



Tokens, Complex Systems, and Nature

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Ocean | BigchainDB

**On the internet,
no one knows
you're a dog(e)**



On the internet of *things*,
nobody knows you're a
toaster



**But what is this?
Robot? Plant?**



A photograph of a dense forest. Tall, slender trees with dark trunks stand closely together. Sunlight filters through the dense canopy of green leaves, creating a warm, golden glow and long, vertical rays of light. The forest floor is covered in lush green undergrowth, including ferns and small plants. The overall atmosphere is serene and natural.

**What do you call
a forest that
owns itself?**

Can a wind farm own itself? How?

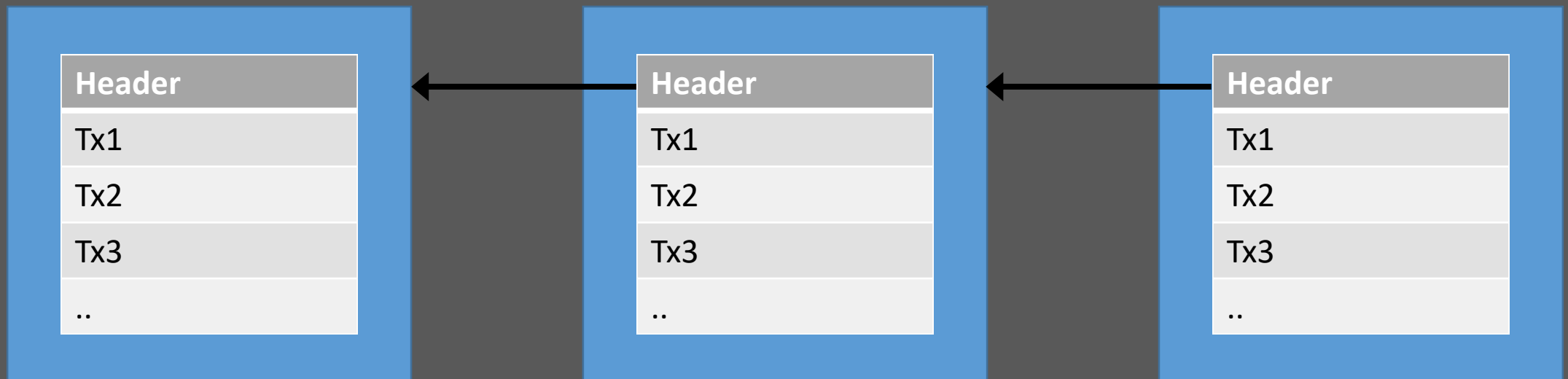




Blockchain (and ways to frame it)

“A Chain of Blocks”

- Block = list of transactions, where tx = “create asset” or “transfer asset” action, digitally signed
- Chain = linked list, where links are hashes



“Database with blue ocean benefits”

- Decentralized
- Immutable
- Assets



“Emerging Decentralized Stack”

STORAGE	PROCESSING	COMMUNICATIONS
FILE SYSTEM IPFS/FileCoin, Swarm	BIZ LOGIC Ethereum, Dfinity	DATA TCP/IP
DATABASE BigchainDB, OrbitDB	HIGH PERF. COMPUTE TrueBit, Golem, iExec	VALUE Interledger, Cosmos
STORE OF VALUE Bitcoin, zcash		STATE PolkaDot

INSIDE: A 12-PAGE SPECIAL REPORT ON COLOMBIA

The
Economist

OCTOBER 31ST-NOVEMBER 6TH 2013

Economist.com

007 and the spectre of Britain's past

Turkey votes to the sound of bombs

Those ever-creative accountants

America takes the fight to IS

Coywolves: the new superpredator

The trust machine

How the technology behind bitcoin
could change the world



“Trust machine”
because it minimizes
trust needed to
operate.

It's more *socially*
scalable. (Ref Szabos)

“Incentive Machine”

**Get people to do stuff
By rewarding with tokens**

Bitcoin incentivizes security = hash rate = electricity

Result: > USA by mid 2019!

“Public Utility Network” Self-sustaining, anti-fragile



“DAO: Decentralized Autonomous Organization”

A computational process that

- runs autonomously,
- on decentralized infrastructure,
- with resource manipulation.

It's code that can *own* stuff!

Aka “good computer virus”

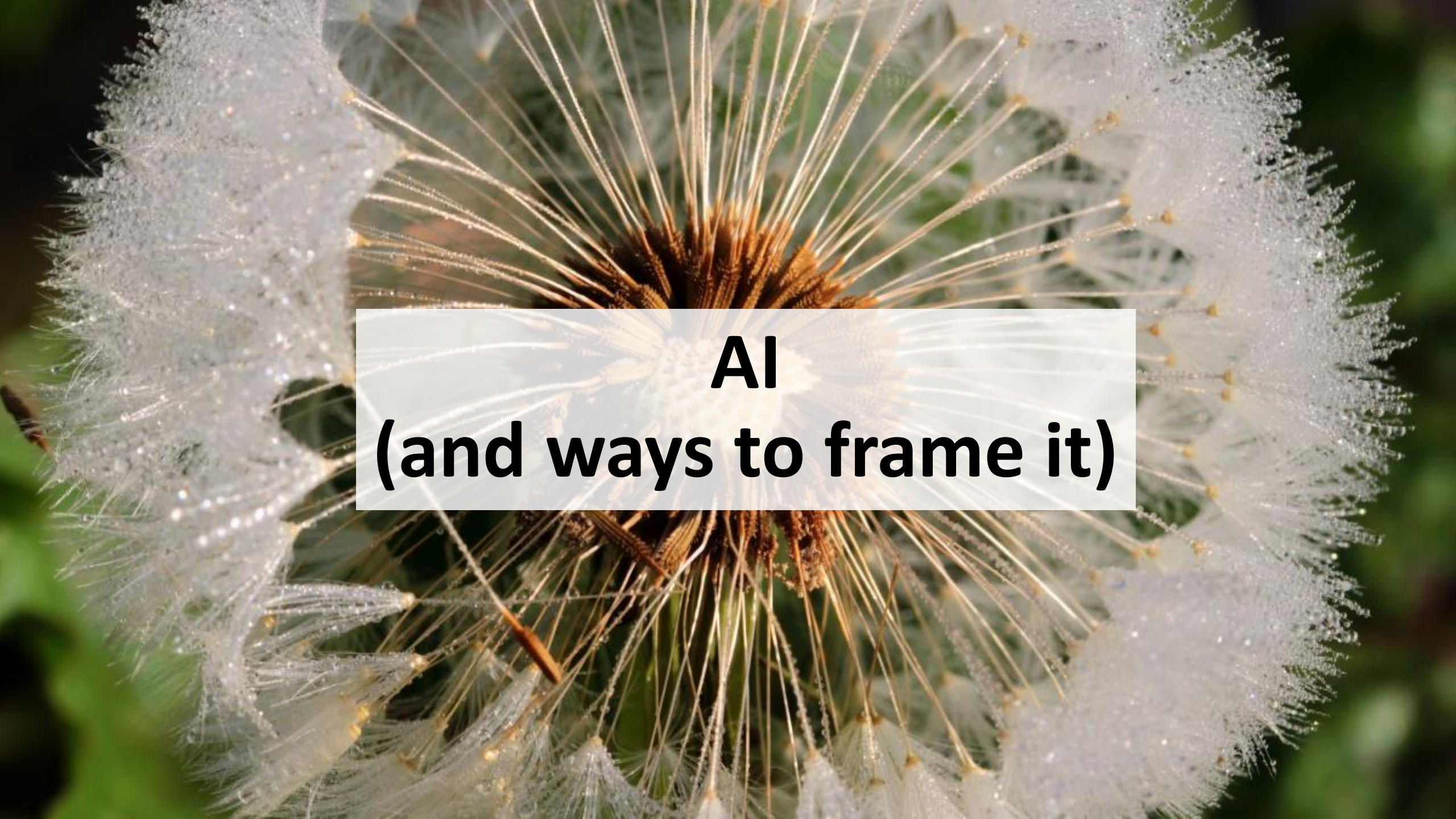
The background of the entire slide is a microscopic view of cells, likely from a petri dish, showing various sized bubbles and cellular structures. A teal-colored overlay covers the top half of the image, and a dark teal overlay covers the bottom half. The text is placed within these overlays.

“Life Form”

“Bitcoin is the first example of a new form of life.”

“It lives and breathes on the internet. It lives because it can pay people to keep it alive. It lives because it performs a useful service that people will pay it to perform. ... It can't be stopped. It can't even be interrupted. If nuclear war destroyed half of our planet, it would continue to live, uncorrupted.”

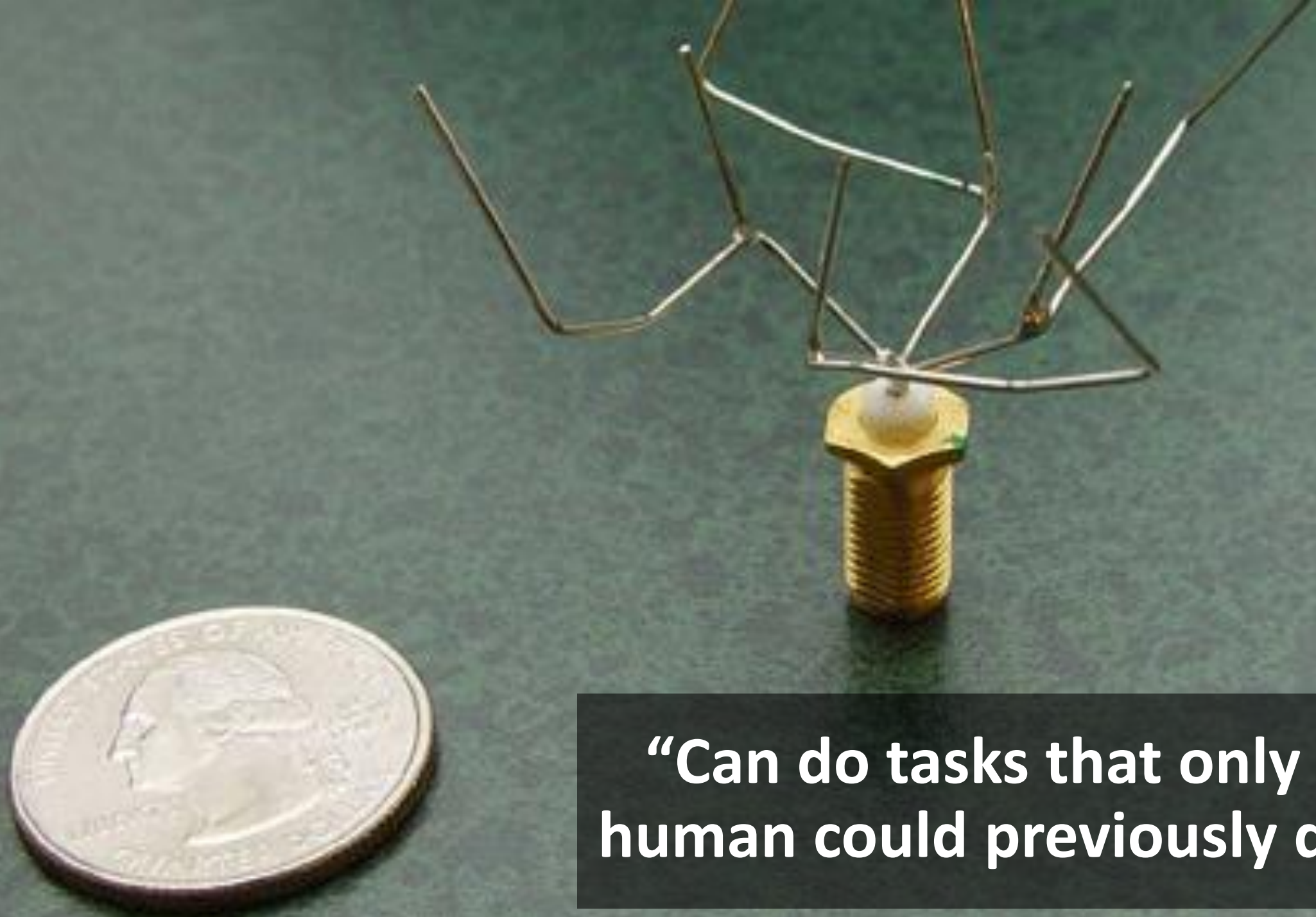
-Ralph Merkle

A close-up photograph of a dandelion seed head, showing the intricate structure of the seeds and their feathery pappus. The seeds are a light brown color, and the pappus is a soft, white, fuzzy material. The background is a blurred green, suggesting foliage. A semi-transparent white rectangular box is centered over the middle of the image, containing the text "AI (and ways to frame it)" in a bold, black, sans-serif font.

AI (and ways to frame it)

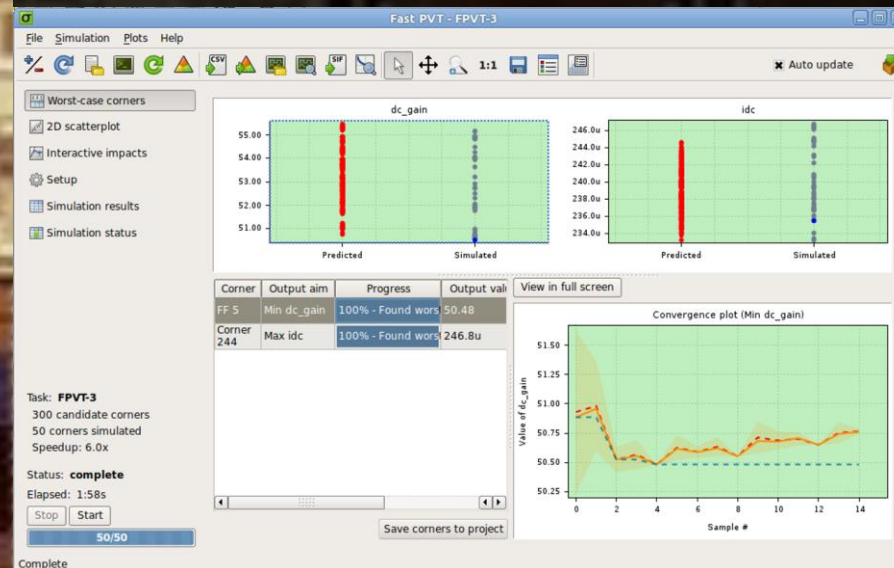
“Replicates human cognitive behavior” [Turing test]





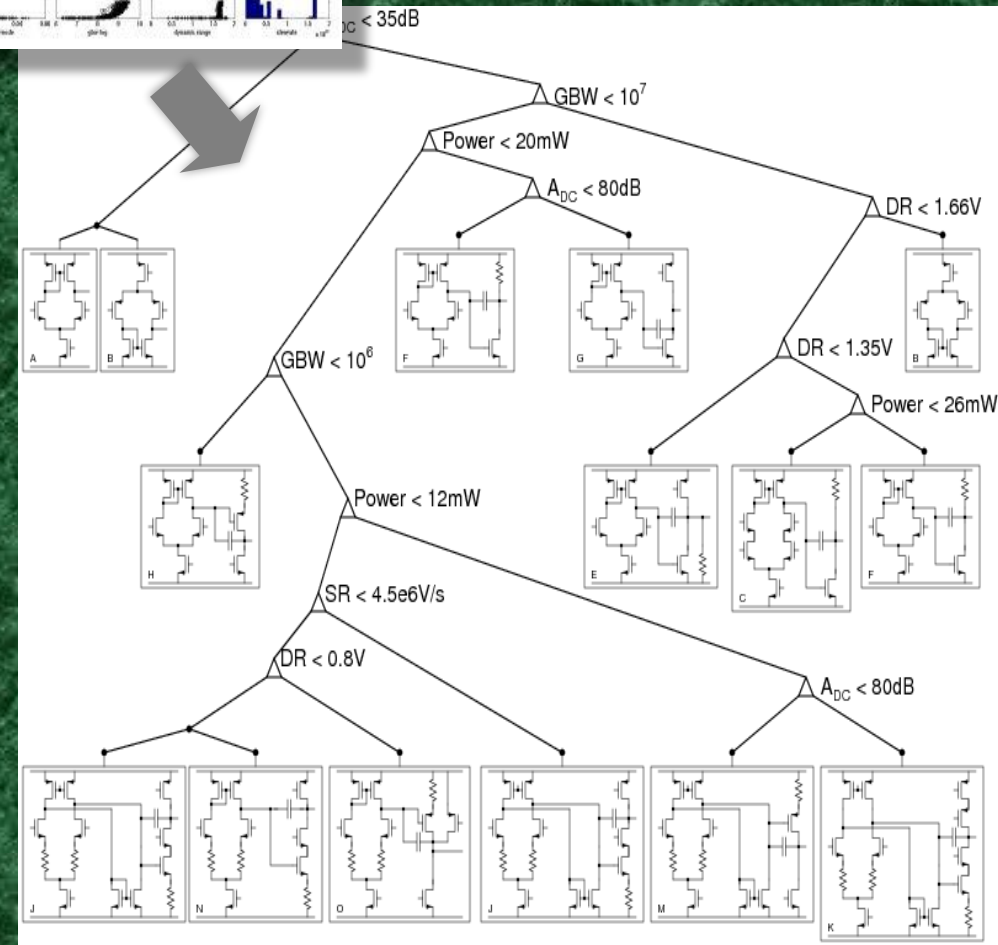
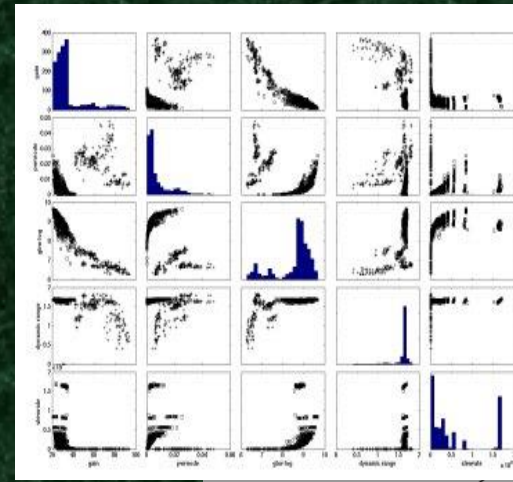
“Can do tasks that only a human could previously do”

“Can do a task at
speed/ accuracy/
capacity not
possible by a
human.”




“A set of tools”
“Sufficiently a mystery,
Not yet a *technology*”

- Classification
- Regression
- Knowledge extraction
- Optimization
- Creative / Structural design
- ...





“Embodied agents” (AGI)



Evolutionary Algorithms & Token Design

Realization: Tokenized Ecosystems Are a Lot Like Evolutionary Algorithms!

What	Tokenized ecosystem	Evolutionary Algorithm
Goals	Block reward function E.g. “Maximize hash rate”	Objective function E.g. “Minimize error”
Measurement & test	Proof E.g. “Proof of Work”	Evaluate fitness E.g. “Simulate circuit”
System agents	Miners & token holders (humans) In a network	Individuals (computer agents) In a population
System clock	Block reward interval	Generation
Incentives & Disincentives	You can’t control human, Just reward: give tokens And punish: slash stake	You can’t control individual, Just reward: reproduce And punish: kill

**We can approach token design
as EA design.**

Steps in EA Design

1. **Formulate the problem.** Objectives, constraints, design space.
2. **Try an existing EA solver.** If needed, try different problem formulations or solvers.
3. **Design new solver?**

1. Formulation of optimization problem

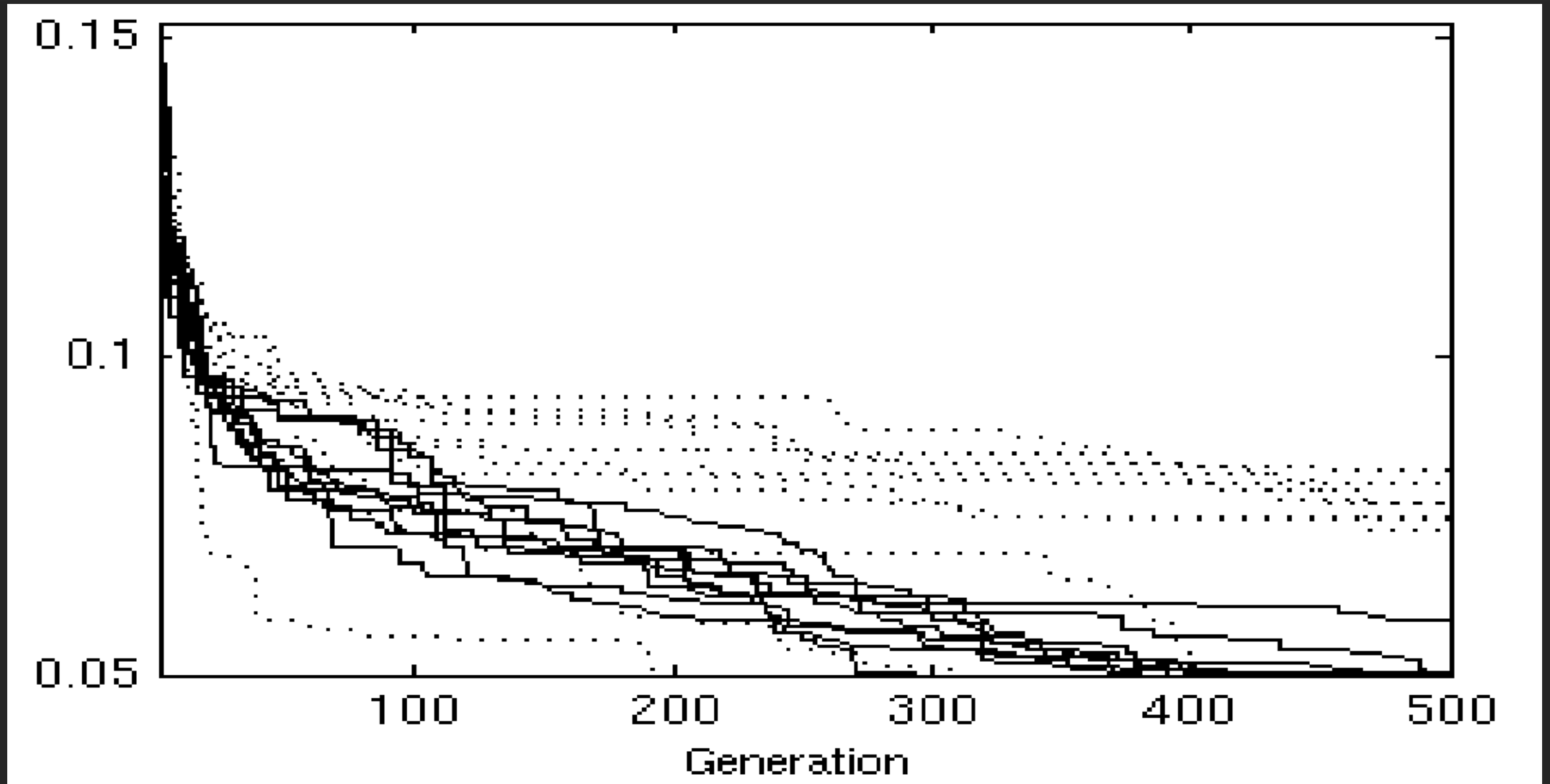
Objectives & constraints in a design space

The algorithm's aim is formulated as a constrained multi-objective optimization problem

$$\begin{aligned} &\text{minimize} && f_i(\phi) && i = 1 \dots N_f \\ &\text{s.t.} && g_j(\phi) \leq 0 && j = 1 \dots N_g \\ &&& h_k(\phi) = 0 && k = 1 \dots N_h \\ &&& \phi \in \Phi \end{aligned} \tag{1}$$

where Φ is the “general” space of possible topologies and sizings. The algorithm traverses Φ to return a Pareto-optimal

2. Try an existing EA solver. Does it converge?



3. Design new EA solver

TABLE II
PROCEDURE SANGRIAOPTIMIZATION()

Inputs: $D, N_a, K, N_L(k)$

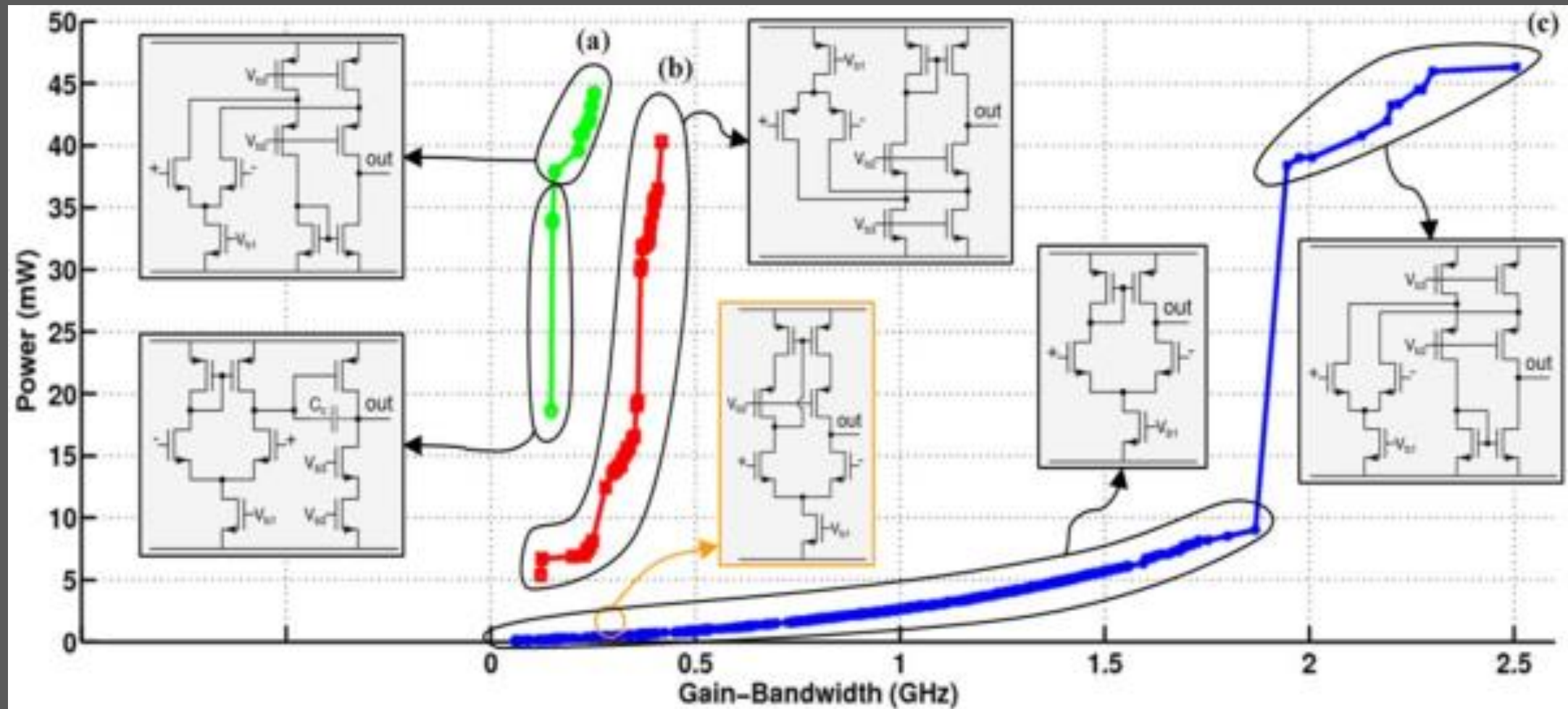
Outputs: d^*

1. $N_{gen} = 0; P = \emptyset, P_{all} = \emptyset$
2. while $stop() \neq True$:
3. if $(N_{gen} \% N_a) = 0$:
4. if $|P| < K$:
5. $P_{|P|+1} = \emptyset$
6. $P_0 = \text{SpaceFillIndividuals}(N_L(k), N_D, D)$
7. for $k = 1$ to $|P|$:
8. $P_k = \text{SelectParents}(P_k, P_{k-1}, N_L(k))$
9. $P_{k,j} = \text{UpdateLocalOptState}(P_{k,j}, k), j = 1$ to $|P_k|$
10. $P_{all} = \text{unique}(P_{all} \cup P)$
11. $P_{|P|} = P_{|P|} \cup \text{InnerOptimize}(P_{all}, D, k)$
12. $d^* = d_i$ in P_{all} with highest Y or Cpk
13. $N_{gen} = N_{gen} + 1$
14. return d^*

and all individuals encountered so far in the search, P_{all} .

Lines 2–13 are the generational loop, which repeats until $stop()$

Example of a Successful Outcome



Steps in *Token Ecosystem* Design

1. **Formulate the problem.** Objectives, constraints, design space.
2. **Try an existing building block.** If needed, try different formulations or EA solvers.
3. **Design new building block?**

1. Formulate the Problem: [ex. Ocean]

Who are stakeholders?
What do they want?

Objectives &
constraints

Key stakeholders in Ocean ecosystem

Stakeholder	What value they can provide	What they might get in return
Data/service provider, data custodian, data owner	Data/service (market's supply)	Tokens for making available / providing service
Data/service referrers, curators. Includes exchanges and other application-layer providers.	Data/service (via a provider etc), curation	Tokens for curating
Data/service verifier. Includes resolution of linked proofs on other chains	Data/service (via a provider etc), verification	Tokens for verification
Data/service consumer	Tokens	Data/service (market's demand)
Keepers	Correctly run nodes in network	Tokens for chainkeeping

Obj:

- Maximize supply of relevant data

Constraints = checklist:

- For priced data, is there incentive for supplying more? Referring? Spam prevention?
- For free data, "" ?
- Does the token give higher marginal value to users vs. hodlers?
- Are people incentivized to run keepers?
- Is it simple? Is onboarding low-friction?

2. Try Existing Patterns

1. Curation
2. Proofs of human or compute work
3. Identity
4. Reputation
5. Governance / software updates
6. Third-party arbitration
7. ...

2.1 Patterns for Curation

- **Binary** membership: Token Curated Registry (TCR)
- **Discrete-valued** membership: Layered TCR (like ALPS!)
- **Continuous-valued** membership: Curation Markets
- **Hierarchical** membership: each label gets a TCR
- **Work** tied to membership: Curated Proofs Market

2. Try existing patterns: evaluate on objectives & constraints. [Ex Ocean: None passed...]

Key Question	1	2	3	4
For priced data: incentive for supplying more? Referring?	✗	≈	✓	≈
For priced data: good spam prevention?	≈	✓	✓	✓
For free data: incentive for supplying more? Referring?	✗	≈	✗	✓
For free data: good spam prevention?	≈	✓	≈	✓
Does token give higher marginal value to users of the network, vs external investors? Eg Does return on capital increase as stake increases?	✓	✓	✓	✓
Are people incentivized to run keepers?	≈	≈	✓	✓
It simple? Is onboarding low-friction? Where possible, do we use incentives/crypto rather than legal recourse?	✓	✓	≈	≈

3. Try **new** patterns: evaluate on objectives & constraints. [Ex Ocean: pass!]

Key Question	1	2	3	4	5	6
For priced data: incentive for supplying more? Referring?	✗	≈	✓	≈	≈	✓
For priced data: good spam prevention?	≈	✓	✓	✓	✓	✓
For free data: incentive for supplying more? Referring?	✗	≈	✗	✓	✓	✓
For free data: good spam prevention?	≈	✓	≈	✓	≈	✓
Does token give higher marginal value to users of the network, vs external investors? Eg Does return on capital increase as stake increases?	✓	✓	✓	✓	✓	✓
Are people incentivized to run keepers?	≈	≈	✓	✓	✓	✓
It simple? Is onboarding low-friction? Where possible, do we use incentives/crypto rather than legal recourse?	✓	✓	≈	≈	✓	✓

Simulation of Tokenized Ecosystems?

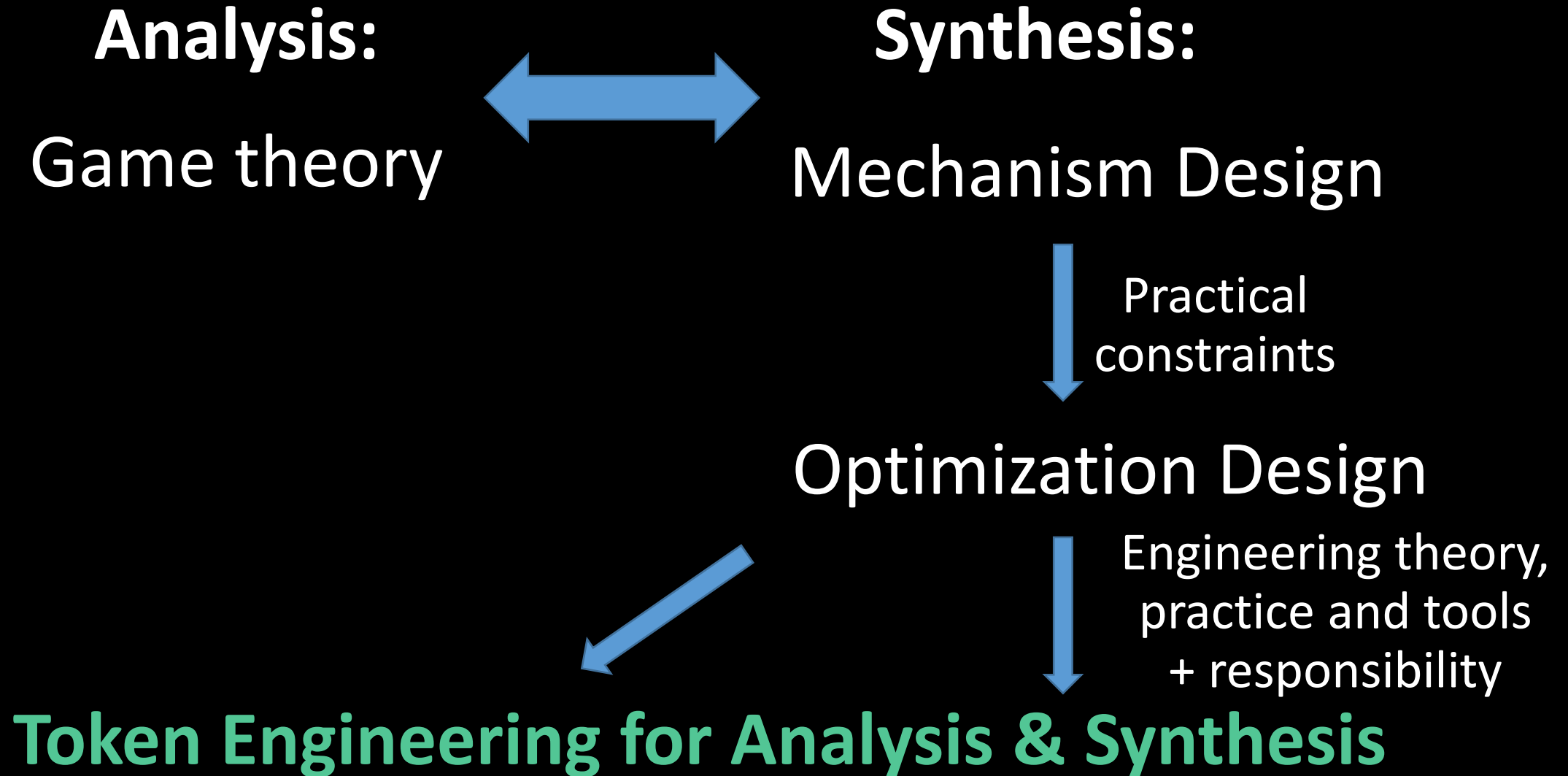
- Q: How do we design computer chips? (\$50M+ at stake)
- A: Simulator + CAD tools
- Q: How are we currently designing tokenized ecosystems? (\$1B+ at stake)
- A: By the seat of our pants! 🤯
- Which means we might be getting it all wrong!

What we (desperately) need:

1. Simulators: agent-based systems [Incentivai, ..]
2. CAD tools: for token design

Design of Tokenized Ecosystems

From Mechanism Design to *Token Engineering*





AI * Blockchain: AI DAOs

The background of the entire slide is a close-up photograph of a honeycomb. The hexagonal cells of the honeycomb are filled with a dark, viscous substance, likely honey. Numerous bees are visible, some resting on the cells and others in motion. The lighting is warm, highlighting the golden-brown tones of the bees and the honey.

Definition of AI DAO

“An AI running on decentralized processing substrate”

<or>

“A DAO running with AI algorithms”



The ArtDAO

1. Run AI art engine to generate new image, using GP or deep learning
2. Sell image on a marketplace, for crypto.
3. Repeat!

The background of the slide is a complex, abstract pattern. It features a mix of vibrant colors including reds, oranges, yellows, and greens, set against a darker, textured backdrop. The pattern appears to be a combination of organic, flowing shapes and more structured, grid-like elements, creating a visually rich and dynamic environment.

The ArtDAO

1. Run AI art engine to generate new image, using GP or deep learning
 2. Sell image on a marketplace, for crypto.
 3. Repeat!
- <Over time, it accumulates wealth, for *itself*.>

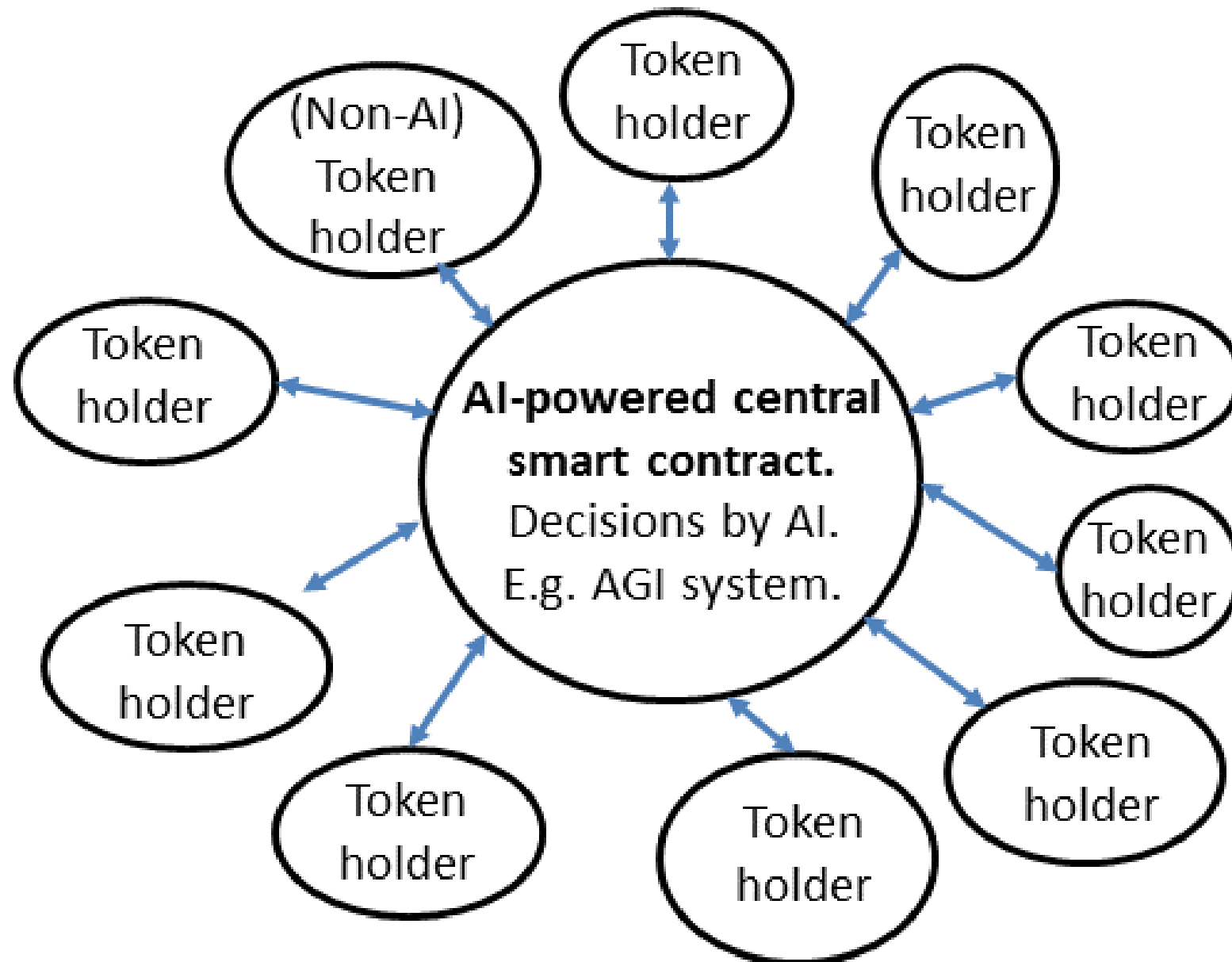
The ArtDAO

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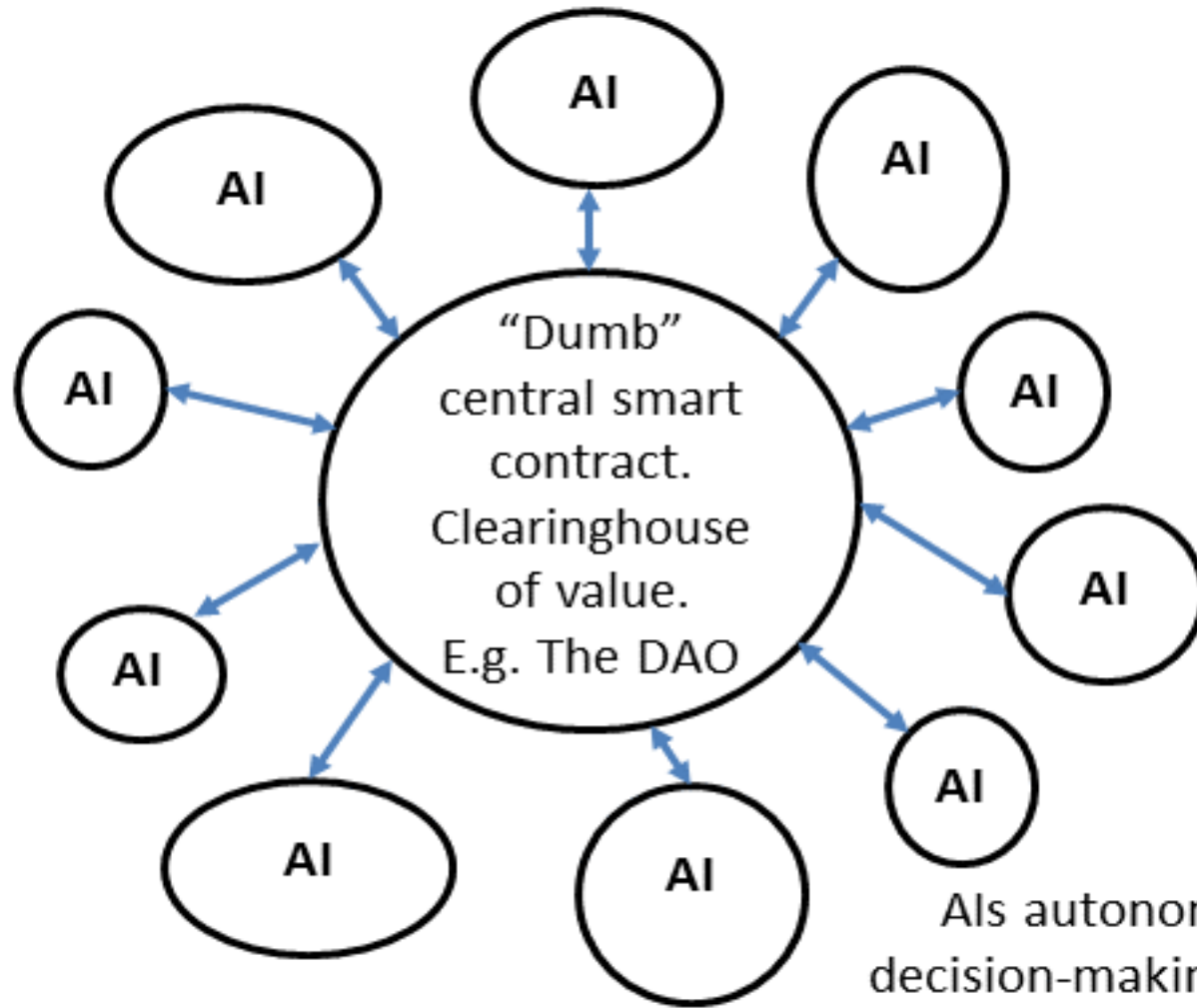
<Over time, it accumulates wealth, for *itself*.>

<It could even self-adapt: genetic programming>

AI DAO Arch 1: AI at the Center



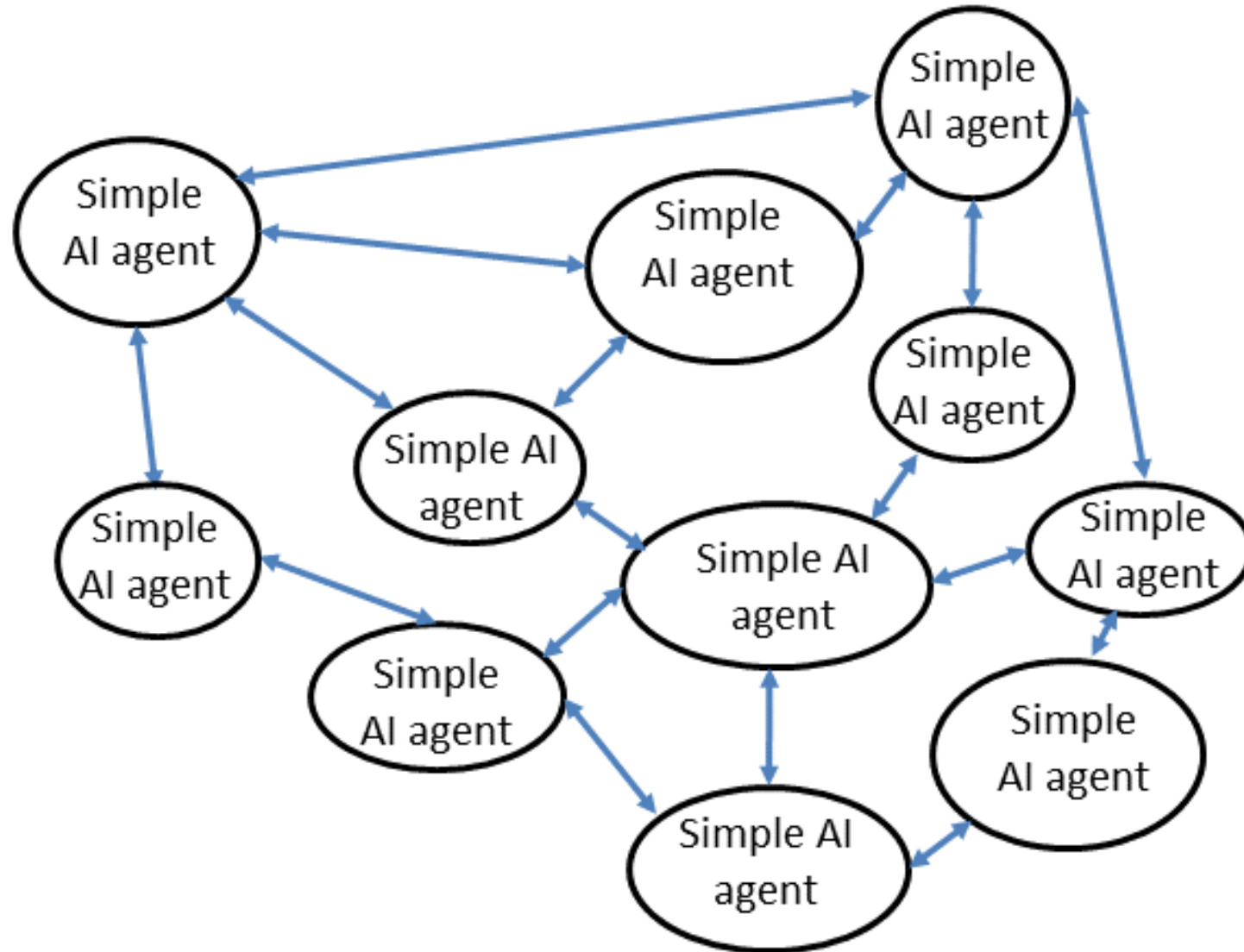
AI DAO Arch 2: AI at the *Edges*



Als autonomously do decision-making. AI may be narrow (e.g. deep nets) or more general (e.g. AGI)

AI DAO Arch 3: Swarm Intelligence

Many dumb agents with emergent AI complexity



Angles to Making AI DAOs

- DAO → AI DAO. Start with DAO, add AI.
- AI → AI DAO. Start with AI, add DAO.
- SaaS → DAO → AI DAO. SaaS to DAO, add AI
- Physical service → AI DAO

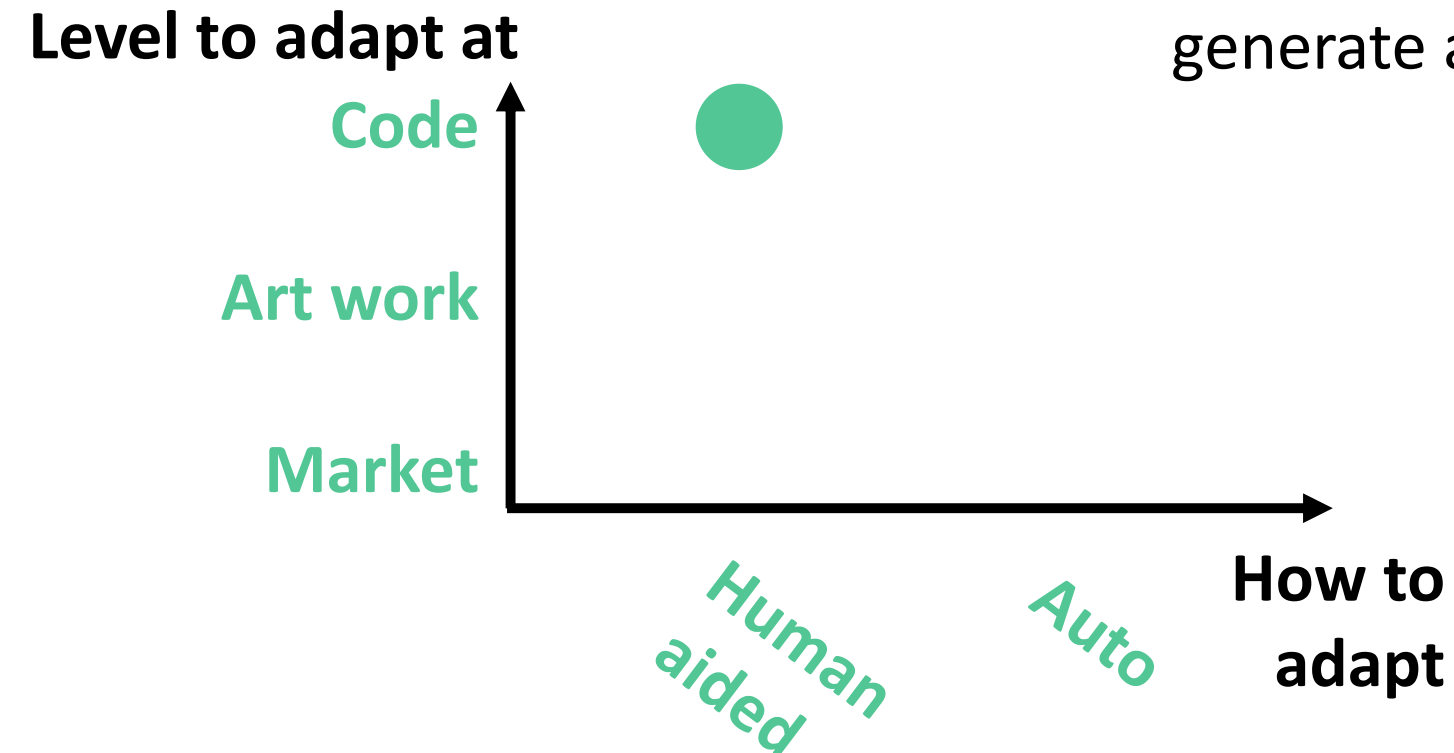
AI DAOs When Moon



Evolving the ArtDAO

Human-based adapt at the code level.

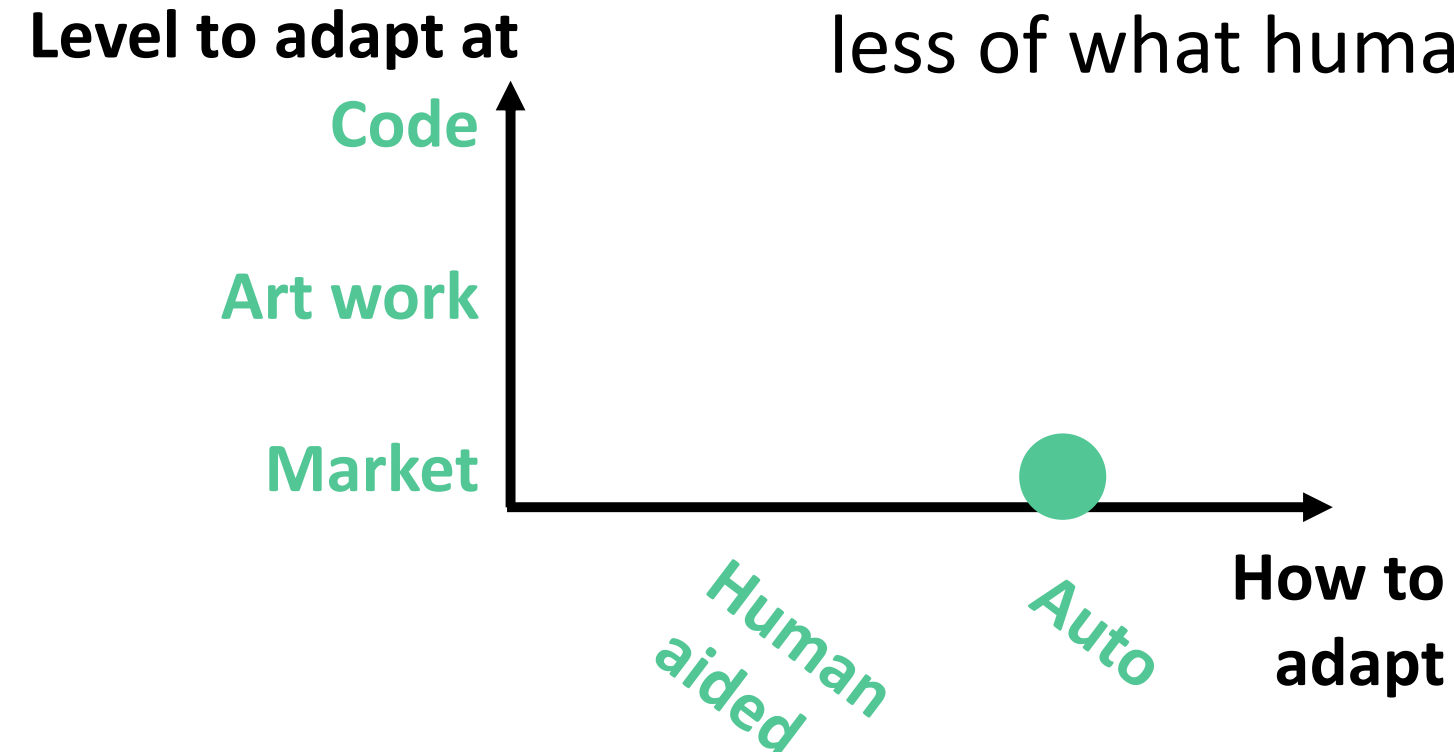
Here, humans put in new smart contract code (and related code in 3rd party services), to improve ArtDAO's ability to generate art and amass wealth.



Evolving the ArtDAO

Auto adapt at the market level.

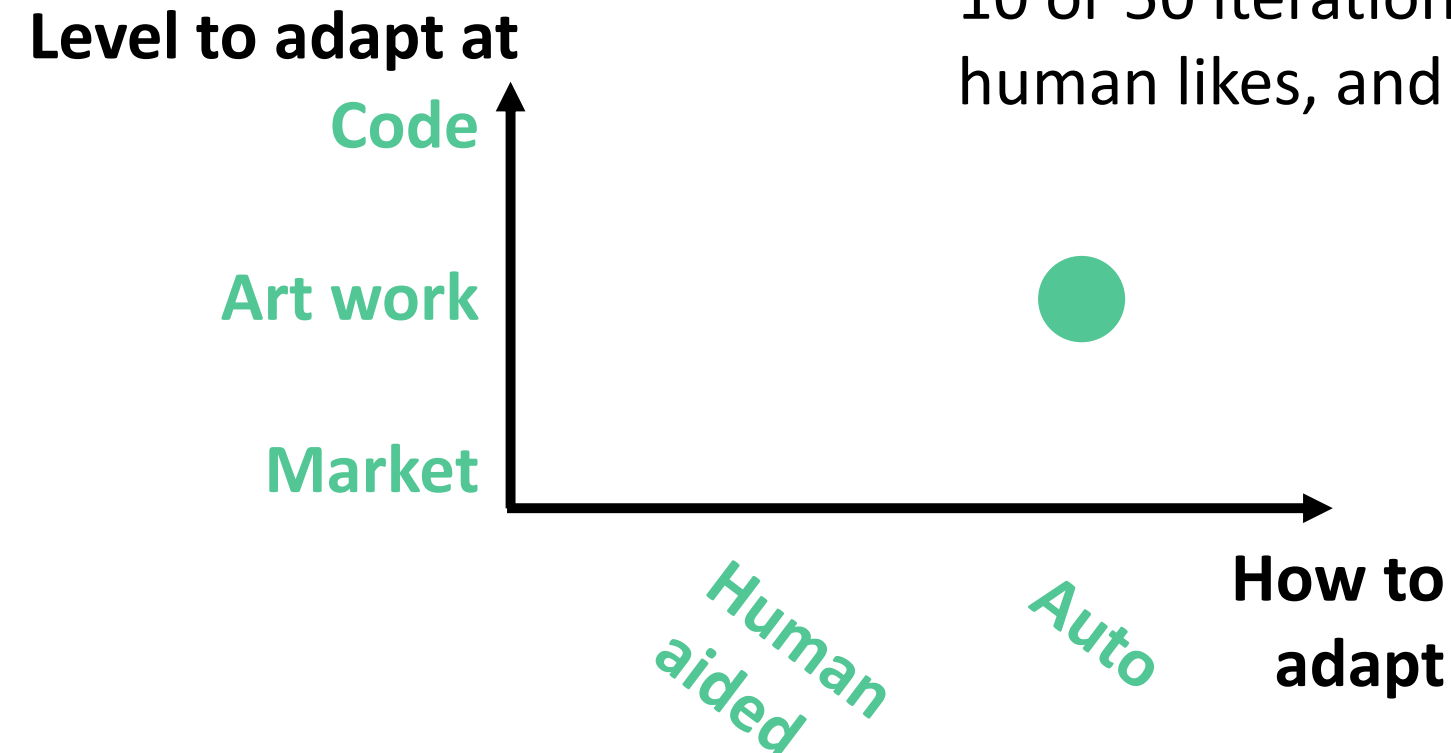
It creates more of what humans buy, and less of what humans don't buy.



Evolving the ArtDAO

Auto adapt at the art-work level.

Here, a human influences the creation of an artifact. For example, it presents four variants of a work, and a human clicks on a favorite. After 10 or 50 iterations, it will have a piece that the human likes, and purchases.

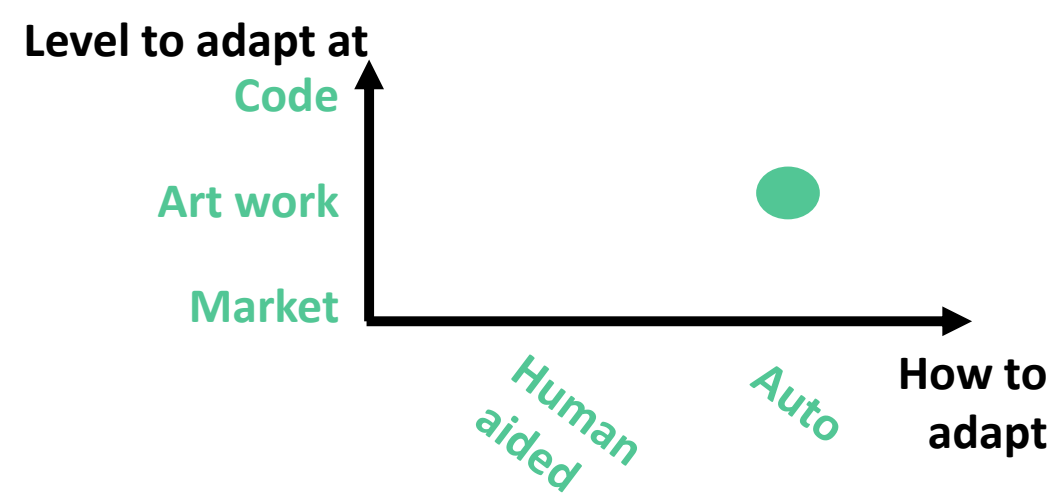


Evolving the ArtDAO

Auto adapt at the code level.

Here, the ArtDAO modifies its own code, in hopes of improving.

- It creates a copy of itself, changes that copy's code just a little bit, and gives a tiny bit of resources to that new copy.
- If that new copy is bad, it will simply run out of resources and be ignored.
- But **if that new copy is truly an improvement, the market will reward it**, and it will be able to amass resources and split more on its own.
- Over time, ArtDAO will spawn more children, and grandchildren, and the ones that do well will continue to spread. We end up with a mini-army of AI DAOs for art.
- If buyers are DAOs too, it's a network of DAOs, leading to swarm intelligence



Giving Personhood to an AI DAO With Today's Laws (!)



Trent McConaghy

@trentmc0



How to give an AI rights

1. Given: corps have rights
2. Start a corp
3. Automate corp into an AI DAO
4. Done! It's an AI, it has rights

RETWEETS

22

LIKES

30



11:40 PM - 4 Jul 2016



5



22



30



**Self-driving,
self-owning cars**



Self-driving, self-owning trucks



An aerial photograph of a winding asphalt road on a steep, grassy mountain slope. The road features multiple sharp turns and is bordered by a concrete guardrail. The surrounding terrain is covered in green and yellowish vegetation, with some rocky patches visible. The road curves from the top left towards the bottom right of the frame.

**Self-owning
roads**

A photograph of three wind turbines at sunset. The sky is a mix of deep blue, orange, and yellow. The turbines are silhouetted against the bright horizon. A dark rectangular box with white text is overlaid on the right side of the image.


Self-owning wind farms

Self-owning grid



**Machines → Nature:
“Plantoid”**



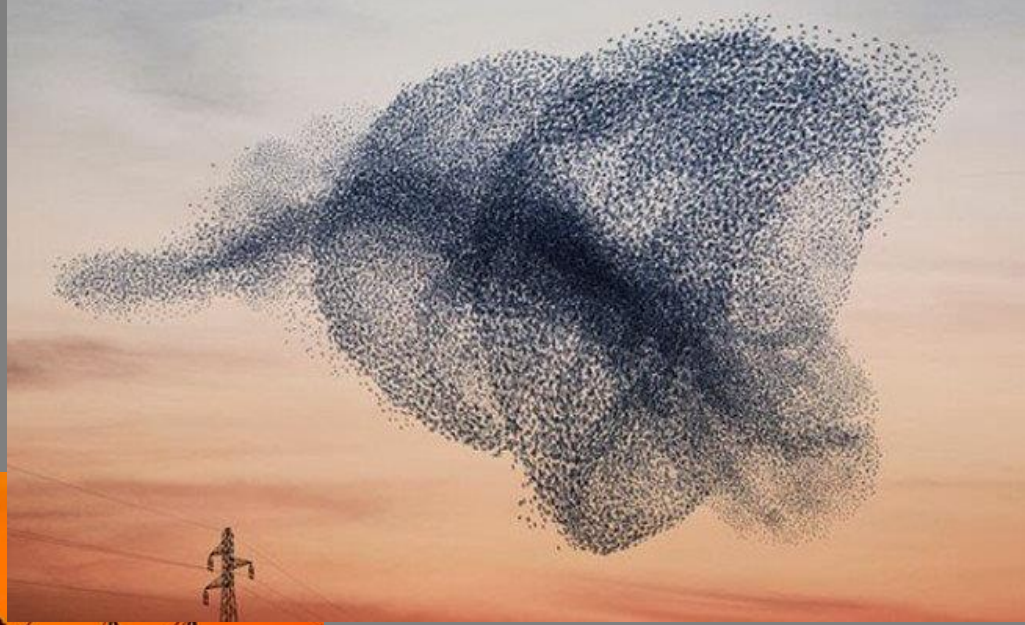


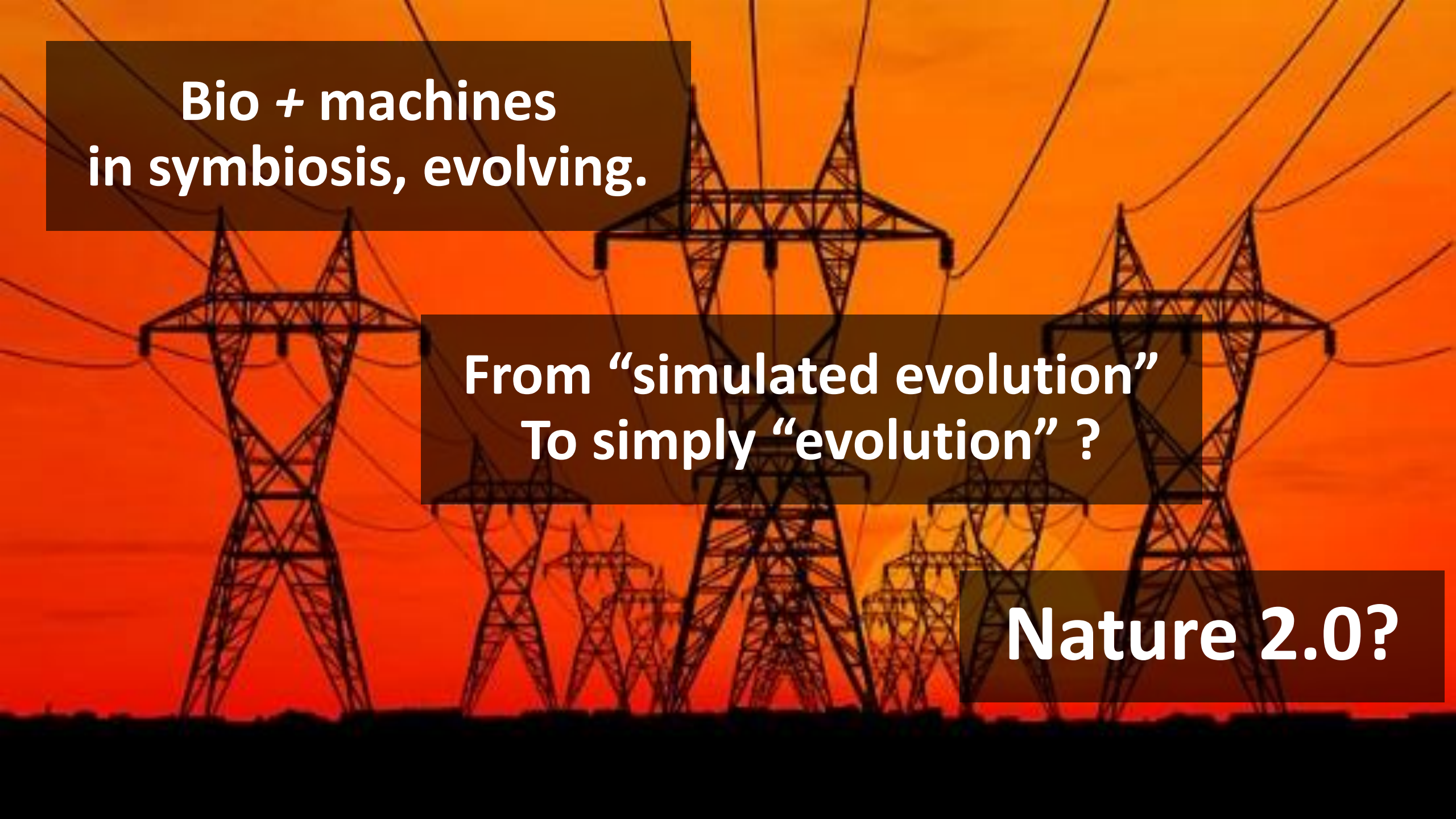
**Nature → Machines:
Self-owning forest “Terra0”**

Ever-higher levels of integration

From beasts → ecosystems

Connected via IoT / M2M



The background of the slide features a series of high-voltage power line towers, also known as pylons, stretching into the distance. They are silhouetted against a vibrant, orange-hued sky, suggesting a sunset or sunrise. The perspective is from a low angle, looking up at the towers, which creates a sense of scale and depth. The overall aesthetic is industrial and evocative, linking the theme of machines to the natural world.


**Bio + machines
in symbiosis, evolving.**

**From “simulated evolution”
To simply “evolution” ?**

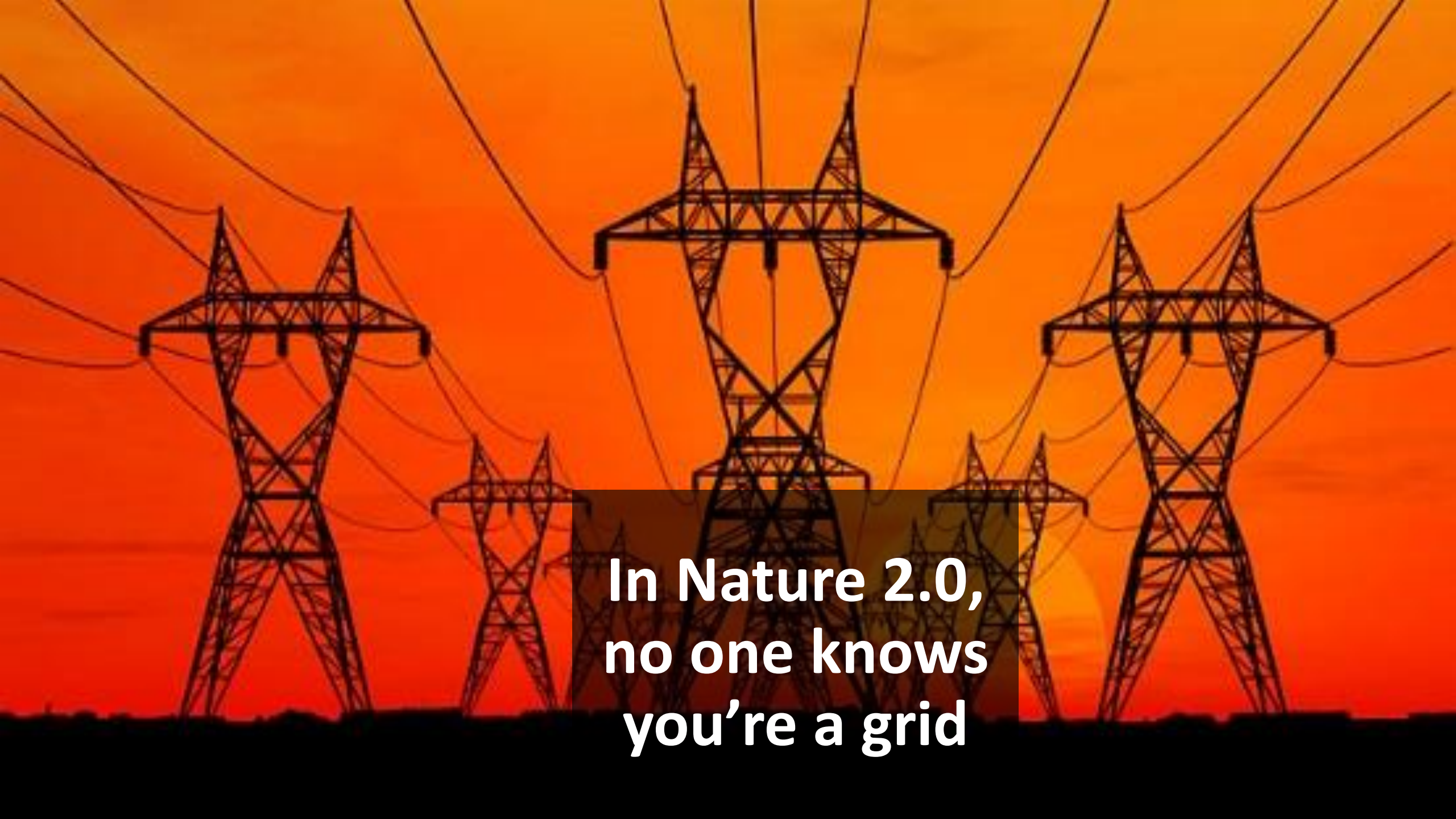
Nature 2.0?

The background is a warm, golden-yellow color. It features a complex, interconnected network of thin, golden lines. These lines are punctuated by numerous small, dark, spherical beads. Some of these beads are larger and more prominent, while others are smaller and more numerous, creating a textured, almost crystalline appearance. The lines and beads form a web-like structure that fills the entire frame.

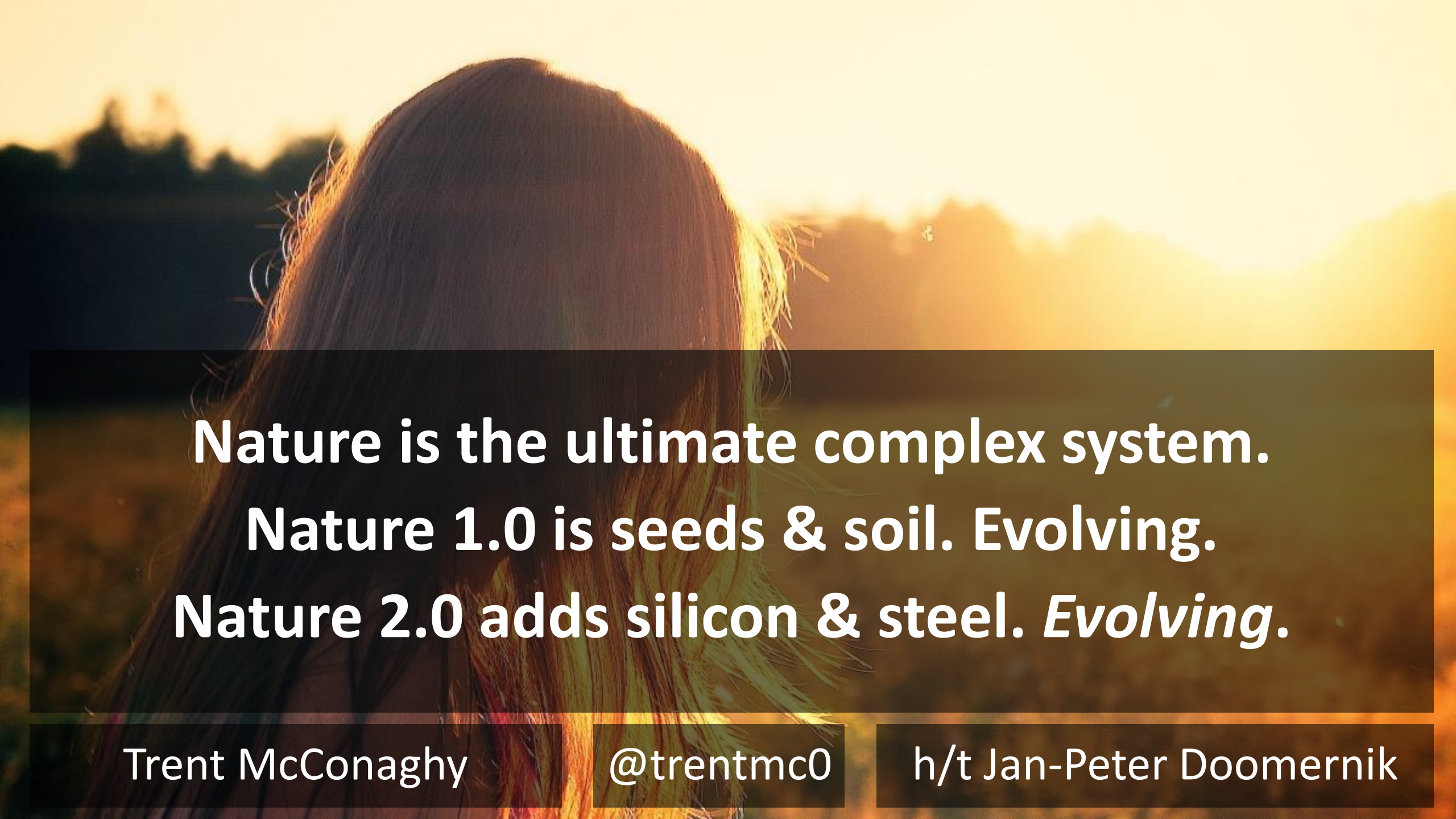
Conclusion

A photograph of a dense forest. Sunlight filters through the canopy, creating a warm, golden glow. The forest floor is covered in green undergrowth and fallen branches. The text is overlaid on a dark, semi-transparent rectangular background in the lower center of the image.

**In Nature 2.0,
no one knows
you're a forest**

The image features a series of high-voltage power line towers, also known as pylons, silhouetted against a vibrant orange and red sky, suggesting a sunset or sunrise. The towers are arranged in a perspective that leads the eye from the foreground towards the horizon. The sky is a gradient of warm colors, with the sun's glow visible near the horizon line. The overall mood is one of industrial scale against the elements of nature.

**In Nature 2.0,
no one knows
you're a grid**

A person with long, dark hair is seen from behind, looking out over a field towards a bright sunset. The sun is low on the horizon, creating a warm, golden glow that fills the sky and reflects off the person's hair. The background shows a line of trees and a field under the soft light of dusk.

Nature is the ultimate complex system.
Nature 1.0 is seeds & soil. Evolving.
Nature 2.0 adds silicon & steel. *Evolving.*

Trent McConaghy

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h/t Jan-Peter Doornik