Experience Management with Artificial Intelligence

Vadim Bulitko, David Thue, Alejandro Ramirez, Sergio Poo Hernandez
Introduction

- Virtual experience management
  - AI problem
- Player modelling
- AI planning
- Emotion modeling
Virtual Experience

- Entertainment
- Training
Training

- Inherent complexity of physical phenomena and personnel activities
- Concurrent crises
- Limited resources
- Information overload
- Considerable uncertainty
- Psychological stress
- Very limited real-life practice

Simulated DC environment: DC-Train 2.0
Learning Player Preferences for Better Interactive Stories
Lorek
Scanner Results: Rich

- Element Zero
- Iridium
- Platinum
- Palladium

30 Probes

http://www.gamersglobal.de
Lorek
Scanner Results: Rich
Anomaly Detected!

3500 Element Zero
4000 Indium
2000 Platinum
4500 Palladium

30 Probes

http://www.gamersglobal.de/
Three Different Players

Lost Operative

Lost Operative

Lost Operative

All screenshots from http://guides.ign.com
Three Different Players

Lost Operative

Lost Operative

Lost Operative

10

All screenshots from http://guides.ign.com
Three Different Players

Lost Operative

Lost Operative

Lost Operative

6

10

All screenshots from http://guides.ign.com
Three Different Players

Lost Operative

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Lost Operative

6

10

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All screenshots from http://guides.ign.com
How can we do better?

Lost Operative

All screenshots from http://guides.ign.com
How many will the average player see?
Suppose that average players see 70% of available N7 missions.

How many will the average player see?
A Given Single Player
A Given Single Player
70% of available N7 missions
A Given Single Player
70% of available N7 missions

<table>
<thead>
<tr>
<th>10</th>
<th>8</th>
<th>5</th>
<th>8</th>
<th>2</th>
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<tbody>
<tr>
<td>6</td>
<td>3</td>
<td>7</td>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>
How can we do better?
How can we do better?
Three Different Players

- Lost Operative
- Lost Operative
- Archeological Dig Site

All screenshots from http://guides.ign.com
If you know about your audience, you can tell a better story.
Our Goals

More Fun   More Agency

by automatically learning about each player, and selecting content that’s best for them
PaSSAGE
Player-Specific Stories via
Automatically Generated Events
Learning Player Preferences
Player types come from Robin's Laws of Good Game Mastering (Laws 2002)
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Player types come from Robin's Laws of Good Game Mastering (Laws 2002)
Better Interactive Stories
First Testbed
Increasing Player Fun

LITTLE RED RIDING HOOD

David Thue, Eric Wasylissen, Michael Webb Vadim Bulitko, Marcia Spetch
Evaluation

Results for Increasing Fun

| 114 players | mean age 19.5 | 1/3 male |

(Thue et al., AIIDE 2010)
Evaluation
Results for Increasing Fun

114 players  mean age 19.5  1/3 male

Player-Specific Stories are more Fun: 93% Confidence

(Thue et al., AIIDE 2010)
Our Goals

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by automatically learning about each player,
and selecting content that's best for them
Our Goals

More Fun ✓ More Agency

by automatically learning about each player, and selecting content that’s best for them
PaSSAGE 2.0
Player-Specific Stories via Automatically Generated Events
Protests over ending of *Mass Effect 3* show fan investment in story control

By Kyle Orland | Published 7 days ago

Many *Mass Effect 3* players feel kind of like Commander Shepard in this image, watching helplessly as events transpire out of their control.
Proposed Approach
Inspiration from Psychology

The Control Heuristic

When our decisions lead to desirable outcomes, our perceived agency is increased.

(Thompson et al., Psychological Bulletin 1998)
Proposed Approach
Inspiration from Psychology

The Control Heuristic

When our decisions lead to desirable outcomes, our perceived agency is increased.

(Thompson et al., Psychological Bulletin 1998)

Our goal is to maximize the desirability of the content that occurs as a result of player decisions.
Lord of the Borderlands

Vile beast! You will regret running into us this day!

1. We will kill you!
2. I bet we'll get a reward if we bring you in alive!
3. Bluffs: We are scouts from the army!
4. Whisper: Colin, make a distraction!
5. Intimidate: It's two on one, monster. Leave while you can!

We need strength as the monsters besiege our Empire in the North, along with all the wisdom and cunning you've got.

David Thue, Trevon Romanuik,
Charles Crittenden
Vadim Bulitko, Marcia Spetch
Congratulations, students.
My boy! My boy! You've been locked up in that school for far too long. It is good to see you!
My boy! My boy! you've been locked up in that school for far too long. It is good to see you!
My boy! My boy! You've been away too long. It is so good to see you again.

You're the lord's nephew? They told me that I was going to face you in a duel! I guess that plan went awry.
Come no closer!
Your people don't trust me or my fellow rebels yet, but I'm sure that a few words from you will get us what we need: weapons, armor, and supplies.
My boy! My boy! You’ve been locked up in that school for far too long. It is good to see you!
You're the lord's nephew? They told me that I was going to face you in a duel! I guess that plan went awry.
Evaluation
Results for Increasing Agency

141 players  mean age 19.4  38% male

Player-Specific Stories give a feeling of more Agency:

96% Confidence

(Thue et al., AIIDE 2011)
Our Goals

More Fun ✓ More Agency

by automatically learning about each player, and selecting content that’s best for them
Our Goals

More Fun ✔ More Agency ✔

by automatically learning about each player,
and selecting content that’s best for them
• By dynamically selecting story content based on a learned model of player preferences, we can increase the amount of fun and agency that players perceive.
Automated Planning and Player Modelling for Interactive Storytelling
The Agency Maximization Problem

**Authorial**
- Story trajectories
- Resources

**Experience Manager**
- Increase player fun and agency
- Procedural generation

**Evaluation**
- Measure perception
Experience Management as a Formal Problem
Experience Management as a Formal Problem

Game states
- Goals
Experience Management as a Formal Problem

Game **states**
- Goals

Player **actions**
- Player’s **policy**
Experience Management as a Formal Problem

Game states
- Goals

Player actions
- Player’s policy

Transition function
Experience Management as a Formal Problem

Game states
- Goals

Player actions
- Player’s policy

Transition function

Reward function
Experience Management as a Formal Problem

Game states
- Goals

Player actions
- Player’s policy

Transition function

Reward function

Trajectory
Experience Management as a Formal Problem

Game **states**
- Goals

Player **actions**
- Player’s **policy**

**Transition** function

**Reward** function

**Trajectory**

**Markov Decision Process**
Generative Experience Managers
Generative Experience
Managers

Generative Experience Managers

Generative Experience Managers

ASD
ASD

Automated Story Director (Riedl et al., 2008)

\[ S_0 \xrightarrow{a_0} S_1 \xrightarrow{} \ldots \xrightarrow{} g \]
ASD

Automated Story Director (Riedl et al., 2008)

Ruptures = inconsistencies

Planning fixes inconsistencies
  ◦ Longbow
  ◦ ASD Three-tiered Planning
ASD

Automated Story Director (Riedl et al., 2008)

Ruptures = inconsistencies

Planning fixes inconsistencies
- Longbow
- ASD Three-tiered Planning

Procedural generation
Evaluation
PAST

Player-specific Automated Storytelling
(Ramirez and Bulitko, 2012)
PAST

Player-specific Automated Storytelling
(Ramirez and Bulitko, 2012)
PAST
PAST

Diagram showing states and transitions:
- $s_0$ to $s_1$: greet
- $s_1$ to $s''$: kill wolf
- $s'$ to $s''$: resurrect wolf
- $s''$ to $s_1$: introduce grendel
- $s_1$ to $s''$: no transition
- $s''$ to $s_0$: no transition
- $s_0$ to $s_1$: no transition
- $s_1$ to $s''$: no transition
- $s''$ to $s_0$: no transition
- $s_0$ to $s_1$: no transition
- $s_1$ to $s''$: no transition
- $s''$ to $s_0$: no transition
PAST

\[ s_0 \rightarrow s_1 \rightarrow ? \rightarrow s' \rightarrow s'' \rightarrow g \]

- greet
- kill wolf
- resurrect wolf
- introduce grendel

Player model
PAST

\[ s_0 \rightarrow s_1 \rightarrow s' \rightarrow s'' \rightarrow g \]

- **greet**
- **kill wolf**
- **introduce grendel**
- **resurrect wolf**
Goal

Evaluate planning-based experience managers for **fun** and **agency**
Goal

Evaluate planning-based experience managers for **fun** and **agency**
Evaluation Design

- Text-based prototype
- Two-way ANOVA
- Fun and agency
- Gamers vs. non-gamers
User Study 1

Agency

Fun
User Study 1

Agency

Fun

![Bar chart showing agency scores for gamers and non-gamers. The chart indicates higher agency scores for non-gamers compared to gamers.](chart.png)
User Study 1

Agency

Fun

<table>
<thead>
<tr>
<th></th>
<th>Fun Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamers</td>
<td>0.3</td>
</tr>
<tr>
<td>Non-gamers</td>
<td>0.46</td>
</tr>
</tbody>
</table>

81
User Study 2

Agency

Fun
User Study 2

Agency

Fun

72

Fixed ASD PAST
User Study 2

Agency

Fun

<table>
<thead>
<tr>
<th></th>
<th>Fixed</th>
<th>ASD</th>
<th>PAST</th>
</tr>
</thead>
</table>

![Fun Score Graph]

- **Gamers**
  - Fixed: 0.4
  - ASD: 0.5
  - PAST: 0.4

- **Non-gamers**
  - Fixed: 0.5
  - ASD: 0.6
  - PAST: 0.3

72
User Study 3

Agency

Fun
User Study 3

![Agency and Fun](image)

<table>
<thead>
<tr>
<th></th>
<th>Agency Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamers</td>
<td>0.6</td>
</tr>
<tr>
<td>Non-gamers</td>
<td>0.4</td>
</tr>
</tbody>
</table>

34
User Study 3

Agency

Fun

---

34

![Bar chart showing Fun Score for Gamers and Non-gamers. Gamers have a higher Fun Score compared to Non-gamers.]
Discussion

User Studies

- ASD increases \textit{fun} and \textit{agency}
- PAST increases \textit{agency}
- Adequate content \textit{distribution} is important
A Call for Emotion Modeling in Interactive Storytelling
Related Work

- Experience Managers with emotional curves:
  - Façade (Mateas et al. 2003)
  - DDM (Weallans et al. 2012)
  - Left 4 Dead’s AI Director (Booth 2009)
Related Work

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Approach

- Enhance PAST to handle emotion curves when making selections.

- Development in 2 parts:
  - Baseline: Manually annotate events.
  - Procedural: Incorporate EMA. (Marsella et al. 2003)
EMA: EMotion & Adaptation
Psychological Underpinnings

Figure 1: The cognitive-motivational-emotive system. Adapted from Smith and Lazarus’ (1990)
# Appraisals

## Table 1: Appraisal Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevance</td>
<td>Does the event require attention or adaptive reaction</td>
</tr>
<tr>
<td>Desirability</td>
<td>Does the event facilitate or thwart what the person wants</td>
</tr>
<tr>
<td>Causal attribution</td>
<td></td>
</tr>
<tr>
<td>Agency</td>
<td>What causal agent was responsible for an event</td>
</tr>
<tr>
<td>Blame and Credit</td>
<td>Does the causal agent deserve blame or credit</td>
</tr>
<tr>
<td>Likelihood</td>
<td>How likely was the event; how likely is an outcome</td>
</tr>
<tr>
<td>Unexpectedness</td>
<td>Was the event predicted from past knowledge</td>
</tr>
<tr>
<td>Urgency</td>
<td>Will delaying a response make matters worse</td>
</tr>
<tr>
<td>Ego Involvement</td>
<td>To what extent does the event impact a person’s sense of self (social esteem, moral values, cherished beliefs, etc.)</td>
</tr>
<tr>
<td>Coping potential</td>
<td></td>
</tr>
<tr>
<td>Controllability</td>
<td>The extent to which an event can be influenced</td>
</tr>
<tr>
<td>Changeability</td>
<td>The extent to which an event will change of its own accord</td>
</tr>
<tr>
<td>Power</td>
<td>The power of a particular agent to directly or indirectly control an event</td>
</tr>
<tr>
<td>Adaptability</td>
<td>Can the person live with the consequences of the event</td>
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[from Gratch and Marsella 2004]
# EMA subset

## Table 3: Emotion categorization and intensity rules

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<thead>
<tr>
<th>Appraisal Configuration</th>
<th>Emotion</th>
<th>Intensity</th>
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<tbody>
<tr>
<td>Desirability(p) &gt; 0, Likelihood(p) &lt; 1.0</td>
<td>Hope</td>
<td>Desirability(p)×Likelihood(p)</td>
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<tr>
<td>Desirability(p) &gt; 0, Likelihood(p) = 1.0</td>
<td>Joy</td>
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<tr>
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<td>Fear</td>
<td></td>
</tr>
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<td>Desirability(p) &lt; 0, Likelihood(p) = 1.0</td>
<td>Distress</td>
<td></td>
</tr>
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<td>Desirability(p) &lt; 0, causal attribution(q)=blameworthy</td>
<td>Anger</td>
<td></td>
</tr>
<tr>
<td>Desirability(q ≠ p) &lt; 0, causal attribution(p)=blameworthy, causal agent = p</td>
<td>Guilt</td>
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### Table 3: Emotion categorization and intensity rules

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Conclusions

- Player experience management
- Player modelling
  - play styles
  - emotions
- Fun and agency improvement
- Procedural accommodation of player actions
Questions?