



# Remember to Relax!

*Realizing Relaxed Behaviors in AAA Games*

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***Lead Programmer***

**Avalanche Studios**

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***Senior Animation Programmer***

**Ubisoft Entertainment**



# Introduction

- Who we are?
  - Bobby Anguelov
  - Jeet Shroff
- What we will talk about:
  - Relaxed NPC Behaviors
  - Interacting with the world
  - Reacting to the world



# Importance of Relaxed Behaviors

- Populating the World
  - Create a sense of a living, breathing world
  - Ground the player
- Gameplay Mechanics
  - Playground for the player
- Narrative Staging











# Challenges

- **Production Cost!**
  - Content Creation
  - Behavior Authoring + Setup
  - Testing + Tuning





# Challenges

- Variety and Repetition
  - Behavior Loops
  - Behavior Spam





# Challenges

- Transitions and Interruptions
  - Transitioning between AI behaviors
  - Interrupting/Resuming AI behaviors

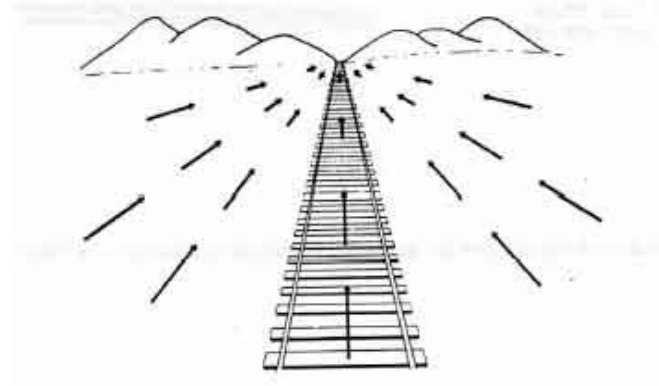






# Movement

- Goal-Oriented Movement
- Using Environment



- Pseudo-Scripting Paths



Relaxed



Core  
Behavior

Move Around  
Script / Sidewalk / Roam Area



# Crowd Movement

- Crowds generally rely on “wandering” movement
- Flow patterns essential to guide wandering crowd movement. Provide Uniform Flow.
- Bias avoidance to *speed modification*, rather than direction



# Going Beyond Movement

- Movement is not enough!!!
- NPCs need to exist in the environment
  - Understand the environment and objects in it
  - React to the environment events
  - Interact with each other as well as the player

**So how do we convey this context to the NPCs?**



2 Devs = 1 Approach

**External Actions**





# External Actions

## External Action

Context

Conditions

Spatial Link

AI Behaviors

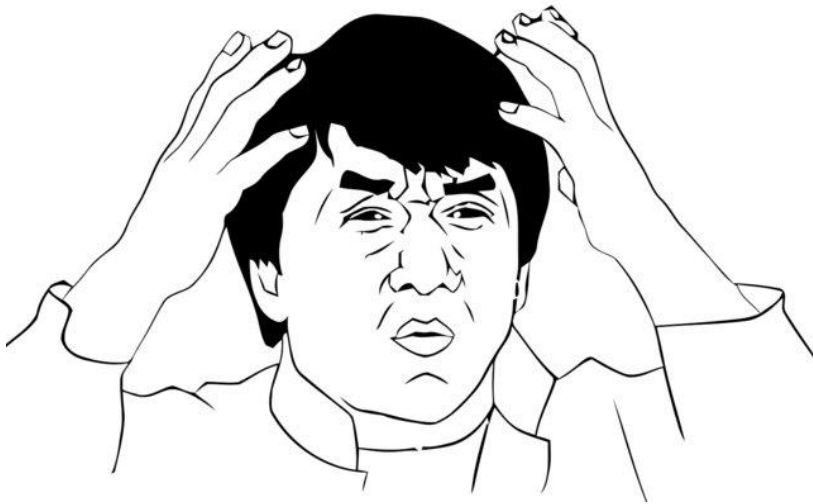
Animations

Sounds

- Contains Behavior, Animation, Sound
- Has a context defining conditions and a spatial link
- External to the core-behavior set



# External Actions == Smart Objects?!?!



**How is this different from traditional smart objects?!**



# External Actions = Smart Objects++

- Drag and Drop Paradigm
  - Environment should be define context and behavior
  - External actions can be as complex as needed
  - Extend to other non-relaxed states as well

Core AI

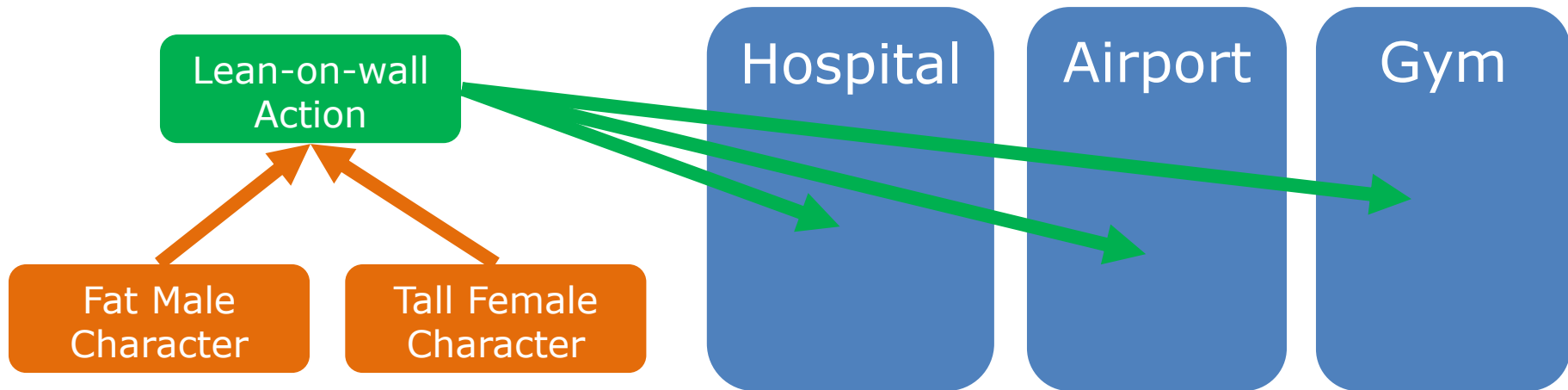
Extended Behaviors  
(Relaxed)

Environment



# Reusability of External Actions

- High focus on reusability
  - Across different levels & character types
  - Investment in IK + runtime retargeting = huge wins for memory/production





**MYTH**

**Runtime Ad Targeting  
is expensive**





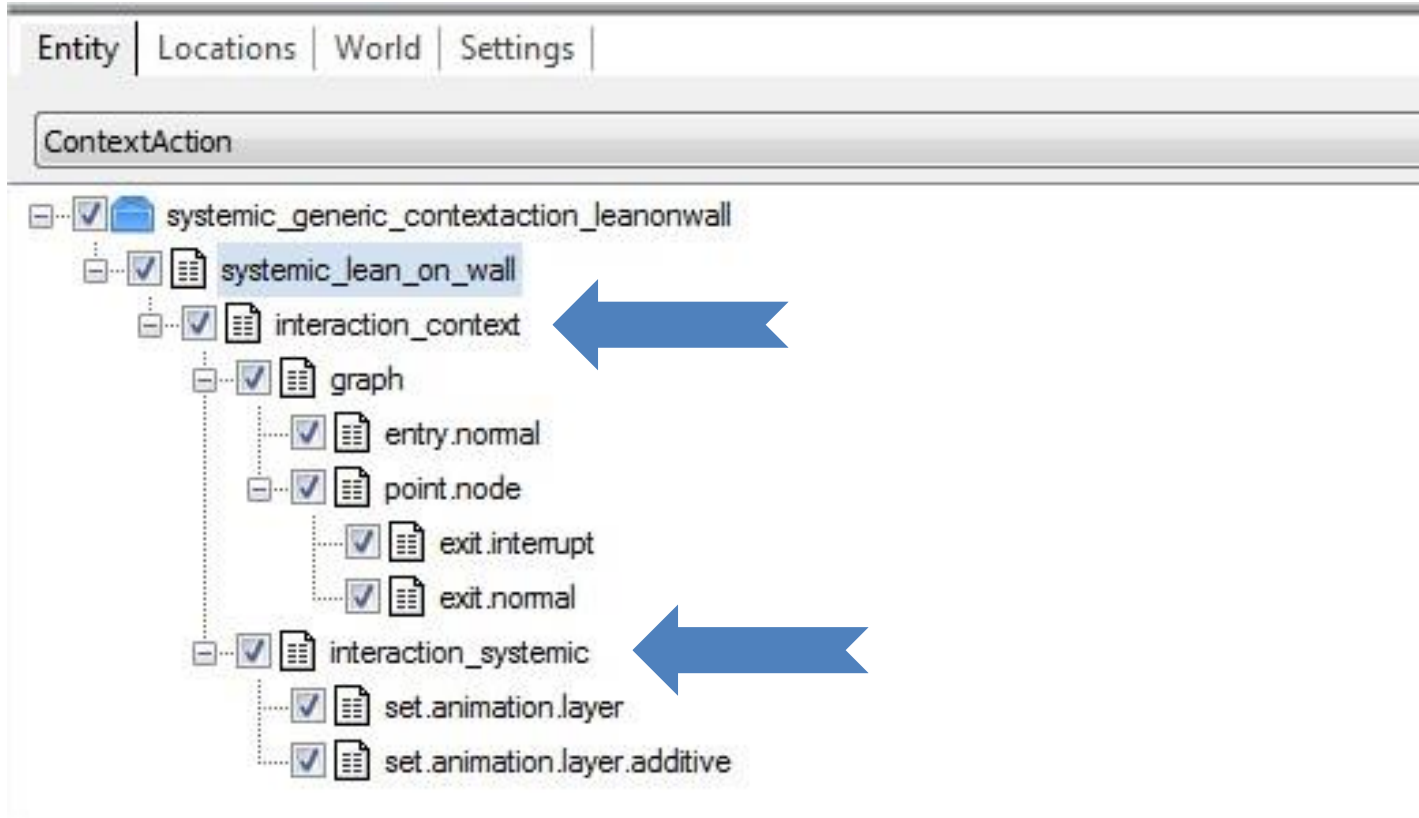


# Empower Content Team

- Empower level artists / designers
  - Empower content creators (Level/Game Designers)
  - Remove the need for programmers to author/tune setups
- Parallelize production of external actions
  - Doesn't impact core AI
  - Cheap and effective tool for post-launch content
  - Localize bugs to either Core AI or a specific external action
  - **Reduces production cost and risk!**




# Implementation Details





Property View

[-] 1. Transform	
world	pos=<0.000, 0.000, 0.000> rot=<0.000, -0.000, 0.000> scale=<1.00, 1.00, 1.00>
[+] Contextual Action Interactions	
[-] Files	
behaviour_tree	
[+] Filters - Faction	
[-] Filters - Gender	
Female	<input checked="" type="checkbox"/>
Male	<input checked="" type="checkbox"/>
[-] Parameters	
allow_secondary_actions	<input checked="" type="checkbox"/>
cooldown_max	25.000000
cooldown_min	10.000000
disable_look_at	<input type="checkbox"/>
duration_max	60.000000
duration_min	30.000000
exclude_range	30.000000
max_occupants	1
num_of_variations	1
search_range	7.000000
staged_only	<input type="checkbox"/>
use_look_at_for_interest_reaction	<input type="checkbox"/>
weapon_needed	<input type="checkbox"/>





# Integrating External Actions

- External actions placed in “locations”
- Loads in only the external data needed
- Memory efficient

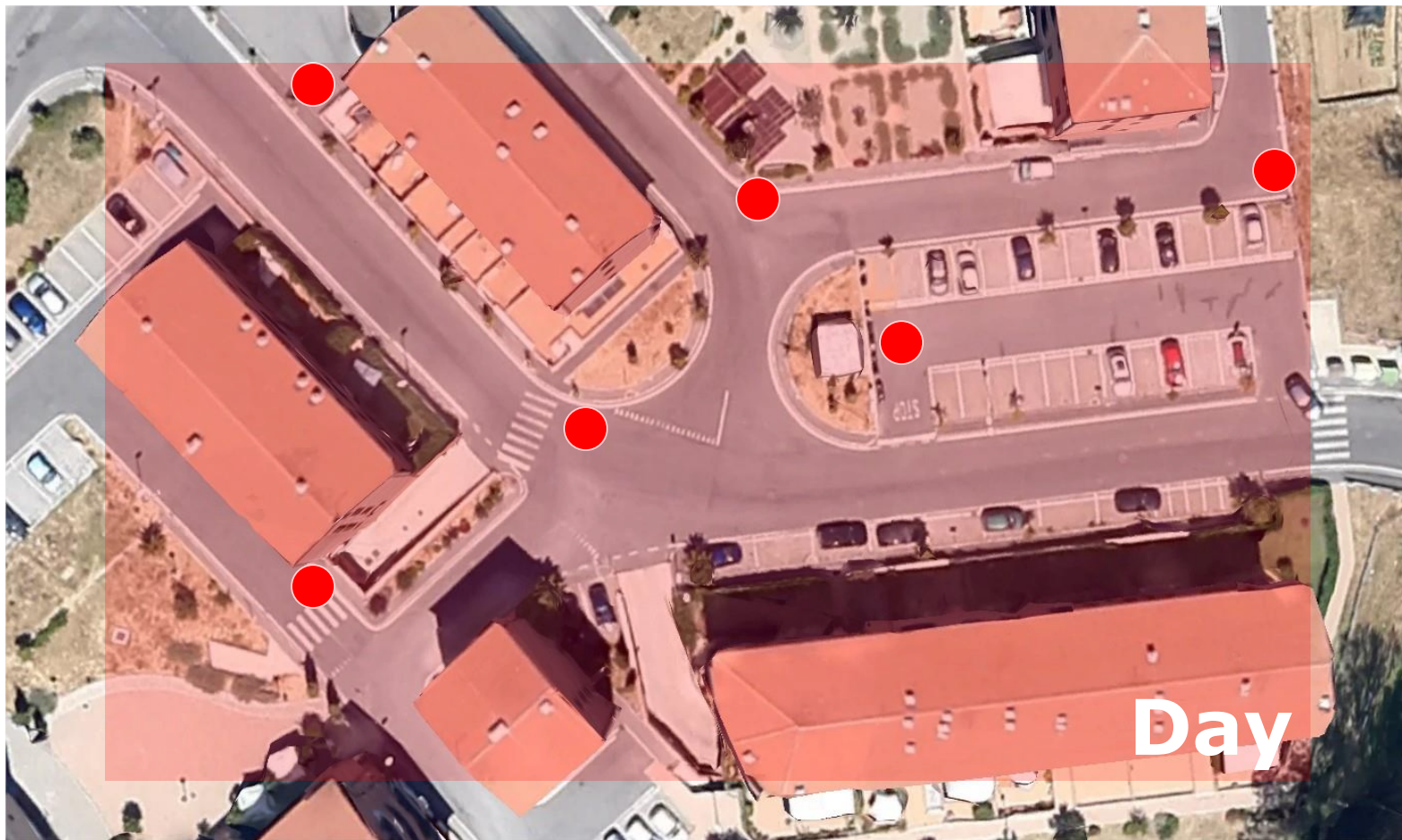






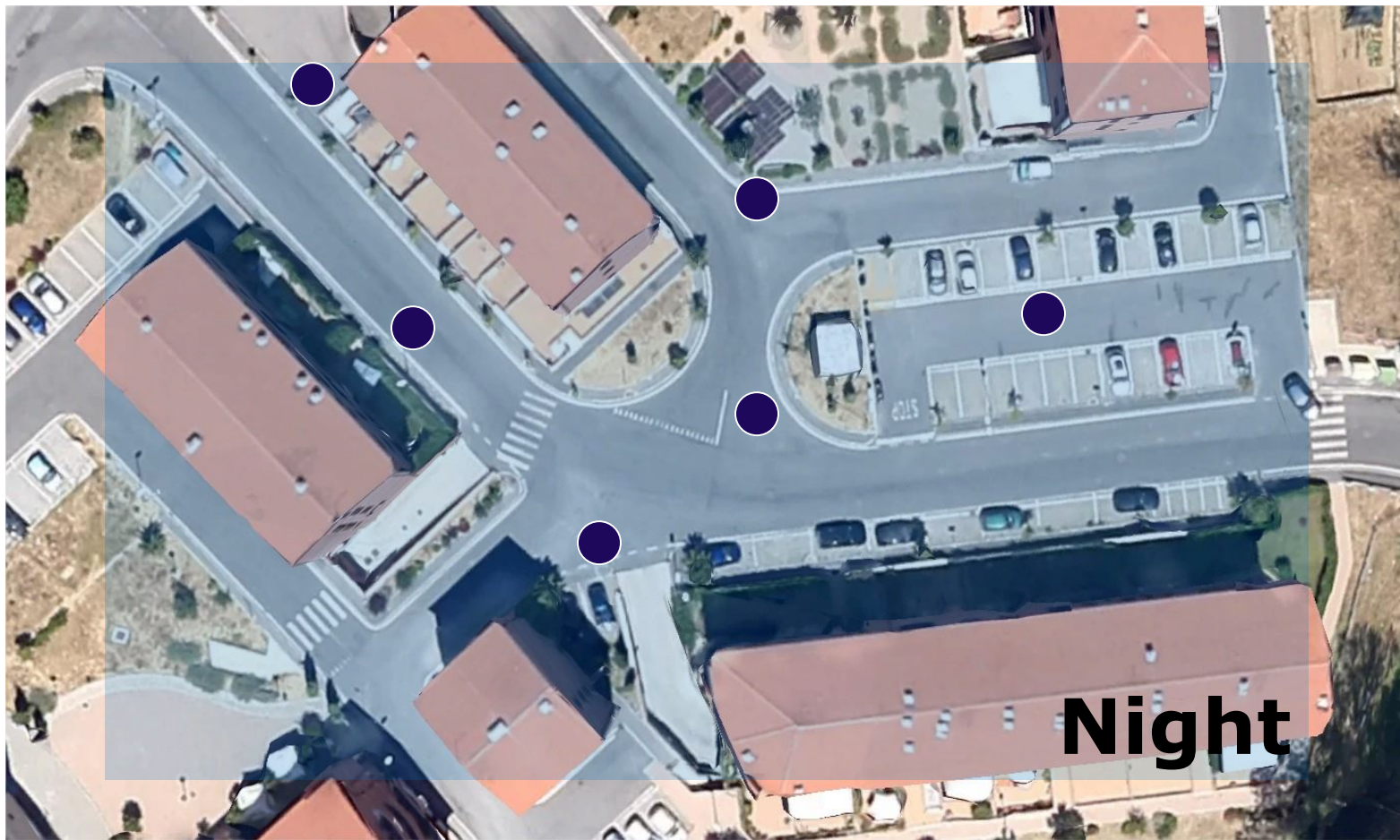


Day











# Animation Concerns with External Actions

- Issues in games when interacting with objects:
  - Sliding to Spot
  - Animation popping (on entry / interruptions)
- Solutions:
  - Looser tolerance
  - Animation Warping
  - Not a silver bullet -

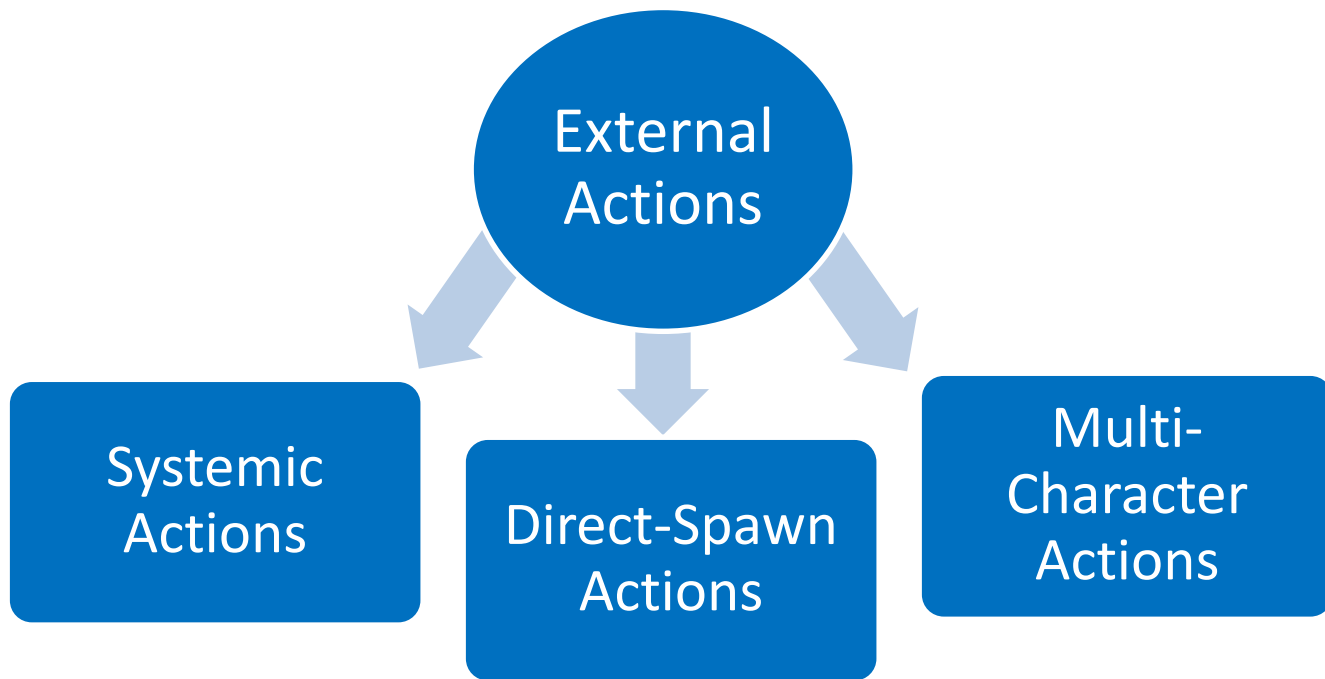
**Finding Balance: Realizing Responsive  
High Fidelity Character Movement in  
Just Cause 3**

**Wednesday, 5-6  
West Hall, Room 2016**





# Usage Examples



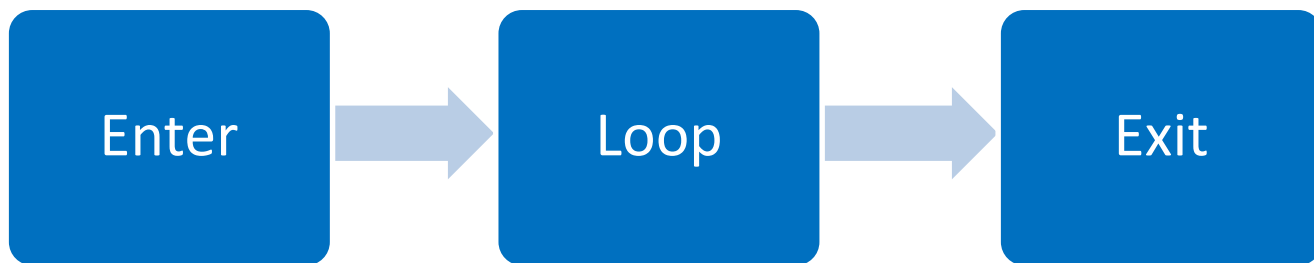


# Systemic Actions

- An external action which can be found and used systemically from the core behavior
- Useful for:
  - Contextual awareness
  - Basic interaction with the environment

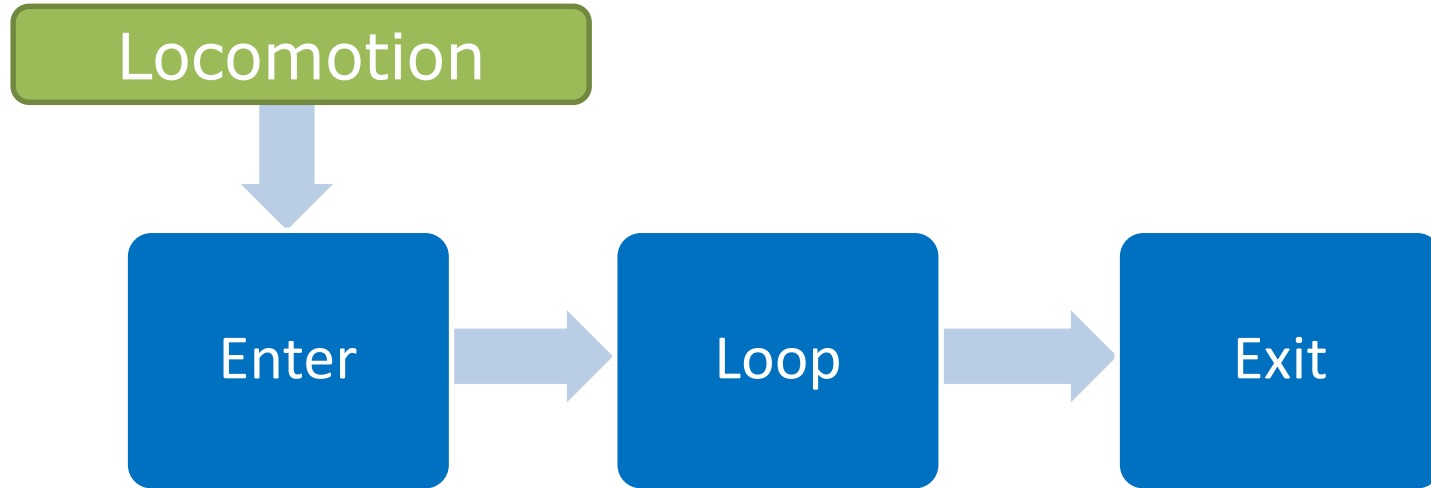


# Systemic Actions



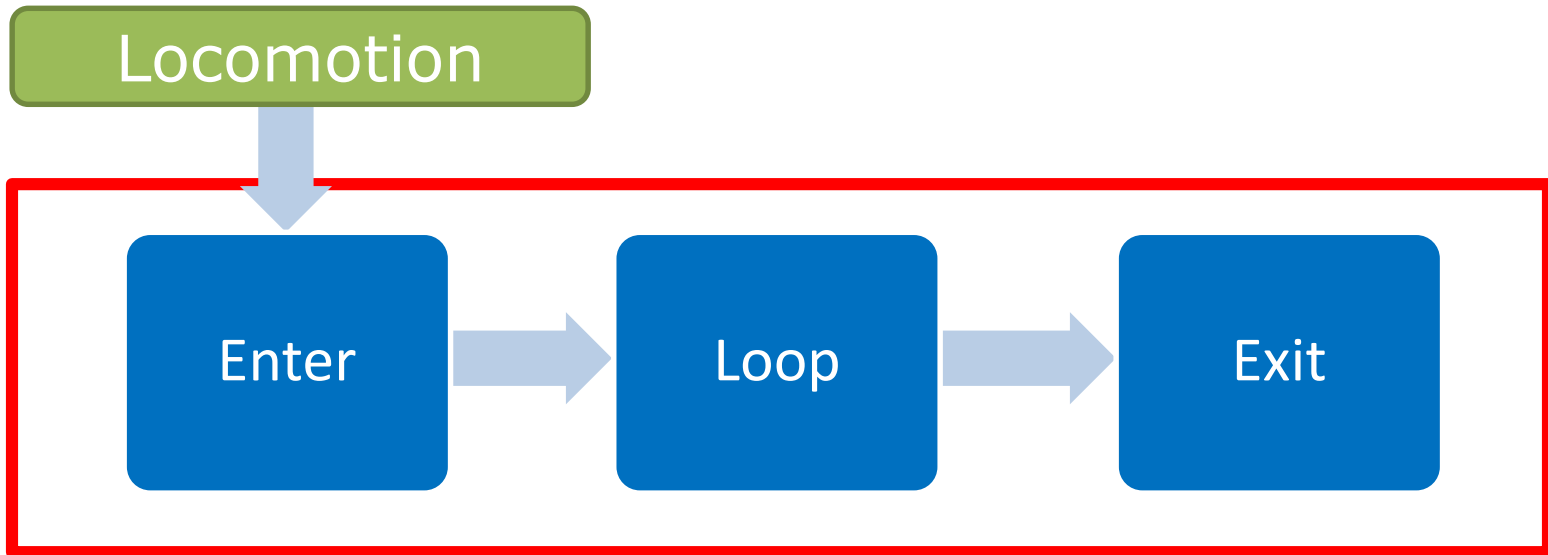



# Systemic Actions





# Systemic Actions

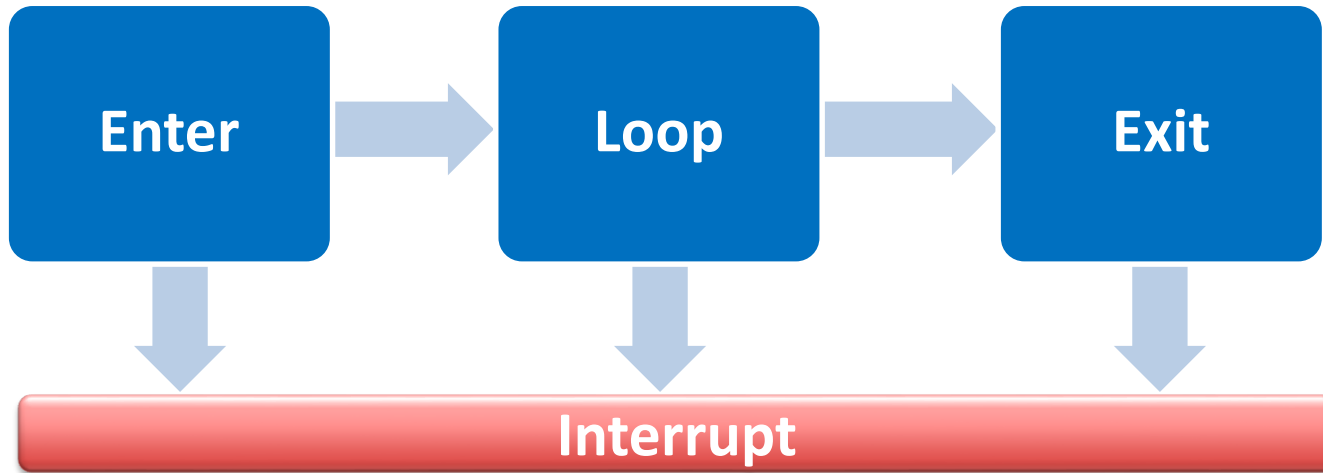




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# Systemic Actions

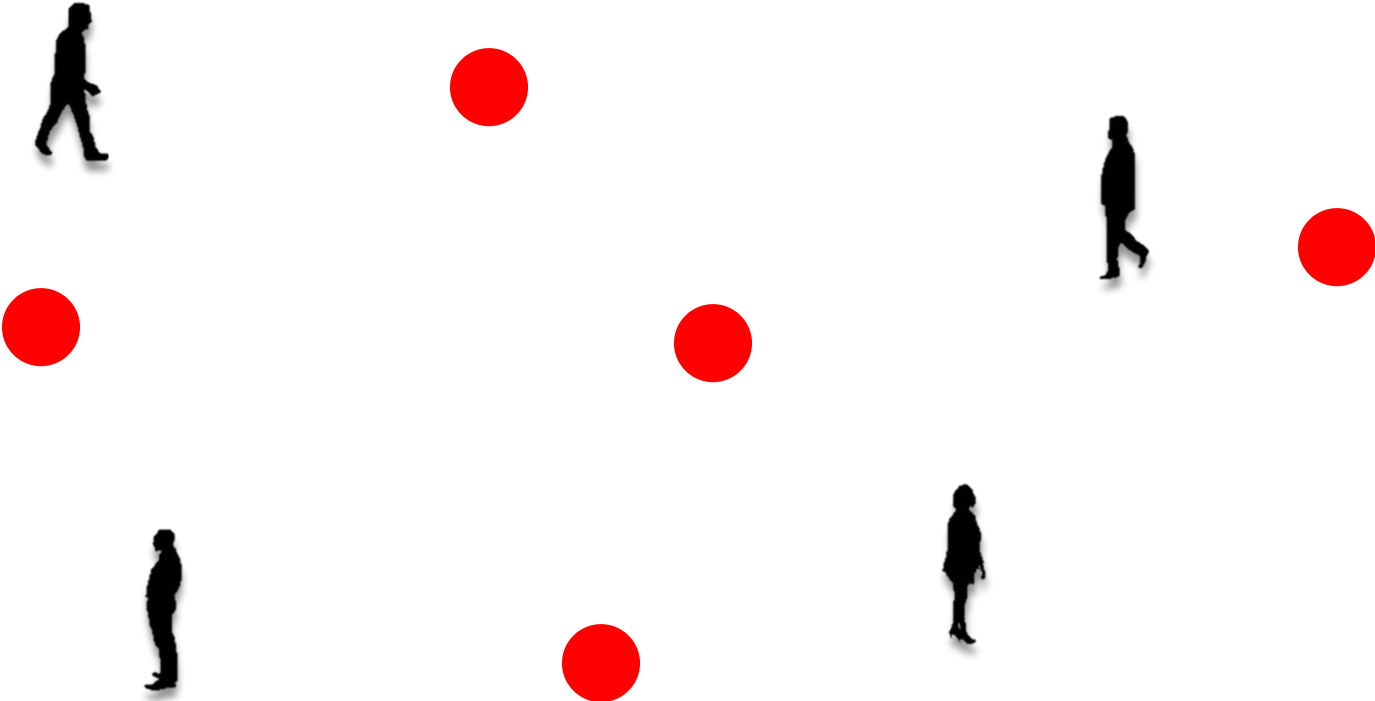


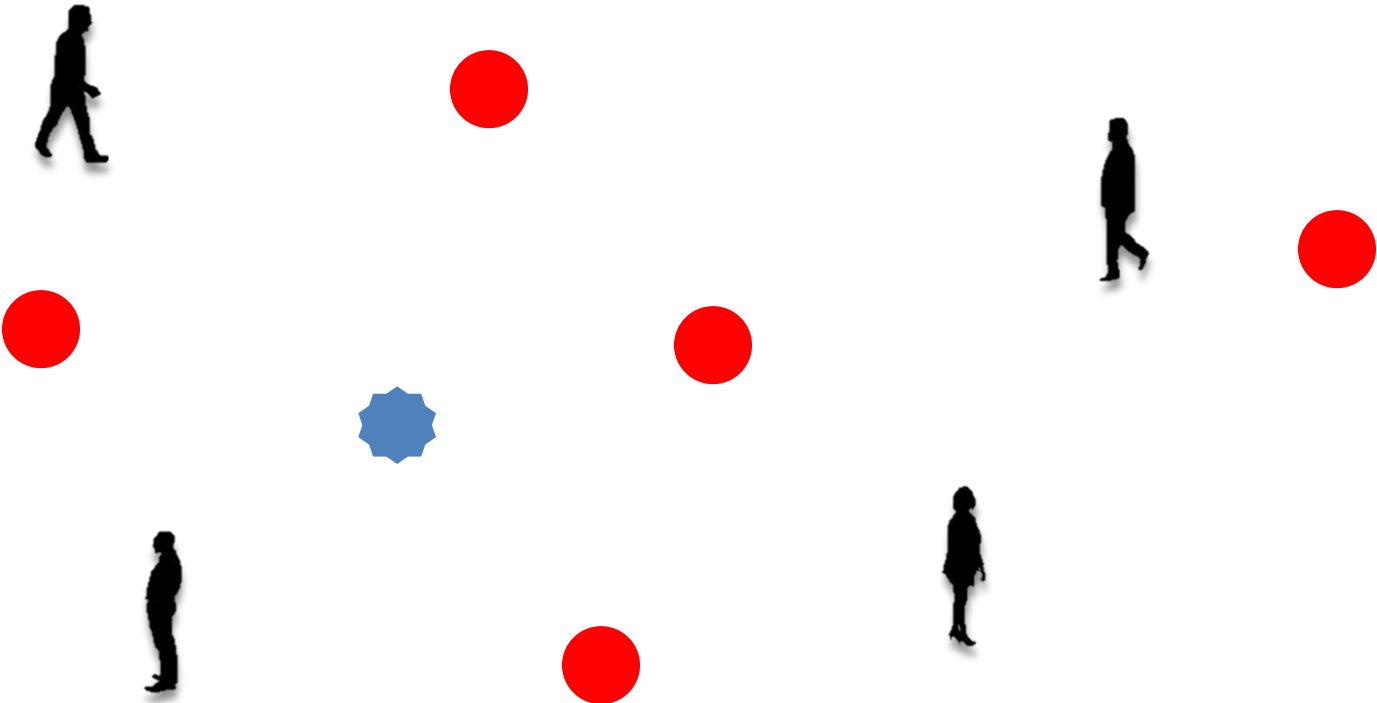


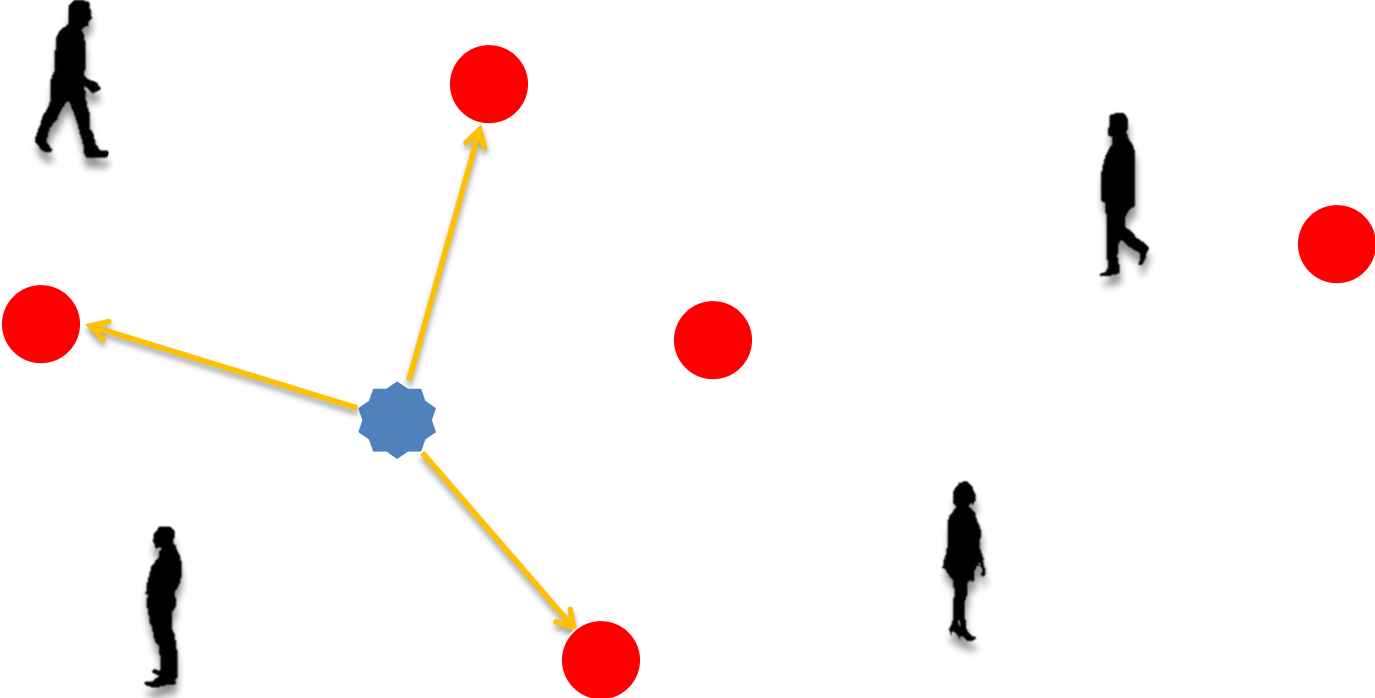
# Linked Systemic Actions

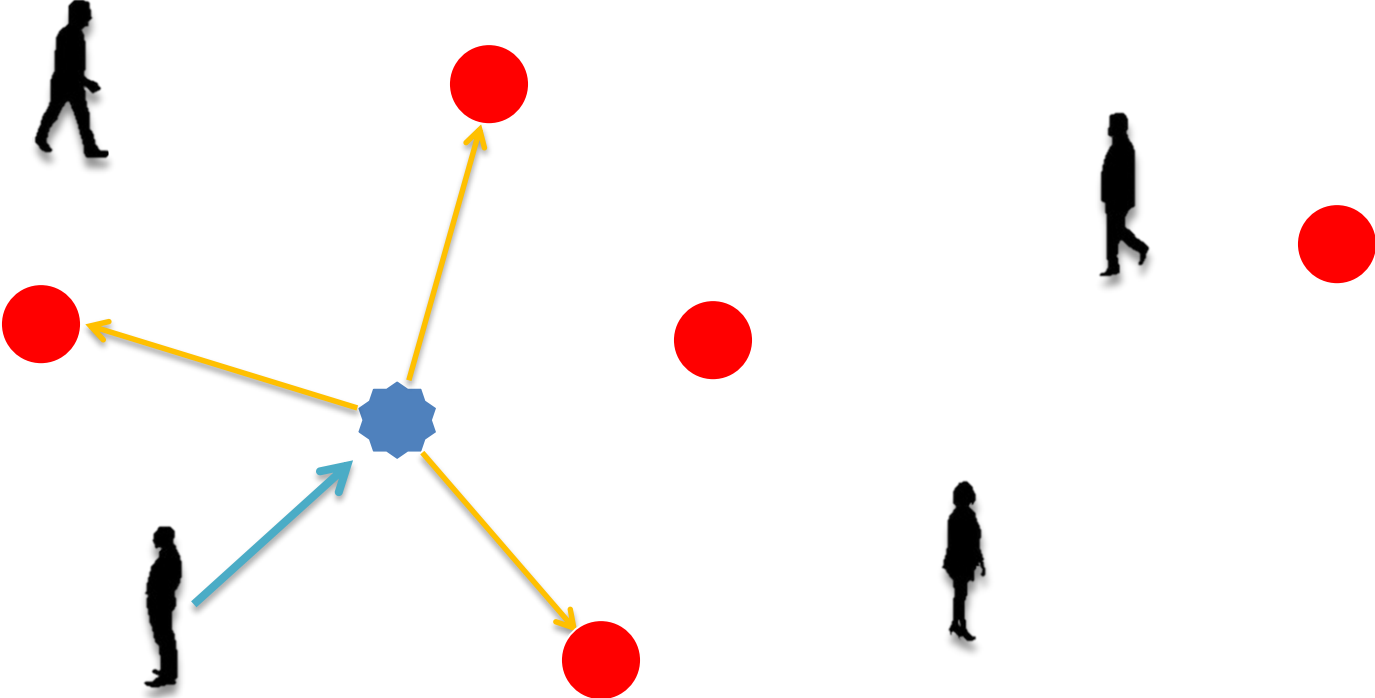
- An external action that can link up and reserve a group of systemic actions
- Useful for:
  - Injecting purpose
  - Role based behavior













# Linked Systemic Actions

- Compound Behavior
  - Sequence of actions pre-reserved with repeat
- Vagrant Behavior
  - Random list of actions based on usage criteria but pre-reserved



# Direct-Spawn Actions

- An external action where character(s) directly spawn and execute the action
- Useful for:
  - Actions you wouldn't do systemically
  - Staging and scene building
  - Complex interactions / Encounters
- Tied more closely with spawn system and has various spawn setups



# Direct-Spawn Actions

- Entity includes
  - External action
  - Spawn rule
  - Uses a spawn chance / event



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# Multi-Character Actions

- An external action where characters interact with each other
- Parent + Child(ren)
- Examples
  - Guard frisking a suspect
  - Two people sitting on stairs having a conversation



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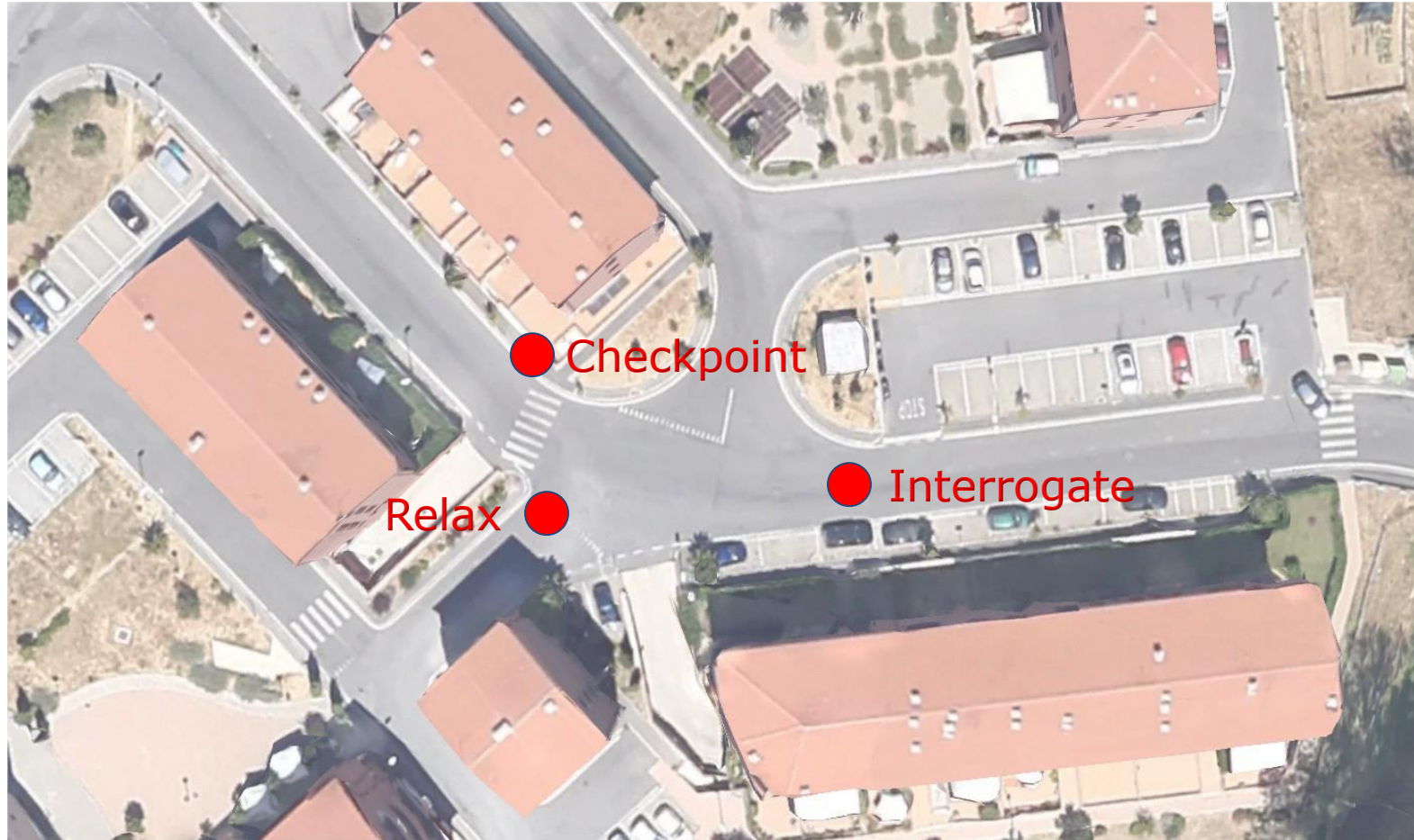


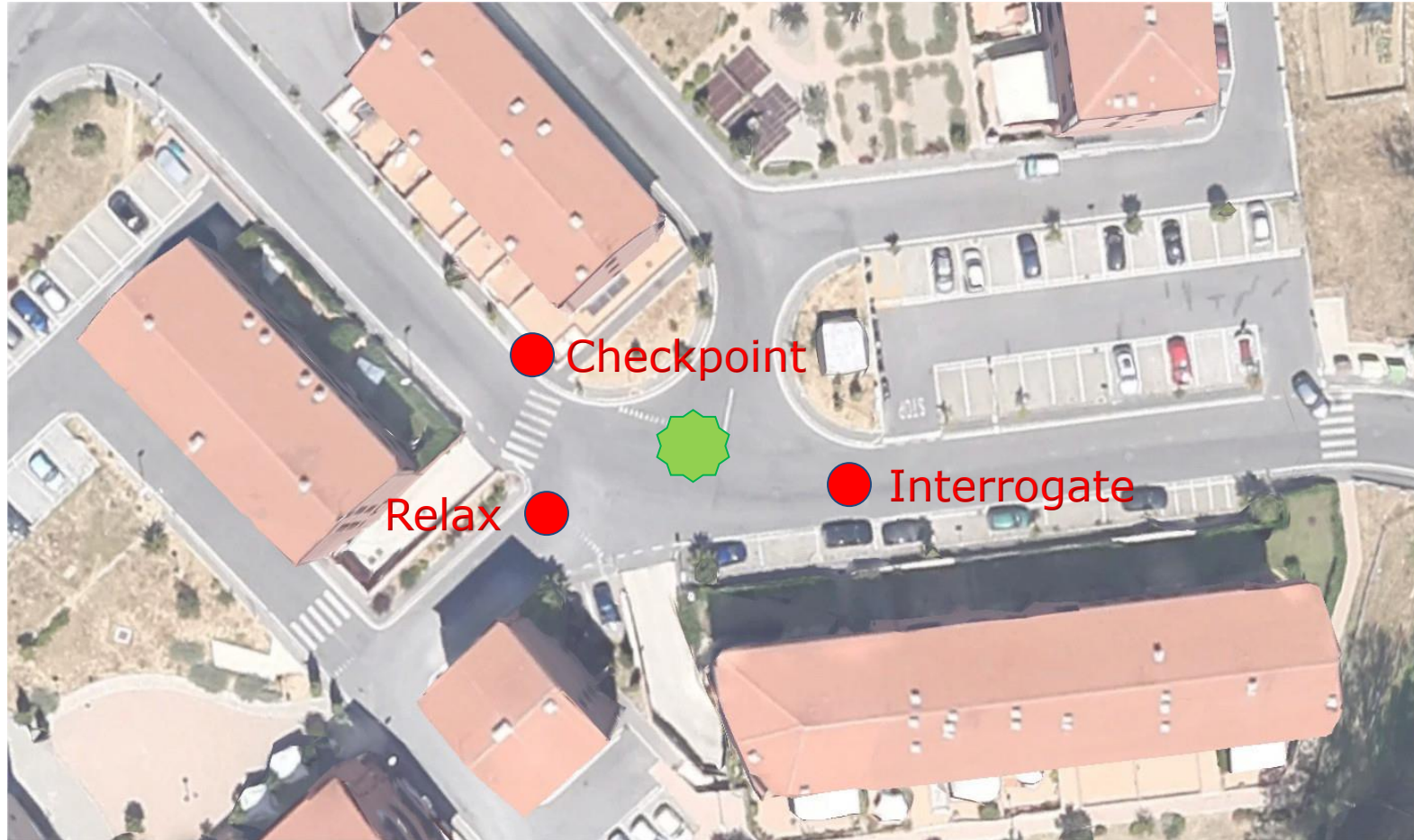
# Direct Spawn Groups

- Breaking up the repetition
- Supporting a narrative
- Cause and effect

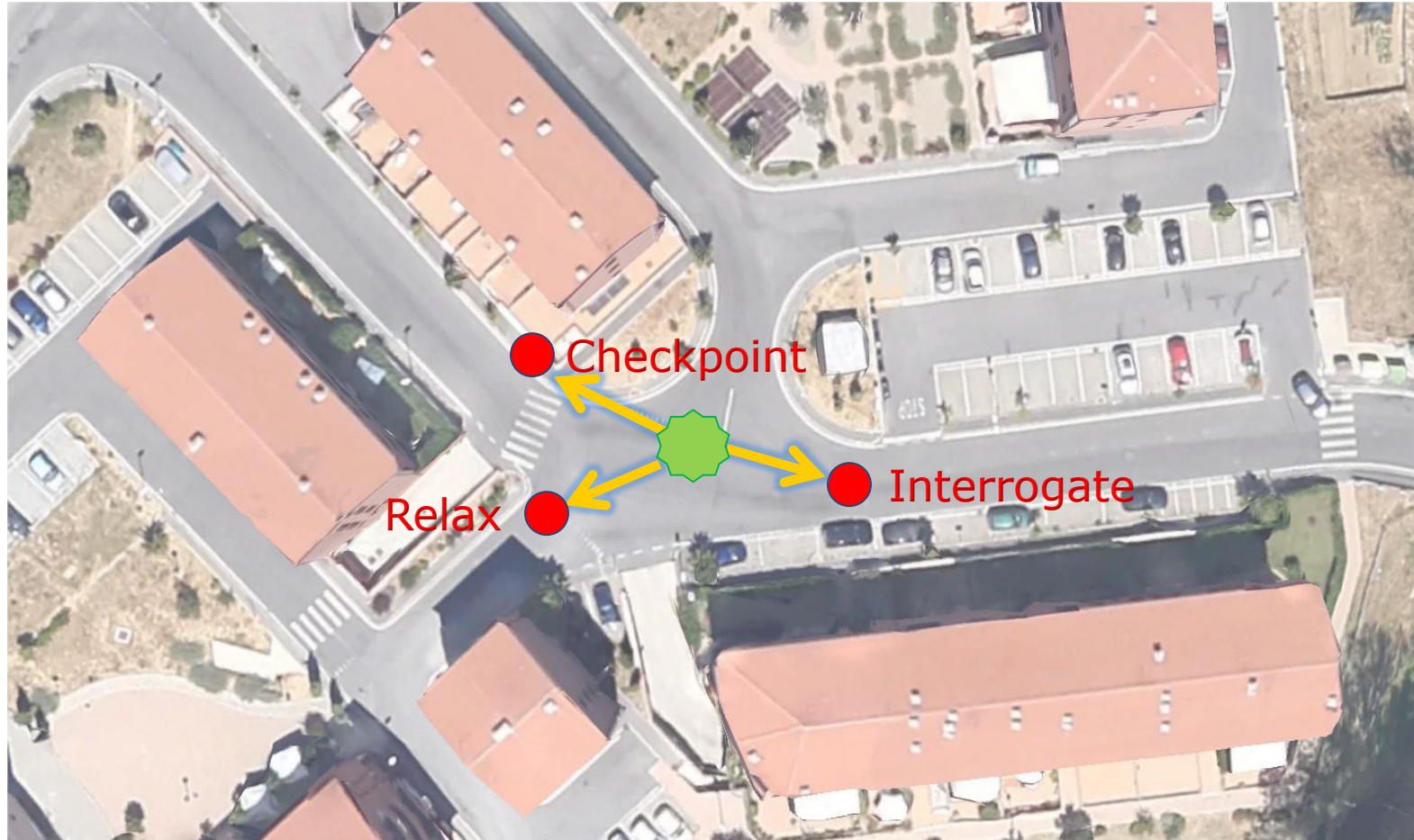


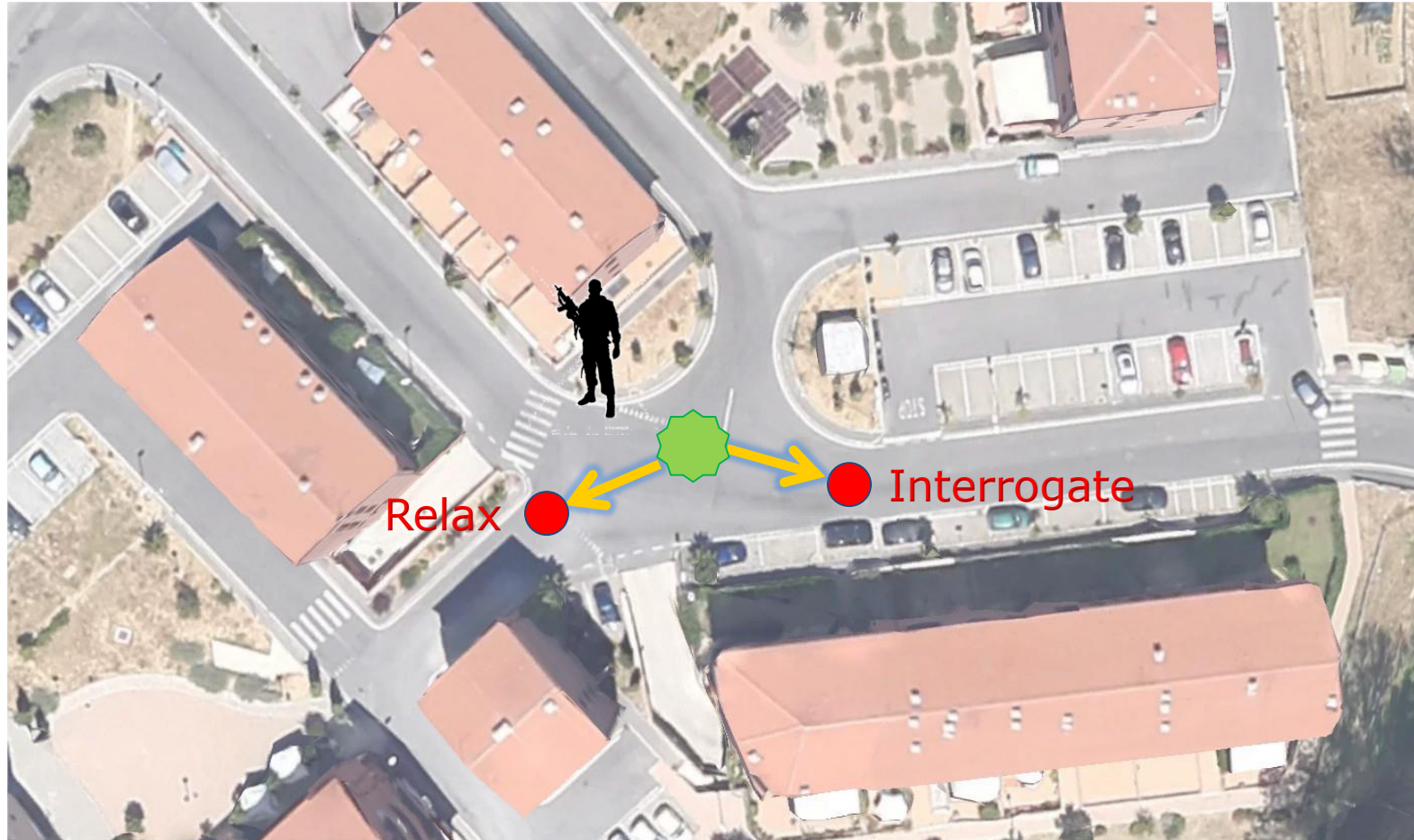




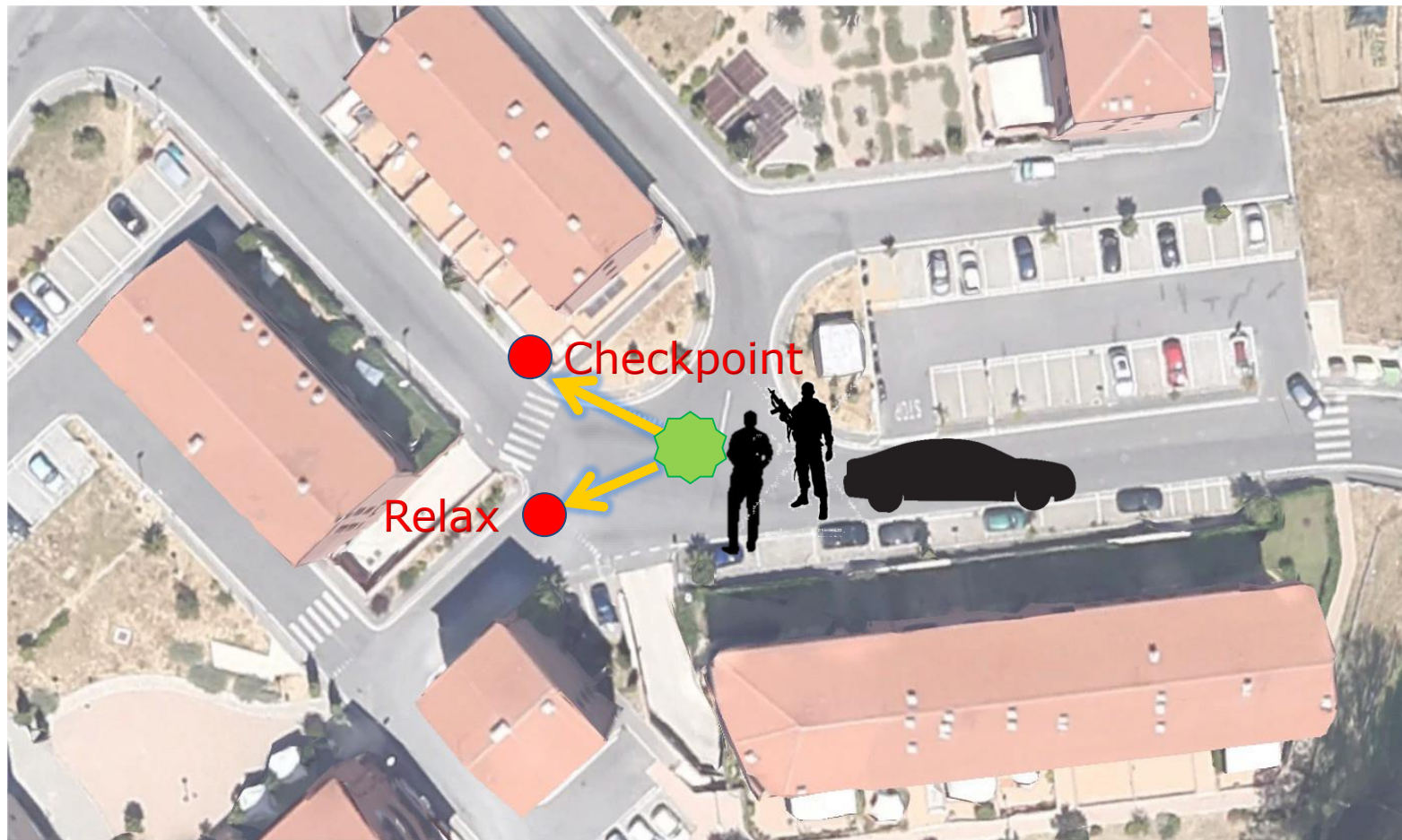


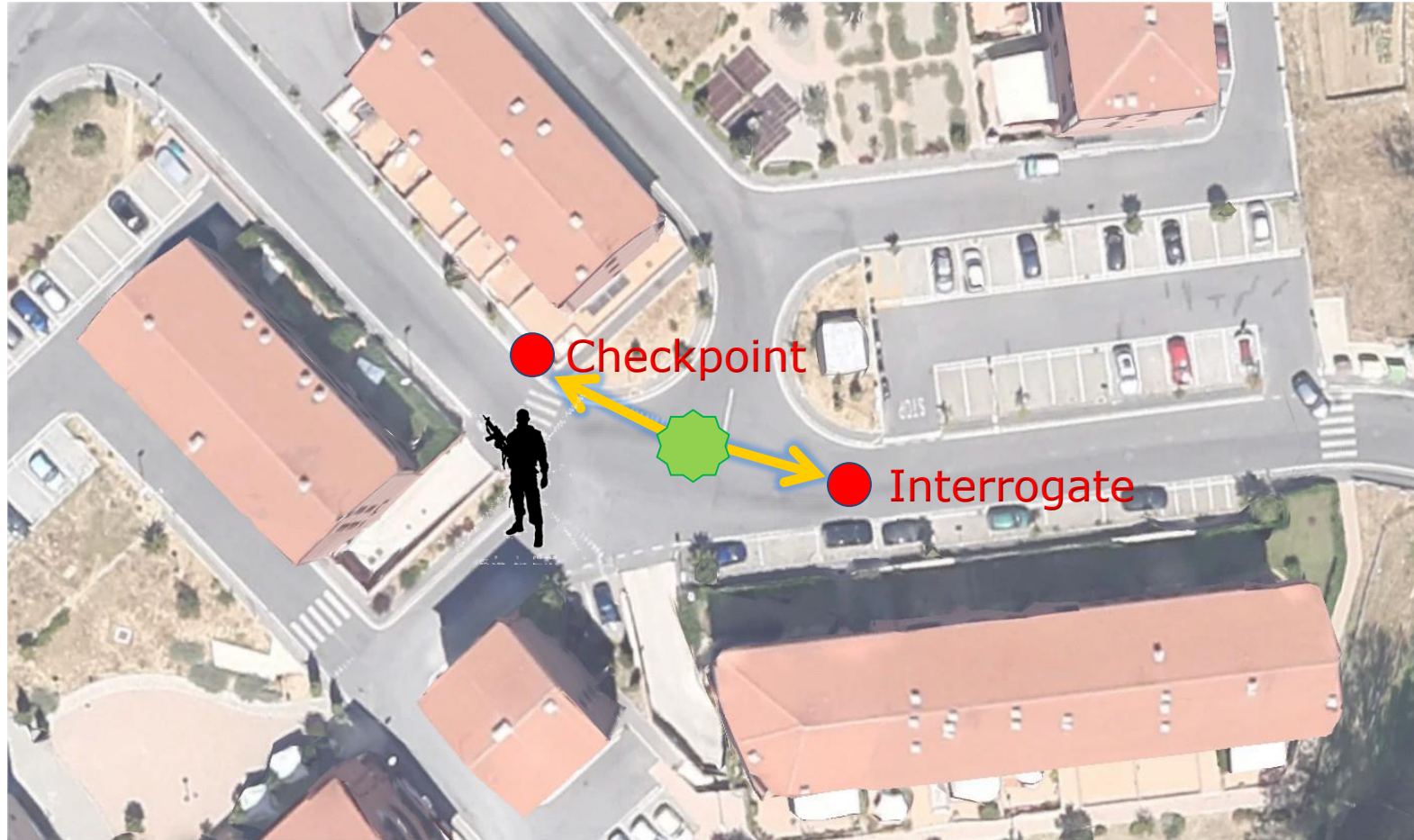














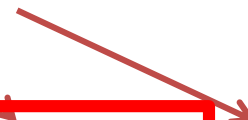
# Open World Encounters

- Sprinkle Spawning
  - Dynamic
- Road-side scenarios
- Gameplay encounters
- Useful for
  - Populating the open-world





Core  
Behavior



Ext  
Actions

Find Ext  
Actions

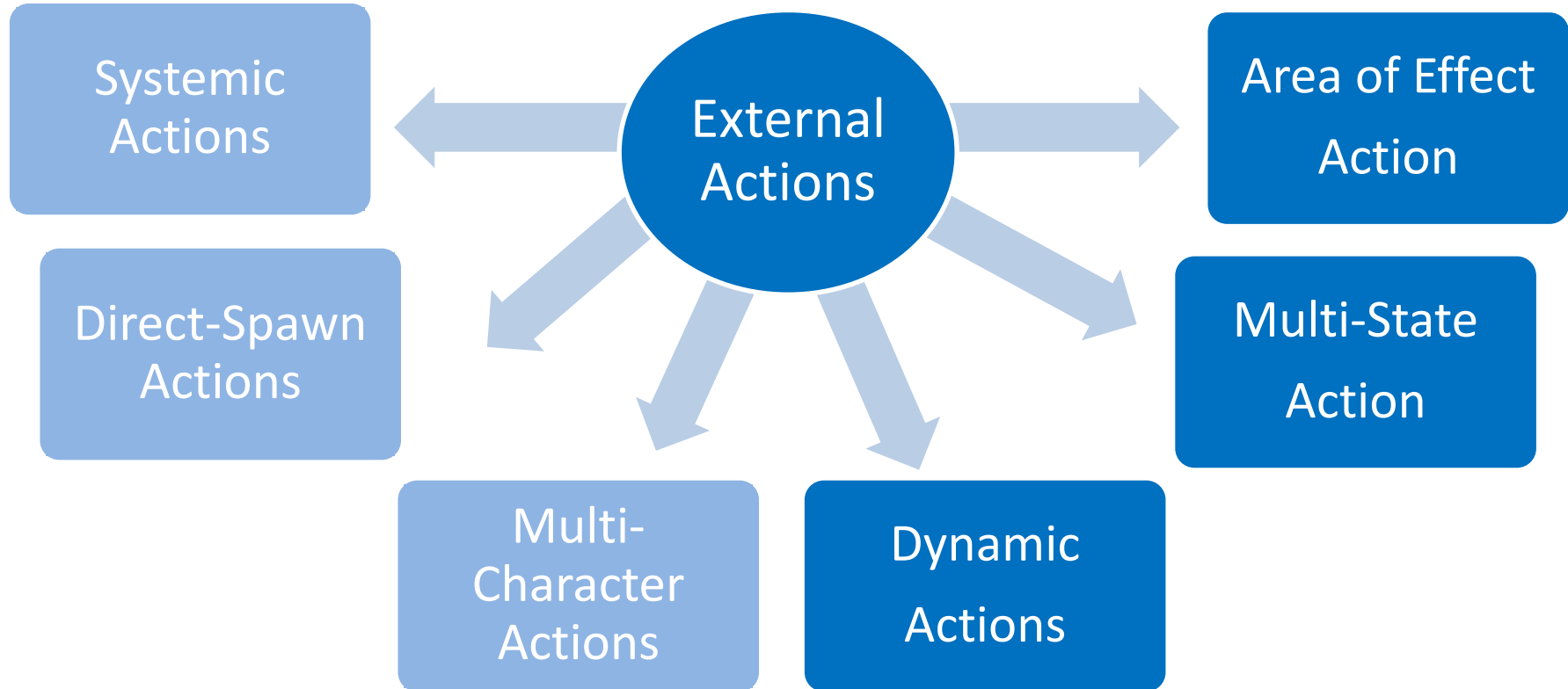
Move  
Around



RunExternalTree



# More Usage Examples





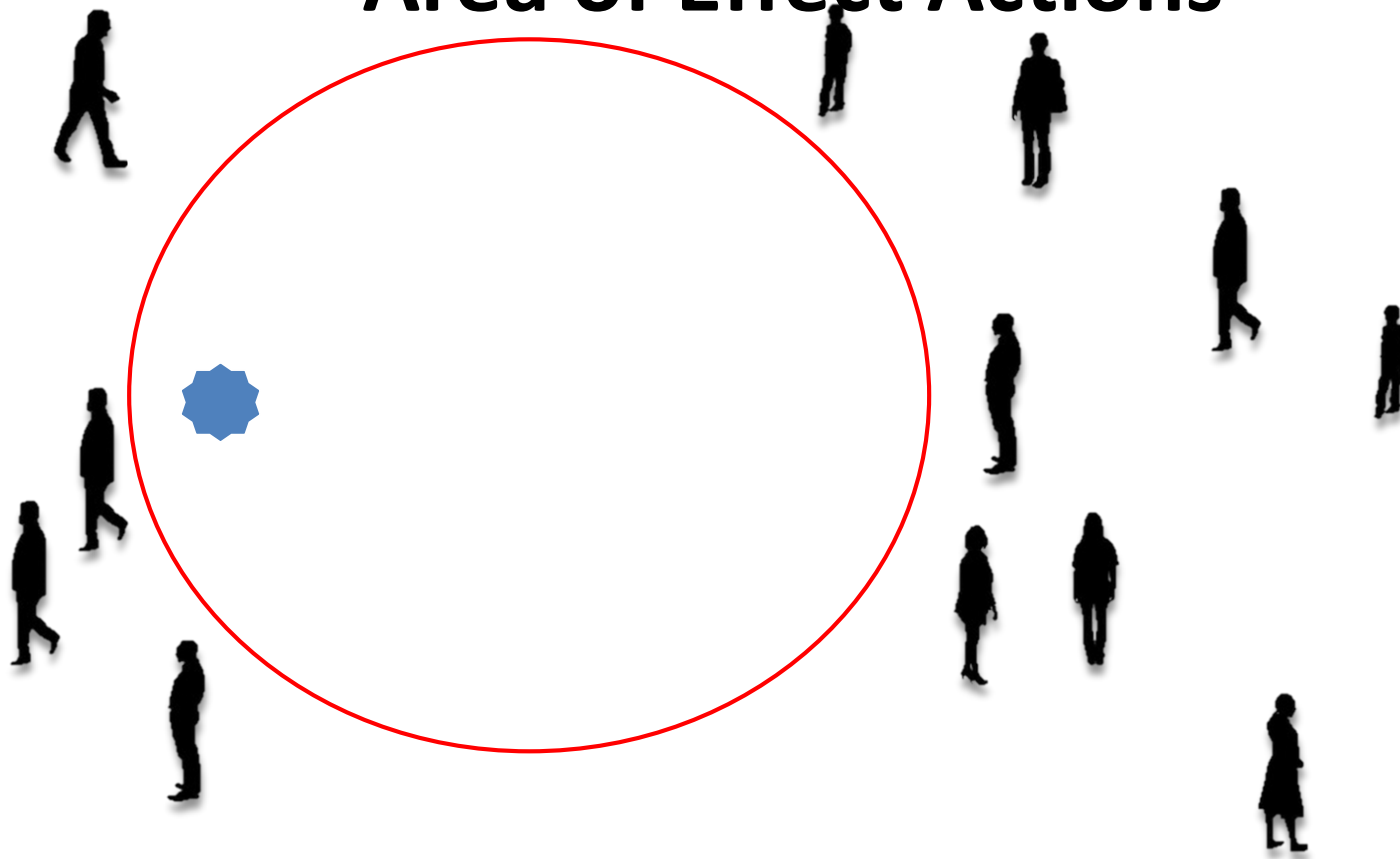
# Area of Effect Actions

- An external action which can affect all NPCs within its activation area
- Useful for:
  - Crowd attraction
  - Environmental flavor





# Area of Effect Actions







# Area of Effect Actions



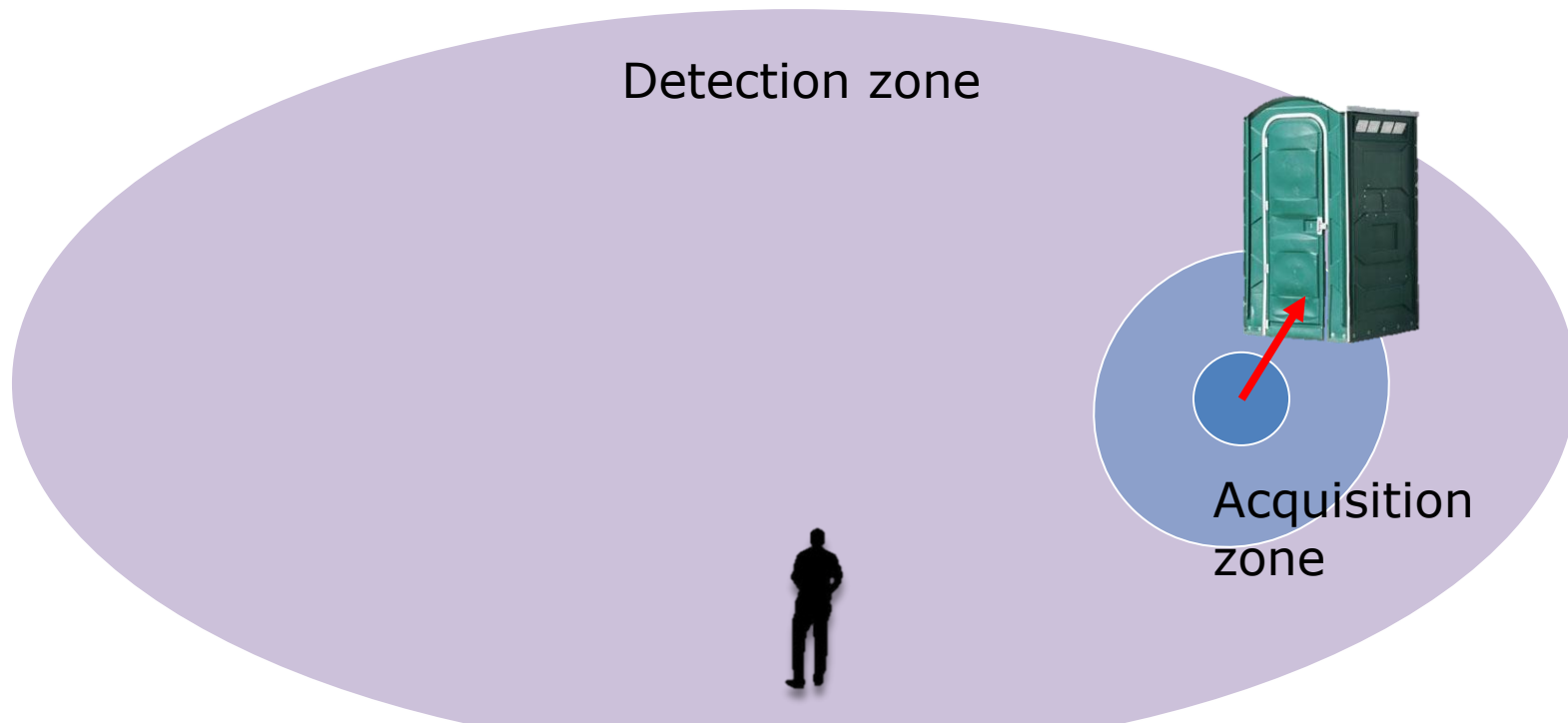


# Multi-State Actions

- An external action that contains logic which can switch it to a different states based on the context / environment
- Useful for:
  - Faking complex social/environmental behaviors
  - Can contain an entire multi-agent AI system

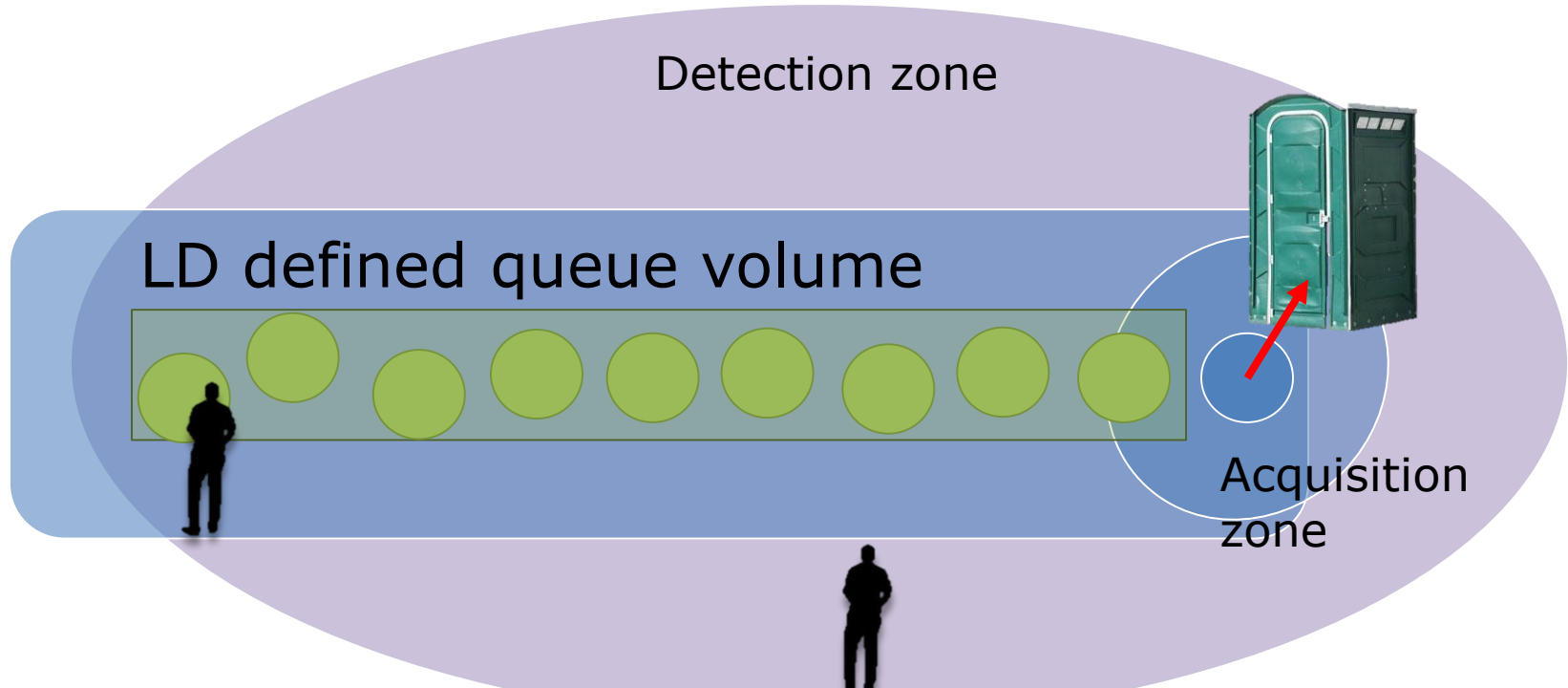


# Multi-State Actions



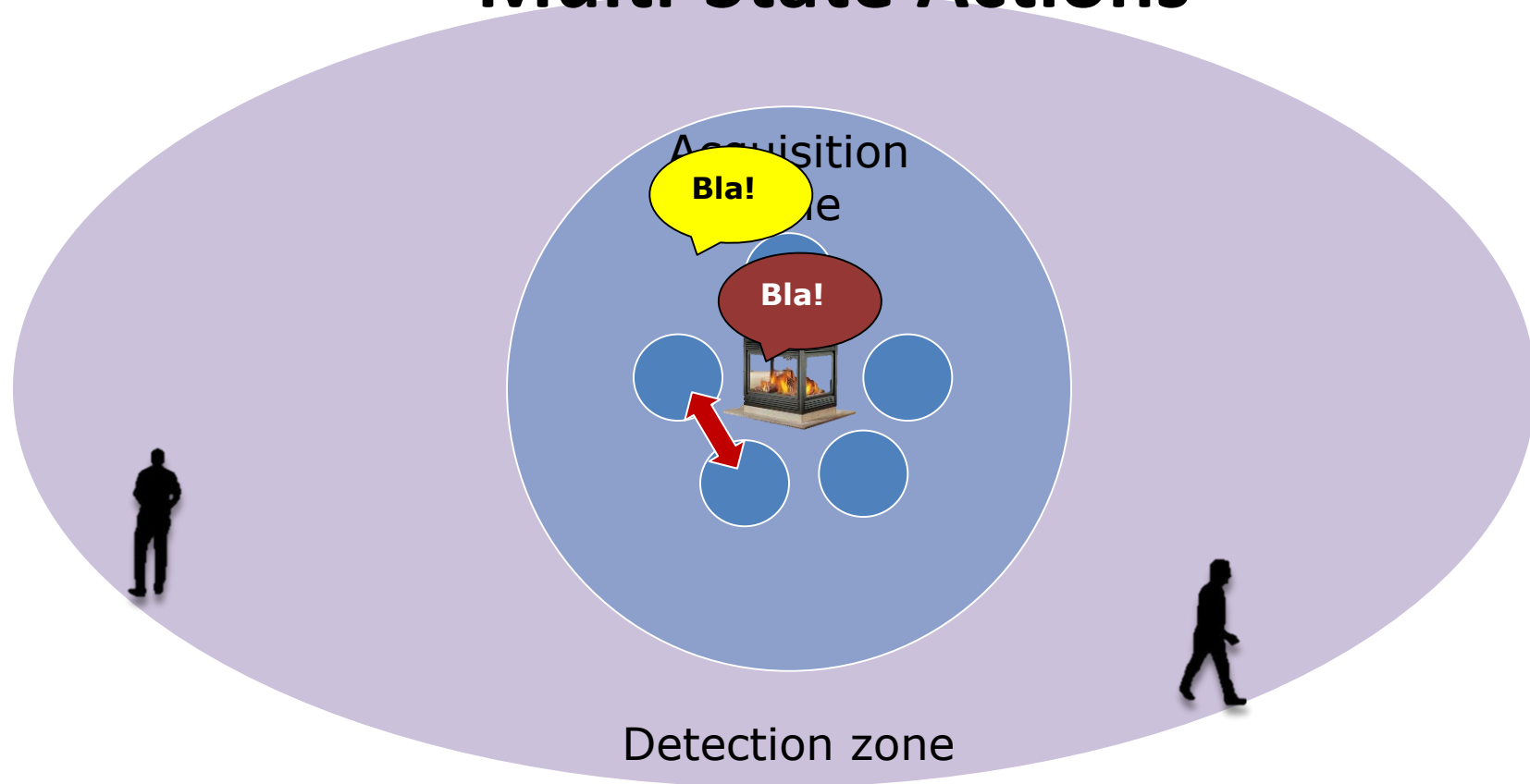


# Multi-State Actions



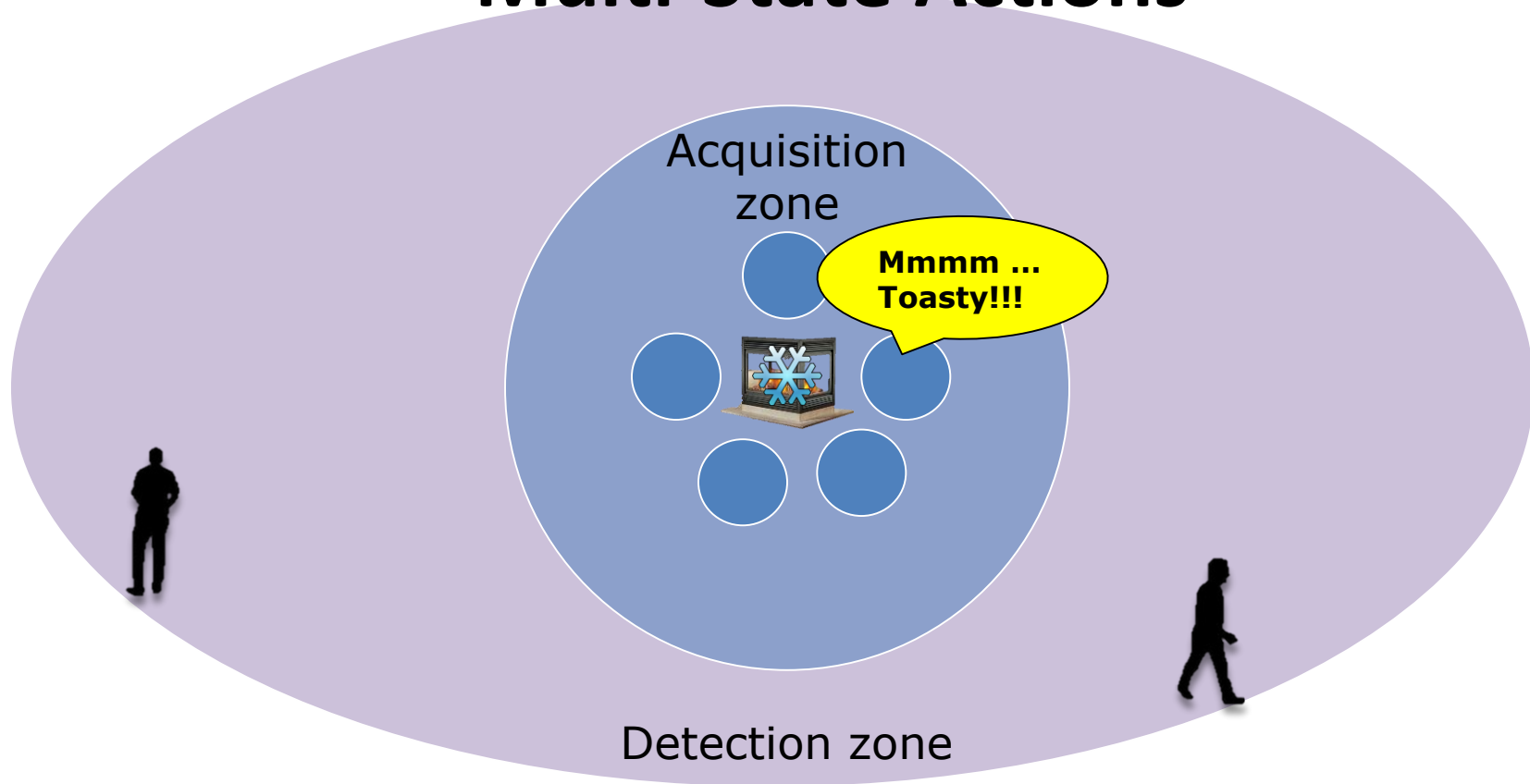


# Multi-State Actions



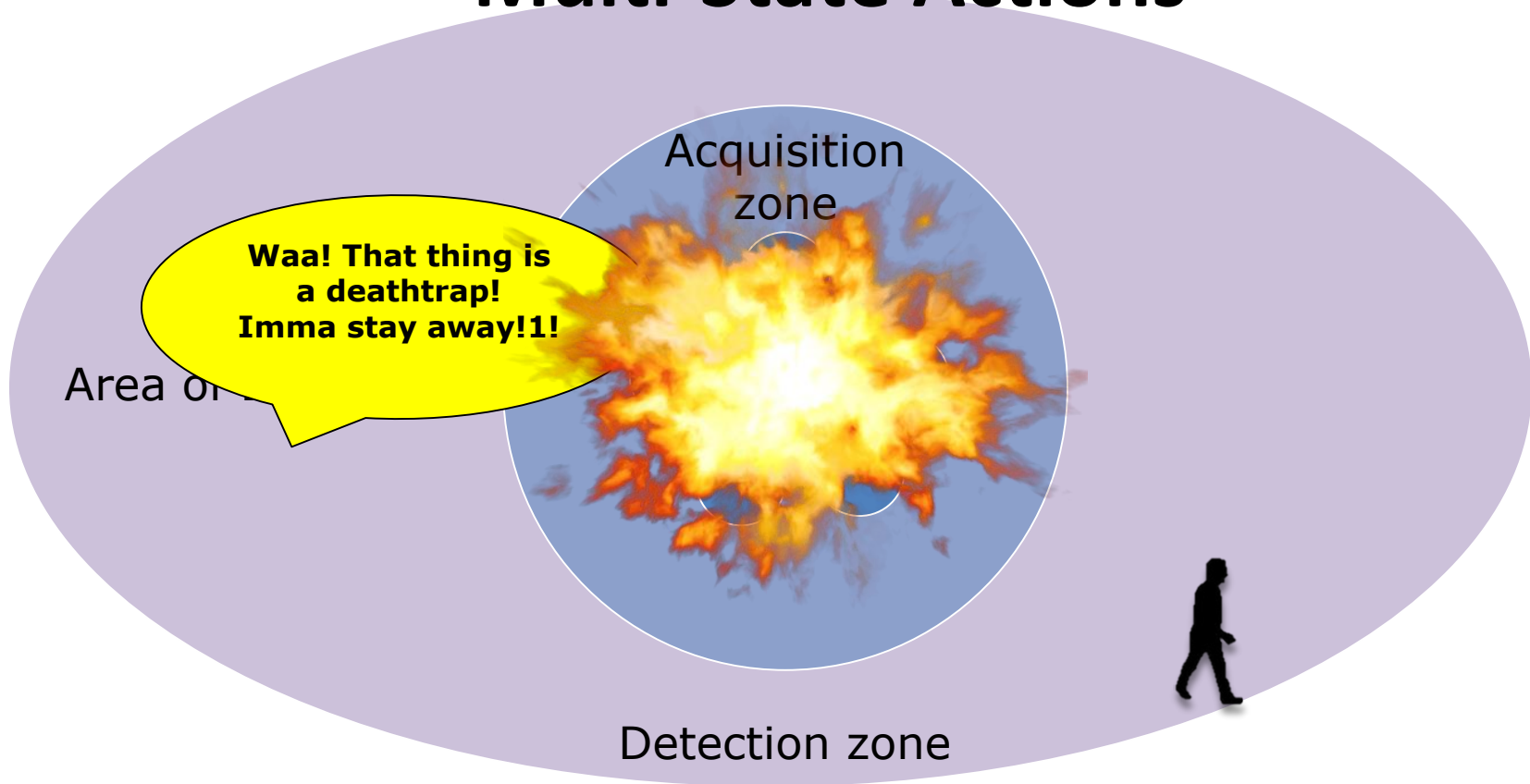


# Multi-State Actions





# Multi-State Actions





# Dynamic External Actions

- An external action that is spawned dynamically at runtime based on rules or events
- Examples:
  - A smoking action
  - A cell phone conversation
  - An alarm
  - A fire





# Dynamic External Actions

## Spawning Rules:

- Gameplay e.g. alarms/fires/etc...
- External action director

**Spawned external actions are “hints”**

**Decision to use is left up to the agent**



# Dynamic External Actions





# Dealing with Repetition

- Behavior tends to feel
  - Synchronized
  - Repetitive
- Very noticeable with smaller groups
- Solution: add lots of content
  - Time / Memory
  - Unnatural (only so many ways you can lean on a wall)



# Dealing with Repetition

- Animation Masking
- Secondary Actions / Behaviors
- Extend to all relaxed behaviors
  - Moving
  - Performing external actions (can decide if they want to)



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# Dealing with Repetition in the Crowd

- Specific movement is a lot less visible
  - Focus on visual variation more (skins/height/color)



Less of This



More of This



# Reacting to the World

*If the world ignores the player, the player  
ignores the world!*



# Basic Awareness

- Run in parallel with all relaxed behaviors (with some exceptions)
- Examples
  - NPCs passing by
  - Fast moving vehicles





# Look-At Realization

- Masked animation to stabilize the head or chest
  - Important for variance in poses for different external actions
- IK to follow and track object of interest
- Actions or behaviors can choose to enable/disable



# Event Based Awareness

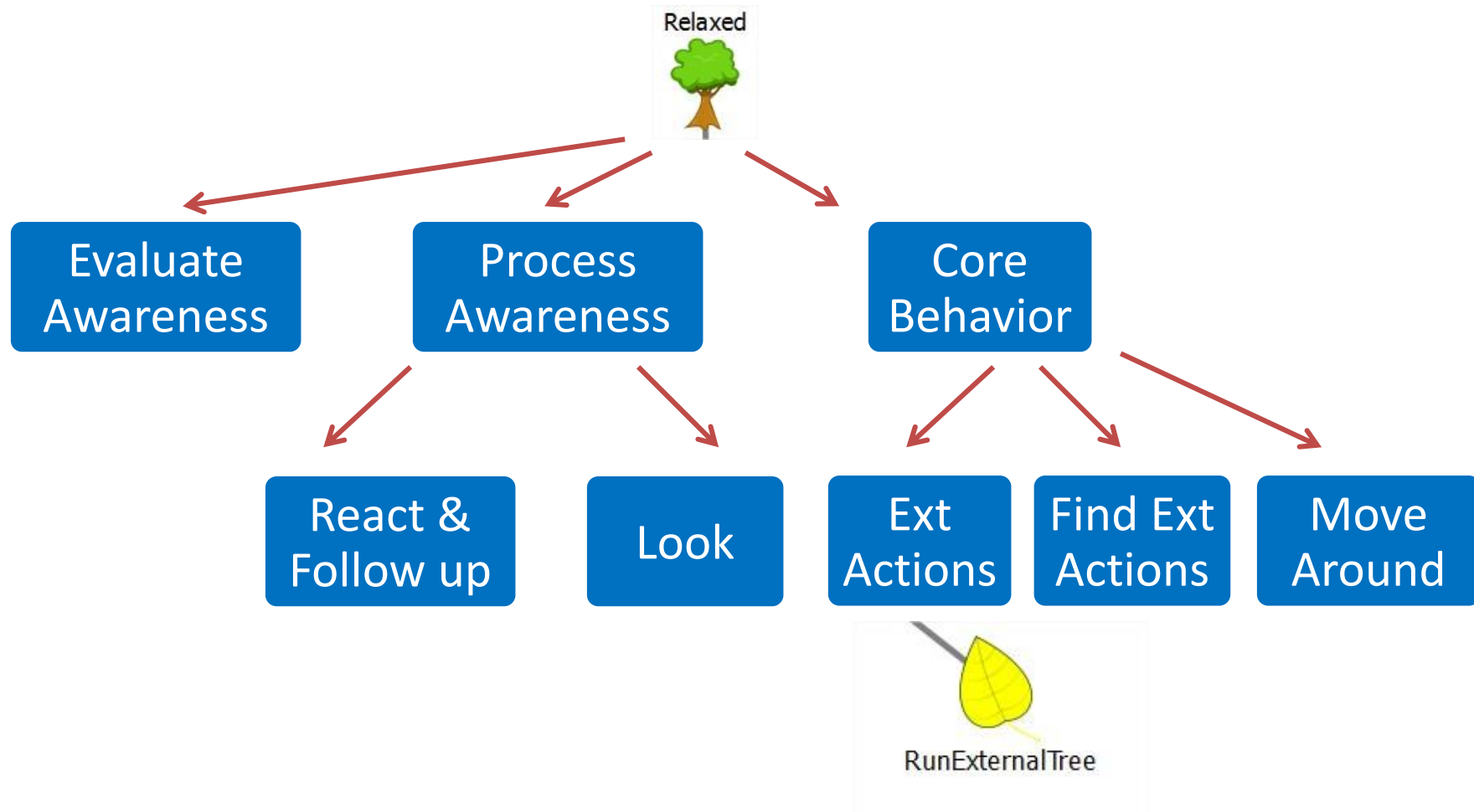
- State-defined events
  - Civilian gets shot
  - Player lands his parachute
- Visual events
  - Dead civilian lying around
- Propagation



# Action Persistence

- Interest vs. Danger
  - Danger = mental state transition
- Action Persistence
  - Pause current behavior
  - Do something meaningful in parallel
  - Resume behavior (if applicable)







# Interruption

- Behavior dependant
- Moving around
  - Interrupted by next behavior
- External Actions
  - Ignore
  - Fall back to look-at
  - Interrupt animation





# React and Follow Up

- Reaction system
  - Intensity based reactions
  - Variable but standardized
- Data-driven by designers
- Observe / Investigate behavior

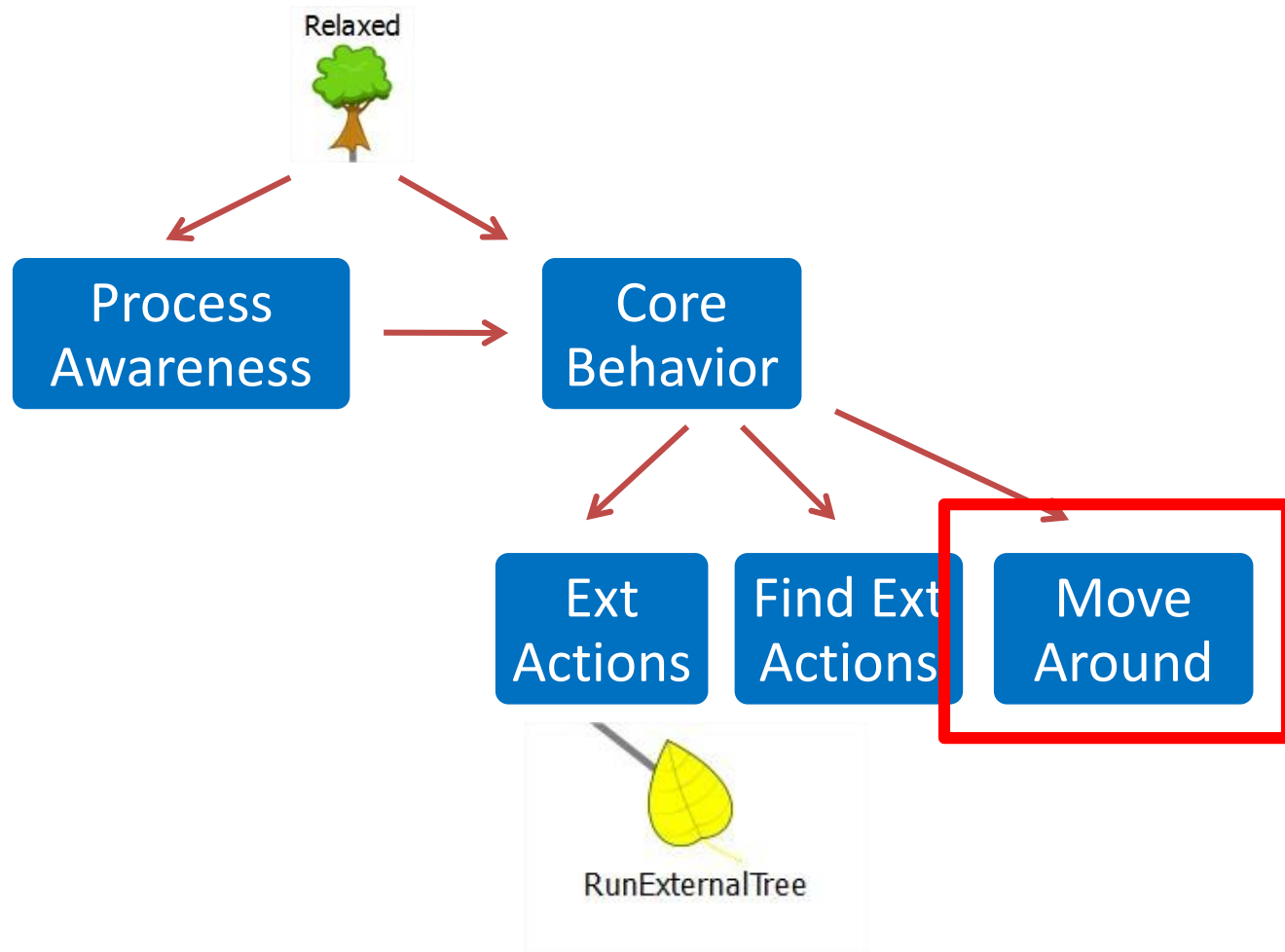


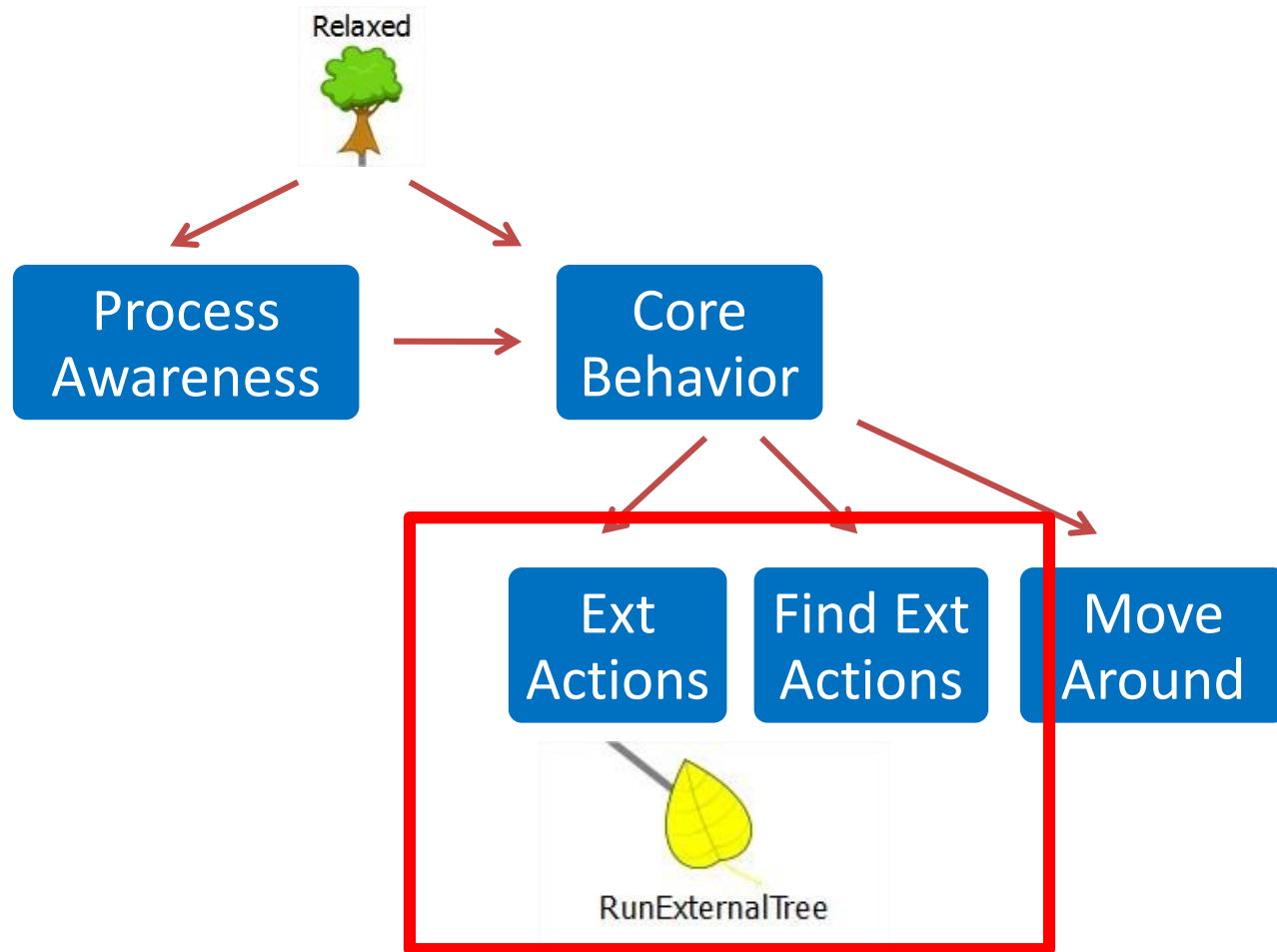


# Resuming Behavior

- Behavior itself decides how to resume or restart
- Validate and Go!









# Conclusions

I think that wraps it up and in closing:



**External Actions  
are  
Awesome!**





# Questions?



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