Background

- Games becoming pervasive medium for a range of applications
- New modes of Entertainment, Education, Social Interaction, Training, Remote Collaboration, Medical Treatments and many other contexts
- With this increased use comes a demand for new methods of content creation
- Procedural Content Generation (PCG): the automatic creation of novel game content
- Dynamic scene geometry
- Dynamic world states and game context
- Personable and procedurally animated characters (e.g. Spore)
- Procedurally generated narrative with complex narrative structures
Narrative-based PCG

- When interaction within a game is automatically generated, the cinematics for the game cannot be pre-scripted
- Procedural generation of cinematics requires complex computational models
- Directorial and character goals
- Character actions and plans
- Dialog, background music, lighting, and sequencing
Automatic Generation of Cinematic Communication

- Input story (sequence of actions and events) and scene geometry
- Exploit computational model of cinematic conventions and communication
- Generate shot sequences designed to effectively convey the unfolding storyline
Example

- Setting: WestWorld
- Protagonist: Lazarus Lane (Cowboy, Thug)
- Goal: Communicate the story of Lazarus Lane
  - robbing the Lincoln County Bank

[1] Lane walks in the bar
[2] Lane looks at the barman
[3] Lane threatens the barman with a gun
[4] The threatens barman gave Lane the machete
[5] Lane goes to the bank
[6] Lane looks at the teller
[7] Lane bribes the teller with machete
[8] The bribed teller gives Lane gold from the vault
Viz. 1: Overview Shot
Viz. 2: Following the actor

You better give that to me if you want to live.

Please don’t hurt me. Here take this Machete, just let me go.

Please don’t hurt me. Here take this Machete, just let me go.
LANE: Jack Daniels. I'll take the bottle.

VINNY: This gotta teach you.

SHERIFF: I will be back in 3 days.

LANE: Hand over that tax money lady.

LANE: Hand over that tax money lady.
Outline

- Related Work
- Problem and Solution
  - Desired Properties
  - Representation
  - Reasoning algorithm
  - Execution Environment
- Evaluation
- Future Work
## Related Work

### Geometric Camera Placement
- Occlusion free camera view
- Determination of camera parameters to satisfy user specified geometric constraints

### Linguistics
- Syntactic constraints on generation
- Discourse relations in multi-sentential text
- Communicative acts

### Film Theory
- Cinematic Idioms

### Narrative Theory
- Dramatic Patterns
- Narrative Comprehension
# Related Work

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Related work: Geometry-based camera placement

Goal: Procedural camera placement in 3D environments to satisfy user specified constraints

Previous Approaches:

Visual primitives [Drucker et al. 94]
Film Idioms [He li wei et al. 96]
Constraint Solver [Bares, Lester 97]
Genetic Algorithms [Halper, Olivier 01]
Neural Networks [Hornung 03]
Related Work: Geometry-based camera placement

(a) View of two subjects featuring occlusion-avoidance
(b) Overview with one inset and color-coded highlights
(c) Overview with two multi-shot insets
(d) Overview and inset of cop but culled multi-shot of bank
# Related Work

## Geometric Camera Placement
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- Syntactic constraints on generation
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## Narrative Theory
- Dramatic Patterns
- Narrative Comprehension
Related Work: Discourse Generation

Goal: Generation of coherent multi-sentential text for satisfying communicative goals

Previous Approaches:

- Theory of Discourse Structure [Grosz et al. 86]
- Rhetorical Structure Theory [Mann et al. 87]
- Planning approaches [Moore and Paris 89, Maybury 92, Hovy 93]

**Communicative act** (Discourse action): Intentional linguistic action executed to manipulate beliefs of the hearer (Inform, Command, Request, Ask)
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Problem Statement

Given, a story

- set of actions
- causal and temporal relationships between actions
- a set of communicative goals

construct a schedule of camera shots

such that the resulting visualization

is coherent

follows acceptable cinematic conventions
**Desired Solution Properties**

- **Selection of Salient Elements**
  - Discourse action should select elements of the story that best achieve communicative goals

- **Coherence**
  - Discourse actions collectively communicate the story such that viewers are able to identify relationships between story and discourse actions

- **Consistency**
  - Discourse actions do not introduce causal or temporal inconsistencies
Darshak’s Approach

Representation
- Narrative Patterns
- Camera placement idioms

Reasoning
- Hierarchical Planning
- Temporal Scheduling

Execution
- Procedural Action Classes
- Execution Management
Why Planning?

- Automatic generation of action sequences to achieve specified goals
- Action Operators: Primitive and Abstract
- Relationships between actions:
  - Causal: Preconditions and Effects
  - Hierarchical: Decomposition
- Constraints: Object constraints and temporal ordering constraints

Jhaia A, and Young R M, Representational Requirements for a Plan Based Approach to Camera Control in Virtual Environments, In Proceedings of 2nd Artificial Intelligence in Interactive Digital Entertainment Conference (AIIDE 2006), Marina Del Rey, CA, 2006
Representation: Cinematic Discourse

- Narrative Patterns
- Episodes/Scenes
- Primitive Operators
Narrative Patterns

Abstract Narrative Patterns serve to:

- Guide the flow of narrative
- Verify plot consistency
- Exploit viewer’s familiarity with idioms
Background

Narrative Theory

- Story and Discourse [Chatman]
- Story Structure
  - Story Grammars [Propp]
  - Dramatic patterns in narrative [Polti]
- Narrative Comprehension
  - Discourse Comprehension [vanDijk]
  - Film comprehension [Branigan]
Conversations/Episodes

Episode operators:

- Represent complex idioms
- Guide the selection of individual shot parameters

**Decomposition**: Conversation

:parameters - ?c, ?dir

:constraints ((conversation ?c) (conv-steps ?c ?slist))

:tconstraints ((starts-at ?T_s (start (first ?slist))))

:steps

  step1: (apex-shot ?c ?dir))
  forall ?step in ?slist
  step2: (film-dialog ?step ?dir)

:orderings ((step1 step2))

:rewrites (BEL V (Occurs ?c))

  forall ?step in ?slist
  (BEL V (Occurs ?step))
Primitive Operators

Primitive operators serve to:

- Establish Focus
- Set Camera Attributes

**Type:** LookAt

**Parameters:** ?focus, ?shot-type, ?dir, ?T\_start, ?T\_end

**Preconditions:**
- (not (infocus ?focus))@[?T\_start)

**Constraints:**
- (> T\_end T\_start)

**Effects:**
- (infocus ?focus)@[?T\_start, ?T\_end)

**Type:** PanWithActor

**Parameters:** ?focus, ?shot-type, ?dir, ?T\_start, ?T\_end

**Preconditions:**
- (infocus ?focus)@[?T\_start)
- (not (panning ?shot-type ?dir))@[?T\_1, ?T\_start]

**Constraints:**
- (> T\_end T\_start) (< (- T\_end T\_start) 10)

**Effects:**
- (infocus ?focus)@[?T\_start, ?T\_end)
- (panning ?shot-type ?dir) [?T\_start, ?T\_end)}
Background

Film Theory

- Composition [Arijon]
- Continuity [Mascelli, Monaco]
- Transition [Mascelli, Katz]
- Coherence [Branigan, Van Sijll]
Reasoning

• Discourse Planning
  • Input
    • Story Representation
    • Operator Library
  • Algorithm
    • Content Selection
    • Causal Planning
    • Temporal Scheduling
  • Output: Combined Story and Discourse Plan

Reasoning

- **Input**
  - **Story Representation**
  - **Operator Library**
  - **Story-World Actions**
  - **Discourse Actions**

**Input Story:** Bank Robbery

**[INIT]** \( I_1 \) (not (has gold thief))

**[S_1]** Guard leaves bank
  - (effect \( S_1 \) (not (at bank guard)))

**[S_2]** Thief enters bank
  - (prec \( S_2 \) (not (at bank guard)))
  - (effect \( S_3 \) (at bank thief))

**[S_3]** Thief steals gold
  - (prec \( S_3 \) (at bank thief))
  - (effect \( S_3 \) (has gold thief))

**[S_4]** Thief runs away
  - (effect \( S_4 \) (at hideout thief))

**[CL1]** Causal Link: \( S_1 \) -- \( S_2 \) (not (at bank guard))

**[OL1]** Ordering Link: \( S_3 \) --> \( S_4 \)

**[Goal]** \( SG_1 \) (has gold thief)

Reasoning: Plan Space

- Planning Process
  - Plan Space
  - Flaw Repair
  - Search Control
  - Heuristic function

Init → Goal

Expansion

Rank: x
Rank: y
Rank: Z
Planning Algorithm

DPOCL-T (P_c - Partial Plan, Δ-Operator Library, λ-Domain Definition)
Decompositional Partial Order Causal Link Algorithm with Temporal constraints

Termination: If P_c has no flaws or if there are no steps for expansion

Causal Reasoning
a) Goal Selection:
    Pick an open condition p@[t_a, t_b) from set of goals G
b) Action Selection:
    Select actions with effects that unify with the selected open condition
    and add them to the partial plan

Episode Decomposition
Nondeterministically select an unexpanded step from P_c and expand

Threat Resolution
Promotion/Demotion: Add ordering constraint between steps
Separation: Update co-designation list

Temporal Scheduling
Recursive Invocation
Causal Reasoning

Result of Decomposition and Causal Planning

• Combined Story and Discourse Plan
• Causally consistent
• Partially ordered
Temporal Reasoning

Temporal Constraints
- Implicit ($\text{Start}_{\text{act}} \rightarrow \text{End}_{\text{act}}$)
- Story $\rightarrow$ Story
- Camera $\rightarrow$ Story
- Camera $\rightarrow$ Camera
Execution

- Cinematographer
  - Manages execution of story and camera actions
  - Sets geometric constraints
    - Location Constraints (shot length, shot direction)
    - Rotation Constraints (horizontal and vertical angles)
    - Lens Constraints (field of view)
  - Interface with the constraint solver

- Cameraman
  - Continuously maintains the camera at a solution that satisfies all the current constraints

Evaluation

- Domain: Westworld
  - Established conventions
  - Simple story structure
  - Silent Western: No audio, no facial expressions, limited lighting changes to reflect the context [Seif el-Nasr, Perlin, Paiva]
Experiments

- Experimental Methodology based on cognitive model of comprehension called QUEST (Graesser et. al. 91)
- Goodness of Answer (GOA) ratings

Jhala A and Young R M, Comparison of Different Visualization Strategies on Story Comprehension, International Conference on Interactive Digital Storytelling (ICIDS09), Portugal, December 2009.
Results Summary

- Viz. strategy does affect story comprehension
- Significant differences between MS and other two strategies
- No significant differences between Darshak and OTS but interesting observations for further study
Future Directions

- Interactive Storytelling
- Serious Games and Training Simulations
  - Experiential learning
  - Reflective Feedback
- Games and Film
  - Authoring tools for creating Machinima and pre-visualizations
  - Models for representing and algorithms for automatically evaluating visual media for cinematic quality
Serious Games

• Leaders project
  • Branching storyline with cinematics for leadership training

• America’s Army: Adaptive Thinking and Leadership
  • Multiplayer training simulation
  • In-class After-Action Review

Authoring Tools for Machinima

- Longboard project at NCSU funded by Microsoft