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# Soar-RL and agent-based computational economics

## Soar Workshop 2008


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**Slide 1**

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RUG, 8/30/2007

# Outline

- Project background
- Economic models and agent-based modeling
- From game theory to games (board game)
- Soar-RL
- Conclusions/Evaluation

# Project

- NWO-ACTS *Sustainable Hydrogen* Program
- Postdoc
- Aim: *Obtaining insight into how regulation should be designed as an optimal impetus for a technological hydrogen reform and how, next to regulatory schemes, expectations and perceptions of stakeholders affect this transition path.*

# Agent-based modeling in Economics

- Addressing conceptual difficulties in neo-classical economics (e.g., *rational expectations*)
- Economic agents as *objects*
- 'Generative social science' (Epstein & Axtell, 1996)
- Computational economics (Tesfatsion & Judd, 2006)

- Simulation vs. Optimization?
- Myopic adjustment vs. Planning?

# Game theory and Game AI

- Evolutionary game theory (Weibull, 1995)
- Learning in games (Fudenberg & Levine, 1998)
- Fictitious play & Reinforcement learning
- Justification for *Nash equilibrium*

- *What about winning and losing*?
- Serious games for Economists? (Grevers & van der Veen, to appear)

# Model

- Consumer:

$$U = \sum_{t=0}^{T} \frac{1}{(1+\rho)^t} u(c_t)$$

$$u(c_t) = \frac{c^{1-\theta} - 1}{1-\theta}$$

$$r_t + 1 = (\rho + 1)\left(\frac{c_t}{c_{t-1}}\right)^{\theta}$$

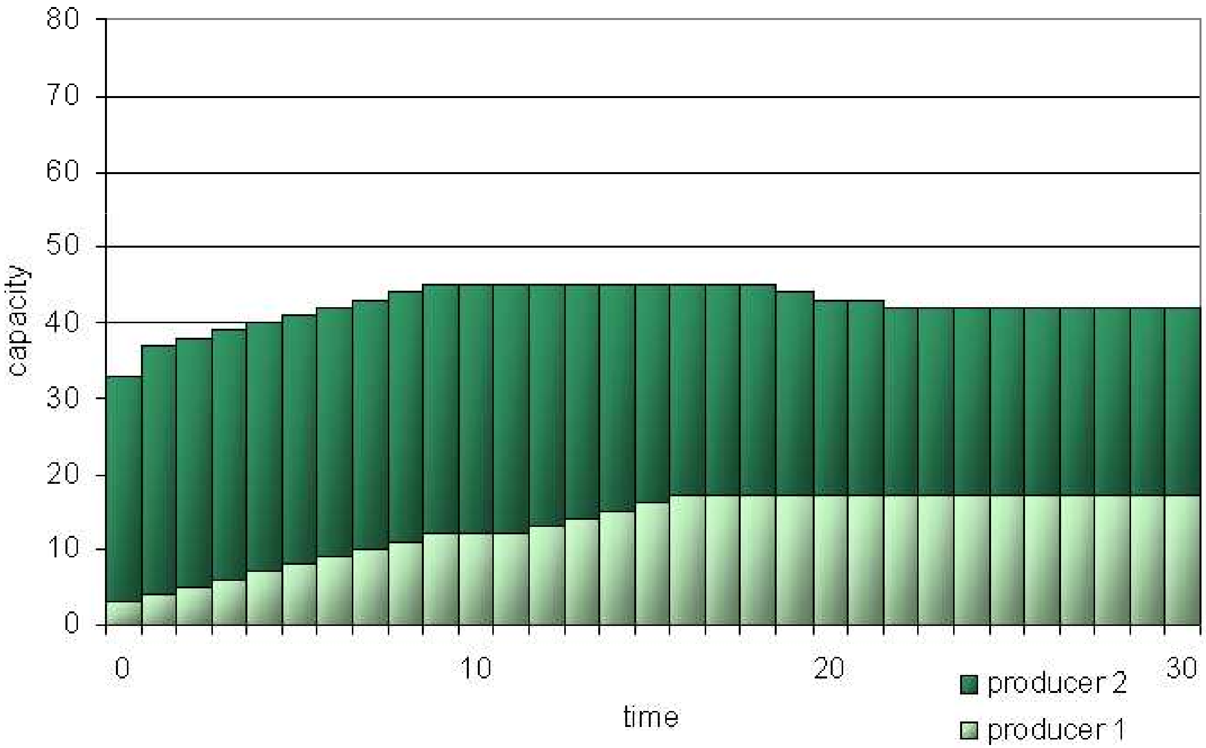
# Model

- Producer:

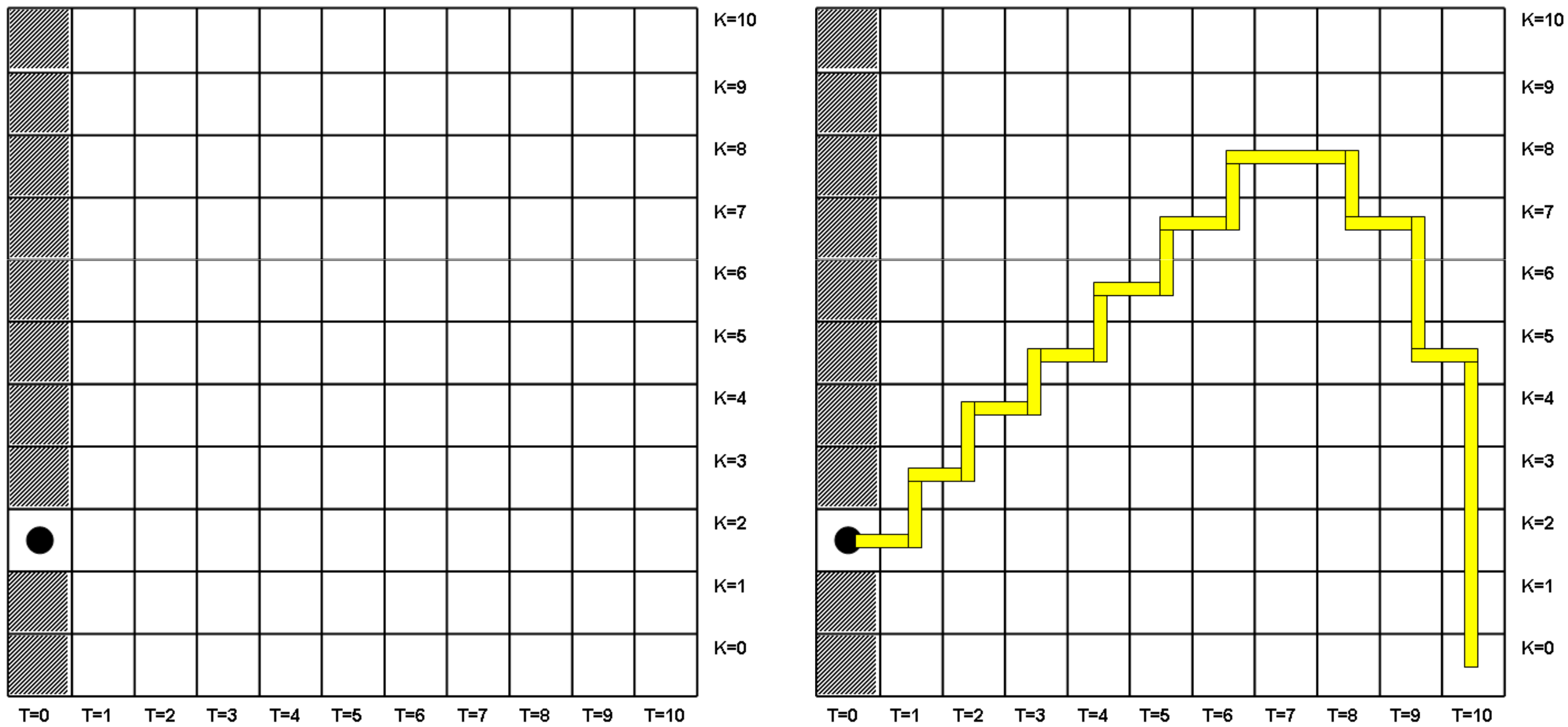
$$c_t = f(t) - i_t$$

$$V = \sum_{t=1}^{T} \frac{f(k_t) - (1 + r_t) i_{t-1}}{\prod_{\tau=1}^{t} (1 + r_\tau)}$$

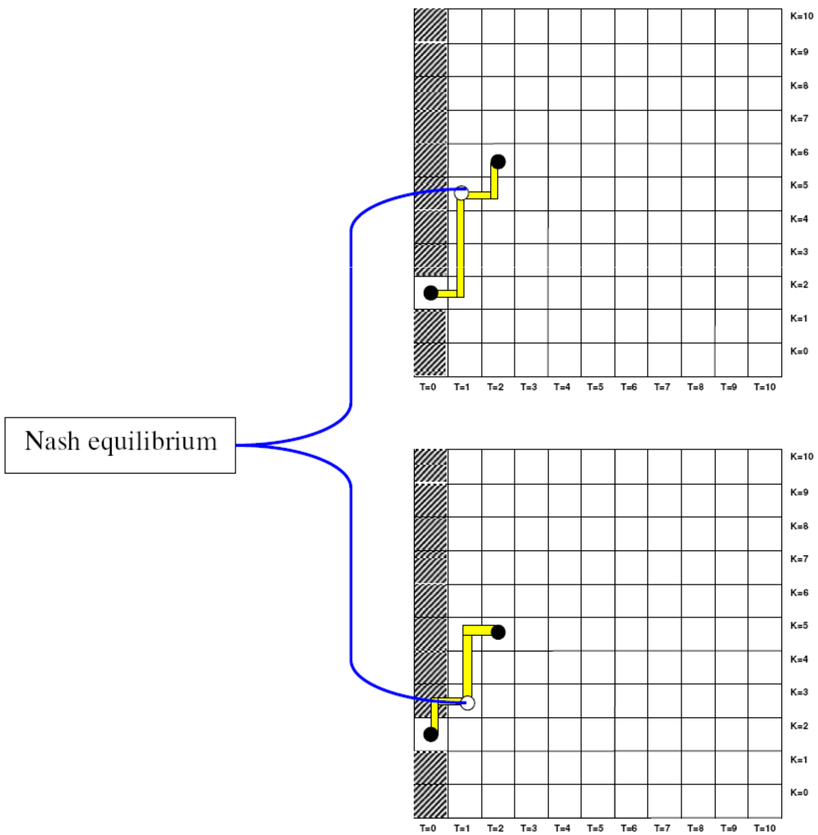
# Installed production capacity



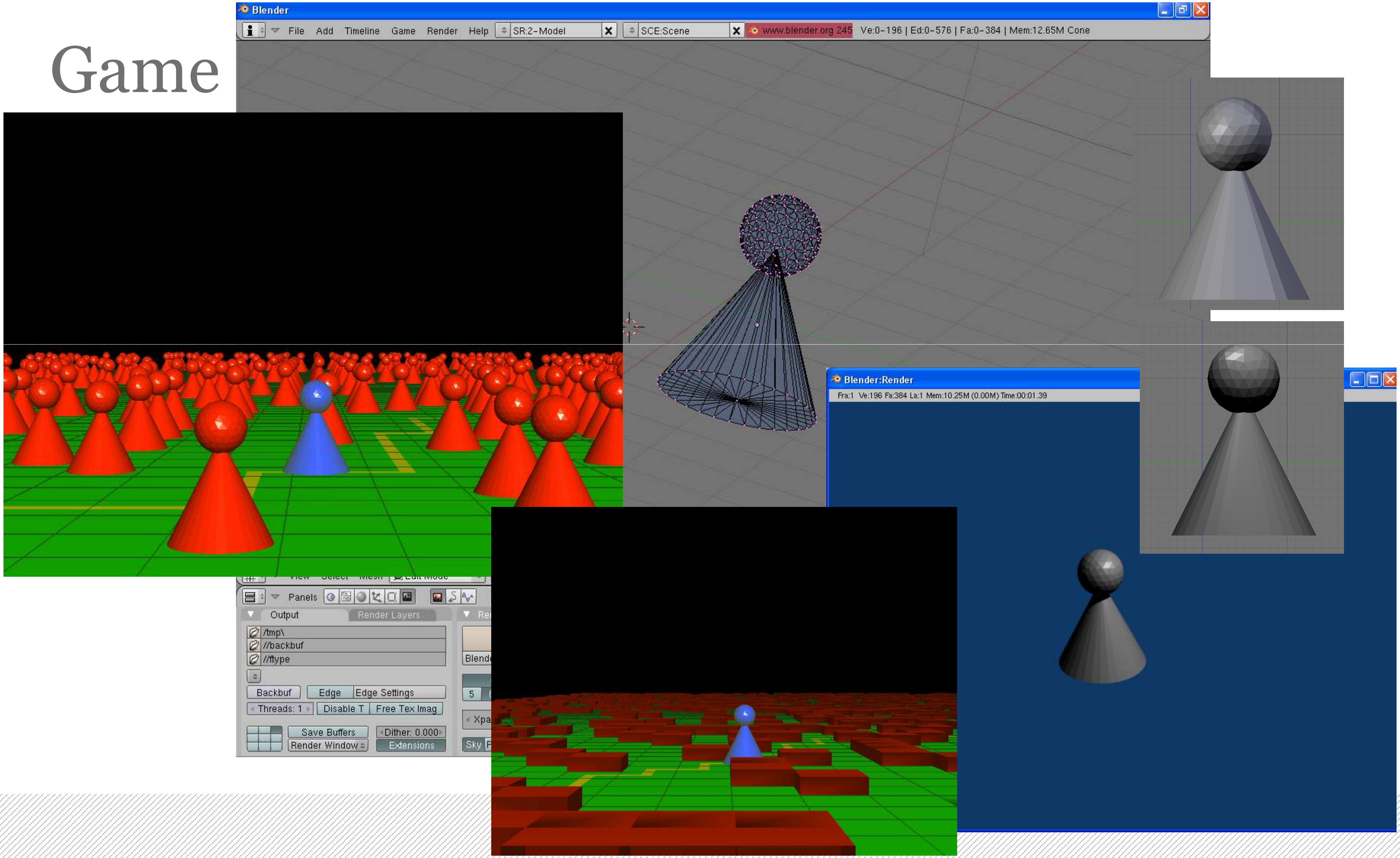
# Grid



# Strategic interaction



# Game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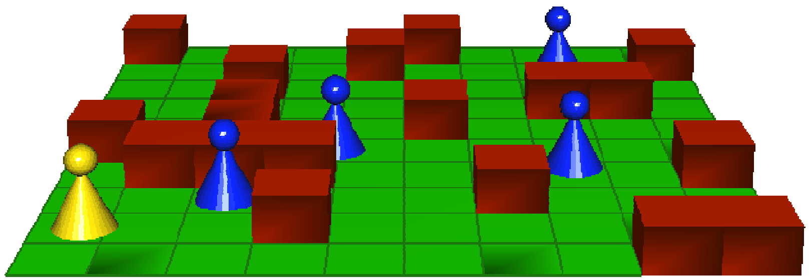
Extensions

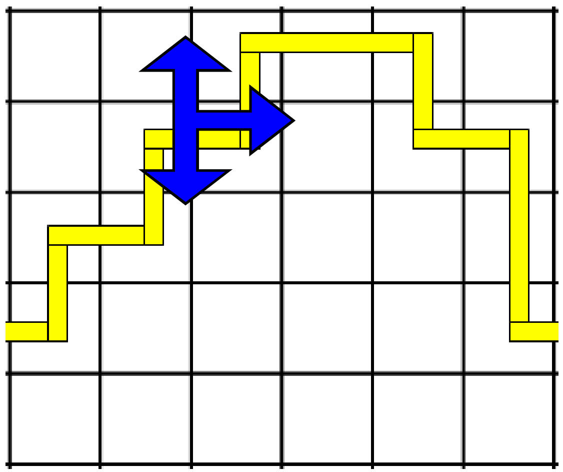
# Board game (shortest path)

- Dynamic programming replaced by Soar-RL
- Multiple agents (obstacles)
- Implemented in C++ (SML, OpenGL)
- ABM as Python module (Soar-RL embedded)



# Soar-RL in our project

- Q-value and Boltzmann equation have economic-theoretic counterparts: utility/profit and *logit* choice
- Bridge between computational method and production system
- Productions as basis for cognitive model of producer tactics



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# Conclusions/Evaluation

- Work in progress
- Reinforcement learning in Soar offers an intuitive starting point for applying a cognitive architecture in agent-based computational economics

- Knowledge on cognitive architectures in our project limited
- Relation with AI in games (tactical reasoning)?
- Suggestions welcome

# Acknowledgements


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