Player Modeling in IDA

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Interactive Drama

The Boundary Problem

- Author defines a *story space*
  - The space of intentionally dramatic stories possible
  - Consonance between player actions and authored content

- Player actions may lead to a world state outside the boundary of the story space

The dramatic experience may stall or even halt…

Contributions

1. Incorporation of semi-autonomous characters
2. A *complete* story director with..
   a. Player knowledge modeling
   b. Player prediction
   c. Both reactive and preemptive direction for addressing boundary problems
   d. Two-tiered selection of content
3. A story representation that supports:
   a. Reactive & preemptive direction
   b. Pacing
4. Evaluation via archetypes

IDA: An Interactive Drama Architecture

AI Character
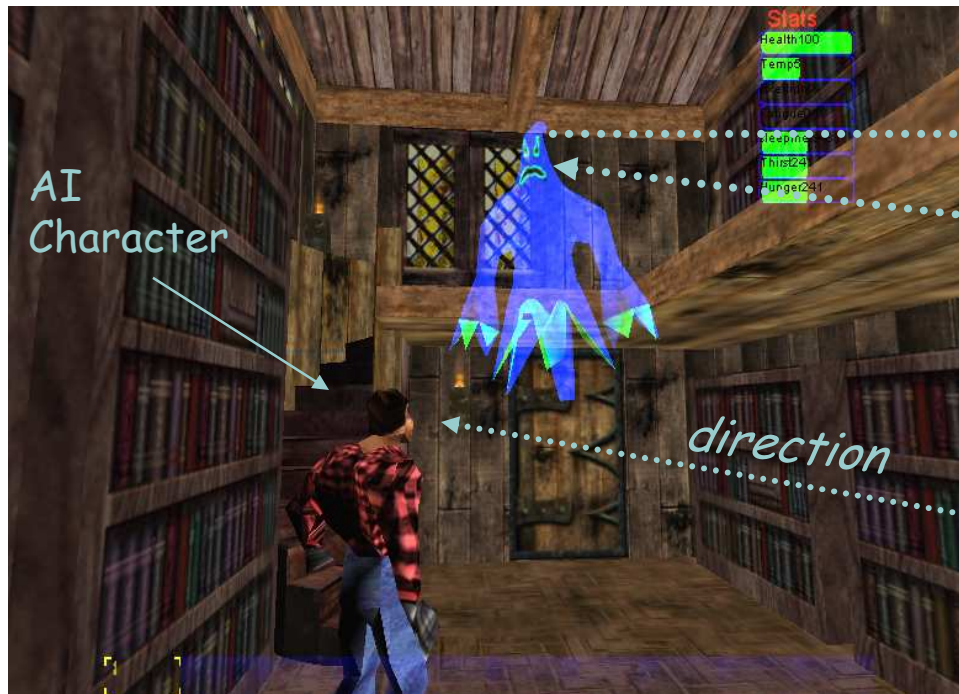
Haunt 2: Built in Unreal Tournament

percepts

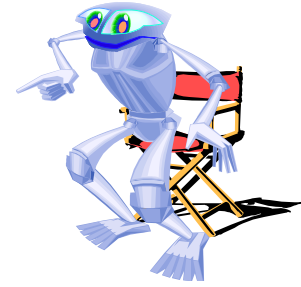user actions

Human player

direction

story content

AI Director

Author

Director

- Omniscient & omnipotent intelligent agent
- Executes "direction"
  - Enacts story content
  - Mediates between player actions & plot
  - Influences player behavior to stay within story space
    - Based on current actions
    - Based on predicted actions

Direction Execution Cycle

Input from environment

world state change?

Knowledge Maintenance

Record world state

Hypothesize entity knowledge

note timing violation for undirected precondition

record condition as directed

Reactive Direction

continue

Plot Monitoring

plot point with only performed descendents?

Mark plot points as active / inactive

world fact matches active plot point precondition?

Mark precondition as true / false

note precondition with NPCs only *or* performing plot point has been fulfilled

record condition as directed

Story Direction

world fact matches unbound variable in active plot point?

Instantiate variable

actions to perform?

no plot point selected to perform?

Select plot point for performing

record condition as preemptively directed

plot point just performed?

Predict player

Preemptive Direction

boundary problem predicted for undirected precondition?

Knowledge Maintenance

- Records when world changes significantly
- Observes story world omnisciently
- Creates new WMEs to reflect changes in the state of the world
- Hypothesizes basic situational awareness of entities in the story world
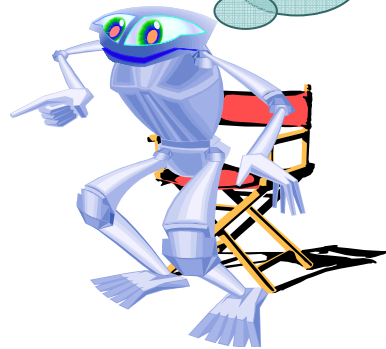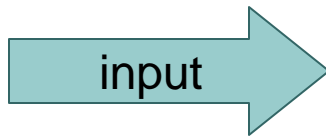- Applies ontology of everyday world knowledge

Hypothesized Knowledge

- Player is in lobby, invisible
- Sally is in the lobby
- Innkeeper is in the lounge
- Corpse is in the library
- Thermos is in the lobby
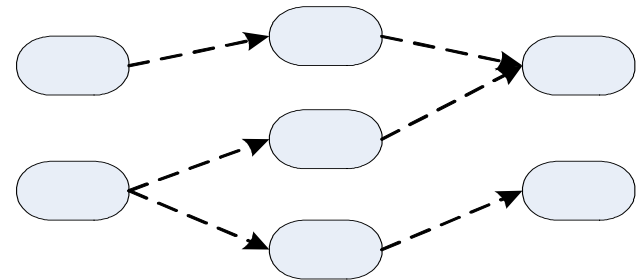
```
The player knows:
•Exists(Sally)
•Exists(Thermos)
•In(Sally , Lobby)
•In(Thermos, Lobby)
•Thermos is for drinking
```

input

Plot Monitoring

- Occurs when plot content matches with current knowledge base
  - State of the world
  - Mental states
- Plot:
  - Content: plot points
    - Preconditions
    - Actions
  - Structure:
    - Ordering constraints
    - Timing constraints

Plot selection

- What if there is more than one candidate for performance?
- Two-tiered process
  - Player-motivated
  - Director-selected
- Selected plot point marked

Reactive Direction

- Immediate response to boundary problems
- Relies on more *effective* director strategies
- Boundary problems signaled by an *occurrence of timing violations*

Preemptive Direction

○ Preemptive response to predicted boundary problems

○ Relies on more *subtle* director strategies

○ Queries predictive model of player behavior

More believable than relying only on reactive measures or directing continuously

Example

•User has been moving to new rooms…
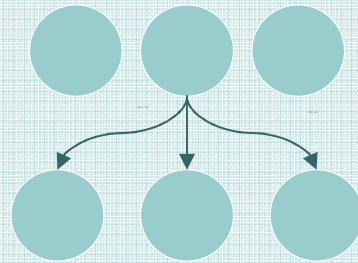•Predicted goal: *Explore*

→Predicted timing constraint violation

create sound

CRASH
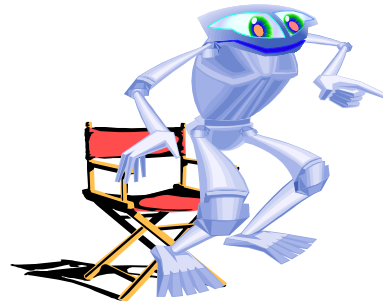
Single Modeling Run
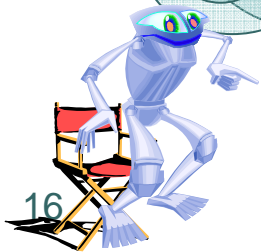
world state

state copy

result

{Success, 0.42}

model

Player Prediction

○ Success

- Precondition is fulfilled before a timing constraint is violated

○ Failure

- Timing constraint is violated

○ Result determines:

- *if* the director preemptively directs
- *how* it directs preemptively

Probabilistic Sampling

- Player model
  - Returns a tuple, M $\rightarrow$ (R, P)
    - R: success / failure
    - P: probability of particular sequence of actions chosen
  - Runs created iteratively until an author-defined limit ρ is reached
- Director computes confidence in the user fulfilling plot content (C_m)
  - Function of likelihood of each run & its result
  - $C_m > \alpha$ $\rightarrow$ success
  - $C_m < \alpha$ $\rightarrow$ insignificant success *or* failure

Connecting Modeling to Direction

- Direction chosen by best *score*
- Scores dynamically assigned as function of modeling result, C_m
- Each director action rated by a scoring function:

  $Score_{action} = (Sub * S_{action} + Eff * E_{action}) / 2$

  - S_{action} / E_{action}: authored rating for a particular director action
  - Sub / Eff: weights assigned at run-time

- Example: *transport-player* {S = 0.05, E=.9}

Quantitative Evaluation

- Play as archetypes
  - Explorer
  - Chaser
  - General
- Experimental groups
  - Modeling on
  - No modeling
    - Model still run
    - Preemptive direction "turned off"
- Measures
  - Boundary problems
  - Frequency of direction
  - Average subtlety of direction

Results

○ No difference for avg subtlety and # of directions

- Director should direct the same #
- Small variability in ratings or problem in authorship

Results (cont.)

- Boundary problems
  - modeling < no_modeling ($p < 0.01$)
  - Within-groups:
    - General: no effect
    - Chaser: no effect
    - Explorer: $p < 0.01$
- Why?
  - Lack of general coverage of predictive model
  - Explorer easily "most accurate" hand-encoded model
  - Points to the need for adaptive modeling

Future Work

- Authoring tools
- Categorization of director strategies
- Player modeling
  - Unified model
    - Knowledge model
    - Behavioral model
    - Skill model
  - Adaptive models
- Adaptive story for education
  - Story as engagement
  - Experience tailored for dramatic and learning value

Nuggets

- A *complete* story director with..
  - Player knowledge modeling
  - Player prediction
  - Both reactive and preemptive direction
  - Two-tiered selection of content
- A story representation that supports
  - Reactive & preemptive direction
  - Pacing
- Evaluation via archetypes
- Successful defense (!)

Coal

- *Haunt 2* did not wind up being a complete or robust experience
- Starting over with a new domain
- No rigorous user study done in evaluation
- Possible bias in evaluation
  - Parameter values
  - Archetype & individual sensitivity to direction