AIIDE’08

Artificial Intelligence for
Interactive Media and Games

Professor Charles Rich
Computer Science Department
rich@wpi.edu

Artificial Intelligence and
Interactive Digital
Entertainment Conference 2008

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Stanford University
Stanford, California, USA

http://www.aiide.org
### Mission Statement

AIIDE is the definitive point of interaction between entertainment software developers interested in AI and academic and industrial AI researchers. Sponsored by the Association for the Advancement of Artificial Intelligence (AAAI), the conference is targeted at both the research and commercial communities, promoting AI research and practice in the context of interactive digital entertainment systems with an emphasis on commercial computer and video games.

### By the Numbers

- 3 days
- about 130 attendees
  - about 80% academic, 20% industry [guessing]
- 26 papers presented
  - 23 academic, 3 industry
- 8 technical sessions
- 1 panel (mixed)
- 5 invited talks
  - 1 academic, 4 industry
- 7 poster/demos (all academic)
Technical Sessions

1. Applications of Reinforcement Learning
2. Singular Techniques
3. Planning for Actions, Story and Design
4. Social Intelligence
5. Stochastic and Evolutionary Approaches
6. Hierarchical Models for Behavior and Plot
7. Robustness and New Capabilities from Reasoning
8. Unconventional Pathfinding Applications & Approaches

1. Applications of Reinforcement Learning

Intelligent Trading Agents for Massively Multi-player Game Economies

- J. Reeder, U. Central Florida
- G. Sukthankar, U. Central Florida
- M. Georgiopoulos, U. Central Florida
- G. Anagnostopoulos, Florida Inst. of Technology
Intelligent Trading Agents...

- **Goal:** create intelligent trading agents for virtual markets

- **Example:** Eve Online
  - 220,000 active players
  - 460,000 player characters
  - trading billions of units per month

Intelligent Trading Agents...

- Roles for autonomous trading agents in MMORPG marketplaces
  - provide liquidity for human players in less active markets (cf. Wall Street)
  - mechanism for game designers to manage markets (e.g., deflate prices)
Intelligent Trading Agents...

- focus on the problem of creating agents with good “financial tactics” in buying and selling
- show that a reinforcement learning approach based on the market microstructure can give a trading agent a competitive advantage in amassing wealth over standard fixed policies.
- also need to protect agents from player exploitation (the introduction of easily duped trading agents in the virtual market would create an easy avenue for smart players to cheaply acquire rare items)
- imbuing agents with the ability to learn trading policies from recent historical data will make them potentially more resistant to predatory trading practices.

Table 1: Agent trading options (ISK: EVE Currency)

<table>
<thead>
<tr>
<th>Agent Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Do Nothing</td>
</tr>
<tr>
<td>1</td>
<td>Bid 10% lower than the current Best Bid</td>
</tr>
<tr>
<td>2</td>
<td>Bid 1 ISK below the current Best Bid</td>
</tr>
<tr>
<td>3</td>
<td>Bid 1 ISK above the current Best Bid</td>
</tr>
<tr>
<td>4</td>
<td>Bid 10% higher than the current Best Bid</td>
</tr>
<tr>
<td>5</td>
<td>Place a Market Buy order</td>
</tr>
</tbody>
</table>

*agent trains on recent market data to learn optimal trading strategy*
Table 2: Average normalized cost for all buying and selling policies.

<table>
<thead>
<tr>
<th>Item</th>
<th>OBS</th>
<th>IMB0</th>
<th>SV</th>
<th>RL (best)</th>
<th>VWAP</th>
<th>SMO</th>
<th>UMO</th>
<th>LMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Polymers</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>-0.028504579</td>
<td>0.082028063</td>
<td>0.14643748</td>
<td>0.158661913</td>
<td>0.133918673</td>
</tr>
<tr>
<td>Ceramic Powder</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.002357988</td>
<td>0.09489403</td>
<td>0.145539648</td>
<td>0.15691056</td>
<td>0.127830972</td>
</tr>
<tr>
<td>Crystalline Alloy</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.159725478</td>
<td>0.201720732</td>
<td>0.219639237</td>
<td>0.228334847</td>
<td>0.222763274</td>
</tr>
<tr>
<td>Ferrous Alloy</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.109680314</td>
<td>0.145763227</td>
<td>0.165234565</td>
<td>0.16647955</td>
<td>0.167232386</td>
</tr>
<tr>
<td>Hexite</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>-0.00674535</td>
<td>0.052654967</td>
<td>0.10281265</td>
<td>0.10323569</td>
<td>0.09616695</td>
</tr>
<tr>
<td>Platinum Techneite</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.026604871</td>
<td>0.053103663</td>
<td>0.066995723</td>
<td>0.06530677</td>
<td>0.066640438</td>
</tr>
<tr>
<td>Rolled Tungsten</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.109903174</td>
<td>0.213910098</td>
<td>0.250990439</td>
<td>0.26104617</td>
<td>0.248051276</td>
</tr>
<tr>
<td>Silicon Dioxide</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.14209934</td>
<td>0.293920089</td>
<td>0.396878418</td>
<td>0.368359824</td>
<td>0.39838207</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.035423385</td>
<td>0.086367207</td>
<td>0.108323317</td>
<td>0.131406645</td>
<td>0.102222527</td>
</tr>
<tr>
<td>Titanium Chromide</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.034383084</td>
<td>0.066614538</td>
<td>0.080647685</td>
<td>0.083648374</td>
<td>0.076903095</td>
</tr>
</tbody>
</table>

2. Singular Techniques

Lightweight Procedural Animation with Believable Physical Interactions

- Ian Horswill, Northwestern University
twig

• Library for
  – Procedural animation
  – Simple physics

• Intended for interactive narrative
  – Fast
  – AI-friendly
  – Supports scripting, running as a server, or direct authoring of behaviors

• Work in progress

• Open source
  – Runs under XNA
  – Ought to run on Xbox (not tested)

• Two applications
  – Simulation of Ainsworth’s “safe home base” phenomenon
  – Webcomic

Lightweight Procedural Animation...

• http://twigblog.wordpress.com
Lightweight Procedural Animation

**script fragment**

Bryan: say "They're doing medical experiments on us?" Michael
Bryan: hold script
Bryan: goto camera 3.6 &
Bryan: say "You bastards!" camera
Michael: goto Bryan 0.25 (-1 0 0) &
Thug: goto Bryan 0.5 (0 0 0) &
Michael: say "Quiet!" Bryan
Michael: say "They'll hear you!" Bryan
Bryan: say "I'm not some lab animal!" Michael
Thug: say "I'm with AAA!
Come with me" Bryan
Bryan: lookat Thug
Bryan: say "I know my rights!" Thug
Bryan: say "IRB would never sign off on this!" Michael
Thug: hold Bryan
Michael: say "It's run by Alberto Gonzales now." Bryan &
Bryan: fight Thug
pause 0.5
Bryan: say "Widgets of the world unite!" Thug
Thug: goto offstage &
Bryan: drop script
Bryan: "Soylent green/it's made out of pixels!" Bryan
titles: fade to black 2

3. Planning for Actions, Story and Design

Simulation-Based Story Generation with a Theory of Mind

- H. Chang & V. Soo, National Tsing Hua University, Taiwan
Simulation-Based Story Generation...

- **Goal**: “Emergent narrative”, i.e., stories emerge from autonomous interactions among NPC’s and/or player

- **Challenge**: How to guide narrative to be interesting

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**Figure 1**: Schematization of Iago’s social plan.

*Characters*: I = Iago, H = Emilia, C = Cassio, O = Othello, D = Desdemona.
*Places*: G = Garden, B = Bedroom, R = Cassio’s residence, P = Palace.
*Objects*: H = Desdemona’s handkerchief.
Table 1: Belief revision/motivation rules for the *Othello* scenario.

<table>
<thead>
<tr>
<th>Source</th>
<th>Motivational Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal motive</td>
<td><strong>Greed</strong>: self((s)) &amp; at((s), (?l)) &amp; at((o), (?l)) &amp; precious((o)) \rightarrow holds((s), (o))</td>
</tr>
<tr>
<td></td>
<td><strong>Curiosity</strong>: self((s)) &amp; befriends((s), (?a)) &amp; request((?a), (s), at((s), (?l))) \rightarrow at((s), (?l))</td>
</tr>
<tr>
<td>Emotion</td>
<td><strong>Jealousy</strong>: self((s)) &amp; loves((s), (?a)) &amp; loves((a), (?b)) \rightarrow dead((?a)) &amp; dead((?b))</td>
</tr>
<tr>
<td>Social disposition</td>
<td><strong>Obedience</strong>: self((s)) &amp; loves((s), (?a)) &amp; request((?a), (s), holds((?a), (o))) \rightarrow holds((?a), (o))</td>
</tr>
</tbody>
</table>

Belief Revision Rules

**Folk psychology**: isGift\(\text{From}(\(g\), \(?a\)) \& isGift\(\text{To}(\(g\), \(?b\)) \& holds(\(?c\), \(?g\)) \& ((\text{woman}(\(b\)) \& \text{man}(\(c\)) \lor (\text{man}(\(b\)) \& \text{woman}(\(c\)))) \rightarrow \neg\text{loves}(\(b\), \(?a\)) \& \text{loves}(\(b\), \(?c\))

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![Figure 2: Architecture of the social planning agent.](IMGD 400X (B 09))

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Simulation-Based Story Generation...

- “our main concern is whether the system can generate new stories”

4. Social Intelligence

Otello: A Next-Generation Reputation System for Humans and NPCs

- M. Sellers, Online Alchemy, Inc.
Next-Generation Reputation System...

as more games merge into online social spaces, reputation systems are becoming increasingly important to players looking for gaming partners

also new gameplay ideas
  • compete on who is more respected, more loved, or more feared
  • reward players who fill social roles, such as being reputation “hub”, etc.

Figure 1: Anne does not know Carl, so his reputation with her comes through Bob. Debbie does not trust Bob, so his opinion of Carl does not matter to her.
5. Stochastic and Evolutionary Approaches

- Constructing Complex NPC Behavior via Multi-Objective Neuroevolution
  - J. Schrum & R. Mukkulainen, U. Texas Austin

Constructing Complex NPC Behavior...

- **Goal:** Discover NPC behavior automatically

- **Benefits:**
  - save production time/effort
  - learn counterintuitive behaviors
  - find weaknesses in static scripts
  - tailor behavior to human plays
6. Hierarchical Models for Behavior and Plot

Hierarchical Petri Nets for Story Plots Featuring Virtual Humans

- D. Balas, C. Brown, A. Abonyi & J. Gemrot,
  Charles U. in Prague
Hierarchical Petri Nets...

Hierarchical Petri Nets

- formal and graphical (intelligible, like FSM’s)
- story plots can be branching
- episodes can happen *in parallel*
- can be hierarchical

Fig. 2. Petri Nets examples. a) The action generates one token if there is one token in the upper container and two in the lower container. b) The two actions are in conflict. Had there been two tokens in the container, the actions could run in parallel.
7. Robustness and New Capabilities from Reasoning

Recombinable Game Mechanics for Automated Design Support

- M. Nelson, Georgia Inst. of Technology
- M. Mateas, U. California Santa Cruz
Recombinable Game Mechanics...

- GameMaker and Alice provide support for novices to *implement* games

- How about a similar approach for *designing game mechanics*?

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Recombinable Game Mechanics...

- Factor game design into four areas
  - *abstract mechanics*: state and state evolution
  - *concrete representation*: audiovisual realization of game state
  - *thematic content*: real-world references a game makes
  - *control mappings*: how player interacts with game

- Library of combinable components at all levels
8. Unconventional Pathfinding Applications and Approaches

A Cover-Based Approach to Multi-Agent Moving Target Pursuit

- A. Isaza, J. Lu, V. Bulitko & R. Greiner, U. Alberta
A Cover-Based Approach...

- **Goal:** An efficient multi-agent system (algorithm) that is capable of capturing a single moving target
- **Challenge:** To coordinate multiple pursuers
- **Solution:** An elegant uniform algorithm based on “cover sets”
Panels & Invited Talks

- Realistic Human Characters
  - Chris Darken, Naval Postgraduate School
  - Richard Evans, EA/Maxis
  - Borut Pfeifer, EA Los Angeles
  - Michael Mateas, UC Santa Cruz
- Experiments in Musical Intelligence
  - David Cope, UC Santa Cruz
- The AI of Spore
  - Eric Grundstrom, EA/Maxis

Invited Talks

- Halo 3 Objective Trees: A Declarative Approach to Multiagent Coordination
  - Damian Isla, Bungie Studios
- The Past, Present and Future of Game AI
  - Steve Rabin, Nintendo of America
- Performing Intent
  - Doug Church, EA Los Angeles
  - Borut Pfeifer, EA Los Angeles
Questions?  Comments?