The Evolution of Life and Mind

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- the word we ascribe to...

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- and, typically, reproduce.

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- the word we ascribe to...
- complex dynamical processes that persist...
- and, typically, reproduce.
- Life interacts with and, often, adapts to its environment, within the lifetime of an organism, and/or over multiple generations of organisms.

Answer: Mind is...

- intelligence...

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- intelligence...
- plus, sometimes, self-awareness.

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Answer: Intelligence is...

- the word we ascribe to...
- complex behavioral responses that foster persistence...
- and, typically, reproduction.
- Intelligence is what allows a living organism to effectively interact with and adapt to its environment within its own lifetime.

Evolution is a Tautology

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- Life is the inescapable product of the tautology of evolution;
- and so is intelligent life.

The Map is not the Territory

- Study what mind *is*,
  - not what it is like
- Study what life *is*,
  - not what it is like

But Maps are Good

- Maps confer an evolutionary advantage

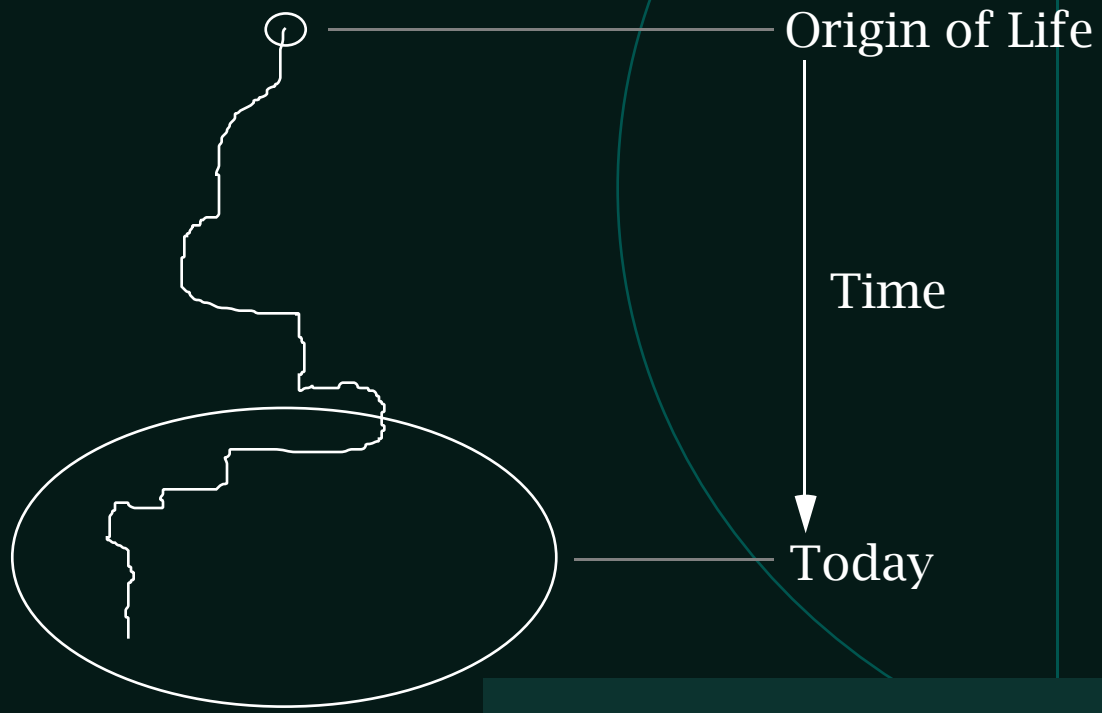
But Maps are Good

- Maps confer an evolutionary advantage
- The origin of the map is the origin of self-awareness

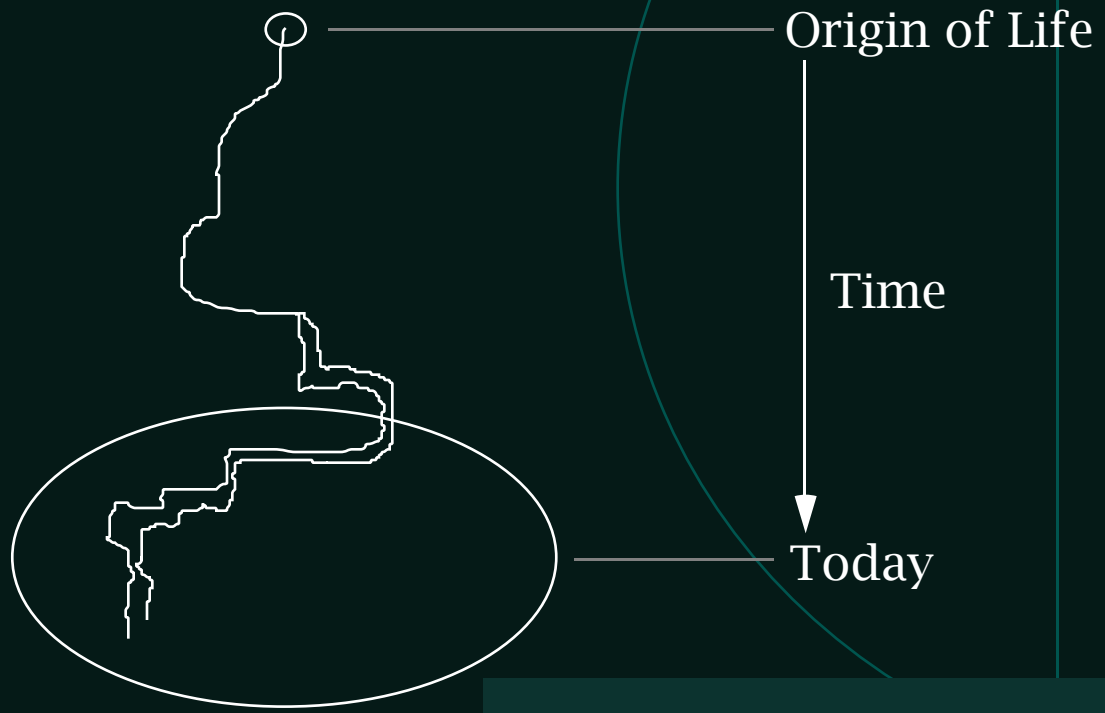
Learn from What Might Be

- Artificial Life is the study of
  - "life as it might be" informing
  - "life as it is".

Life As It Is



Life As It Is & As It Might Be



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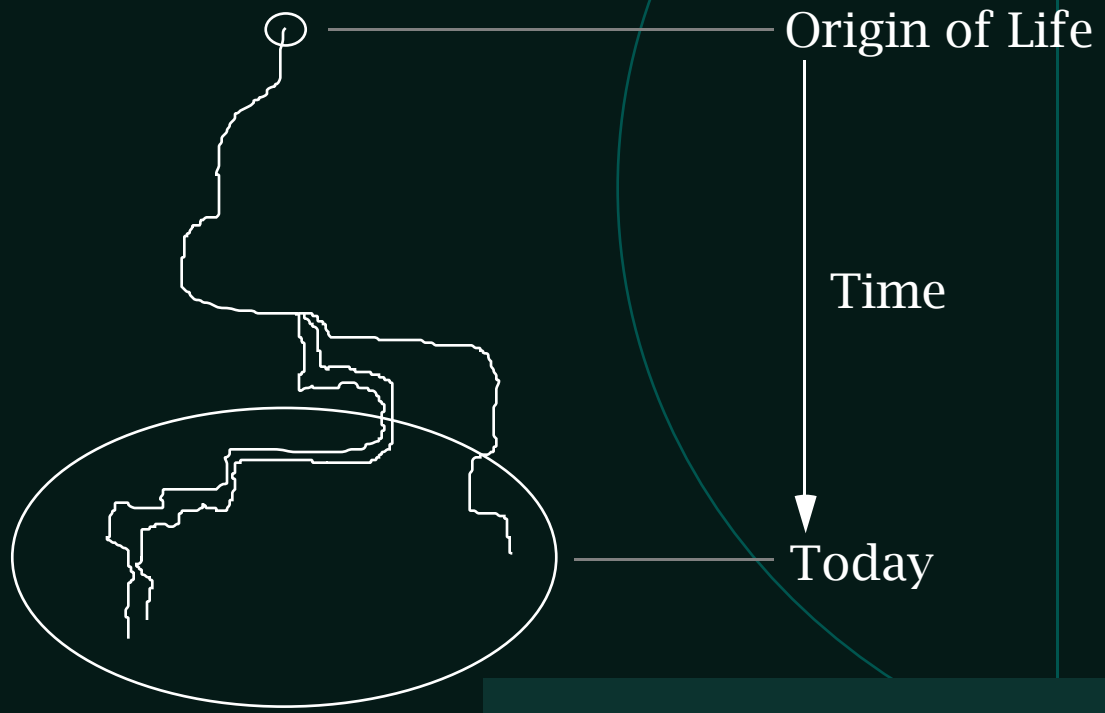

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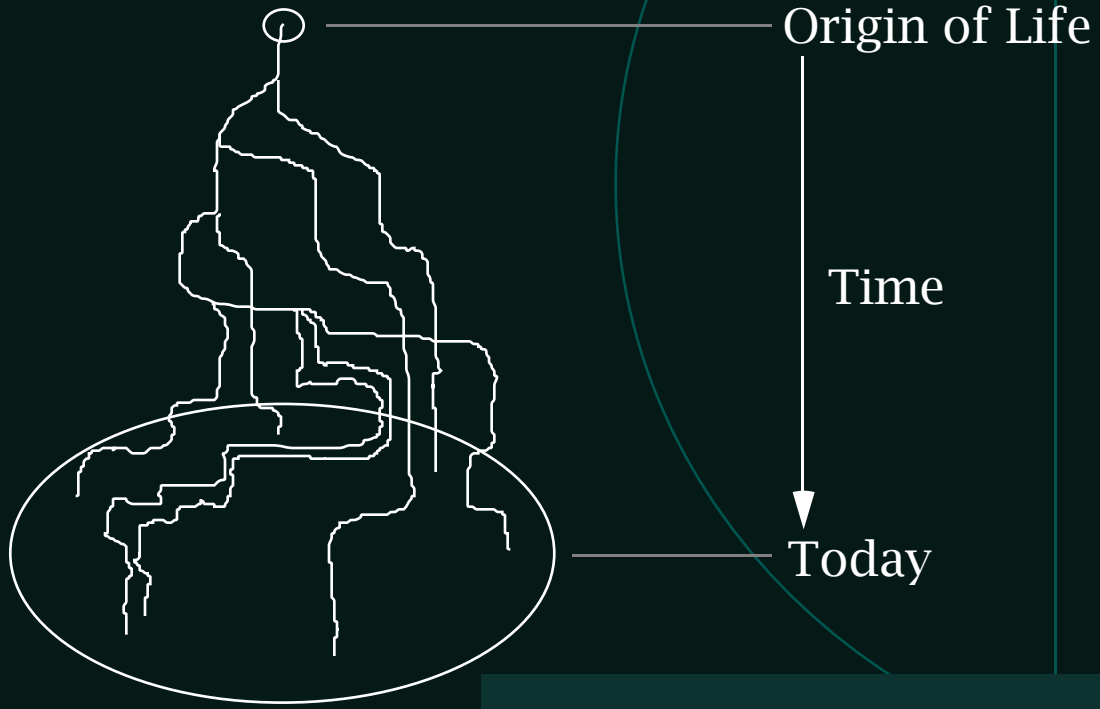

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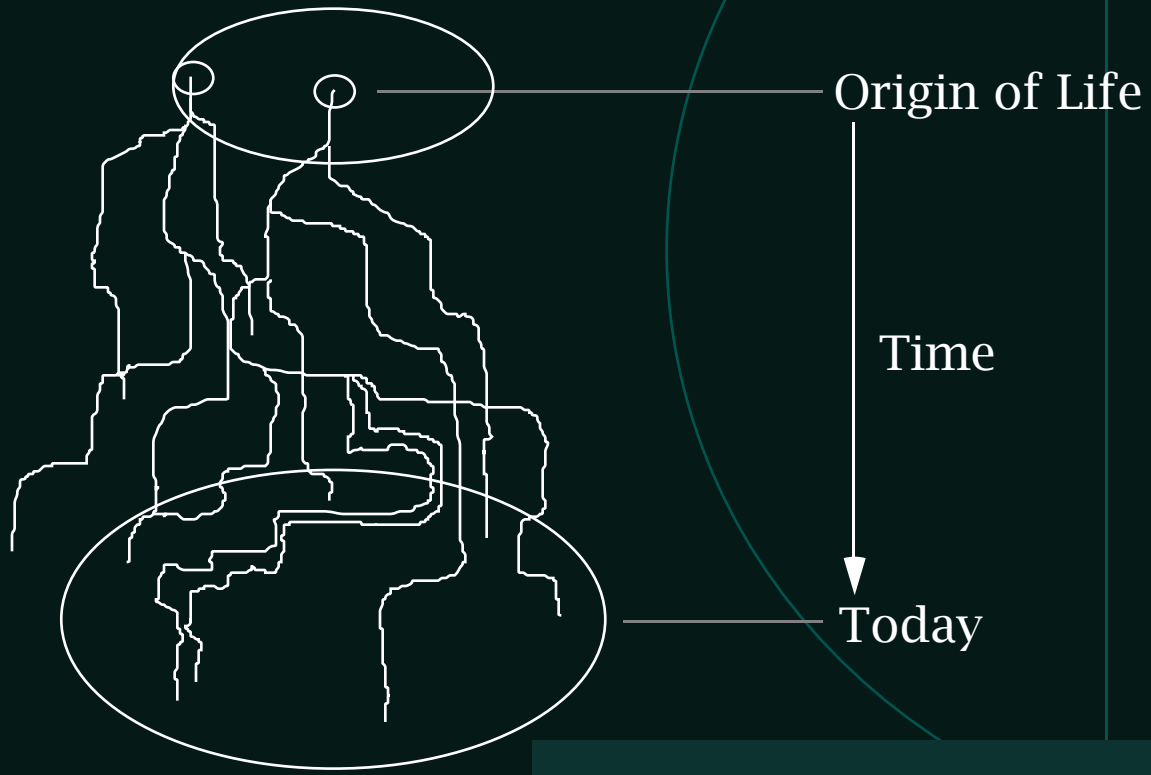

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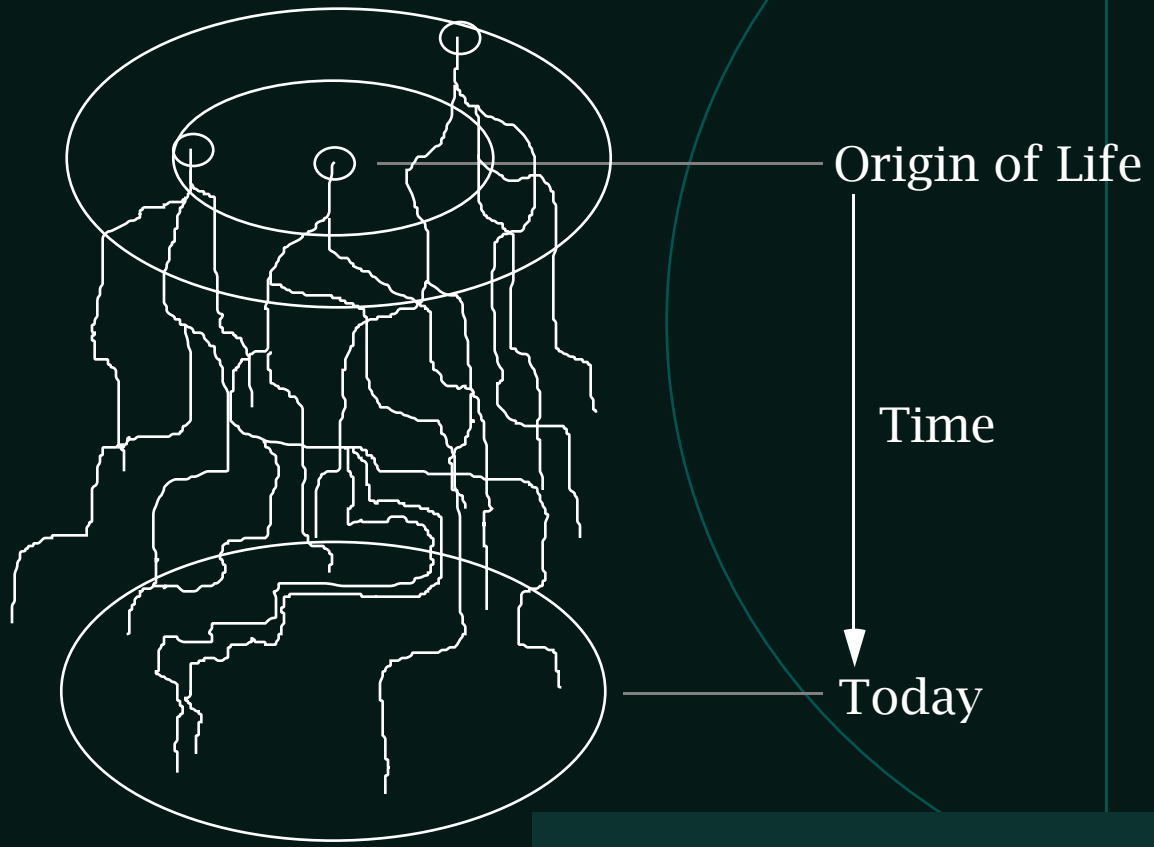

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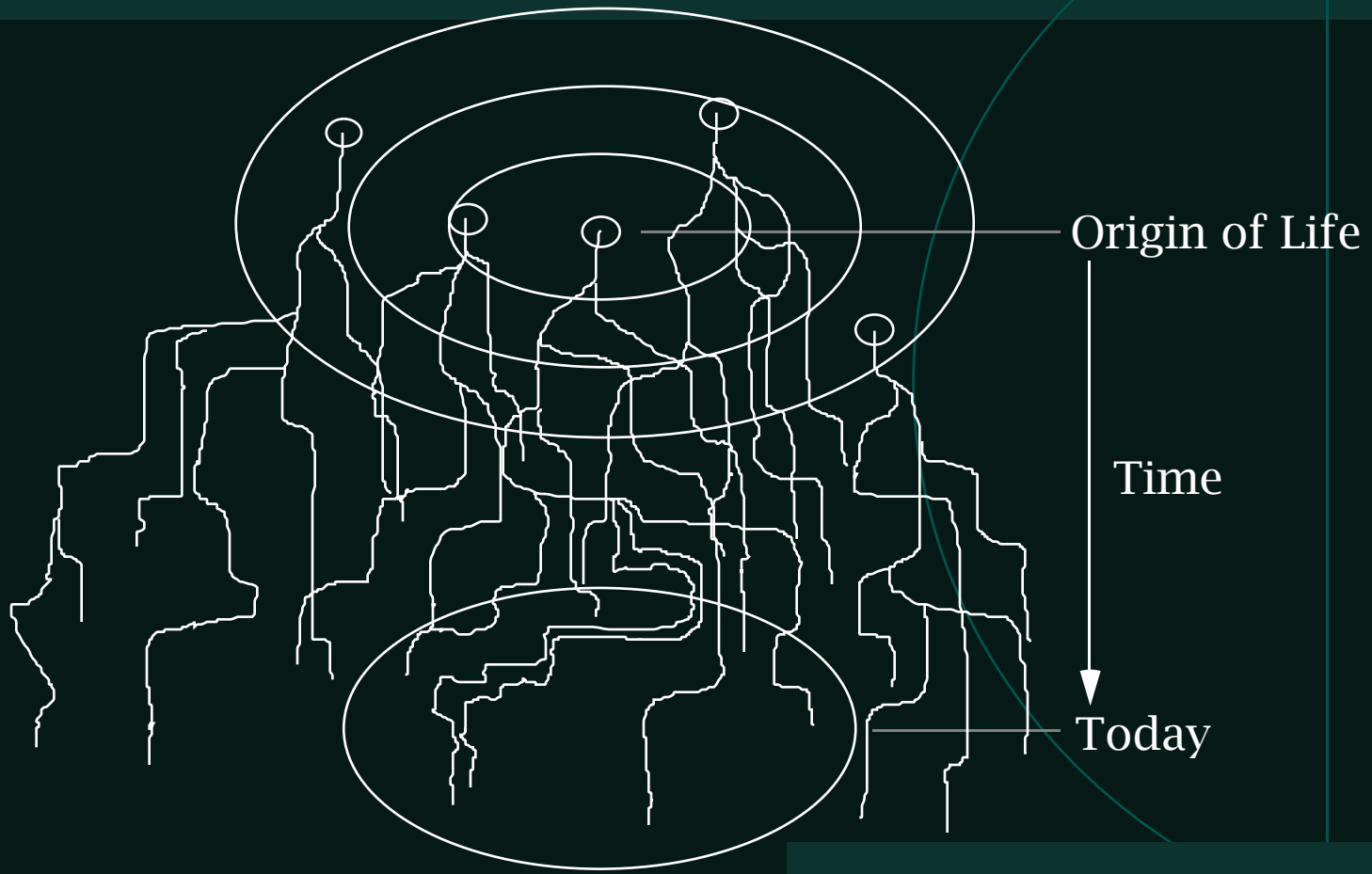

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Learn from What Might Be

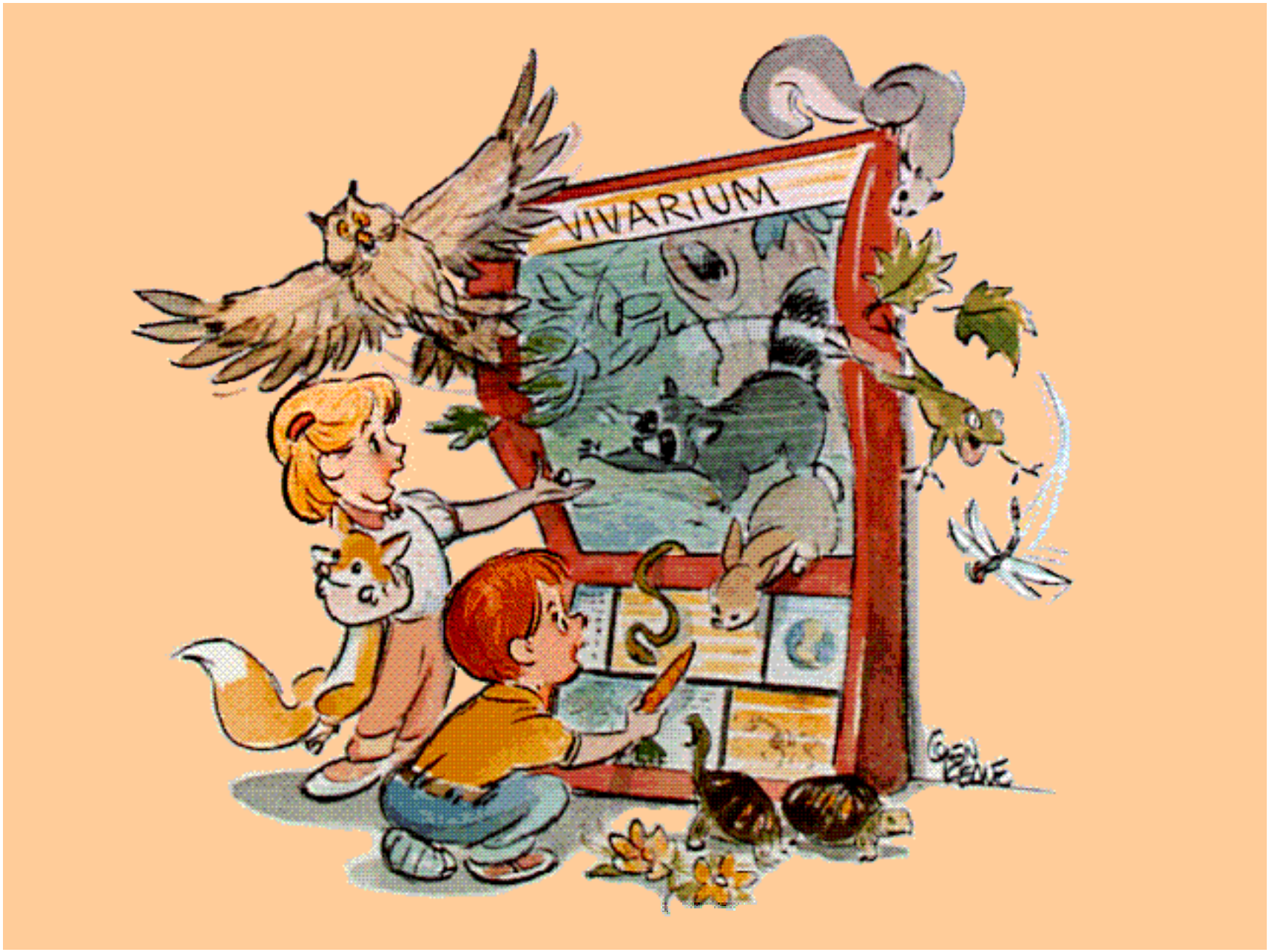
- Artificial Life is the study of
  - "life as it might be" informing
  - "life as it is".
- It can also be the study of
  - "mind as it might be" informing
  - "mind as it is".

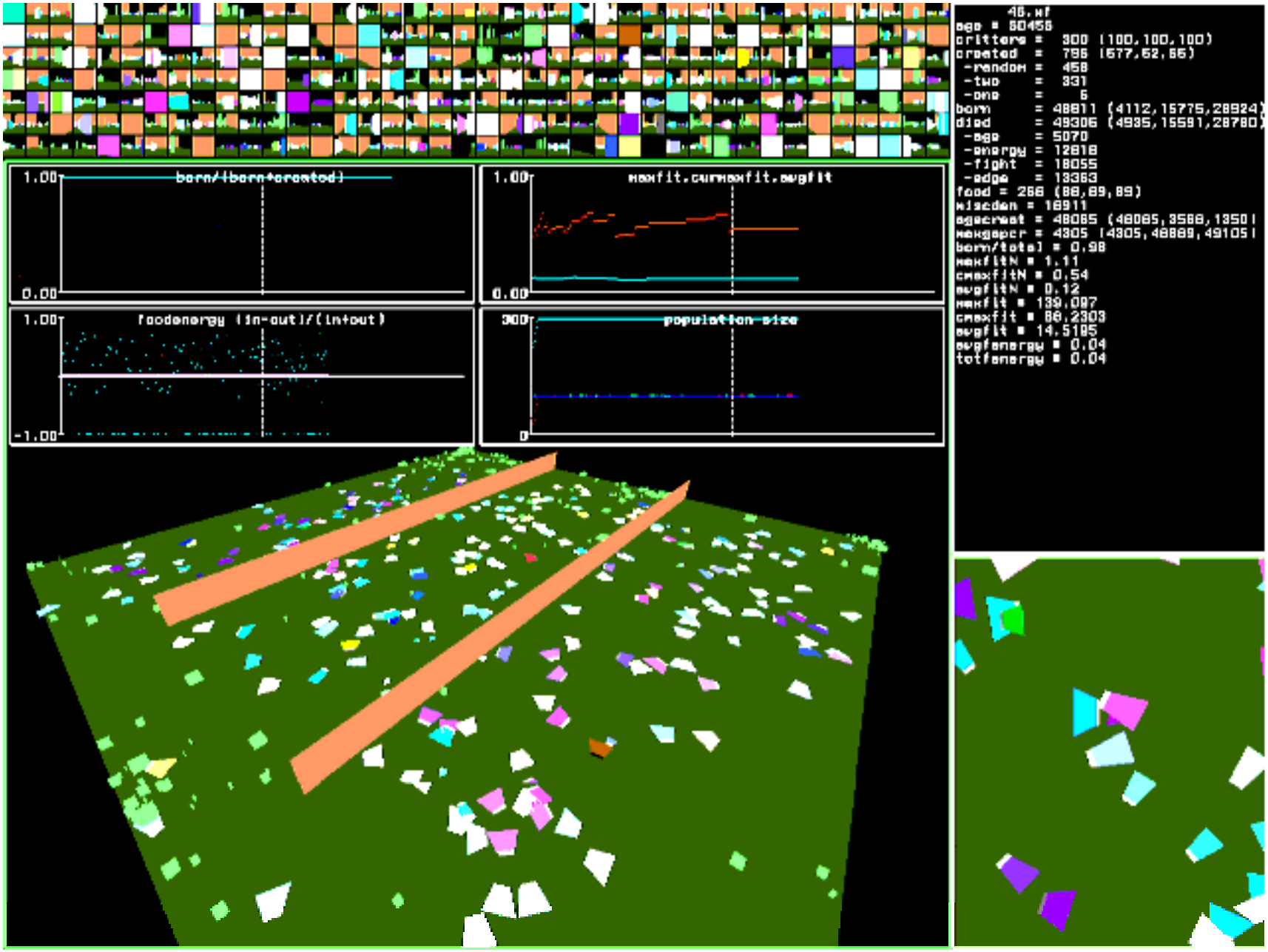
Road Map to Artificial Life & Mind

- Provide a suitably rich physics
- Provide adequate energy
- Invoke evolution
  - By its nature, it produces what we seek
- Wait

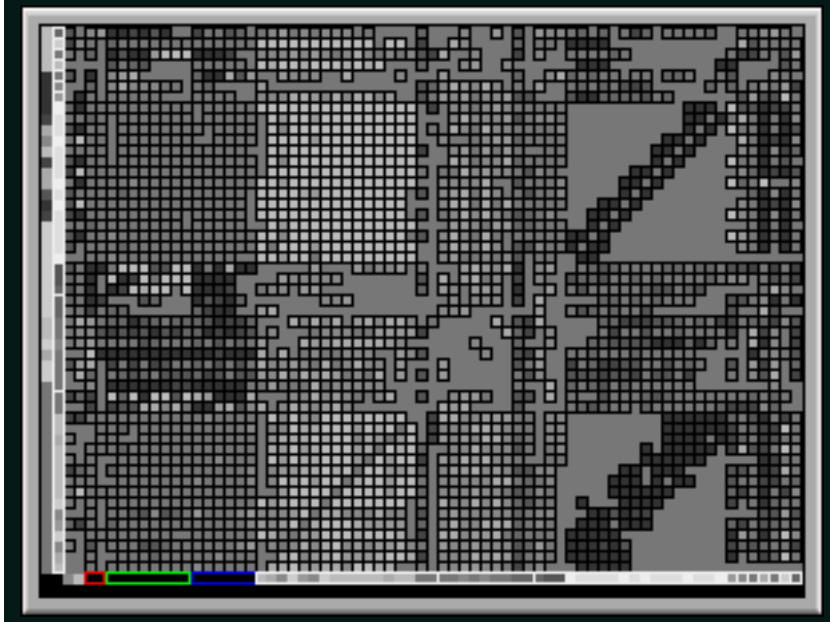
Some Shortcuts

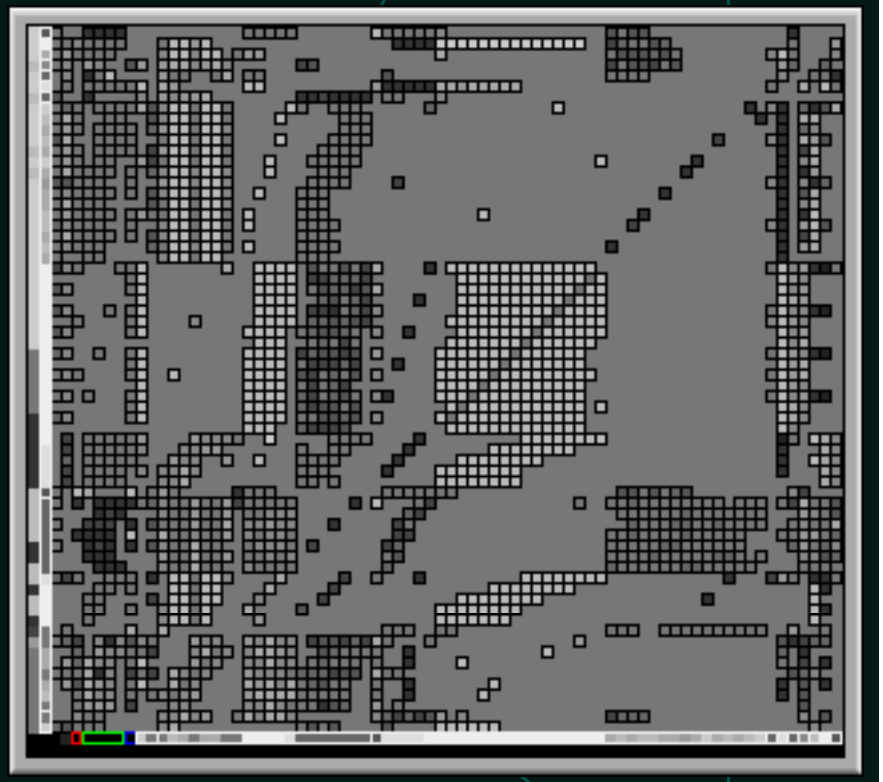
- Use biologically inspired models
  - Provide a rich genetic structure
  - Provide a rich ontogeny
  - Provide a rich environment
  - Use neural models
    - Every natural example of higher intelligence is based on these.
  - Invoke evolution
  - Wait, but not nearly as long


VIVARIUM


1.00
born/(born+created)
0.00
1.00
maxfit,curmaxfit,avgfit
0.00
1.00
foodenergy (in-out)/(in+out)
-1.00
300
population size
0
46.nf
age = 50455
critters = 300 (100,100,100)
created = 795 (677,62,56)
-random = 458
-two = 331
-one = 6
born = 48811 (4112,15775,28924)
died = 49306 (4935,15591,28780)
-age = 5070
-energy = 12818
-fight = 18055
-edge = 13363
food = 266 (88,89,89)
wiseden = 18911
agecreat = 48085 (48085,3588,1350)
maxgaper = 4305 (4305,48889,49105)
born/total = 0.98
maxfitN = 1.11
cmaxfitN = 0.54
avgfitN = 0.12
maxfit = 139.087
cmaxfit = 80.2303
avgfit = 14.5105
avgfenergy = 0.04
totfenergy = 0.04

Evolving Neural Architectures



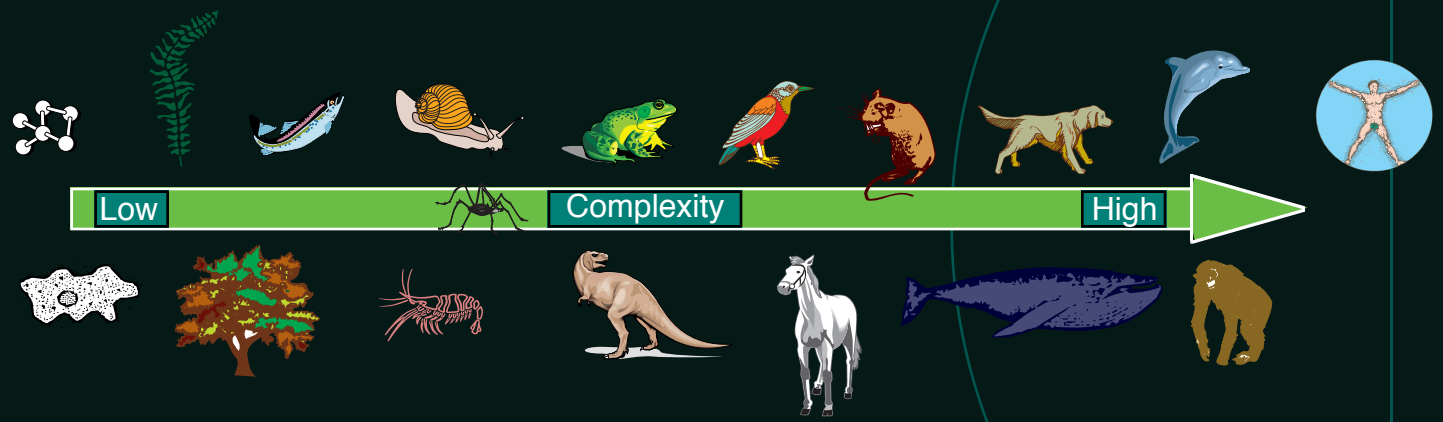


Speciation and Complex Emergent Behaviors

- "Joggers"
- "Indolent Cannibals"
- "Edge-runners"
- "Dervishes"
- Visual response
- Fleeing attack
  - Fighting back
- Latest simulation...
  - Foraging / Grazing / Food attraction
  - Swarming / Flocking
  - Following / Chasing

PolyWorld Video

Spectrum of Life and Intelligence



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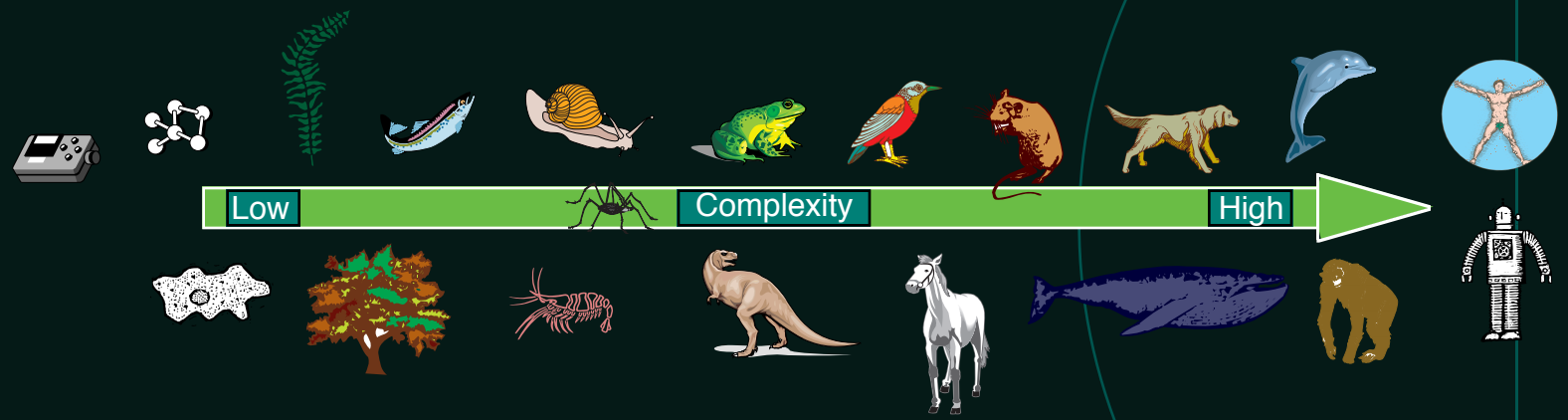
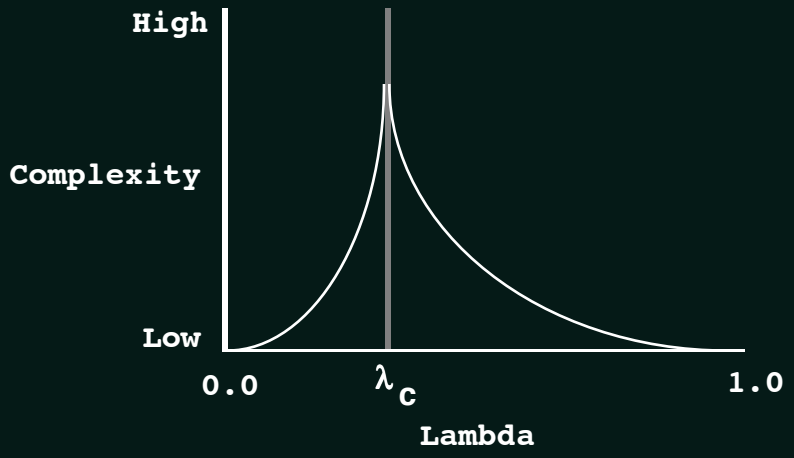


Complexity and Life

- Chris Langton's "lambda" parameter (ALife II)
  - Complexity = length of transients
  - λ = # rules leading to nonquiescent state / # rules



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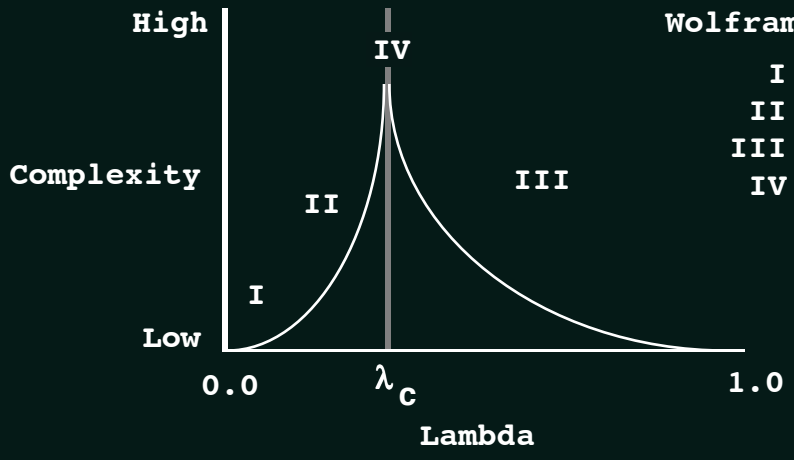

Wolfram's CA classes:

I = Fixed
II = Periodic
III = Chaotic
IV = Complex

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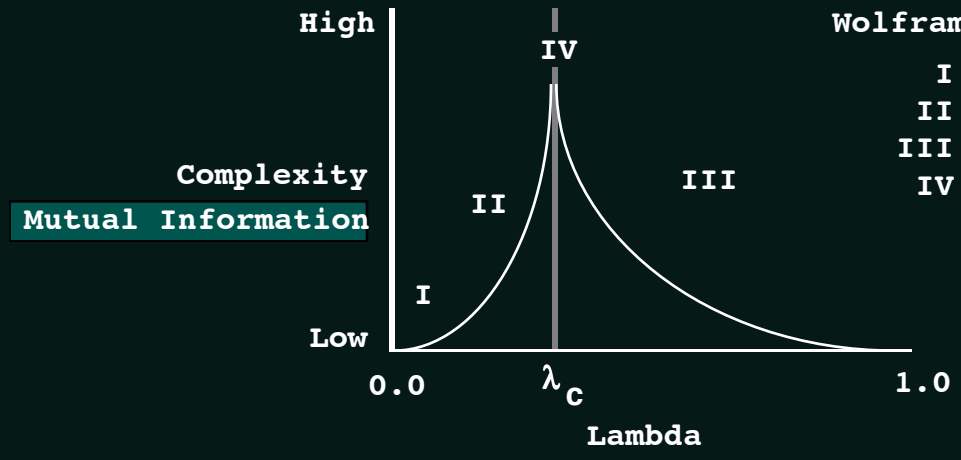

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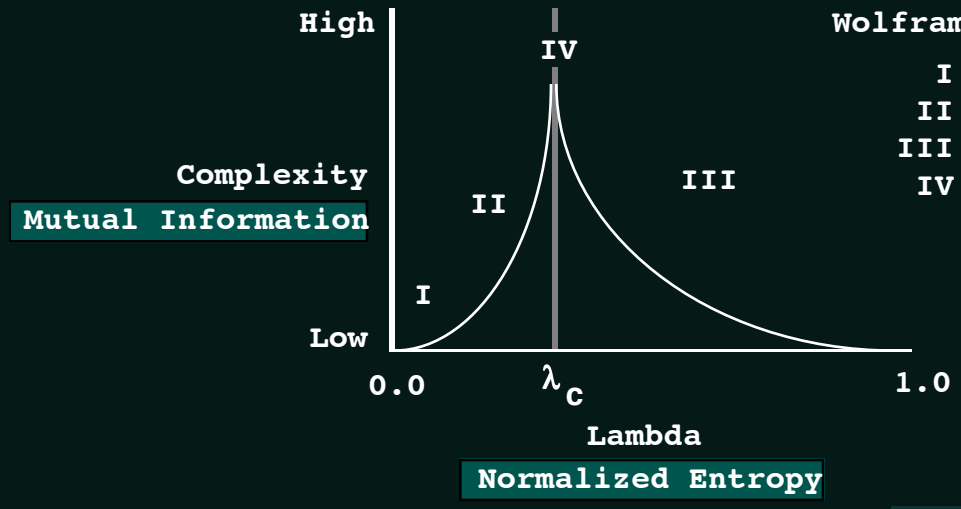

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Measuring Life and Intelligence

- Measure state and compute complexity
- What complexity?
  - Mutual information
  - Other
- What state?
  - Chemical composition
  - Electrical charge
  - Value of a software variable
- What scale?
  - Multiple

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  - Measure behavioral states?

Another Shortcut

- In addition to biologically inspired shortcuts...
- Define suitable measure of complexity
  - Must be well behaved
  - Measure neural states
  - Measure behavioral states?
- Use complexity directly as the fitness function

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