COMP270: Mathematics for 3D Worlds & Simulations

2: Authored Behaviours I

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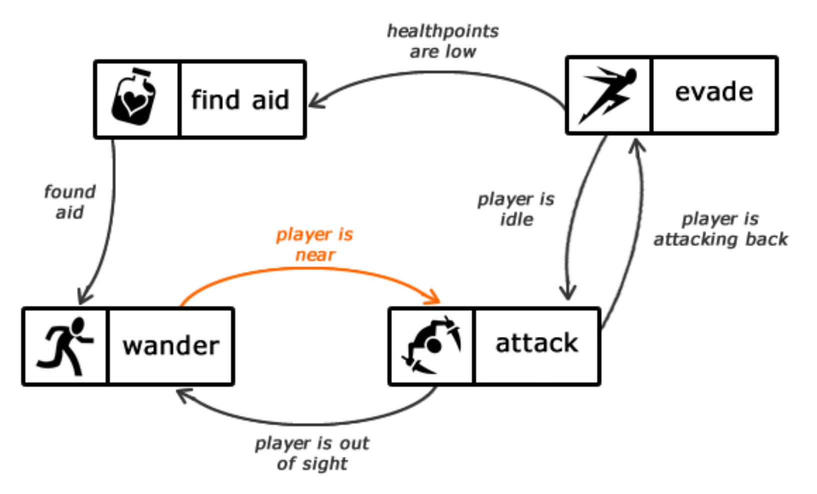
AI architectures

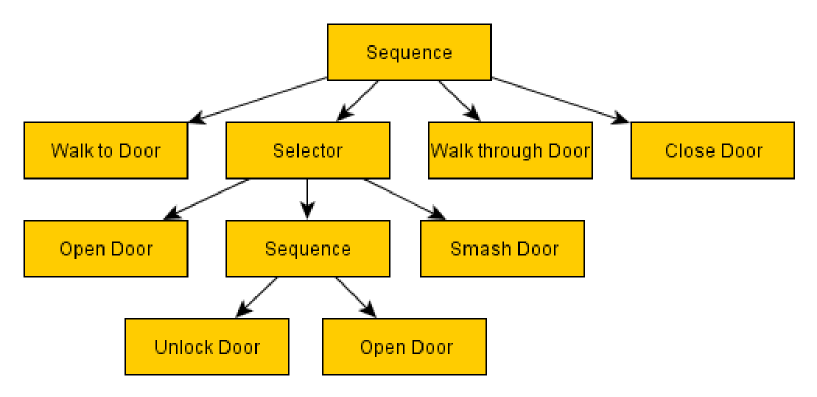
Rule-based AI

Generally implemented as `if` statements or event-based triggers

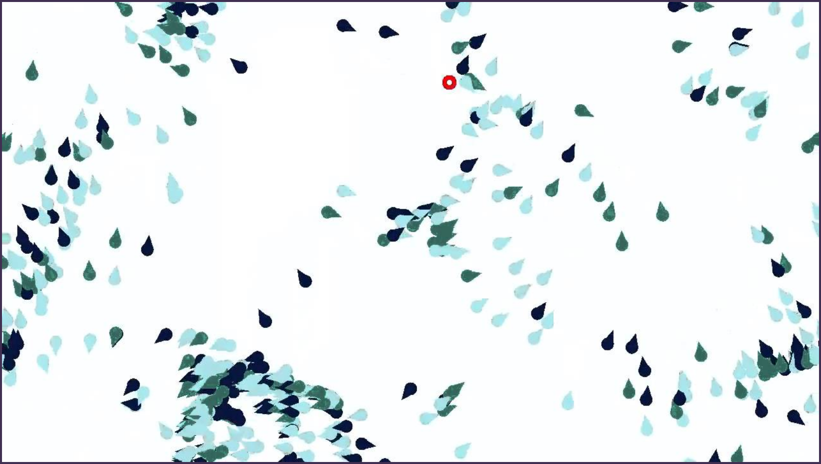
Finite state machines



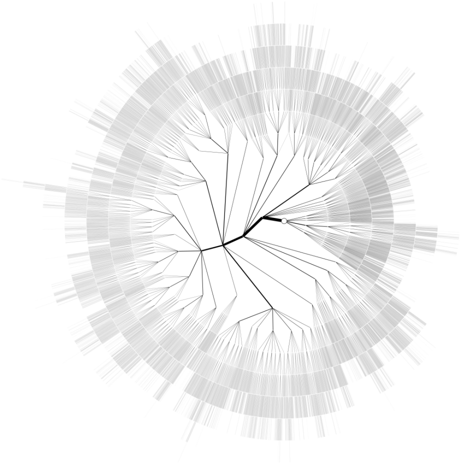
Behaviour trees



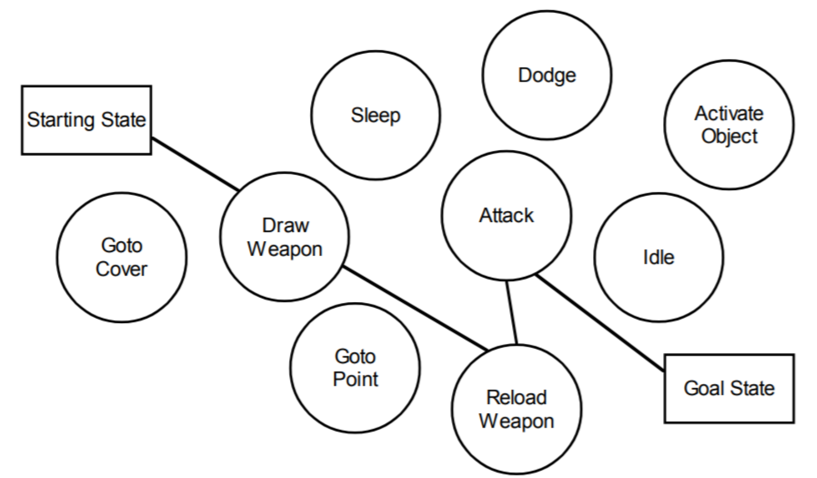
Multi-agent approaches (e.g. flocking)



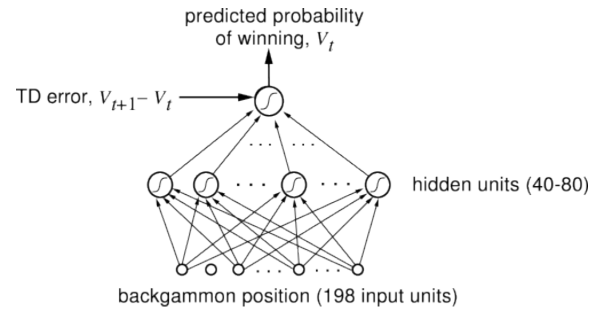
Game tree search



Planning


Starting State
Sleep
Dodge
Activate Object
Goto Cover
Draw Weapon
Attack
Idle
Goto Point
Reload Weapon
Goal State

Machine learning


predicted probability of winning, V_t
TD error, $V_{t+1} - V_t$
hidden units (40-80)
backgammon position (198 input units)

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- Do you want to **design** the AI behaviours yourself, or do you want them to **emerge** from the system?
- Predictability and authorial control versus adaptability and novelty
- Can also combine the two, e.g. use a rule-based system to constrain a CI system

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- Each ghost has 3 states
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  - Frightened: move randomly

Ghost “personalities”

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- Orange ghost: aim for Pac-Man until 8 spaces away, then aim for corner

Ghost movement

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- Can't reverse or stay still
- Therefore can't get stuck, despite imperfect pathfinding

Ghost behaviour

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- However, the combination of them leads to interesting gameplay and illusion of personality

Design lessons

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- Bugs in AI don't always matter...

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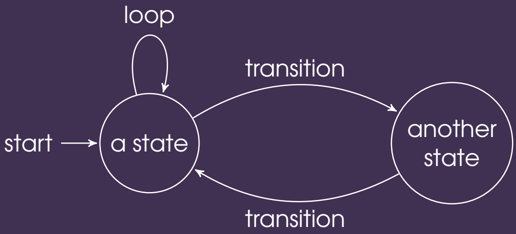
- At any given time, the FSM is in a **single state**
- **Inputs** or **events** can cause the FSM to transition to a different state

State transition diagrams



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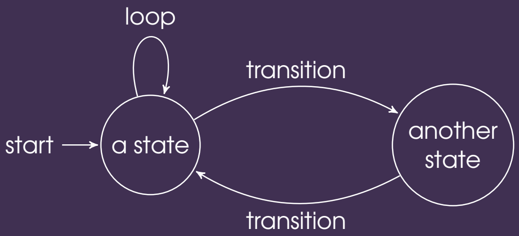

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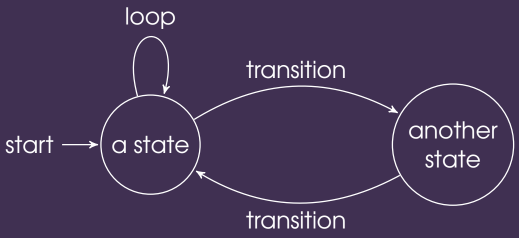

- FSMs are often drawn as **state transition diagrams**
- Reminiscent of **flowcharts** and certain types of **UML diagram**

FSMs for AI behaviour

The next slide shows a simple FSM for the following AI behaviour, for an enemy NPC in a shooter game:

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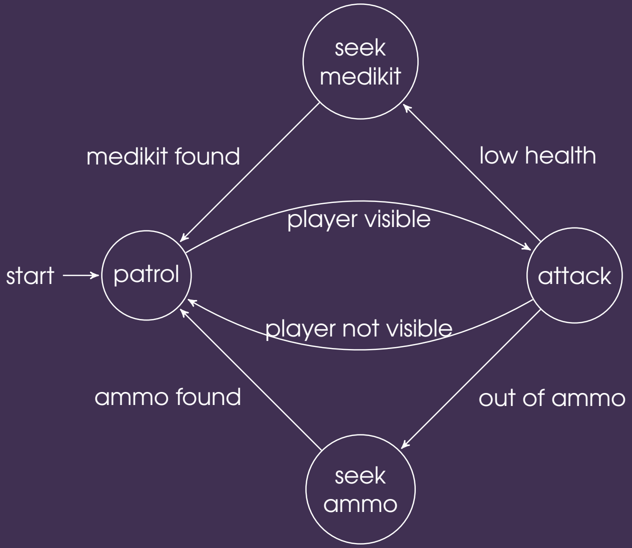
- If you are low on ammo, run away and find ammo. Then resume patrolling


seek medikit
medikit found
low health
player visible
start
patrol
attack
player not visible
ammo found
out of ammo
seek ammo

Other uses of FSMs

As well as AI behaviours, FSMs may also be used for:

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Beyond FSMs

Some topics for you to research, for when plain old FSMs aren't enough...

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- Hierarchical FSMs
- Nested FSMs
- Stack-based FSMs
- Hierarchical task networks
- ...

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Behaviour Trees

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- Allow **complex behaviours** to be built up from **simple components**
- Allow for **more complex** behaviours than FSMs
- First used in Halo 2 (2005), now used extensively
- Also used in robotics and other non-game AI applications

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- **Unreal**: an advanced BT system is built in
- **Unity**: numerous free and paid options on the Asset Store e.g. Behavior Machine, Behavior Designer, Behave, RAIN

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  - Failure
- “Running” status allows nodes to represent operations that **last multiple frames**

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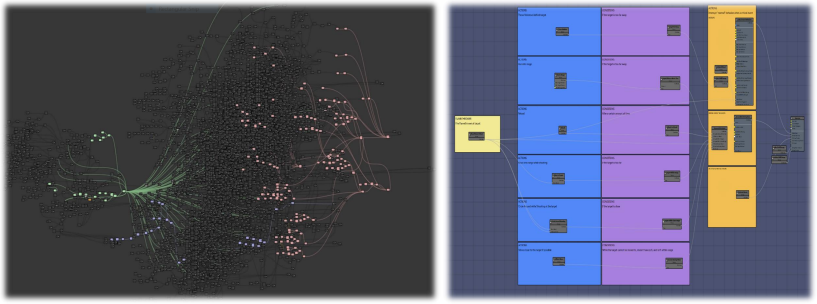
- (Shared blackboards mean that your AI has "telepathy" — this may or may not be desirable!)

BTs in The Division



http://www.gdcvault.com/play/1023382/
AI-Behavior-Editing-and-Debugging