



COMP250: Artificial Intelligence

2: Designing AI behaviours

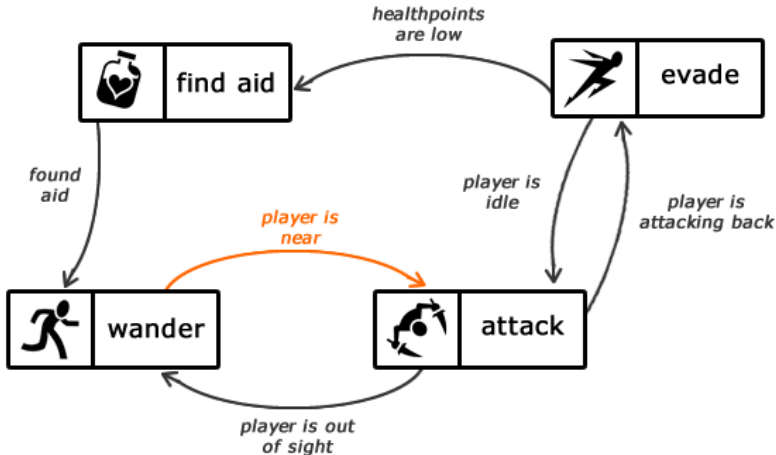
AI architectures



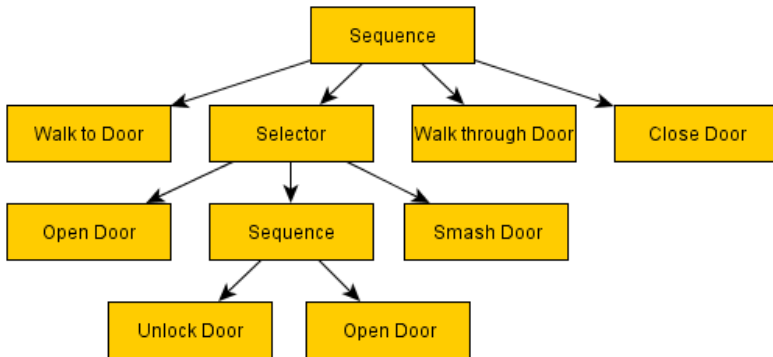
Rule-based AI

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

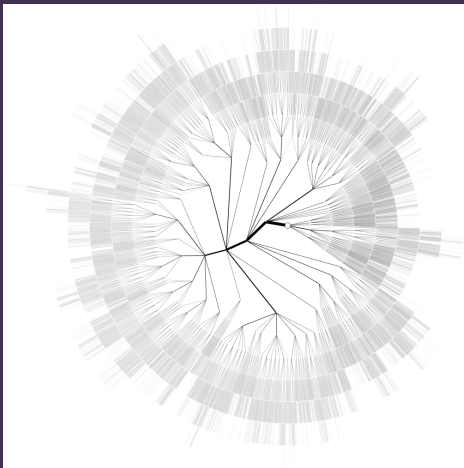
Finite state machines



Behaviour trees



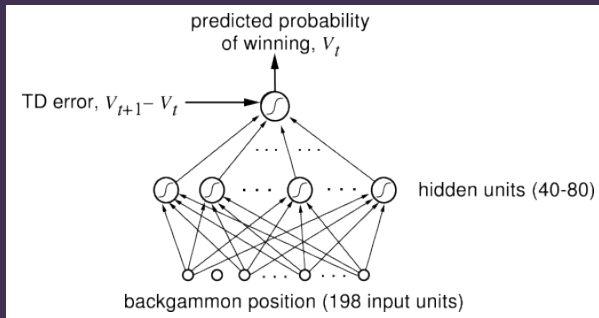
Game tree search



Multi-agent approaches (e.g. flocking)



Machine learning



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- ▶ ... and **computational intelligence**
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- ▶ Predictability and authorial control versus unpredictability and novelty

Logic



Logical operations

Python	C family	Mathematics	Behaviour tree
<code>not a</code>	<code>!a</code>	$\neg A$ or \overline{A}	Inverter
<code>a and b</code>	<code>a && b</code>	$A \wedge B$	Sequence
<code>a or b</code>	<code>a b</code>	$A \vee B$	Selector

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- ▶ E.g. `LivesIn(Bob, Falmouth)` could be a predicate for “Bob lives in Falmouth”

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- ▶ $\forall x : \text{LivesIn}(x, \text{Falmouth}) \implies \text{LivesIn}(x, \text{Cornwall})$

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- ▶ This relies on an extra piece of domain knowledge: Truro is the only city in Cornwall
 - ▶ $\forall x : \text{InCornwall}(x) \wedge \text{IsCity}(x) \implies x = \text{Truro}$

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- ▶ And if someone lives in Cornwall then they live in England

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- ▶ Therefore if someone lives in Falmouth then they live in England

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- ▶ Important applications in economics, ecology and social sciences as well as AI

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- ▶ If **both betray each other**, both get an F

Payoff matrix

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	A silent	A betray
B silent	A: 50 B: 50	A: 70 B: -100
B betray	A: -100 B: 70	A: 0 B: 0

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Socratic FALCOMPED: what would you do?

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... and Bob's thought process is the same!

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- ▶ If all players are **rational** (in the sense of wanting to maximising payoff), they should converge upon a Nash equilibrium

Does every game have a Nash equilibrium?

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	A rock	A paper	A scissors
B rock	A: 0 B: 0	A: +1 B: -1	A: -1 B: +1
B paper	A: -1 B: +1	A: 0 B: 0	A: +1 B: -1
B scissors	A: +1 B: -1	A: -1 B: +1	A: 0 B: 0

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- ▶ If we try to reason naïvely, we get stuck in a loop
 - ▶ If I choose paper, you'll choose scissors, so I should choose rock, but then you'll choose paper, so I'll choose scissors, so you'll choose rock, so I choose paper...

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- ▶ The optimum strategy is to be **unpredictable**

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- ▶ E.g. if you always choose paper, I choose scissors
- ▶ If we try to reason naïvely, we get stuck in a loop
 - ▶ If I choose paper, you'll choose scissors, so I should choose rock, but then you'll choose paper, so I'll choose scissors, so you'll choose rock, so I choose paper...
- ▶ The optimum strategy is to be **unpredictable**
- ▶ Choose rock with probability $\frac{1}{3}$, paper with probability $\frac{1}{3}$, scissors with probability $\frac{1}{3}$

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- ▶ A **mixed strategy** assigns probabilities to actions and chooses one at random
- ▶ In contrast to a **pure** or **deterministic strategy**, which always chooses the same action
- ▶ If we allow mixed strategies, **every game has at least one Nash equilibrium**

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- ▶ Socrative FALCOMPED: make your guesses!

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- ▶ Which means the average can't possibly be greater than 44.444
- ▶ So no rational player would guess greater than 29.629

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- ▶ So no rational player would guess greater than 44.444
- ▶ Which means the average can't possibly be greater than 44.444
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- ▶ ... and so on ad infinitum

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- ▶ Which means the average can't possibly be greater than 66.666
- ▶ So no rational player would guess greater than 44.444
- ▶ Which means the average can't possibly be greater than 44.444
- ▶ So no rational player would guess greater than 29.629
- ▶ ... and so on ad infinitum
- ▶ So the only **rational** guess is 0, as every rational player should guess 0 and $\frac{2}{3}$ of 0 is 0

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- ▶ However it's important to remember that **humans aren't always rational**