COGS 300 — Emergence 01 — Oct 21/25

Today we will start on our journey into new complexity science. We will learn about the theory of emergent intelligence by studying its components & seeing examples, and playing with it.

We'll start with automata. The idea with automata is that they are extremely rule-based systems

Langton's Ant ★ show + demo.

White → turn 90° right, W→B, FWD 1
Black → turn 90° left, B→W, FWD 1

Usually, the Ant produces a highway on a blank page, but will be chaotic for 10k steps. But small changes in the initial config make it so that's not known characteristic.

Chaos: not just "craziness" but the property of a system that means it's impossible to a-priori predict an outcome without "running" the simulation

↳ small changes in initial parameters = big changes in system evolution

★ Double pendulum simulation

★ Langton's Ant
↳ which rules produce periodic behavior?
→ which rules produce unpredictable?

compare to natural automata. Is anything "that" automatic?

Splex wasp vs alzheimers.

Conway + emergent self-perpetuation

one or zero neighbours = die
four or more neighbours = die
2 or 3 n = live
3 n = born

★ Discover self-perpetuating patterns.
↳ how is this similar or diff. than life?
→ is this system chaotic?

If time: can you design a goal-finding automaton?

→ only see current cell colour
→ only turn + move fwd.
→ infinite space.

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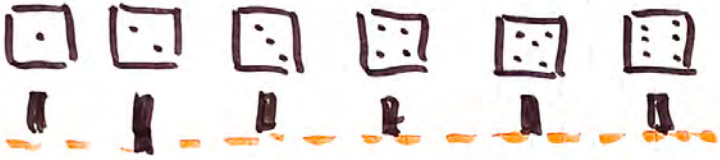
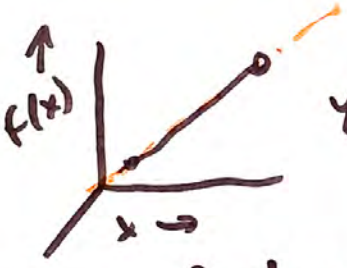
Warm up: Draw something random.
Draw something simple.
Draw something complex.

what's the difference?



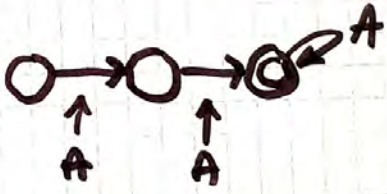


$y = mx + b$

Automata

FSM = DFA

Langton's Ant



Langton's Ant

no known x, y range

Ant = {↑, ←, ↓, →}

White → 90° right
W → B
Fwd 1

Black → 90° left
B → W
Fwd 1

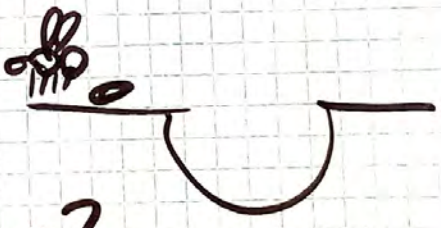
chaos + complexity

↓

unpredictable ... could be deterministic

must run the simulation

sphex WASP



alzheimers

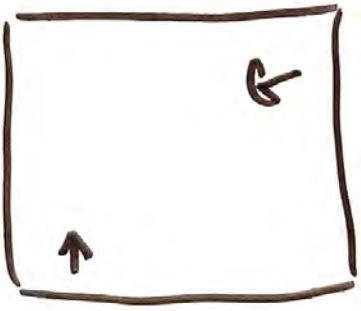
memory?

conway's game of life ③

1 or 0 neighbours = die
4+ " = die
2 or 3 " = live
3 " = born

Goal-find automaton

ant = {↑ → ↓ ←}
cell = {B, W}
actions = turn + fwd 1 memory
goal = red



goal-finding automaton?

emergence