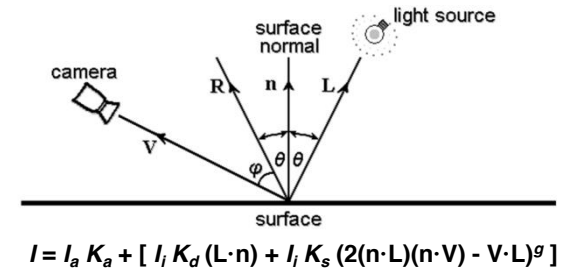
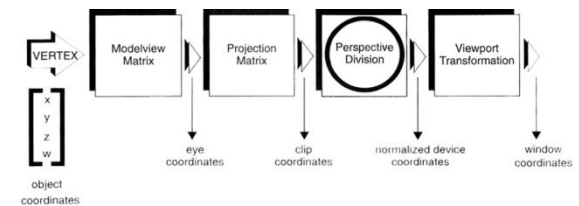
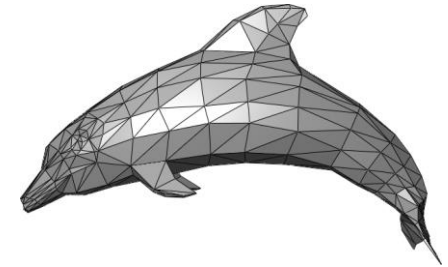
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- for each vertex (corner point of a polygon) of a polygonal mesh
 1. transform the vertex so it is located at the correct position in the virtual world



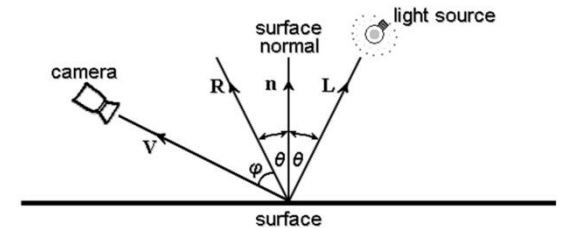
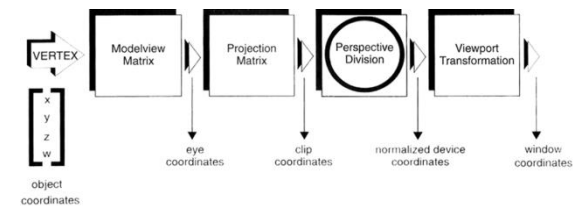
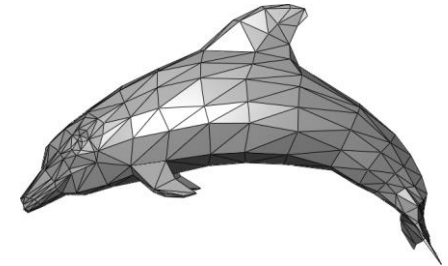
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 2. perform the lighting calculation (approximation of real lighting) for each transformed vertex
 3. draw the final object in the scene by interpolating the colours at the vertices (this is Gouraud Shading)



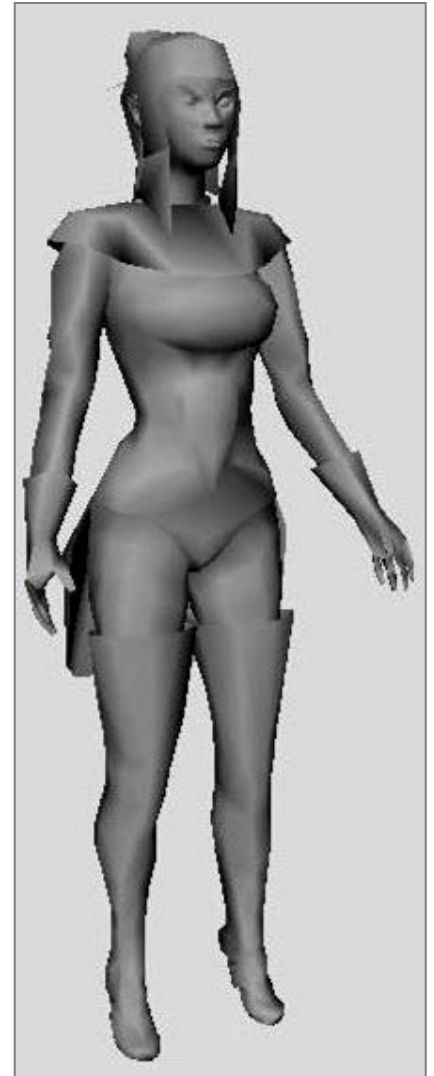
$$I = I_a K_a + [I_i K_d (L \cdot n) + I_i K_s (2(n \cdot L)(n \cdot V) - V \cdot L)^g]$$



Game Character Creation

Basics:

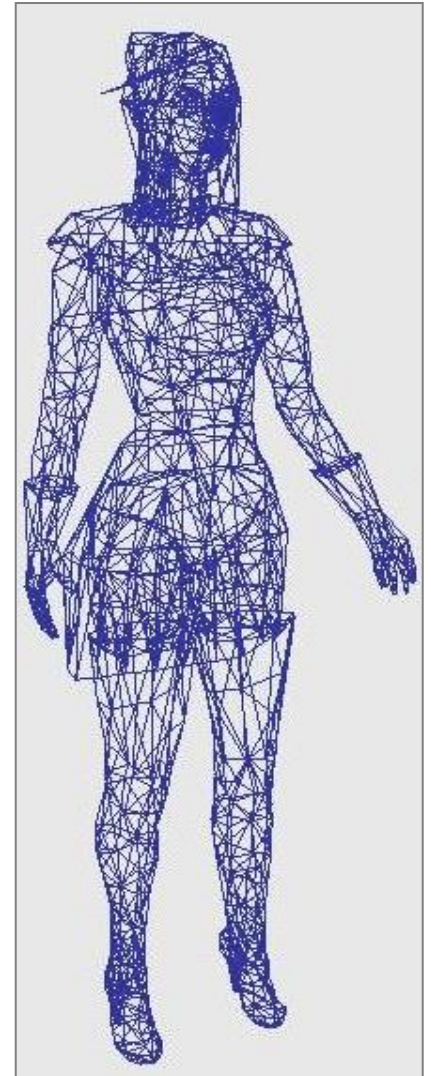
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Game Character Creation

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2. this results in a polygonal mesh



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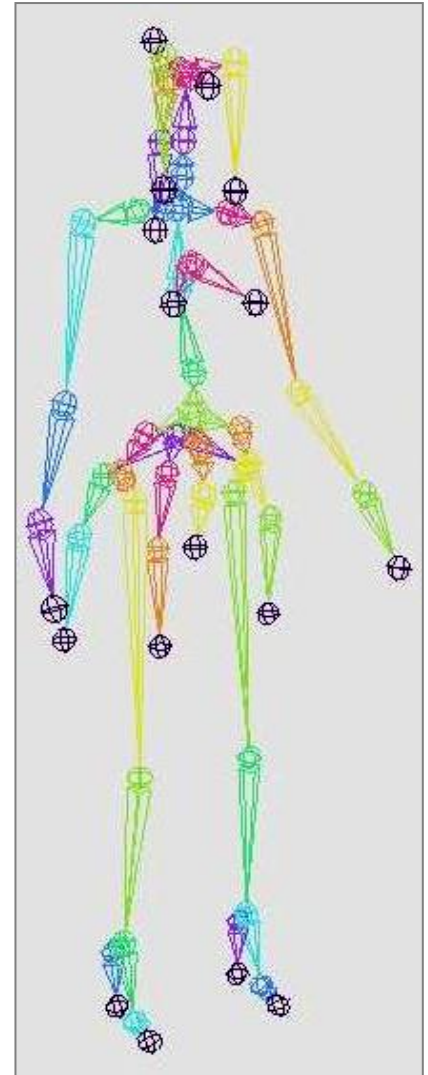
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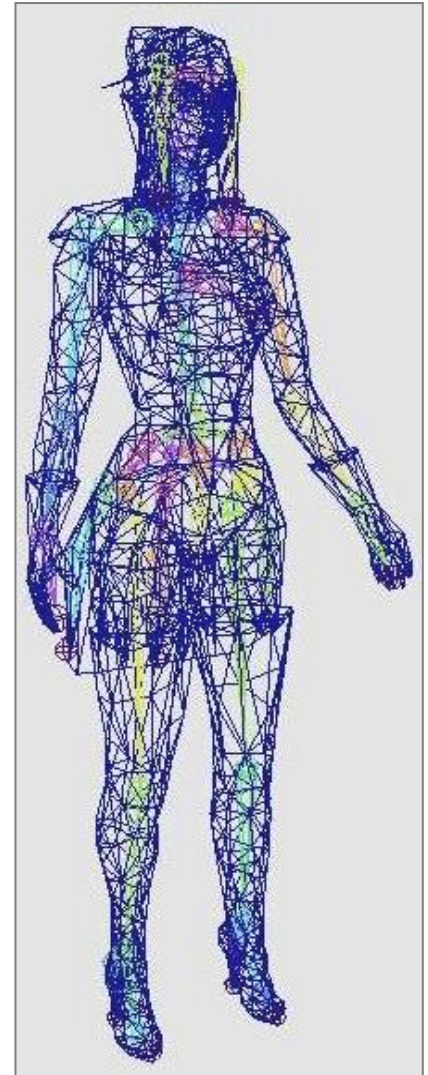
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5. this is then anchored to the mesh to drive each of the character's motions



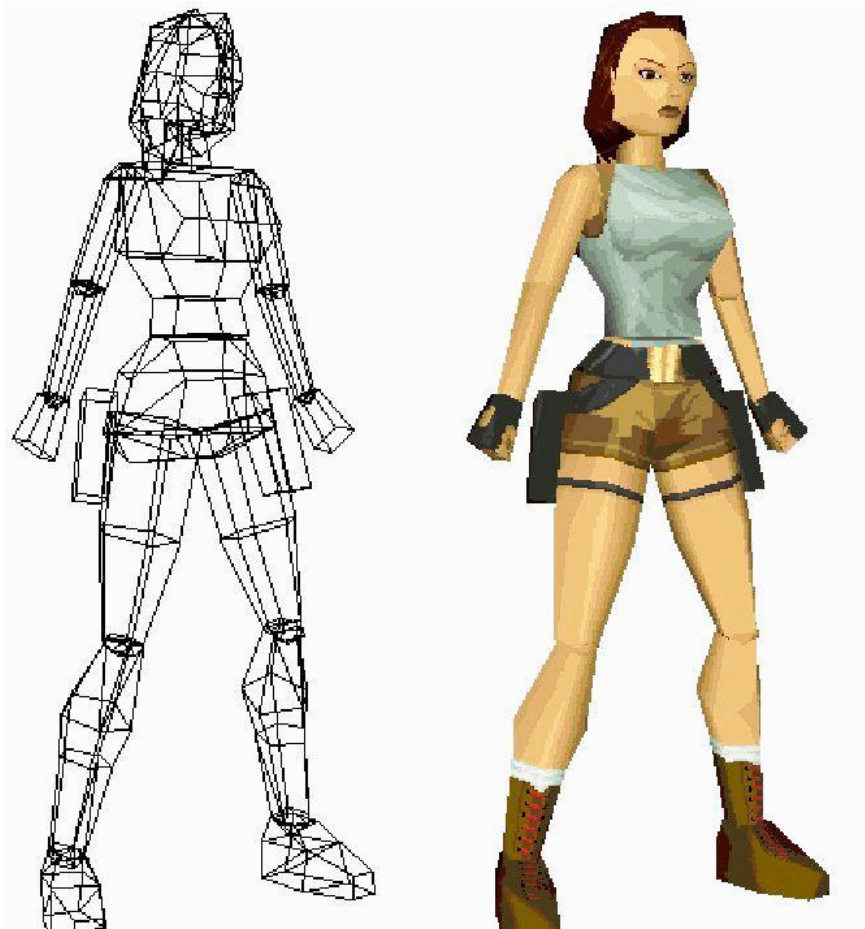
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6. the result is a game character that can be integrated into a game

Game Character Creation

Future Game Characters need more details.



Tomb Raider (1996)

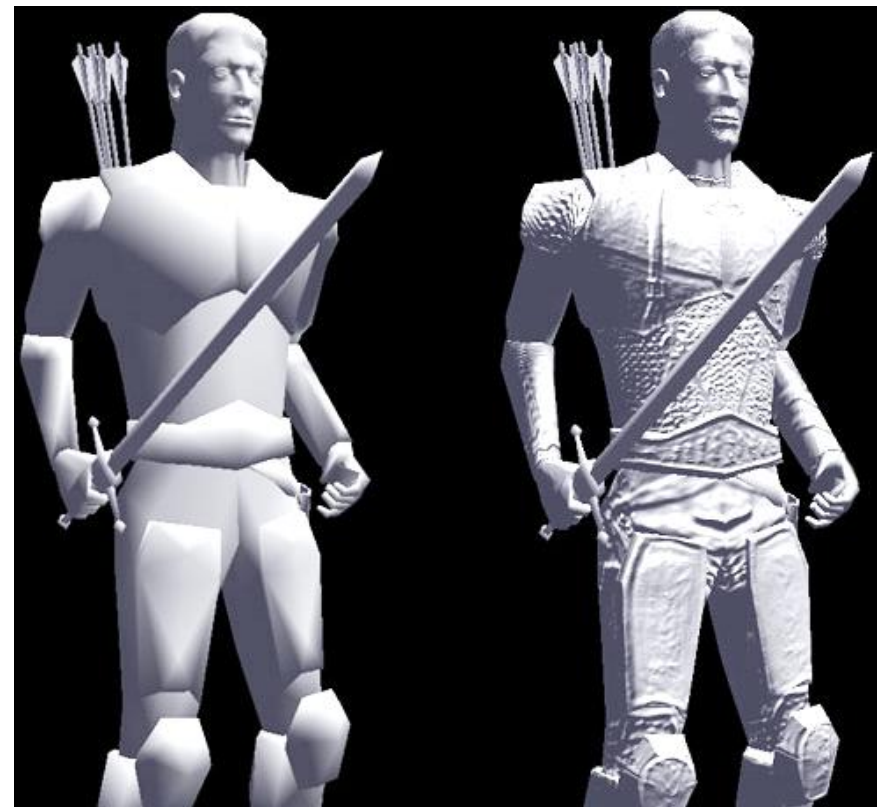


Tomb Raider: Anniversary (2007)

Game Character Creation

Future Game Characters need more details.

- apart from adding more polygons, modern graphics cards allow the use of normal maps:
 1. lighting information from a high resolution model is captured in a special texture map
 2. this is applied to a low polygon model, creating the illusion of detail



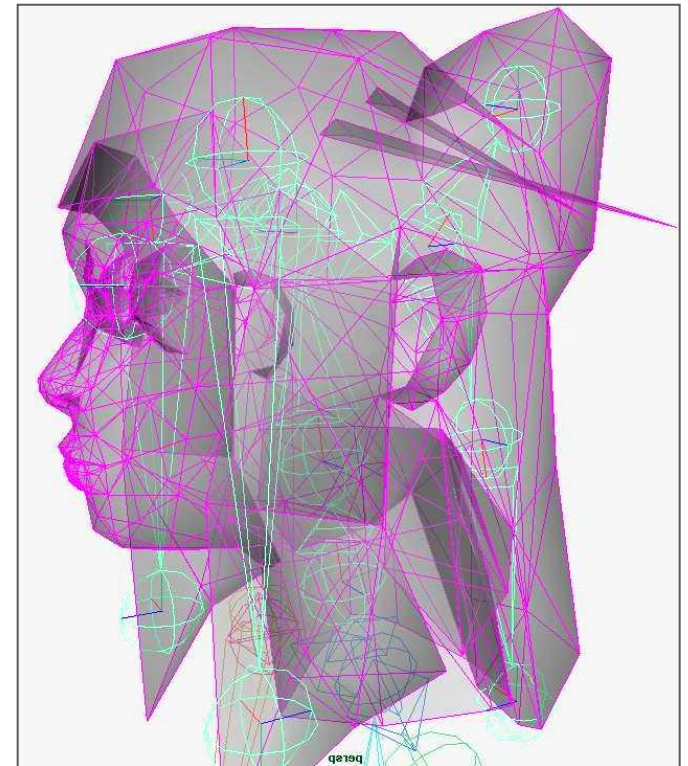
smooth shading

normal mapping

Game Character Creation

Future Game Characters have facial expressions.

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Game Character Creation

Future Game Characters have facial expressions.

- originally achieved with facial rigs, i.e. internal 'bones' that 'drive' the animation of the skin/mesh
- now usually achieved with facial blend-shapes, i.e. different versions of the mesh with different expression that are interpolated to create a variety of new expressions



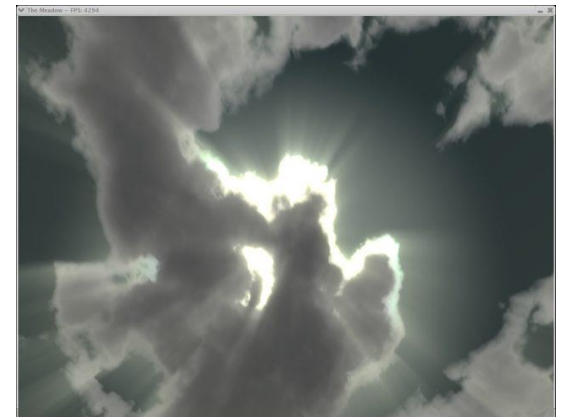
NVIDIA "Dawn" and "Faceworks" Demos

Image from Lorach, T. (2007). GPU Blendshapes.

Real-Time Computer Graphics

Future Game Graphics use HDR lighting.

- High-Dynamic-Range lighting emulates real luminance ranges on limited hardware (tonemapping)
- detail in bright and dark areas of the image is preserved, resulting in a richer environment
- allows “bloom” where very bright image areas appear to glow



Real-Time Computer Graphics

Future Games use real-time global illumination.

- GI simulates the interactions of light with its environment, including reflections and indirect lighting
- GI lit scenes appear more realistic and 'rich'
- most existing approaches are pre-computed, i.e. do not provide dynamic lighting

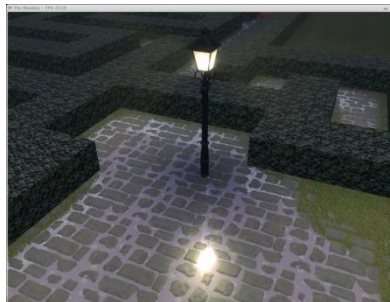


NVIDIA GI Works

Real-Time Computer Graphics

Future Games simulate natural phenomena.

- clouds & smoke that interact with their environment and with lights
- intangible forces, such as wind
- water surfaces that reflect the environment and rain



Real-Time Computer Graphics

Future Games use physically realistic materials.

- simulation of materials under the influence of physical forces enhances the realism of scenes
- important visual effects are the deformation and fracture of materials
- stresses up to a certain threshold deform objects, then they break



The Future of Gaming is...

Procedural Synthesis

What is Procedural Synthesis?

automatic generation
(based on algorithms)
of „Content“

- autonomous or user-directed
- deterministic / reproducible
- not restricted to visible world elements



Infinity: The Quest for Earth

Why use Procedural Synthesis?

modern games include detailed virtual worlds – players expect detailed virtual worlds



Why use Procedural Synthesis?

modern games include detailed virtual worlds – players expect detailed virtual worlds

- manual creation of all world elements would be too time consuming and too expensive
- some things are too complex to be created by hand
- manually created objects would require too much storage space



Why use Procedural Synthesis?

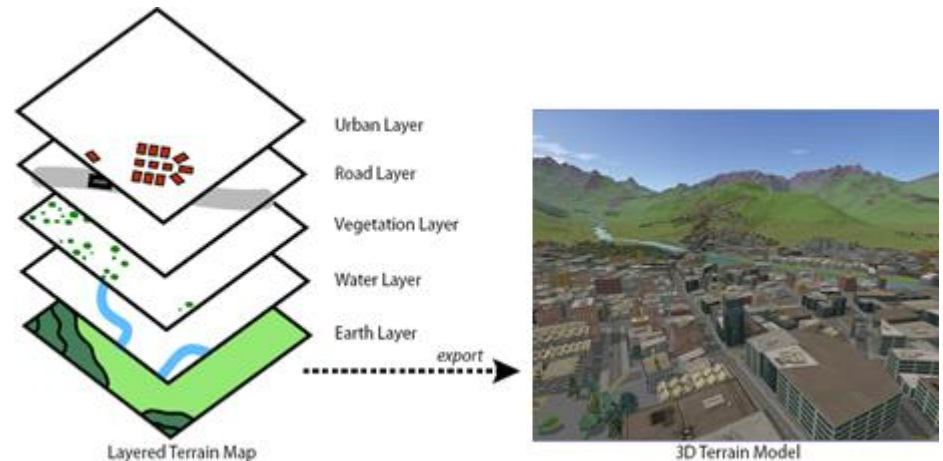
wide ranging application areas

- generation of textures for emulating different materials
- terrain generation/synthesis
- simulation/emulation of natural phenomena
- animation/motion synthesis
- generation of artificial structures
- behaviour simulation/emulation



Procedural Generation of Cities

- combines several procedural methods in a series of subsequent synthesis phases
 - terrain generation (incl. water distribution based on the terrain)
 - vegetation synthesis (based on terrain & water distribution)
 - road layout (based on the terrain)
 - plots/properties (constrained by road layout)
 - buildings (within plots/properties)



Procedural Synthesis Challenges



autonomy

control

- as much as possible should be automated
 - the end result should still be predictable
- unsolved questions that will have to be answered

The Future of Gaming is...

AI and Behaviour

Artificial Intelligence (AI)

- a means for creating engaging gameplay opponents & collaborators

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- in games this should be “intelligent” but not “too intelligent”

this raises some interesting questions

What is intelligence?

- a problem of philosophy or a problem of science?

What is intelligence?

- a problem of philosophy or a problem of science?
- Aristotle tried to establish rules of “correct thinking”

Socrates is a man



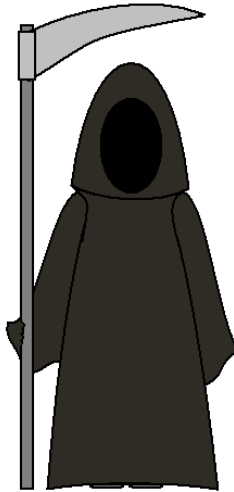
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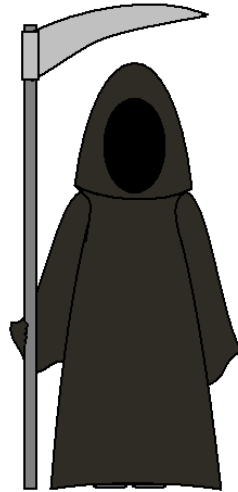
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⇒ Socrates is mortal



Deductive Reasoning

What is intelligence?

- deductive reasoning (modal logic) is not really the answer

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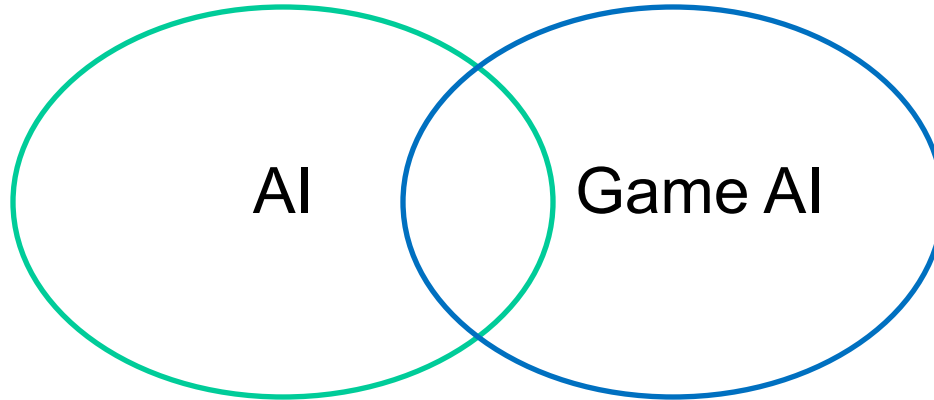
- deductive reasoning (modal logic) is not really the answer
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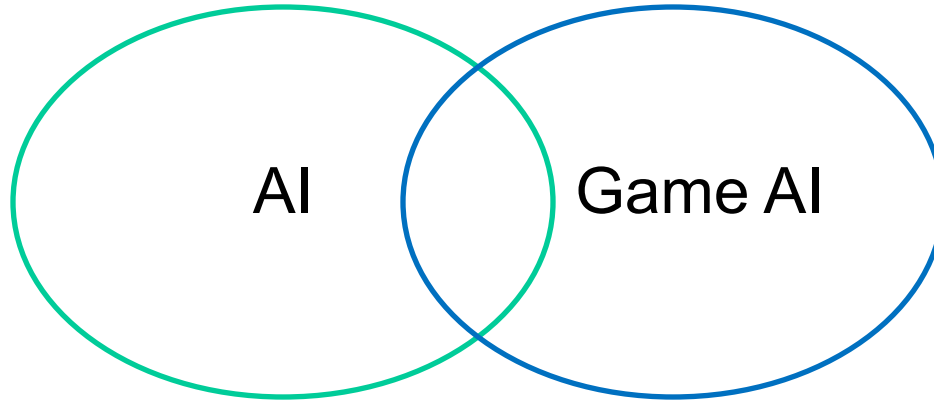
we need intelligent computer players
(NPCs – Non-Player Characters)

What is Game AI?



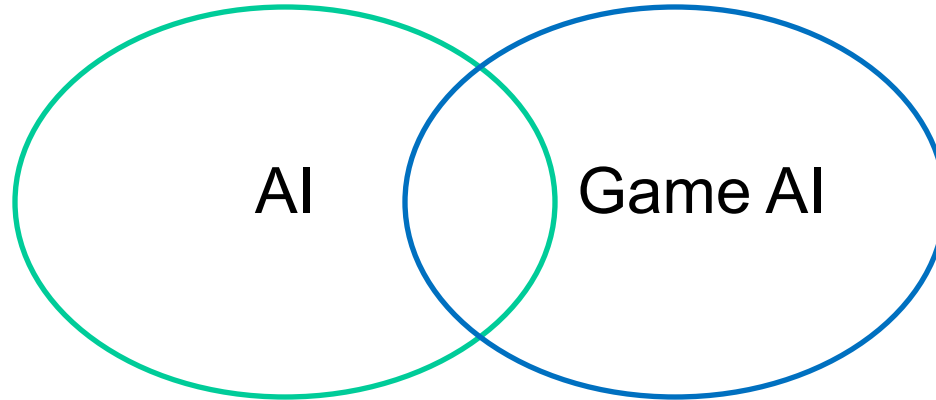
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What is Game AI?



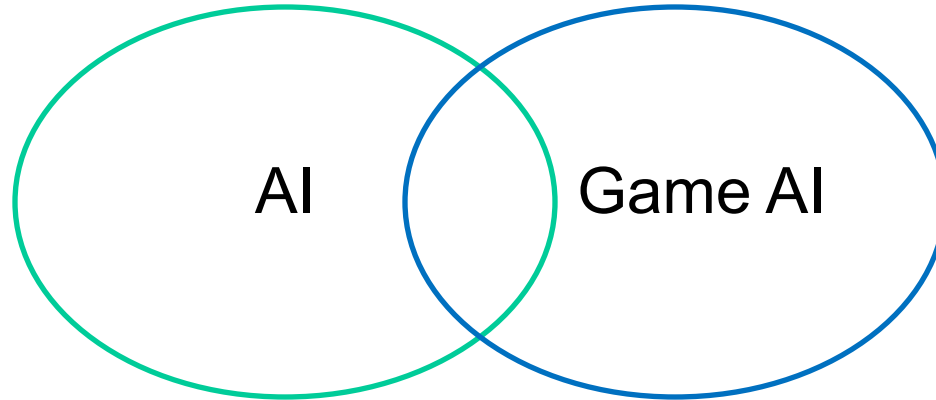
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- behaviour more important than intelligence

What is Game AI?



- different from conventional “academic” AI
- behaviour more important than intelligence
- illusion of intelligence – not real intelligence

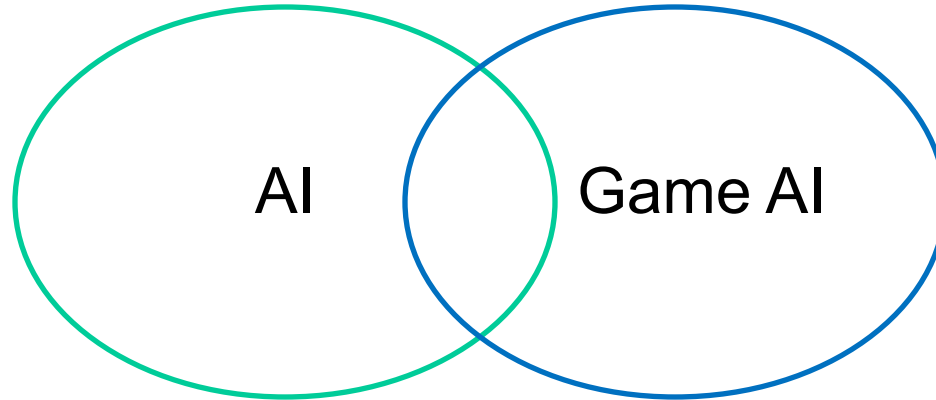
Game Artificial Intelligence



What does Game AI do?

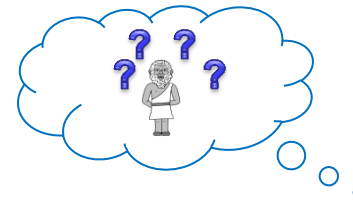


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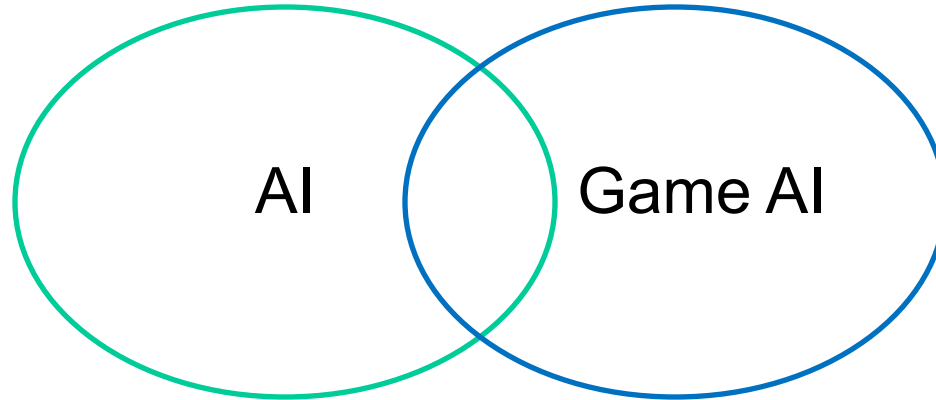


Usually restricted to:

1. [decision making](#)

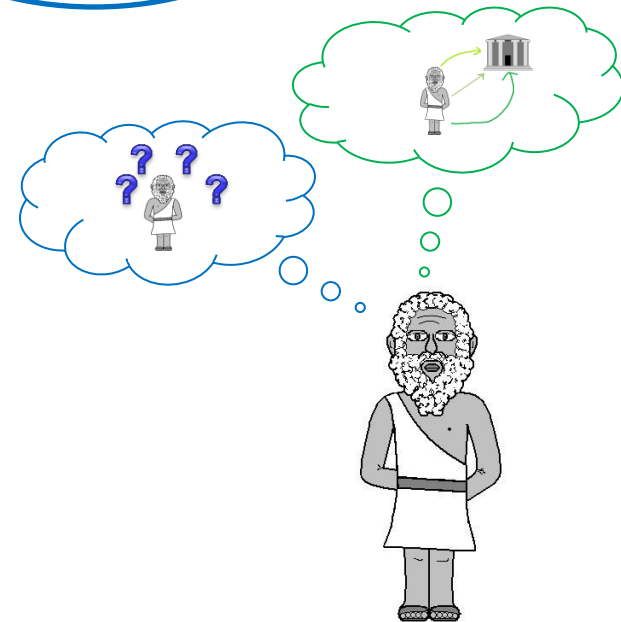


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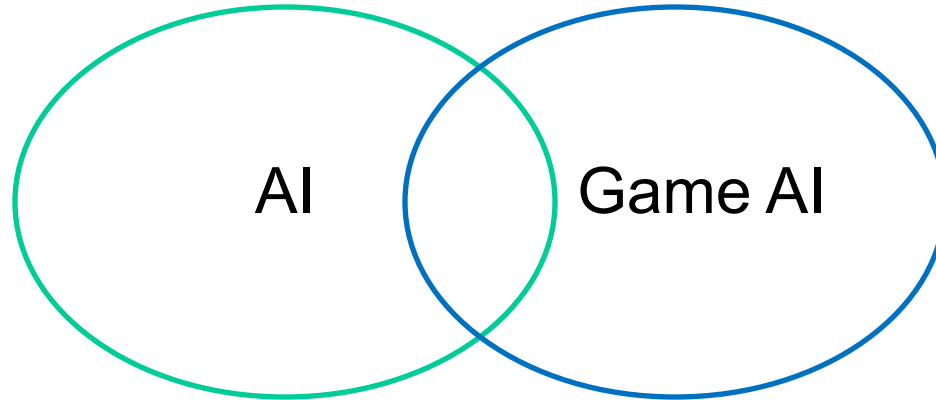


Usually restricted to:

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2. path finding (planning)

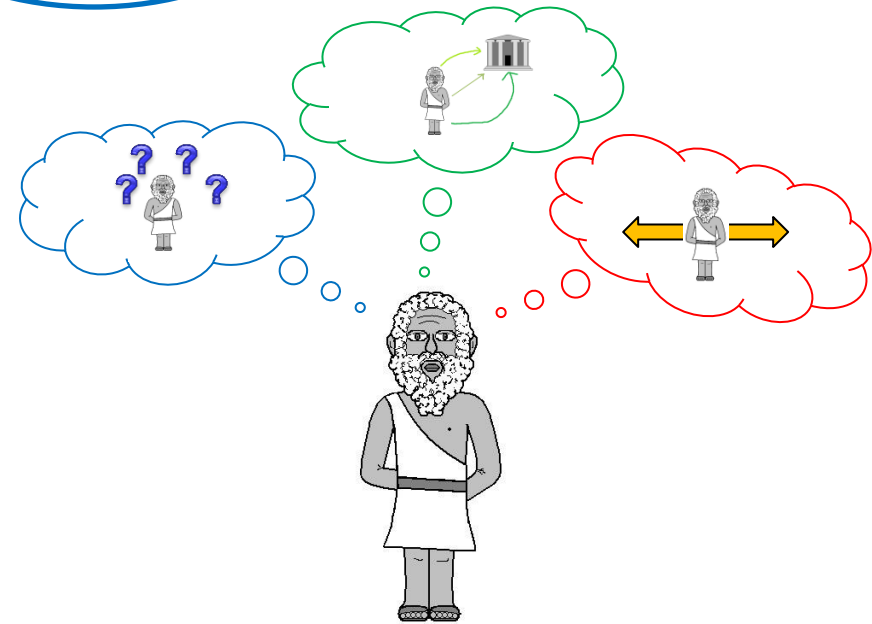


Game Artificial Intelligence



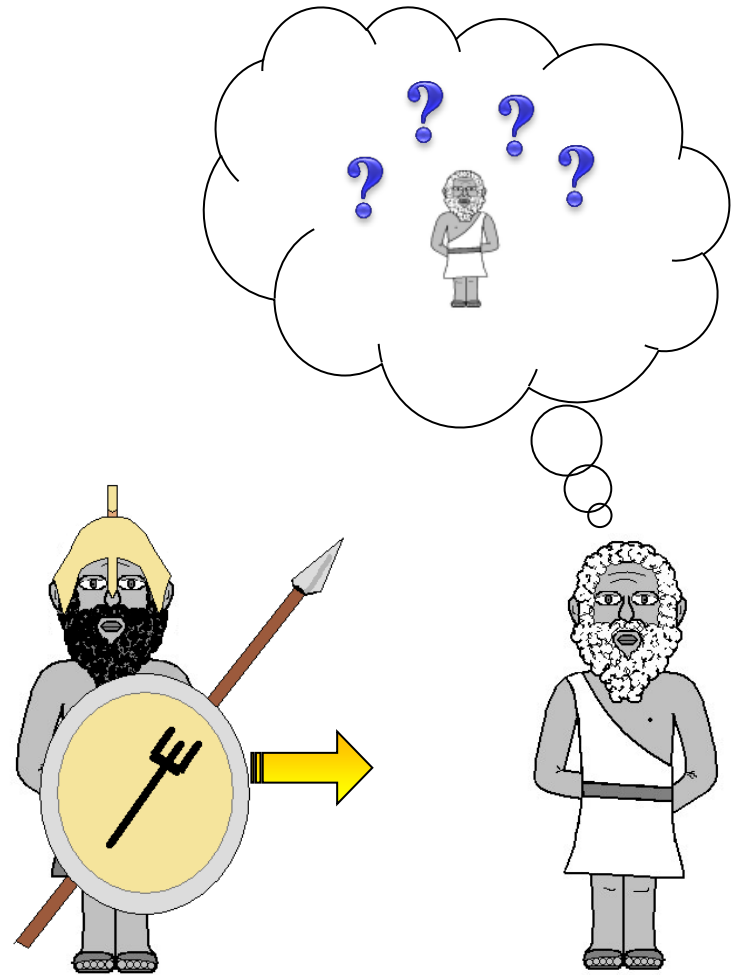
Usually restricted to:

1. decision making
2. path finding (*planning*)
3. steering/navigation (*motion control*)



Game AI – Decision Making

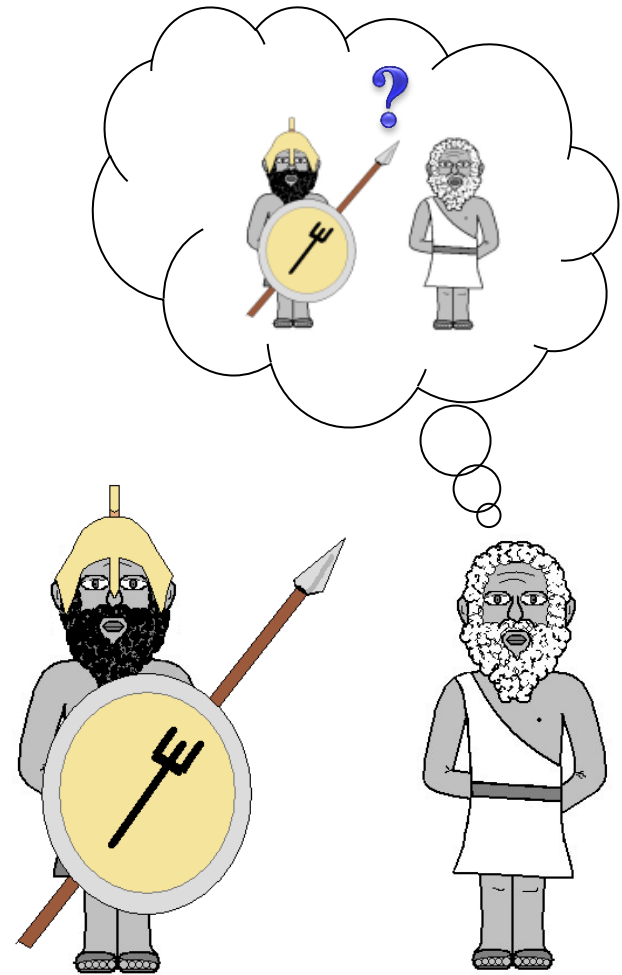
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games have used rule-
based systems



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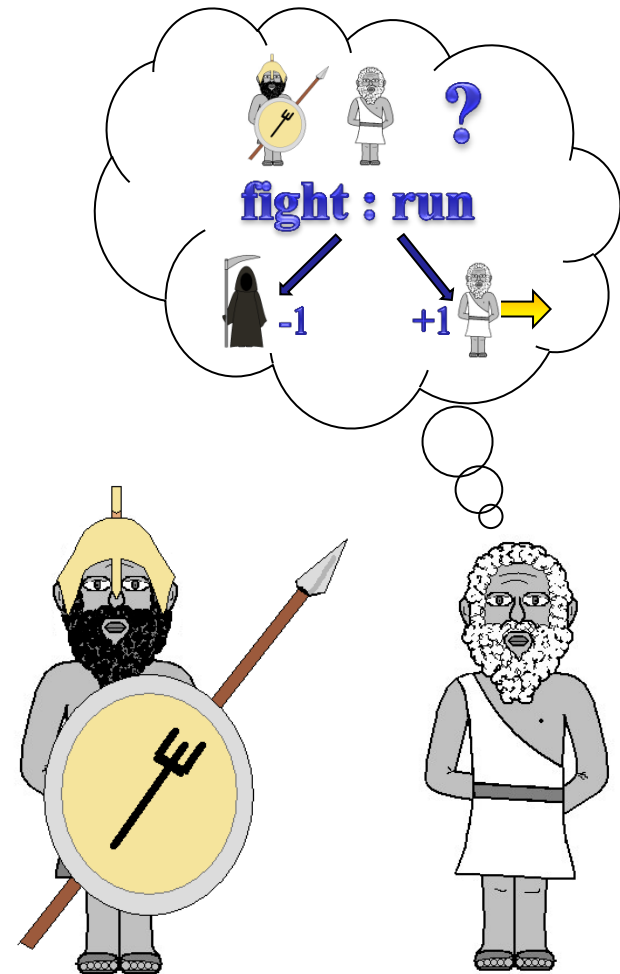
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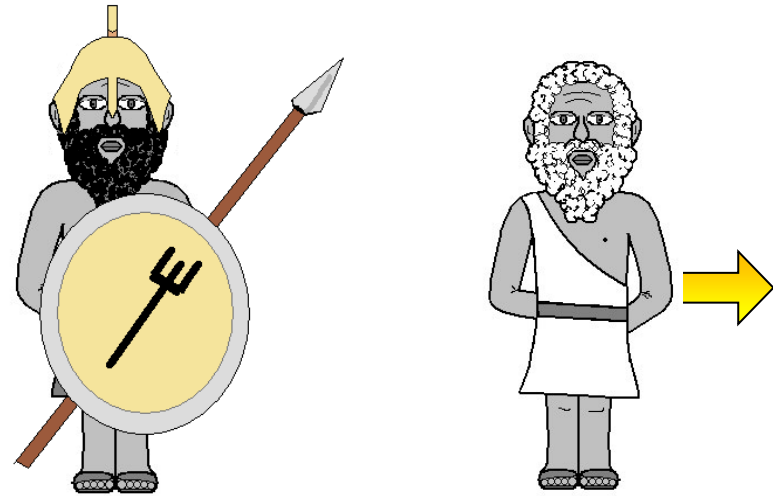
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Game AI – Decision Making

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1. a game event triggers a situation evaluation
2. simple rules (if→then)
check which response
has a positive result
3. the decision is made and
implemented



Game AI – Decision Making

- rule-based systems are easy to create, but their complexity grows exponentially

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- modern games have rich virtual environments with thousands of objects and characters that NPCs can interact with



Assassin's Creed 3

Game AI – Decision Making

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- modern games have rich virtual environments with thousands of objects and characters that NPCs can interact with
- future games need AI techniques that scale well to these new requirements



Assassin's Creed 3

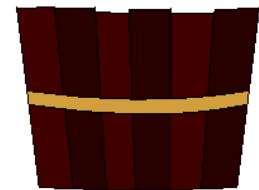
Path Planning & Navigation

- a virtual world given as a graph allows planning algorithms to find paths
- game characters can then follow these paths
- future games will have graphs of actions and character states to use planning algorithms for decision making



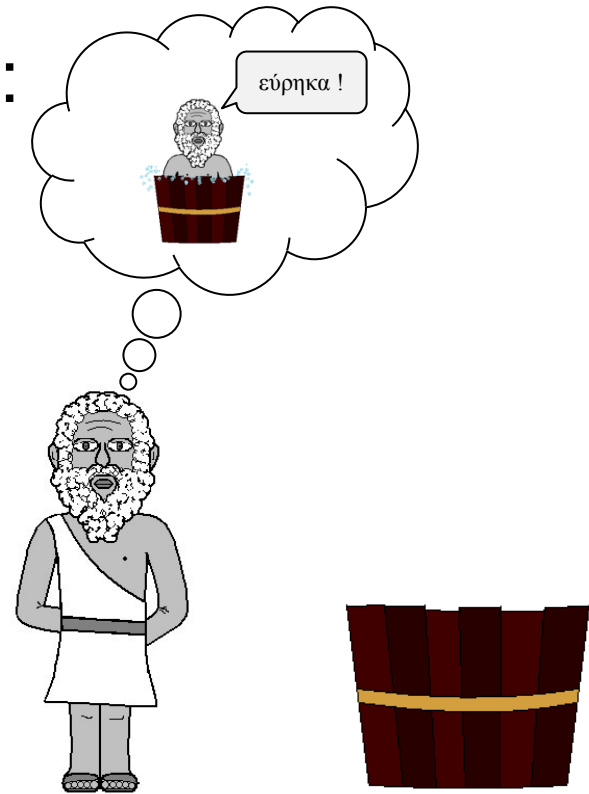
Game AI with Annotated Entities

- future game objects provide their own usage instructions



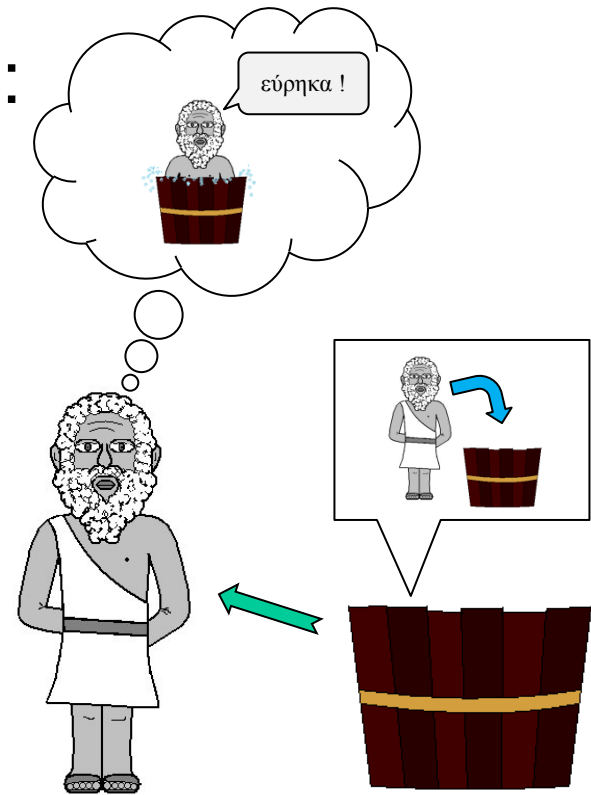
Game AI with Annotated Entities

- future game objects provide their own usage instructions:
 1. a character has the goal to use a game object



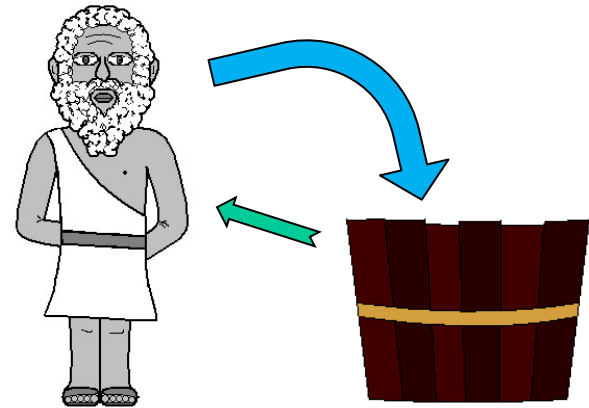
Game AI with Annotated Entities

- future game objects provide their own usage instructions:
 1. a character has the goal to use a game object
 2. the game object sends its usage instructions to the character



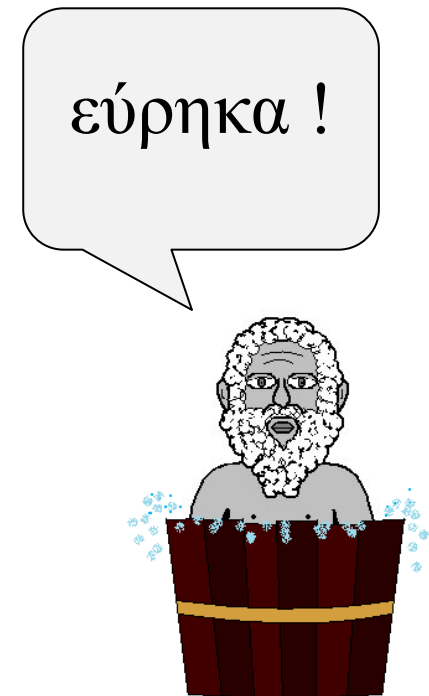
Game AI with Annotated Entities

- future game objects provide their own usage instructions:
 1. a character has the goal to use a game object
 2. the game object sends its usage instructions to the character
 3. the character executes the instructions

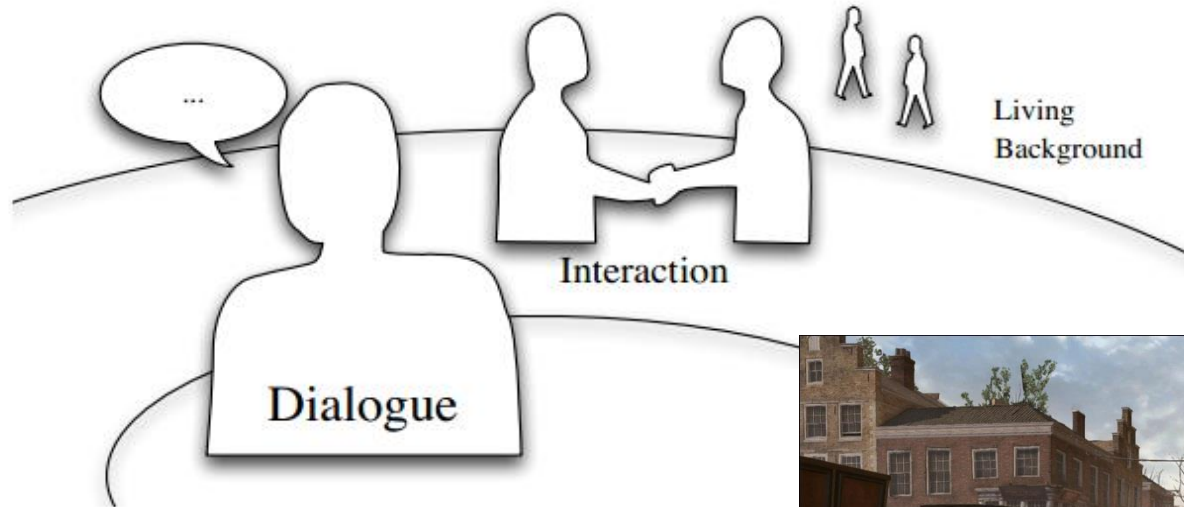


Game AI with Annotated Entities

- future game objects provide their own usage instructions:
 1. a character has the goal to use a game object
 2. the game object sends its usage instructions to the character
 3. the character executes the instructions
- makes it easy to extend the game world



Modelling Character Behaviour



Let's Meet Milo



Assassin's Creed 3, Ubisoft Entertainment

Gesture Interfaces

- interact with the machine in real-time using more natural interfaces
- hand gestures to control objects on the screen without the use of the keyboard and mouse



Facial Expression

- detect and interpret facial expression in using computer vision approaches
- map onto a virtual character in real-time
- for avatars in MMORPG that mirror the facial expressions of their controllers

