Artificial Intelligence and Games

Introduction

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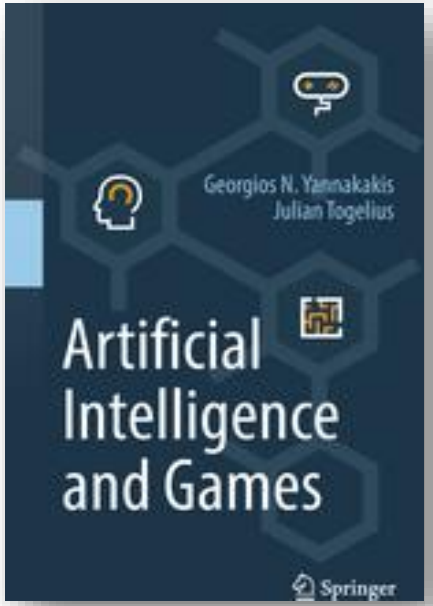


Why a course on AI *in* and *for* Games?

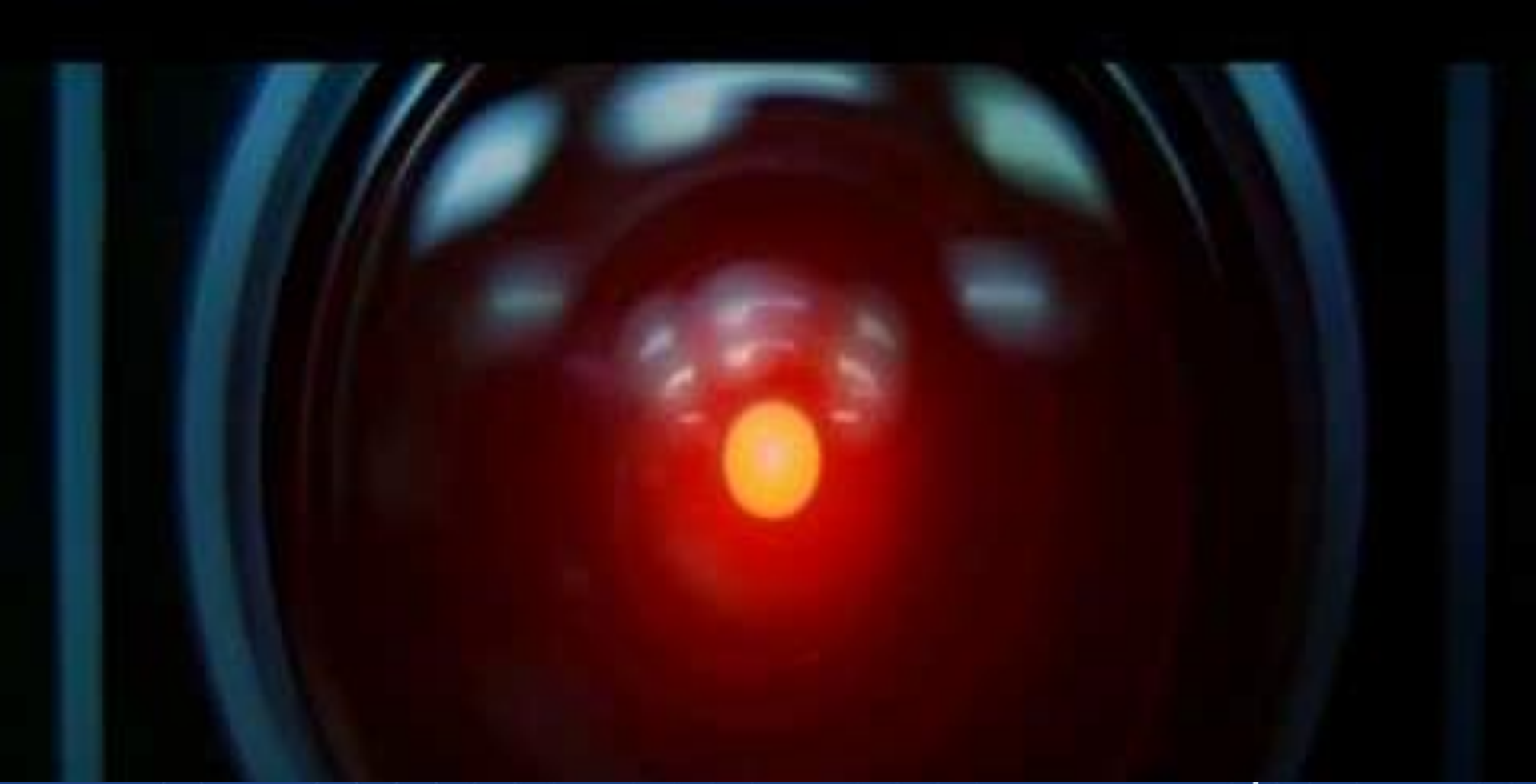
Artificial Intelligence is at the very core of modern game design and development. It plays and tests games, it supports the design of games and it analyses the way we play them. AI techniques used for these tasks include **expert domain-knowledge systems, search and optimization, computational intelligence, and machine learning**. This course aims to introduce students to the theory and practice of **game artificial intelligence.**

Learning Objectives

- Describe and theorize on the AI algorithms covered in class.
- Identify tasks that can be tackled through AI techniques and select the appropriate technique for the problem under investigation.
- Compare the performance of different AI techniques and reflect on their suitability for game AI development.
- Design and implement efficient and robust game AI algorithms.

Class Core Aim

- Give a comprehensive overview of **AI for games** and **games for AI**, as well as hands-on experiences with new technology
- Enable new exciting inventions and discoveries



Artificial Intelligence

Artificial Intelligence

Making **computers** able to do things which currently only **humans** can do

Artificial Intelligence in Games

Making **computers** able to do things which currently only **humans** can do **in games**

What do Humans Do with Games?

- Play them
- Study them
- Build content for them
  - levels, maps, art, characters, missions…
- Design and develop them
- Do marketing
- Make a statement
- Make money!

Games for Artificial Intelligence

Games are **Hard** and **Interesting** Problems!

Calm

Stressed

Richest (?) HCI

NEVERMIND

BIOFEEDACK IN ACTION

Games are everywhere

More Content More Data

NSF

DARPA

Games are content-intensive

Games and AI Areas

Perception
Signal Processing
Machine Learning
Artificial Psychology
Planning and Search
KR and Reasoning
Natural language processing
Navigation
...

nature International weekly journal of science

ARTICLE PREVIEW

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NATURE | LETTER

日本語要約

Google DeepMind

Human-level control through deep reinforcement learning

Volodymyr Mnih, Koray Kavukcuoglu, David Silver, Andrei A. Rusu, Joel Veness, Marc G. Bellemare, Alex Graves, Martin Riedmiller, Andreas K. Fidjeland, Georg Ostrovski, Stig Petersen, Charles Beattie, Amir Sadik, Ioannis Antonoglou, Helen King, Dharshan

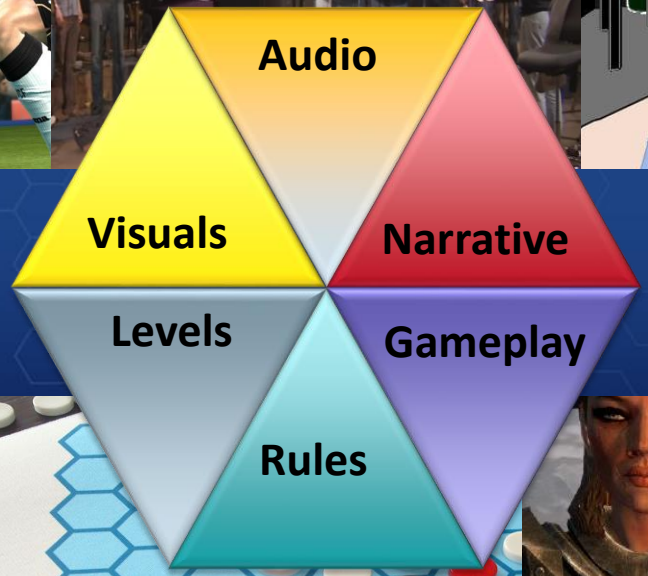
ure14236

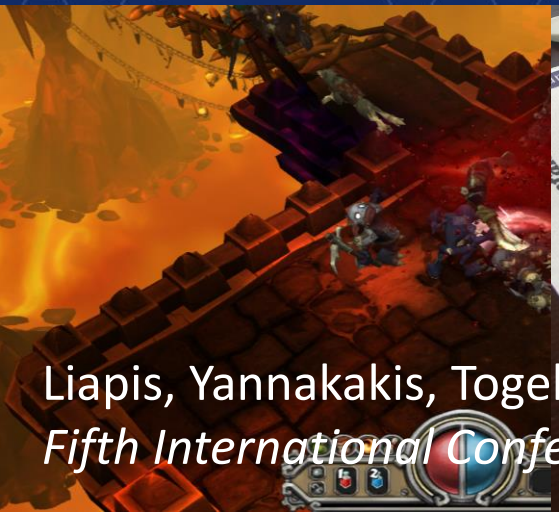
ed online 25 February 2015

le metrics

Games realise AI's long-standing goals

Multifaceted Creativity

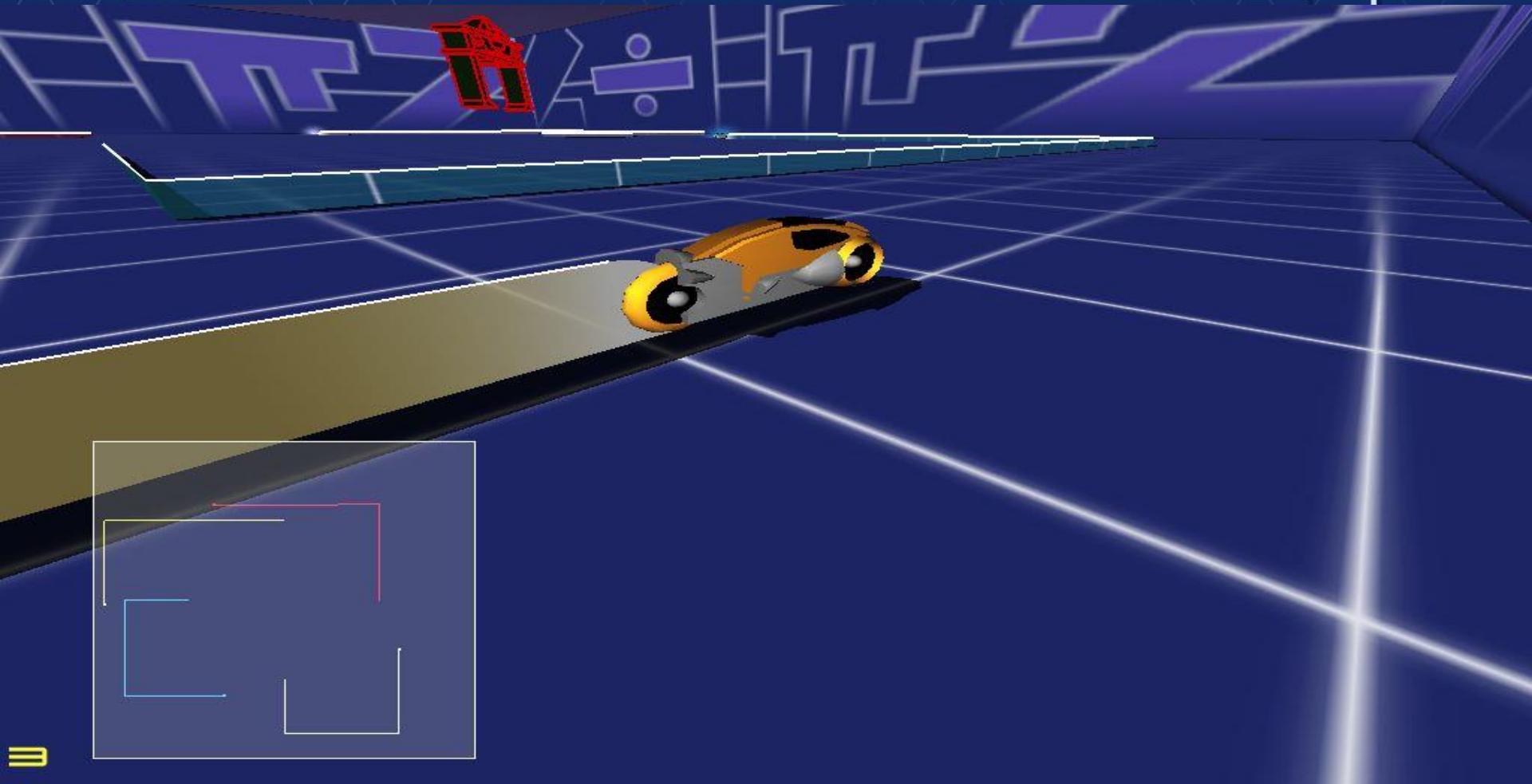




Liapis, Yannakakis, Togelius: **"Computational Game Creativity,"** in *Proceedings of the Fifth International Conference on Computational Creativity*, 2014.

Artificial Intelligence **for** Games

AI Plays and Improves your Game



What is Diablo 3: "[previous] games established the series' hallmarks: randomized levels, the relentless attacks of monsters and events in a **perpetually fresh** world, [...]"

"Experience Daylight, a **procedurally generated** psychological thriller for your PC."

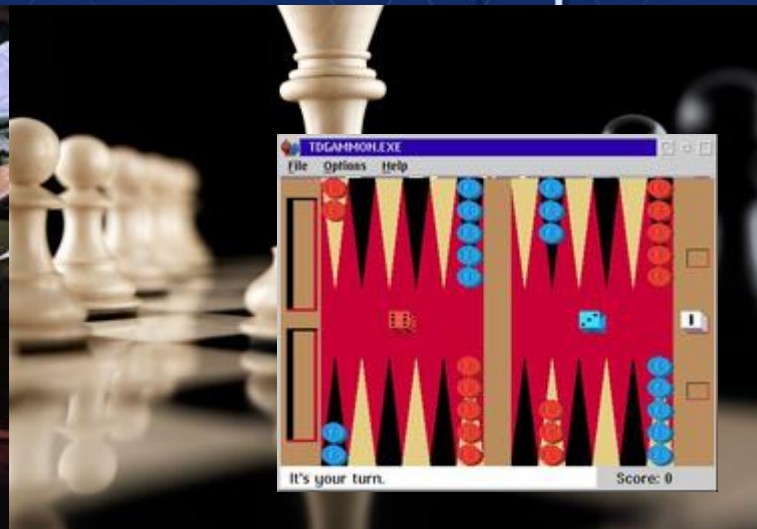
More Content, Better Content!

Player Experience – Data Mining

AI and Games History – **Academia**

A long-lasting love (1950s)

Early Days on the Board (60s-present)



The Digital Era - A milestone

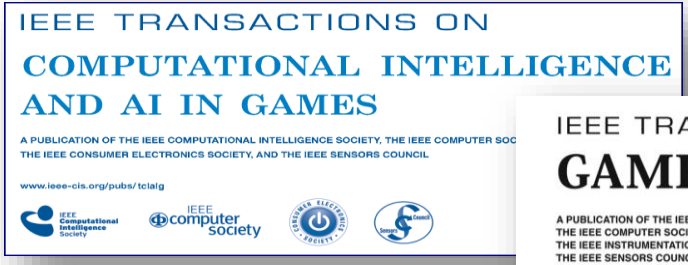
- The Game Turing test was passed by two AI-controlled bot entries in *Unreal Tournament 2004,* in 2012!
- Neuroevolution was one of the approaches

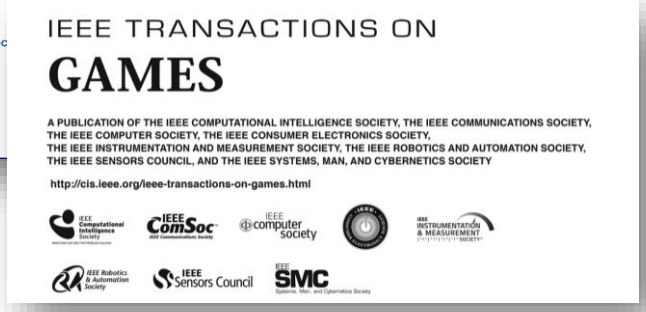
The Digital Era – A few other milestones

Maluuba

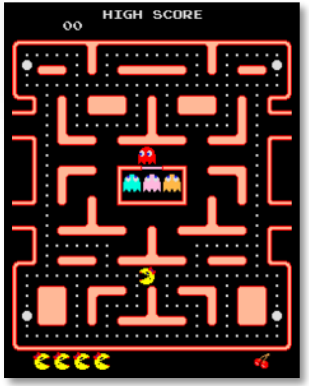
DeepMind

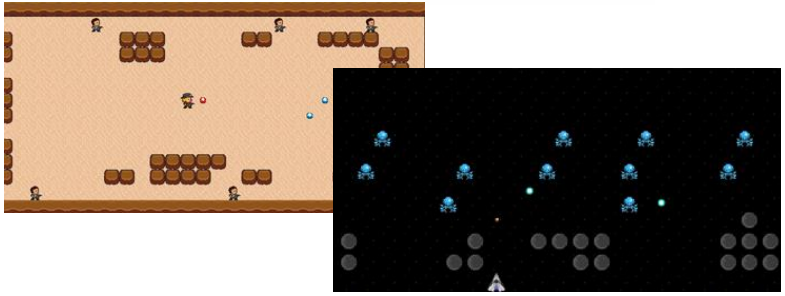
From Board to Computer Game AI



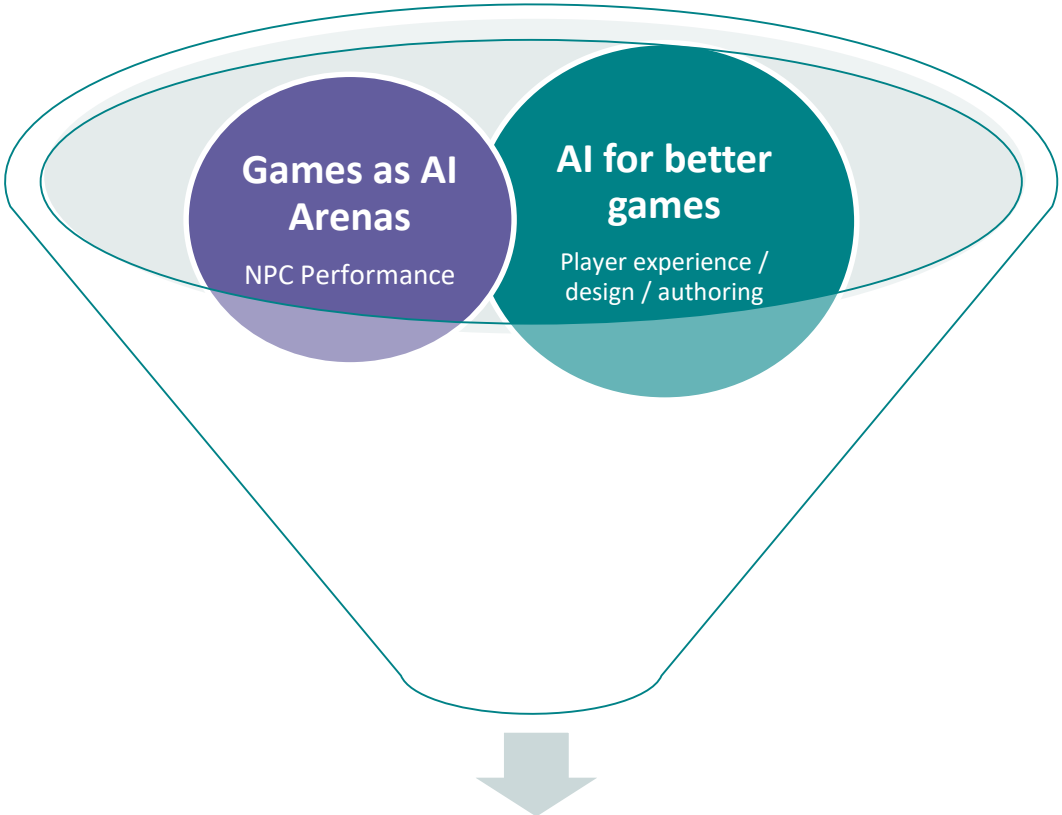


IEEE CIG and AIIDE Competitions

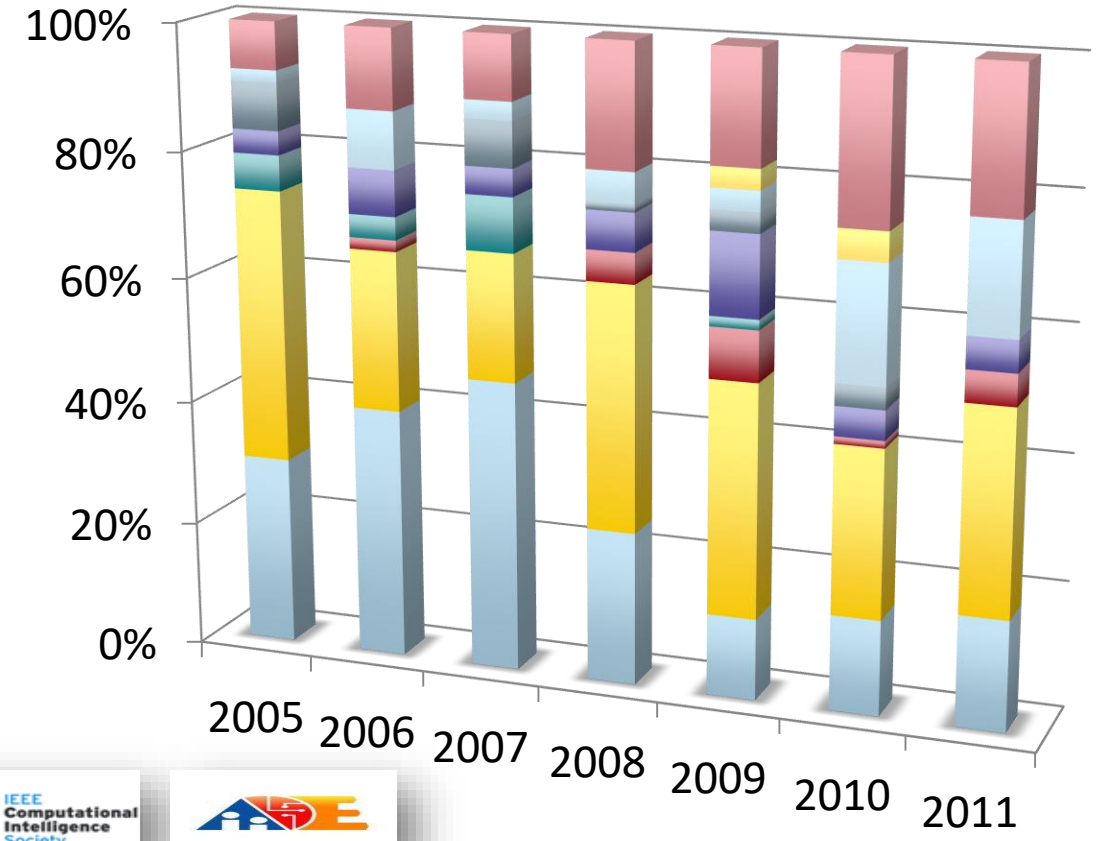




Computer Game AI in Academia: History



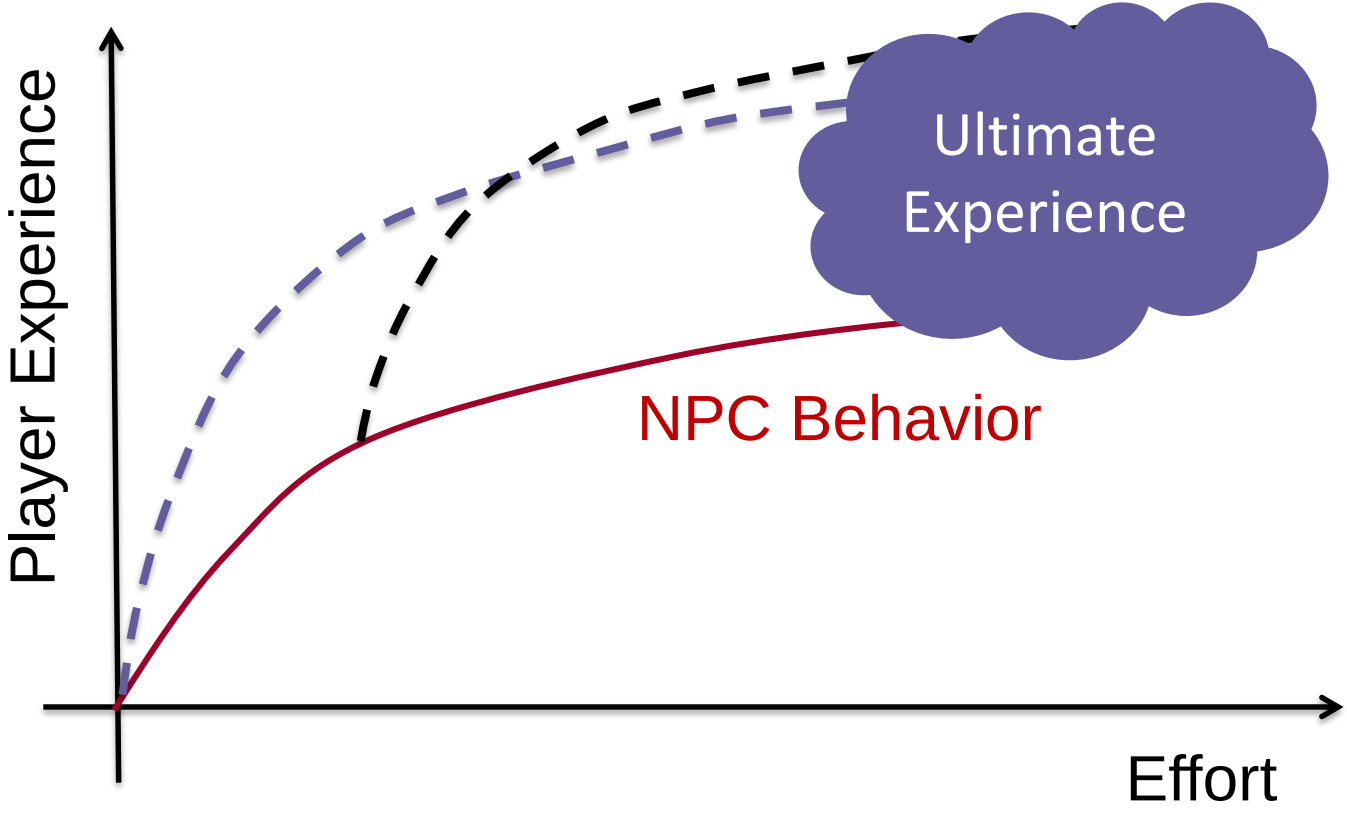
Computer Game AI



- Player Experience/Believability
- Game DM
- PCG
- Interactive Storytelling
- Pathfinding
- Robotics/A-Life
- Authoring
- NPC
- Board/Math games

IEEE Computational Intelligence Society

Game AI is Dead!

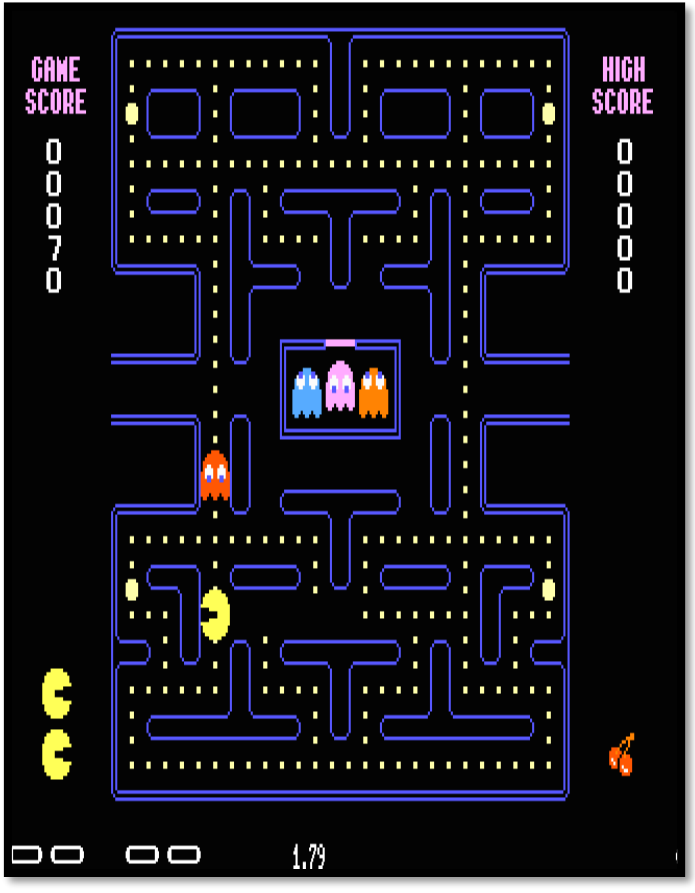


Yannakakis, G. N. "**Game AI revisited**" *Proceedings of the 9th conference on Computing Frontiers*. ACM, 2012.

AI and Games: A bit of history – **Industry**

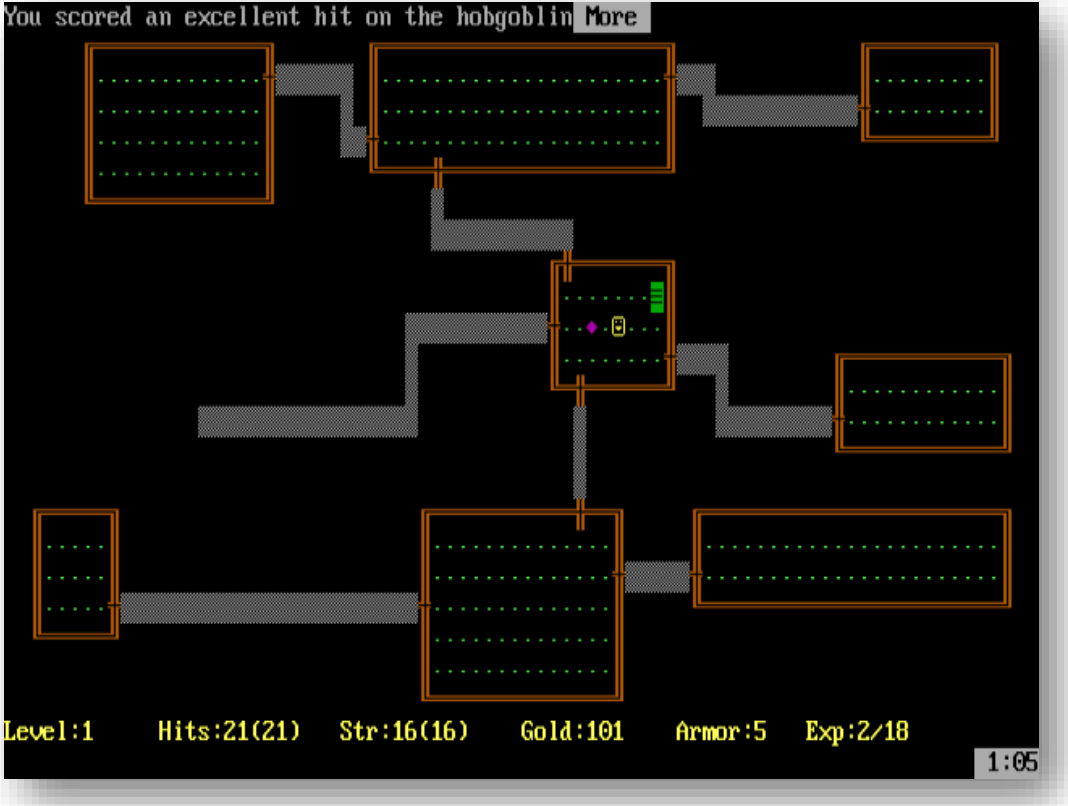
PacMan (Namco, 1980)

- Implicit cooperation
- Differing Ghost "Personalities"
  - Aggressive **Blinky**
  - Cunning **Pinky**
  - Wired **Inky**
  - Scared **Clyde**
- Attack – don't care waves
- No randomness



Rogue (AI Design, 1980)

- Level generation
- Constructive approach
- Inspired rogue-like game genre

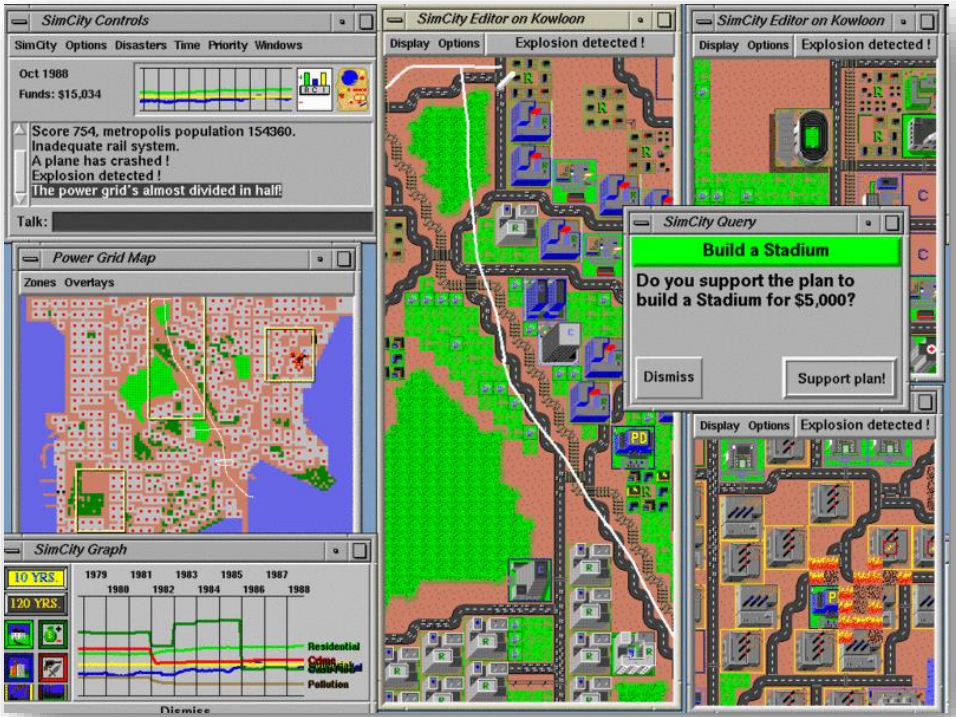


Elite (Acornsoft, 1984)

- Galaxy generation
- Compression

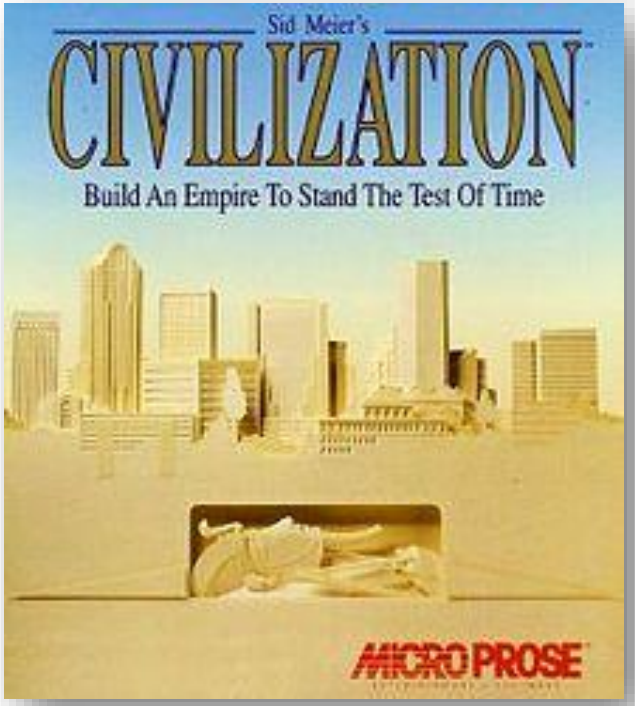
SimCity (Maxis, 1989)

- Cellular automata
- Influence Maps



Civilization (MicroProse, 1991)

- Map/Level generation

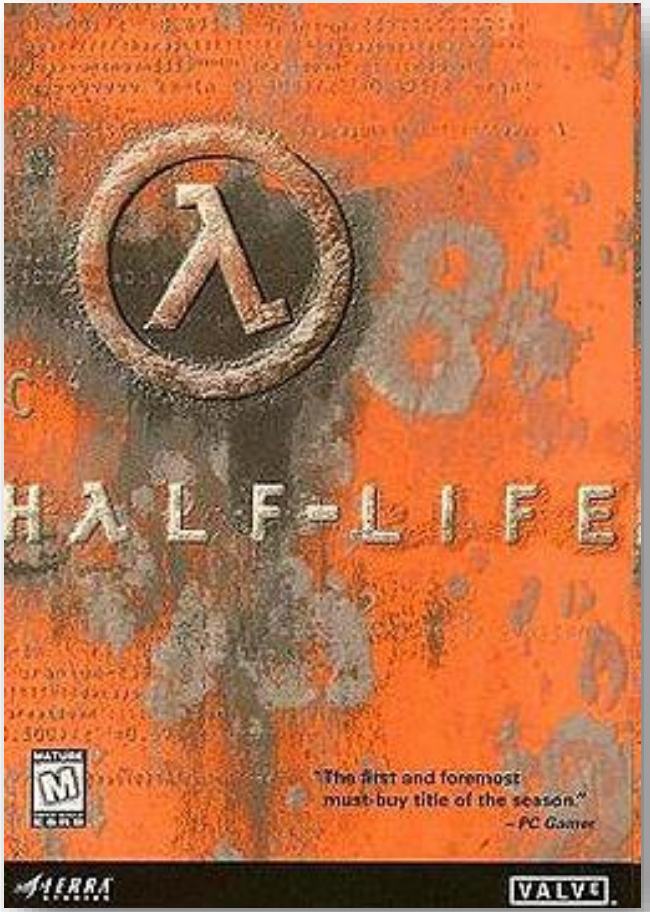


Thief (EIDOS, 1998)

- Stealth FPS, FP-Sneaker
- Advanced sensory system
- Guards perceive and respond to the environment
  - Noise, lighting, movement, and shadows.

Half-Life (Valve, 1998)

- FPS + puzzle solving
- Opponent Tactics
  - Coverage, dodging, full-level navigation
- Integration of AI into the story
- Valve hired Quake AI Mod developers for HL 2



Sims (EA, 2000)

- Smart (interactive) terrains
- Smart (interactive) objects

Black & White (EA, 2000)

- Perceptrons, Decision Trees, Belief-Desire-Intentions model
- Imitation Learning
- Reinforcement learning: creature slapped or stroked
- Gesture recognition

Halo 2 (MS Game Studios, 2004)

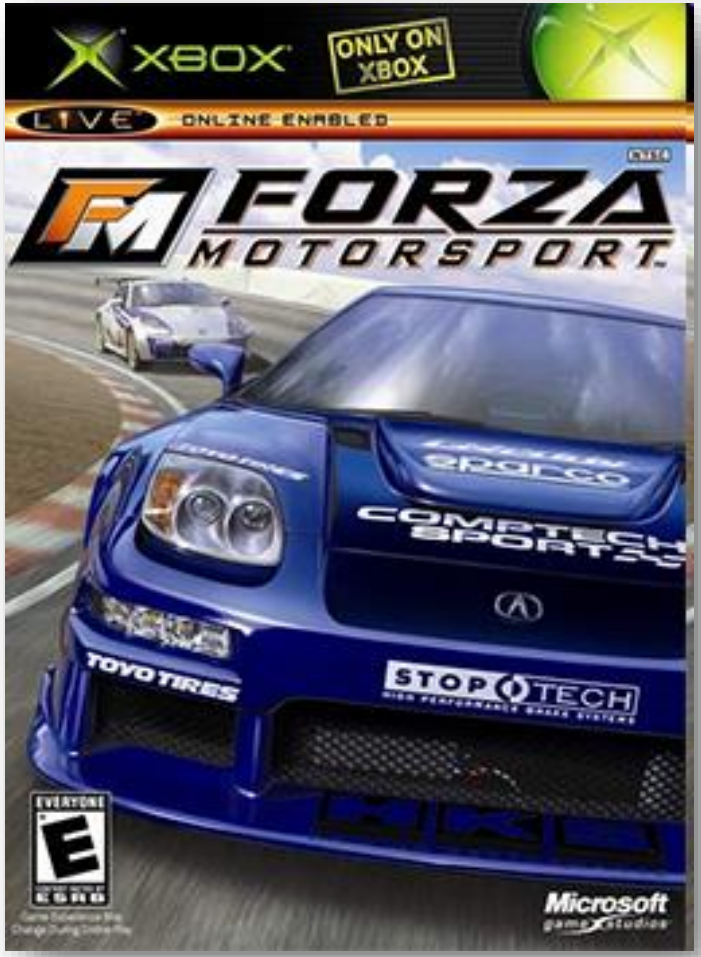
- The revolution of **Behavior Trees**
- More human-like bots

F.E.A.R. (Sierra, 2005)

- Best AI opponent – bot (at the time)
- Bot squads, teammate behaviors
- Cover when hit from behind
- Intelligent tactics
- Move through walls and under objects
- Planning system based on STRIPS
- “Environments to showcase the AI”

Forza Motorsport (MS game studios, 2005)

- Drivatar system
- Imitation Learning
- MS Research – Cambridge

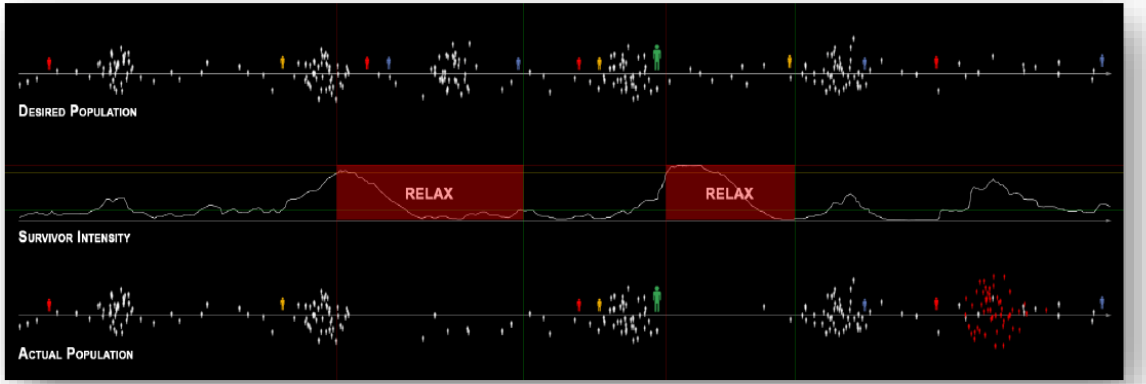


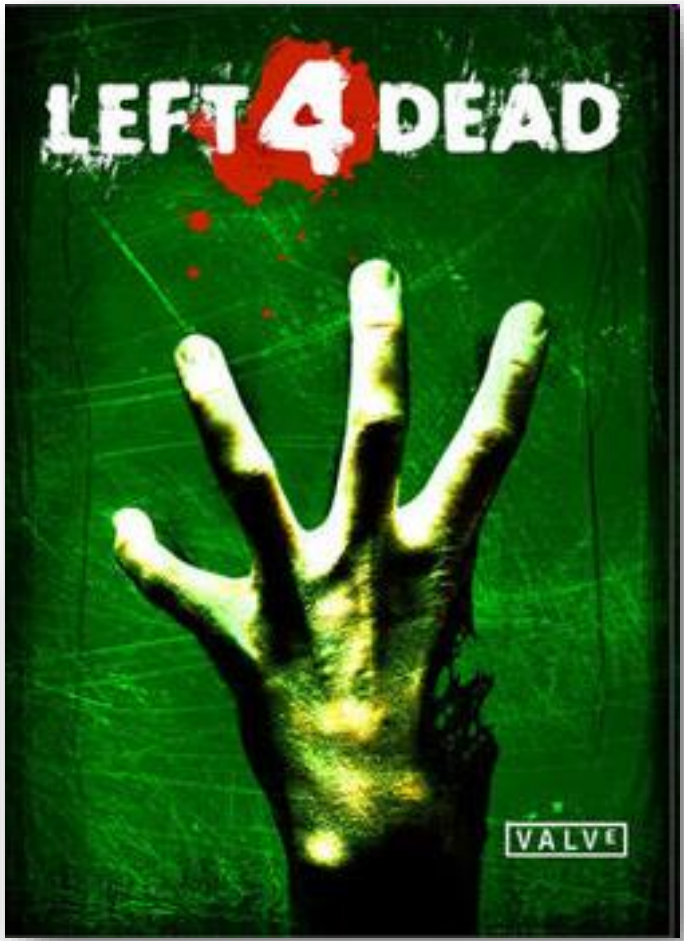
Façade (Mateas & Stern, 2005)

- Interactive Storytelling
- Natural Language Processing
- AI faults: absorbed by game (character) design

Left 4 Dead (Valve, 2008)

- **AI director**
  - Intelligent enemy placement
  - Intelligent item placement
  - Player emotional cues (visual effects, dynamic music)



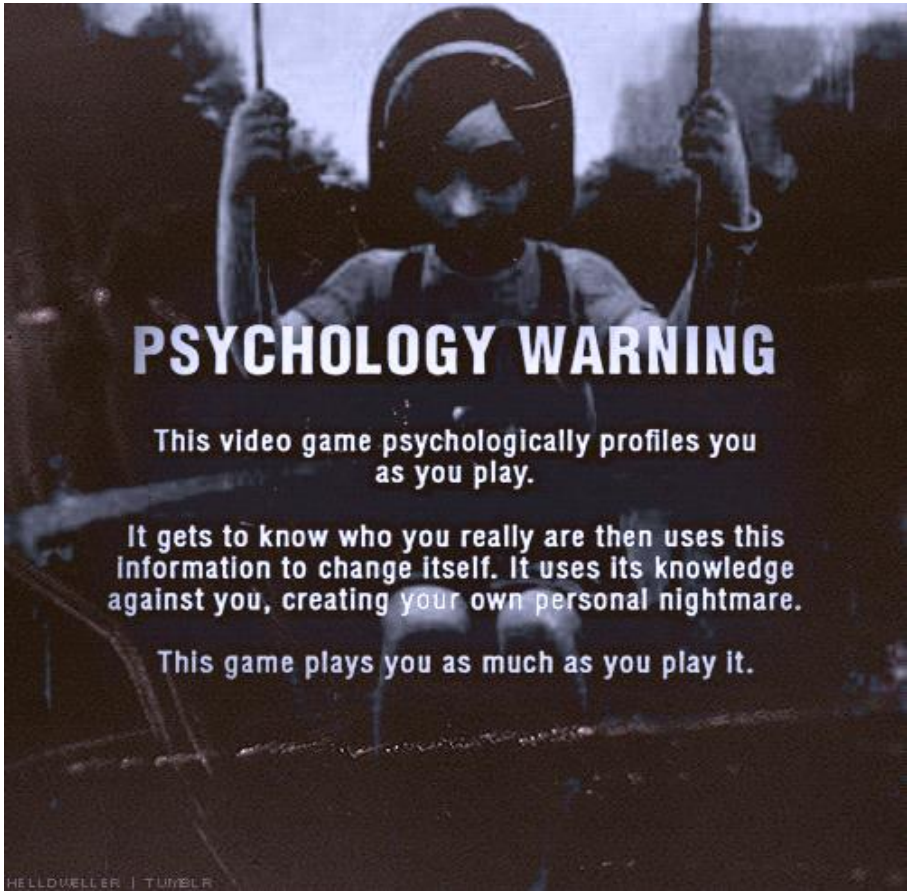


Spelunky (Mossmouth, 2008)

- Level generation
- Ultimate re-playability
- Guarantees playability

Silent Hill (Konami, 2010)

- Survival horror
- Personality-based adaptation



Heavy Rain (Quantic Dream, 2010)

Various Kinect Games (2010 – …)

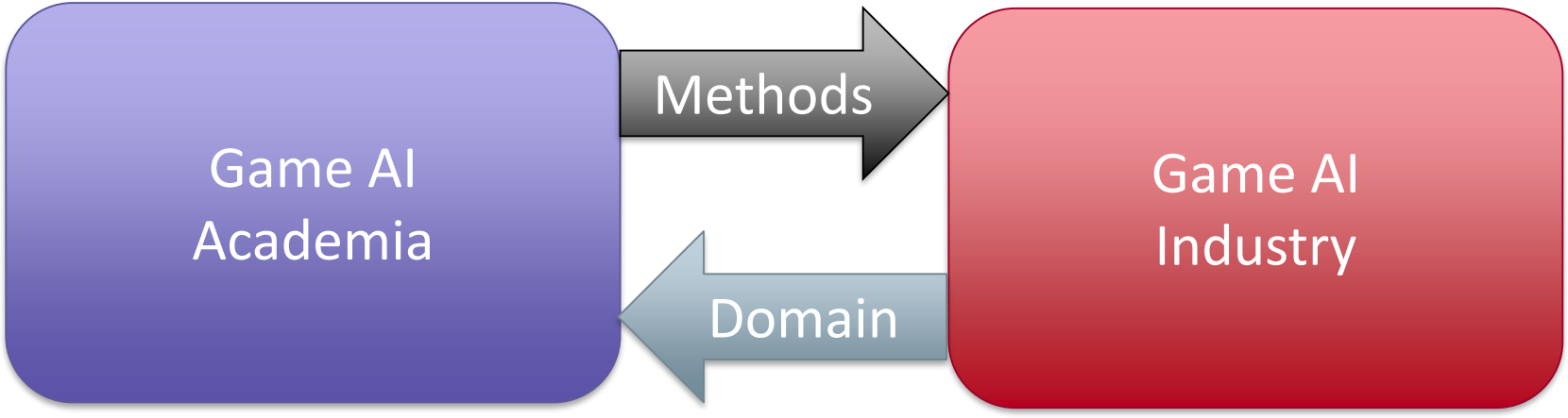
- E.g. Kate & Milo (demo), Kinectimals, etc..
- Affective AI
- Posture (fully body) Recognition
- Speech recognition

Bioshock Infinite (2k Games, 2013)

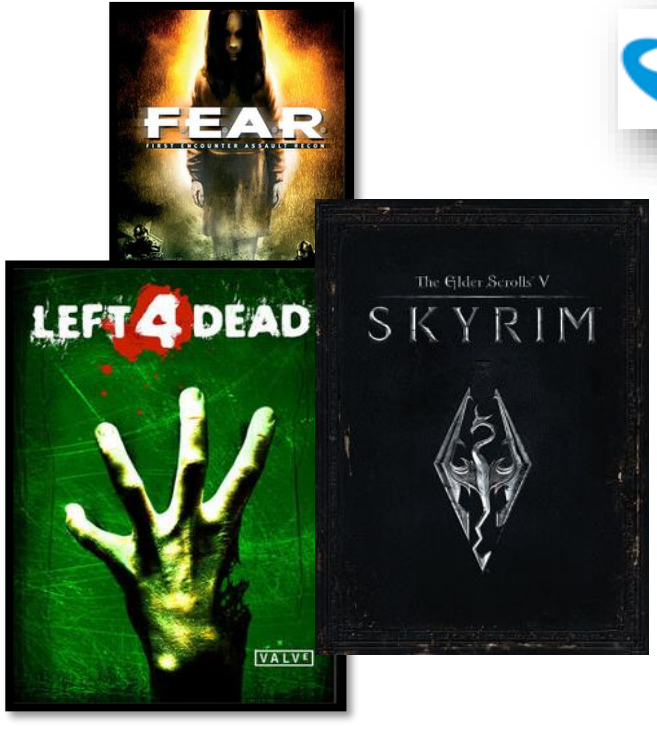
Nevermind (Flying Mollusk, 2016)

No Man's Sky (Hello Games, 2016)

A historical “gap”



Some Facts about the “Gap”



IEEE Computational Intelligence Society

AIIDE

AI Summit

GDC

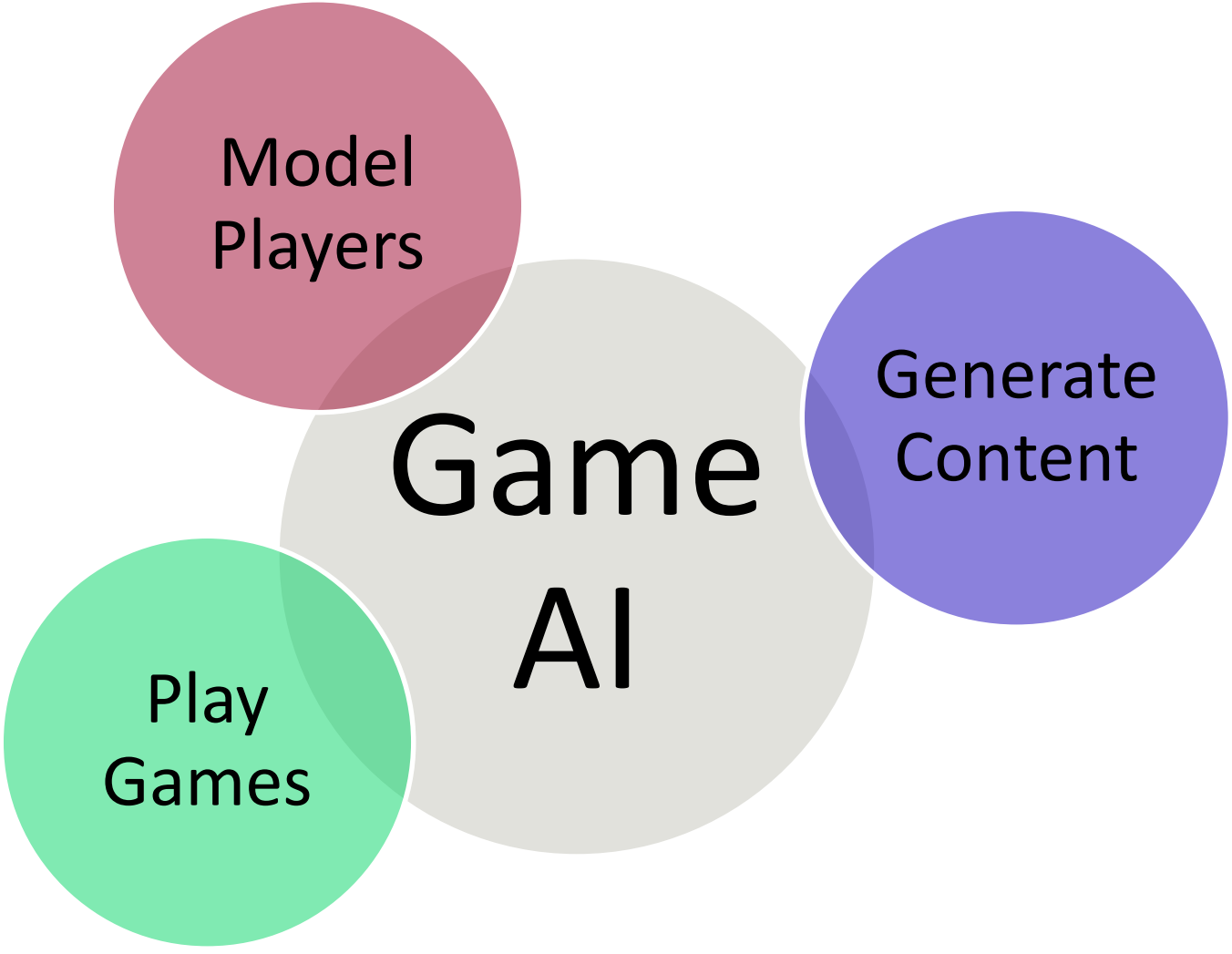
Games helps us design **better** AI…

…and AI can help us make **better** games ...

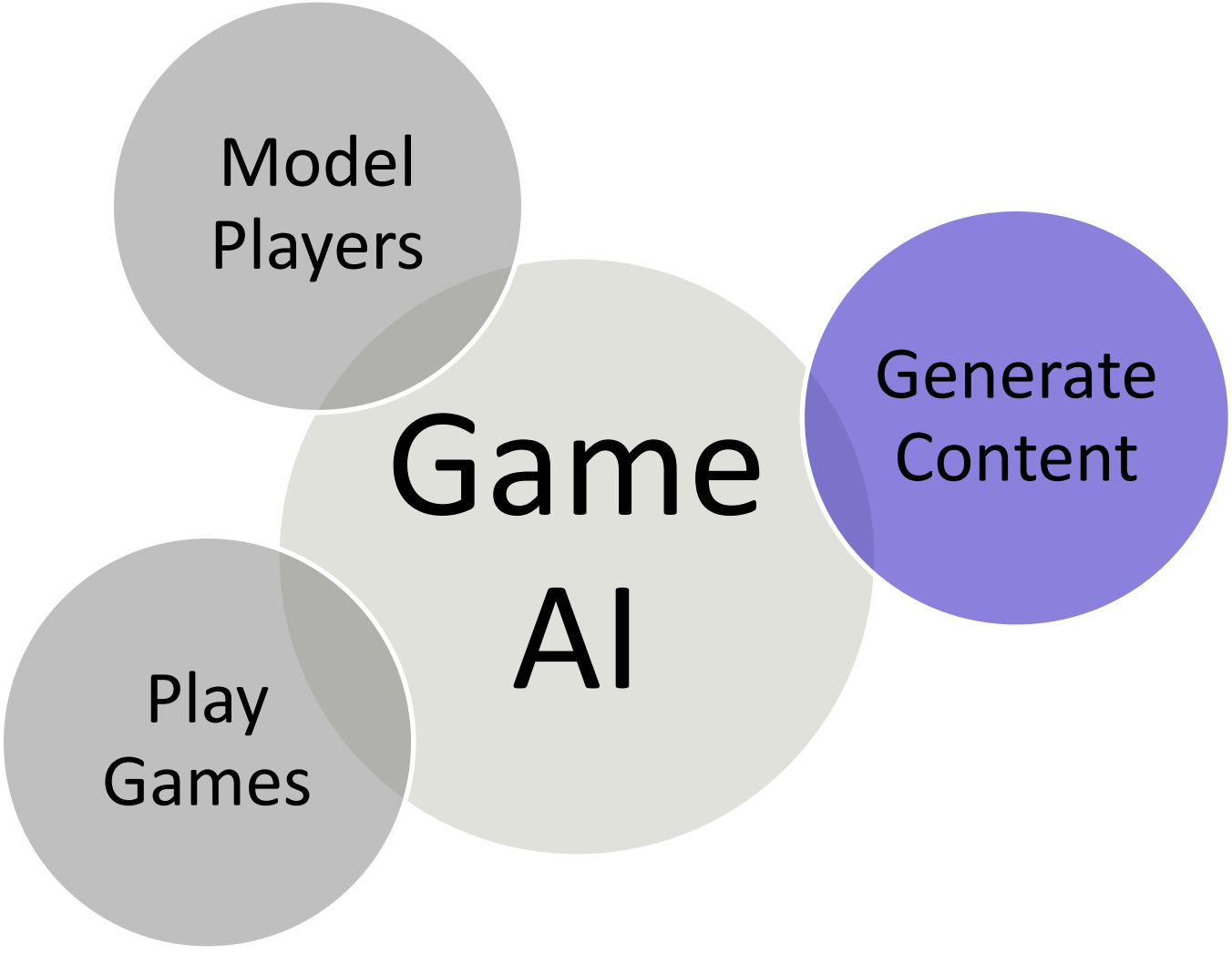
…but not necessarily through **game agents**!

How then?

G. N. Yannakakis, "**Game AI Revisited**," in *Proceedings of the 9th ACM Computing Frontiers Conference*, pp. 285-292, 2012. (**invited paper**)

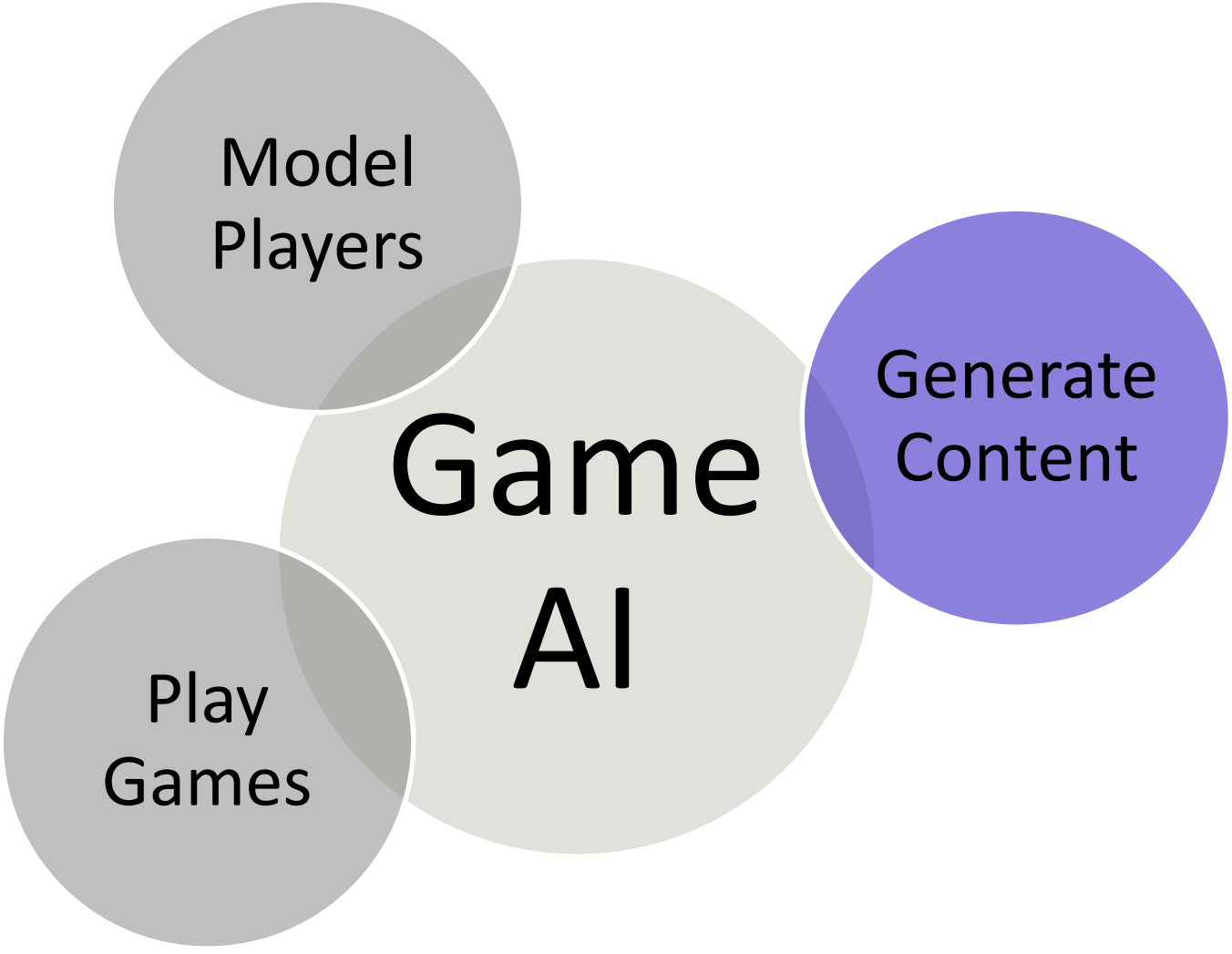


G. N. Yannakakis and J. Togelius, "**Artificial Intelligence and Games**," Springer Nature, 2018



G. N. Yannakakis and J. Togelius, "**Artificial Intelligence and Games**," Springer Nature, 2018

Procedural Content Generation



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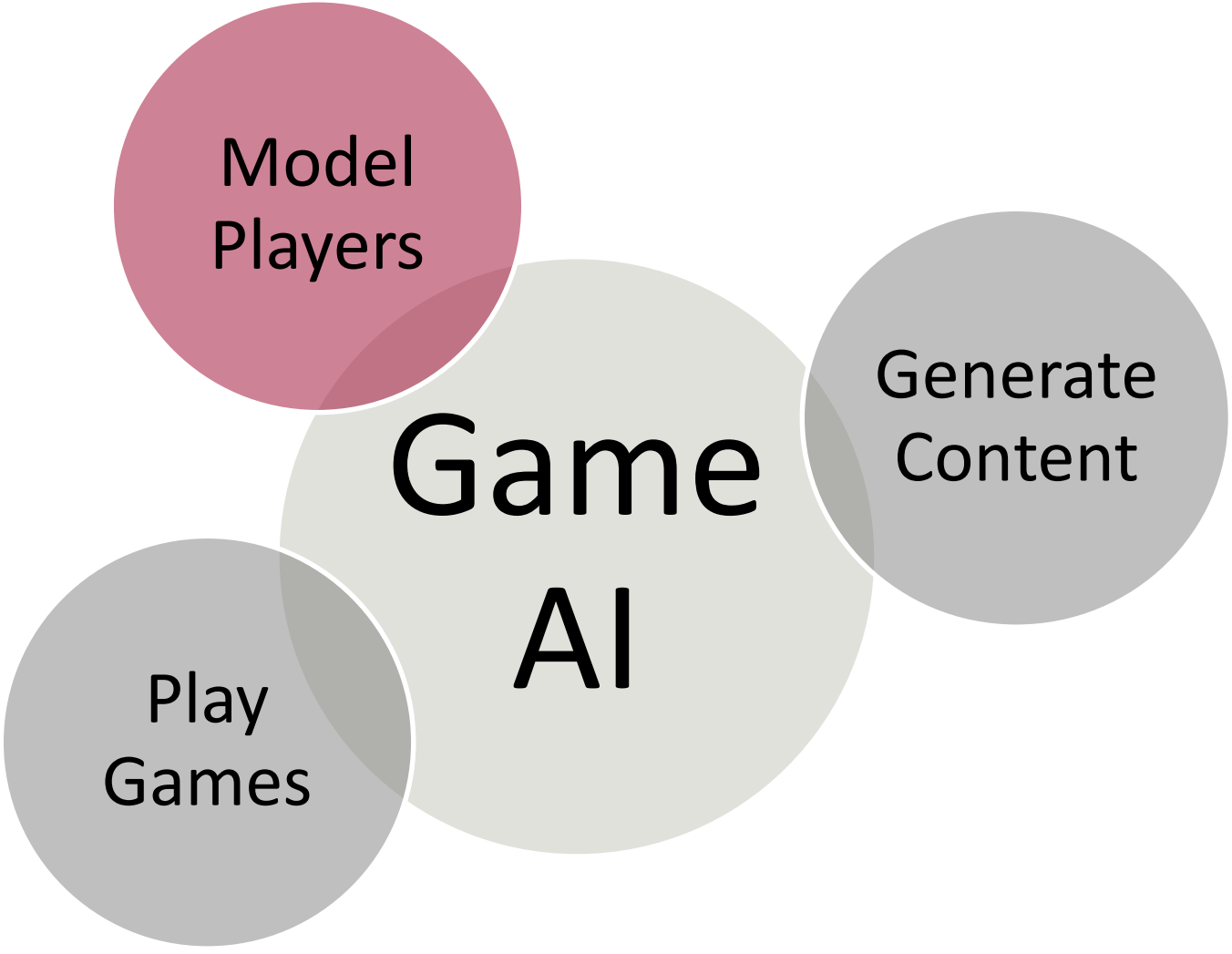


G. N. Yannakakis and J. Togelius, "**Artificial Intelligence and Games**," Springer Nature, 2018

“**Games** cannot be dissociated from **emotion** and **learning**…”

G. N. Yannakakis and A. Paiva “**Emotion in Games**,” in *Oxford Handbook of Affective Computing*, 2014

Player Modeling

“Games: the **final frontier** for AI?”

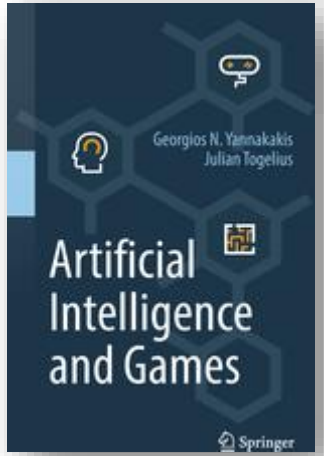
“AI: the **next step** for Games!”

About the Book

Welcome to the Artificial Intelligence and Games book. This book aims to be the first comprehensive textbook on the application and use of artificial intelligence (AI) in, and for, games. Our hope is that the book will be used by educators and students of graduate or advanced undergraduate courses on game AI as well as game AI practitioners at large.

Final Public Draft

The final draft of the book is available here!



Readings: Chapter 1

gameaibook.org