Building and Evaluating an A.I. Game Master

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http://playpassage.com
Acknowledgements

- David Thue, my Ph.D. student
  - principal investigator on the project
  - made most of these slides and videos
- Marcia Spetch
- Eric Wasylissen
- Michael Webb
- Trevon Romanuik
- Charles Crittenden
- Mila Kwiatkowska
Interactivity in Storytelling
Interactivity in Storytelling
Interactivity in Storytelling

It was a dark and stormy night...
Interactivity in Storytelling
Interactivity in Storytelling
Recap
Recap
Recap
Recap
Recap
Recap
Recap
Hypothesis

If you know about your audience, you can tell a better story.
Refined Hypothesis

- By modeling a player we can increase their:
  - fun
  - perceived agency

- As a result, we will be telling a better story
Part 1: Increasing Fun

PaSSAGE
Player-Specific Stories via Automatically Generated Events
**Approach**

- **Observe player actions** as they relate to in-game events
- **Model the player** by measuring inclinations toward different styles of play
- From a library of encounters, **choose an encounter** to occur which allows the player to play in the modelled style
- Repeat
Approach

- **Encounter Manager**
  - Model Values
    - (Relate)
  - Model Updates
    - (Interpret)

- **Game Engine**
  - Encounters
    - (Decide)
  - Audio/Video
    - (Convey)

- **Player Model**
  - (Interpret)

- **Player**
  - (Gather)
  - Actions
Encounters

- A sequence of events that directly involve the player
- Each encounter has at least one course of action available to the player
- Each course of action is tailored to appeal to one or more types of player
Robin Laws’ Player Types

<table>
<thead>
<tr>
<th>Player Type</th>
<th>Enjoys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Gamer</td>
<td>Acquiring items and abilities</td>
</tr>
<tr>
<td>Fighter</td>
<td>Fighting</td>
</tr>
<tr>
<td>Tactician</td>
<td>Solving logical puzzles</td>
</tr>
<tr>
<td>Specialist</td>
<td>Exploiting their character’s special skills</td>
</tr>
<tr>
<td>Method Actor</td>
<td>Having their personality tested</td>
</tr>
<tr>
<td>Storyteller</td>
<td>Complex plots</td>
</tr>
<tr>
<td>Casual Gamer</td>
<td>Being with their friends</td>
</tr>
</tbody>
</table>

Player Model

- Fighter
- Method Actor
- Storyteller
- Tactician
- Power Gamer
Player Model

[Diagram showing a player model with categories: Fighter, Method Actor, Storyteller, Tactician, Power Gamer]
Player Model

- Fighter
- Method Actor
- Storyteller
- Tactician
- Power Gamer
PaSSAGE

Demo
Demo

Encounter Library

Murder  Knockdown  Lost Child
Demo

Encounter Library

2 Branches:
- Storyteller/Method Actor, Power Gamer

2 Roles:
- Parent, Child

- Murder
- Knockdown
- Lost Child
Which encounter comes next?
Demo

Encounter Library

Murder  Knockdown  Lost Child
Demo

Encounter Library

Murder

Lost Child
Demo

Encounter Library

Murder

Lost Child

PaSSAGE
Demo

Encounter Library

Murder

Lost Child
Demo
Encounter Library

Murder

Lost Child

PaSSAGE
Demo
Encounter Library

Murder

Lost Child
PaSSAGE’s choice

Encounter: Lost Child

Branch: Power Gamer
Demo

Encounter Library

Murder

Lost Child
LITTLE RED RIDING HOOD
Evaluation

Results

114 players  mean age 19.5  1/3 male

(Thue et al., AIIDE 2010)
Evaluation

Results

114 players mean age 19.5 1/3 male

Player-Specific Stories are more Fun: 93% Confidence

(Thue et al., AIIDE 2010)
Part 2: Increasing Agency

PaSSAGE 2.0
Player-Specific Stories via Automatically Generated Events
Agency is one’s sense of having influence over the course of an experience.
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“...a generalized sense of control is important to well being in daily life...” (Larson, 1989)

Larson. Is feeling "in control" related to happiness in daily life?. Psychological reports (1989) vol. 64 (3 Pt 1) pp. 775-84
Agency is one’s sense of having influence over the course of an experience.

“...a generalized sense of control is important to well being in daily life...” (Larson, 1989)

“...people become inactive and depressed if their actions cannot affect what happens to them.” (Bandura, 1982 vis. Seligman, 1975)

Larson. Is feeling "in control" related to happiness in daily life?. Psychological reports (1989) vol. 64 (3 Pt 1) pp. 775-84
In an interactive story, the audience is able to affect what happens next.
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Agency is one’s **sense** of having influence over the course of an experience.

In an interactive story, the audience is **able** to affect what happens next.
Interactive Stories
A Tree-like Representation

The Mystery of Chimney Rock
by Edward Packard

CHOOSE YOUR OWN ADVENTURE #5
Bantam Books, New York, 1979

Graph by Sean Michael Ragan

http://www.seanmichaelragan.com/html/03B2008-oy-o-%5B5
Choose_Your_Own_Adventure_book_as_directed_graph.shtml
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Interactive Stories
Choose Your Own Adventure Books

http://amyfabulous.wordpress.com/2008/07/30/my-very-own-choose-your-own-adventure-book/
Interactive Stories
Choose Your Own Adventure Books

story states

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Interactive Stories
Choose Your Own Adventure Books

- story states
- instructions from author

Choose Your Own Adventure Books

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Interactive Stories
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Interactive Stories
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Story states

Instructions from author

Audience decision

Human computation

http://amyfabulous.wordpress.com/2008/07/30/my-very-own-choose-your-own-adventure-book/
Interactive Stories

Computer Role-Playing Games

- Deus Ex (Ion Storm)
- Fable I, II, & III (Lionhead Studios)
- Fallout 1 & 2 / Planescape: Torment (Black Isle Studios)
- Morrowind / Oblivion / Fallout 3 (Bethesda Softworks)
- Baldur’s Gate II: Shadows of Amn / Neverwinter Nights / Star Wars: Knights of the Old Republic / Dragon Age: Origins / Mass Effect 1 & 2 (BioWare)
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source: steampowered.com
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  “Complex Moral Choices
  • There are no easy choices”
  
  - Dragon Age: Origins

source: steampowered.com
Problem Formulation
Increase Agency in Interactive Stories
Problem Formulation

Increase Agency in Interactive Stories

We propose to tackle the computational tasks of:
Problem Formulation
Increase Agency in Interactive Stories

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1) **deciding, at run-time**, which of several potential events in an interactive story will maximize the
Problem Formulation
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1) **deciding, at run-time**, which of several potential events in an interactive story will maximize the feelings of agency of each particular player, and
Problem Formulation
Increase Agency in Interactive Stories

We propose to tackle the computational tasks of:

1) deciding, at run-time, which of several potential events in an interactive story will maximize the feelings of agency of each particular player, and

2) executing such decisions in the context of an interactive story that is coherent, testable, and inclusive of the aesthetics of traditional authors.
Increasing Agency is Complicated

Problem Formulation
Problem Formulation

Increasing Agency is Complicated

Professional reviews of Fable III:

- Tom Mc Shea, GameSpot

- Chris Boutilier, Extreme Gamer
Increasing Agency is Complicated

Professional reviews of Fable III:

“The lack of choice in how the main quest plays out is disappointing”

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http://www.gamespot.com/xbox360/rpg/fableiii/review.html
Problem Formulation
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Problem Formulation

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http://n4g.com/news/640189/extreme-gamer-fable-iii-review
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Problem Formulation

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- “The lack of choice in how the main quest plays out is disappointing”
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- “Lack of interesting moral choices until the end”

- “Interesting player choices”

- “Fable III' doesn't waste any time putting you in the hot seat to make some life changing decisions.”
  - Chris Boutilier, Extreme Gamer

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http://n4g.com/news/642189/extreme-gamer-fable-iii-review
Problem Formulation

Increasing Agency is Complicated

One Size does not Fit All

Players can experience the same content, but feel different amounts of agency.
Problem Formulation

Increasing Agency is Complicated
Problem Formulation
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Professional review of inFamous:
Problem Formulation
Increasing Agency is Complicated

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“You have a choice in how [the story] plays out, which gives you a strong connection to the events, sucking you further into the world.”
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“Powerful moral choices”

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Content Matters
Experiencing different story content generally leads to different amounts of agency being felt.
Increasing Agency is Complicated

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Experiencing different story content generally leads to different amounts of agency being felt.
Problem Formulation
Increase Agency in Interactive Stories

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Experiencing different story content generally leads to different amounts of agency being felt.
Problem Formulation
Increase Agency in Interactive Stories

Agency can be maximized by selecting story content
Problem Formulation
Increase Agency in Interactive Stories

Agency can be maximized by selecting story content

One Size does not Fit All
Players can experience the same content, but feel different amounts of agency.
Problem Formulation
Increase Agency in Interactive Stories

Agency can be maximized by selecting story content

We should select content based on knowledge about each player
Problem Formulation

Components of an A.I. Game Master

We need an A.I. system that can:
We need an A.I. system that can:

Select story content to maximize agency (based on player information)
Problem Formulation
Components of an A.I. Game Master

We need an A.I. system that can:

- Select story content to maximize agency (based on player information)
- Learn about players
Inspiration
Pen-and-Paper Role-Playing Games

Inspiration
Pen-and-Paper Role-Playing Games

Game Master

Inspiration
Pen-and-Paper Role-Playing Games

Game Master
Players

Players

Inspiration
Pen-and-Paper Role-Playing Games

Game Master

Players

Players


Inspiration
Pen-and-Paper Role-Playing Games

Game Master

Players

Players


Increasing Agency in Interactive Stories

Building and Evaluating an A.I. Game Master
Evaluation Metric

Player Ratings of Agency

My inputs had considerable impact on the events in the story. *

1 2 3 4 5

Strongly Disagree ● ● ● ○ ● Strongly Agree

I had the feeling that I could affect directly something on the screen. *

1 2 3 4 5

Strongly Disagree ● ● ● ● ○ Strongly Agree

The consequences of my inputs were clearly visible. *

1 2 3 4 5

Strongly Disagree ● ● ● ○ ● Strongly Agree

(survey by Klimmt et al.)
Related Work
(Abridged)
Related Work

(Abridged)

Influencing Players instead of Increasing Agency
Related Work
(Abridged)

- Influencing Players instead of Increasing Agency
- Guiding players away from unsupported actions
Related Work (Abridged)

- Influencing Players instead of Increasing Agency
- Guiding players away from unsupported actions
- Predict player “mistakes”, trigger distractions
Related Work
(Abridged)

- Influencing Players instead of Increasing Agency
  - Guiding players away from unsupported actions
  - Predict player “mistakes”, trigger distractions
  - Convincing players to take a particular action
Related Work

(Abridged)

- Influencing Players instead of Increasing Agency
  - Guiding players away from unsupported actions
  - Predict player “mistakes”, trigger distractions
  - Convincing players to take a particular action
  - Add persuasive statements to an interactive story

(Magerko 2006)
Related Work
(Abridged)

- Influencing Players instead of Increasing Agency
- Guiding players away from unsupported actions
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(Magerko 2006)

no human study
Related Work

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- Influencing Players instead of Increasing Agency
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(Magerko 2006) (Roberts et al. 2009) (Figueiredo et al. 2010)

no human study
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- Influencing Players instead of Increasing Agency
  - Guiding players away from unsupported actions
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  - Convincing players to take a particular action
  - Add persuasive statements to an interactive story

(Magerko 2006) (Roberts et al. 2009) (Figueiredo et al. 2010)

no human study only one attempt each, small study, no A.I.
PaSSAGE

Player-Specific Stories via Automatically Generated Events

2.0
Proposed Approach
Designing an A.I. Game Master

We need an A.I. system that can:

- Select story content to maximize agency (based on player information)
- Learn about players
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Proposed Approach
Designing an A.I. Game Master

We need an A.I. system that can:

Select story content to maximize agency (based on player information)
learn about players

We can learn player preferences over story content
Proposed Approach
Designing an A.I. Game Master

We need an A.I. system that can:

- Select story content to maximize agency (based on player information)
- Learn about players
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.

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Our goal is to maximize the desirability of the content that occurs as a result of player decisions.
Proposed Approach
Estimating Player-Specific Content Desirability

Our goal is to maximize the desirability of the content that occurs as a result of player decisions
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Estimating Player-Specific Content Desirability

Our goal is to maximize the desirability of the content that occurs as a result of player decisions
Proposed Approach

Estimating Player-Specific Content Desirability

How desirable is each branch?

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

Estimating Player-Specific Content Desirability

How desirable is each branch?

annotate with author estimates

annotate with author estimates

Our goal is to maximize the desirability of the content that occurs as a result of player decisions.
Our goal is to maximize the desirability of the branches that occur as a result of player decisions.
Proposed Approach
Estimating Player-Specific Content Desirability

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Proposed Approach

Estimating Player-Specific Content Desirability

How desirable is each branch?

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Proposed Approach
Estimating Branch Desirability

How desirable is each branch?

Our goal is to maximize the desirability of the branches that occur as a result of player decisions

△ Player Decision  ❙ Decision Test
Proposed Approach
Maximizing Desirability to Increase Agency
Proposed Approach
Maximizing Desirability to Increase Agency

Player Decision
Decision Test
Proposed Approach
Maximizing Desirability to Increase Agency
Proposed Approach
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Proposed Approach
Maximizing Desirability to Increase Agency

decision test
Proposed Approach
Maximizing Desirability to Increase Agency
Proposed Approach
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event selection

Player Decision  Decision Test  Event Selection
Proposed Approach
Maximizing Desirability to Increase Agency

Design Time:

△ Player Decision  ❗️ Decision Test  ✏️ Event Selection
Proposed Approach
Maximizing Desirability to Increase Agency

Diagram:
- △ Player Decision
-  Decision Test
-  Event Selection

Tree structure:
- A
- E
- Decision Tests
- Event Selections
Proposed Approach
Maximizing Desirability to Increase Agency

Player Decision  Decision Test  Event Selection
Proposed Approach
Maximizing Desirability to Increase Agency
Proposed Approach
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Proposed Approach
Maximizing Desirability to Increase Agency
Congratulations, students.
Player Decision  Decision Test  Event Selection
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!

△ Player Decision  ❓ Decision Test  ❁ Event Selection
My boy! My boy! You've been too long.

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.
Locked up in that school for far too long to see you!

△ Player Decision  ❖ Decision Test  ❖ Event Selection
E  E  E

Player Decision  Decision Test  Event Selection
You're the hero, [player]. The plotline is that I was going to kill a man, and you're here to prevent me from doing so.

Player Decision

Come no closer!

Decision Test

Event Selection
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.
Player Decision

Decision Test

Event Selection
Player Decision  Decision Test  Event Selection
Proposed Approach
Maximizing Desirability to Increase Agency

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Proposed Approach
Maximizing Desirability to Increase Agency

Branch Desirability = PlayerModel • Annotations
Proposed Approach
Maximizing Desirability to Increase Agency

Branch Desirability = PlayerModel • Annotations
Proposed Approach
Maximizing Desirability to Increase Agency

Sub-event Desirability $= \max_{\text{branches}} (\text{Branch Desirability})$
Our goal is to maximize the desirability of the branches that occur as a result of player decisions.

\[
\text{Branch Desirability} = \text{Player Model} \cdot \text{Annotations}.
\]

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\text{Sub-event Desirability} = \max_{\text{branches}} \left( \text{Branch Desirability} \right)
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Sub-event Desirability = \( \max \) branches (Branch Desirability)
Our goal is to maximize the desirability of the branches that occur as a result of player decisions. Branch Desirability = Player Model Annotations.

Sub-event Desirability = \(\max\) branches (Branch Desirability)
Our goal is to maximize the desirability of the branches that occur as a result of player decisions.

Branch Desirability = Player Model Annotations

Sub-event Desirability = \max_{\text{branches}} (\text{Branch Desirability})

Proposed Approach
Maximizing Desirability to Increase Agency

Foreseeability Annotations
Our goal is to maximize the desirability of the branches that occur as a result of player decisions. Branch Desirability = PlayerModel Annotations.

\[
\begin{align*}
\text{Sub-event Desirability} &= \max_{\text{branches}} (\text{Branch Desirability})
\end{align*}
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Branch Desirability = PlayerModel Annotations

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Proposed Approach
Maximizing Desirability to Increase Agency
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Sub-event Desirability

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Proposed Approach
Maximizing Desirability to Increase Agency

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\text{Branch Desirability} = \text{PlayerModel Annotations}. 
\]

Event Desirability

\[
\text{Event Desirability} = e^+ + \alpha(e^+ - e^-) 
\]

Diagram:

- Player Decision
- Decision Test
- Event Selection

Sub-event Desirability

Sub-event foreseeability annotations

Event Selection

Sub-event desirability
Proposed Approach
Maximizing Desirability to Increase Agency

\[
\text{Event Desirability} = e^+ + \alpha (e^+ - e^-)
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Proposed Approach
Maximizing Desirability to Increase Agency

Our goal is to maximize the desirability of the branches that occur as a result of player decisions.

Branch Desirability = Player Model  Annotations.

Event Desirability = \( e^+ + \alpha (e^+ - e^-) \)
Proposed Approach
Maximizing Desirability to Increase Agency

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Branch Desirability = PlayerModel Annotations.

Event Desirability = $\sum \mathbf{e}^+ + \alpha (\mathbf{e}^+ - \mathbf{e}^-)$
Proposed Approach
Maximizing Desirability to Increase Agency

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Maximizing Desirability to Increase Agency

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Event Desirability

\[ E = e^+ + \alpha(e^+ - e^-) \]
Proposed Approach
Maximizing Desirability to Increase Agency

Event Desirability = \( e^+ + \alpha (e^+ - e^-) \)
Proposed Approach
Maximizing Desirability to Increase Agency

Event Desirability = \( e^+ + \alpha (e^+ - e^-) \)
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Maximizing Desirability to Increase Agency

Our goal is to maximize the desirability of the branches that occur as a result of player decisions.

\[
\text{Branch Desirability} = \text{PlayerModel} \cdot \text{Annotations}.
\]

Event Desirability

\[
E = \mathbf{e}^+ + \alpha (\mathbf{e}^+ - \mathbf{e}^-)
\]
Proposed Approach
Maximizing Desirability to Increase Agency

Event Desirability
\[ E = e^+ + \alpha(e^+ - e^-) \]

- Player Decision
- Decision Test
- Event Selection

Branch Desirability = PlayerModel Annotations.

Sub-event Desirability
\[ \text{sub-event desirability} \]

Event Desirability
\[ e^+ + \alpha(e^+ - e^-) \]

foreseeability annotations
Maximizing Desirability to Increase Agency

**Proposed Approach**

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Proposed Approach
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Maximizing Desirability to Increase Agency

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Event Desirability

\[ \text{Event Desirability} = e^+ + \alpha(e^+ - e^-) \]

Our goal is to maximize the desirability of the branches that occur as a result of player decisions.

Branch Desirability = PlayerModel Annotations.

\[ \text{sub-event desirability} = \text{foreseeability annotations} \]

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Proposed Approach
Maximizing Desirability to Increase Agency

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\]

Diagram:
- Δ Player Decision
- ? Decision Test
- E Event Selection

Desirability calculations:
- Event desirability
- Sub-event desirability
- Foreseeability annotations
Proposed Approach
Maximizing Desirability to Increase Agency

\[
\text{Event Desirability} = e^+ + \alpha (e^+ - e^-)
\]
Evaluation

Results

141 players  mean age 19.4  38% male

(Thue et al., AIIDE 2011)
Evaluation

Results

141 players mean age 19.4 38% male

Player-Specific Stories give a feeling of more Agency: 96% Confidence

(Thue et al., AIIDE 2011)
Future Work
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- Investigate survey effects on fun
Future Work

- Investigate survey effects on fun
- Beyond self-reports
Future Work

- Investigate survey effects on fun
- Beyond self-reports
- Target fun & agency simultaneously
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Future Work

- Investigate survey effects on fun
- Beyond self-reports
- Target fun & agency simultaneously
- Learn annotations from game traces and human GMs:
  - player typing
  - player-specific foreseeability values
- Emotion trajectories in space
- Technology commercialization (e.g., BioWare Corp.)
Conclusion

PaSSAGE
Player-Specific Stories via Automatically Generated Events
Conclusion

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.
As you journey along the path you meet an old man.

He tells you that modern neuroscience has proved that all our actions and decisions are merely the machinations of a predetermined universe and that our concept of ‘free will’ is naught but a comforting illusion.

If you agree with his hypothesis, turn to page 72

If you disagree, turn to page 72