

DECISION MAKING AND KNOWLEDGE REPRESENTATION IN HALO 3

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INTRODUCTION

- **Halo 3:** First person shooter for Xbox 360, involving combat, driving vehicles and dozens of weapons.
- **AI:** Provide entertaining and challenging opponents for 10+ hours of gameplay...
...and provide allied support characters, too.

DECISION MAKING

BEHAVIOUR TREES

KNOWLEDGE REPRESENTATION

PERCEPTION MODEL

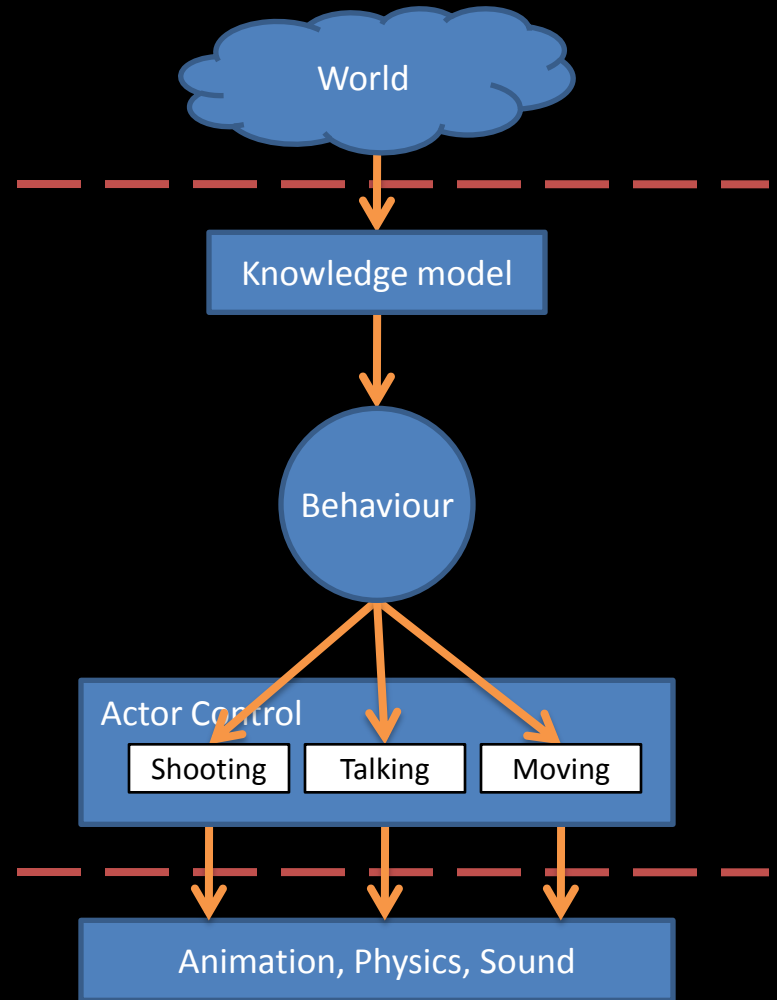
REVIEW

ACTOR CONTROL

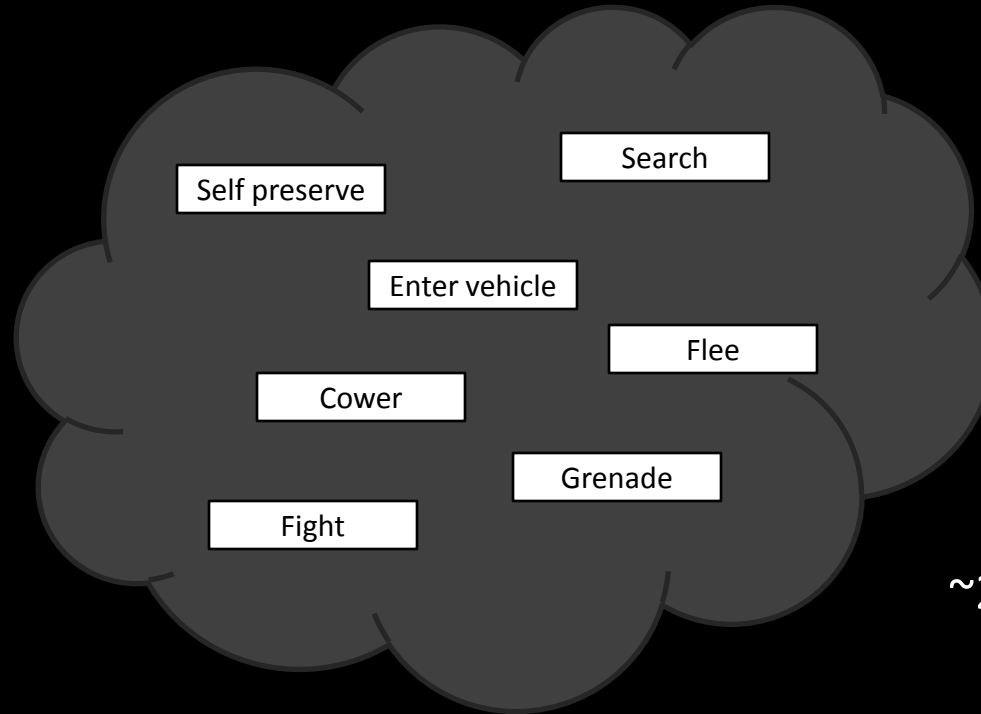
- **Problem:** Actors need to operate in the game environment.
- **Behaviours:** Halo 3 uses reactive behaviours to control the actors.

BEHAVIOURS

- React to knowledge model
 - Targets
 - Projectiles
- Perform actions over time
 - Shoot
 - Move to a point
 - Trigger “actions”
 - Play dialogue



DECISION MAKING



~220 behaviours

- **Problem:** With all these behaviours to choose from, how do we decide what to do?

DECISION MAKING

BEHAVIOUR TREES

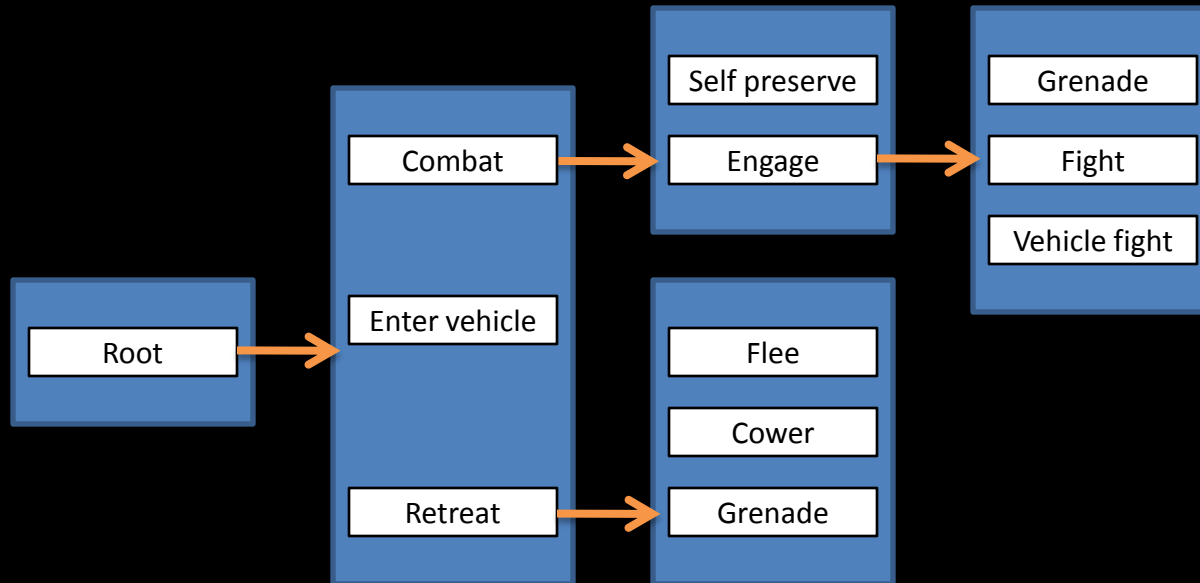
KNOWLEDGE REPRESENTATION

PERCEPTION MODEL

REVIEW

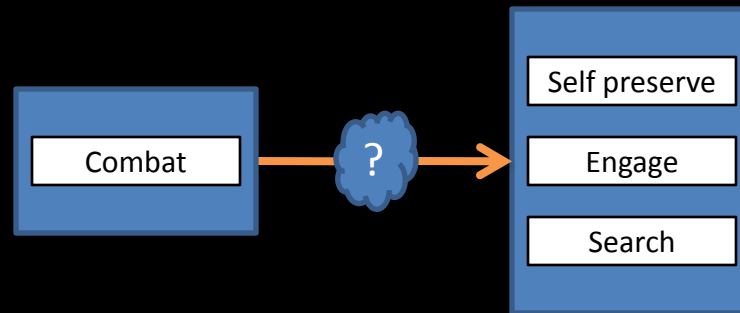
GROWING TREES

- Arrange behaviours hierarchically (Directed Acyclic Graph).



NAVIGATING TREES

- **Problem:** Which child do we choose?



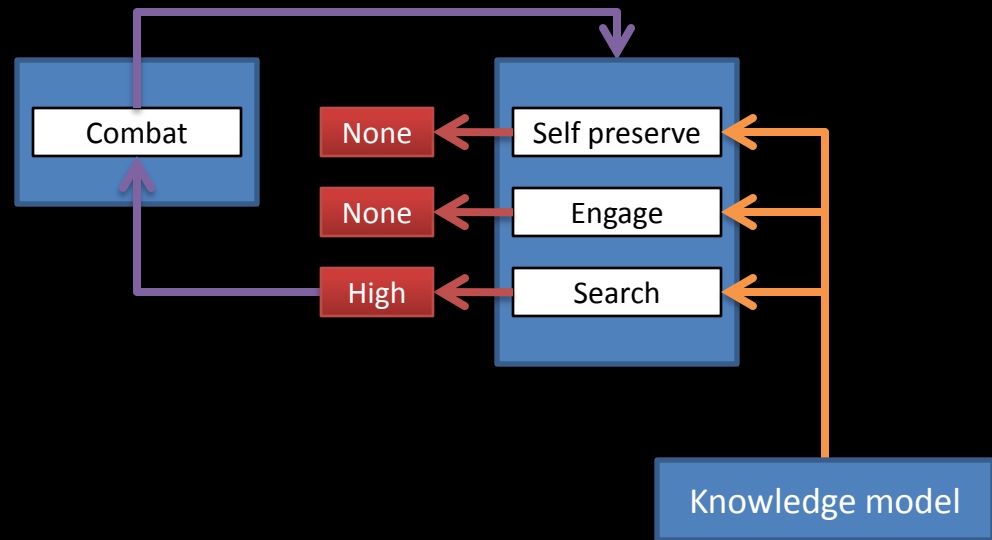
- **Desire:** Query children for their *desire* to execute.

DESIRE

- Behaviour performs some operation on the knowledge model and returns a desire to execute.

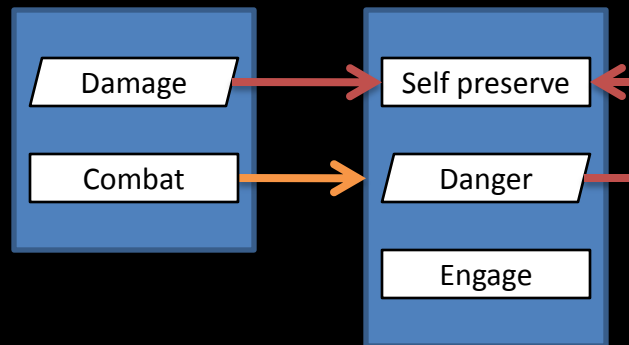
- Strategies

- Prioritised
- Sequential
- Looping



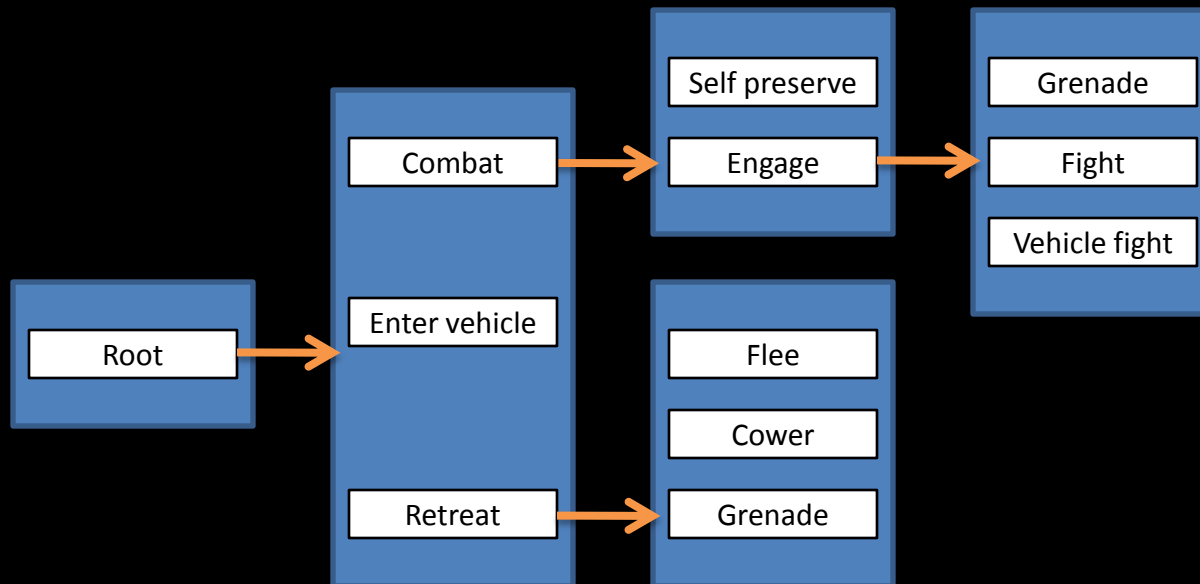
IMPULSES

- **Problem:** What if the desire is not constant?
- **Impulses:** Place different trigger conditions to the same behaviour in the right place.



METADATA

- **Problem:** Desire calculations often duplicated.
- **Conditions:** Describe execution conditions.
 - Vehicle occupancy, alert status, etc.



SUMMARY

- Easy to understand
- Scales effortlessly
- Quick iteration

- Very hard to debug
- Unprecedented results

DECISION MAKING

BEHAVIOUR TREES

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REVIEW

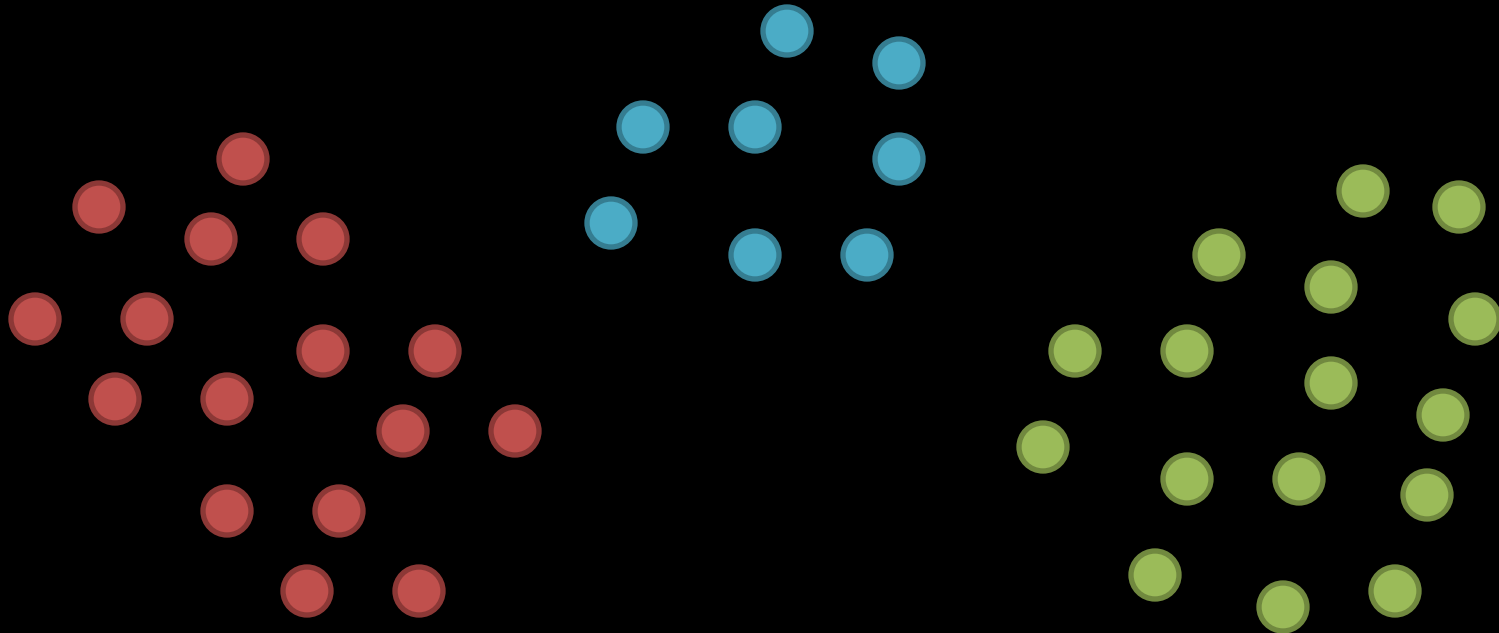
GAME ENVIRONMENT

- **Problem:** Actors need to respond to objects in the game world.
- **Features:** Select what we are interested in, and store relevant information about it.

GAME ENVIRONMENT



A QUESTION OF SCALE

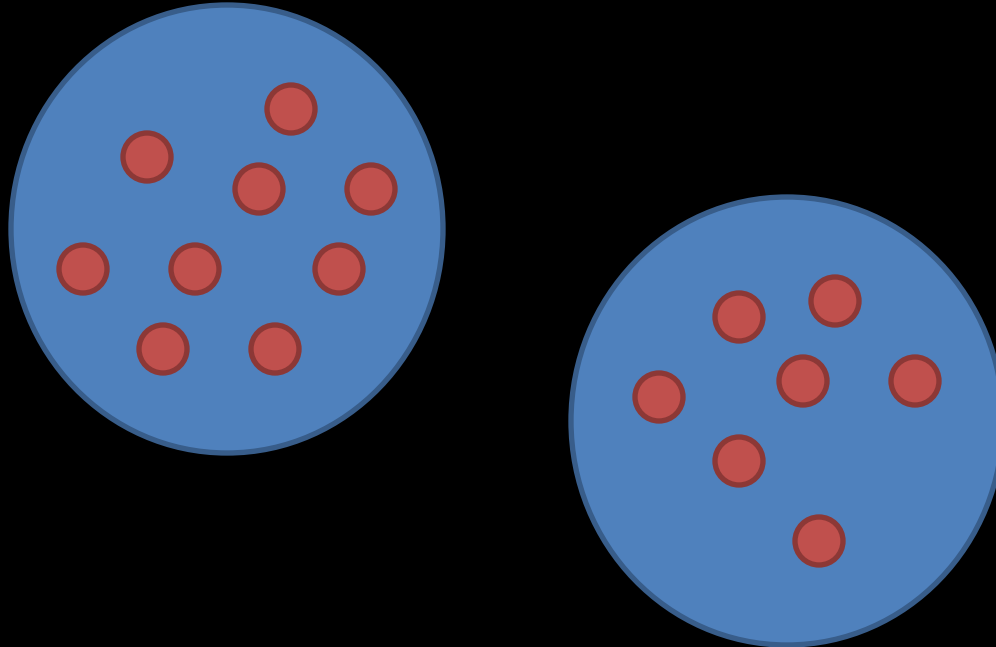


- **Halo 3:** Dozens of actors and objects in a scene
- **Problem:** n^2 starts getting really big!

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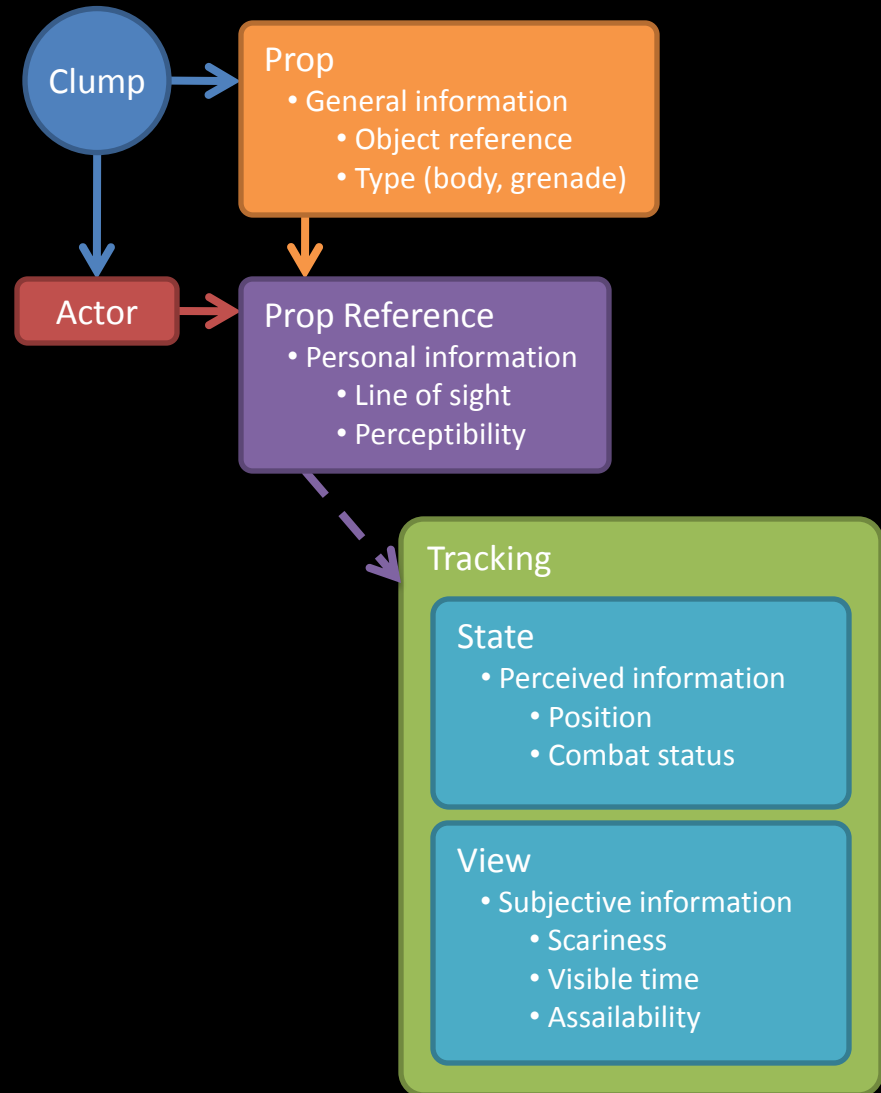
SHARE INFORMATION

- Group proximate allied actors into *clumps*.

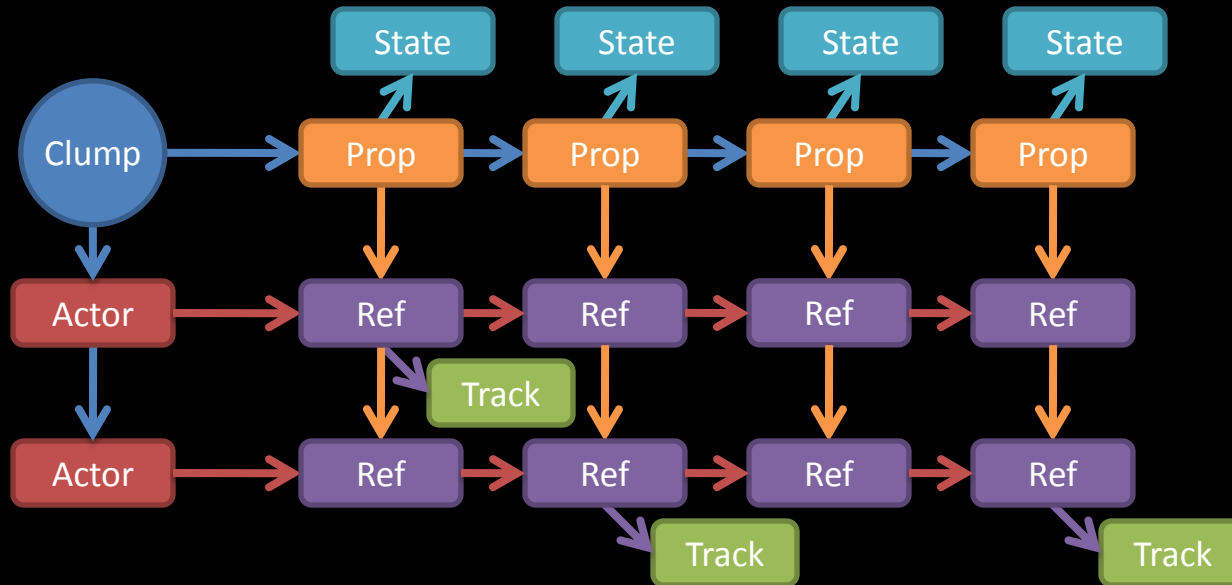


DATA STRUCTURES

- Clump tracks objects using *props*.
- Actor in clump has *reference* to prop.
- Can add (large) *tracking* data.



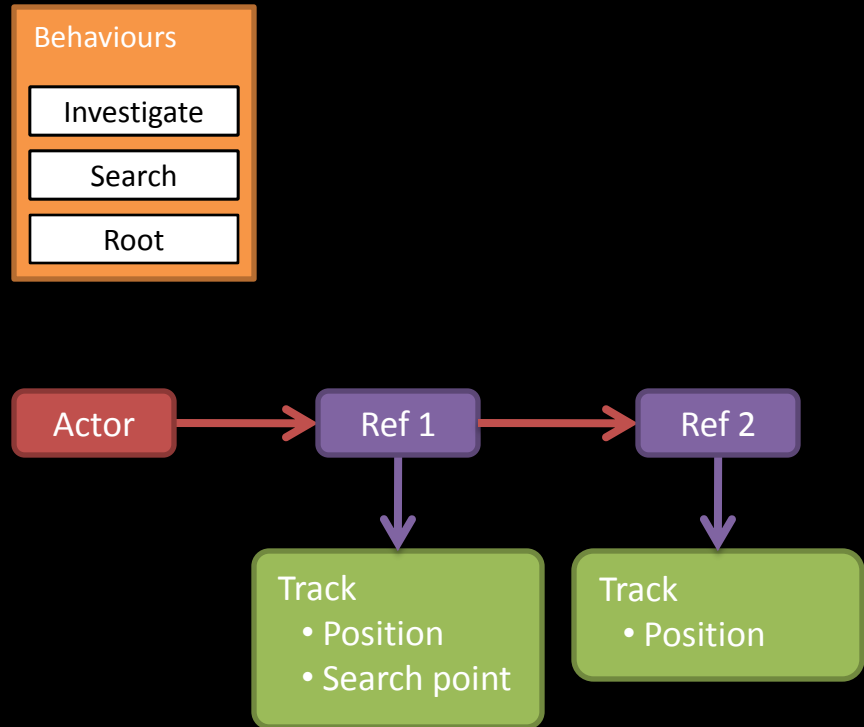
PERCEPTION MODEL



- 2D linked list, allowing quick traversal.
- Sparse allocation of tracking data based on importance of prop.

AN EXAMPLE

- Acquire target 1
- Lose sight of target 1
- Search target 1
 - Last known location inspected
 - New search point selected
- Acquire target 2
 - Search deactivated, short-term state discarded
- Target 2 killed
- Search target 1
 - Where do we search?
 - Existing search point used



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REVIEW

- Decision making using DAG, “behaviour tree”.
 - Behaviours specify operating desire
 - Impulses can trigger behaviours all over the tree
- Knowledge stored in props.
 - Shared between proximate allies
 - Individuals optionally store extended information

QUESTIONS?

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