Experience-Driven Procedural Content Generation

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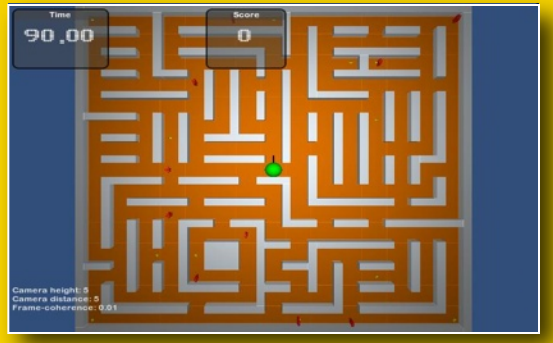

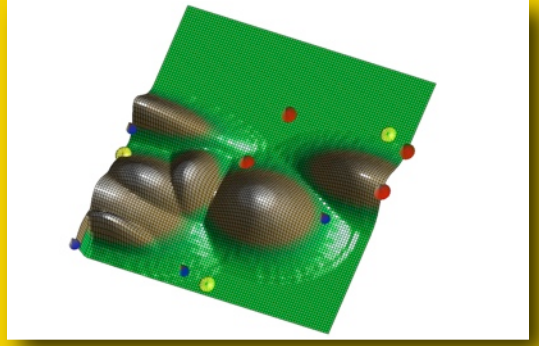

Center for Computer Games Research @ ITU

- http://game.itu.dk
- Established in 2003
- 7 Faculty, 6 PhD students
- Research Areas:
  - Humanities/Arts/Social Sciences:
    Game Theory, Game Design and Analysis
  - Technology/Computing:
    AI, Usability, Player Experience,
    Cognitive/Affective Modeling

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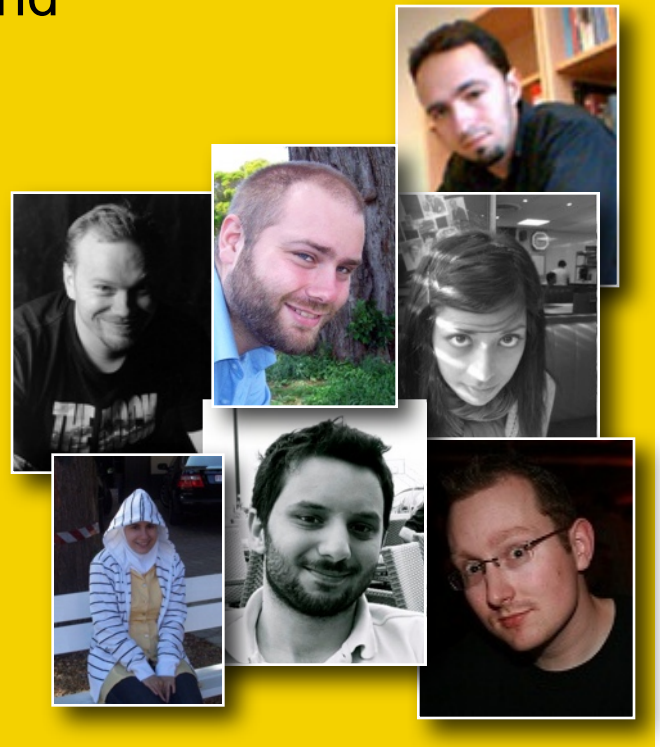
Game AI/Technology SIG

Specialization in Artificial Intelligence and Game technology

- Games and Entertainment
  - Personalization
  - Adaptation
  - Procedural Content Generation
- Games and HealthCare
  - Exertainment, Wiihabilitation
- Games and Education
  - Serious games for conflict resolution



Technology

User/Player Modeling, Real-Time Adaptation, Multimodal Interaction

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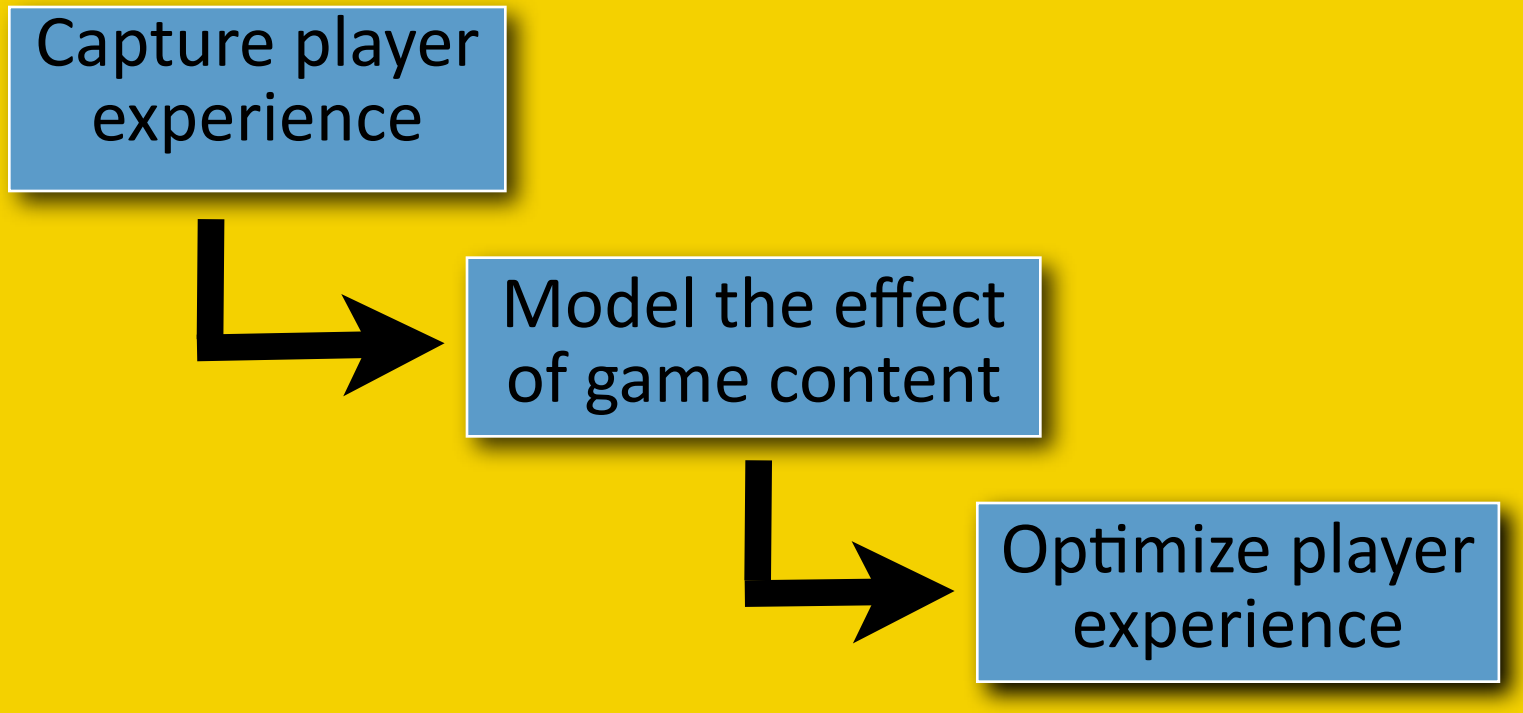
Today's Presentation

- Introduction to
  - Player Experience Modeling
  - Procedural Content Creation/Generation
  - Their relation: EDPCG
- Showcased via dissimilar case-studies
  - Entertainment, Heath Care, Education

Core Idea of EDPCG



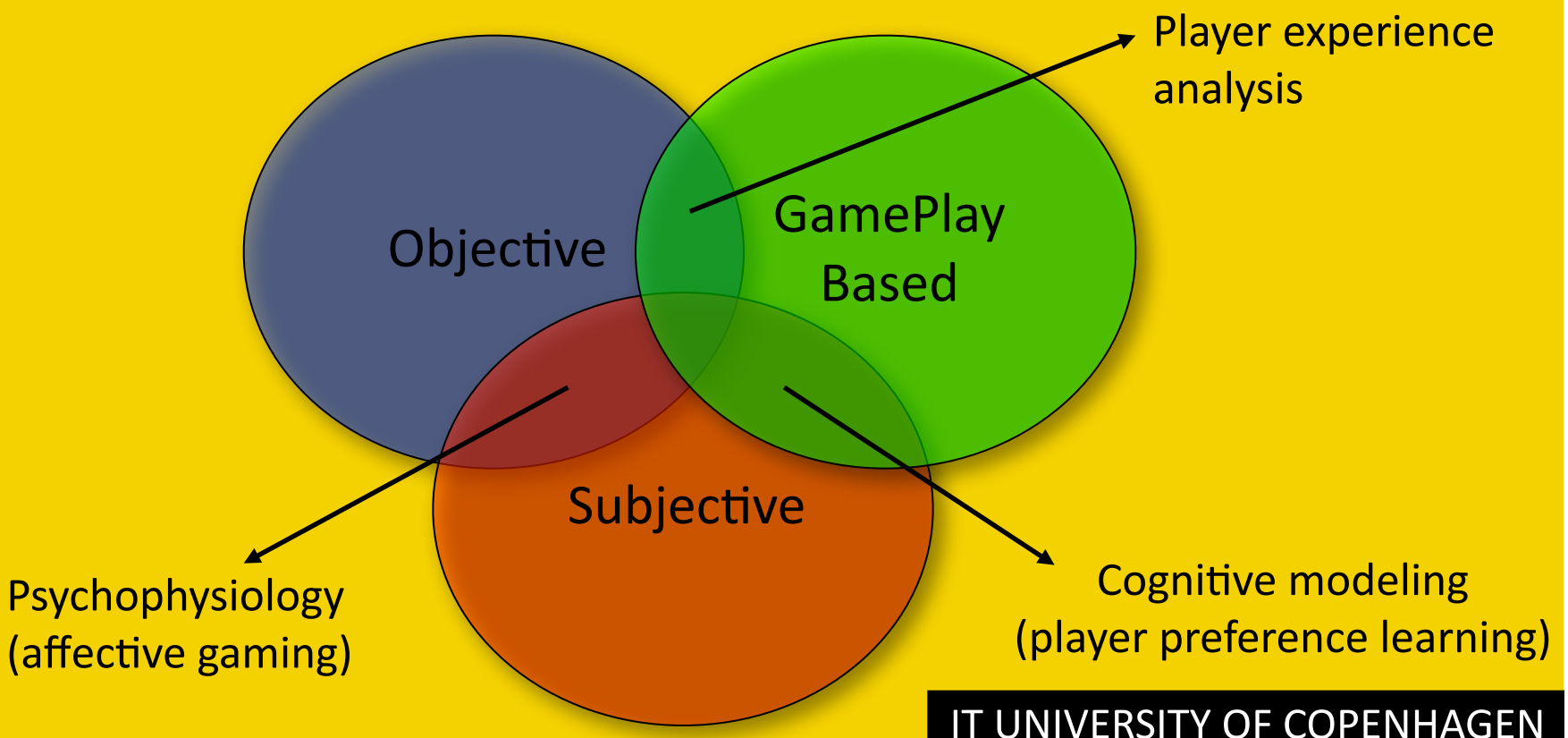
Research questions of EDPCG

- How to capture **Player Experience**?
- How to represent **content**?
- How to evaluate the **quality** of content?
- How to **optimize** game content for Player Experience?

How to Capture Player Experience

- **Subjectively**
  - Asking players: self-report questionnaires (ranking, preferences)
  - **Pros:** subjective self-reported notions of emotional states
  - **Cons:** memory dependent, noisy, post-experience, intrusive
- **Objectively**
  - Physiology (GCR, EEG, EMG, BVP,…); eye-tracking; facial expression; speech
  - **Pros:** reliable measures of user experience
  - **Cons:** noisy; technically non plausible; games have a particular impact on physiology and facial expression; verbal cues are rare; based on annotation of other players
- **GamePlay-Based**
  - Player game preferences (what players do relates to their experience)
  - **Pros:** real-time efficiency, not intrusive
  - **Cons:** strong assumption about similarity of people, limitations in available information

Player Experience Modeling (PEM)



Game Content

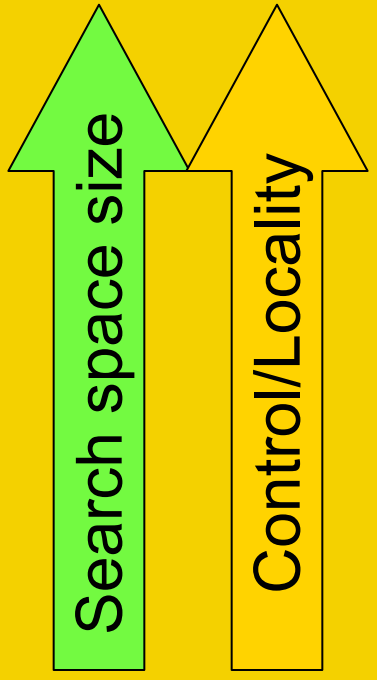
Building blocks of a Game (and Player Experience)

- NPC behavior
- Quest/story
- Camera parameters/settings
- Audio settings
- Levels, maps, tracks
- Game mechanics, game design
- Graphics/textures

We need (ED)PCG to...

- Automate game design and testing processes
- Design new games
- Tailor player experience

Representing Content (e.g. Dungeon Map)



- Directly: grid
- More indirectly: position and orientation of walls
- Even more indirectly: patterns of walls and floor
- Very Indirectly: number of rooms and doors
- Indirectly: random seed

J. Togelius, G. N. Yannakakis, K. Stanley and C. Browne, **Search-Based Procedural Content Generation**, in *Proc. EvoGames 2010, LNCS*

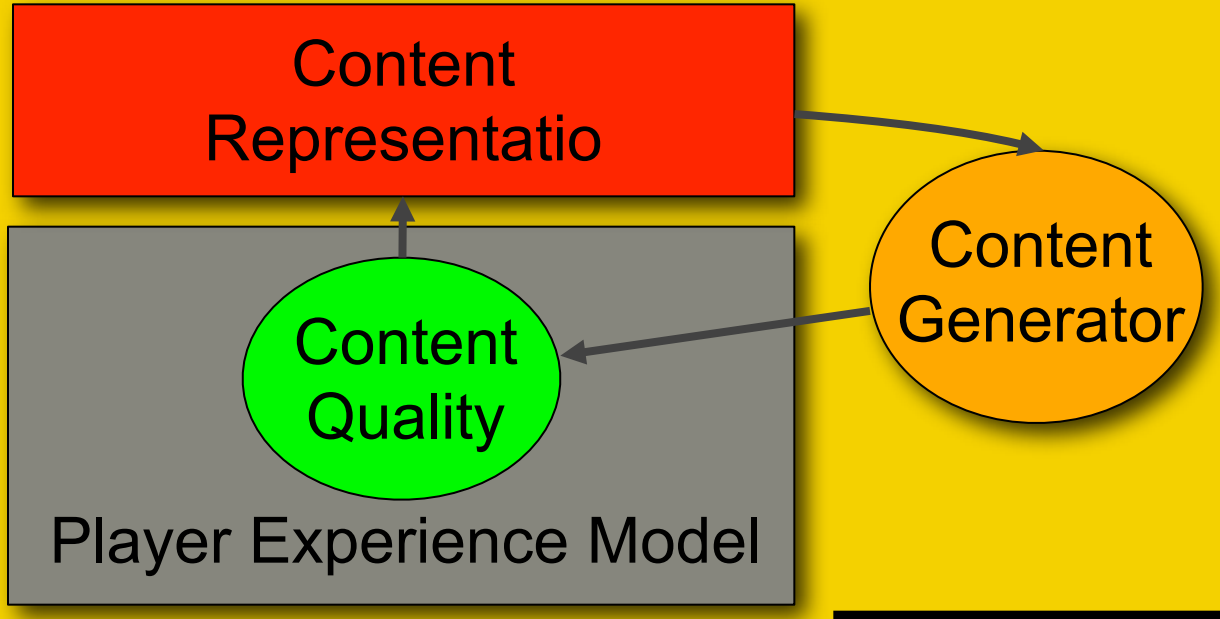
How to Evaluate Content Quality

- **Direct utility/fitness**
  - A direct mapping between content and quality; e.g. number of jumps in a platform game
  - Theory-driven vs. data-driven
- **Simulation-based**
  - An AI agent (human-like?) plays the game for a while and content is evaluated through playing style
  - Static (no learnability) vs. dynamic (content quality fluctuates)
- **Interactive fitness**
  - Real-time evaluation via a player or players
  - Implicit (self-reports, verbal cues) vs. explicit (e.g. picking up weapons)

J. Togelius, G. N. Yannakakis, K. Stanley and C. Browne, **Search-Based Procedural Content Generation**, in *Proc. EvoGames 2010, LNCS*

How to optimize Content for Player Experience

- Search for ***good*** content in the solution space
  - Exhaustive search, gradient search, stochastic (genetic) search, Monte Carlo,…
  - Representation and search space size dependent



G. N. Yannakakis, J. Hallam, **Real-Time Game Adaptation for Optimizing Player Satisfaction**, in *IEEE TCIAIG 2009.*

Ongoing Projects – Games & Entertainment

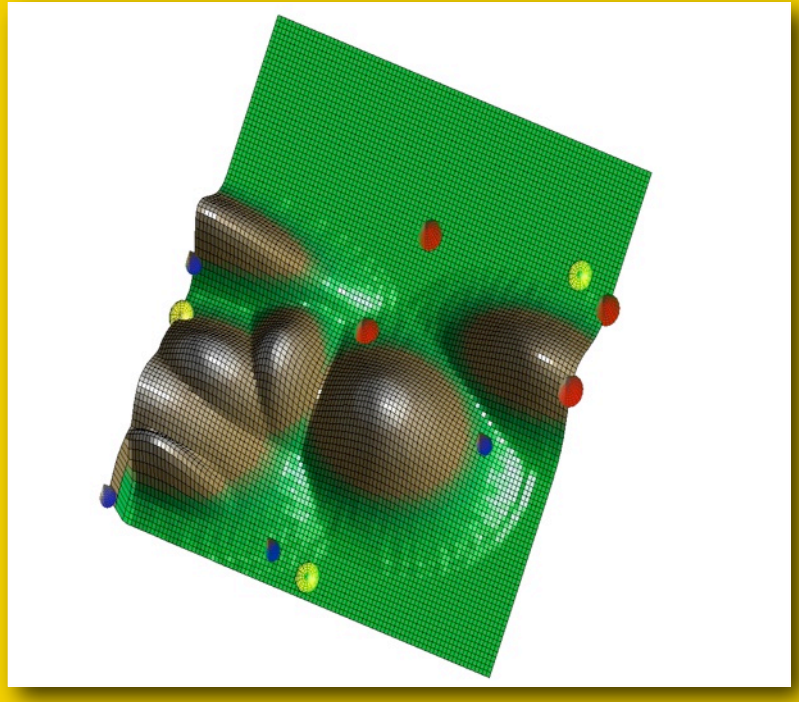
Player Modeling – Tomb Raider Underworld

- Over 1 million player data
  - EIDOS servers
- Player Modeling via self-organization
- Game design
  - Testing and postmortem
  - Is game played as intended
- Tailor player experience

A. Drachen, A. Canossa, G. N. Yannakakis, **Player Modeling using Self-Organization in Tomb Raider Underworld**, *in Proc. of IEEE CIG, 2009.*

Procedural Map Generation: Multi-Objective Evolution

Pilot RTS Maps



StarCraft Maps

J. Togelius, M. Press, N. Baume, S. Wessing, J.Hagelback, and G. N. Yannakakis.,
Multiobjective Exploration of the StarCraft Map Space, *IEEE CIG,* 2010

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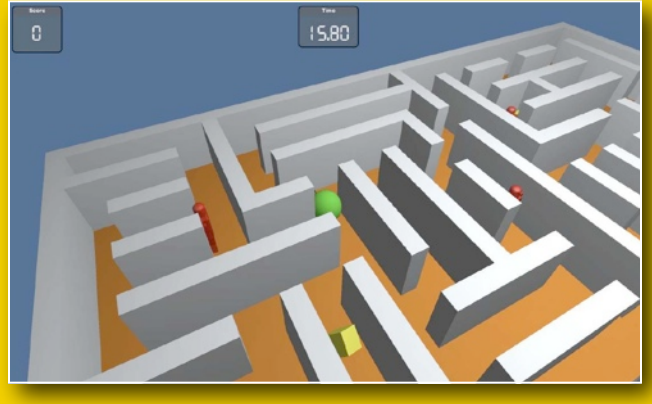
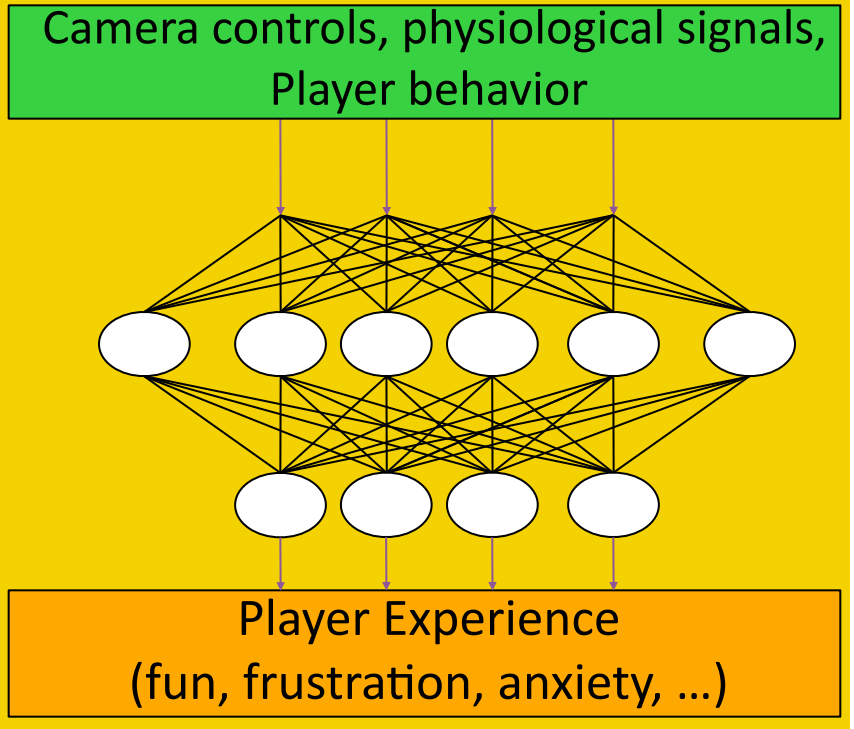
Emotionally Adaptive Camera

- 36 subjects
- Player Experience model accuracy:
  - **76-88%** (3-fold CV)

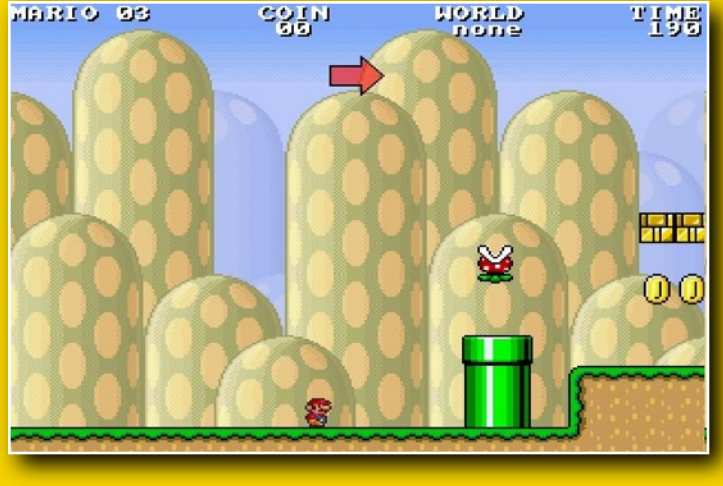


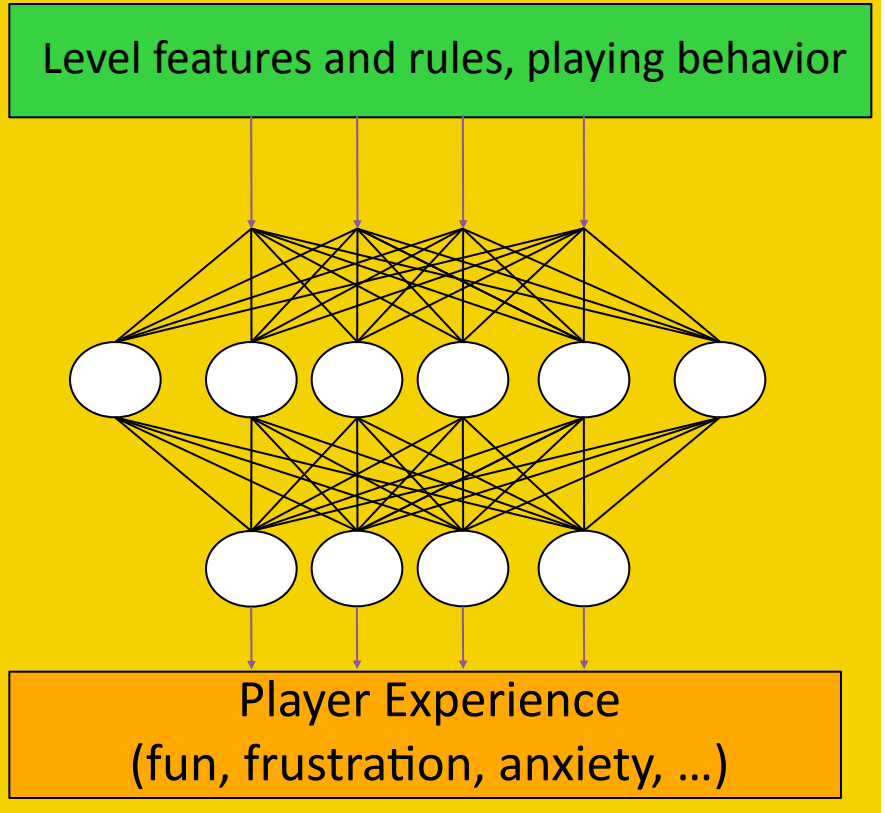


M. Schwartz, H. P. Martinez, G. N. Yannakakis, and A. Jhala, **Investigating the Interplay between Camera Viewpoints, Game Information, and Challenge** in Proc. of AIIDE, 2009

Mario Bros – Adaptive Content Creation

- 240 subjects (960 games)
- Player Experience model accuracy:
  - **73**-**92**% (3-fold CV)





C. Pedersen, J. Togelius, G. N. Yannakakis., **Modeling Player Experience for Content Creation** *IEEE TCIAG,* 2010

Games and HealthCare

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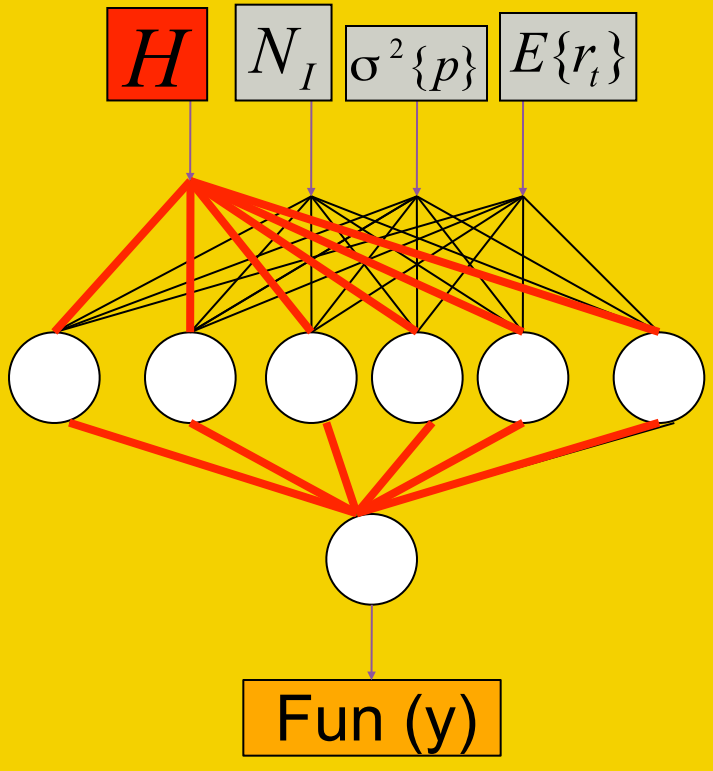
Wiihabilitation

- Difficulty adjustment
- Content = gates
- Content evaluation - player performance

D. Dimovska, P. Jarnfelt and S. Selvig, G. N. Yannakakis, **Towards Procedural Level Generation for Rehabilitation,** in *Proc. of FDG, 2010*

Physical Interactive Games



Game Adaptation for maximizing fun

G. N. Yannakakis, J. Hallam, **Real-Time Game Adaptation for Optimizing Player Satisfaction**, *IEEE TCIAIG,* 2009.

Games and Education

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Serious/Pervasive Games for Conflict Resolution

- Design games for teaching social skills in schools
- User (cognitive, affective) modeling
  - User preferences
  - Natural interaction (face, speech)
- Adaptive quest generation of co-op puzzle games
- EU funded project: “SIREN”

2010 IEEE CIG – ITU, August, 2010

First ever PCG competition: Level generation in Mario Bros

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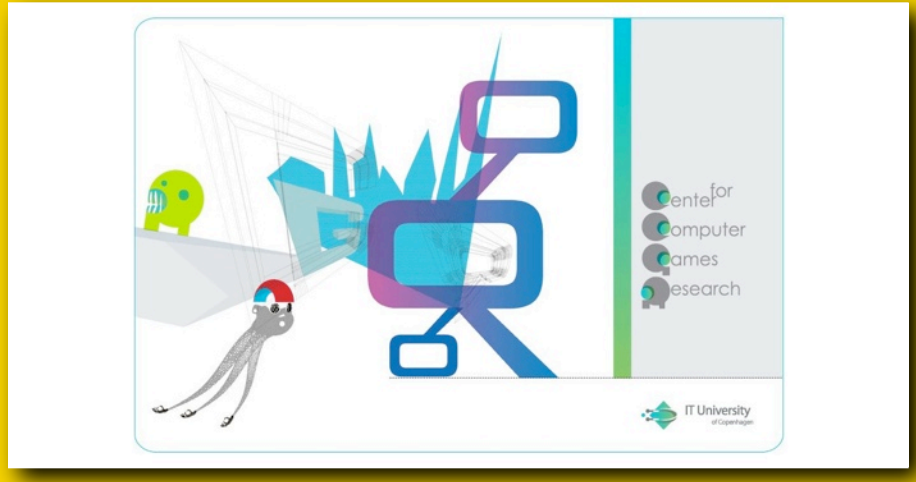
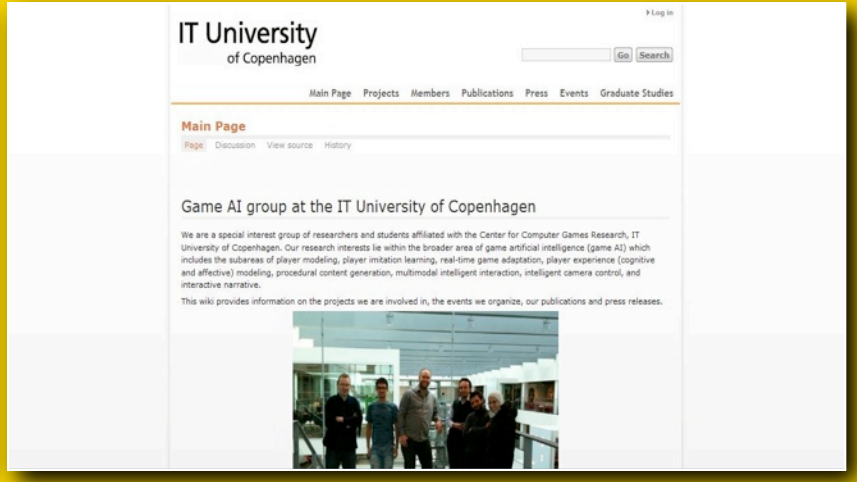
Further Information

game.itu.dk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