Intelligent Narrative Generation: Creativity, Engagement, and Cognition

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Tell me a story
Storytelling

• Storytelling is pervasive part of the human experience
  – Books, movies, computer games, training scenarios, education, every-day communication, etc.

• **Narrative Intelligence**: narrative is a fundamental means by which we organize, understand, and explain the world

• Instill computational systems with the ability to craft and tell stories in order to be better entertainers, educators, trainers, communicators, and generally more capable of relating to humans
Why study story generation?

• Stories are everywhere

• Humans make up stories all the time, but computers do not

• Cognitive science

• Computational creativity

• Practical creativity
There is a woman named Jasmine. There is a king named Jafar. This is a story about how King Jafar becomes married to Jasmine. There is a magic genie. This is also a story about how the genie dies. There is a magic lamp. There is a dragon. The dragon has the magic lamp. The genie is confined within the magic lamp.

King Jafar is not married. Jasmine is very beautiful. King Jafar sees Jasmine and instantly falls in love with her. King Jafar wants to marry Jasmine. There is a brave knight named Aladdin. Aladdin is loyal to the death to King Jafar. King Jafar orders Aladdin to get the magic lamp for him. Aladdin wants King Jafar to have the magic lamp. Aladdin travels from the castle to the mountains. Aladdin slays the dragon. The dragon is dead. Aladdin takes the magic lamp from the dead body of the dragon. Aladdin travels from the mountains to the castle. Aladdin hands the magic lamp to King Jafar. The genie is in the magic lamp. King Jafar rubs the magic lamp and summons the genie out of it. The genie is not confined within the magic lamp. King Jafar controls the genie with the magic lamp. King Jafar uses the magic lamp to command the genie to make Jasmine love him. The genie wants Jasmine to be in love with King Jafar. The genie casts a spell on Jasmine making her fall in love with King Jafar. Jasmine is madly in love with King Jafar. Jasmine wants to marry King Jafar. The genie has a frightening appearance. The genie appears threatening to Aladdin. Aladdin wants the genie to die. Aladdin slays the genie. King Jafar and Jasmine wed in an extravagant ceremony. The genie is dead. King Jafar and Jasmine are married. The end.
Interactive Narrative → Story Generation → Computer Games

Interactive Narrative

Story Generation

Computer Games
Automated story generation

• Automatic creation of meaningful fictional sequences is hard
  – Complexity, subtlety, nuance, mimesis
  – Focus on plot

• Two nearly-universal properties of story
  – Causal progression
    • Perception that the main events of the story make up causal chains that terminate in the outcome
  – Character believability
    • Perception that characters act in a manner that does not distract from one’s suspension of disbelief
    • Characters are perceived to be intentional agents
Computer as author

- Creative writing is a problem-solving activity
- Author goals vs. character goals
- Model: plan out the events that should occur in the narrative
Narratives as plans

- Partial-order plan is a good representation of plot
  - Action, temporality, causality

- Planning: find a sound and coherent sequence of actions that transforms the initial state into one in which the goal situation holds
Planning stories

• But, is planning a good model of story creation?

• Narrative Planning:
  – Multiple characters
  – Goal state describes outcome of the story
  – Outcome is not necessarily intended by any characters

• Augment planning algorithm to reason about author goals and character goals
Fabulist

• Conventional causal dependency planning
  – Provides logical causal progression

• Reasoning about character intentions
  – Use a cognitive model to determine whether characters appear intentional and revise the plan otherwise
  – Insert actions that explain character goals

Falls-in-Love (Vizier, Jasmine, Castle)

Order (Vizier, Aladdin, has(Vizier, Lamp))

Travel (Aladdin, Castle, Mountain)
at (Aladdin, Mountain)

Slay (Aladdin, Dragon, Mountain)
at (Aladdin, Mountain)

Pillage (Aladdin, Lamp, Dragon, Mountain)

has (Aladdin, Lamp)

Give (Aladdin, Lamp, Vizier, Castle)

has (Vizier, Lamp)

Travel (Aladdin, Mountain, Castle)
at (Aladdin, Castle)

 Summon (Vizier, Genie, Lamp, Castle)
at (Genie, Castle)

Command (Vizier, Genie, loves(Jasmine, Vizier))

Love-Spell (Genie, Jasmine, Castle)

Marry (Vizier, Jasmine, Castle)

Appearance-Threatening (Genie, Aladdin, Castle)

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The genie is dead. King Jafar and Jasmine are married. The end.
Effect on reader comprehension?

• Fabulist vs. conventional planner

• Question-answering protocol to elicit readers’ mental models
  – Enablement (how questions)
  – Intention (why questions)

• Compared readers’ answers to the computer’s answers

<table>
<thead>
<tr>
<th>Q: Why did Aladdin travel from the mountains to the castle?</th>
<th>A: Because the genie wanted to cast a spell on Jasmine.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4: Very Good 3: Good 2: Bad 1: Very Bad</td>
<td>4: Very Good 3: Good 2: Bad 1: Very Bad</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Questions computer thinks are “good” (closer to 4)</th>
<th>Questions computer thinks are “bad” (closer to 1)</th>
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<tr>
<td>Fabulist</td>
<td>3.2</td>
<td>1.19</td>
</tr>
<tr>
<td>Control</td>
<td>2.99</td>
<td>1.3</td>
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</table>
The “goodness” question

• Does the story generator know that it is creating something good?

• How can a computational system generate a suspenseful story?
Interactive narrative

A form of digital entertainment in which the player influences a dramatic storyline through actions.
Interactive narrative

- Narrative branches in response to player actions
- Combinatorics of authoring
- Leverage story generator

Automated story director

- Use a story planner to construct alternative branches
- Start with an exemplar narrative (generated or hand-authored)
- Exceptions: player actions that derail the narrative plan
- How to detect exceptions?
- How to respond to exceptions?

Automated story director

- Pre-compute tree of contingency narratives
- Semi-autonomous virtual characters
Replayability and personalization

- Role playing games (and training scenarios) interleave challenges and narrative connectives
- The replay value of a game diminishes as game affordances and story content are exhausted
- Can we adapt an existing game plot so that the player never experiences the same plot progression twice?
- Can we personalize the game to individual players’ skills and interests?
Game adaptation

• Challenge tailoring
  – Choose and order the challenges the player should experience

• Challenge contextualization
  – Provide appropriate motivating story context between challenges
Challenge tailoring

- Which skill-based events and in what order?
- Player model predicts skill performance
Player modeling

- Collaborative filtering via temporal matrix factorization

\[ Z \approx \sum_{k=1}^{K} w_k \circ h_k \circ q_k \]

<table>
<thead>
<tr>
<th>Player</th>
<th>Types</th>
<th>Time</th>
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<td>Fire</td>
<td>Water</td>
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<td>Fire</td>
<td>Water</td>
<td>...</td>
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<tr>
<td>player1</td>
<td>-</td>
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</tr>
<tr>
<td>player2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>player3</td>
<td>1</td>
<td>-</td>
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<tr>
<td>time2</td>
<td>1.2</td>
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<tr>
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<tr>
<th>&quot;skill1&quot;</th>
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<tbody>
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<td>player1</td>
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<tr>
<td>player2</td>
<td>2.5</td>
</tr>
<tr>
<td>player3</td>
<td>1.9</td>
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<td>...</td>
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Plot content optimization

Challenges

![Graph showing time vs. difficulty with markers indicating challenges](graph.png)
Challenge contextualization

- Motivate skill-based events with narrative context
- Use a narrative planner
Virtual world generation

Take water bucket
↓
Pour water on witch
↓
Witch drops shoes
↓
Pick up shoes
↓
Show shoes to king
↓
King trusts you
↓
Tell about princess
↓
Move to lair
↓
Kill dragon
↓
Free princess
↓
Teleport princess to palace
↓
Marry princess

Li & Riedl. Proc. AIIDE 2010 Conference.

Open story generation

• Narrative intelligence is knowledge-intensive, resulting in micro-worlds
• Can we overcome the knowledge engineering bottleneck?
• Can an intelligent system learn to tell stories about any imaginable domain?
Sociocultural storytelling

• Humans rely on a lifetime of experiences from which to explain stories, tell stories, or act in the real-world

• Computational systems can now live in a rich information ecosphere, including the Web, other agents, and humans

• Possible approaches:
  – Read natural language corpora & websites
  – Mine commonsense knowledge bases
  – Learn from humans
Crowdsourcing narrative intelligence

• A crowd of humans on the web → a supercomputer

• **Insight:** humans learn from stories

• Use a crowd to simulate a lifetime of experiences by asking people to tell stories about a specific type of situation

• Crowdsourcing a highly specialized corpus of narrative examples and learn a generalized model of sociocultural situations

Automatically generate stories and interactive experiences **without** a priori domain knowledge authoring
Scheherazade

• Just-in-time model learning
  – Collect written stories via Amazon Mechanical Turk
  – Learn model via semantic parsing, pattern mining, global optimization
  – Barthes: human narratives implicitly encode causality
  – Grice: maxims of quality and relevance (and quantity)

Sociocultural knowledge representation

• Model a situation as a **script**
  – Representation of procedural knowledge
  – Tells one what to do and when to do it
  – Correlated with expertise

• Set of temporally ordered events

• What are the primitive events?

• How are events ordered?
Learning to tell stories

1. Query the crowd
2. Identify the salient events
3. Determine event ordering
4. Mutually exclusive events

• Crowd control:
  - Segment narrative
  - Use one verb per sentence
  - Avoid conditionals and compound structures
  - Avoid using pronouns

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<tr>
<td>b. John stands in line.</td>
<td>b. Mary decides what to order.</td>
</tr>
<tr>
<td>c. John orders food.</td>
<td>c. Mary orders a burger.</td>
</tr>
<tr>
<td>d. John waits for his food.</td>
<td>d. Mary finds a seat.</td>
</tr>
<tr>
<td>e. John sits down.</td>
<td>e. Mary eats her burger.</td>
</tr>
<tr>
<td>f. John eats the food.</td>
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Learning to tell stories

1. Query the crowd
2. Identify the salient events
3. Determine event ordering
4. Mutually exclusive events

- Crowd control simplifies NLP
- Compute semantic similarity between sentences
- Cluster sentences into events

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* Precision ≈ 85%
Learning to tell stories

1. Query the crowd
2. Identify the salient events
3. Determine event ordering
4. Mutually exclusive events

- Seek evidence for temporal relations
- Binomial confidence testing
- Search for the most compact graph that explains the stories

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**Story 1**
- walk/go into restaurant
- read menu
- choose menu item
- take out wallet
- pay for food

**Story 2**
- place order
- wait in line

**Story 3**
- choose menu item
- place order

**Story 4**
- walk/go into restaurant
- pay for food
Learning to tell stories

1. Query the crowd
2. Identify the salient events
3. Determine event ordering
4. Mutually exclusive events

- Measure mutual information between events
- Mutual information is high and co-occurrence is low
- Generalization of “or” relations

Diagram:
- choose restaurant
- drive to restaurant
- walk/go into restaurant
- drive to drive-thru
- mutex
Going on a date to the movies

1. **arrive at theatre**
2. **go to ticket booth**
3. **wait for ticket**
4. **buy tickets**
5. **choose movie**
6. **go to concession stand**
7. **order popcorn / soda**
8. **show tickets**
9. **buy popcorn**
10. **enter theatre**
11. **find seats**
12. **turn off cellphone**
13. **sit down**
14. **eat popcorn**
15. **watch movie**
16. **use bathroom**
17. **discard trash**
18. **talk about movie**
19. **hold hands**
20. **leave movie**
21. **drive home**
Bank robbery

John enters bank

John sees Sally

John waits in line

John approaches Sally

Sally greets John

John pulls out gun

Sally screams

John points gun at Sally

John demands money

Sally collects money

Sally gives John money

John collects money

Sally reads note

John hands Sally a note

The note demands money

John shows gun

Sally opens cash drawer

Sally gives John money

Sally puts money in bag

John leaves bank

John takes bag

Sally presses alarm

John opens bank door

Police arrives

Police arrests John

Sally calls police

John gets in car

John drives away
Narrative generation

- Script defines a space of linear sequences
- Random walk, preserving temporal order and mutual exclusion
- Evaluation shows generated stories statistically indistinguishable from human-authored stories

Interactive narrative generation

You walked to the bank teller. Her name tag read "Sally Smith"
When she saw you, she smiled and said: "How can I help you?"

Now you have the following choices:
1. Give a note to the teller.
2. Give a bag to the teller.
3. Pull our your gun.
Your choice is: 1

You pulled out a note and gave it to Sally.
Sally read the note.
The note read: This is a robbery. Give me money to save your own life.

Now you have the following choices:
1. Give a bag to the teller.
2. Show your gun to the bank teller.
Your choice is:
The road ahead

• Starting with basics: causality, character believability, typicality

• Progressively layering complexity

• Computational aesthetics

• Data-driven tailoring

• Story generation in the real world
Conclusions

• Story generation is a key capability that unlocks many practical, real-world applications
  – Create and manage user experiences in virtual worlds
  – Games, interactive narratives, training simulations, narrative learning environments, virtual characters

• Narrative intelligence is a step toward human-level intelligent systems

• Creative, expressive computational systems
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Thanks! Questions?

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