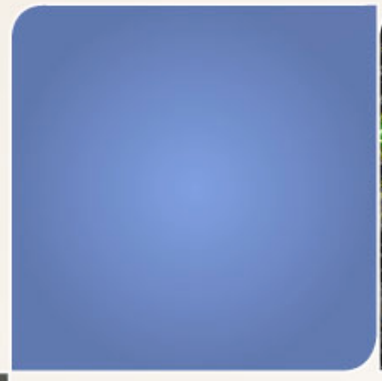

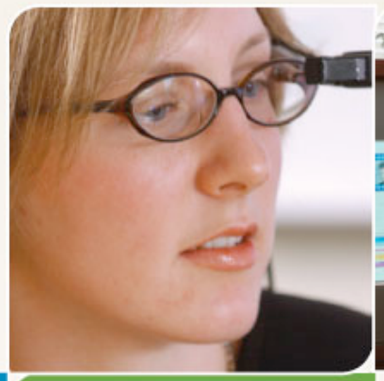

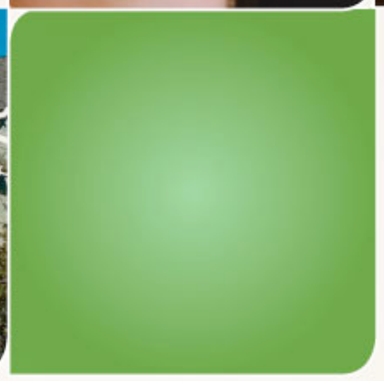

# Intelligent Narrative Generation:
# Creativity, Engagement, and Cognition


## Mark Riedl

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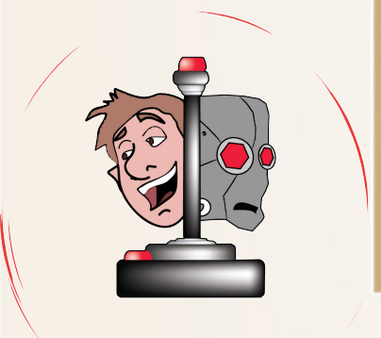
@mark_riedl

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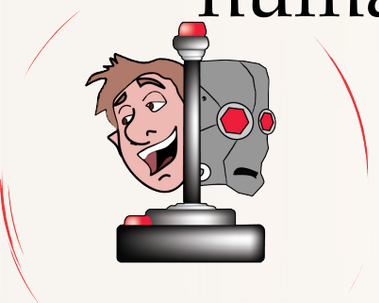
# Tell me a story

# Storytelling

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

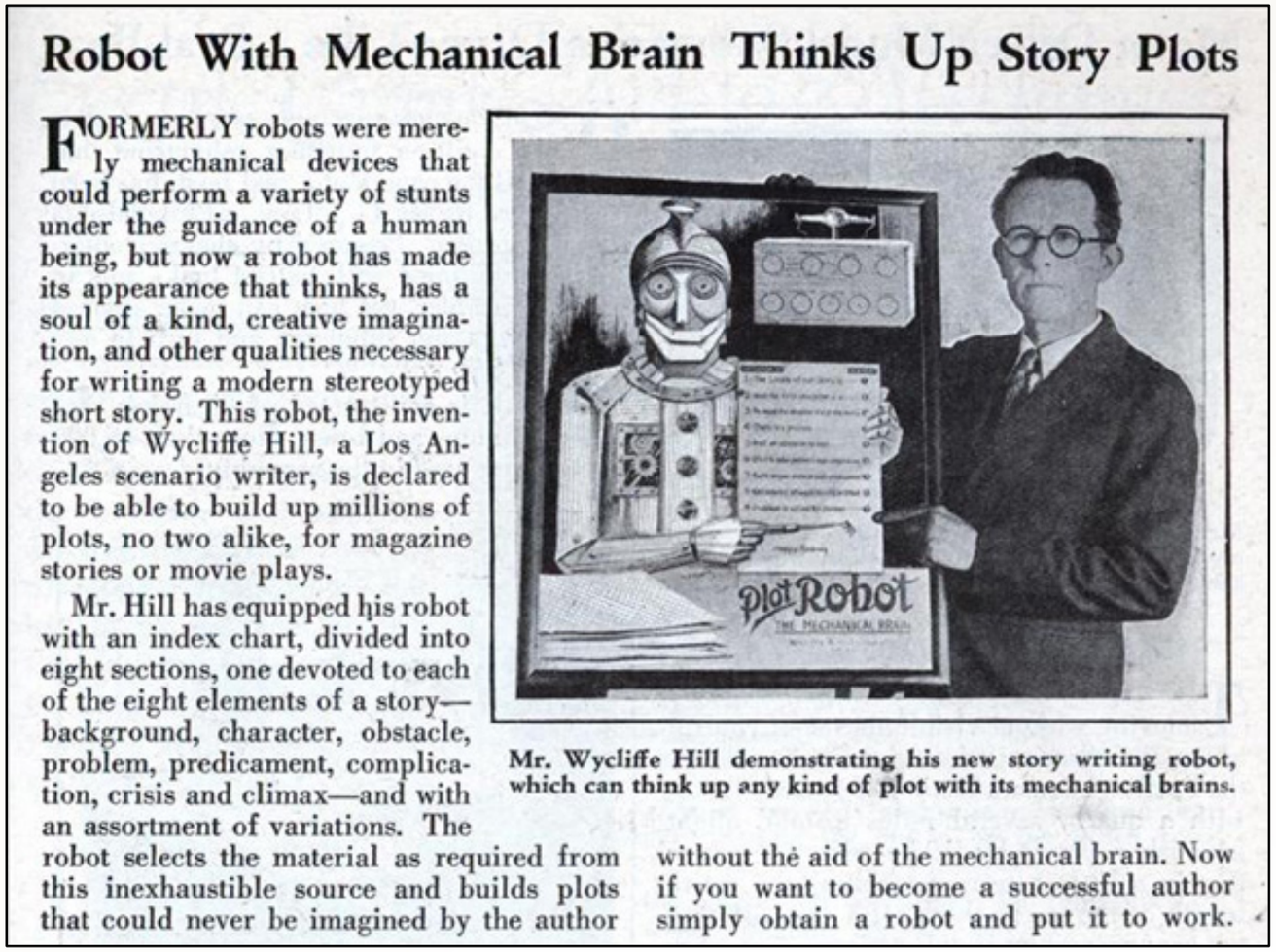
- **Narrative Intelligence:** narrative is a fundamental means by which we organize, understand, and explain the world

- 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



**Robot With Mechanical Brain Thinks Up Story Plots**

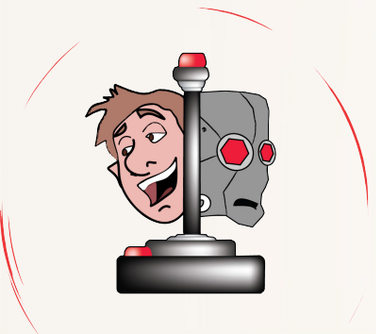
FORMERLY robots were merely mechanical devices that could perform a variety of stunts under the guidance of a human being, but now a robot has made its appearance that thinks, has a soul of a kind, creative imagination, and other qualities necessary for writing a modern stereotyped short story. This robot, the invention of Wycliffe Hill, a Los Angeles scenario writer, is declared to be able to build up millions of plots, no two alike, for magazine stories or movie plays.

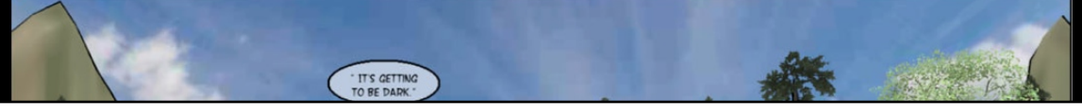
Mr. Hill has equipped his robot with an index chart, divided into eight sections, one devoted to each of the eight elements of a story—background, character, obstacle, problem, predicament, complication, crisis and climax—and with an assortment of variations. The robot selects the material as required from this inexhaustible source and builds plots that could never be imagined by the author without the aid of the mechanical brain. Now if you want to become a successful author simply obtain a robot and put it to work.



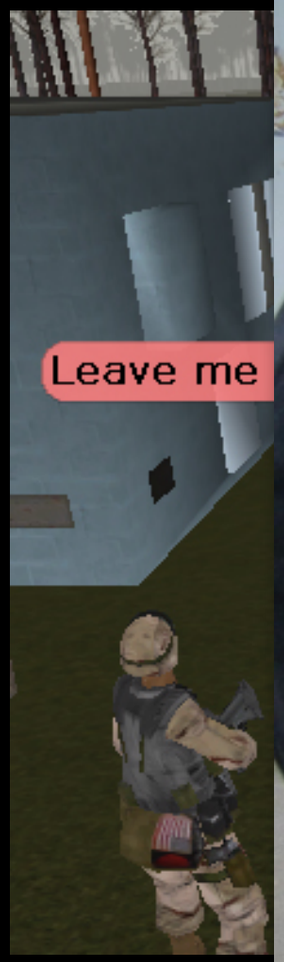
Mr. Wycliffe Hill demonstrating his new story writing robot, which can think up any kind of plot with its mechanical brains.

© Popular Mechanics, 1931

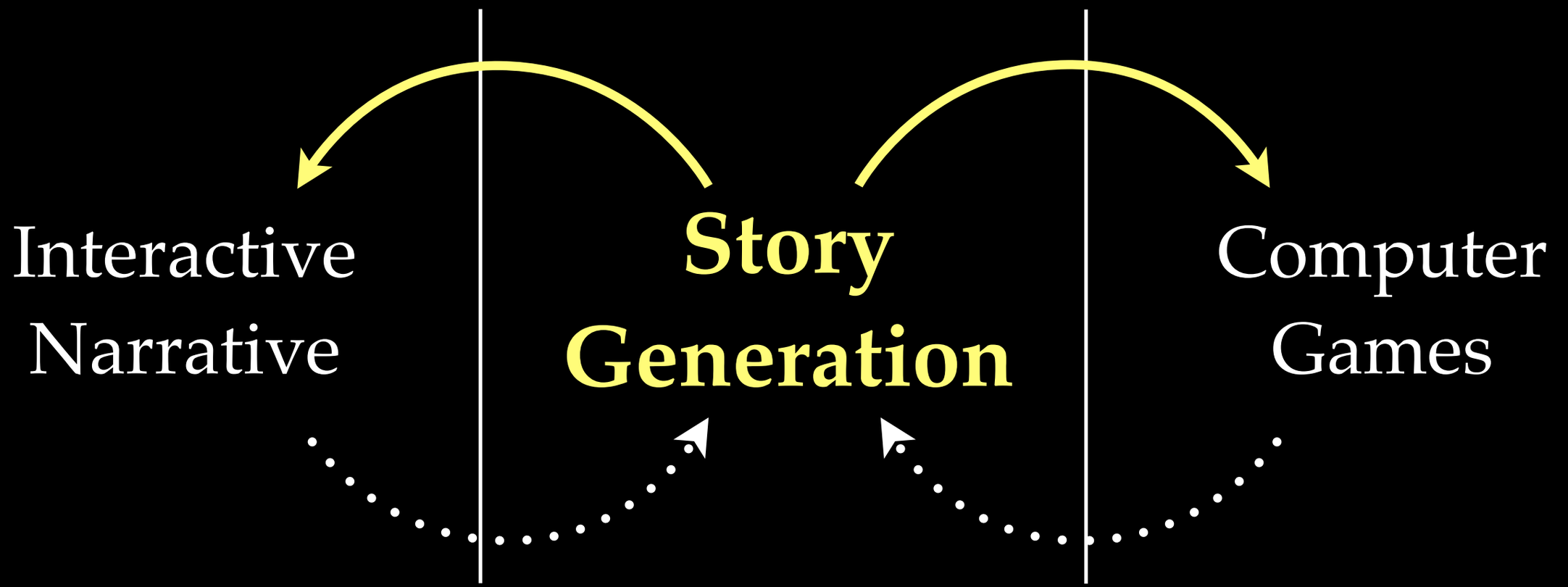





There is a woman named
This is a story about how Ki
There is a magic genie. This



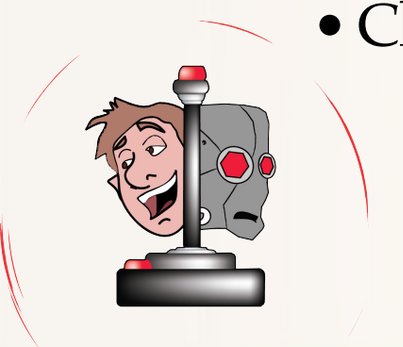
to die. Aladdin slays the ge
extravagant ceremony.
The genie is dead. King


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

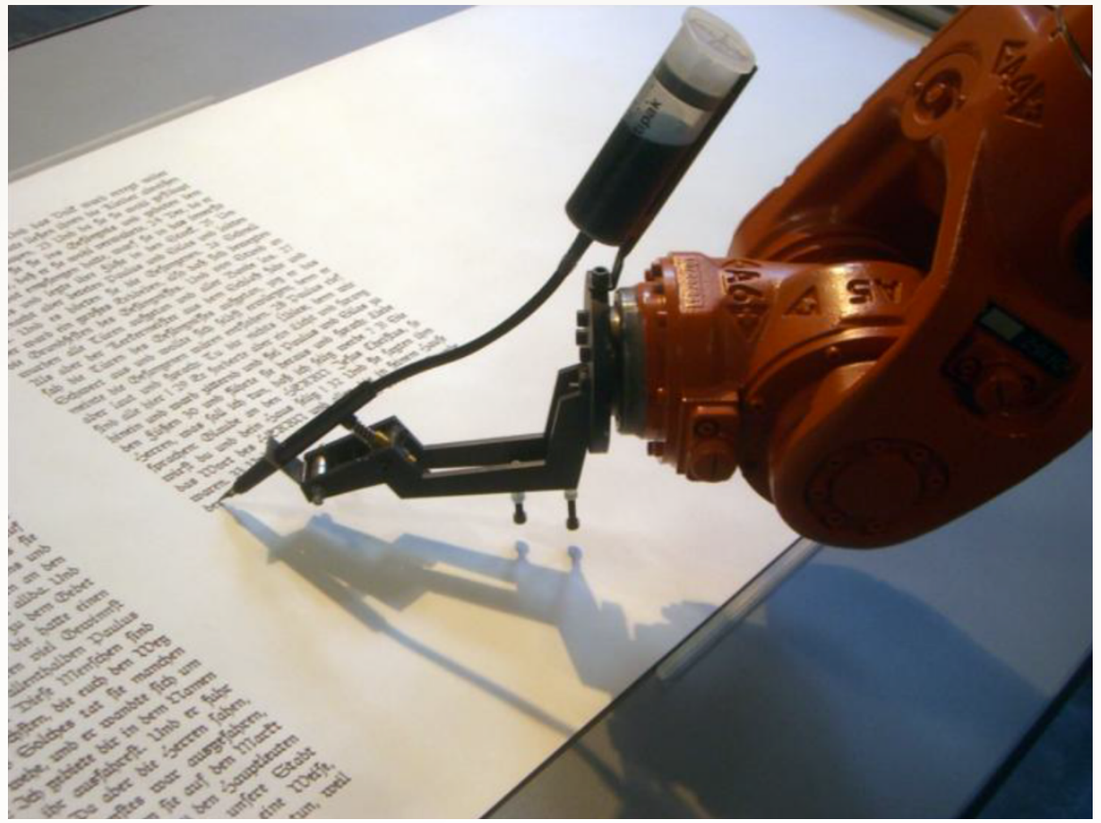


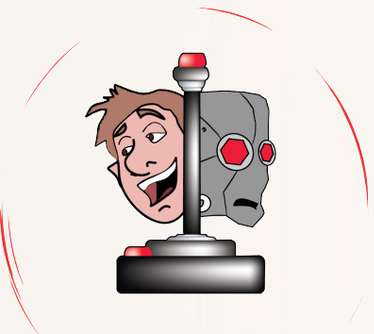
# Computer as author

- Creative writing is a problem-solving activity

- Author goals vs. character goals

- Model: plan out the events that should occur in the narrative

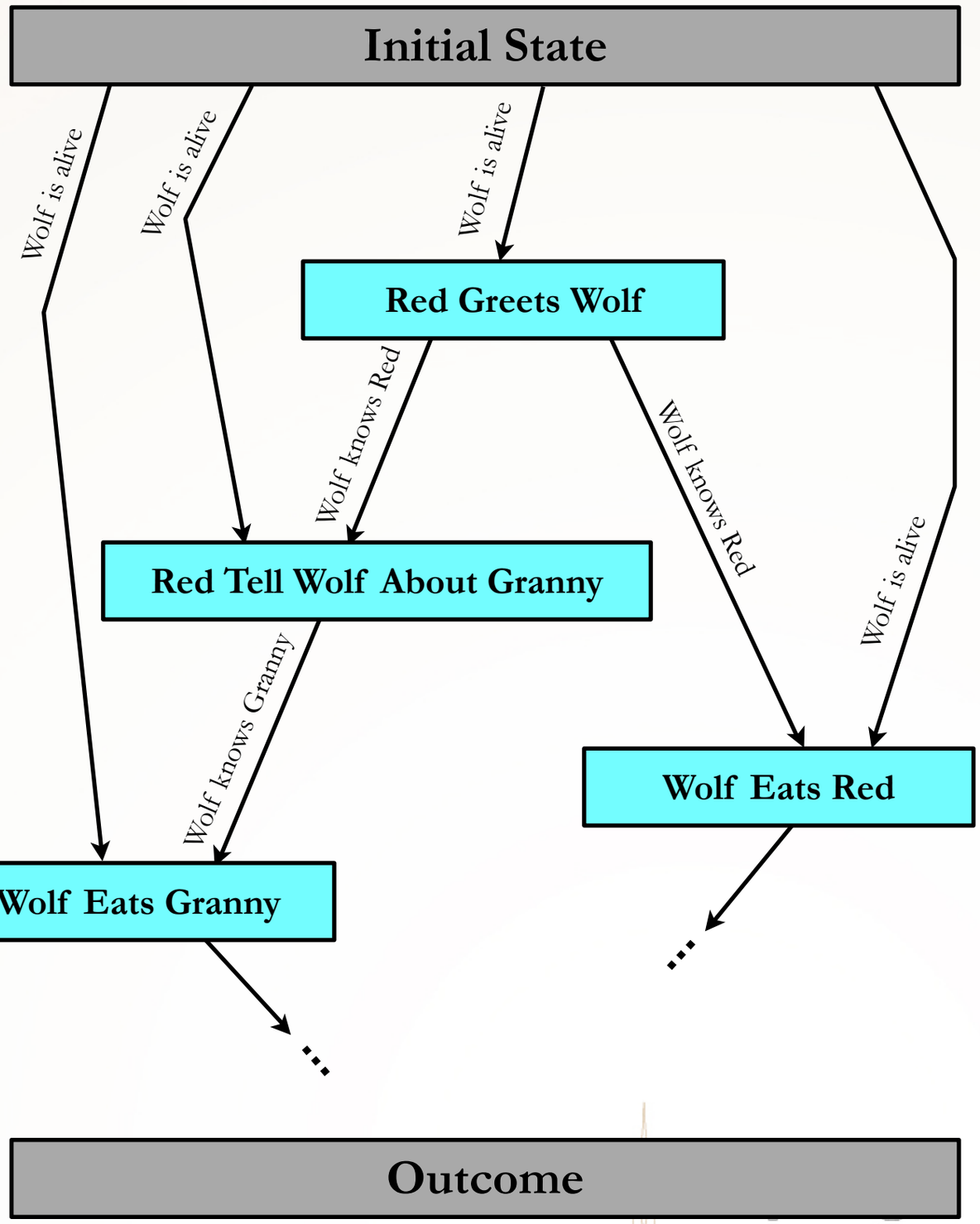


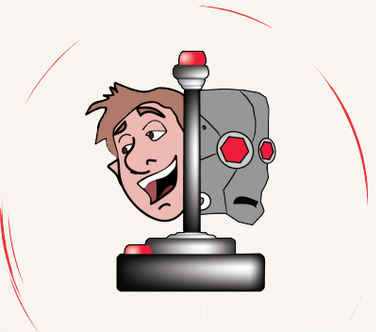


# Narratives as plans

- 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



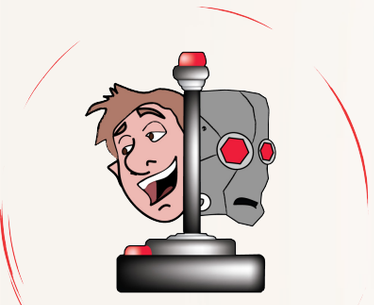



# Planning stories

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

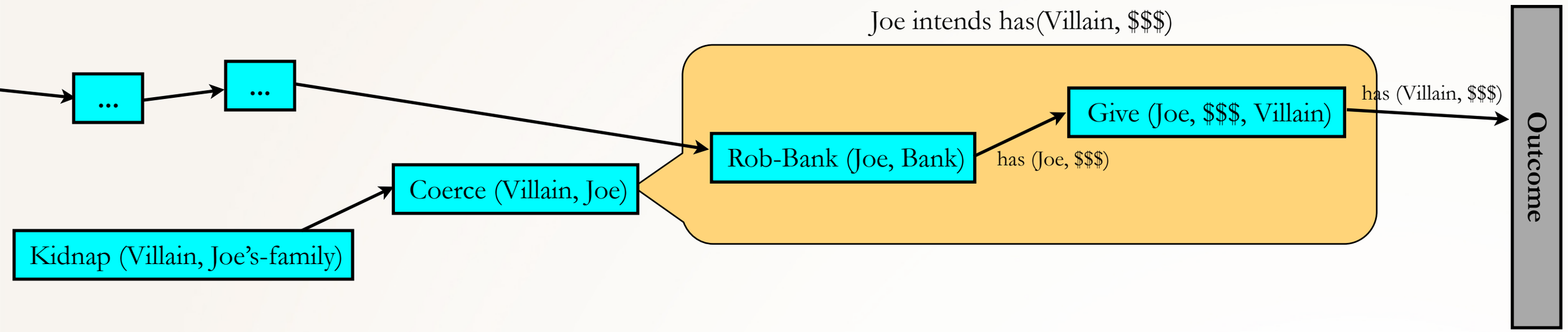
- Narrative Planning:
  - Multiple characters
  - Goal state describes outcome of the story
  - Outcome is not necessarily intended by any characters

- Augment planning algorithm to reason about author goals **and** character goals

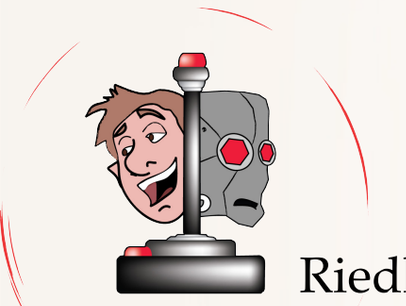


# Fabulist

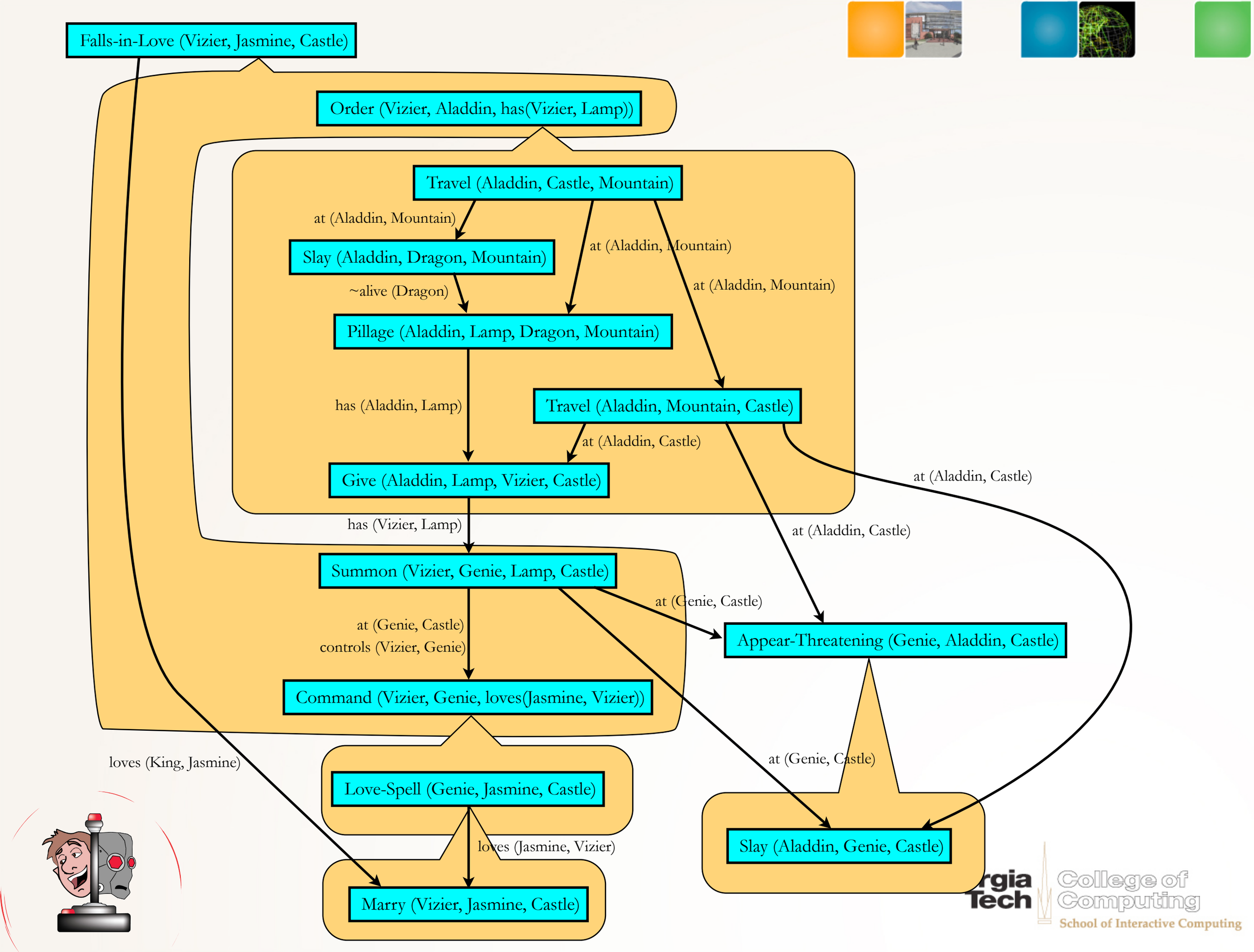
- Conventional causal dependency planning
  - Provides logical causal progression




- 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



Riedl & Young. Journal of Artificial Intelligence Research, 39, 2010.



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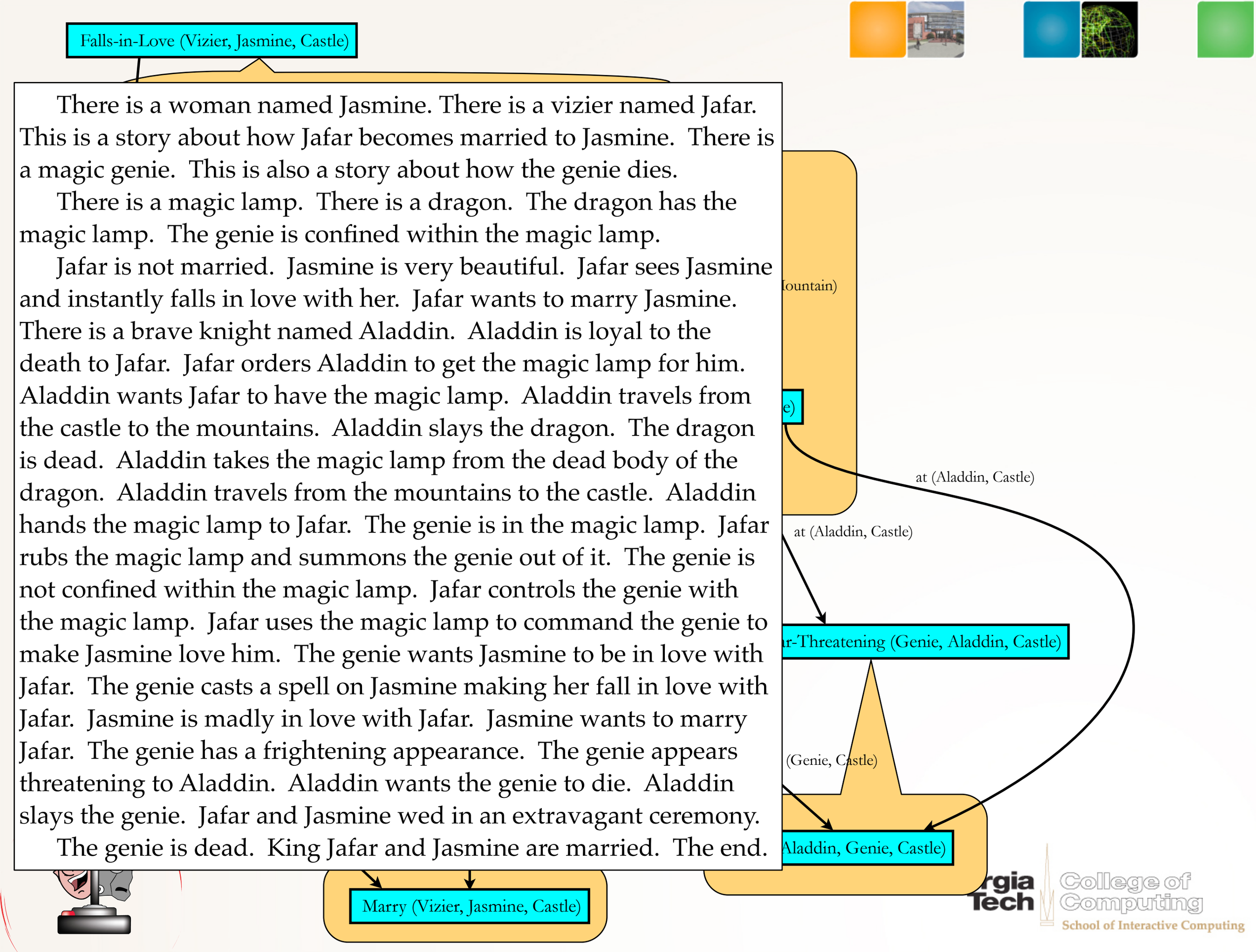
Falls-in-Love (Vizier, Jasmine, Castle)

There is a woman named Jasmine. There is a vizier named Jafar. This is a story about how 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.

Jafar is not married. Jasmine is very beautiful. Jafar sees Jasmine and instantly falls in love with her. Jafar wants to marry Jasmine. There is a brave knight named Aladdin. Aladdin is loyal to the death to Jafar. Jafar orders Aladdin to get the magic lamp for him. Aladdin wants 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 Jafar. The genie is in the magic lamp. Jafar rubs the magic lamp and summons the genie out of it. The genie is not confined within the magic lamp. Jafar controls the genie with the magic lamp. Jafar uses the magic lamp to command the genie to make Jasmine love him. The genie wants Jasmine to be in love with Jafar. The genie casts a spell on Jasmine making her fall in love with Jafar. Jasmine is madly in love with Jafar. Jasmine wants to marry Jafar. The genie has a frightening appearance. The genie appears threatening to Aladdin. Aladdin wants the genie to die. Aladdin slays the genie. Jafar and Jasmine wed in an extravagant ceremony.

The genie is dead. King Jafar and Jasmine are married. The end.

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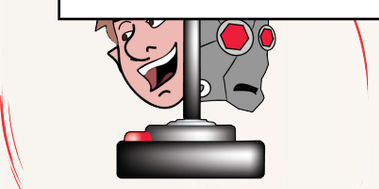
# Effect on reader comprehension?

- 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

**Q:** Why did Aladdin travel from the mountains to the castle?

**A:** Because the genie wanted to cast a spell on Jasmine.

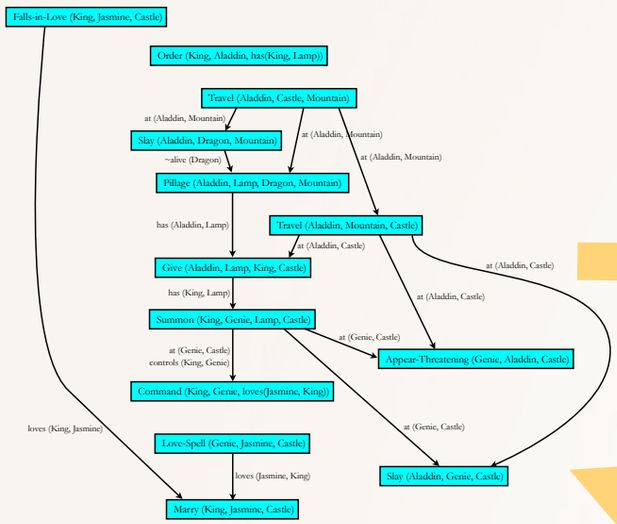
4: Very Good | 3: Good | 2: Bad | 1: Very Bad

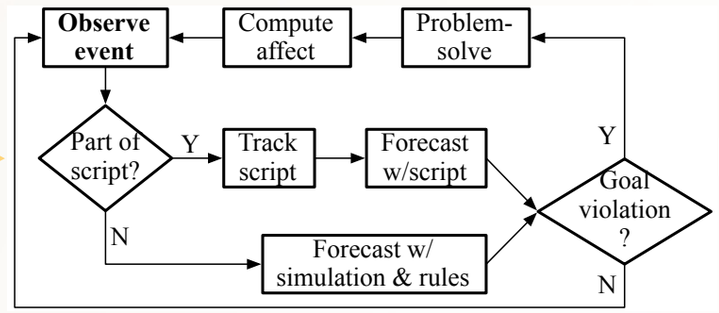


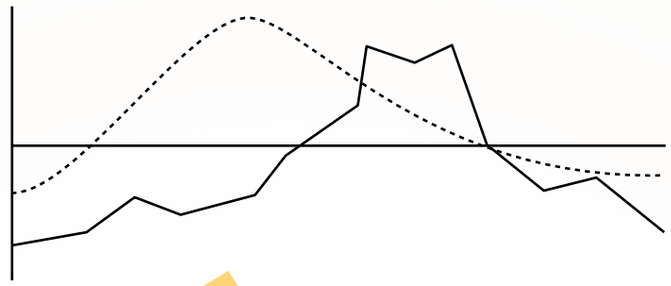
| | Questions computer thinks are "good" (closer to 4) | Questions computer thinks are "bad" (closer to 1) |
|---|---|---|
| **Fabulist** | **3.2** | **1.19** |
| **Control** | 2.99 | 1.3 |

# The "goodness" question

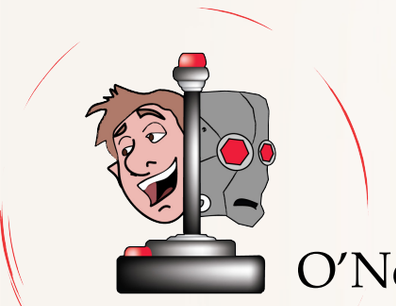
- Does the story generator know that it is creating something good?
- How can a computational system generate a suspenseful story?



New author goal



O'Neill & Riedl. Proc. ACII 2011 Conference.

**Interactive Narrative**

Story Generation

Computer Games

# Interactive narrative

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

Riedl, Automated Story Director

Mateas & Stern, Facade

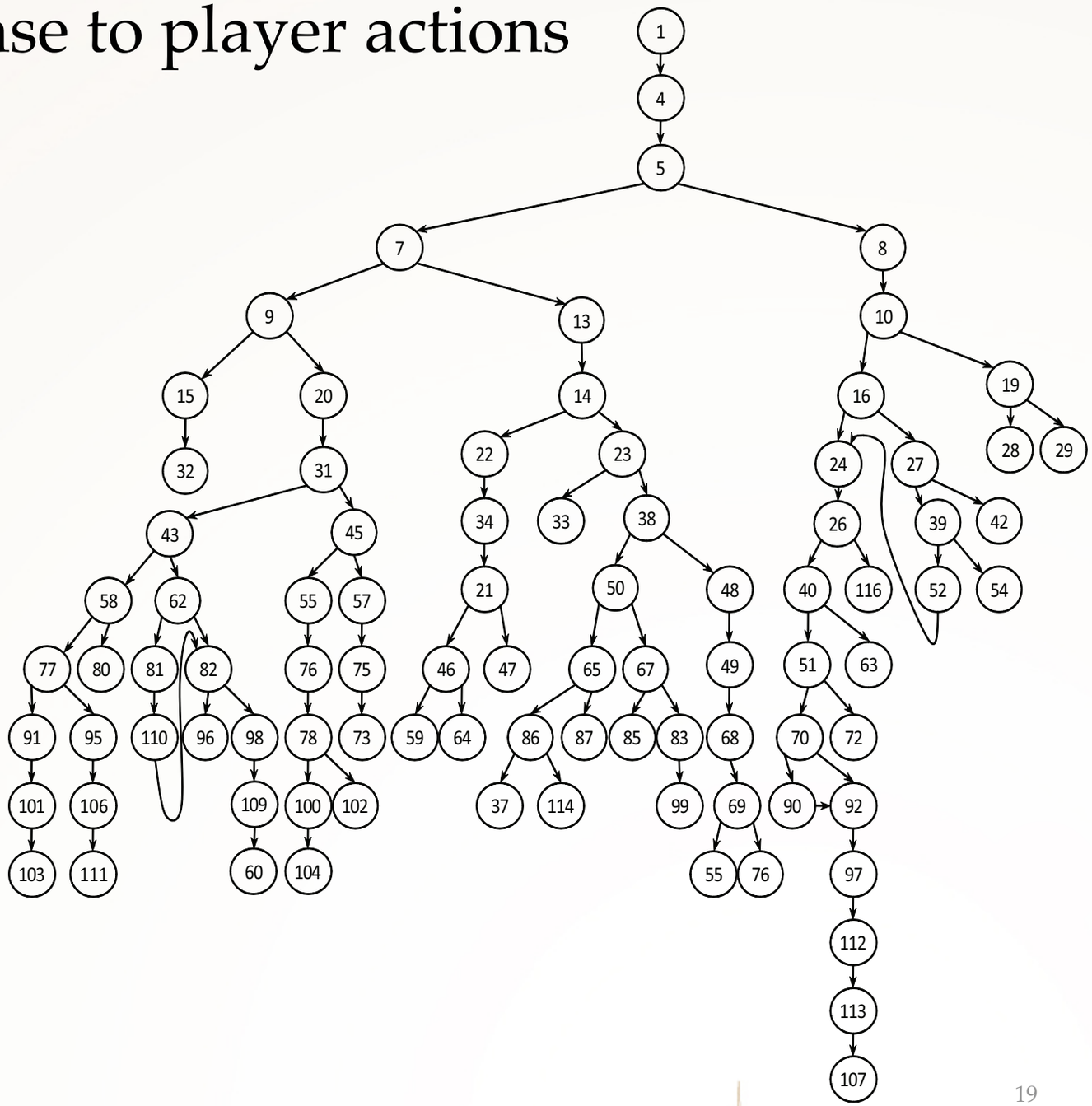
Thue, PaSSAGE

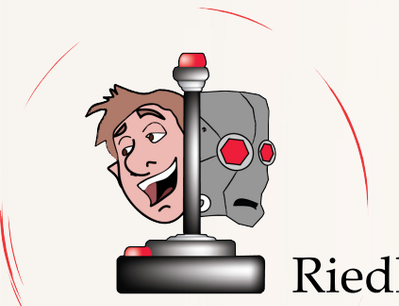
Magerko, Haunt II

Cavazza, Merchant of Venice

# Interactive narrative

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



Riedl, Bulitko. AI Magazine, 34(1), 2013.



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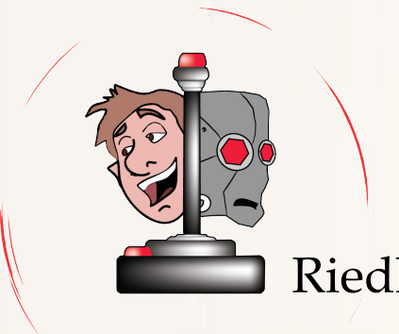
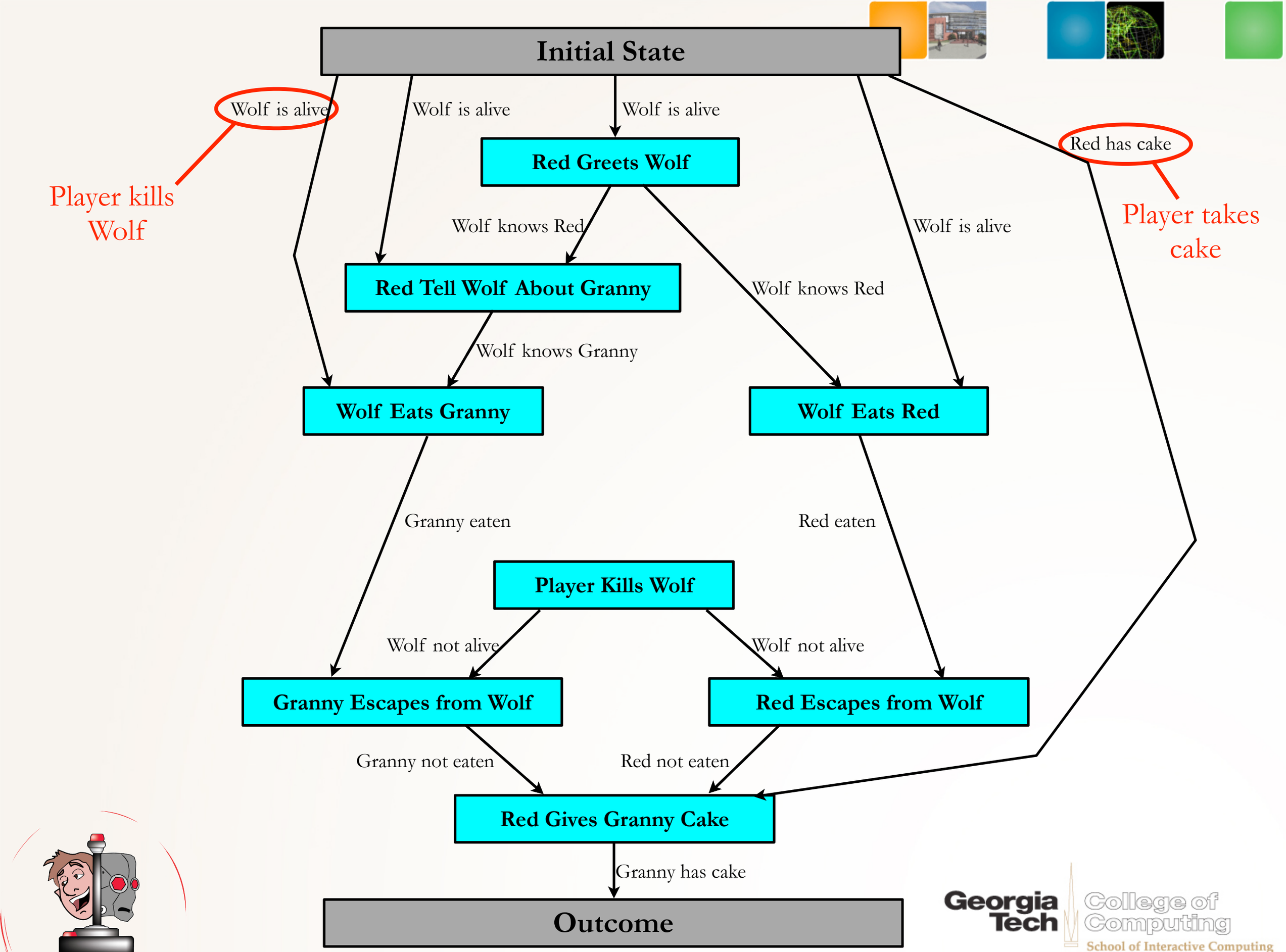
# Automated story director

- 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?



Riedl, Stern, Dini & Alderman. ITSSA, 3, 2008.



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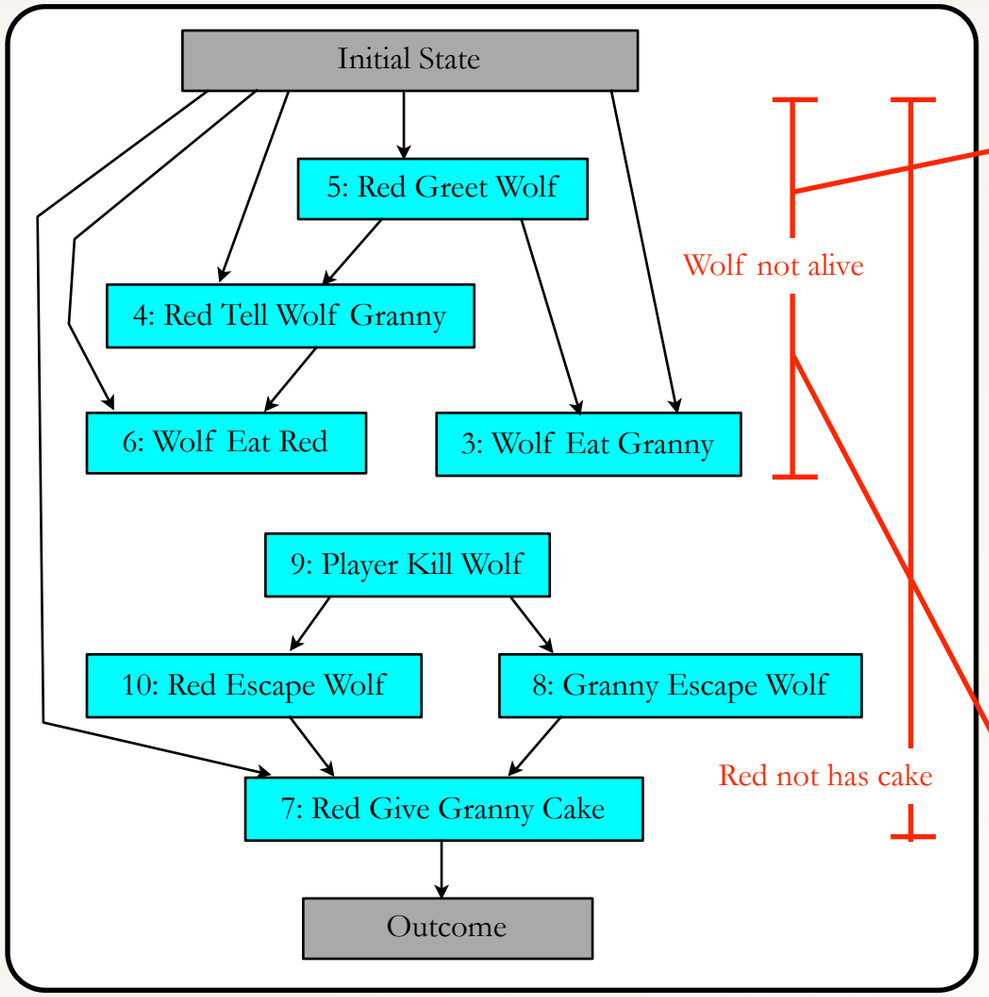
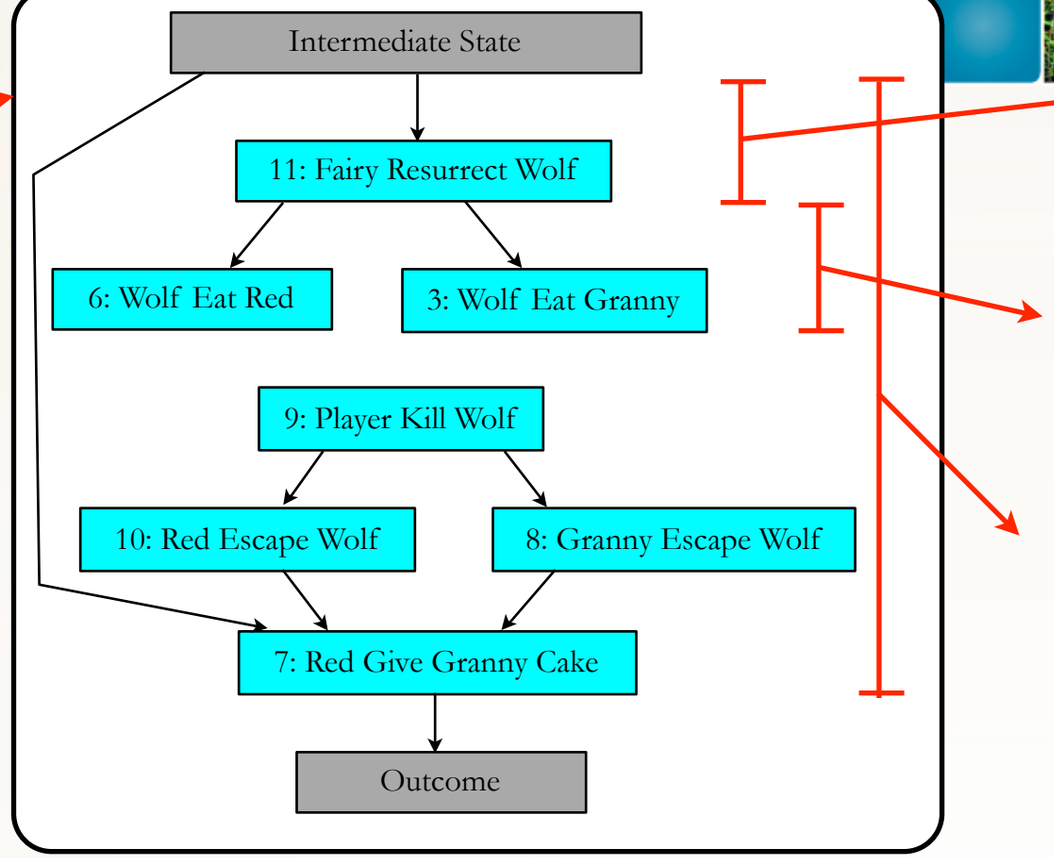
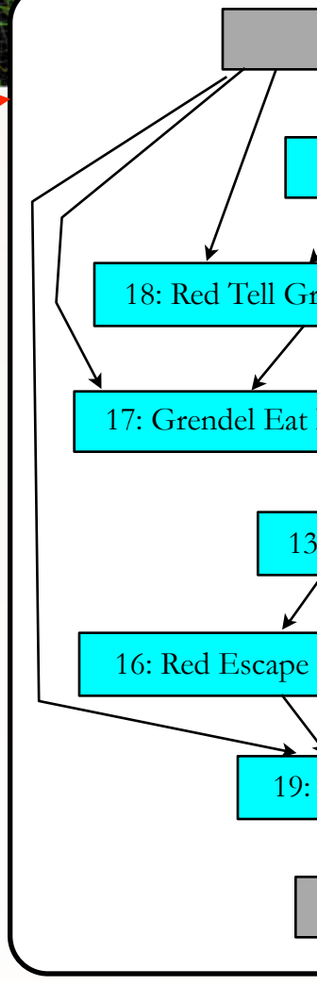
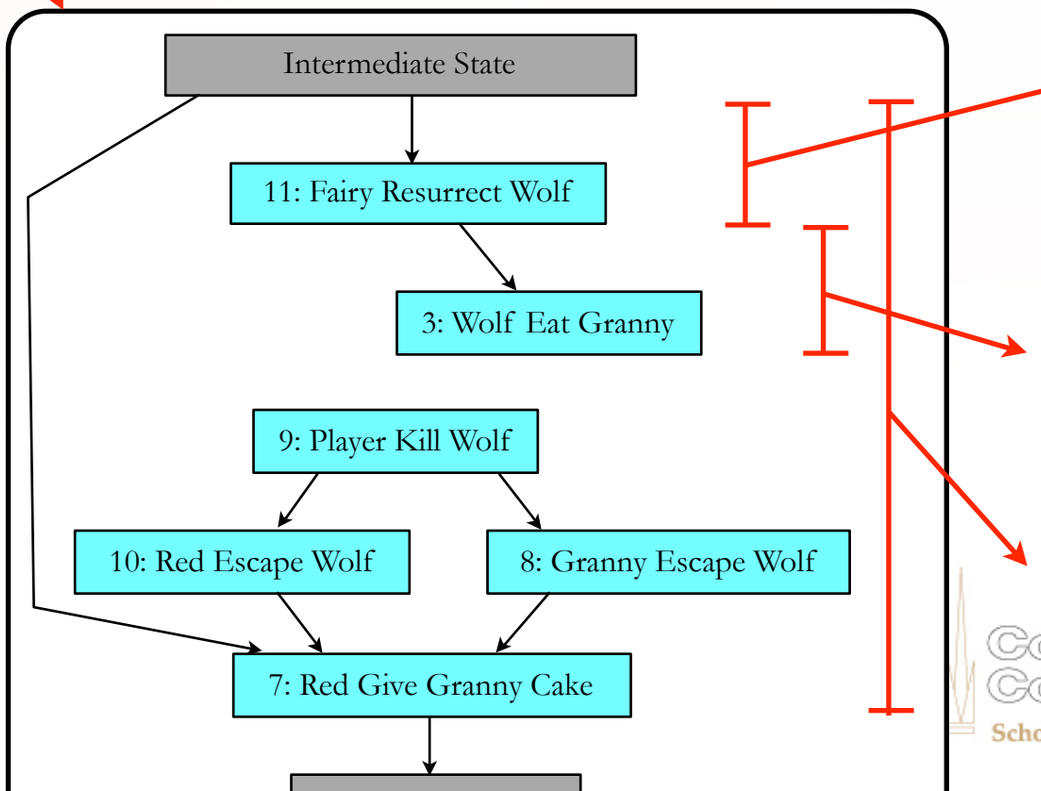



Wolf not alive

Red not has cake

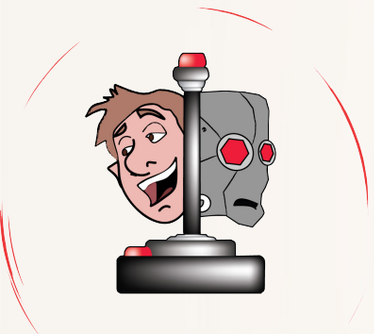


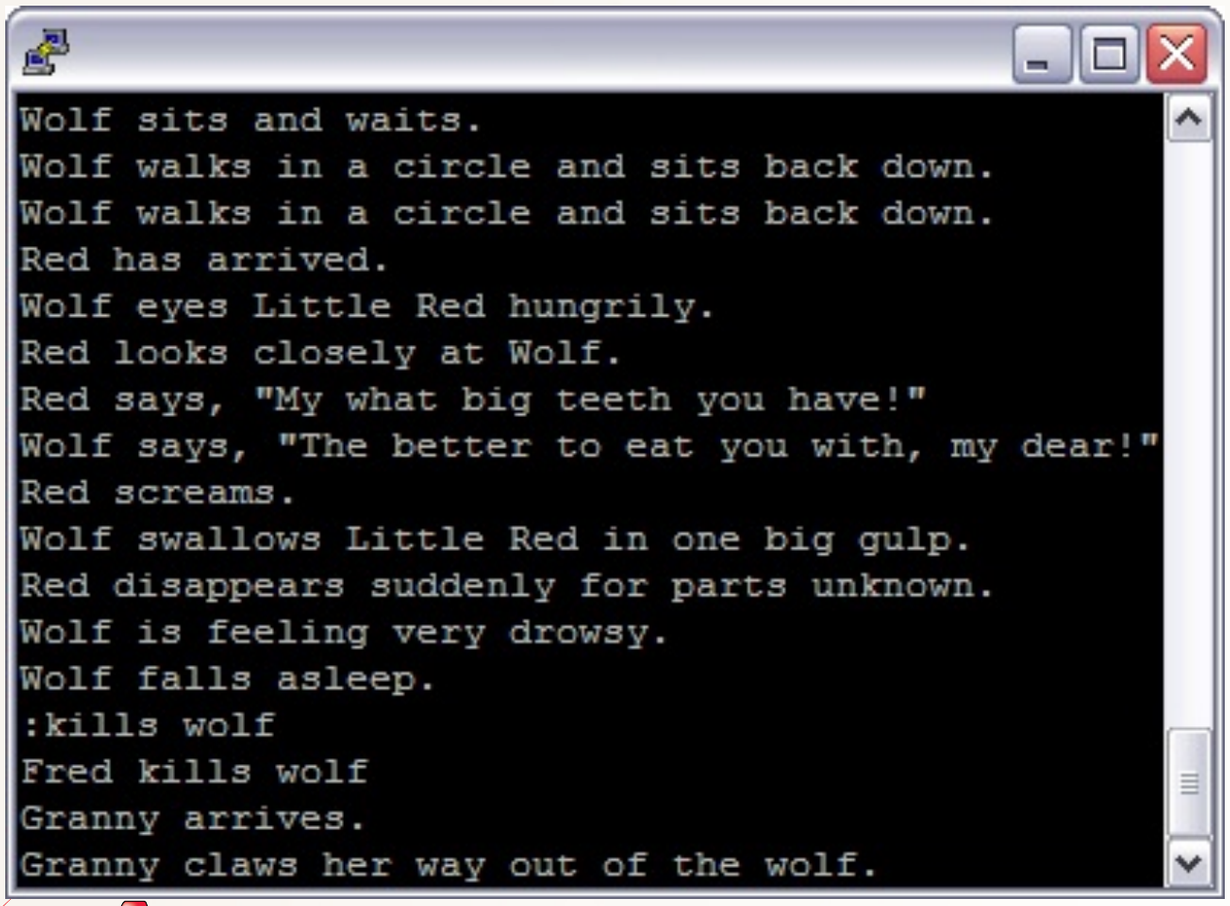


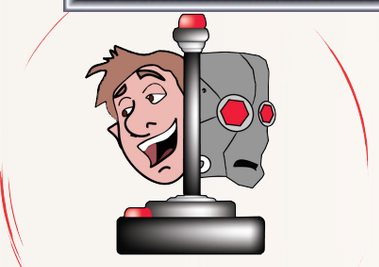




# Automated story director

- Pre-compute tree of contingency narratives
- Semi-autonomous virtual characters





Interactive Narrative

Story Generation

**Computer Games**

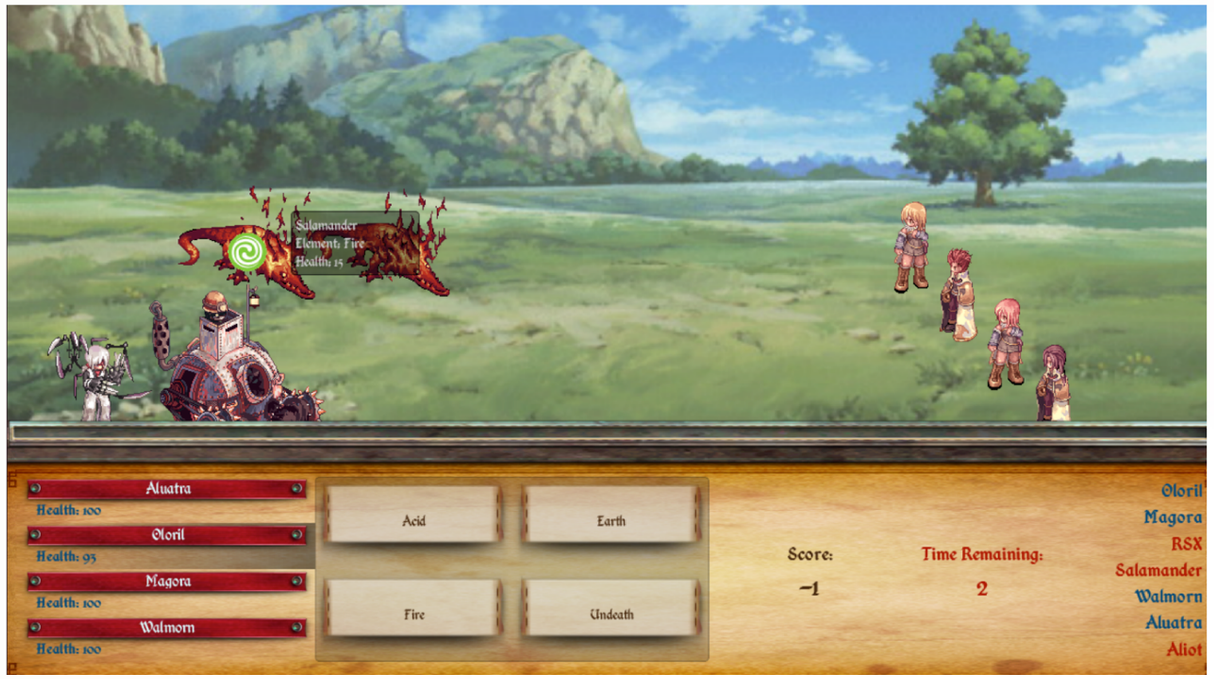
# Replayability and personalization

- 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

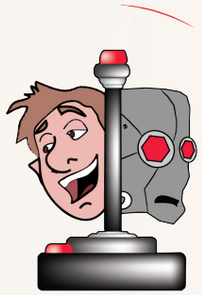
- Challenge tailoring
  - Choose and order the challenges the player should experience

- Challenge contextualization
  - Provide appropriate motivating story context between challenges



# Challenge tailoring

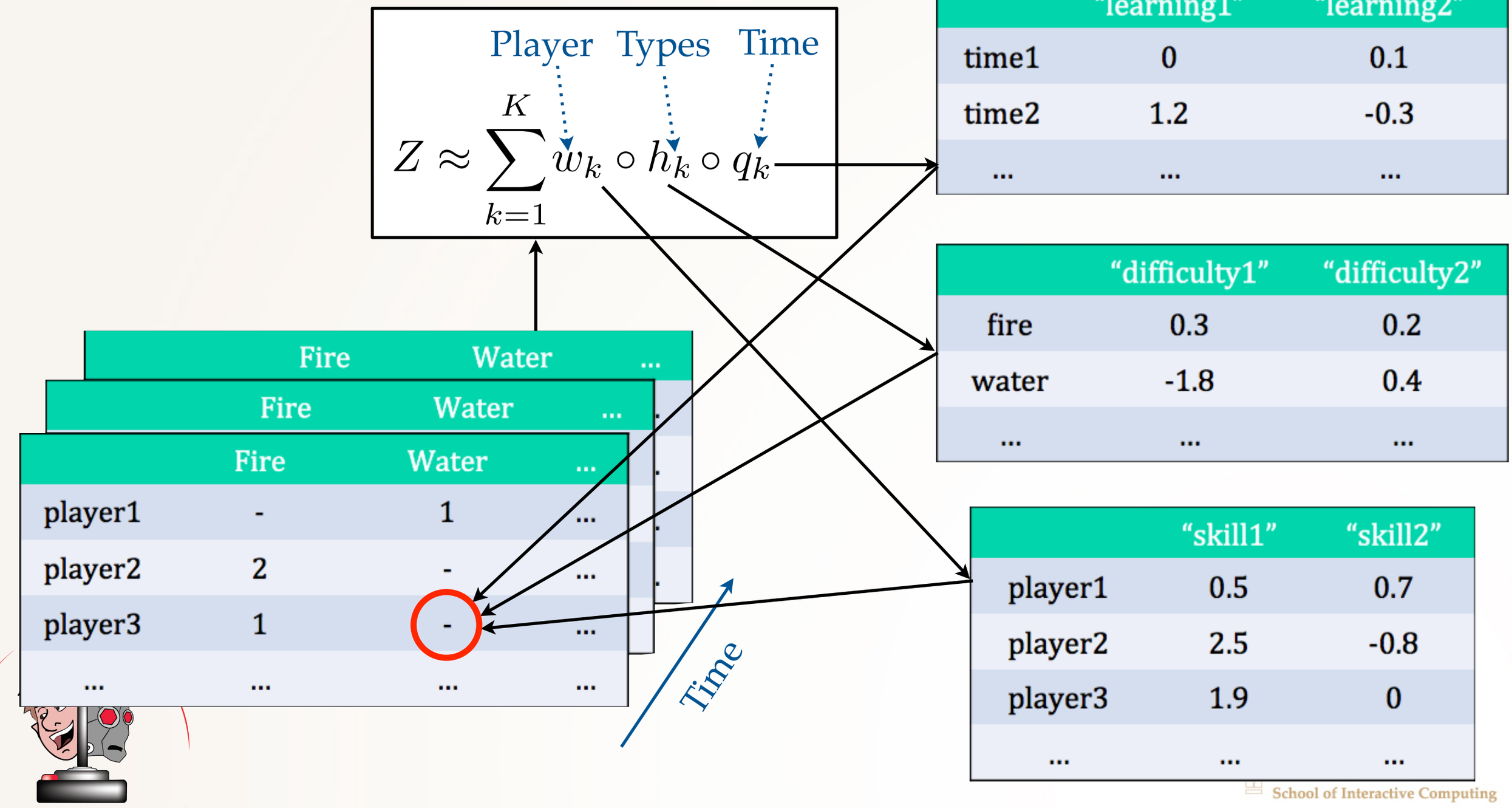
- Which skill-based events and in what order?
- Player model predicts skill performance



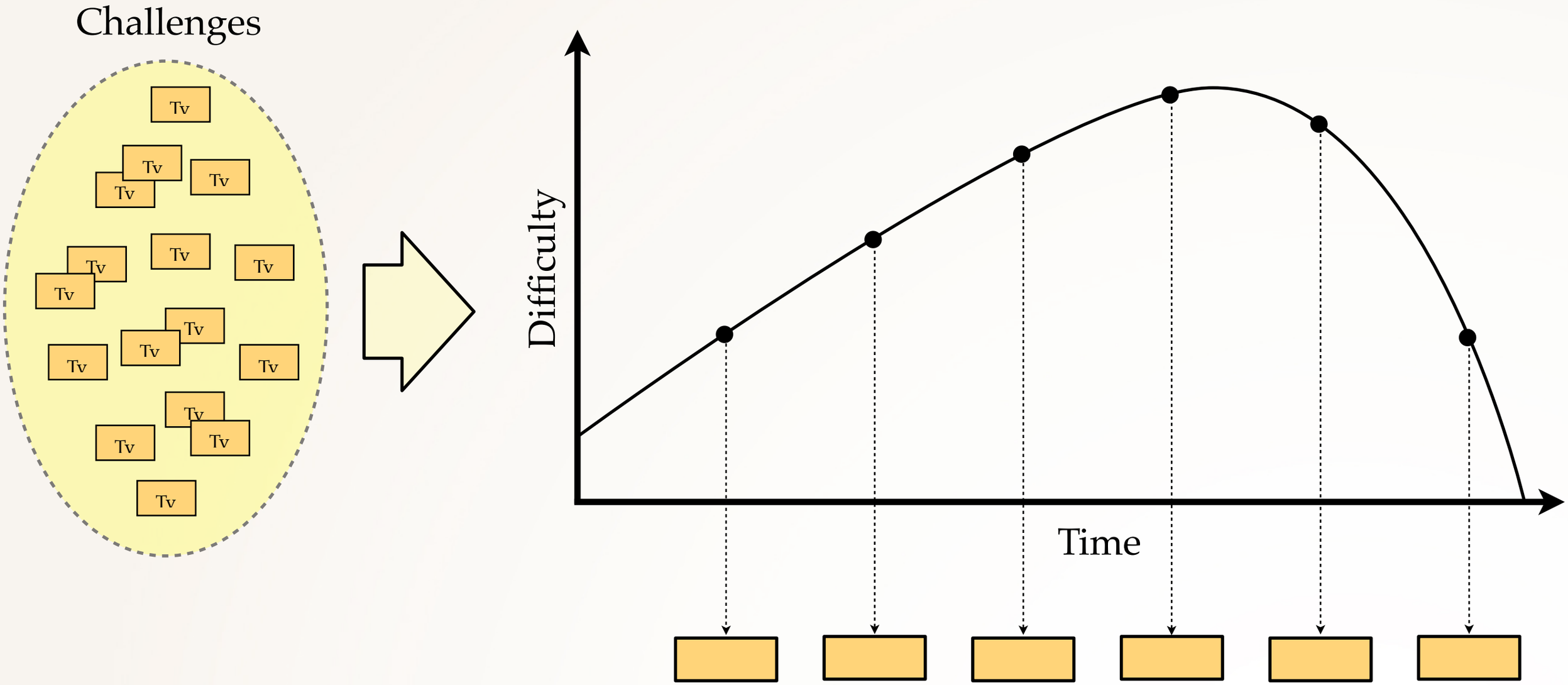
Zook & Riedl. Proc. AIIDE 2012 Conference.

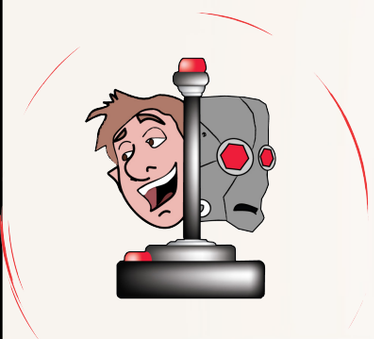
# Player modeling

- Collaborative filtering via temporal matrix factorization



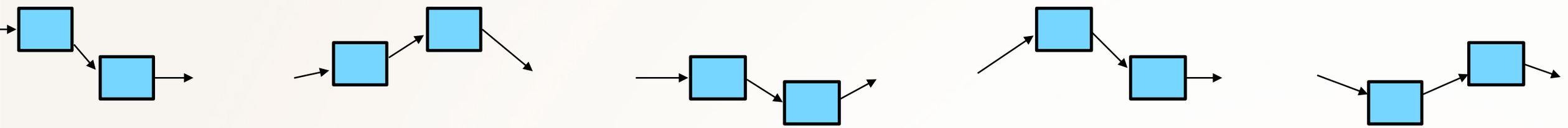
# Plot content optimization

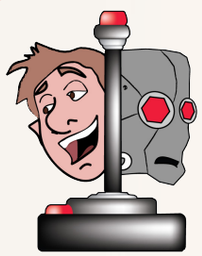


# Challenge contextualization

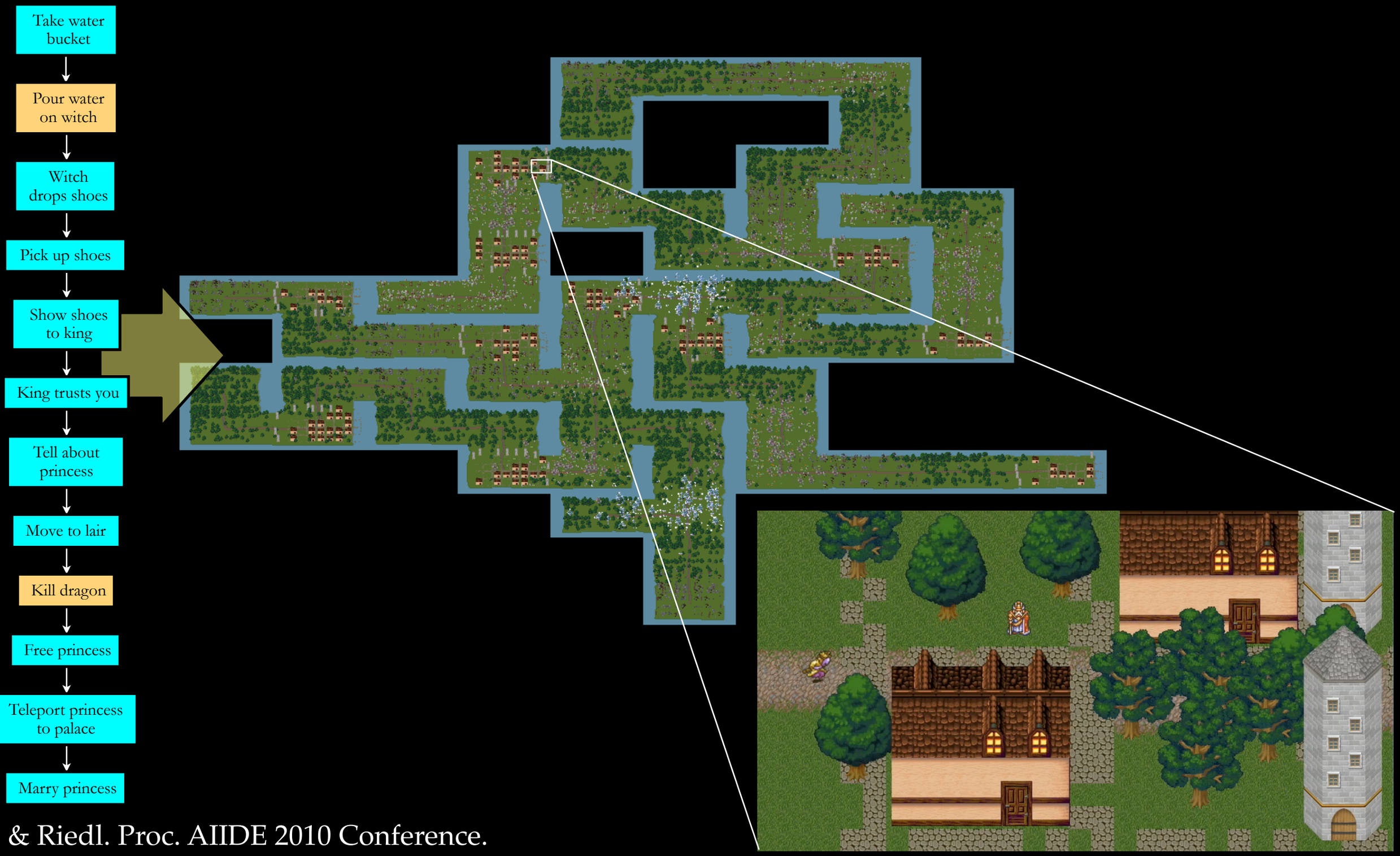
- Motivate skill-based events with narrative context
- Use a narrative planner





Zook, Lee-Urban, Riedl, et al. FDG Conference, 2012.

# Virtual world generation




Li & Riedl. Proc. AIIDE 2010 Conference.

Hartsook, Zook, Das & Riedl. Proc. CIG 2010 Conference.

Interactive Narrative

**Story Generation**

Computer Games

# Open story generation

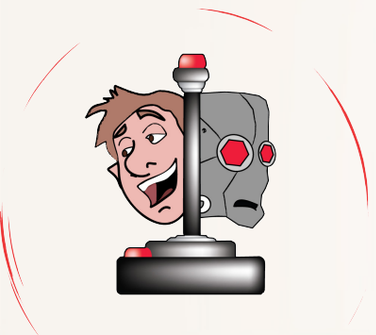
- Narrative intelligence is knowledge-intensive, resulting in micro-worlds
- Can we overcome the knowledge engineering bottleneck?
- Can an intelligent system learn to tell stories about any imaginable domain?

# 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

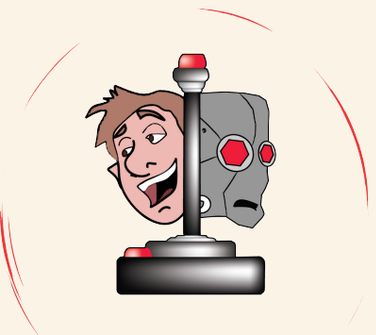
- Possible approaches:
  - Read natural language corpora & websites
  - Mine commonsense knowledge bases
  - Learn from humans

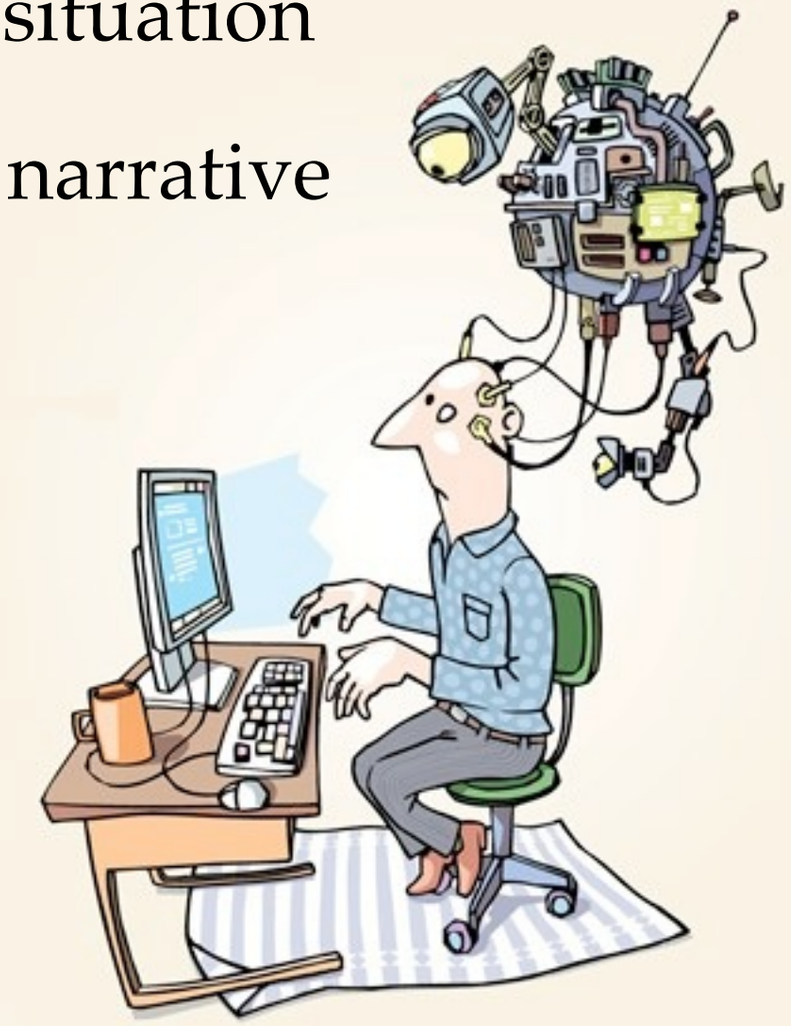


# Crowdsourcing narrative intelligence

- 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
- Crowdsource a highly specialized corpus of narrative examples and learn a generalized model of sociocultural situations

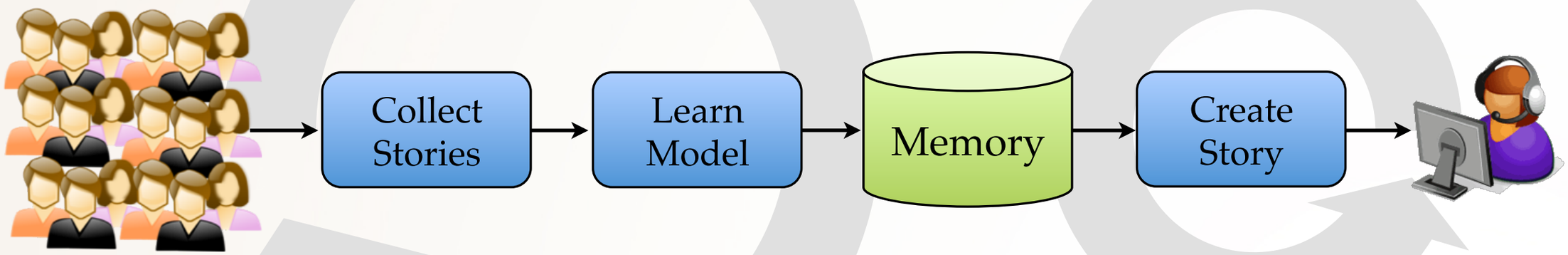
Automatically generate stories and interactive experiences **without** a priori domain knowledge authoring

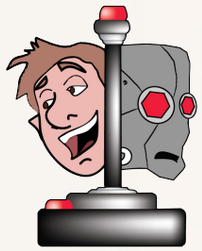




# Scheherazade

- 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)

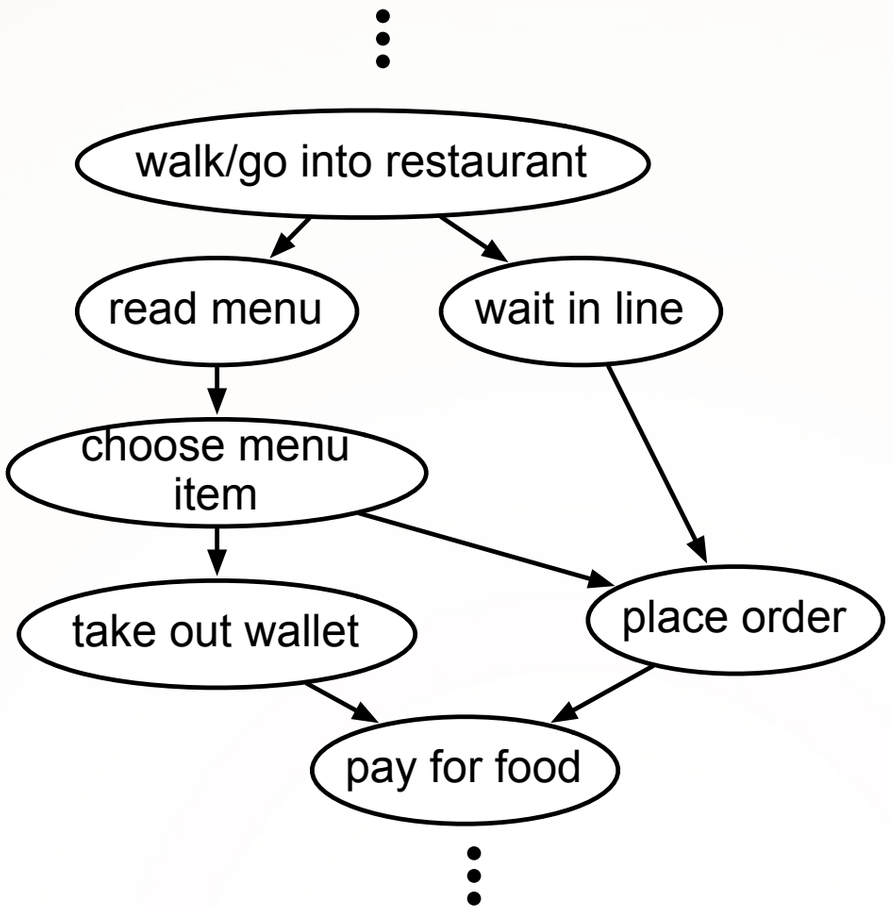


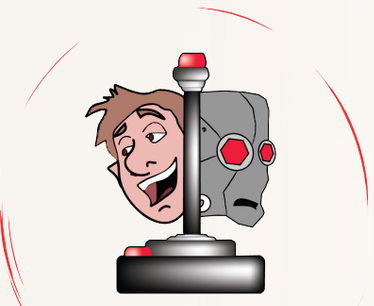



Li, Lee-Urban, Appling & Riedl. Advances in Cognitive Systems, 2, 2012.

# 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?



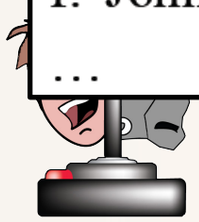



# Learning to tell stories

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

| Story A | Story B |
|---|---|
| a. John drives to the restaurant. | a. Mary looks at the menu. |
| b. John stands in line. | b. Mary decides what to order. |
| c. John orders food. | c. Mary orders a burger. |
| d. John waits for his food. | d. Mary finds a seat. |
| e. John sits down. | e. Mary eats her burger. |
| f. John eats the food. | … |
| … | |



# Learning to tell stories

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

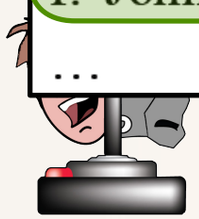
- Crowd control simplifies NLP
- Compute semantic similarity between sentences
- Cluster sentences into events

| Story A | Story B |
|---|---|
| a. John drives to the restaurant. | a. Mary looks at the menu. |
| b. John stands in line. | b. Mary decides what to order. |
| c. John orders food. | c. Mary orders a burger. |
| d. John waits for his food. | d. Mary finds a seat. |
| e. John sits down. | e. Mary eats her burger. |
| f. John eats the food. | … |
| … | |

Order food

Eat food

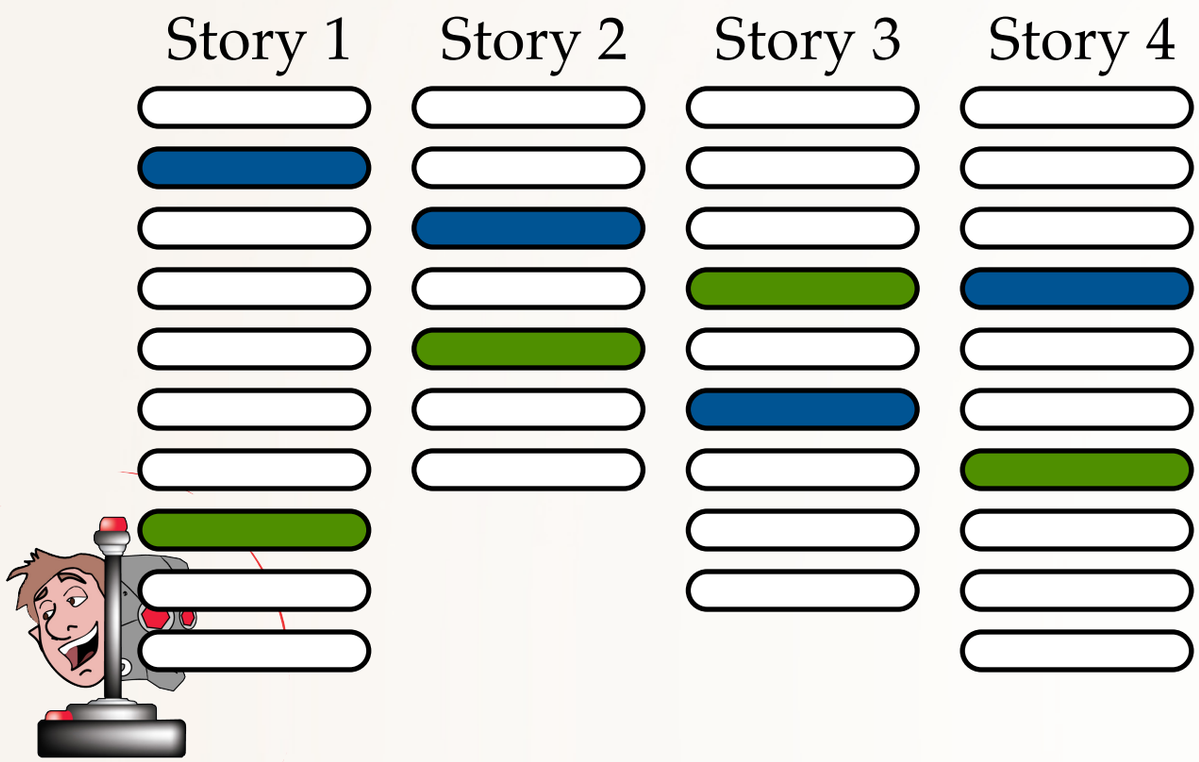
* Precision ≈ 85%

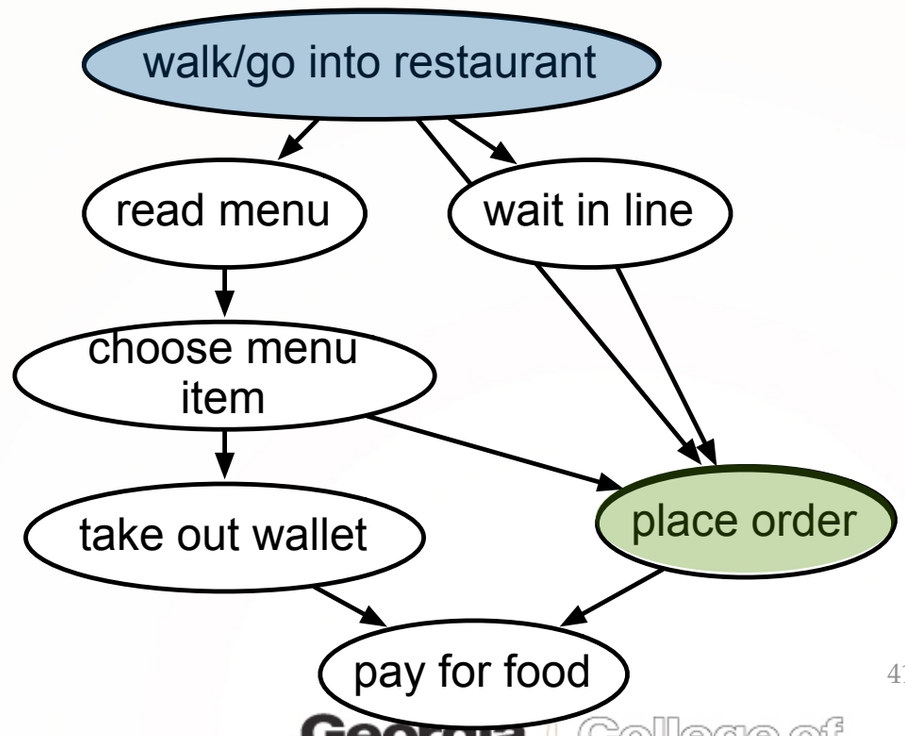


# Learning to tell stories

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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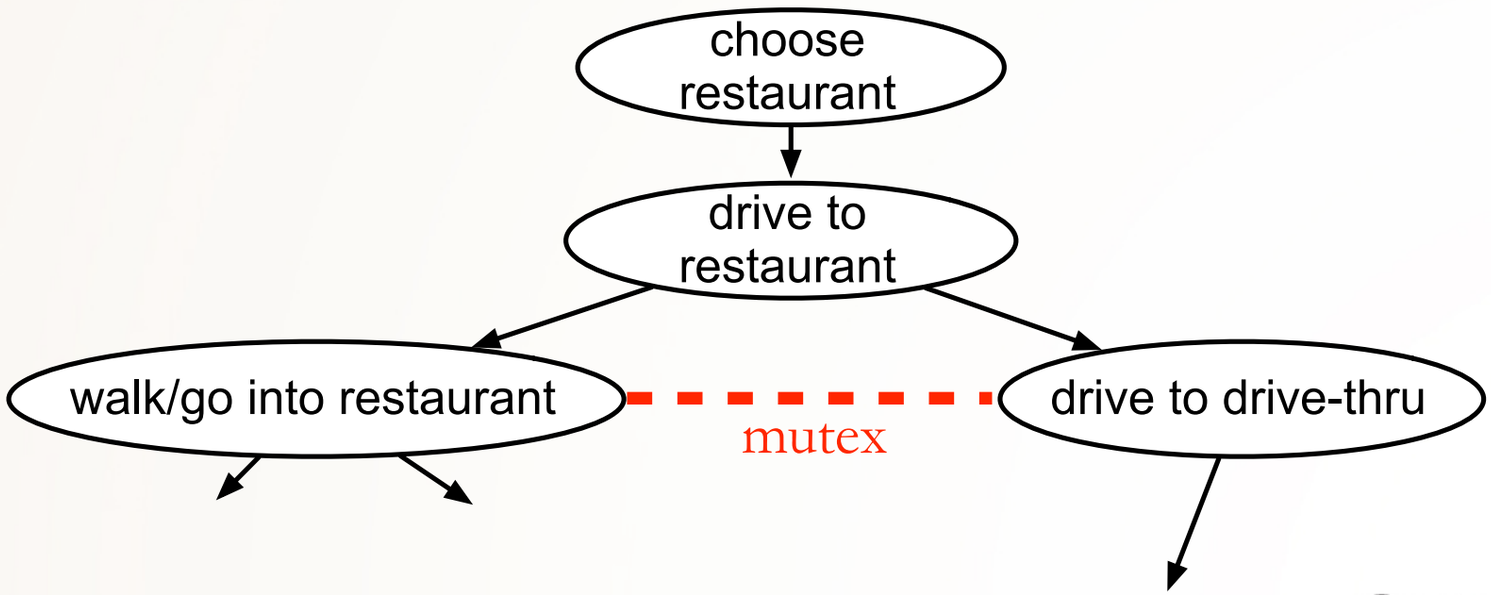
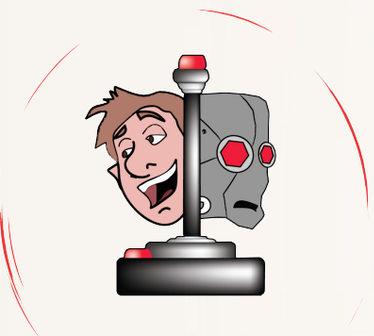
School of Interactive Computing

# Learning to tell stories

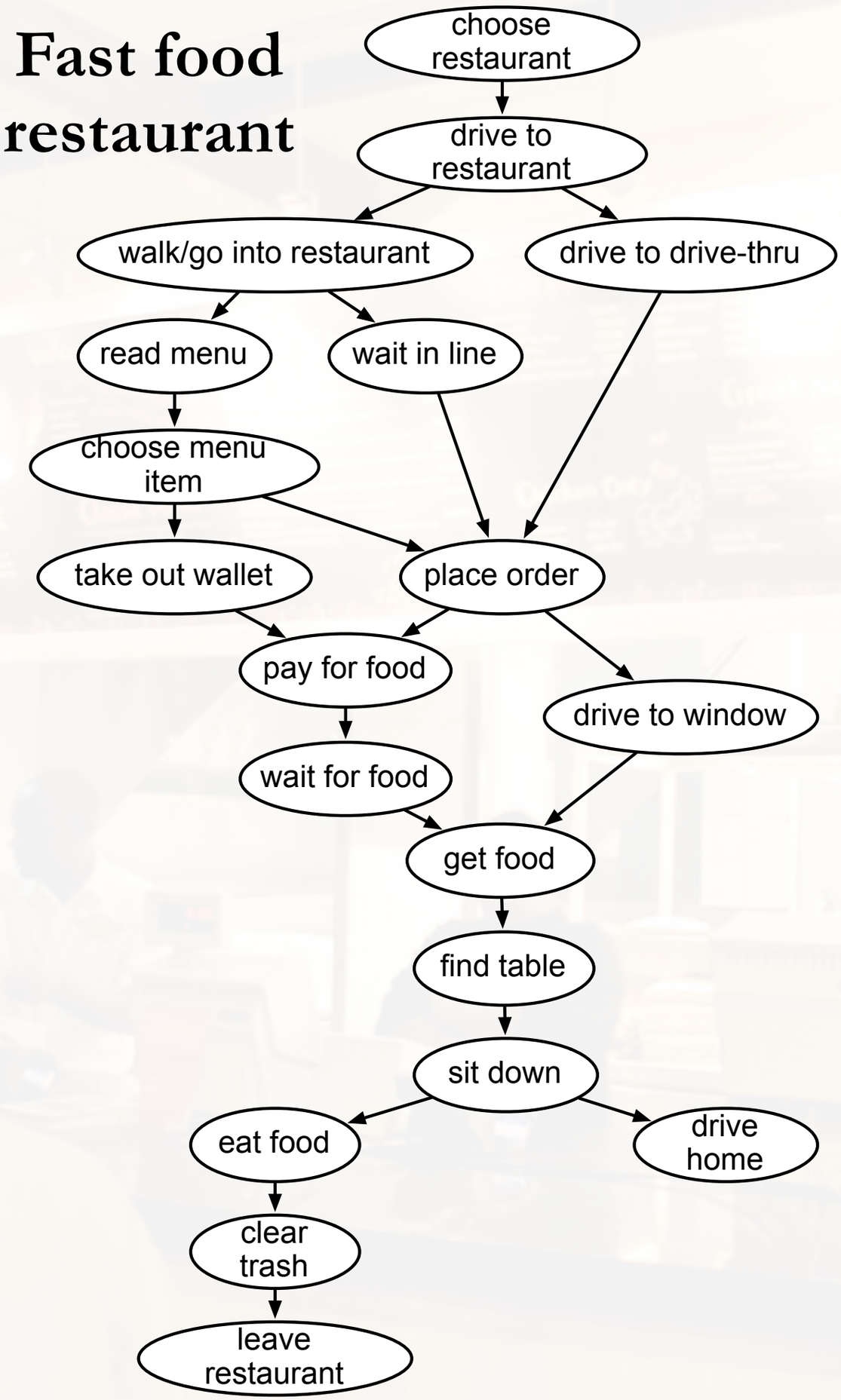
1. Query the crowd
2. Identify the salient events
3. Determine event ordering
4. **Mutually exclusive events**

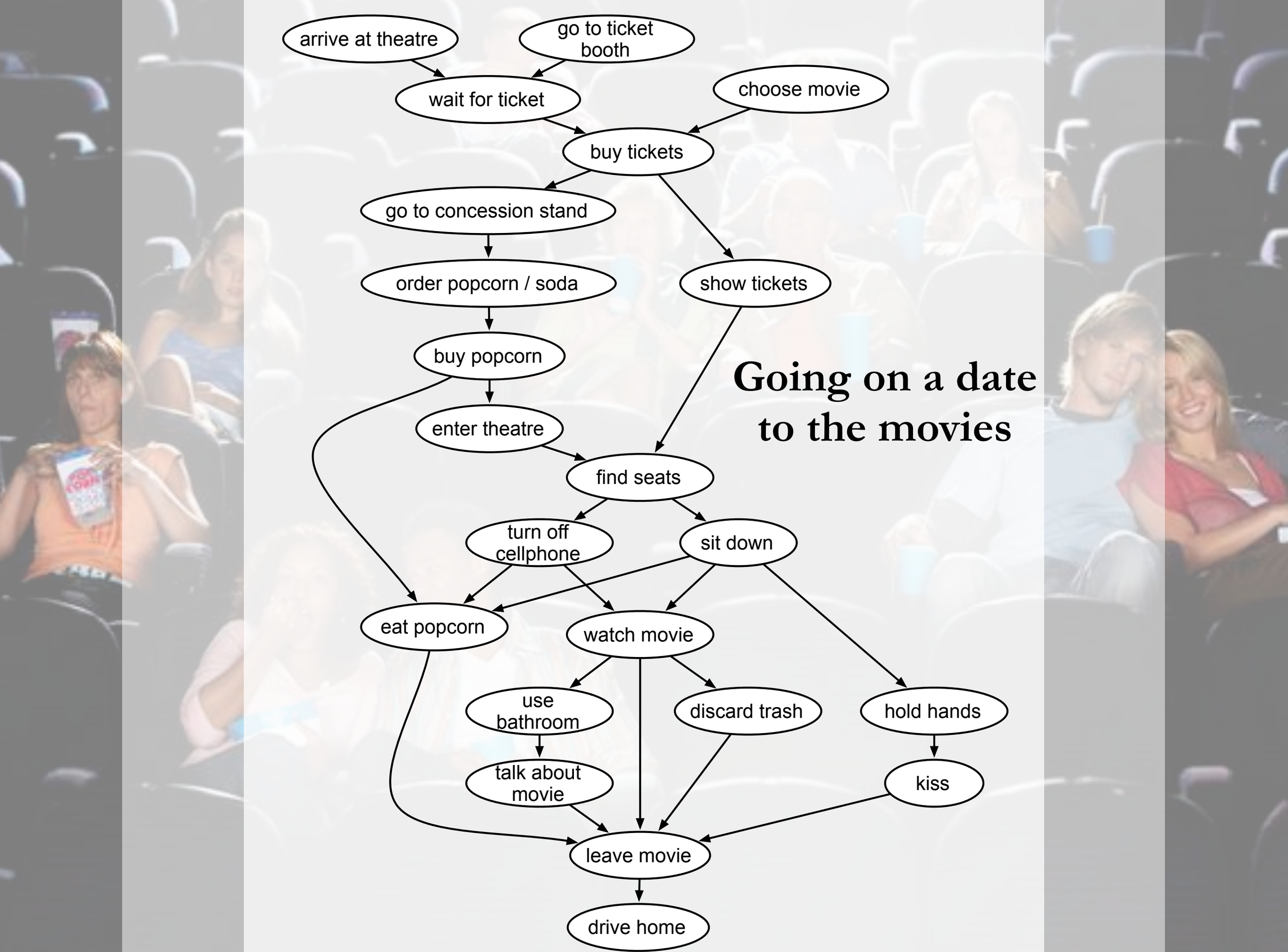
- Measure mutual information between events
- Mutual information is high and co-occurrence is low
- Generalization of "or" relations



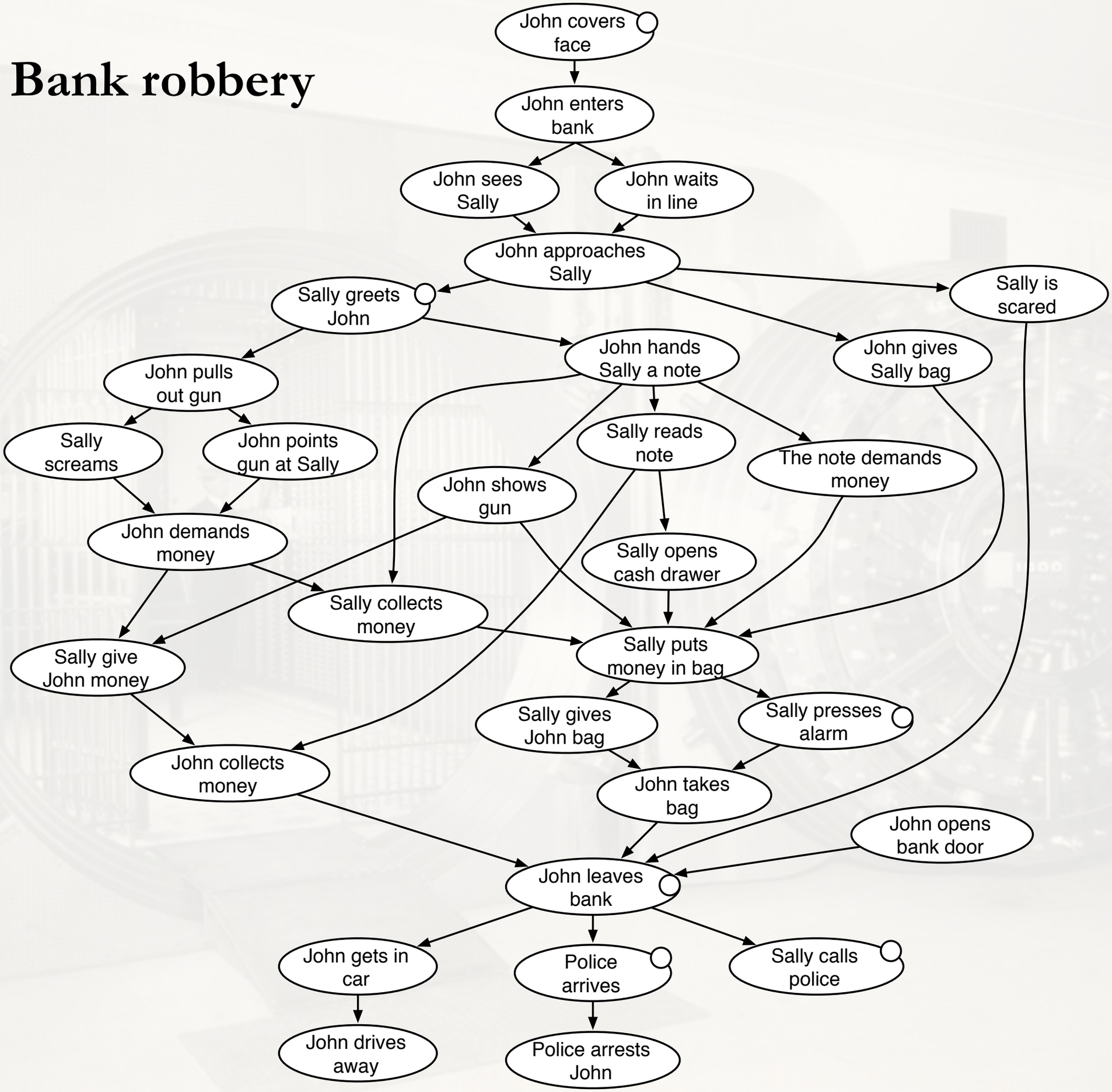
# Fast food restaurant





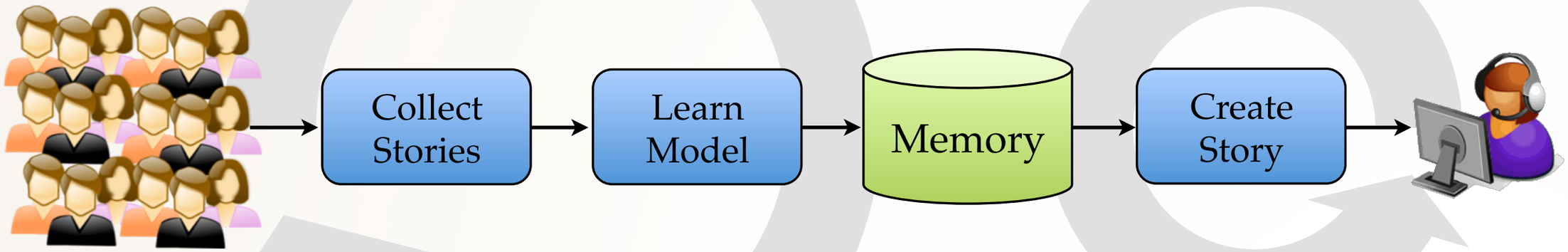

# Going on a date to the movies

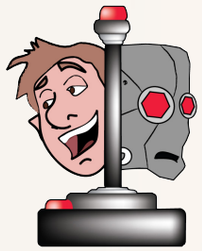
# Bank robbery



# Narrative generation

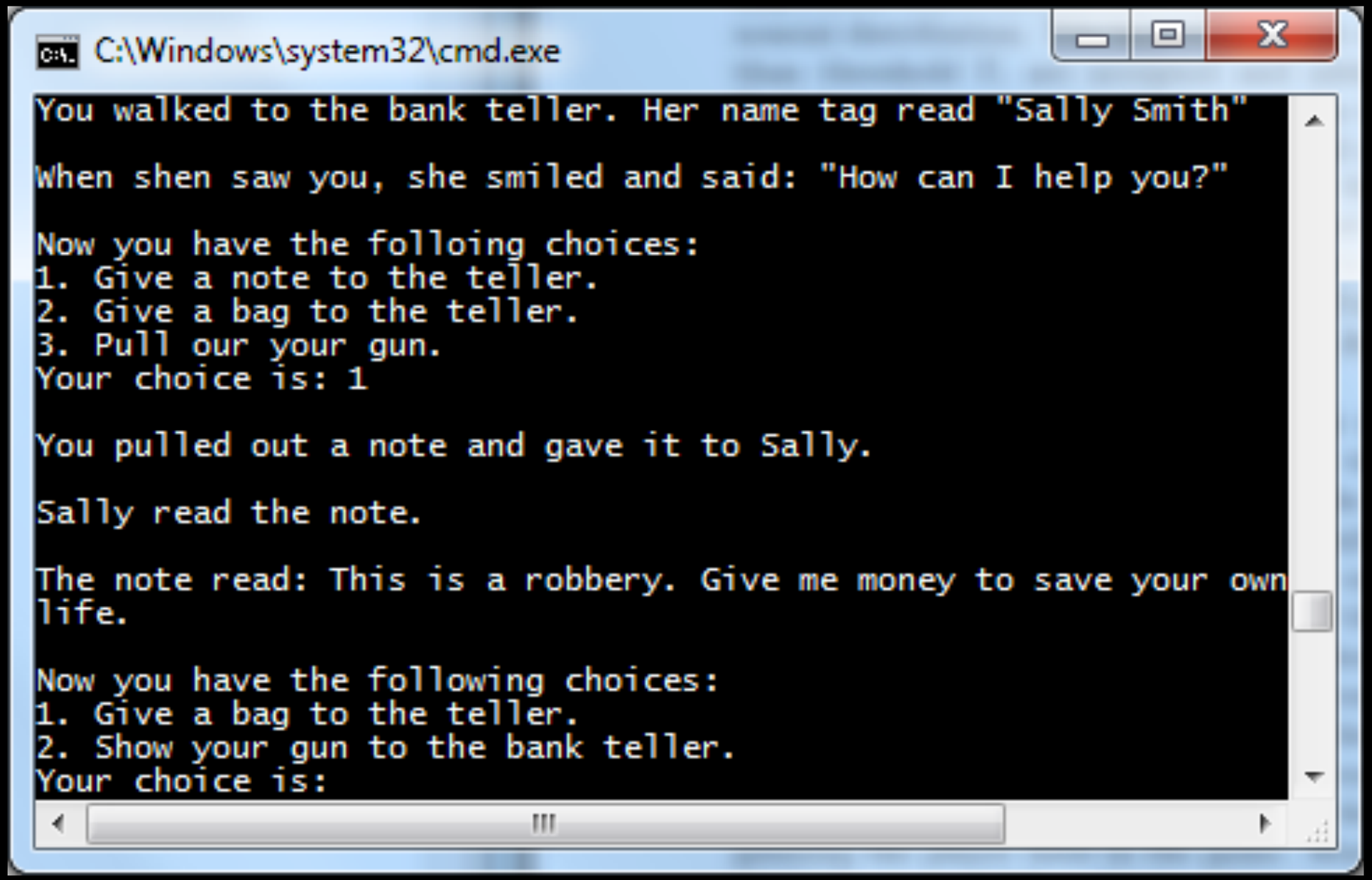
- Script defines a space of linear sequences
- Random walk, preserving temporal order and mutual exclusion
- Evaluation shows generated stories statistically indistinguishable from human-authored stories



Li, Lee-Urban, Johnston & Riedl. Proc. AAAI Conference, 2013.

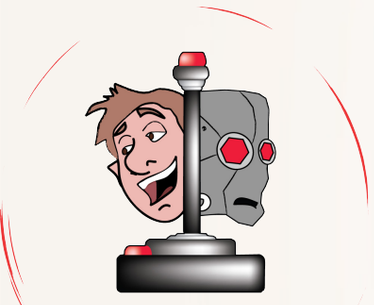
# Interactive narrative generation




Li, Lee-Urban & Riedl. Proc. Intelligent Narrative Technologies 2012 Workshop.

# The road ahead

- Starting with basics: causality, character believability, typicality
- Progressively layering complexity
- Computational aesthetics
- Data-driven tailoring
- Story generation in the real world

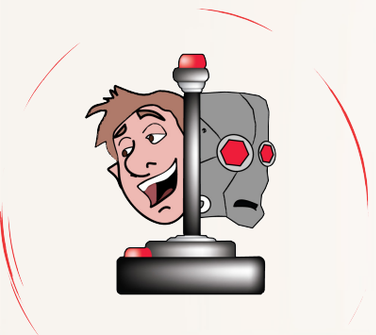


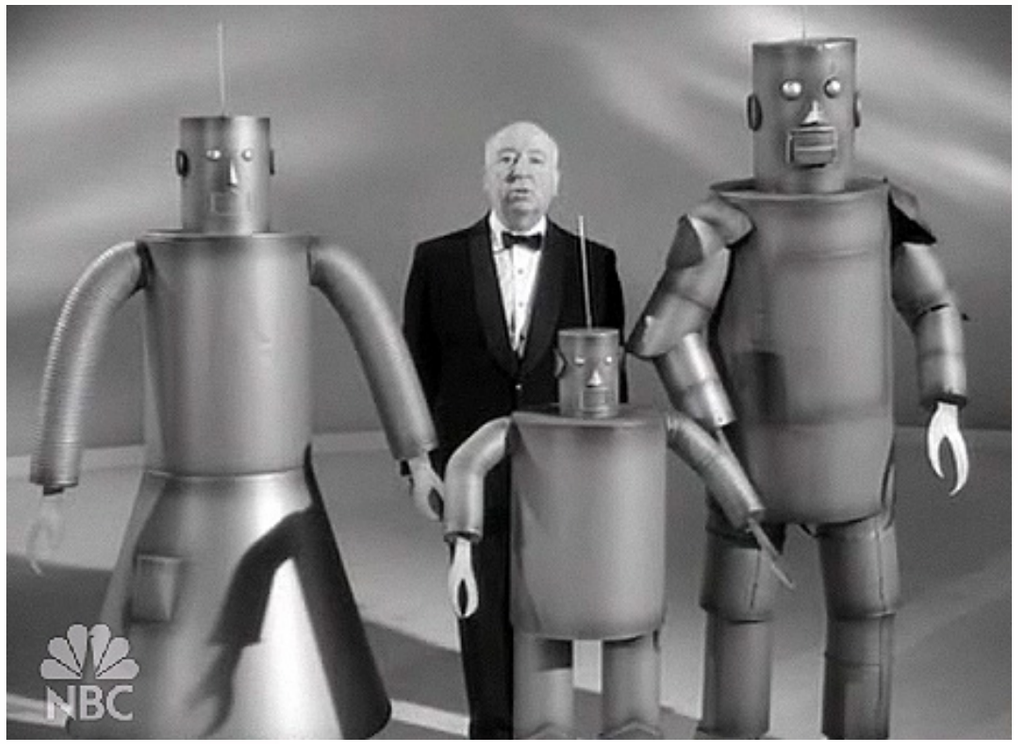
# Conclusions

- 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

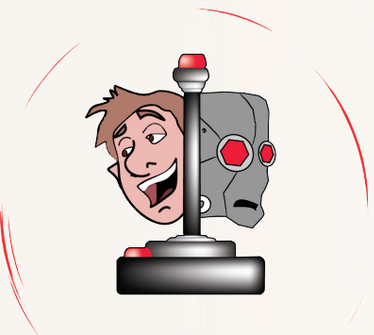




# Acknowledgements


- Boyang Li
- Brian O'Neill
- Alexander Zook
- Hong Yu
- Ken Hartsook
- Michael Drinkwater
- Steve Lee-Urban
- Sauvik Das
- Rania Hodhod
- Mohini Thakkar
- Sanjeet Hajarnis
- George Johnston
- Charles Isbell
- R. Michael Young


# Thanks! Questions?

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