The Illusion of Intelligence

The Integration of AI and Level Design in Halo

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The Illusion of Intelligence

- Target Audience

  Designers, AI Programmers, Halo Players

- Session Overview
  - Discussion of Halo's AI Design Goals
  - Details of the AI Implementation
  - Description of the Level Creation Process
  - Demonstration of Halo's Production Tools
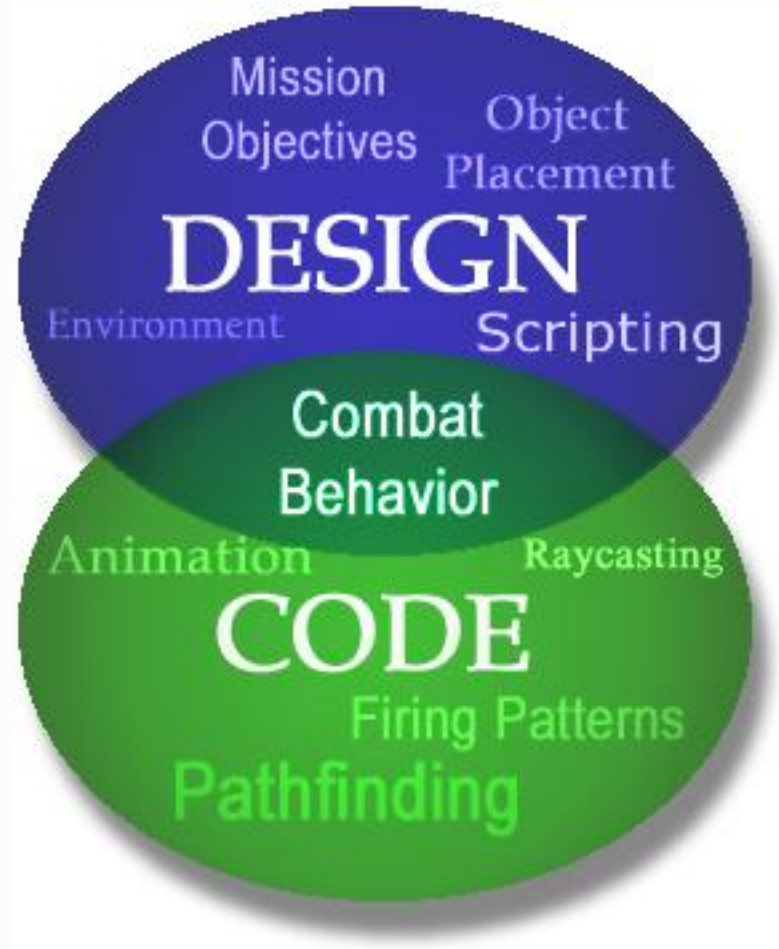
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Meeting Player Expectations

Expectations

- Novel situations
- Total interactivity
- Significant challenge

Methods

- Heavy scripting
- Extended Interface
- Omniscient and relentless enemies

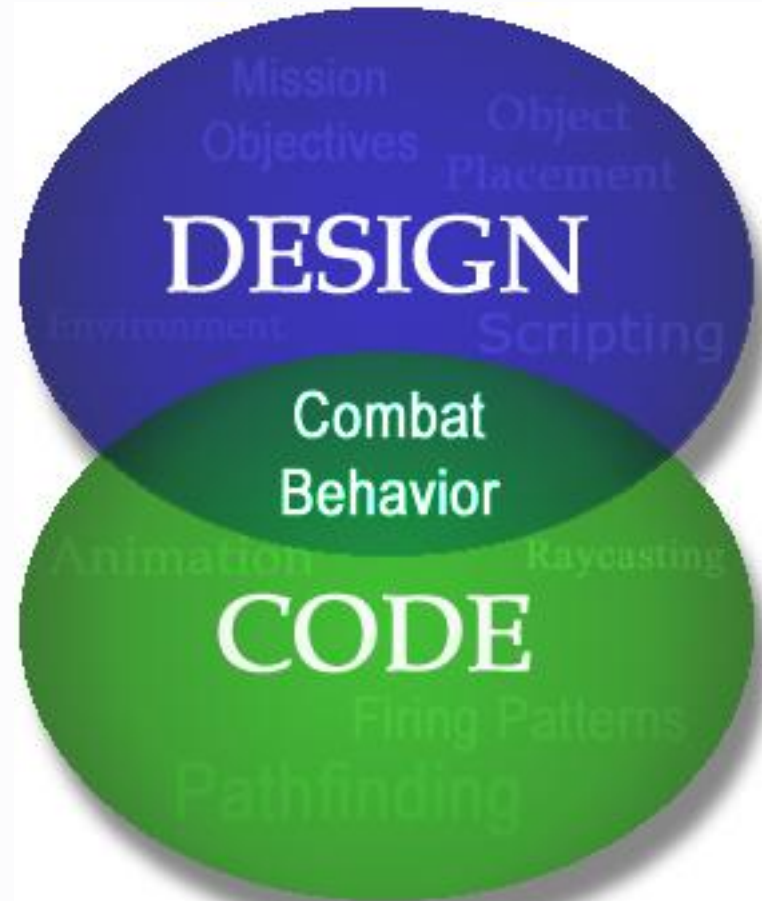BUNGIE

Where Design and Code Overlap

Where Design and Code Overlap

Design Responsibilities

- 3 minute scope
- Racial personalities
- Strategic purpose

Code Responsibilities

- 30 second scope
- Intelligent decisions
- Instant reactions

Design Goals

- **Intelligible**
- Interactive
- Unpredictable

Individual Level

- ○ Imitating the Player's capabilities
- ○ Transparent thought process
- ○ Racial personality

Group Level

- ○ Obvious strategic goals
- ○ Clear racial roles

Design Goals

- Intelligible
- Interactive
- Unpredictable

Impressed
- React to the Player
- Surprise, Anger, Awe

Fooled
- Limited knowledge
- Predictable reactions

Thwarted
- Breaking point
- Flee in Terror, Berserk, Retreat, Defensive State

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Design Goals

- Intelligible
- Interactive
- Unpredictable

Discarded: Randomness

Reactive AI
- Unpredictable player
- Unpredictable situations
- Unpredictable reactions

Analog Reactions
- Position
- Timing

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Technical Constraints

- 20 – 25 Actors
- 2 – 4 Vehicles
- About 15% of Xbox CPU
- Two-player Cooperative
- Support the Design Goals
  - Individual Knowledge
  - Emergent Behavior
  - Understandable

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Making the AI Interactive

Individual Knowledge Model

- Discarded: Complete Model
- 'Real' Perception
  - No cheating
  - Vision, Hearing, Touch, ESP
- Selective Memory
  - Local objects
  - Crucial objects
- Persistent State
  - Can be fooled

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Making the AI Intelligible

Communication of Intent

- **Discarded: Hidden States**
- **Inform the Player**
  - Language, Posture, Gesture
  - Focus of Attention
- **React to the Player**
  - Dialogue
  - Animation

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Making the AI Unpredictable

Emergent Behavior

- Discarded: 'Fuzzy' Emotion System
- Cause-Effect Stimuli
  - Discovery
  - Weapon Fire
  - Damage, Death
- Rich World Simulation
- Unforced Group Behavior

AI Implementation

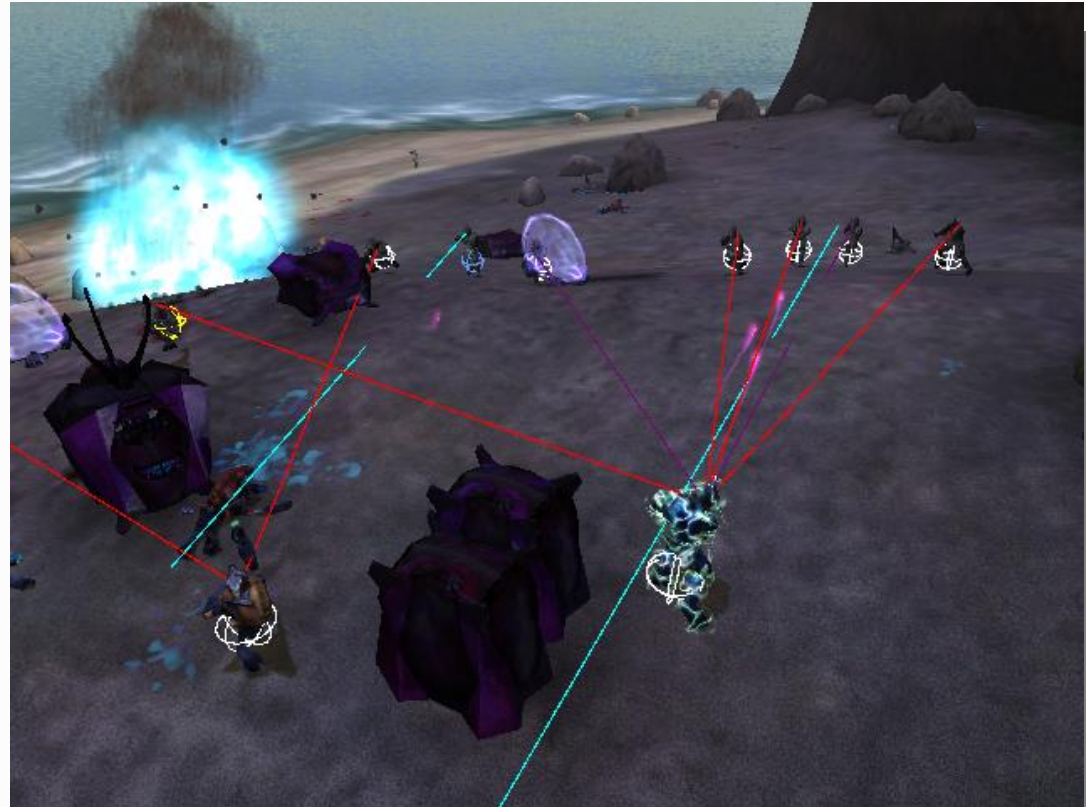# AI Implementation

Design

- Battle Flow

AI Implementation

Design

- Battle Flow

Technical

- Actions and Responses

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Design Implementation

- **Difficulty Level**

- Battle Lines

- Playtest Feedback

- **Lifespan**

  - Smarter = Tougher

  - Tougher = Smarter

Weak Enemy Playtest

Too hard	12%	Very Intelligent	**8%**
About right	52%	Somewhat Intelligent	72%
Too easy	**36%**	Not Intelligent	20%

Tough Enemy Playtest

Too hard	7%	Very Intelligent	**43%**
About right	92%	Somewhat Intelligent	57%
Too easy	**0%**	Not Intelligent	0%

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Design Implementation

- Difficulty Level
- Battle Lines
- Playtest Feedback

- Lifespan
  - Smarter = Tougher
  - Tougher = Smarter
- Consistent Challenge
- Negative Reinforcement
  - Discourage boring tactics
  - Reward experimentation

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Design Implementation

- Difficulty Level
- Battle Lines
- Playtest Feedback

- Strategic Spaces
  - Interconnectivity
  - Killing Zone
- Attacking/Defending States
  - Aggressive Territory
  - Retreat Conditions
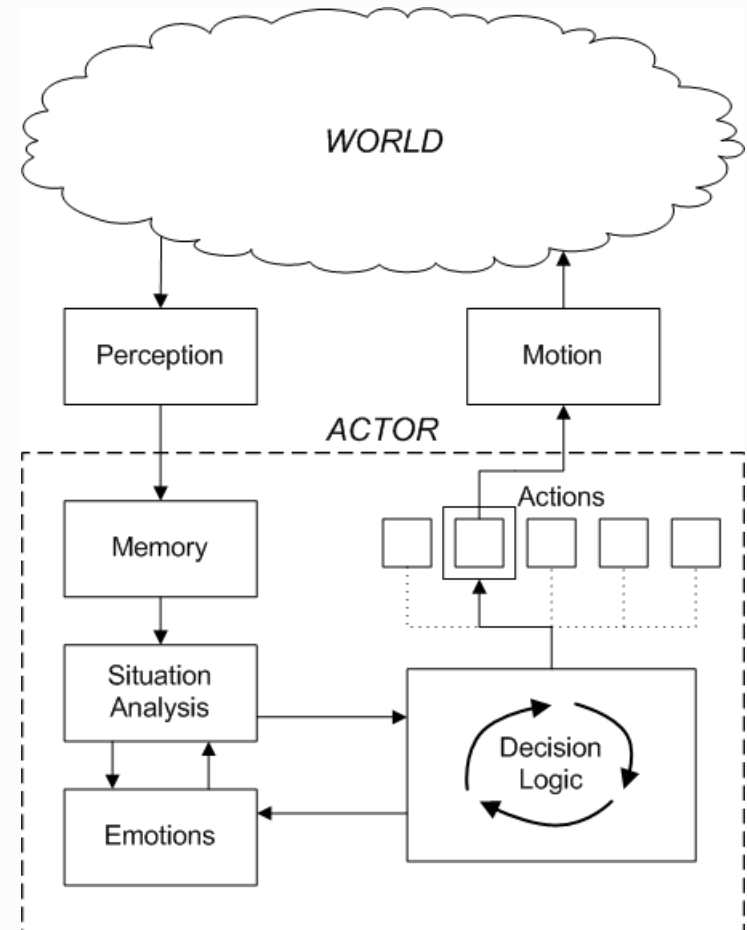 - Defensive Fortification

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Design Implementation

- Difficulty Level
- Battle Lines
- Playtest Feedback

- Things to Avoid
  - Subtlety
  - Looking Broken
  - Insufficient Challenge
- Things to Refine
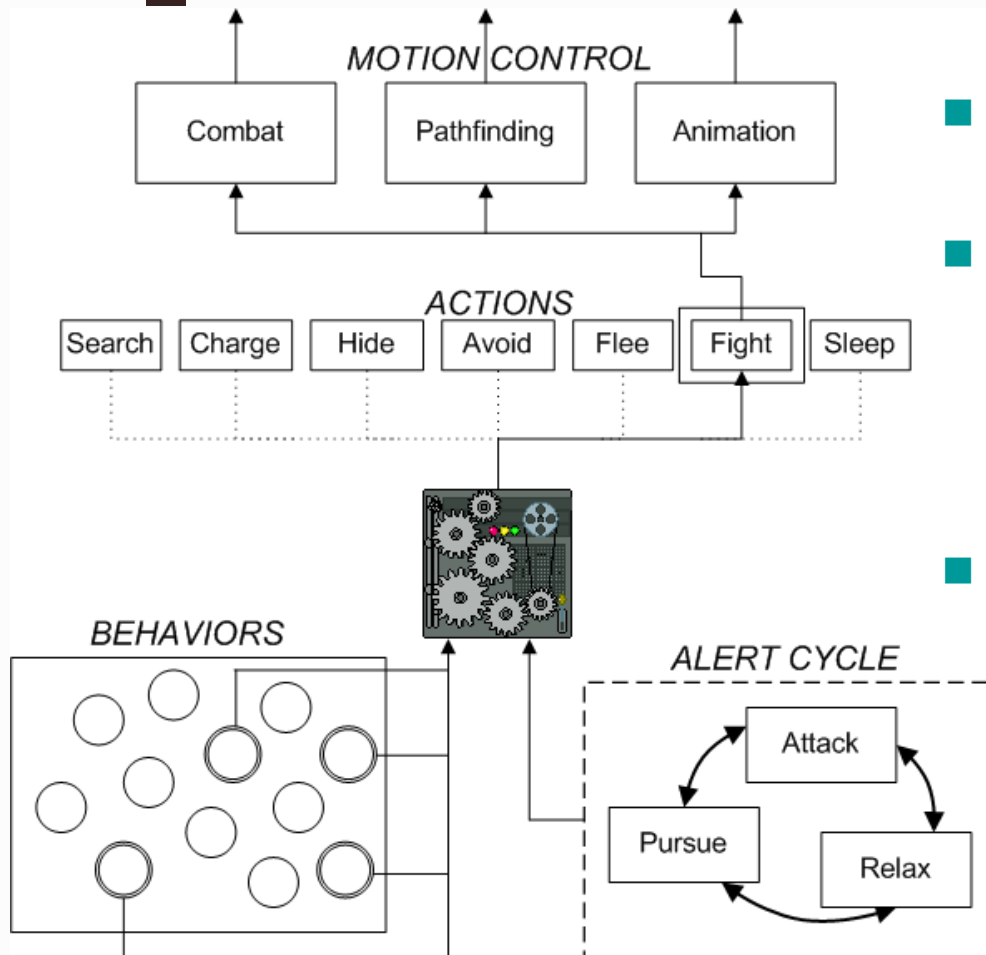 - Communication
  - Animations
  - Engagement Distances

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Anatomy of an Actor

- **World Interface**
  - Information flow restricted
- **Knowledge Model**
  - Layered analysis
  - Distributed over time
  - Generates stimuli
- **Decision Logic selects from Actions**

WORLD

Perception

Motion

ACTOR

Memory

Actions

Situation Analysis

Decision Logic

Emotions

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Decision Logic

- Enemies cause alert
  - *Innate combat cycle*
- Behaviors activated by stimuli
  - *Charge, flee, seek cover*
  - *Throw grenade, enter vehicle, check dead body*
- Each race has a Black Box for action selection
  - *Grunts flee easily*
  - *Elites seek cover if hurt*
  - *Jackals carry shields*

MOTION CONTROL

| Combat | Pathfinding | Animation |

ACTIONS

| Search | Charge | Hide | Avoid | Flee | Fight | Sleep |

BEHAVIORS

ALERT CYCLE

Attack

Pursue

Relax

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Location, Location, Location

- *"This is my goal. Where should I be standing?"*
  - Need a discrete answer to a continuous problem

- Solution: Firing Points

- Weighted and selected
  - line of sight
  - distance to target
  - proximity of cover
  - friends and enemies
  - vehicles, grenades, etc

- Senses environment by multiple ray-casting

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Combat Dialogue

- From decisions and stimuli
  - hurt, death, saw enemy, throw grenade, seek cover
- Hundreds per second
  - Priority, context, uniqueness, relevance
  - Select random dialogue type
  - Nearby characters can reply
- Used for flavor only
  - *57 events*
  - *166 dialogue types*
  - *12 speaking characters*
  - *5147 recorded lines*

I'd have been your daddy but that dog beat me over the fence!

Now who's going to save the human race, bright boy?

Hey mate, this one looks like your sister!

Take that skirt off and get back there and fight, soldier!

I'd love it if you'd STOP KILLING MY MEN!

Get up! Get up so I can kill you again!

Notify his next of kin, because they're next!

And my mum thought I was gonna be a doctor...

I didn't like him either, but damn!

Hey mate, I don't think they're gonna give you a medal for that one...

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Demonstration

In Conclusion...

The Illusion of Intelligence

Combat Behavior is where Design and Code overlap

- **Design Goals**
  - Intelligible
  - Interactive
  - Unpredictable

- **Design Implementation**
  - Difficulty Level
  - Battle Lines
  - Playtest Feedback

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In Conclusion...

Flexible Systems → Emergent Behavior

But make sure it stays fun and comprehensible!

- **Technical Goals**
  - Communication of Intent
  - Individual Knowledge Model
  - Unpredictability

- **Technical Implementation**
  - Actor Structure
  - Decision Logic
  - Firing Points
  - Context-based Dialog

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Any Questions?