ENABL
A Modular Authoring Interface for Creating Interactive Characters
April Grow
Overview

Problem

Research Questions

Related Work

Proposed Work

Evaluation

Schedule
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Schedule
Why Interactive Characters?

- Wide Application & High Demand
- Untapped Markets
Character Creation is Hard

Designer

Builds

Behavior System
Character Creation is Hard

Virtual Agent

Decides

Builds

Behavior System

Designer
Character Creation is Hard

Virtual Agent

Enacts

User or Other Agent

Decides

Behavior System

Builds

Designer

Other Agent

System

Builds

Designer

Expressive Intelligence Studio
Character Creation is Hard

Designer → Builds

Virtual Agent

Behavior System

Decides

Enacts

User or Other Agent

Inputs
Authorial Complexity

Intent/Behavior Planning

Behavior Selection

Behavior Enaction

User I/O

Emotion, Personality, Reactivity, History, Beliefs, Desires, Social Constraints, Story, Coherency, Consistency

Physical Restraints

Designer
Lots of Ways to Fail

- Did something happen?
- What have you got for sale?
- Do you sell spells?

- GUYS, THAT DUDE SCRAPED OUR CAR WITH HIS BIKE.
- KILL HIM

- IN SKYRIM

- Everyone takes an arrow to the knee
Lots of AI Architectures

- Ac-hoc Rules
- Finite State Machines (FSM)
- Hierarchical FSM
- Planners
- Neutral Networks
- Behavior Trees
- ...Mixtures!
Behavior Trees

Sensors

Behavior

Behavior

Behavior

Action

Action

Action

Action

Behavior

Actuators

Behavior

Dynamic Reactive Behavior Trees

ABL!
Behavior Tree Design Tools

Behave 2
- Simple Behaviors
- Static Trees

RAIN{indie}
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Research Questions

- Can modularity reduce the authorial complexity of creating dramatic, embodied, and interactive agents?

  - How can dramatic agent authorial complexity be reduced through modularity?

  - What benefits does working with modular authorial patterns and interfaces provide to authors?
Authorial Complexity & Burden

- Complexity of authoring a single behavior
  - Physical
  - Scenario
  - Design
  - Dynamic Context
Research Questions

- Can modularity reduce the authorial complexity of creating dramatic, embodied, and interactive agents?
  - How can dramatic agent authorial complexity be reduced through modularity?
  - What benefits does working with modular authorial patterns and interfaces provide to authors?
Modularity

- Hierarchy
- Design Patterns / Idioms
- Object-Oriented Programming
- Condensing the amount of *stuff*
  - Connections, moving pieces

Explicit Interface Points

Implicit Concurrency
Research Questions

- Can modularity reduce the authorial complexity of creating dramatic, embodied, and interactive agents?

- How can dramatic agent authorial complexity be reduced through modularity?

- What benefits does working with modular authorial patterns and interfaces provide to authors?
Benefits

- Condensing the amount of *stuff*
  - Simpler Mental Model
- Targeted authoring support
  - Making Implicit knowledge Explicit
- Code reuse via behavior libraries
ENABL: Authoring Interface

- Assistive technology for ABL
  - A Behavior Language
- Reinforces Idioms
  - Provides templates
- Structured behavior patterns
  - Isolate bugs more quickly
- Reusable libraries
- Focus on usability
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Believable Characters

- **Emotion**
  - Consistency & variability (Ortony 2002)
  - Appropriately timed & clearly expressed (Bates 1994)
  - Empathy (Hayes-Roth & Doyle 1998)
  - True to the character's Personality (Loyall 1997)

- **Personality**
  - Piecemeal traits (Ortony 2002)
  - Emotions, agent competence, quirks, relationships, and attitudes should vary between agents (Reilly & Scott 1997) (Loyall 1997)
  - Persona: not just an agent’s function, but the performance of their function (Hayes-Roth & Doyle 1998)
  - Recognizable (Perlin & Goldberg 1996)
Believable Characters

- Reactive/Responsive
  - Alert and perceive the world around them (Lester & Stone 1997)

- Self-Motivation
  - Proactive Engagement (Loyall 1997)
  - Illusion of Life (Loyall 1997)
  - Intentionality & Motivational State (Blumberg 1996)

- Change with Experience
  - Robustness – stays “in character” (Reilly & Scott 1997)
  - Growth – characters change (Loyall 1997)
  - Adaption – Learns new strategies to satisfy goals (Blumberg 1996)
  - Remembering (Hayes-Roth & Doyle 1998)
Believable Characters

- **Social**
  - Relationships & Attitudes (Reilly & Scott 1997)
  - Roles and Constraints (Reilly & Scott 1997)
  - Social Relationships – expressed via emotions and behaviors, and colored by personality (Loyall 1997)
  - Social Relations – Expresses social status, authority, and roles (Hayes-Roth & Doyle 1998)

- **Predictable**
  - Expect and predict how an agent should act (Ortony 2002)
  - Consistency (Loyall 1997)
  - Idiosyncratic & Appropriate (Hayes-Roth & Doyle 1998)

- **Coherence**
  - Contextuality, Continuity, & Temporality (Stone & Lester 1996)
Dramatic Characters

- **Story**
  - Premise (Egri, 1960)
  - Plot Points – “important moments” in a story (Weyhrauch 1997)
  - Dramatic Beat – “the smallest unit of dramatic action” (Reidl & Stern 2006 summarizing McKee 1997)
  - Dramatic Arc (Aristotle 330 BC)
Phew!

Dramatic

Intent/Behavior Planning

Behavior Selection

Behavior Enaction

User I/O

Emotion, Personality, Reactivity, History, Beliefs, Desires, Social Constraints, Story, Coherency, Consistency

Physical Restraints
Agent Design -- BOD

- Object-Oriented Design
- Behavior Decomposition
- Fast Iteration Cycle

Iterative and Agile

Abstract List of Behaviors

List of “Actions” and “Sensors”

Code

ABODE* Tool

D = Designer
P = Programmer

“accept offer”
“tell info”
“greeting”
etc.

“a_accept_object”
“s_get_offered_obj”
“a_greeting”
“s_wait_for_greeting”
etc.

Java or C#
BOD/POSH

- Multiple languages
- Authoring Tools
- Deployed on Undergrad & Graduates
ABL Idioms

- Daemon Behaviors (Weber et. al. 2010)
- Messaging (Weber et. al. 2010)
- Managers (Weber et. al. 2010)
- Micromanagement Behaviors (Weber et. al. 2010)
- Higher-level Beat Behavior Organization (Mateas & Stern 2004)
- Body Resource Management (Mateas 2002)
- Input-Handling Behaviors (Mateas & Stern 2004)
- Joint Behavior Performance Coordination (Mateas 2002)
- Multi-Agent ABT Negotiation (Shapiro et. al. 2013)
- Mood/Emotion Wrap-ons (Shapiro et. al. 2013)
- Performance Manager (Shapiro et. al. 2013)
Authorial Complexity

- Representational Complexity of reactive agents
  - reducing the number of states and transitions reduces the representational complexity
    - (Heckel, Youngblood, & Ketkar 2010).

- “Quantity, of course, is complexity,” (Isla 2005)
Authorial Leverage & Evaluation

\[ \text{Leverage} = \frac{\text{Quality} \times \text{Variability}}{\text{Complexity}} \]

(Chen et. al. 2009)

- Their metrics:
  - Complexity
  - Ease of policy change
  - Variability of experiences
Previous Work: Authoring Tools

- Social Mechanics Design Tool (SMDT)
SMDT Lessons

- Hierarchical Confusion
- Context Confusion

1. buddyNetwork(initiator, responder) greaterThan 50 (precondition)
2. 3 buddyNetwork(initiator, responder) greaterThan 50 (influence rule weight)
3. buddyNetwork(initiator, responder) greaterThan 50 (condition of an effect)
4. buddyNetwork(initiator, responder) +10 (change of the effect)

- Expected Tool Performance
- In-Tool Testing
  - Fast iteration cycle (BOD)
Previous Work: ABL

- IMMERSE
  - AI System for Culturally training Soldiers

- The Social Interaction Unit (SIU)

- The Performance Manager

- Volition Process

- Wrap-On Mechanism
Previous Work: General Authoring

- Requirements Analysis

- 3 Case Studies: BOD/POSH, FAtiMA, & ABL
  - Authoring Challenges
  - Proposed Solutions
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Overview OF PROPOSED WORK

- Authoring Process
- Visualization Modules
  - Reliable Triggering
  - Tweaking Performance Metrics
  - Behavior Interfacing
- Modular Design Pattern
  - Low-Level
  - High-Level
  - Watch for ABL idioms!
- Behavior Libraries
Authoring Process

1. **(Re)Evaluate Mental Model of System**

2. **Edit Code**
   - Were there any compile-time errors?
   - Were there any run-time errors?

3. **Performance Evaluation**
   - No Unintended Side-Effects
   - Intended Effects

4. **No Unintended Side-Effects**
   - Does the behavior “look right”? (Yes)
   - Is the behavior repetitive? (Yes)
   - Does the behavior “read well”? (Yes)
   - Does the behavior interfere with any other behaviors? (No)
   - Do other behaviors still “look right”? (Yes)
Authorial Complexity

Intent/Behavior Planning

Behavior Selection

Behavior Enaction

User I/O

Emotion, Personality, Reactivity, History, Beliefs, Desires, Social Constraints, Story, Coherency, Consistency

Physical Restraints
Authoring Process: Detailed
Visualization Modules
VM: Reliable Triggering

- **RT1**: A meta representation of state and decisions
- **RT2**: A means of automatically triggering decisions
- **RT3**: Controlled randomness, if any randomness is used

- Fast iteration cycle
  - (BOD & Lessons Learned)
Reliable Triggering: ENABL

Pause, record, and play. Plus an interface for file manipulation
VM: Tweaking Performance Metrics

- **TPM1**: Access to where (in the architecture) the metric is defined
- **TPM2**: A means to change the metric, preferably in real time, with immediate results
Tweaking Performance Metrics: ENABL

Tweaking Interface

Alter values in real-time, a GUI accessor to setting key values in WMEs or global scope

Set emotion....

Error!

Log  Log  Log  Log  Log

Happy  Sad  Angry  Afraid  Surprised
VM: Behavior Interfacing/Concurrence

- **BI1**: Meta tracking of ongoing behaviors
- **BI2**: High-level managers to mediate resource conflicts
- **BI3**: Alerts for “hanging” or “stalling” behaviors
Behavior Interfacing/Concurrence: ENABL

A still of the simulation (paused)

Scene

Agents

Interactable via mouse over or click

Behaviors

WMES

Relations

Relevant relational info for other agents

Selection

Examines an agent for close details in side panes
Overview OF PROPOSED WORK

- Authoring Process
- Visualization Modules
  - Reliable Triggering
  - Tweaking Performance Metrics
  - Behavior Interfacing
- Modular Design Pattern
  - Low-Level
  - High-Level
  - Watch for ABL idioms!
- Behavior Libraries
Modular Design Patterns

(Re)Evaluate Mental Model of System

Intent/Behavior Planning
  - Behavior Selection
    - Behavior Enaction
      - User I/O

Emotion, Personality, Reactivity, History, Beliefs, Desires, Social Constraints, Story, Coherency, Consistency

Physical Restraints

Edit Code
  - Were there any compile-time errors?

Performance Evaluation
  - Were there any run-time errors?

No Unintended Side-Effects

Intended Effects

Does the behavior “look right”?
Does the behavior “read well”?
Is the behavior repetitive?
Does the behavior interfere with any other behaviors?
Do other behaviors still “look right”?
Modular Design Pattern: Low-Level

Eye Gaze Module

Module Manager

- ManageGazeTargets()
- GazeAt(target, duration)
- animateEyes()
- animateHead()

Getters/Setters
- RemoveGazeTarget (target)
- EditGazeTarget (target, priority)
- RegisterGazeTarget (priority)

Animation Interface
Modular Design Pattern: Low-Level: ENABL

Eye Gaze Module

An instance of the Body Resource Management Idiom

Manager Idiom

GazeAt(target, duration)

Daemon Behaviors and Messaging Idioms

RemoveGazeTarget (target)

EditGazeTarget (target, priority)

RegisterGazeTarget (priority)

Micromanagement Behaviors Idiom

animateEyes()

animateHead()
Modular Design Pattern: High-Level
Modular Design Pattern: High-Level: ENABL

Item Exchange Module
An instance of the High-level Beat Organization Idiom

sequenceManager()

receiveItem(item, target)

repairDenial()

Potentially Multi-Agent Joint Behaviors

Locomotion Module

Eye Gaze Module

Arm Gesture Module

Inventory Module

Body Resource Management Idioms

expressiveintelligencestudio
ABL Idioms

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- Mood/Emotion Wrap-ons (Shapiro et. al. 2013)
- Performance Manager (Shapiro et. al. 2013)
Module Interface

- Generated Template
- Relevant Variables
- Relevant WMEs
  - Getter/Setter Behavior
  - Getter/Setter Behavior
  - Getter/Setter Behavior
- Manager Behavior
- Performance Behaviors
  - Another Module
  - Animation Interface
- <code>...</code>
Libraries/Modules

- ABL Idioms
- Subsumption modules
- Concurrent behaviors
- Interacting behaviors
- Dependencies & support for other libraries

Implicit Concurrency

Explicit Interface Points
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Applying Authoring Patterns

(Re)Evaluate Mental Model of System

- Intent/Behavior Planning
- Behavior Selection
- Behavior Enaction
- User I/O

- Emotion, Personality, Reactivity, History, Beliefs, Desires, Social Constraints, Story, Coherency, Consistency
- Physical Restraints

Edit Code

- Were there any compile-time errors?

Performance Evaluation

- Were there any run-time errors?

No Unintended Side-Effects

- Intended Effects

- Does the behavior "look right"?
- Is the behavior repetitive?
- Does the behavior "read well"?
- Does the behavior interfere with any other behaviors?
- Do other behaviors still "look right"?
Authorial Leverage

- Evaluation function: Experience quality
  - Ranking agents on believability metrics
    - What emotions were expressed?
    - Was there an identifiable personality?
    - Did the agent acknowledge history?
  - Ranking disruption of behavior errors

- Complexity
- Ease of policy change
- Variability of experiences
Usability & User Studies

- **Usability Evaluation**
  - Author an agent that accomplishes a specific goal
  - 1-on-1 task-based usability studies
  - Group workshops and discussions
    - Captive, predictable audience on a semi-regular schedule

- **Target User Groups**
  - Expert ABL authors
  - **Intermediate ABL authors**
  - Graduate/undergraduate Programmers
    - Workshops & Classes
User Study Plan Timeline

Automatic play trace recordings
Authored code
User profile: experience with agents & authoring
Likert-Scale questions on believability
Qualitative authoring experience

Now
Formative
More informal, Playtesting

End
Summative
Iterations, Evolution, Adding features
Rigorous, Many subjects
Research Questions

- Can modularity reduce the authorial complexity of creating dramatic, embodied, and interactive agents?  
  
  - Yes.

  
- How can dramatic agent authorial complexity be reduced through modularity?
  
  - Templated, Consistent Modules
  - Implementing expert idioms

- What benefits does working with modular authorial patterns and interfaces provide to authors?
  
  - Reduced Complexity
  - Easier & Faster Authoring
  - Behavior/Module Libraries
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## Schedule

<table>
<thead>
<tr>
<th>2014</th>
<th>Fall</th>
<th>ABL Extension, ABL Dependency Tree (Gaudle)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Winter</td>
<td>Prototype ABL scripting &amp; recording IUI &amp; AAAI Workshops* (Gaudle)</td>
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<tr>
<td></td>
<td>Spring</td>
<td>Prototype Scene display with Unity, FDG Workshop*</td>
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<tr>
<td>2015</td>
<td>Summer</td>
<td>Automatic ABT exploration &amp; statistics ICIDS, Creativity &amp; Cognition, ICCS Workshops*</td>
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<tr>
<td></td>
<td>Fall</td>
<td>First draft of authoring library via patterns IVA, DiGRA, AIIDE Workshops*</td>
</tr>
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* Note: These are assuming these conferences are occurring at all, are occurring at roughly at times of the year where they have previously, and that the workshop proposal is accepted.
## Schedule

| 2016 | Winter      | Revise tools, displays, and libraries  
|      |            | Begin Dissertation writing          
|      |            | IUI & AAAI Workshops II*            |
|      | Spring     | Present suite of tools for final round of studies  
|      |            | Propose/Teach class on ABL authoring  
|      |            | FDG Workshop II*                     
|      |            | Continue Dissertation writing, Begin job search  |
|      | Summer     | Continue writing and job search      |
|      | Fall       | Defend Dissertation                 |

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