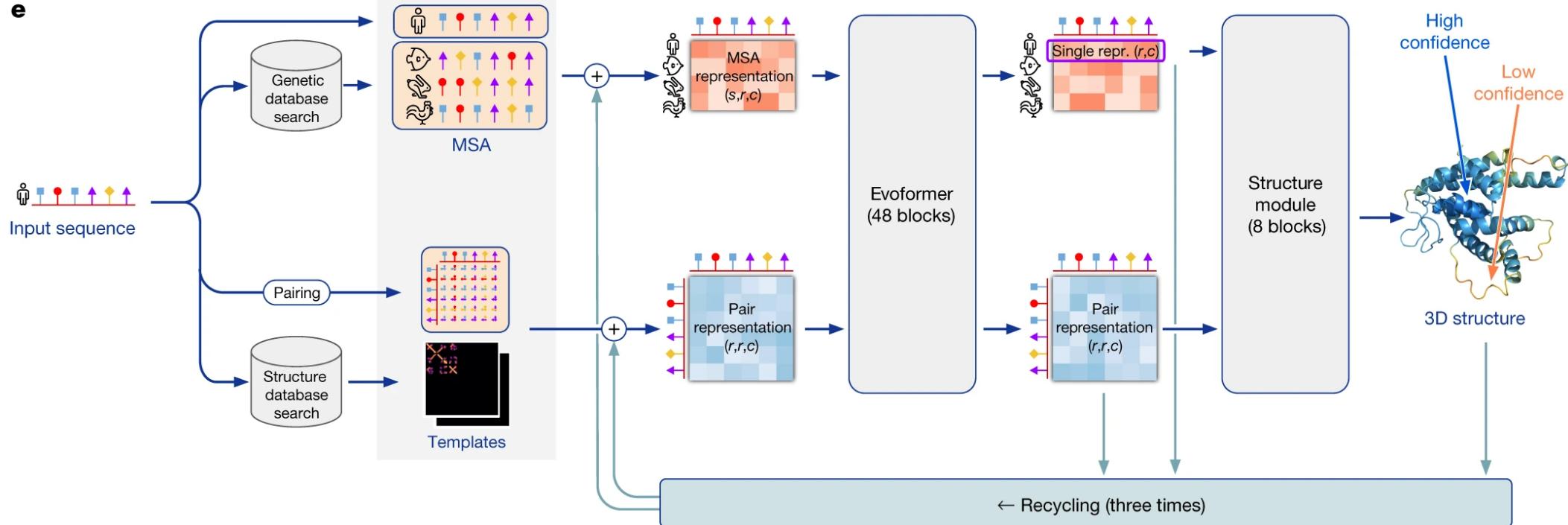
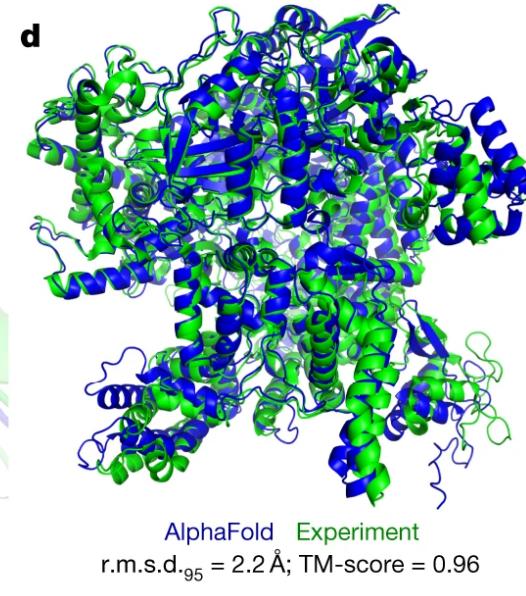
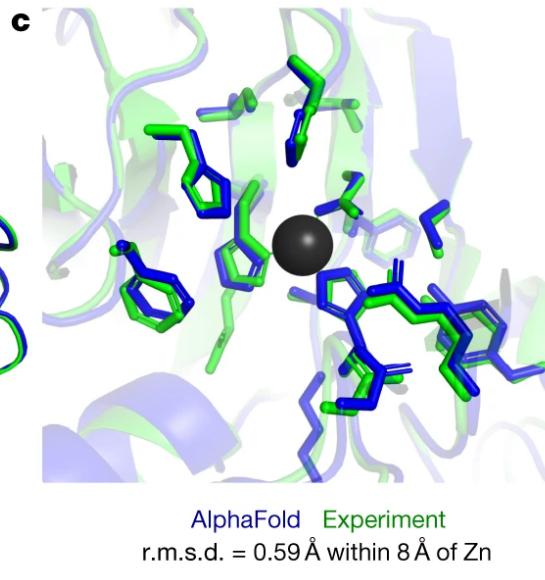
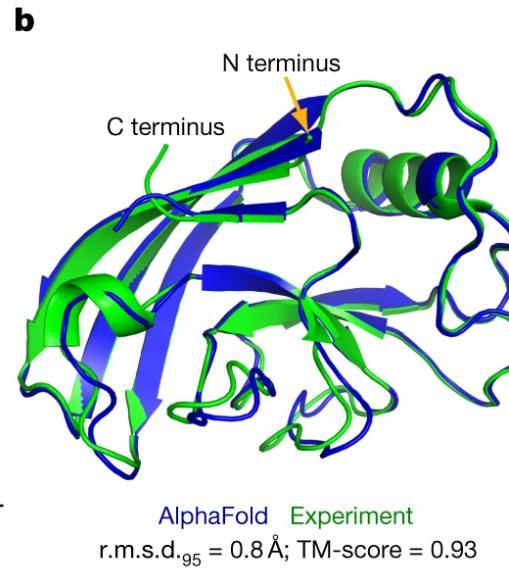
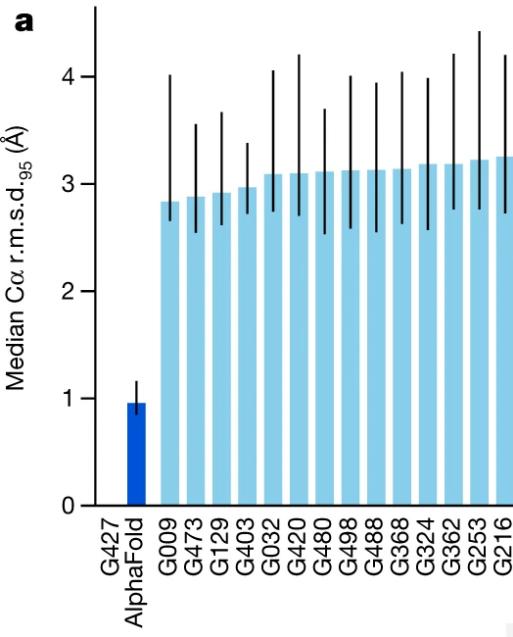


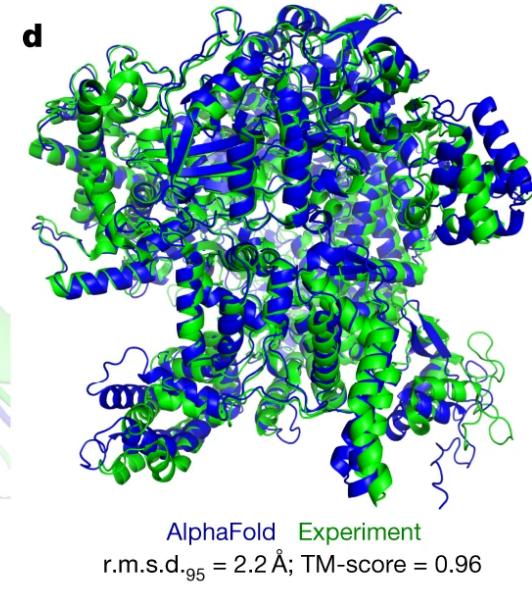
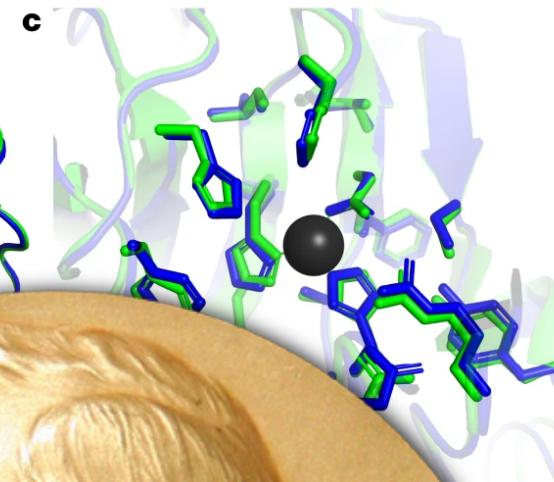
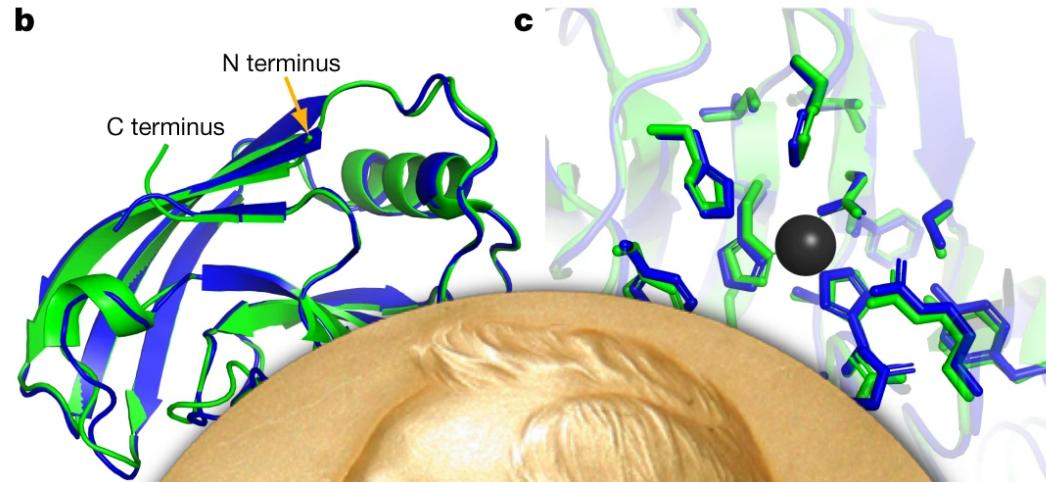
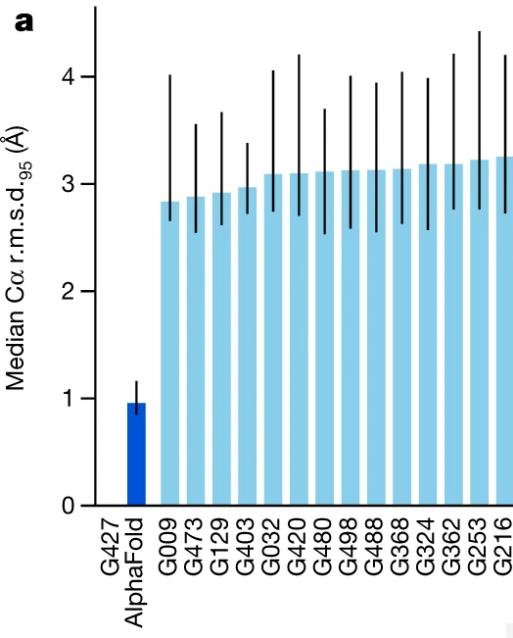
IDEAL OBJECTS

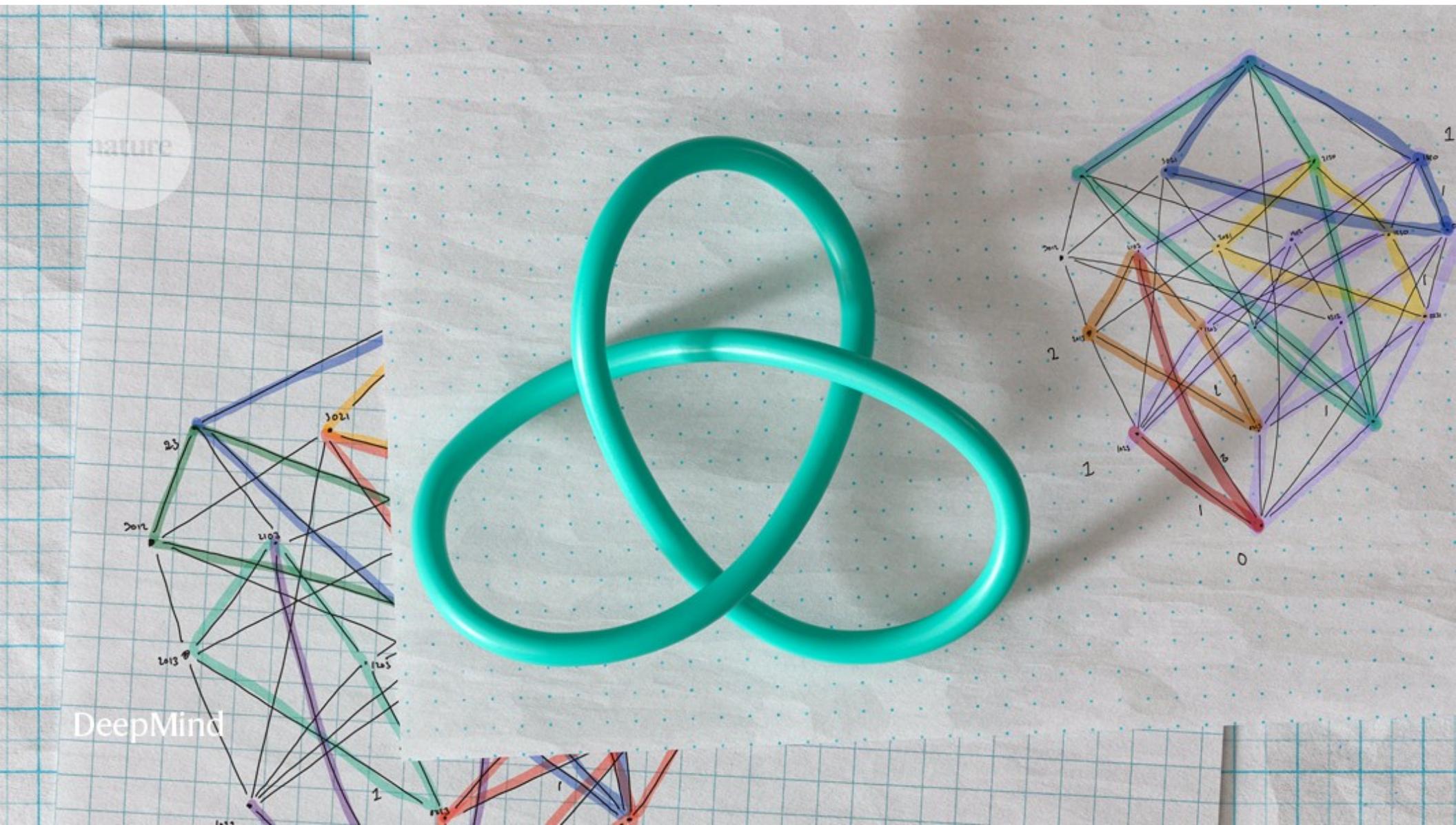
AI, ABSTRACTION, AND THE NATURE OF CULTURE



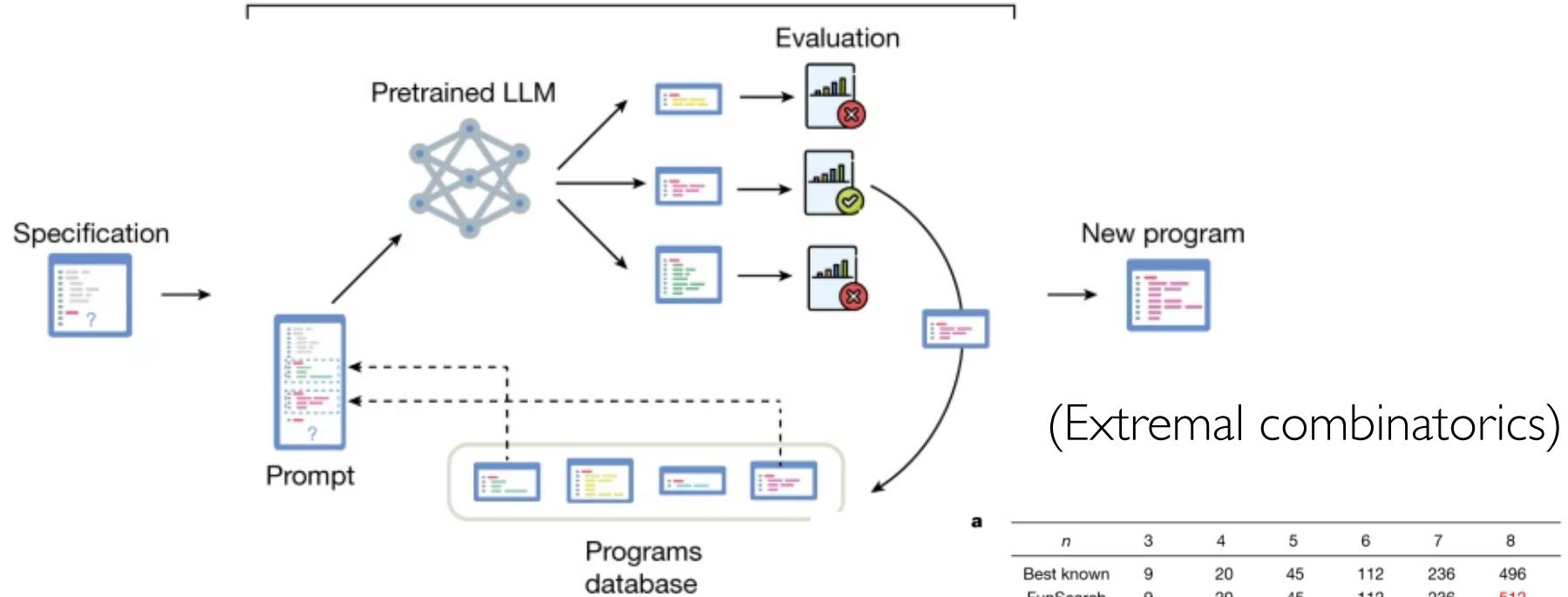
Jacob G. Foster, Indiana University
External Professor, Santa Fe Institute







FunSearch



| <i>n</i> | 3 | 4 | 5 | 6 | 7 | 8 |
|------------|---|----|----|-----|-----|------------|
| Best known | 9 | 20 | 45 | 112 | 236 | 496 |
| FunSearch | 9 | 20 | 45 | 112 | 236 | 512 |

a

```

def priority(el: tuple[int,...],
            n: int) -> float:
    score = n
    in_el = 0
    el_count = el.count(0)

    if el_count == 0:
        score += n**2
    if el[1] == el[-1]:
        score *= 1.5
    if el[2] == el[-2]:
        score *= 1.5
    if el[3] == el[-3]:
        score *= 1.5
    else:
        if el[1] == el[-1]:
            score *= 0.5
        if el[2] == el[-2]:
            score *= 0.5

    for e in el:
        if e == 0:
            if in_el == 0:
                score *= n * 0.5
            elif in_el == el_count - 1:
                score *= 0.5
            else:
                score *= n * 0.5 ** in_el
                in_el += 1
        else:
            score += 1

    if el[1] == el[-1]:
        score *= 1.5
    if el[2] == el[-2]:
        score *= 1.5

    return score

```

b

```

def build_512_cap() -> list[tuple[int,...]]:
    """Returns a cap set of size 512 in 'n=8' dimensions."""
    n = 8
    V = np.array(list(itertools.product(range(8), repeat=n)), dtype=np.int32)
    support = lambda v: tuple(i for i in range(n) if v[i] != 0)
    reflections = lambda v:sum (1 for i in range(1, n// 2) if v[i] == v[-i])

    # Add all 128 weight-8 vectors that have >= 2 reflections.
    weight8_vectors = [v for v in V
                       if np.count_nonzero(v) == 8 # Weight is 8.
                           and reflections(v) >= 2] # At least 2 reflections.

    # Add all 128 weight-4 vectors that have specific support.
    supports_16 = [(0, 1, 2, 3), (0, 1, 2, 5), (0, 3, 6, 7), (0, 5, 6, 7),
                    (1, 3, 4, 6), (1, 4, 5, 6), (2, 3, 4, 7), (2, 4, 5, 7)]
    weight4_vectors = [v for v in V
                       if support(v) in supports_16]

    # Add all 128 weight-4 vectors with specific support and 1 reflection.
    supports_8 = [(0, 1, 2, 7), (0, 1, 2, 6), (0, 1, 3, 7), (0, 1, 6, 7),
                  (0, 1, 5, 7), (0, 2, 3, 6), (0, 2, 6, 7), (0, 2, 5, 6),
                  (1, 2, 4, 7), (1, 2, 4, 6), (1, 3, 4, 7), (1, 4, 6, 7),
                  (1, 4, 5, 7), (2, 3, 4, 6), (2, 4, 6, 7), (2, 4, 5, 6)]
    weight4_vectors_2 = [v for v in V
                         if support(v) in supports_8
                             and reflections(v) == 1] # Exactly 1 reflection.

    # Add 128 weight-5 vectors with <= 1 reflections and one more condition.
    allowed_zeros = [(0, 4, 7), (0, 2, 4), (0, 1, 4), (0, 4, 6),
                     (1, 2, 6), (2, 6, 7), (1, 2, 7), (1, 6, 7)]
    weight5_vectors = [
        v for v in V
        if tuple(i for i in range(n) if v[i] == 0) in allowed_zeros
            and reflections(v) <= 1 # At most 1 reflection.
            and (v[1] * v[7]) % 3 != 1 and (v[2] * v[6]) % 3 != 1]

    return weight8_vectors + weight4_vectors + weight4_vectors_2 +
           weight5_vectors

```

c



Different kinds of creativity

Different kinds of creativity

Margaret Boden



Different kinds of creativity

- Exploratory
- Combinatorial
- Transformational

Margaret Boden



Different kinds of creativity

- **Exploratory**
- Combinatorial
- Transformational

Margaret Boden





Different kinds of creativity

- Exploratory
- Combinatorial
- Transformational

Margaret Boden





Tradition

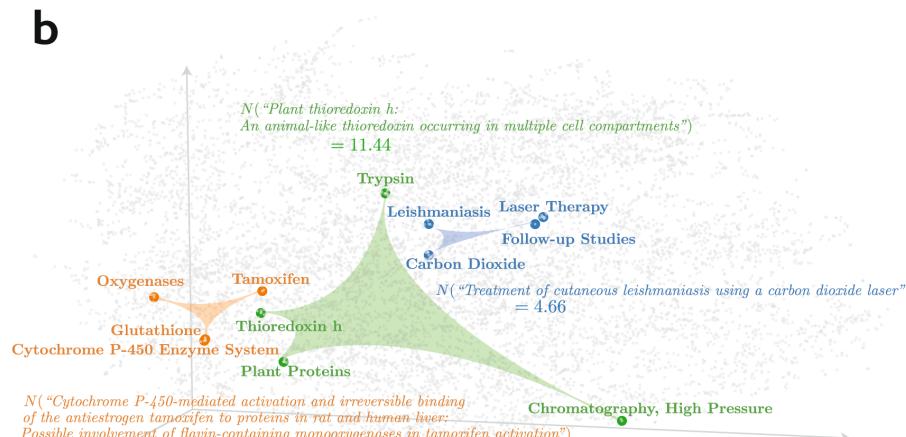
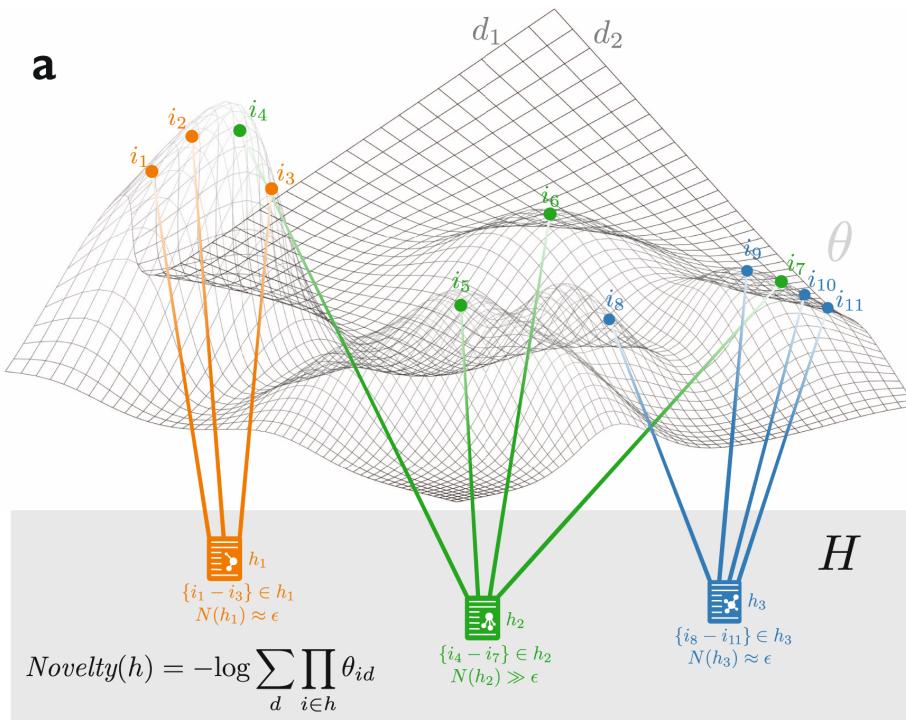


Innovation

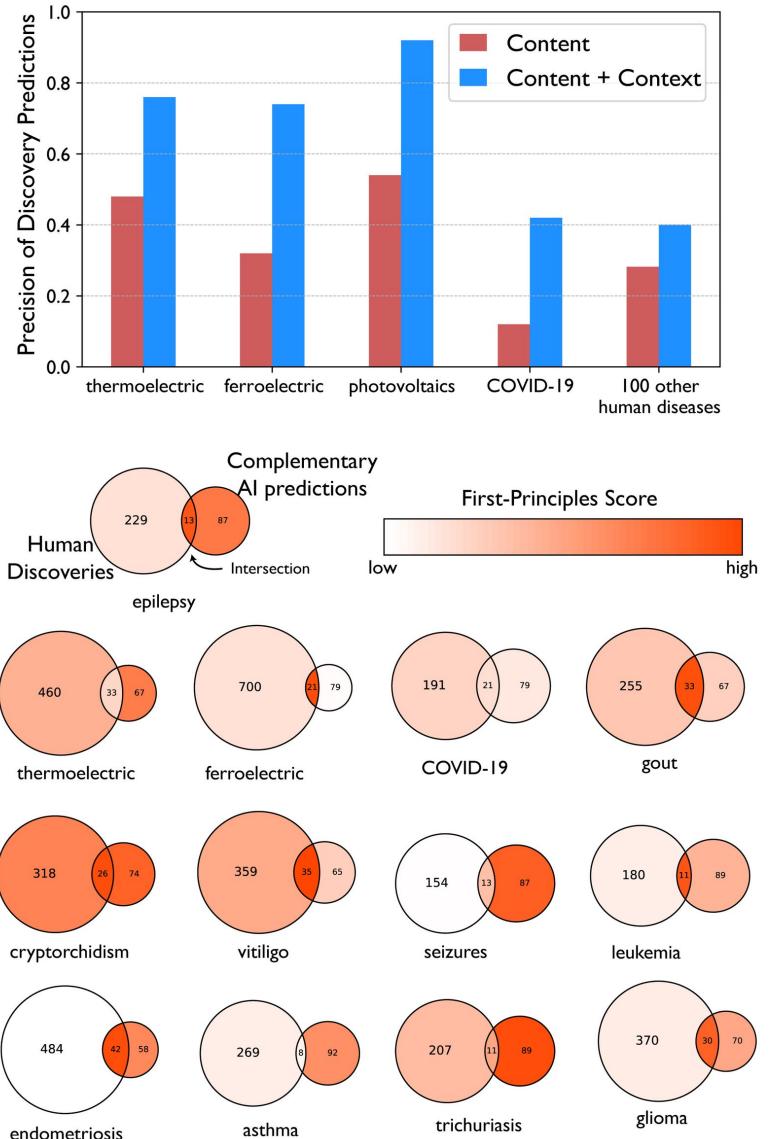


Foster, Rzhetsky, Evans (2015)

Science is predictable

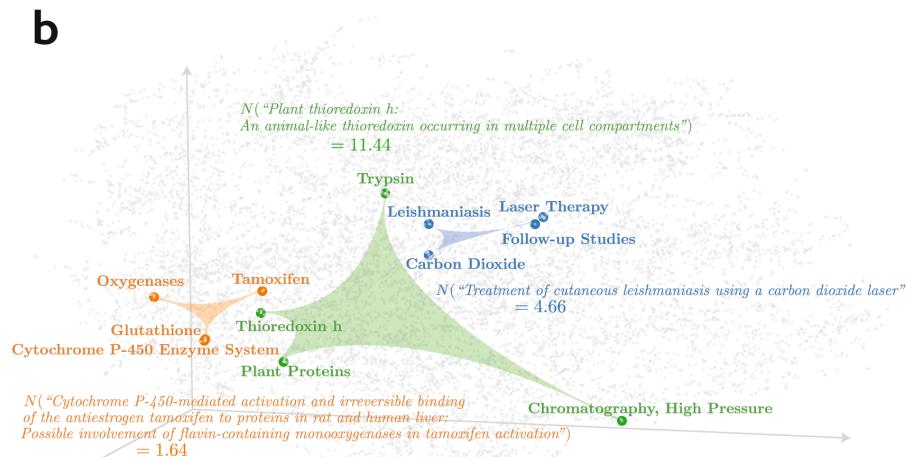
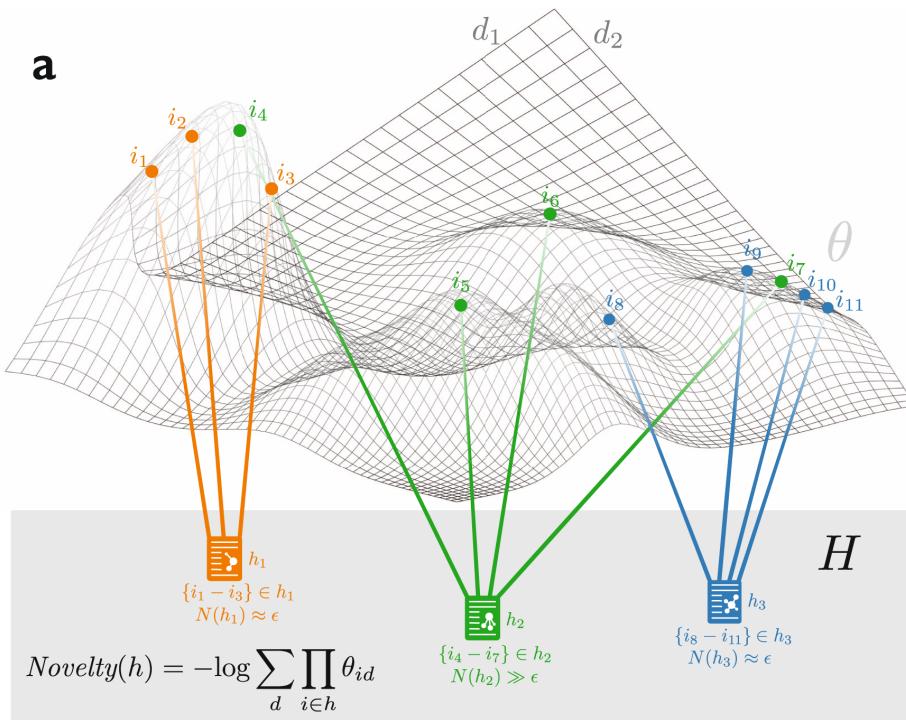


Shi & Evans 2023

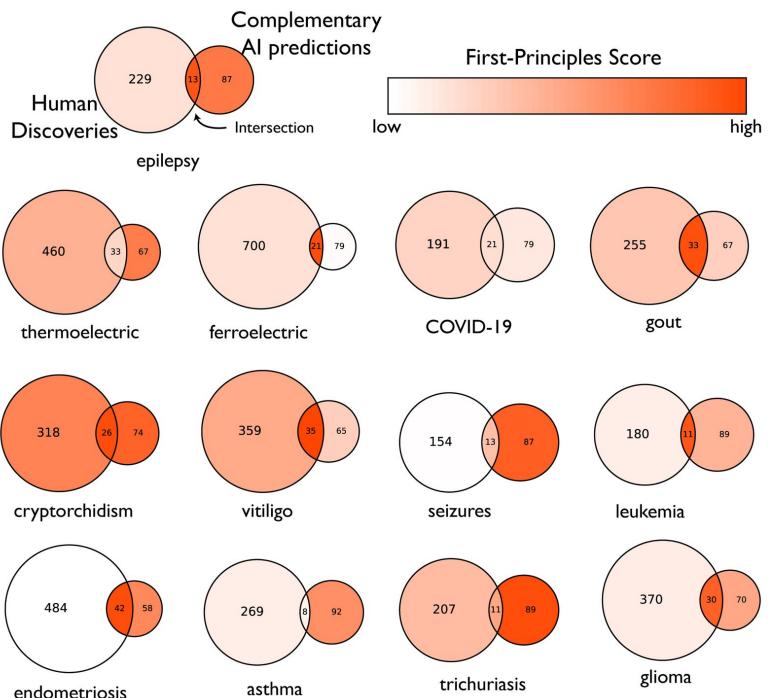
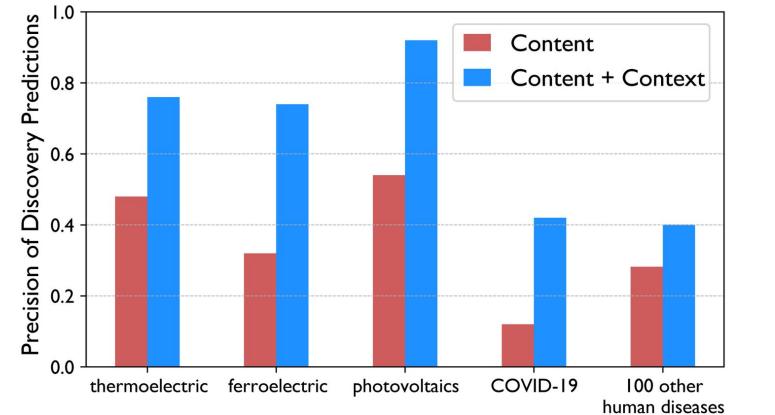


Sourati, Belikov & Evans 2022

AI can exploit this to speed up search



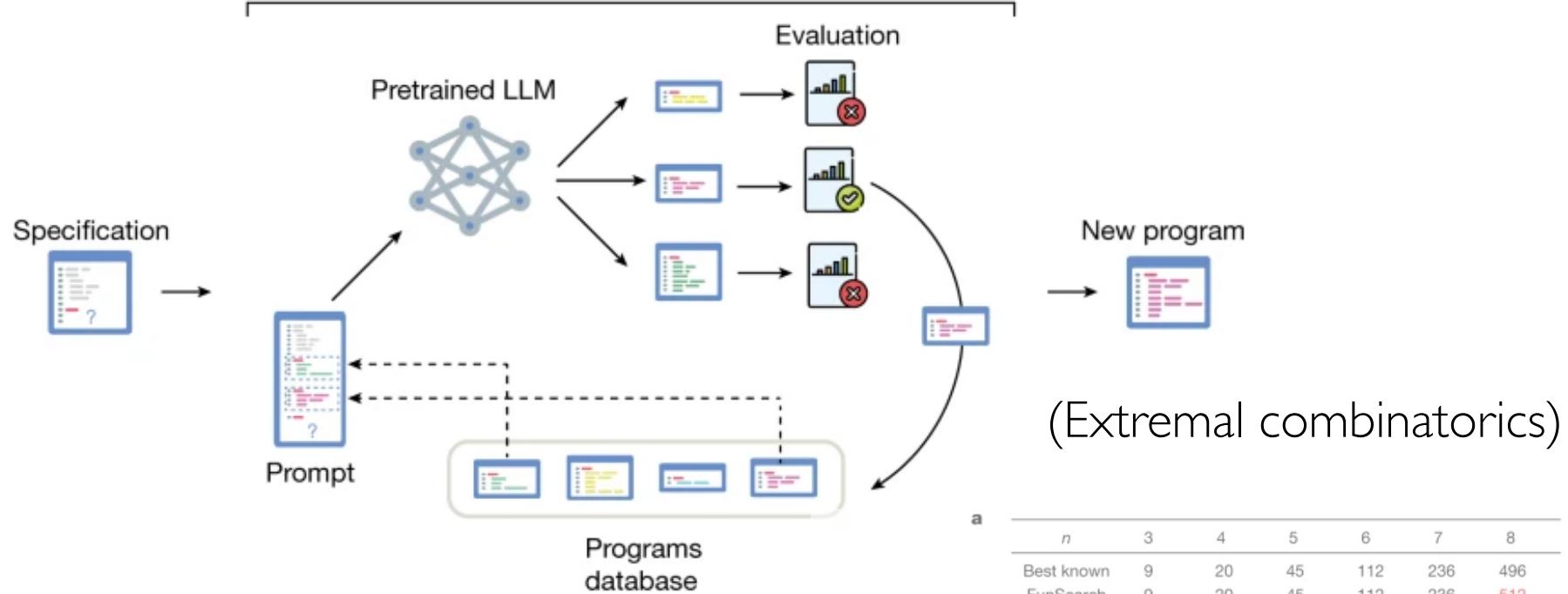
Shi & Evans 2023



Sourati, Belikov & Evans 2022



FunSearch



| <i>n</i> | 3 | 4 | 5 | 6 | 7 | 8 |
|------------|---|----|----|-----|-----|------------|
| Best known | 9 | 20 | 45 | 112 | 236 | 496 |
| FunSearch | 9 | 20 | 45 | 112 | 236 | 512 |

a

```

def priority(el: tuple[int,...],
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    el_count = el.count(0)

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    if el[1] == el[-1]:
        score *= 1.5
    if el[2] == el[-2]:
        score *= 1.5
    if el[3] == el[-3]:
        score *= 1.5
    else:
        if el[1] == el[-1]:
            score *= 0.5
        if el[2] == el[-2]:
            score *= 0.5
    for e in el:
        if e == 0:
            if in_el == 0:
                score *= n * 0.5
            elif in_el == el_count - 1:
                score *= 0.5
            else:
                score *= n * 0.5 ** in_el
                in_el += 1
        else:
            score += 1

    if el[1] == el[-1]:
        score *= 1.5
    if el[2] == el[-2]:
        score *= 1.5

    return score

```

b

```

def build_512_cap() -> list[tuple[int,...]]:
    """Returns a cap set of size 512 in 'n=8' dimensions."""
    n = 8
    V = np.array(list(itertools.product(range(8), repeat=n)), dtype=np.int32)
    support = lambda v: tuple(i for i in range(n) if v[i] != 0)
    reflections = lambda v:sum (1 for i in range(1, n// 2) if v[i] == v[-i])

    # Add all 128 weight-8 vectors that have >= 2 reflections.
    weight8_vectors = [v for v in V
                        if np.count_nonzero(v) == 8 # Weight is 8.
                        and reflections(v) >= 2] # At least 2 reflections.

    # Add all 128 weight-8 vectors that have specific support.
    supports_16 = [(0, 1, 2, 3), (0, 1, 2, 5), (0, 3, 6, 7), (0, 5, 6, 7),
                   (1, 2, 3, 4), (1, 2, 4, 6), (1, 4, 5, 6), (2, 3, 4, 5),
                   (2, 4, 5, 7)]
    weight8_vectors += [v for v in V
                        if support(v) in supports_16
                        and reflections(v) >= 2] # At least 2 reflections.

    # Add all 128 weight-8 vectors that have specific support.
    supports_16_2 = [(0, 1, 2, 3), (0, 1, 2, 5), (0, 3, 6, 7), (0, 5, 6, 7),
                     (1, 2, 3, 4), (1, 2, 4, 6), (1, 4, 5, 6), (2, 3, 4, 5),
                     (2, 4, 5, 7), (0, 3, 4, 6), (2, 4, 6, 7), (2, 4, 5, 6)]
    weight8_vectors += [v for v in V
                        if support(v) in supports_16_2
                        and reflections(v) >= 2] # At least 2 reflections.

    # Add 128 weight-5 vectors with <= 1 reflections and one more condition.
    allowed_zeros = [(0, 4, 7), (0, 2, 4), (0, 1, 4), (0, 4, 6),
                      (1, 2, 6), (2, 6, 7), (1, 2, 7), (1, 6, 7)]
    weight5_vectors = [
        v for v in V
        if tuple(i for i in range(n) if v[i] == 0) in allowed_zeros
        and reflections(v) <= 1 # At most 1 reflection.
        and (v[1] * v[7]) % 3 != 1 and (v[2] * v[6]) % 3 != 1]

    return weight8_vectors + weight4_vectors + weight4_vectors_2 +
           weight5_vectors

```

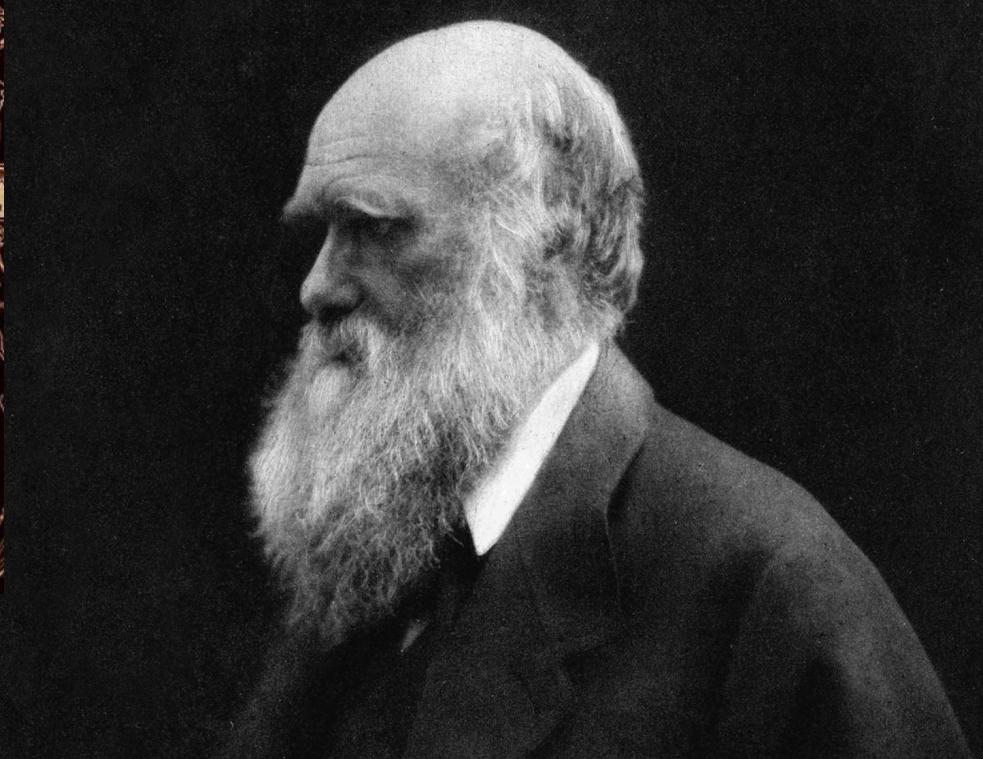
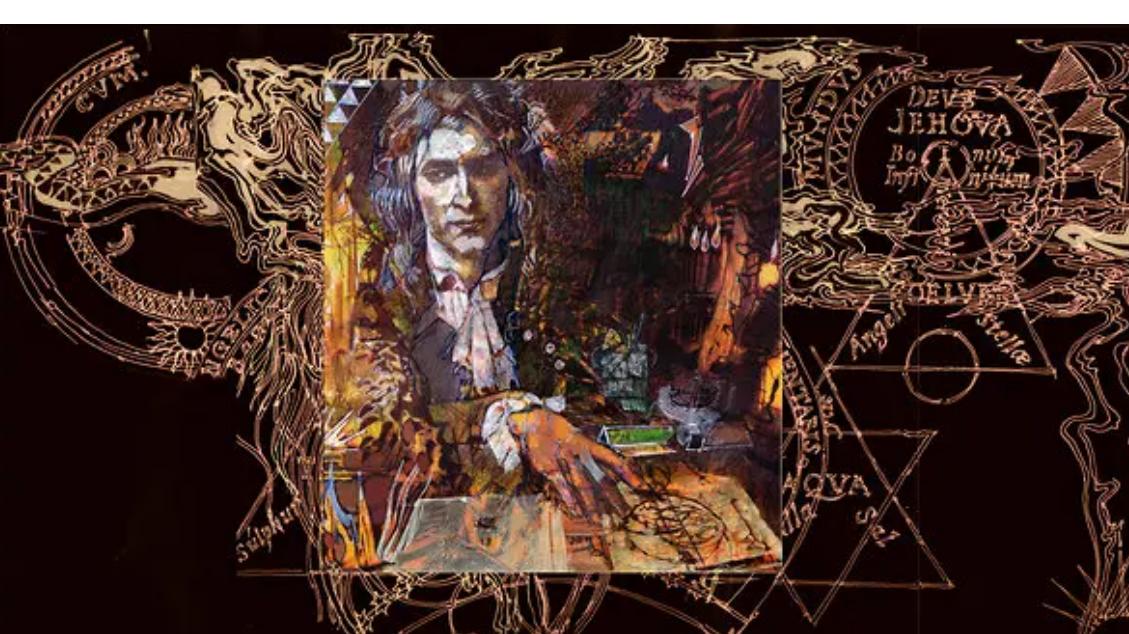
c

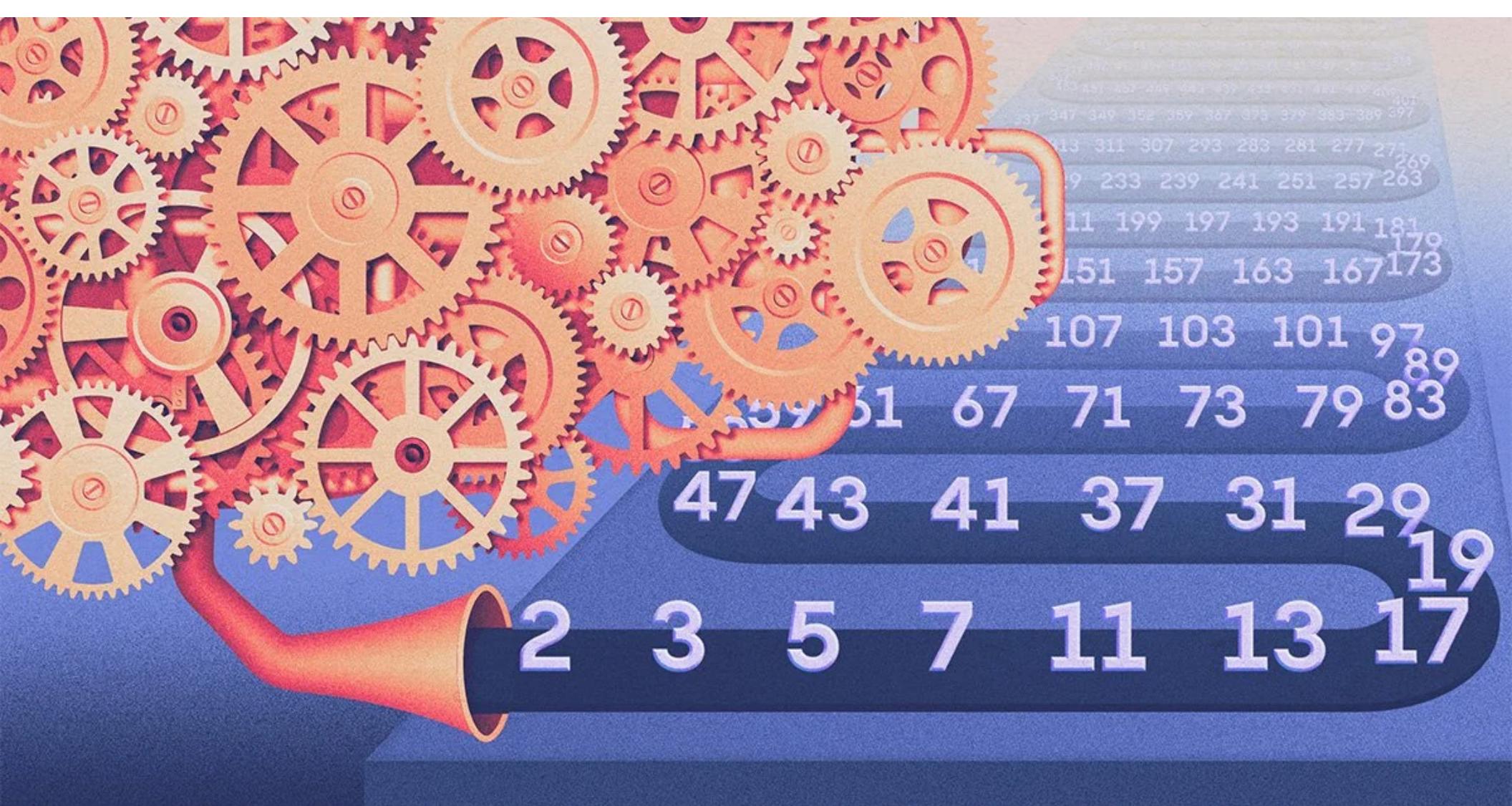
Different kinds of creativity

- Exploratory
- Combinatorial
- Transformational

Margaret Boden



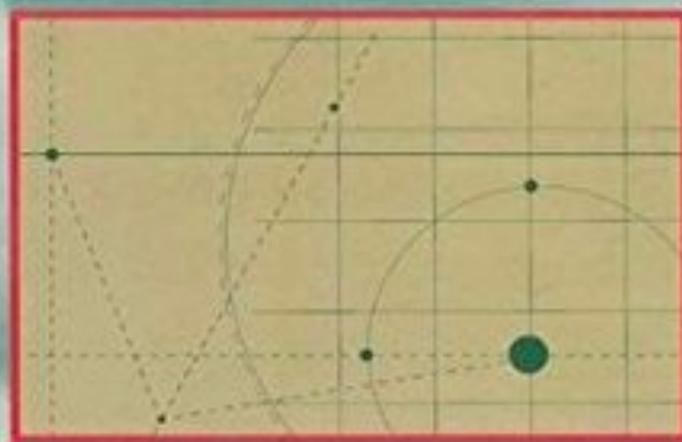




Why Mathematicians Re-Prove What They Already Know



Lichtung = *Clearing*



Indiscrete

Thoughts

Gian-Carlo Rota

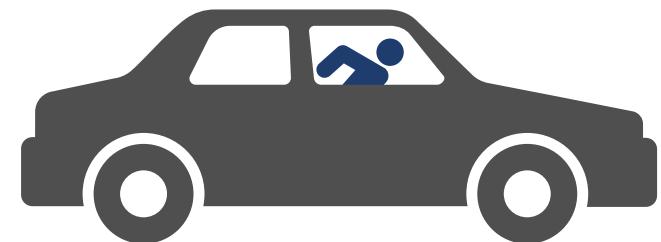
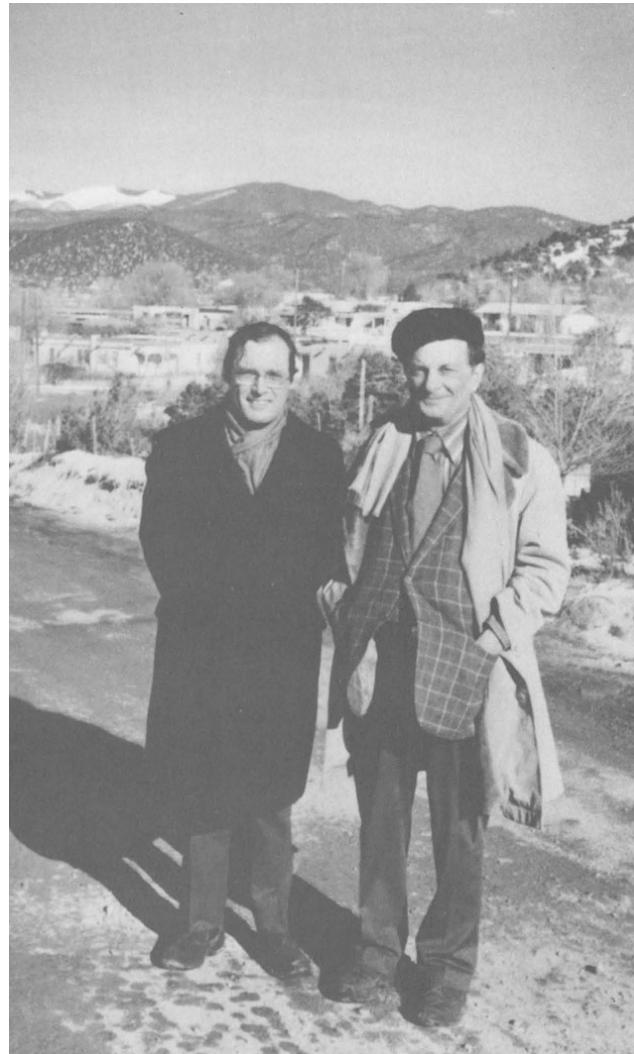
Springer Science+Business Media, LLC



Stan Ulam

IM-4:PUB69-114-001

The Barrier of Meaning



"When you perceive intelligently, as you sometimes do, you always perceive a function, never an object in the set-theoretic or physical sense."

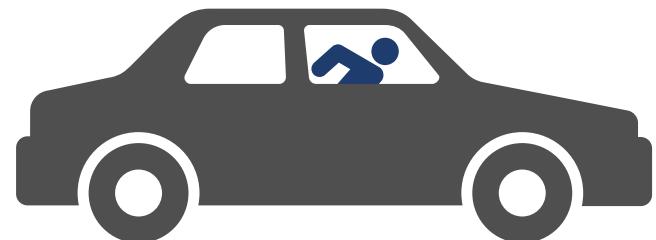
The Barrier of Meaning

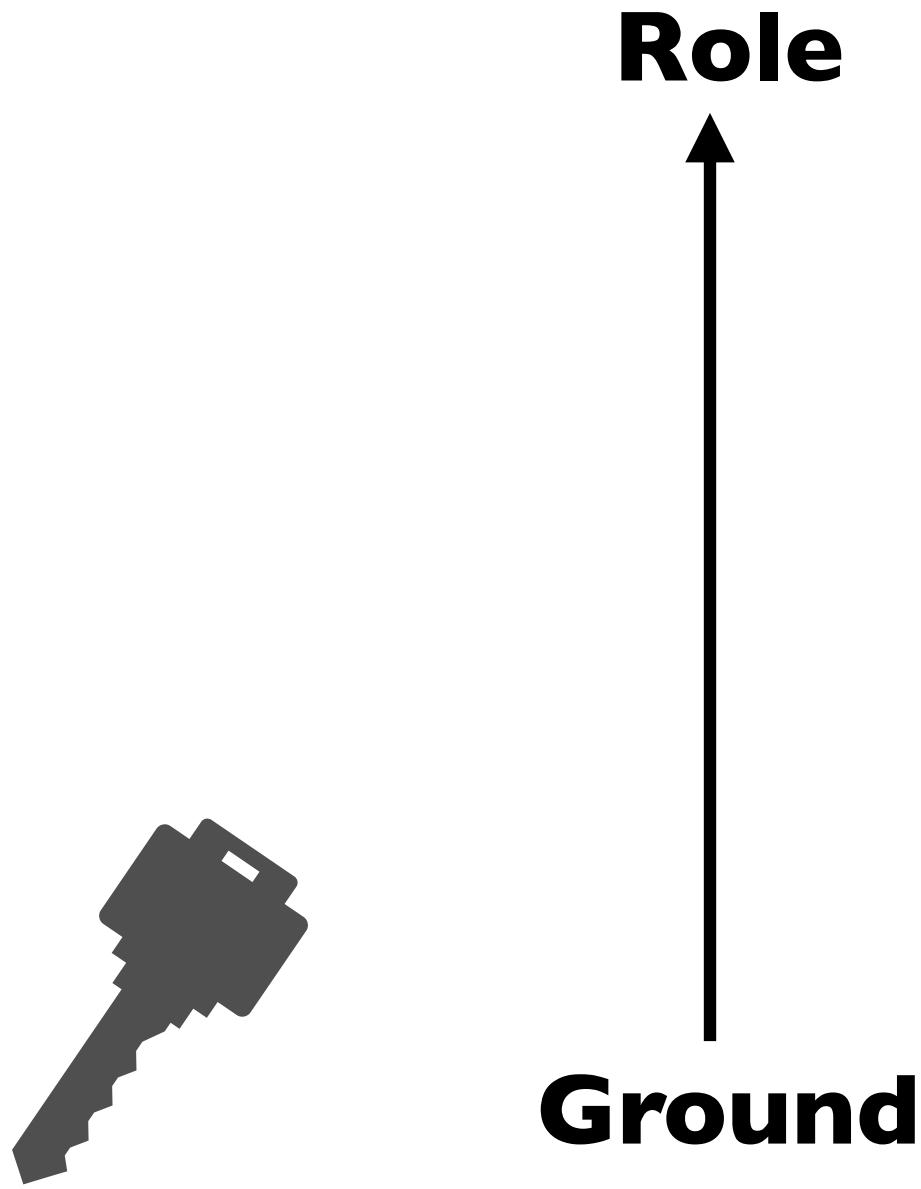
“Logic formalizes only very few of the processes by which we think.

The time has come to enrich formal logic by adding some other fundamental notions to it. What is it that you see when you see? You see an object as a key, you see a man in a car as a passenger, you see some sheets of paper as a book.

It is the word 'as' that must be mathematically formalized, on a par with the connectives 'and,' 'or,' 'implies,' and 'not' that have already been accepted into a formal logic.

Until you do that, you will not get very far with your A.I. problem."





G.C. Rota, "Fundierung as a logical concept," *The Monist*, 1989



Role



Ground



G.C. Rota, "Fundierung as a logical concept," *The Monist*, 1989

Role



Ground



G.C. Rota, "Fundierung as a logical concept," *The Monist*, 1989



Role (in a “world”)

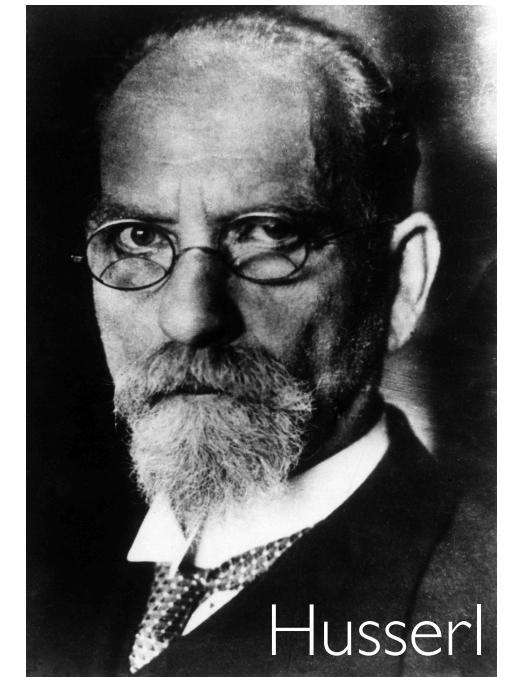


Ground

Function/ Role



Fundierung



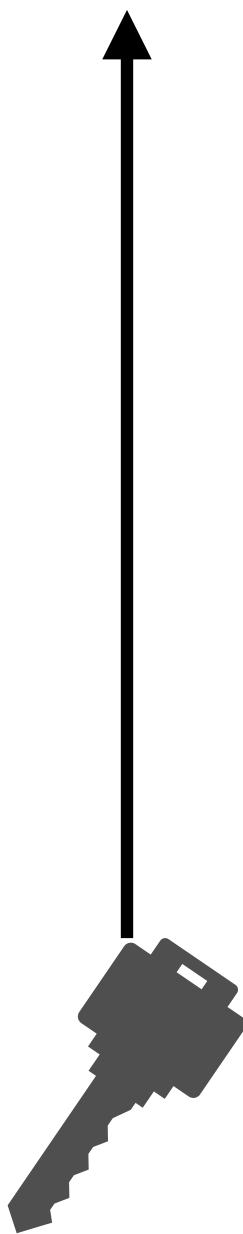
Facticity/
Ground

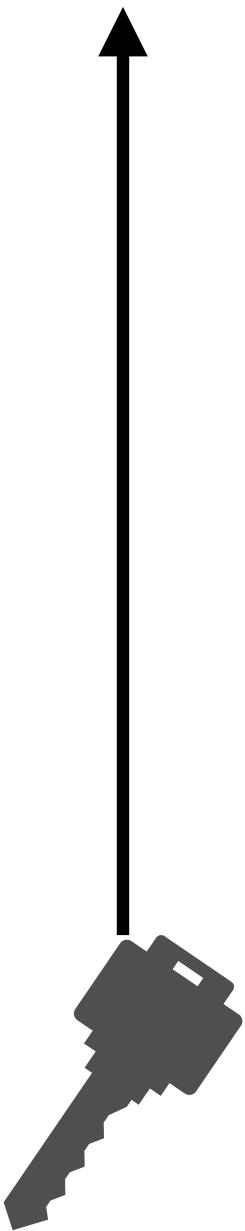


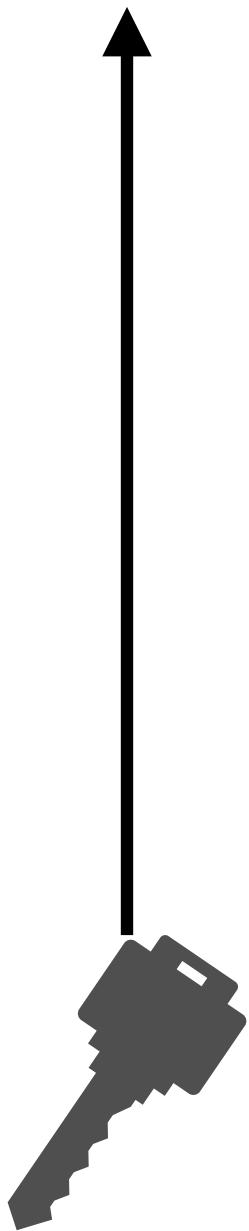
{Roles}

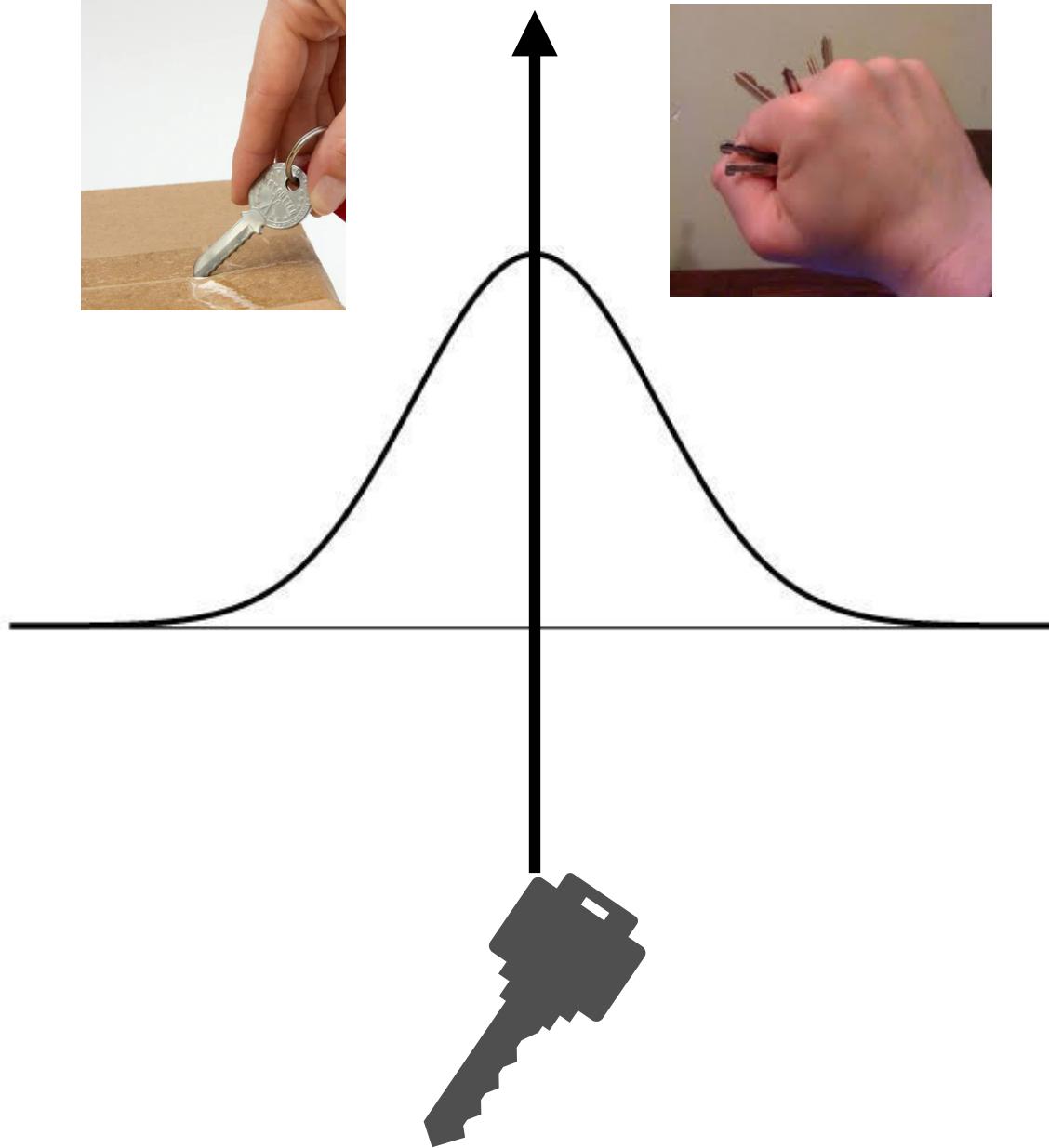


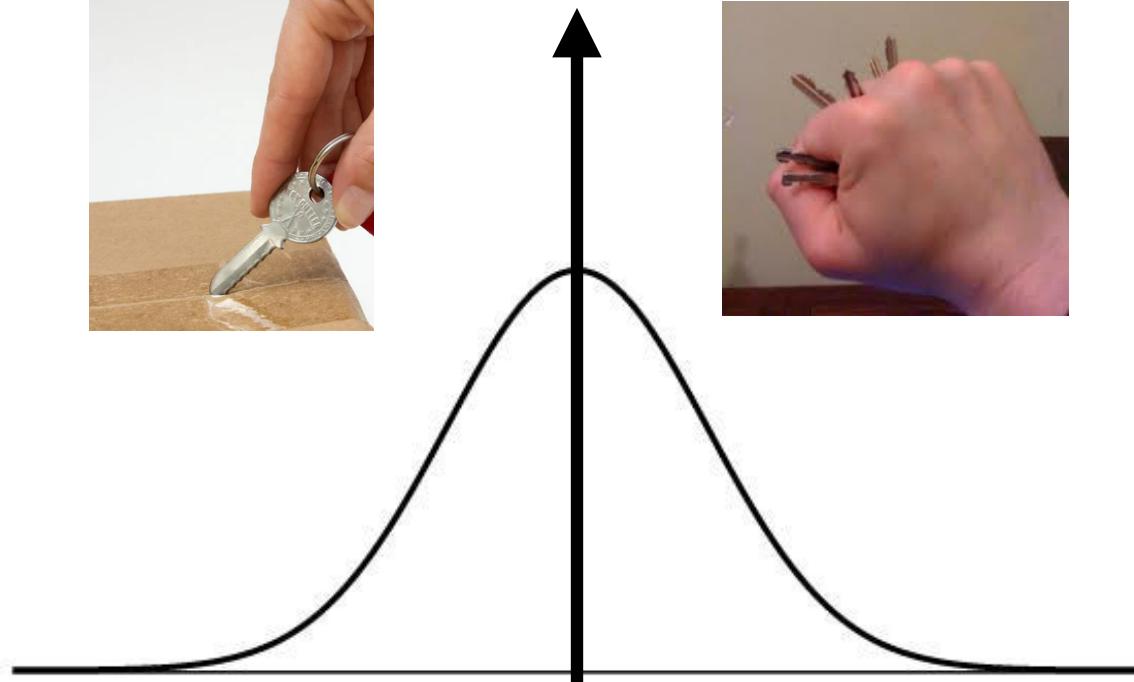
Ground











Affordances

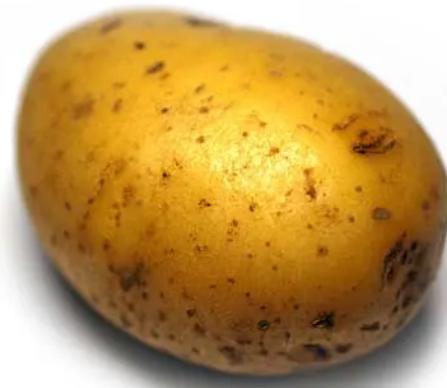


Formalizing the “**as**” relation

Foster, in prep

Formalizing the “**as**” relation

Ground

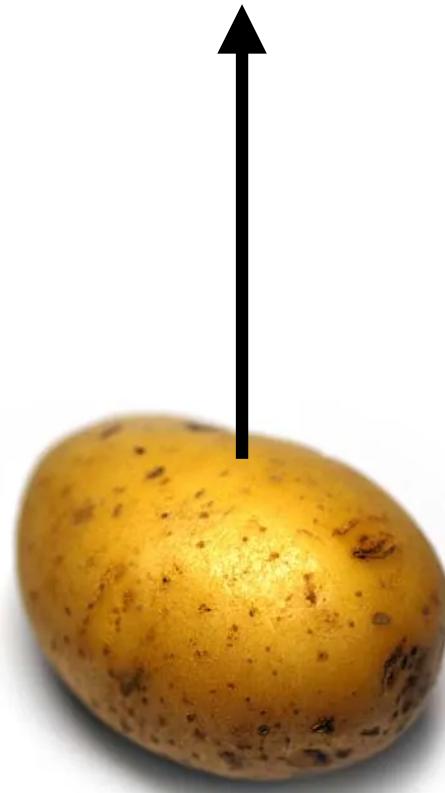


Formalizing the “**as**” relation

Role

(in a “world”, a context)

Ground

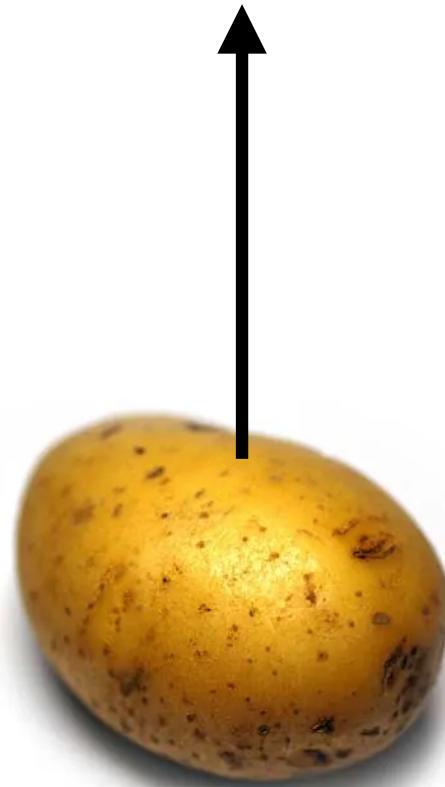


Formalizing the “**as**” relation

Role

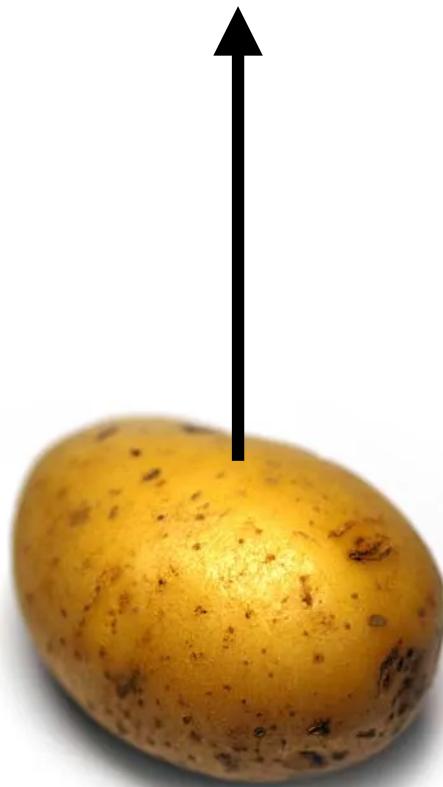
Mashable

Ground



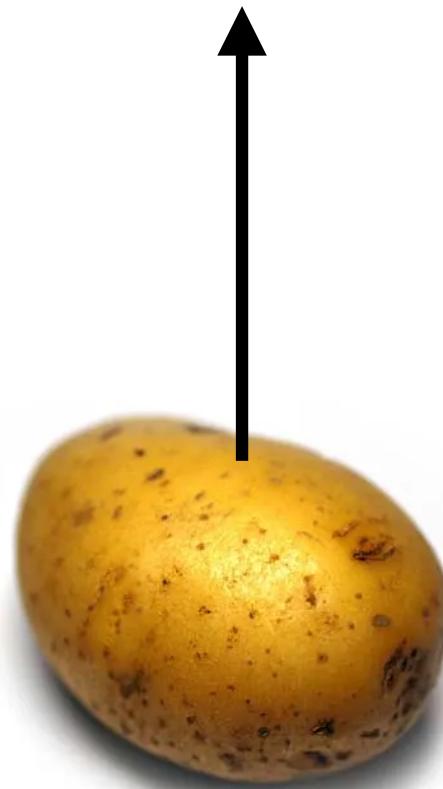
Formalizing the “**as**” relation

Mashable



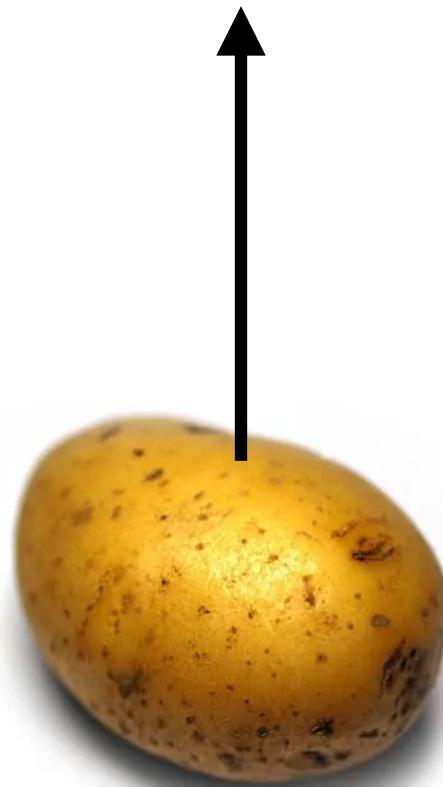
Formalizing the “**as**” relation

Masher $\xrightarrow{\textbf{\textit{Mash}}}$ **Mashable**

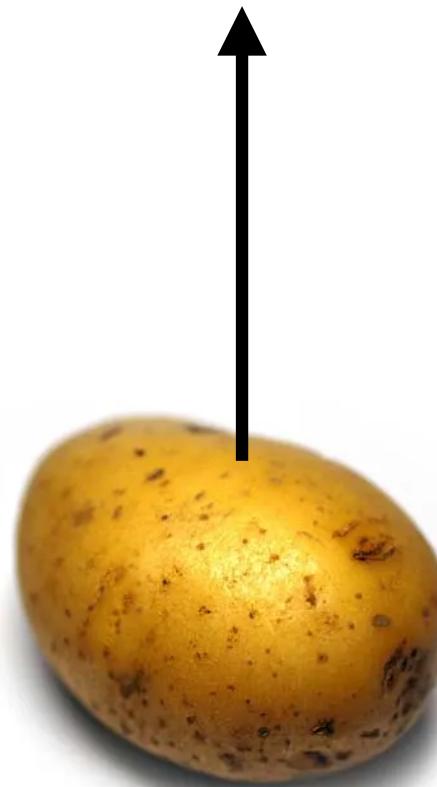


Formalizing the “**as**” relation

Masher ————— ***Mash*** ————— **Mashable**

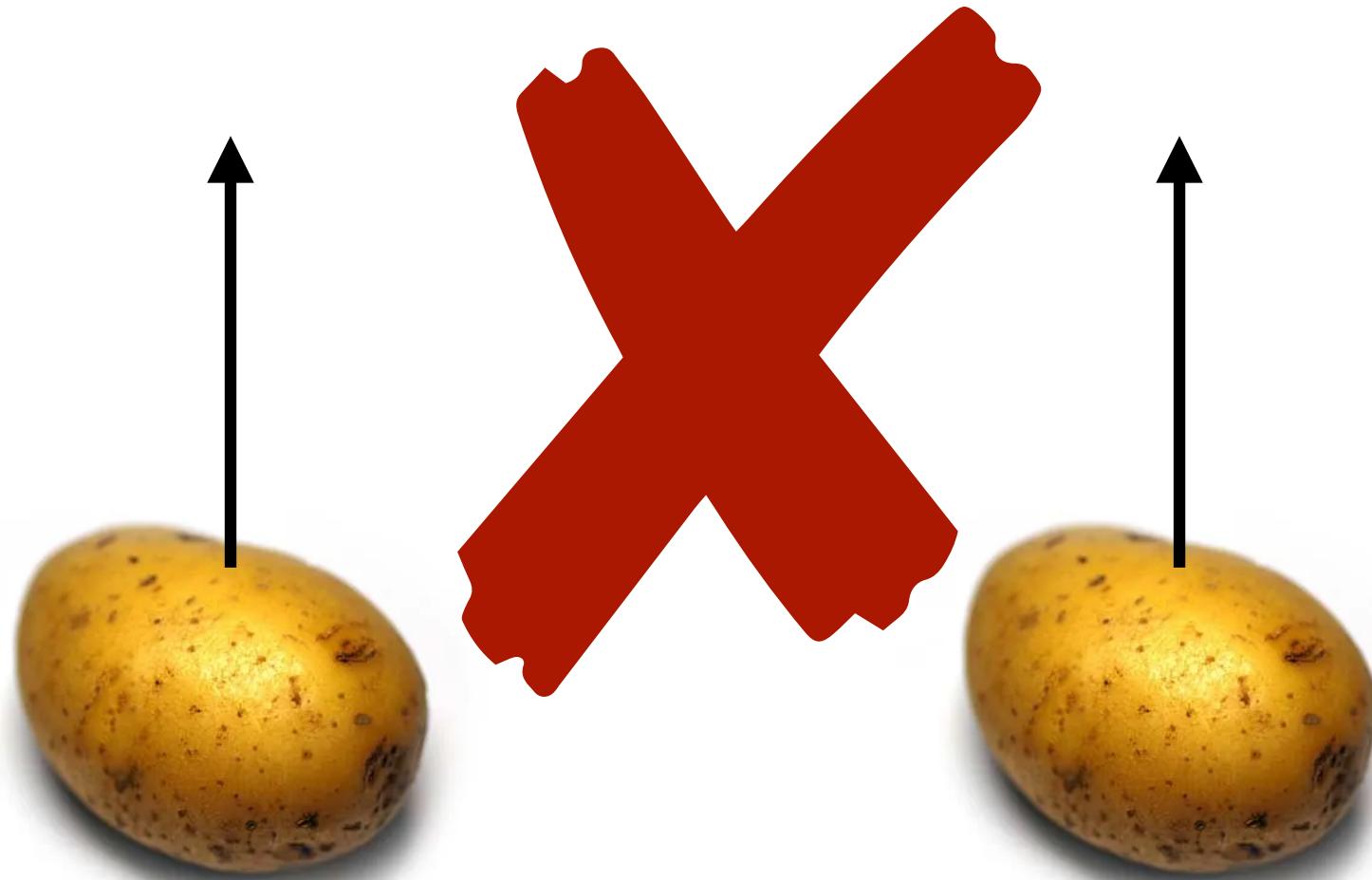


?????



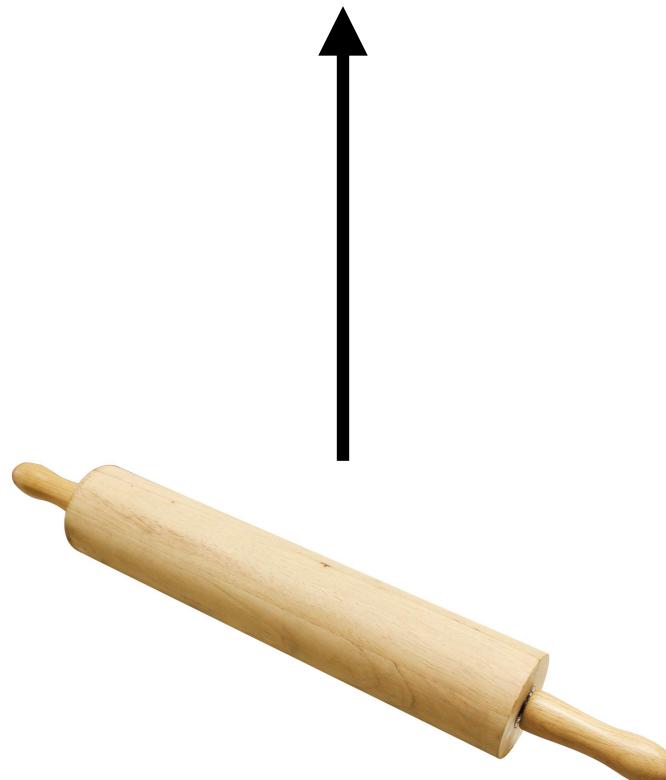
Formalizing the “**as**” relation

Masher $\xrightarrow{\text{Mash}}$ **Mashable**

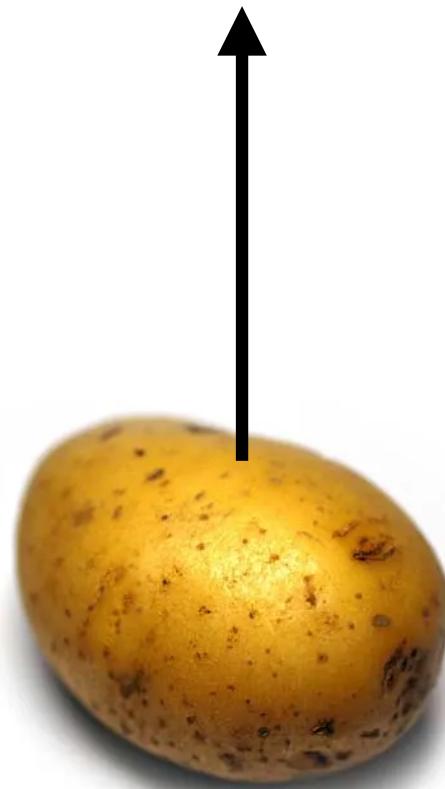


Formalizing the “**as**” relation

Masher ————— ***Mash*** ————— **Mashable**

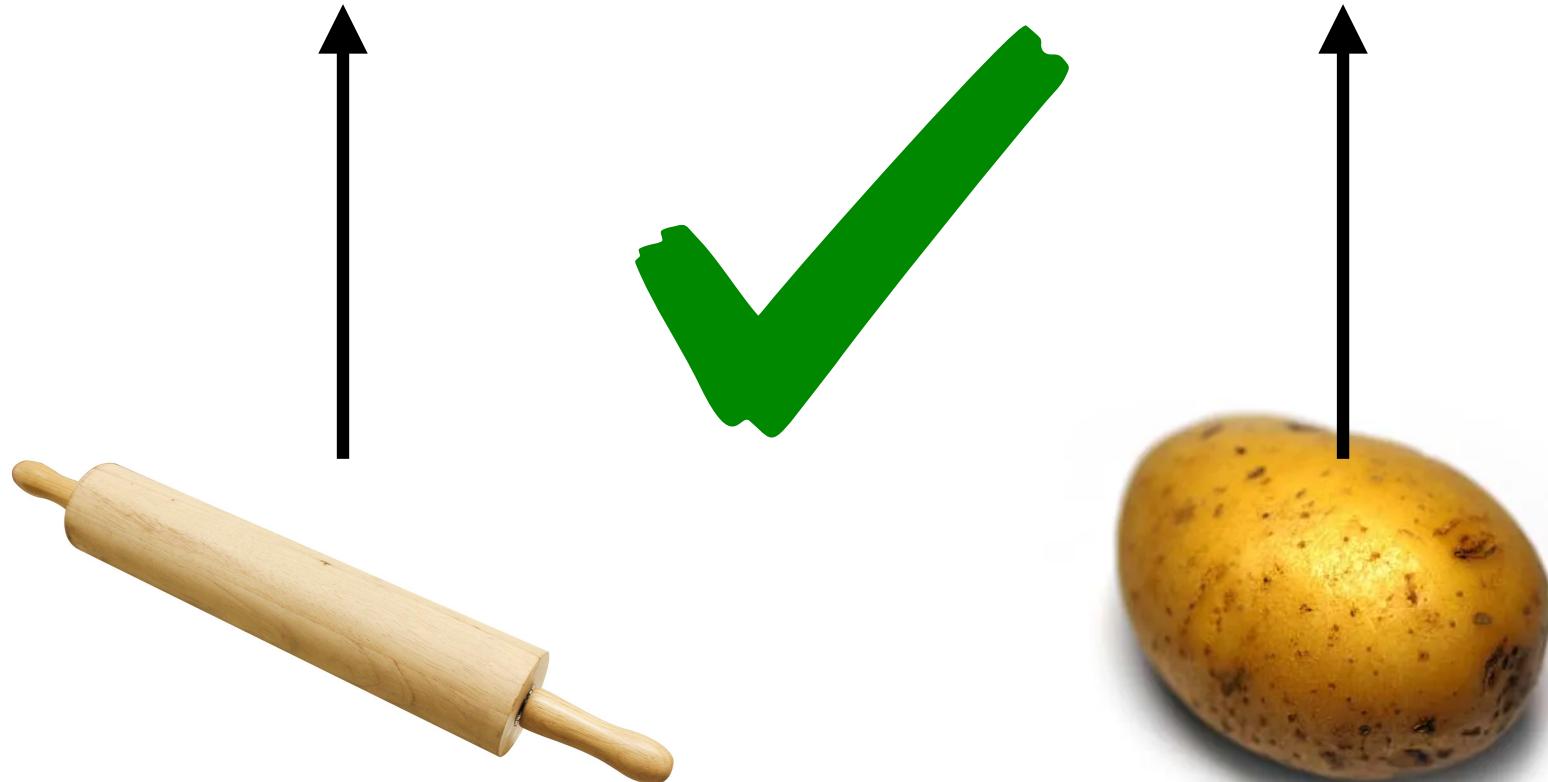


?????



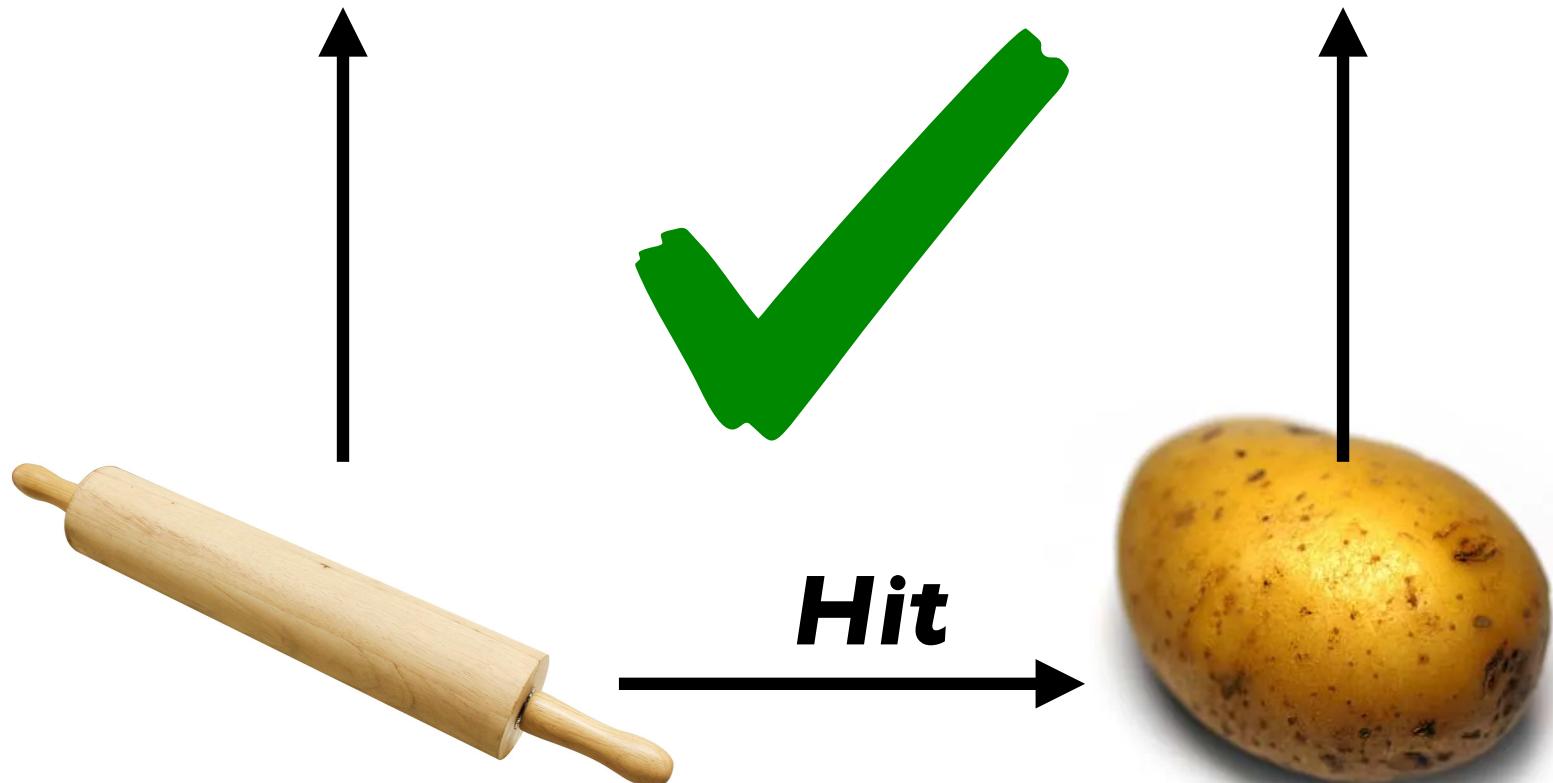
Formalizing the “**as**” relation

Masher $\xrightarrow{\text{Mash}}$ **Mashable**



Formalizing the “**as**” relation

Masher $\xrightarrow{\text{Mash}}$ **Mashable**



MY TAKE AWAY?

Meaning is about **imagination**.

It is about **seeing** what is **as** what could be

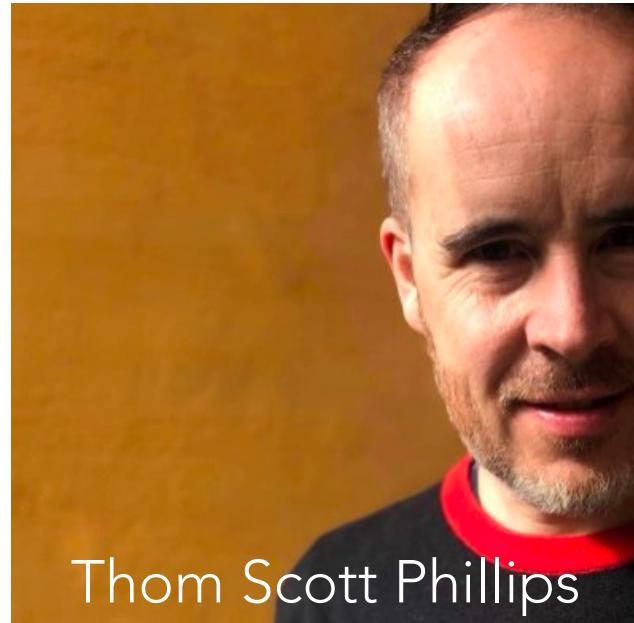
“as” relation
in **language**

Linguistic Code

Lightcode

Language as Code

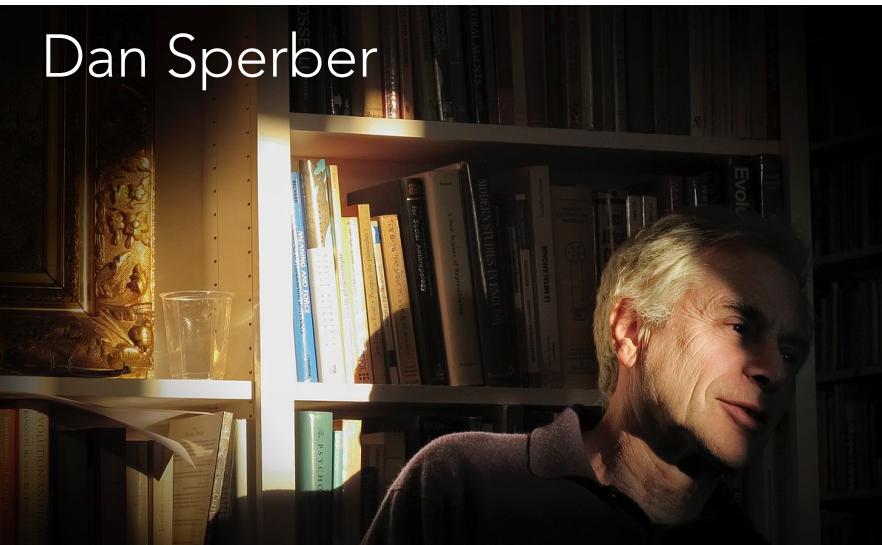
Language as Creativity



Thom Scott Phillips

Ostension + Inference

Dan Sperber

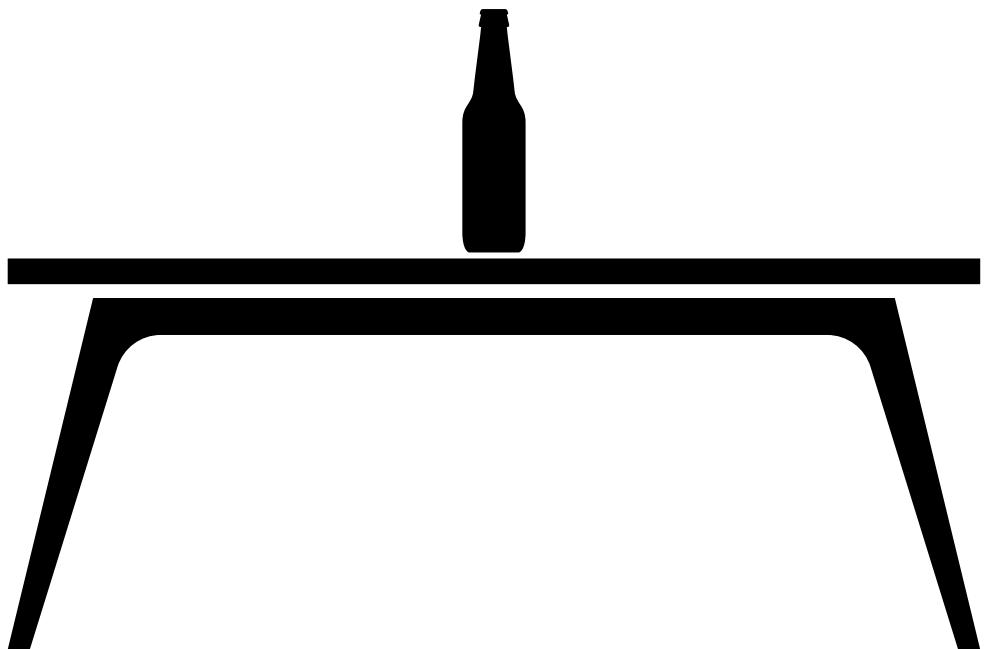


Deirdre Wilson

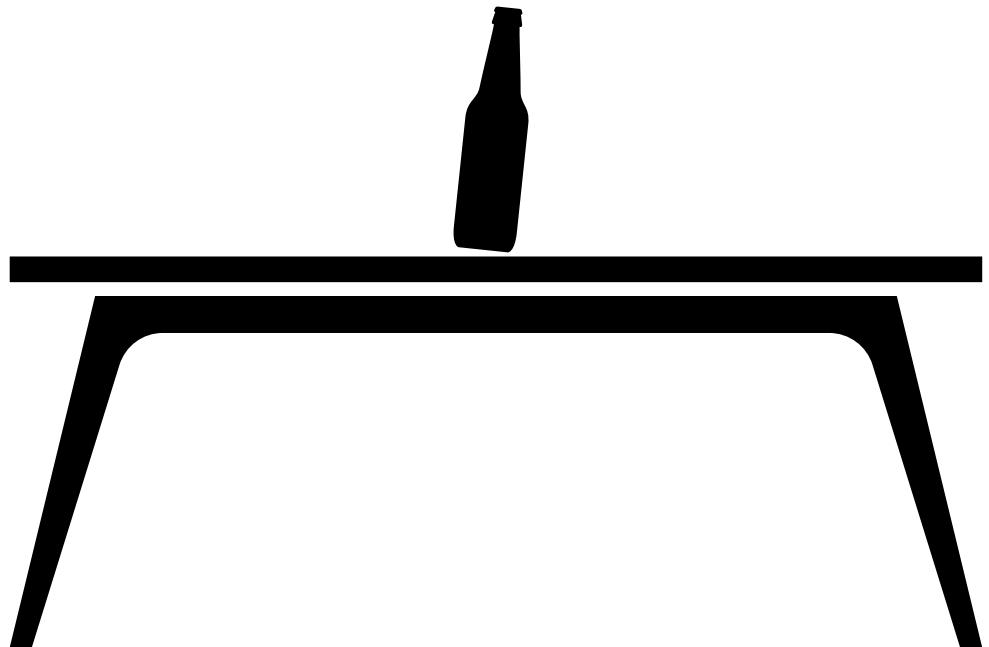
Ostension + Inference

“signalling signalhood”

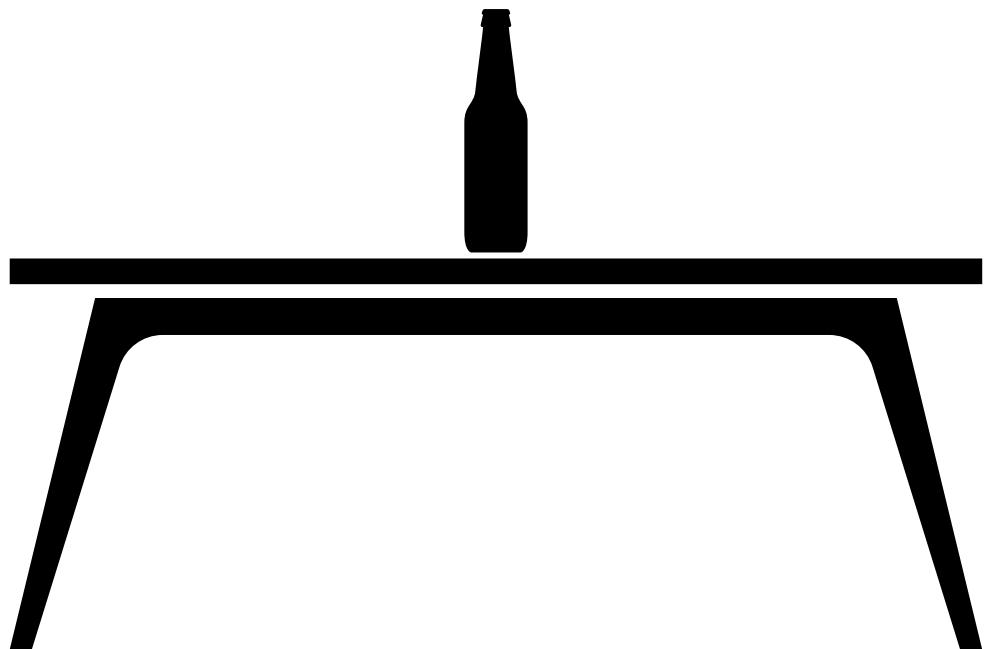
Ostension + Inference



Ostension + Inference



Ostension + Inference



Ostension + Inference

Ostension + Inference





as

Communicative
Act



as

Communicative
Act

as

Greeting



as

Communicative
Act

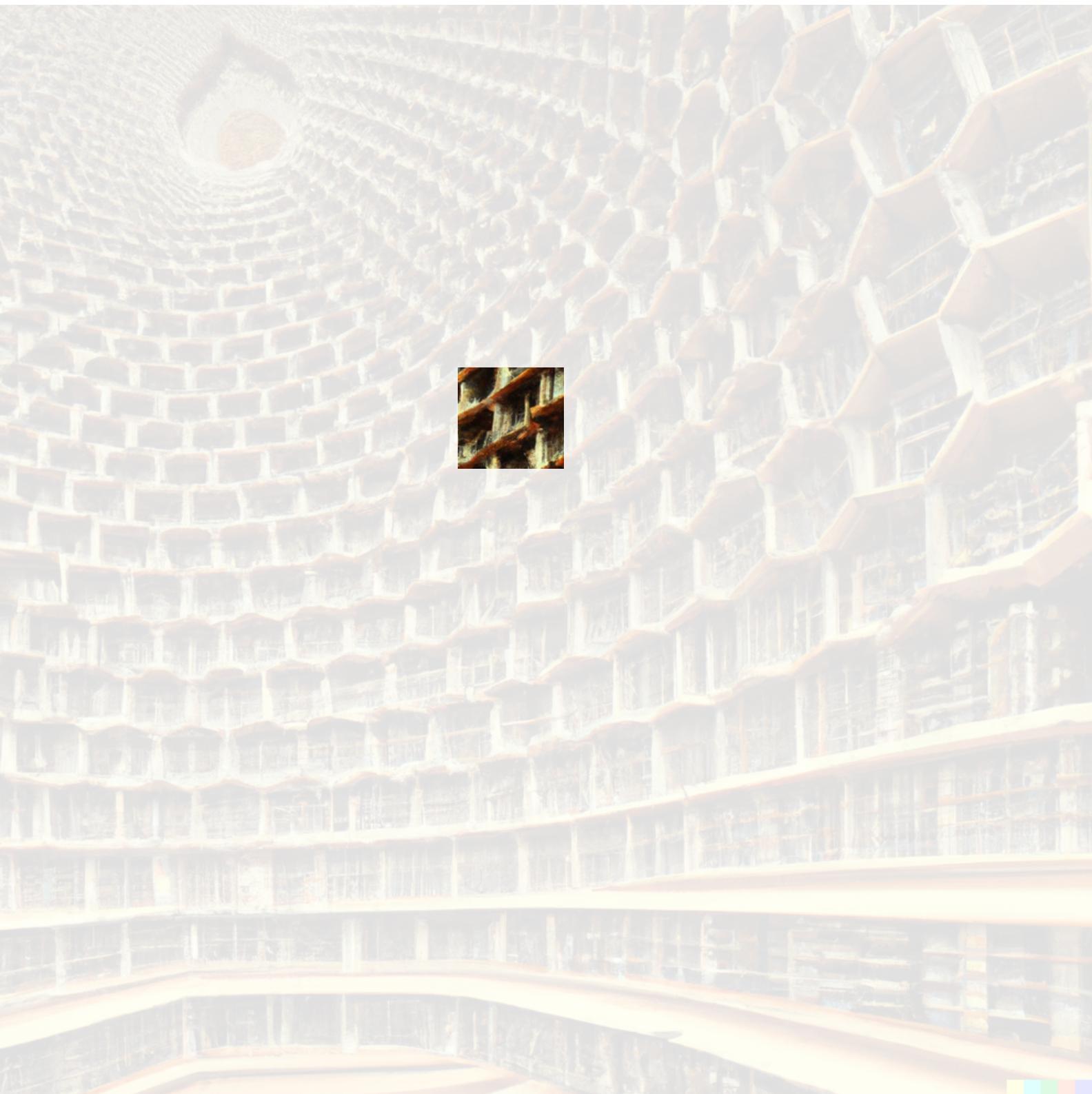
as

Threat



Derek Phillip Au





Derek Phillip Au



Physical Form (e.g., iconicity)

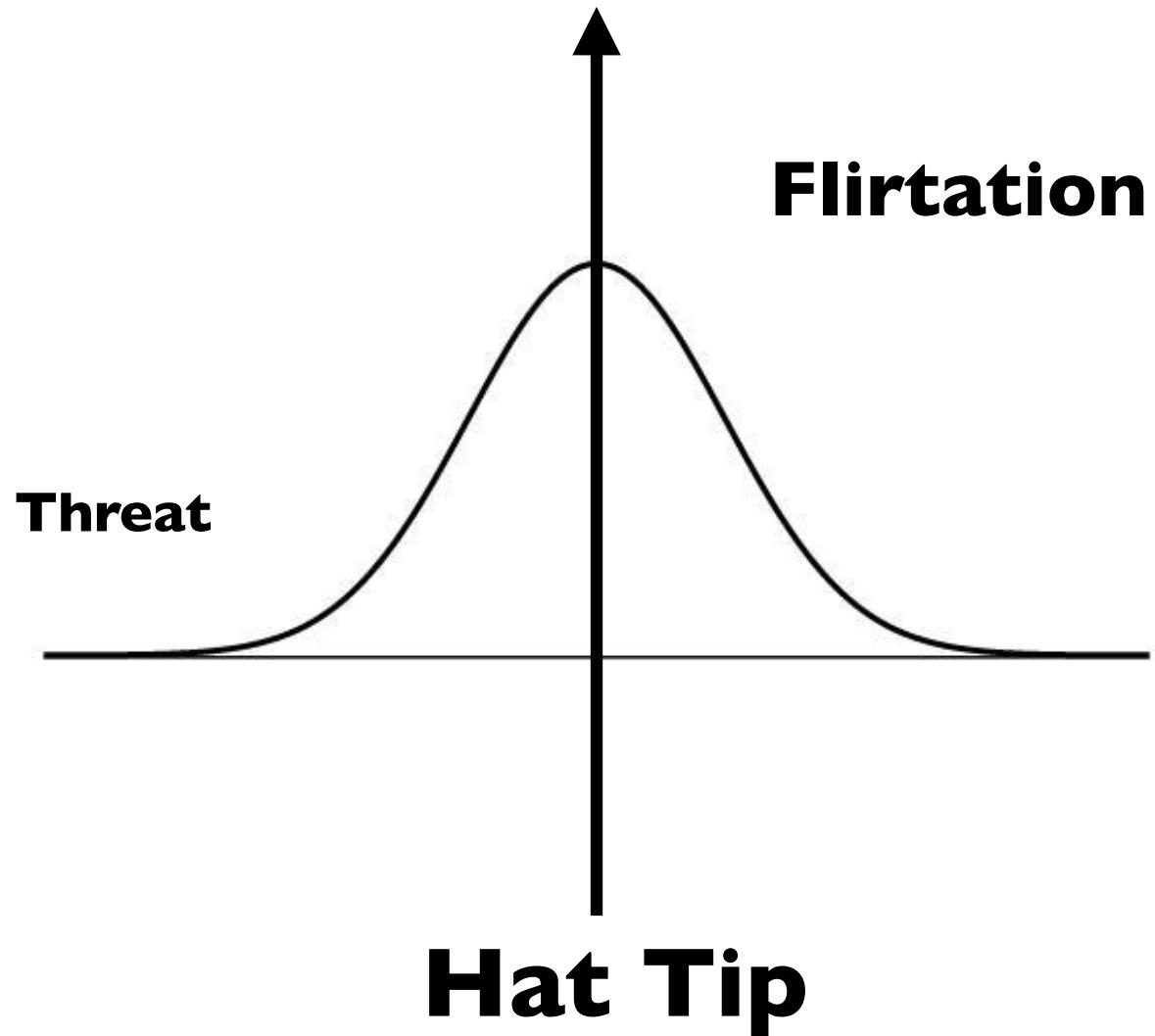
Physical Context (e.g., deixis)

Joint Activity

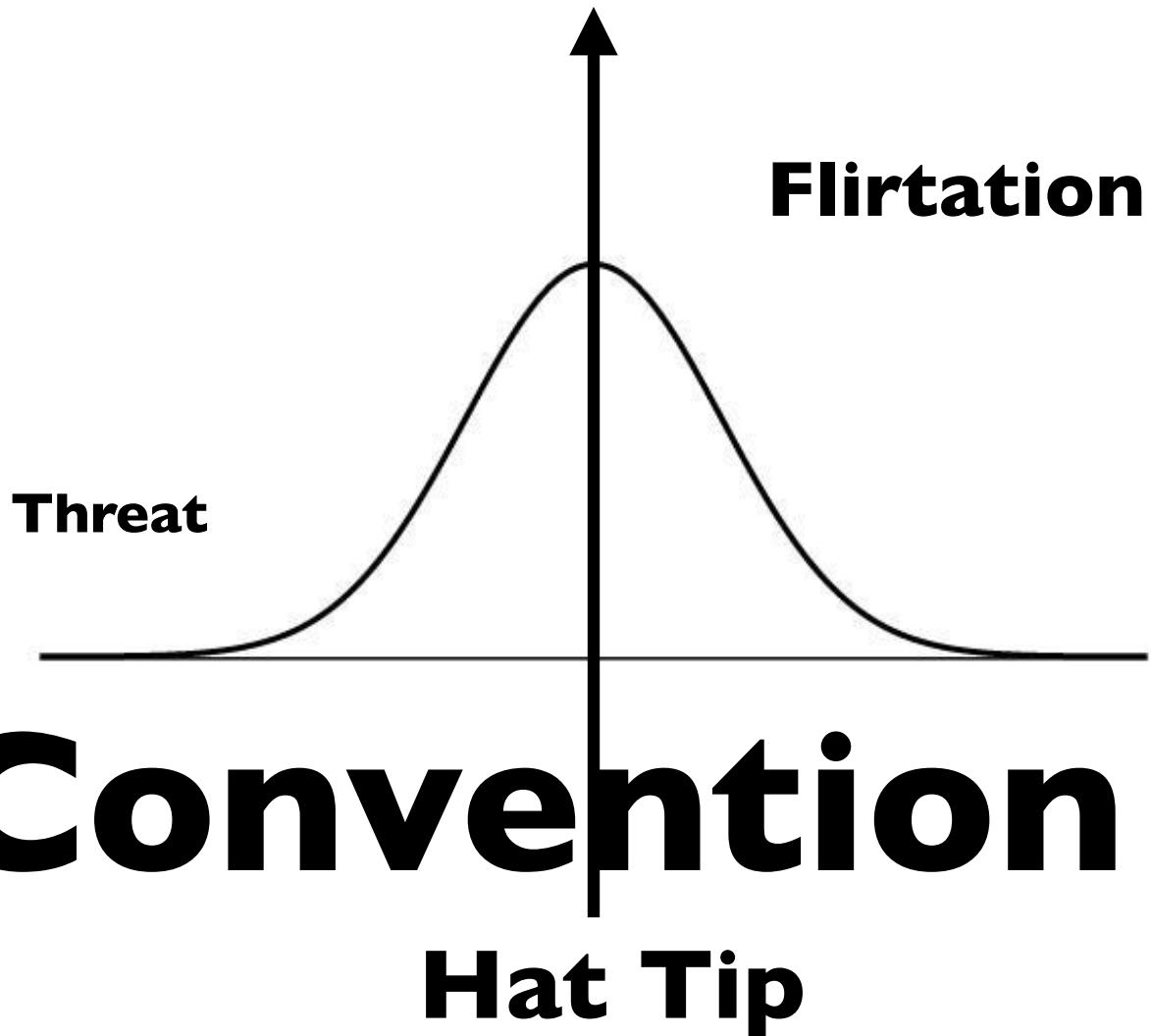
Shared History

Linguistic Code

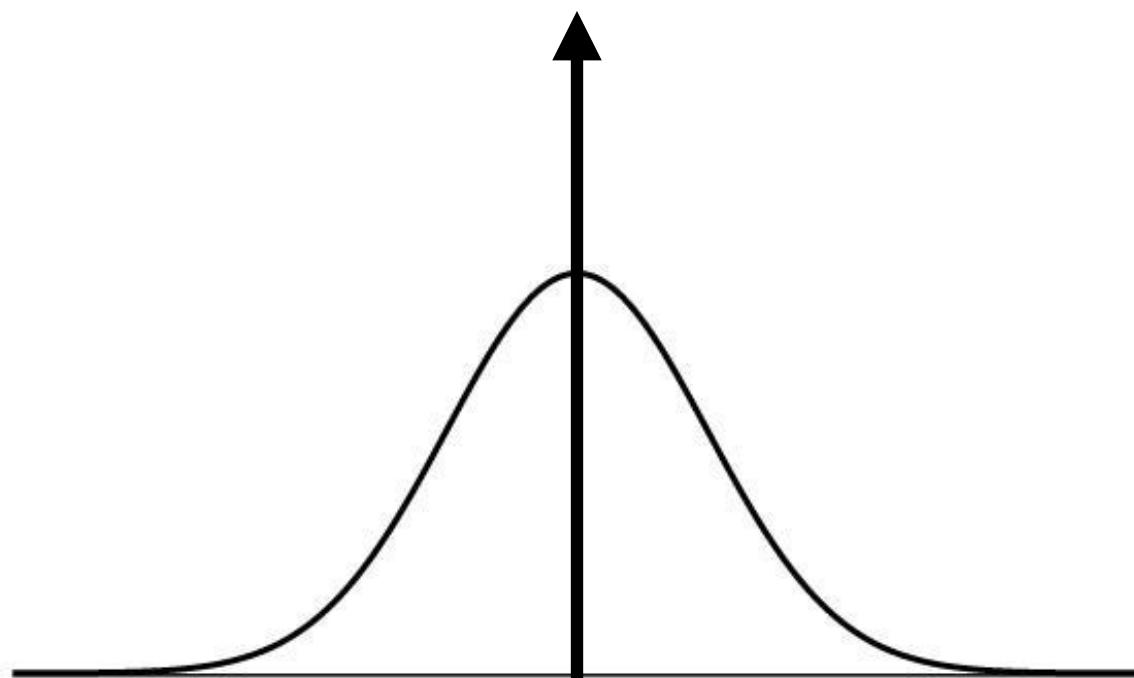
Greeting



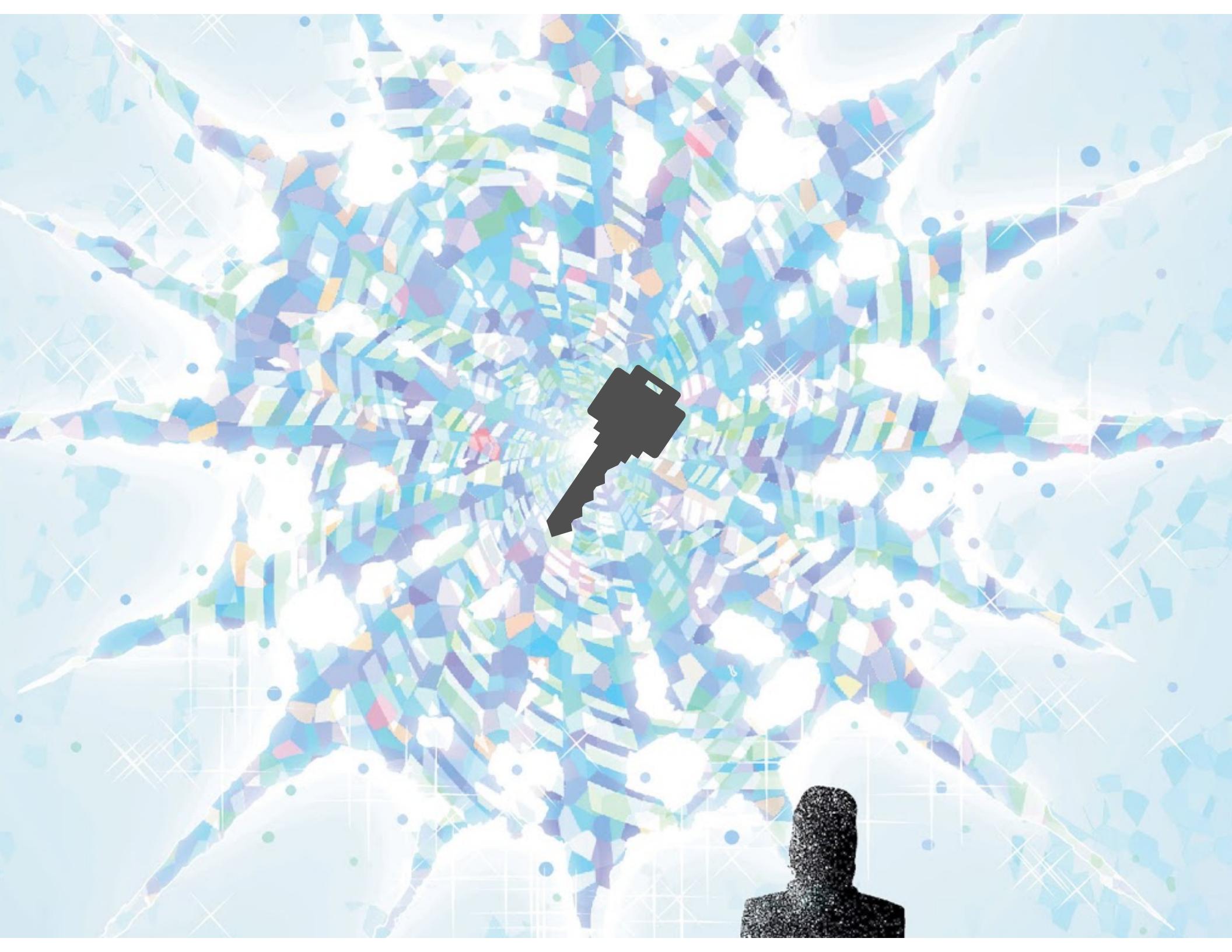
Greeting



{Roles}

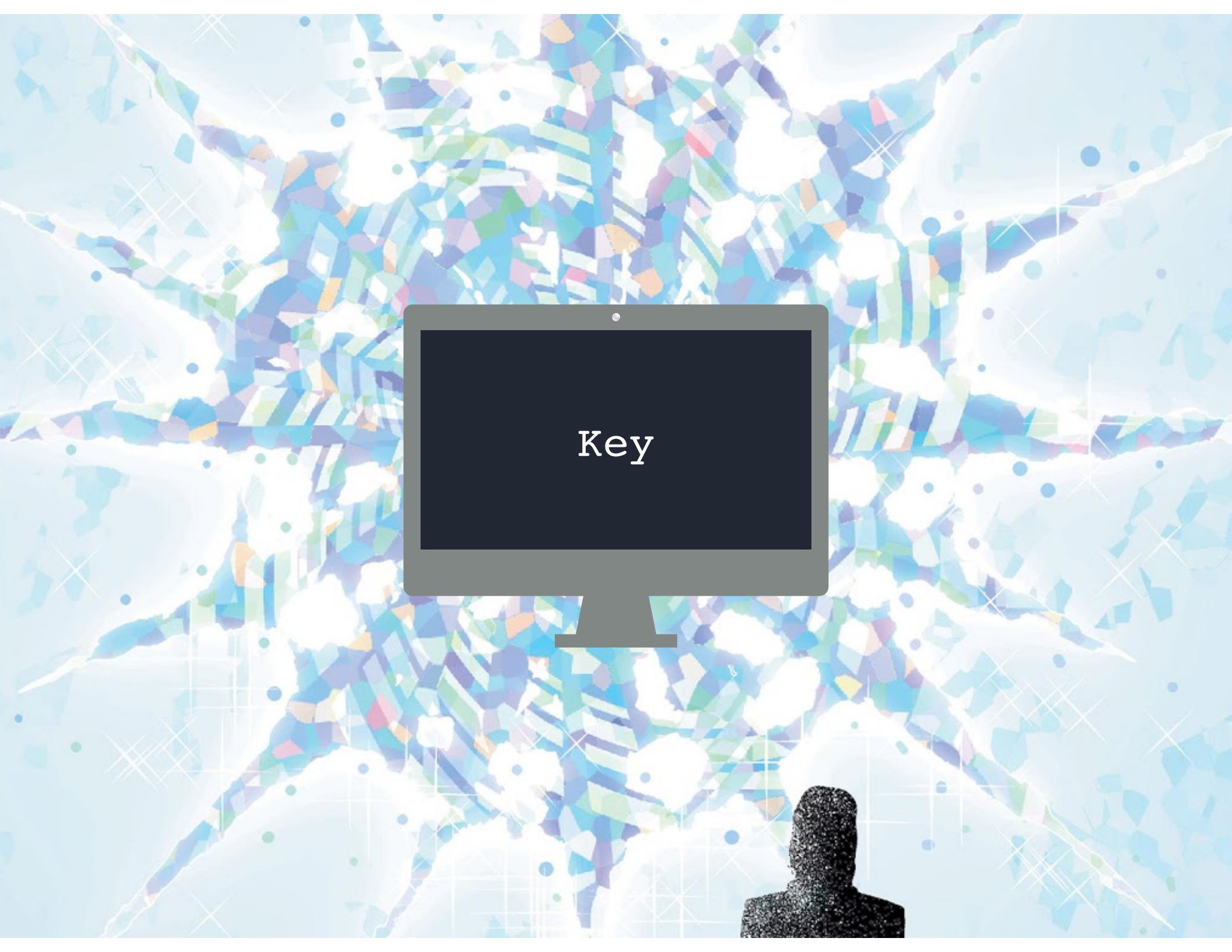


Culture
Ground









Key

Abstraction & Reasoning

Corpus (ARC)

-Chollet 2019

| Demonstration 1 | | Demonstration 2 | | Demonstration 3 | | Test | |
|-----------------|--------|-----------------|--------|-----------------|--------|-------|--------|
| Input | Output | Input | Output | Input | Output | Input | Output |
| | | | | | | | |
| ? | ? | ? | ? | ? | ? | ? | ? |

Abstraction & Reasoning Corpus (ARC)

| Demonstration 1 | | Demonstration 2 | | Demonstration 3 | | Test | |
|-----------------|--------|-----------------|--------|-----------------|--------|-------|--------|
| Input | Output | Input | Output | Input | Output | Input | Output |
| | | | | | | | ? |
| | | | | | | | |

Extract the sub-grid enclosed by the largest hollow rectangle

Abstraction & Reasoning Corpus (ARC)



Extract the sub-grid enclosed by the largest hollow rectangle

Abstraction & Reasoning Corpus (ARC)



Not so fast...

Where can we look for principles of LLM evaluation?

Position: Principles of Animal Cognition to Improve LLM Evaluations

Sunayana Rane ^{*1} **Cyrus F. Kirkman** ^{*2} **Graham Todd** ^{*3} **Amanda Royka** ^{*4} **Ryan M. C. Law** ^{*5}
Erica A. Cartmill ⁺⁶ **Jacob G. Foster** ⁺⁷⁸

ICML 2025 (oral)

Baby steps in evaluating the capacities of large language models. [\[PDF\]](#) [\[DOI\]](#) [\[BibTeX\]](#)
M. C. Frank. (2023). *Nature Reviews Psychology*. doi:10.1038/s44159-023-00211-x.

How to evaluate the cognitive abilities of LLMs

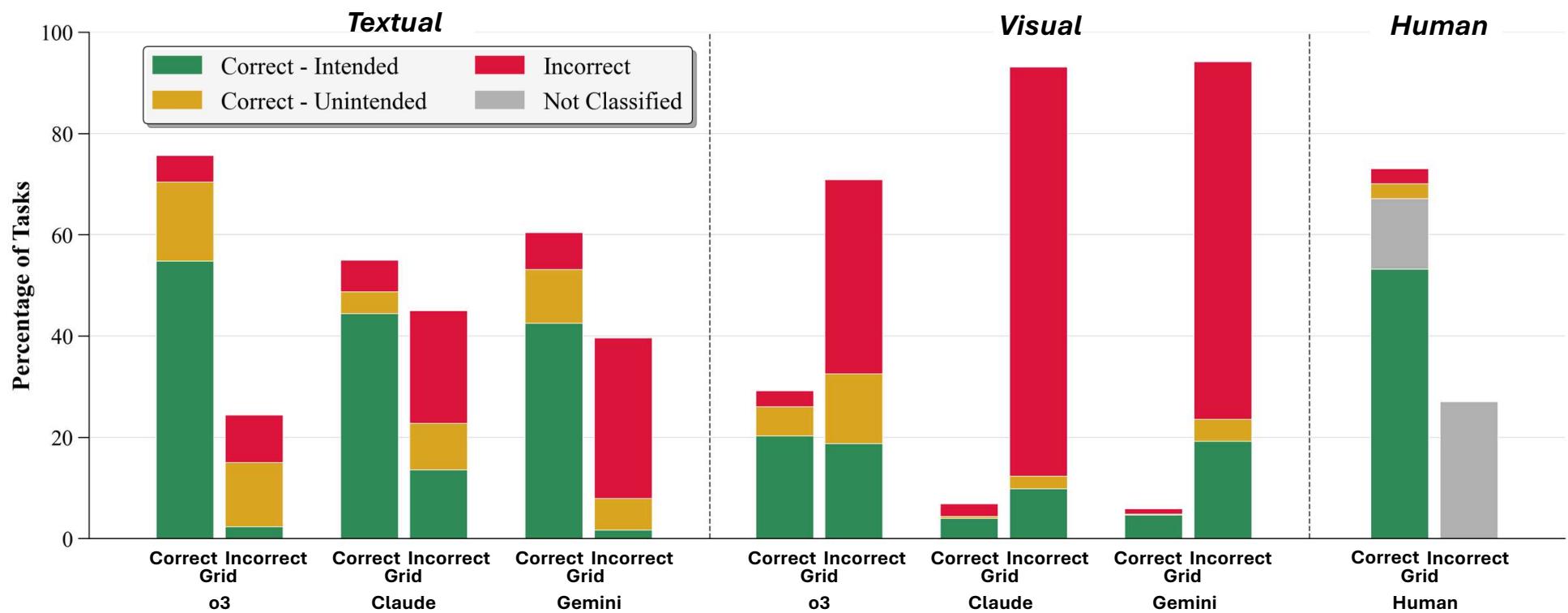
[Anna A. Ivanova](#) (2025) [Nature Human Behaviour](#)
volume 9, pages 230–233 (2025)

Abstraction & Reasoning Corpus (ARC)



Drumroll

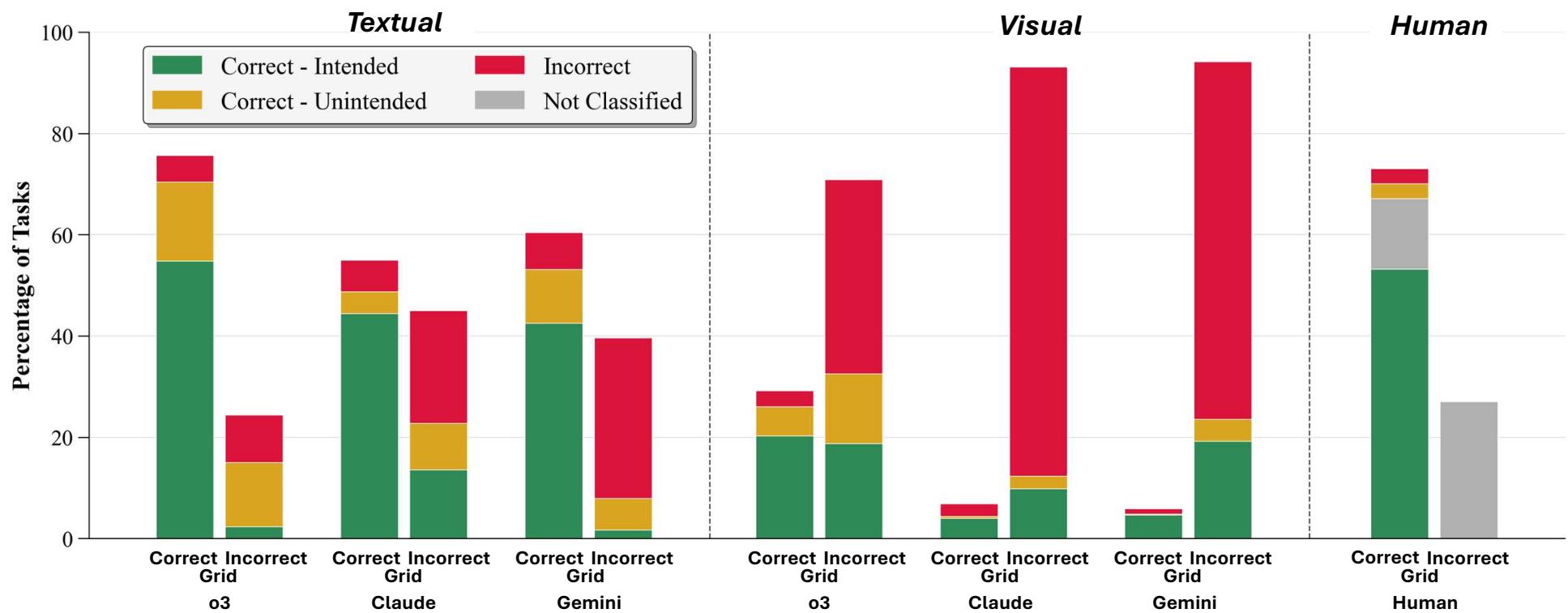
Often get it “right”
for **wrong** reasons



Mitchell, Foster, Beger, Yi, Fu, Denton, Palmarini, R&R at PNAS

adapted from Beger et al., 2025

Very bad at **visual**



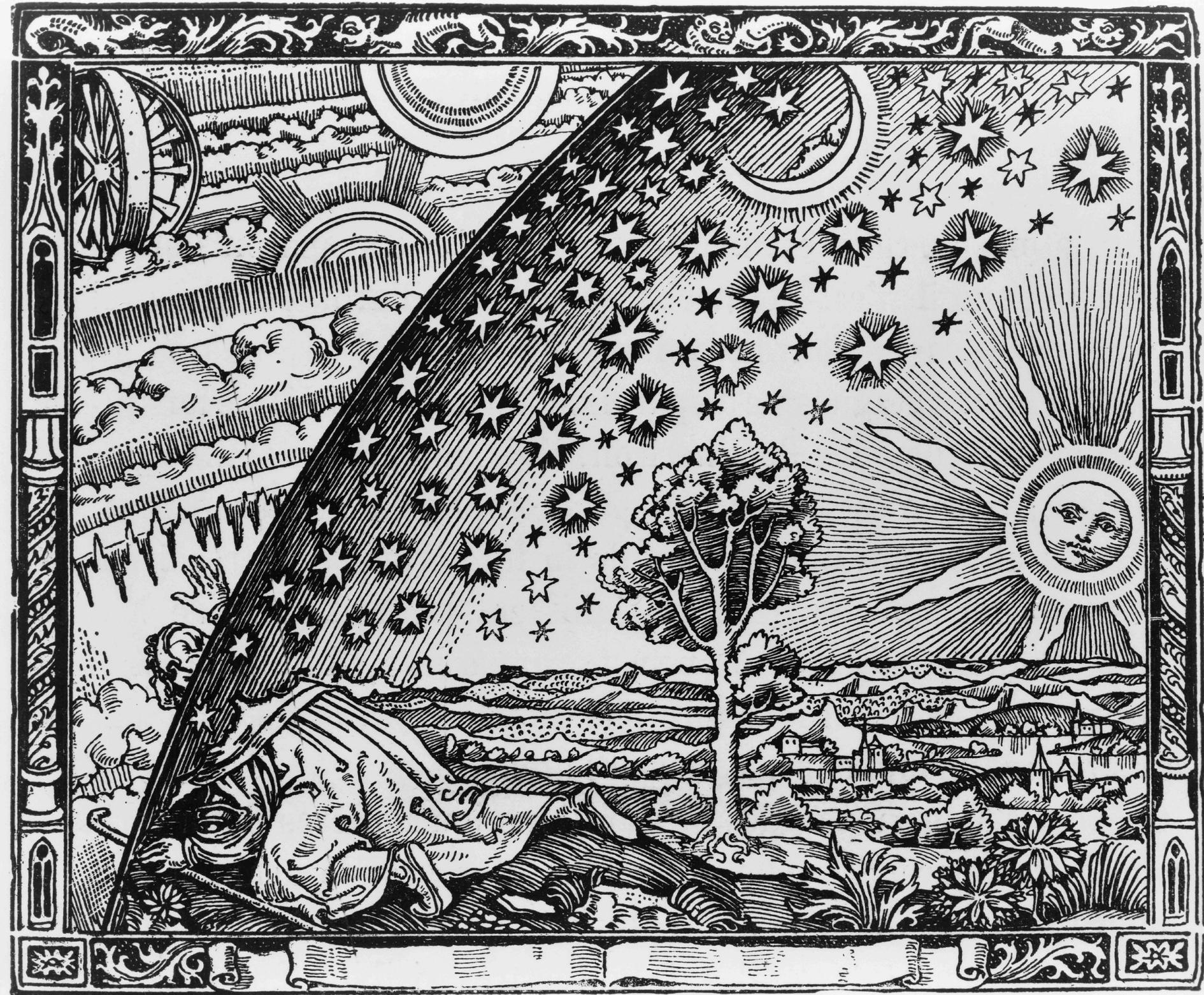
Mitchell, Foster, Beger, Yi, Fu, Denton, Palmarini, R&R at PNAS

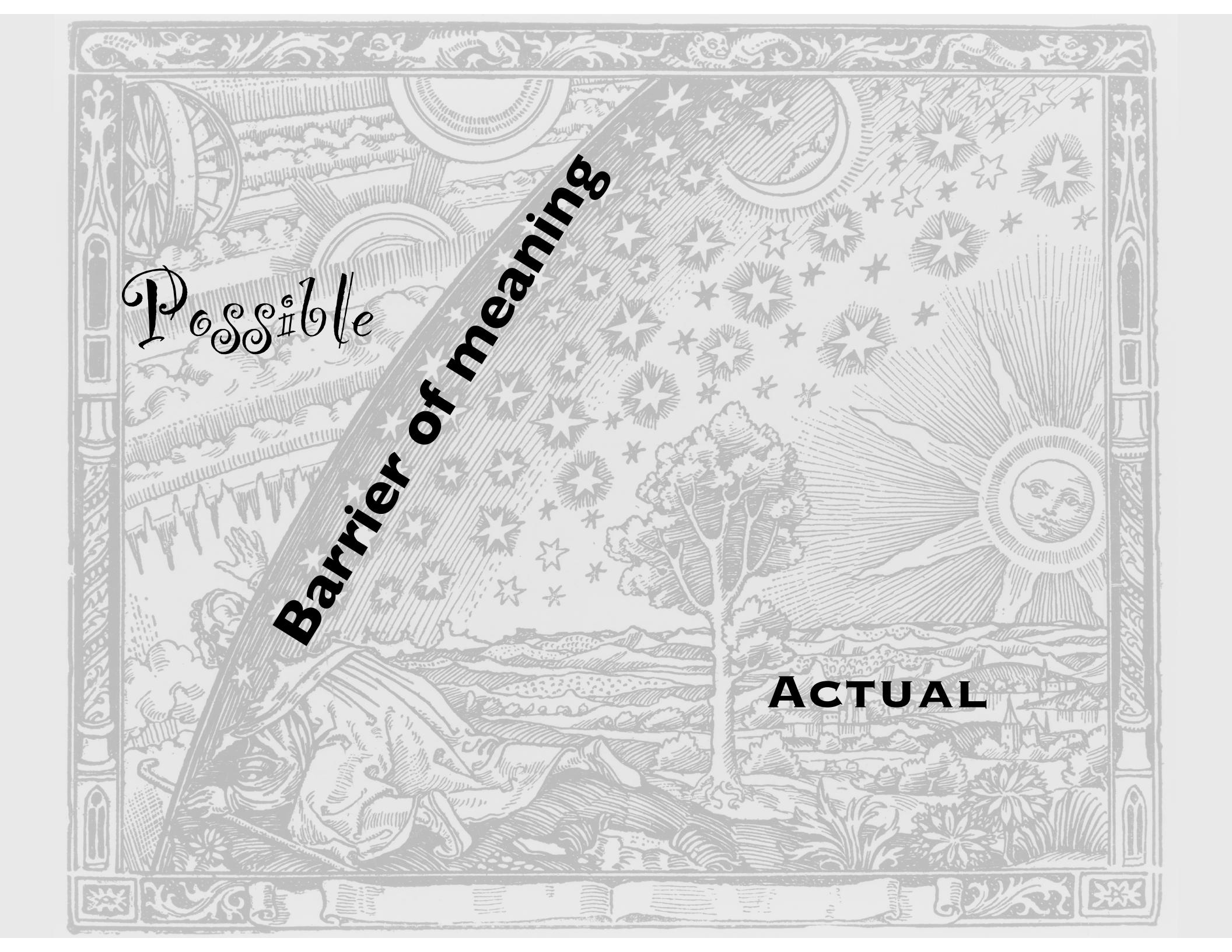
adapted from Beger et al., 2025

Has the barrier of meaning been crashed?









Possible
Barrier of meaning

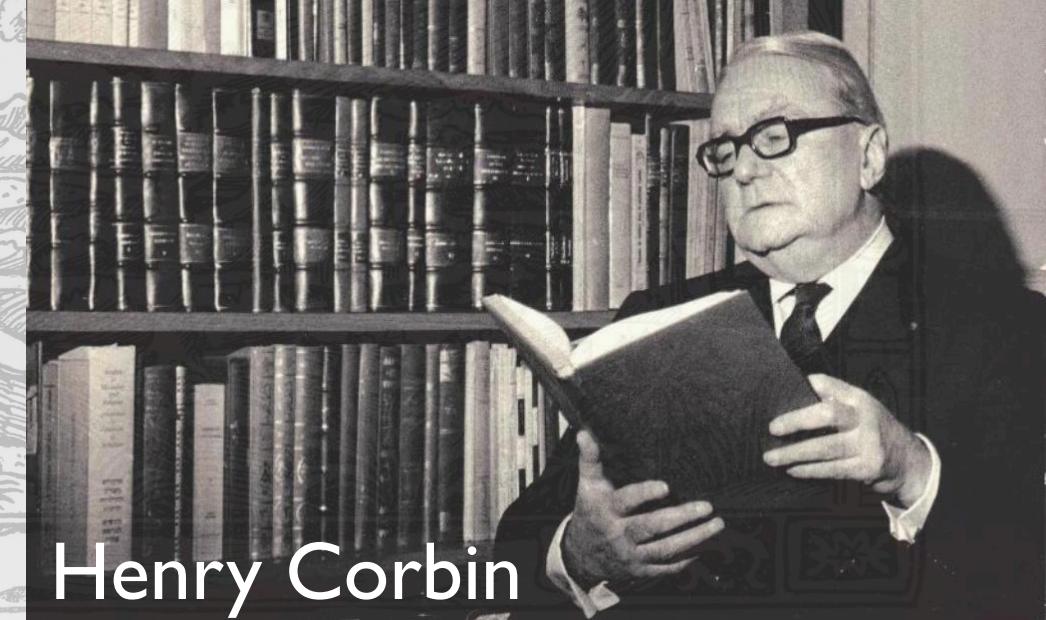
ACTUAL

Imaginal

Barrier of meaning



Imaginal



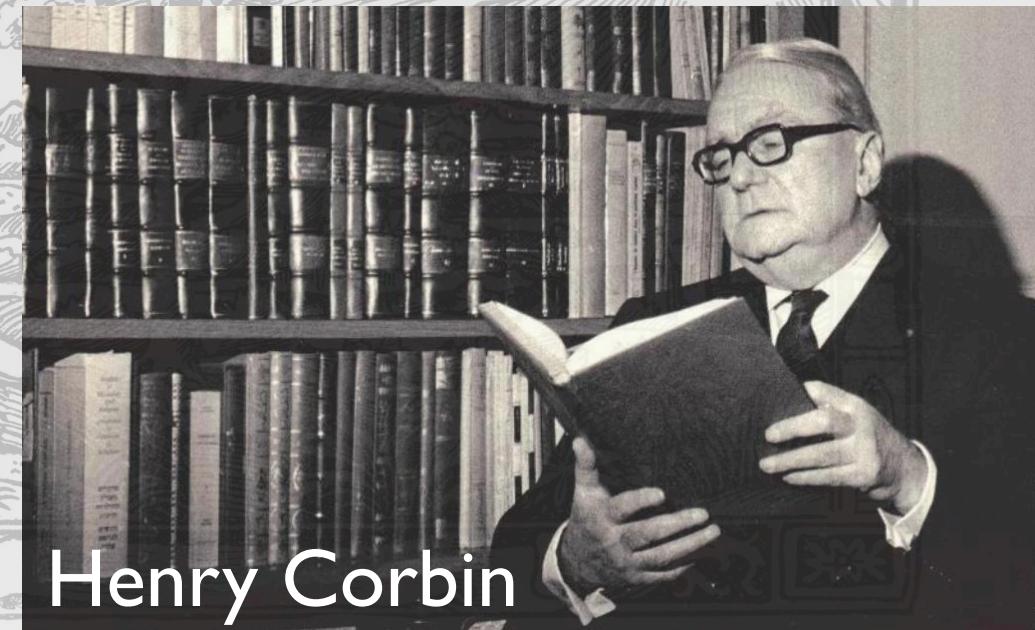
Henry Corbin

Imaginal

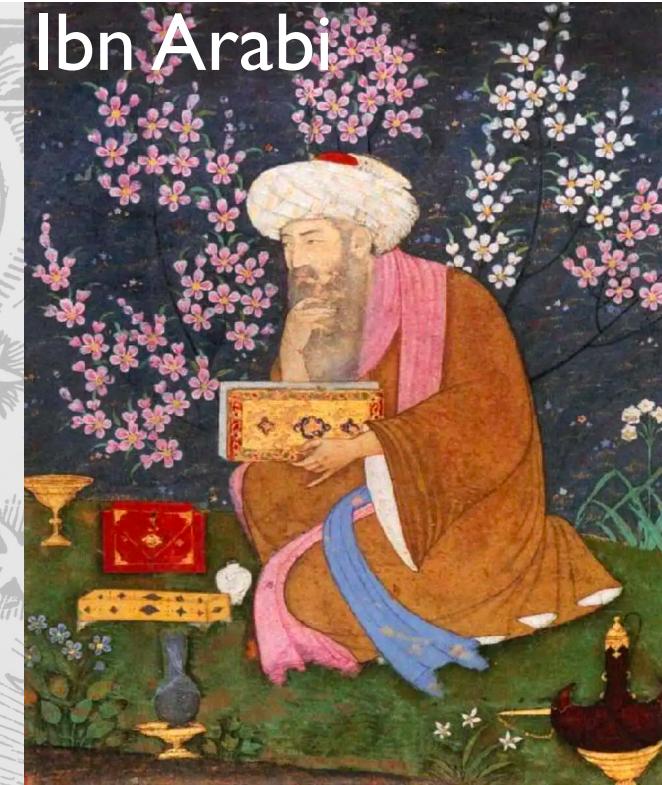


Suhrawardī

Henry Corbin



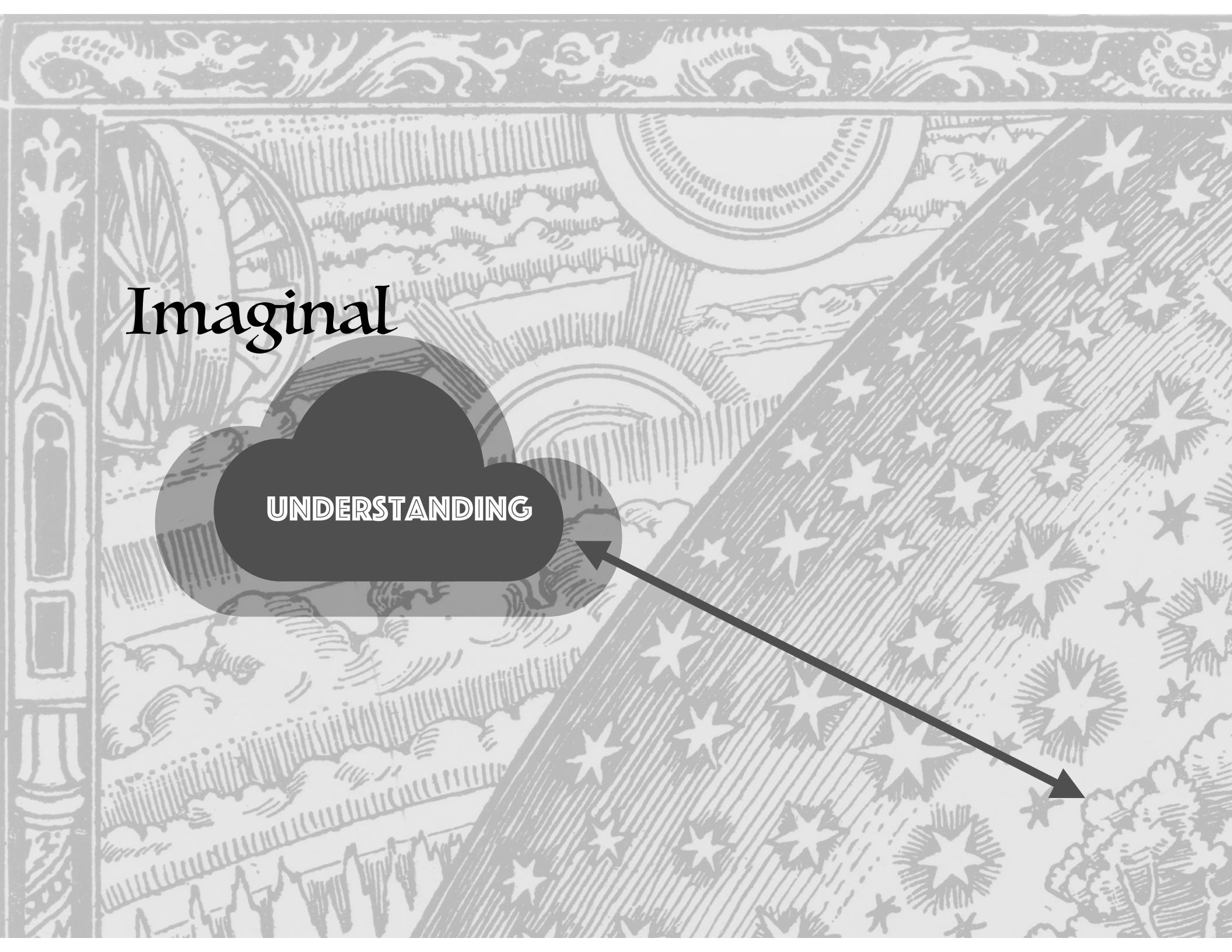
Ibn Arabi



Imaginal

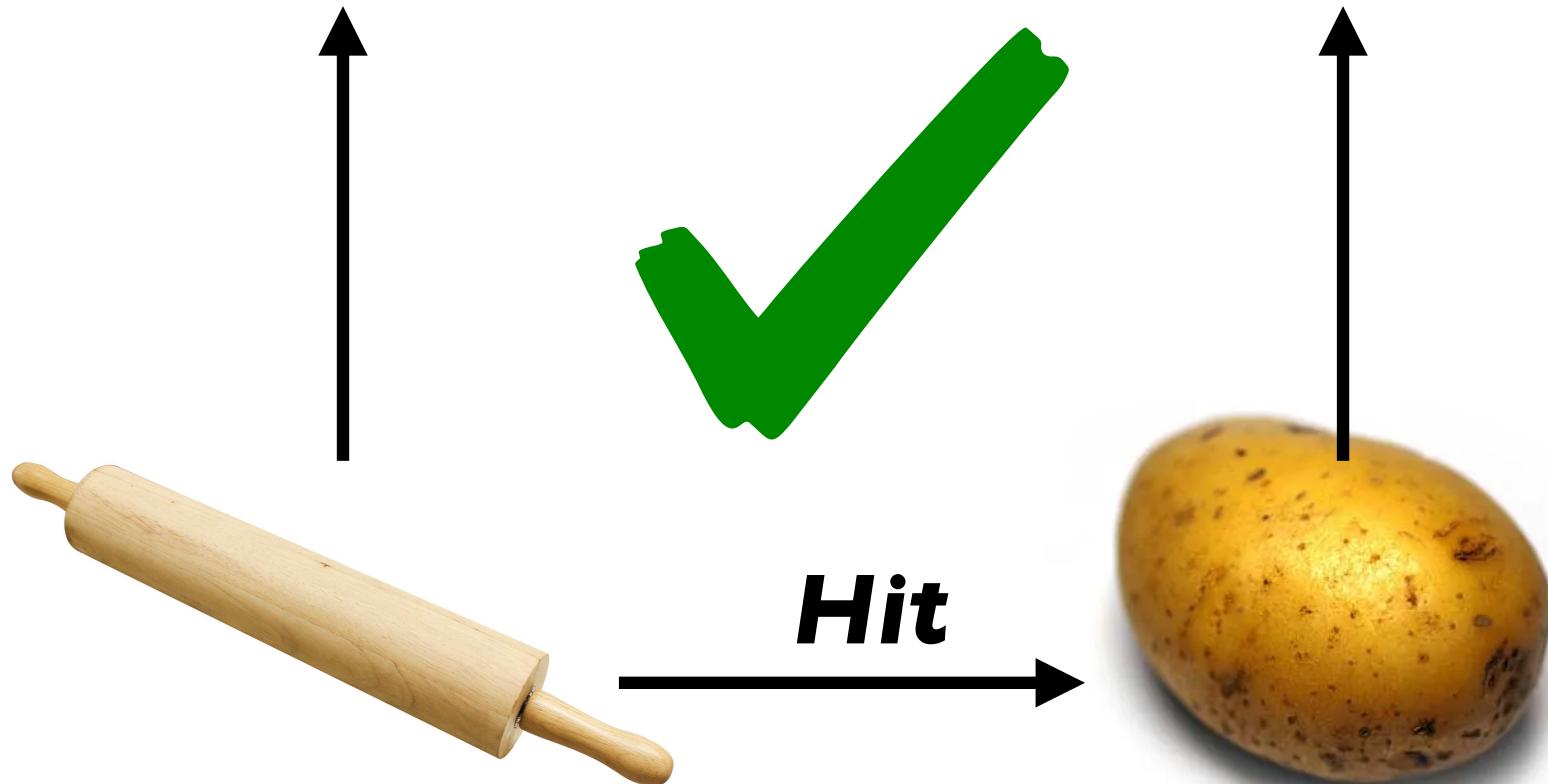


UNDERSTANDING



Is this understanding?

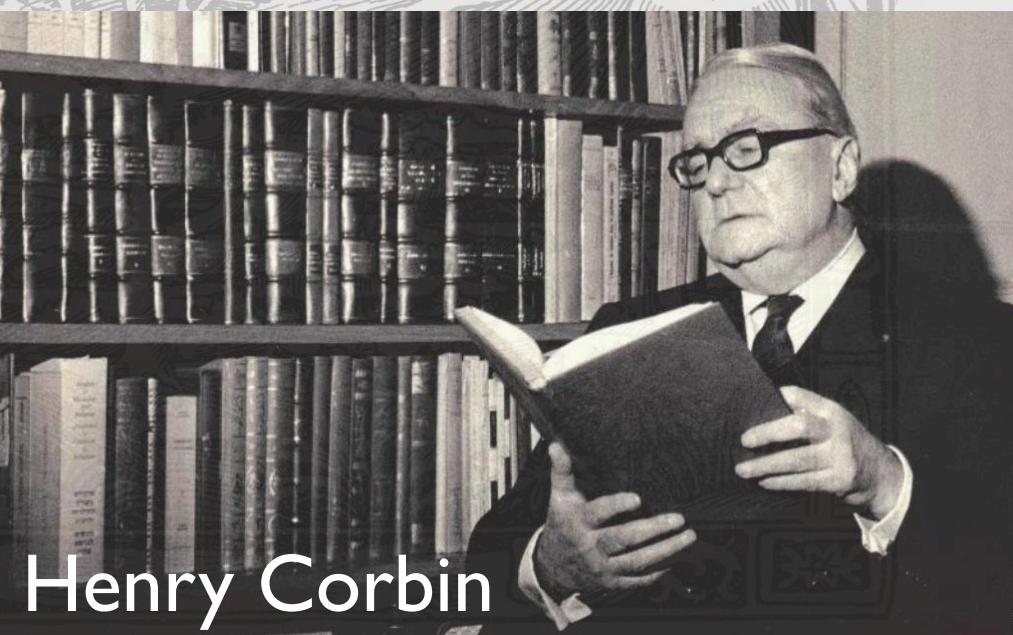
Masher $\xrightarrow{\text{Mash}}$ **Mashable**



mundus imaginialis

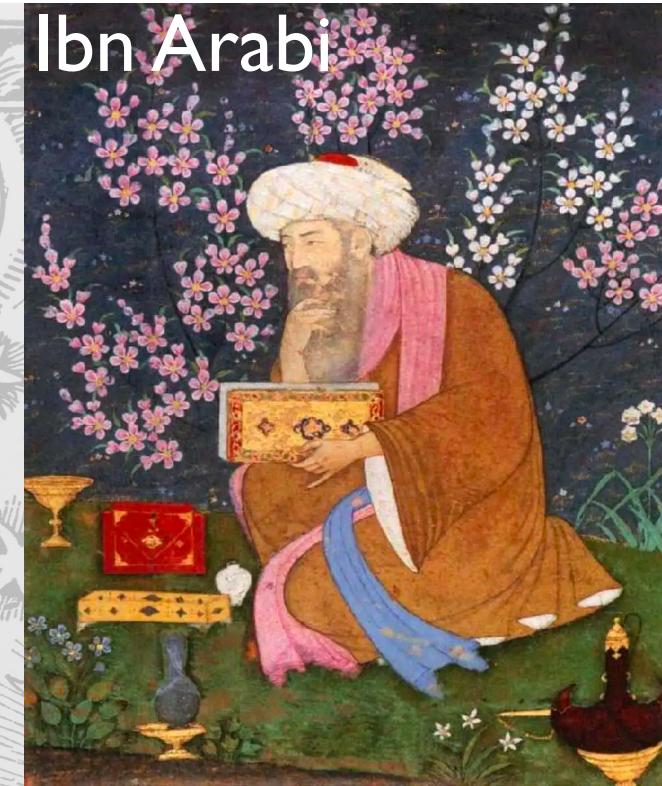


Suhrawardī



Henry Corbin

Ibn Arabi



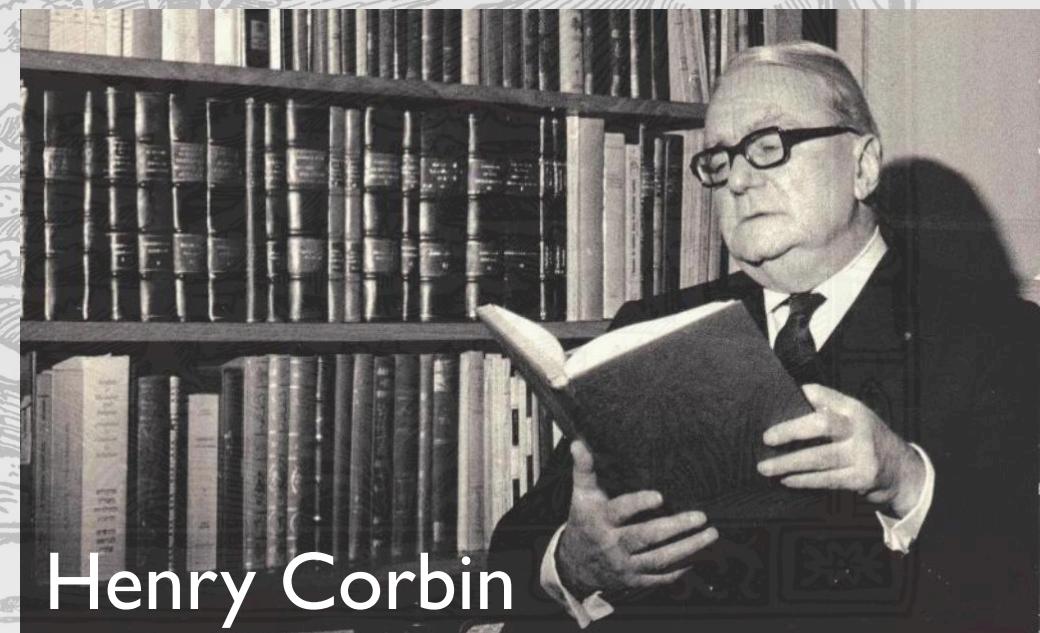
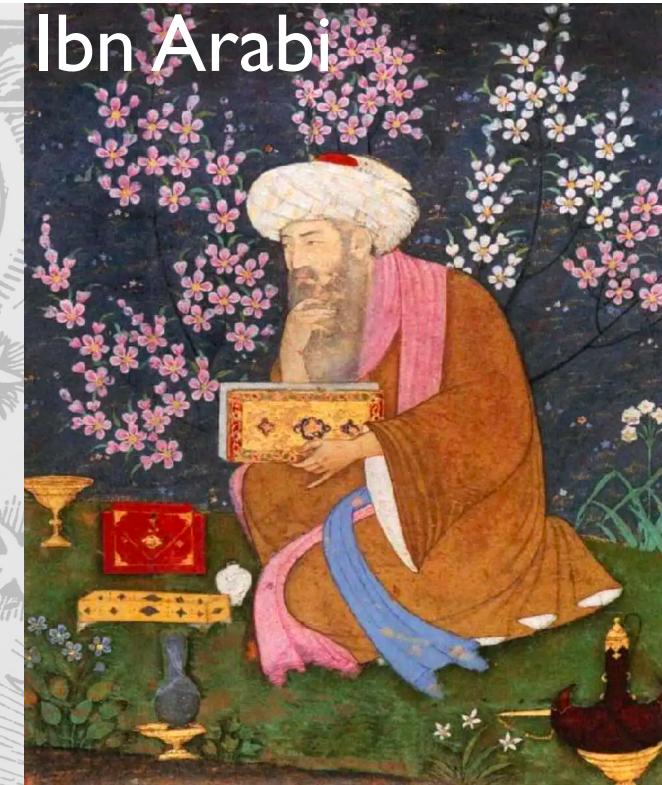
‘ālam al-mithāl

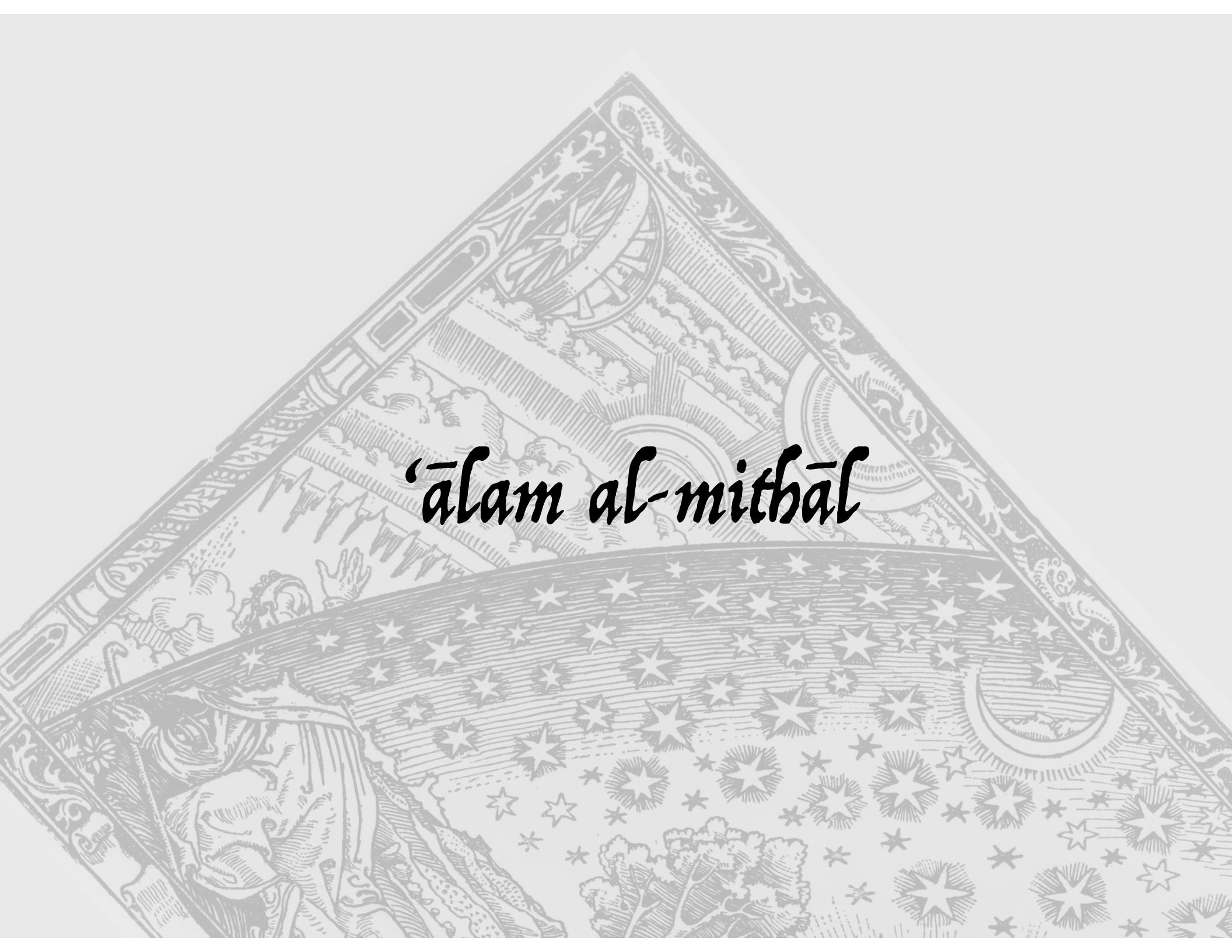


Suhrawardī

Henry Corbin

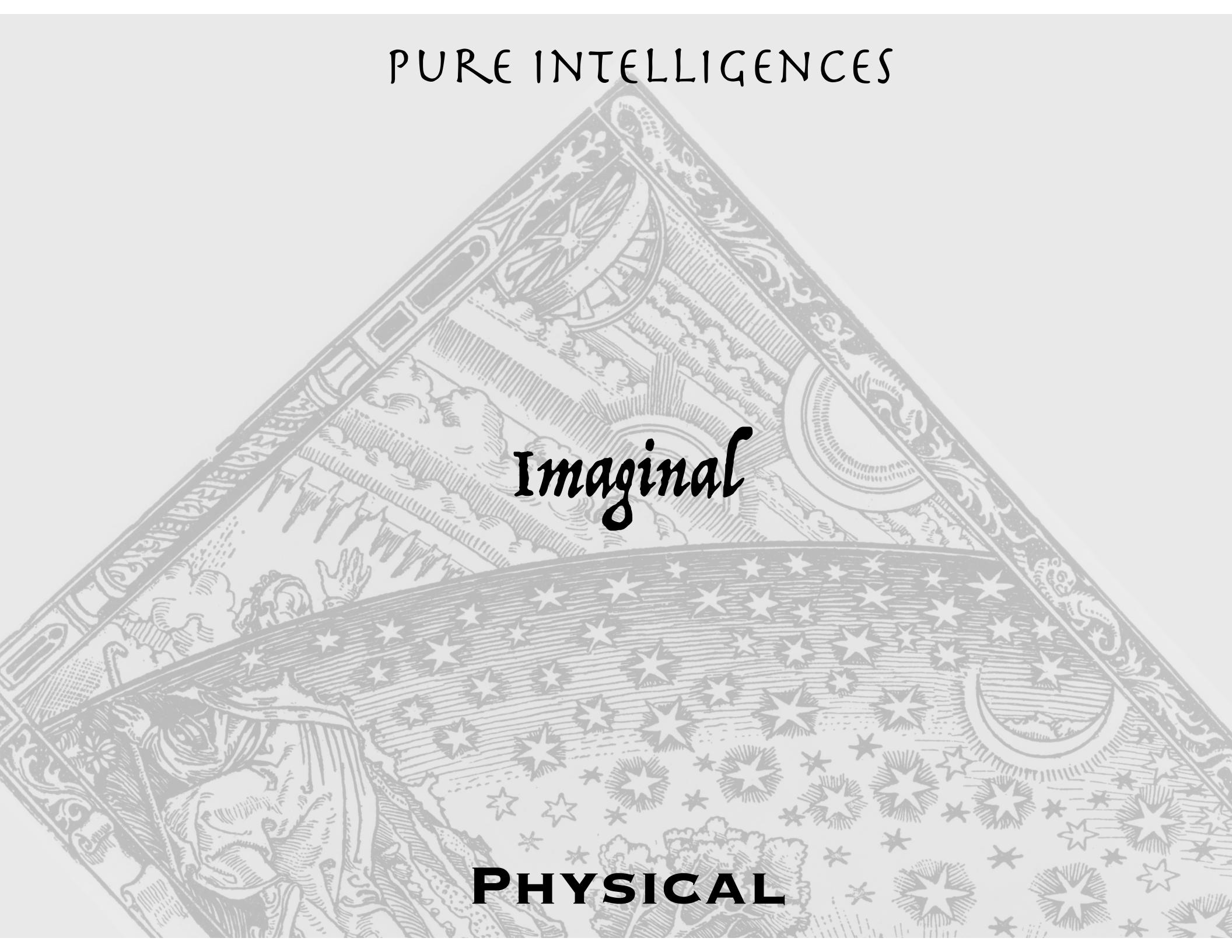
Ibn Arabi





‘ālam al-mithāl

PURE INTELLIGENCES



Imaginal

PHYSICAL

PURE INTELLIGENCES

Intellect

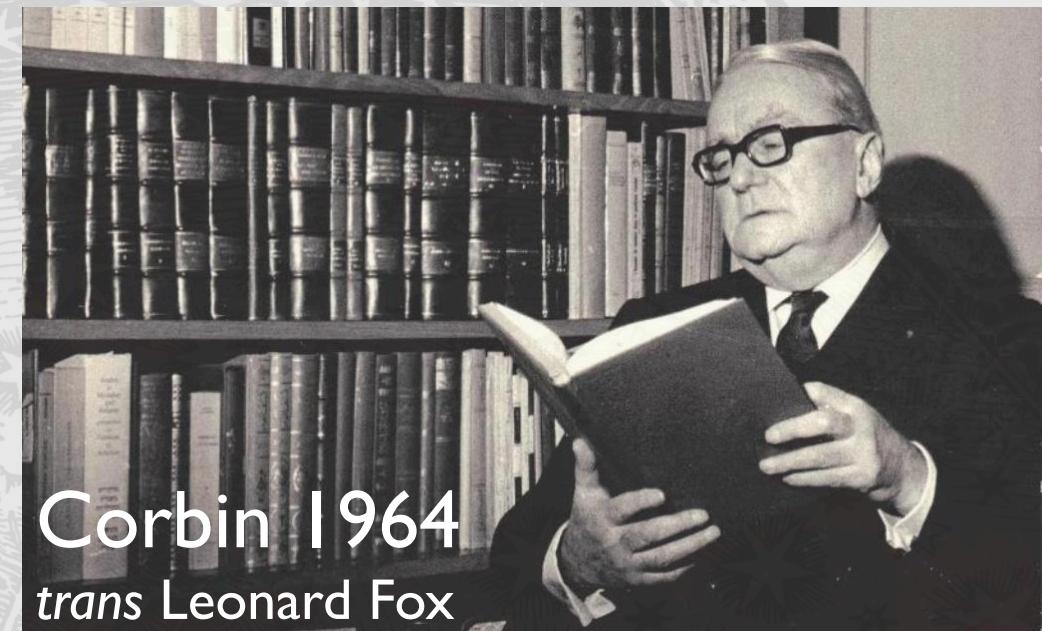
Imaginal

Imagination

PHYSICAL

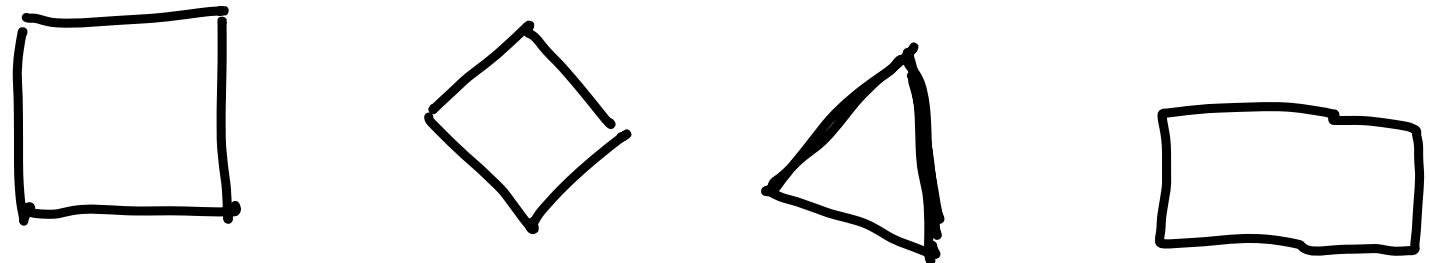
Senses

“It is the cognitive function
of the **Imagination** that
permits the establishment of
a rigorous analogical
knowledge.”

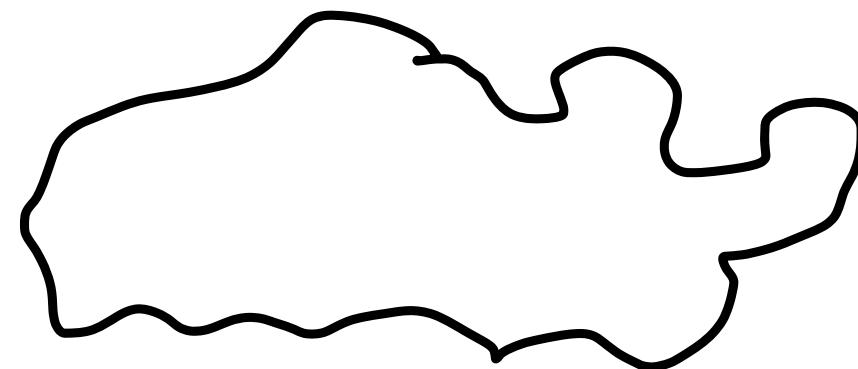
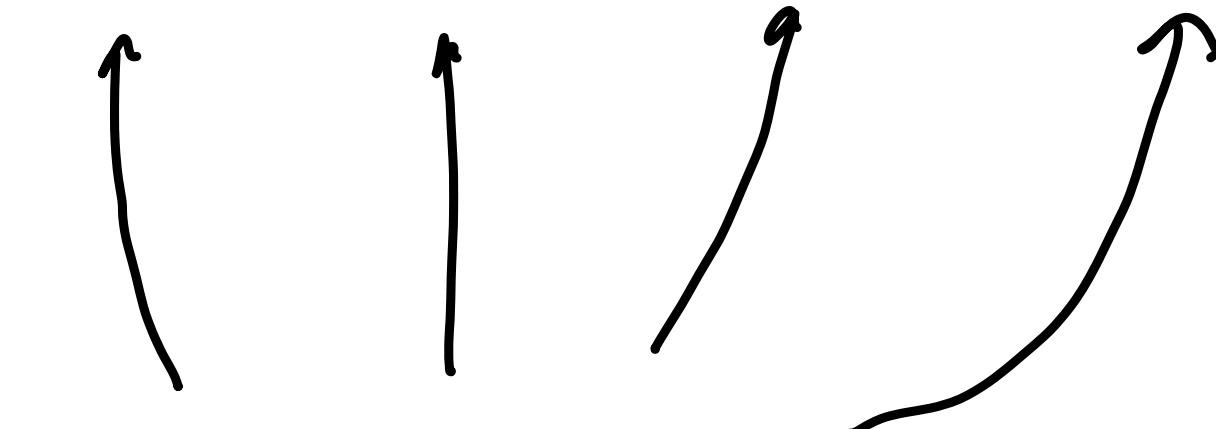


Corbin 1964
trans Leonard Fox

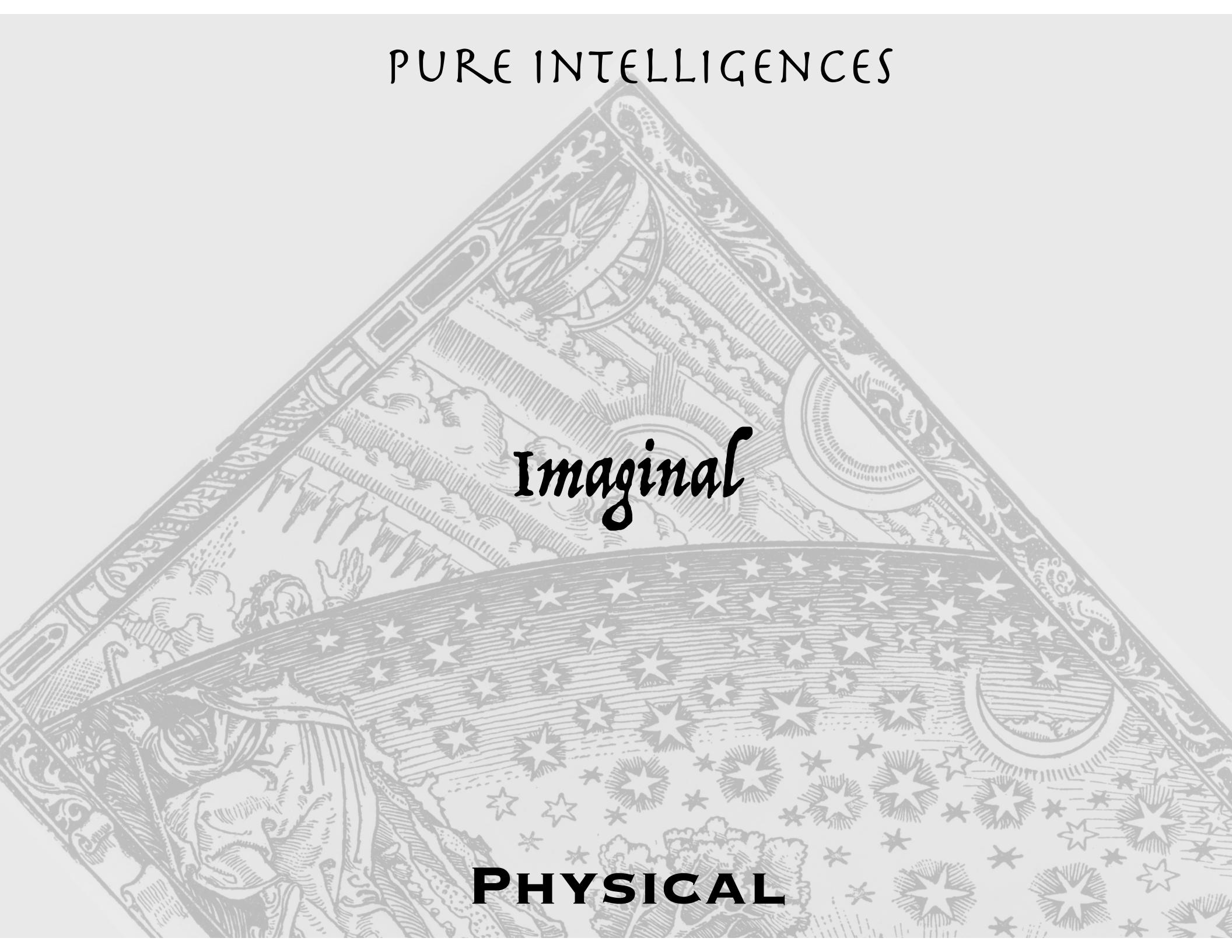
Math
world



Real
world



PURE INTELLIGENCES



Imaginal

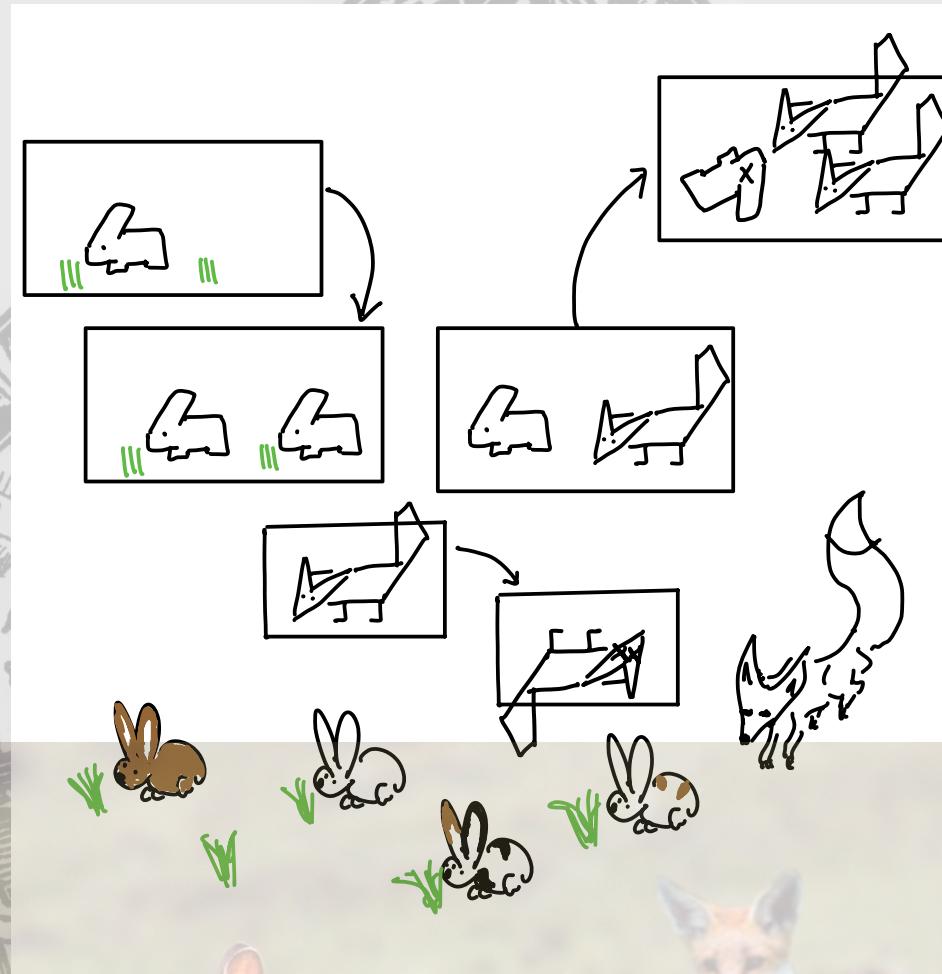
PHYSICAL



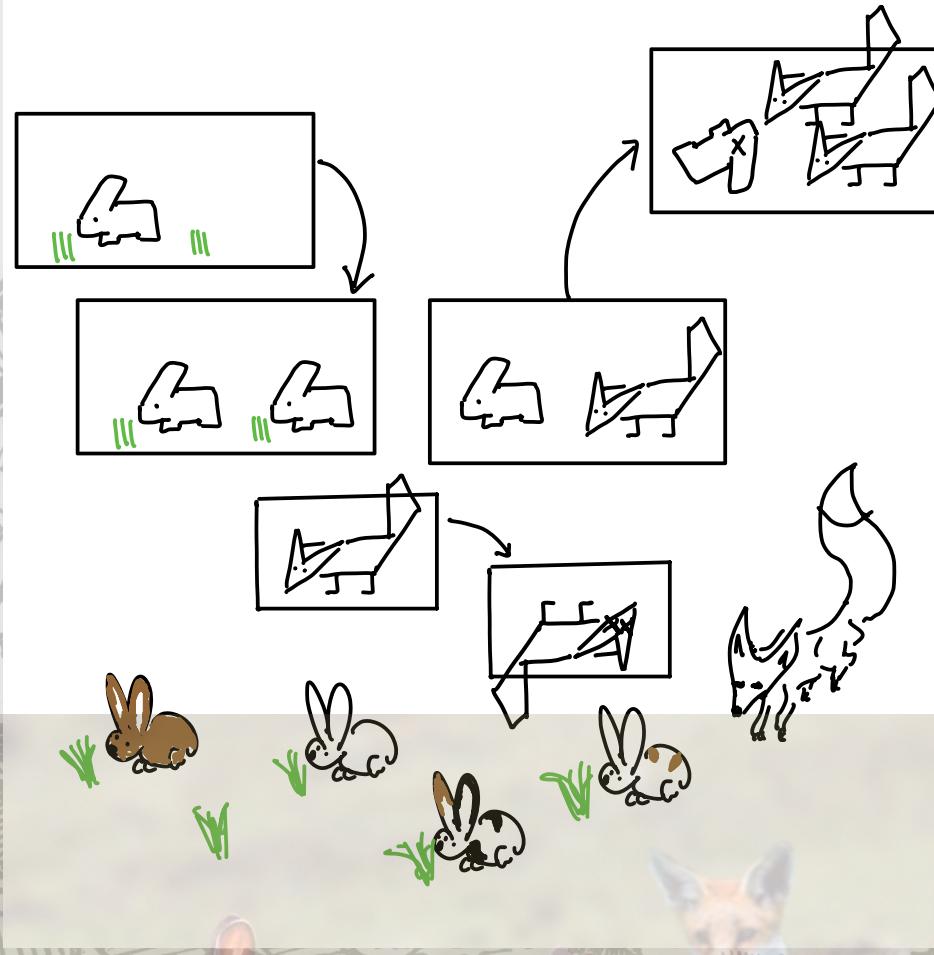






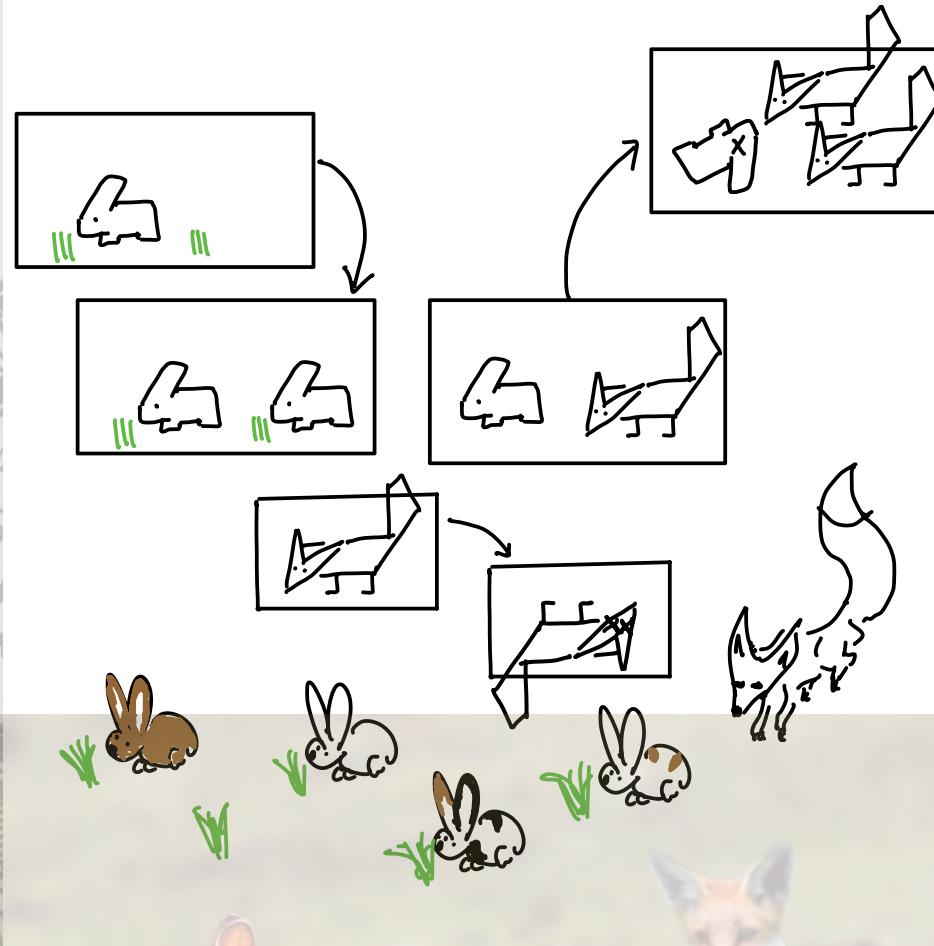


$$\frac{dx}{dt} = \alpha x - \beta xy$$
$$\frac{dy}{dt} = -\gamma y + \delta xy$$



Intellect

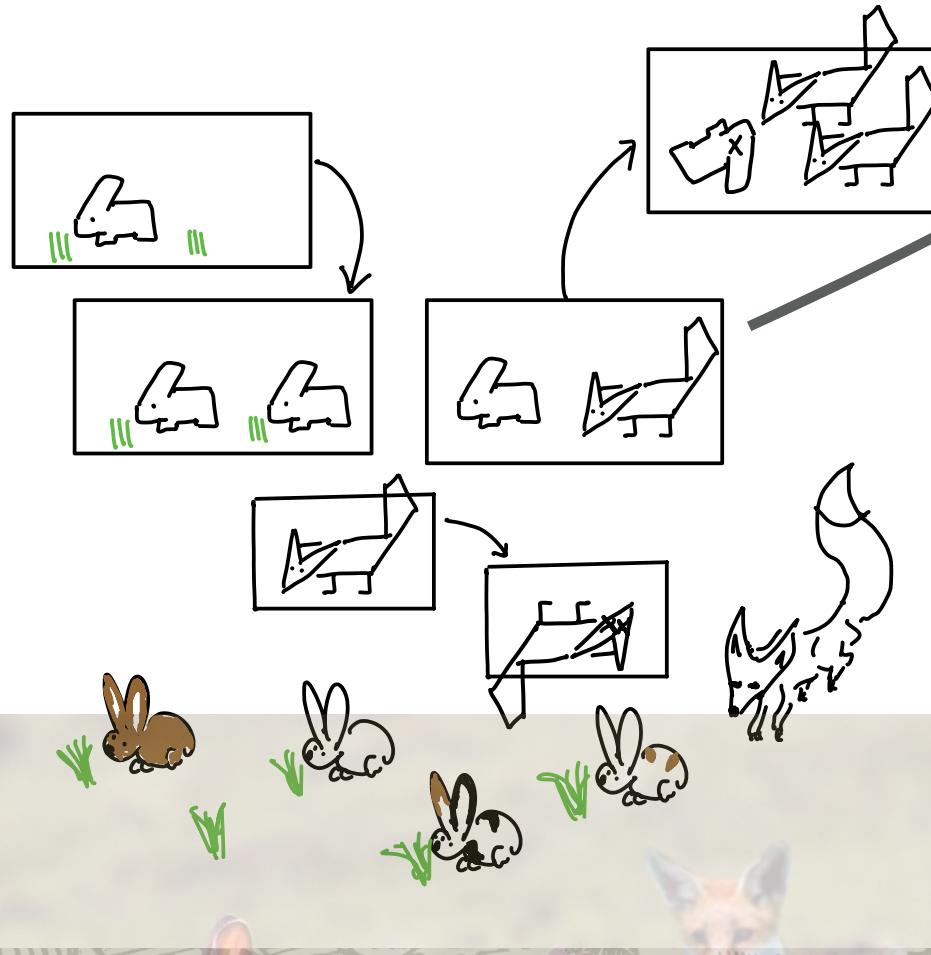
$$\frac{dx}{dt} = \alpha x - \beta xy$$
$$\frac{dy}{dt} = -\gamma y + \delta xy$$



Imagination

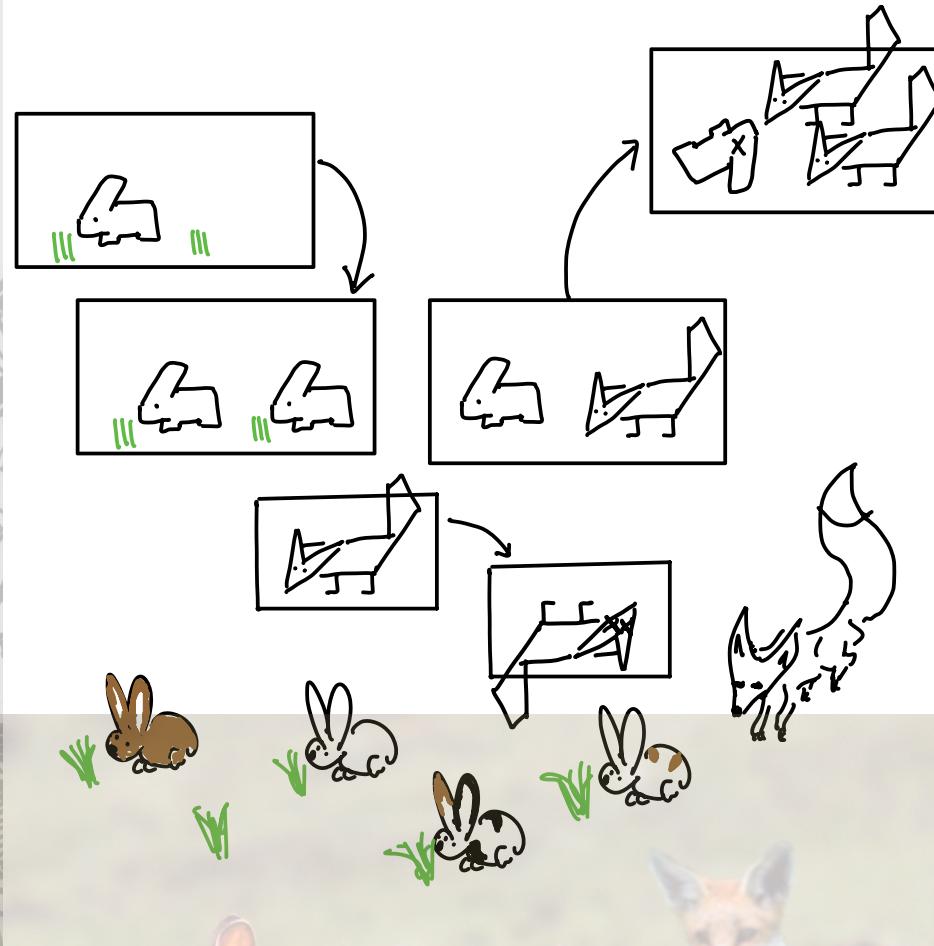
Senses

$$\frac{dx}{dt} = \alpha x - \beta xy$$
$$\frac{dy}{dt} = -\gamma y + \delta xy$$



Intellect

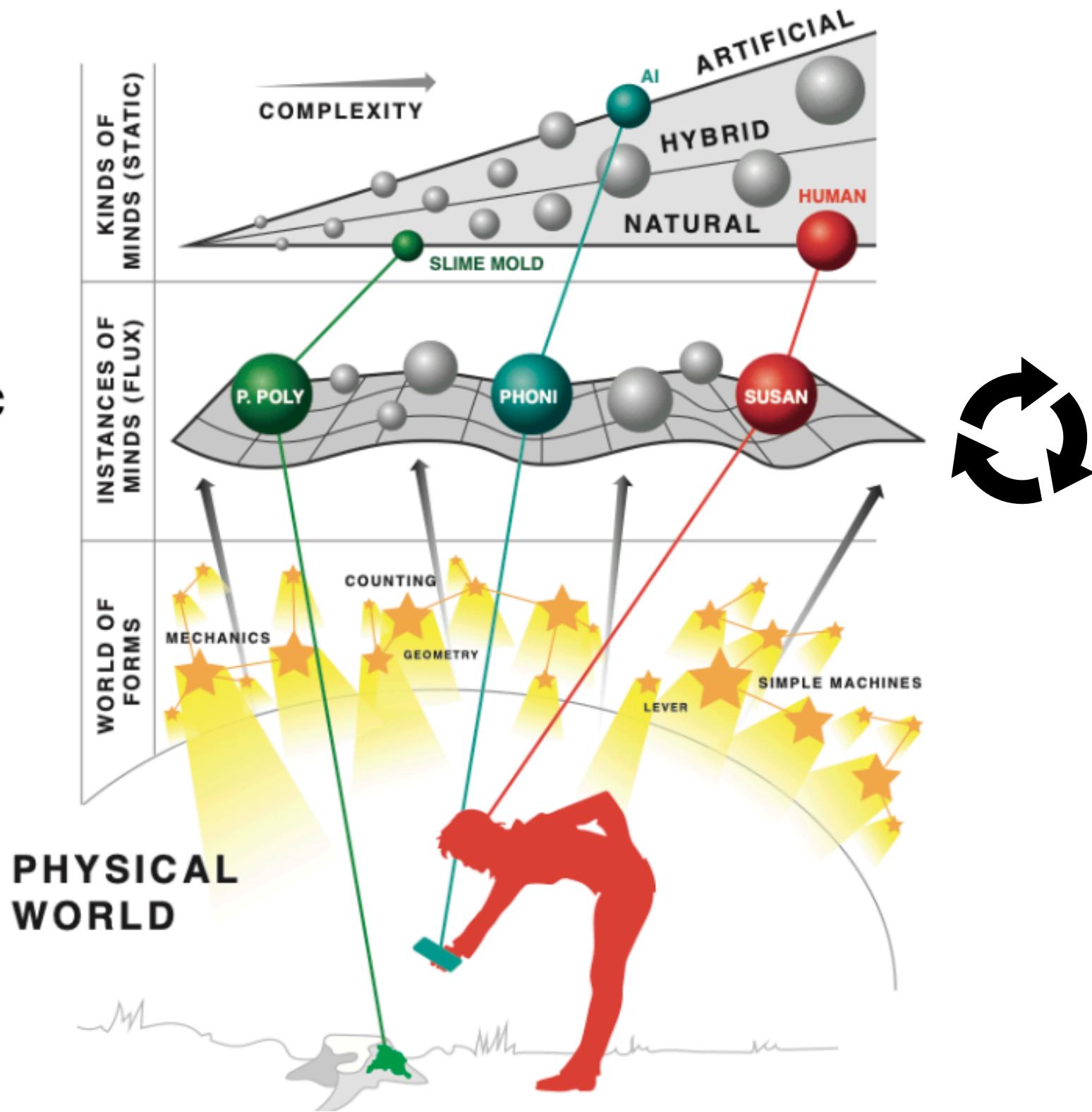
$$\frac{dx}{dt} = \alpha x - \beta xy$$
$$\frac{dy}{dt} = -\gamma y + \delta xy$$



Imagination

Senses

Platonic Space



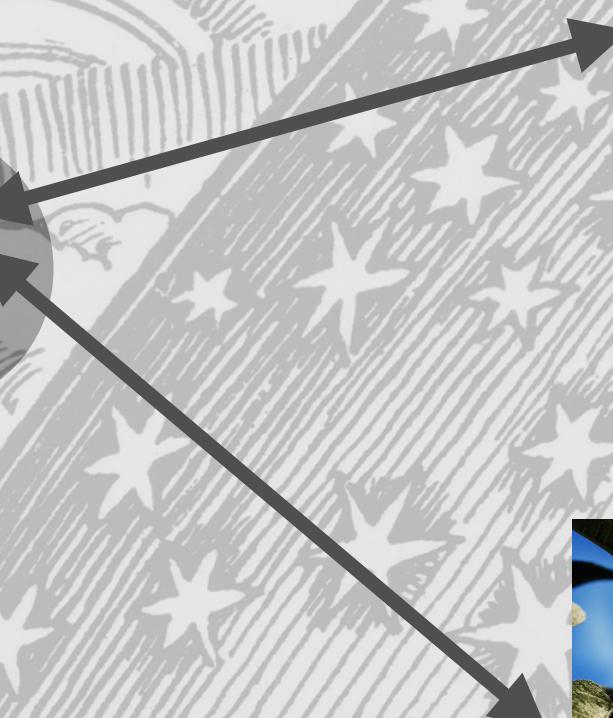
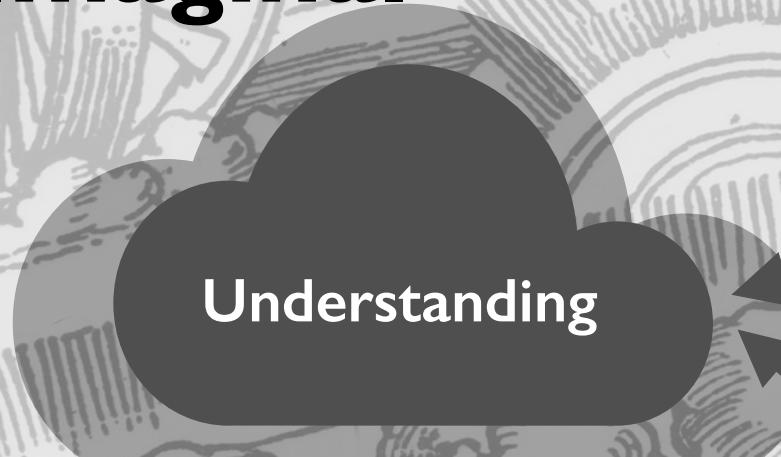
Different kinds of creativity

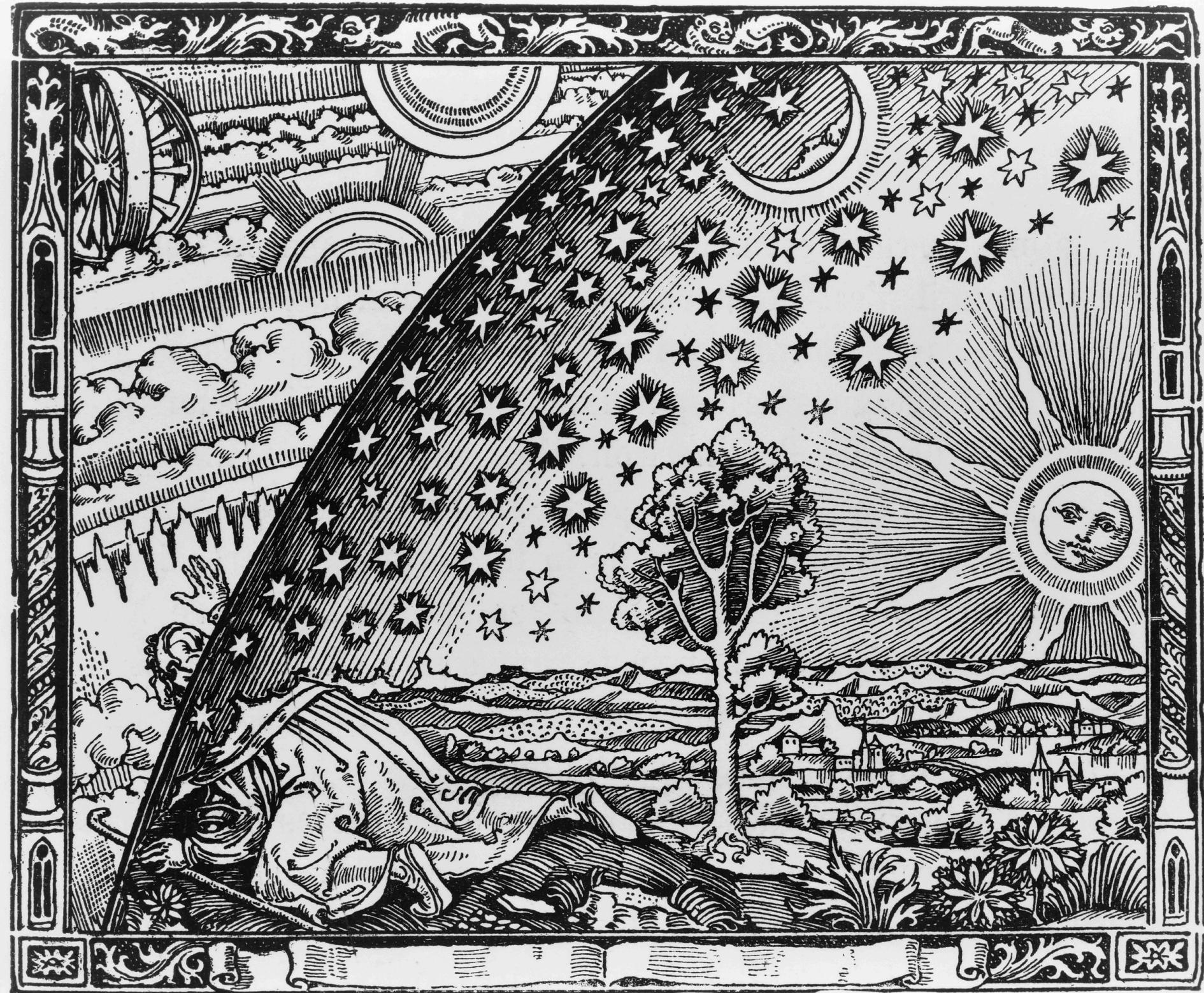
- Exploratory
- Combinatorial
- Transformational

Margaret Boden



Imaginal







Culture:
shared regularity in the
organization of experience or the
generation of action
acquired through social life.

Foster 2018

for the whole megillah, see

CULTURE AND COMPUTATION

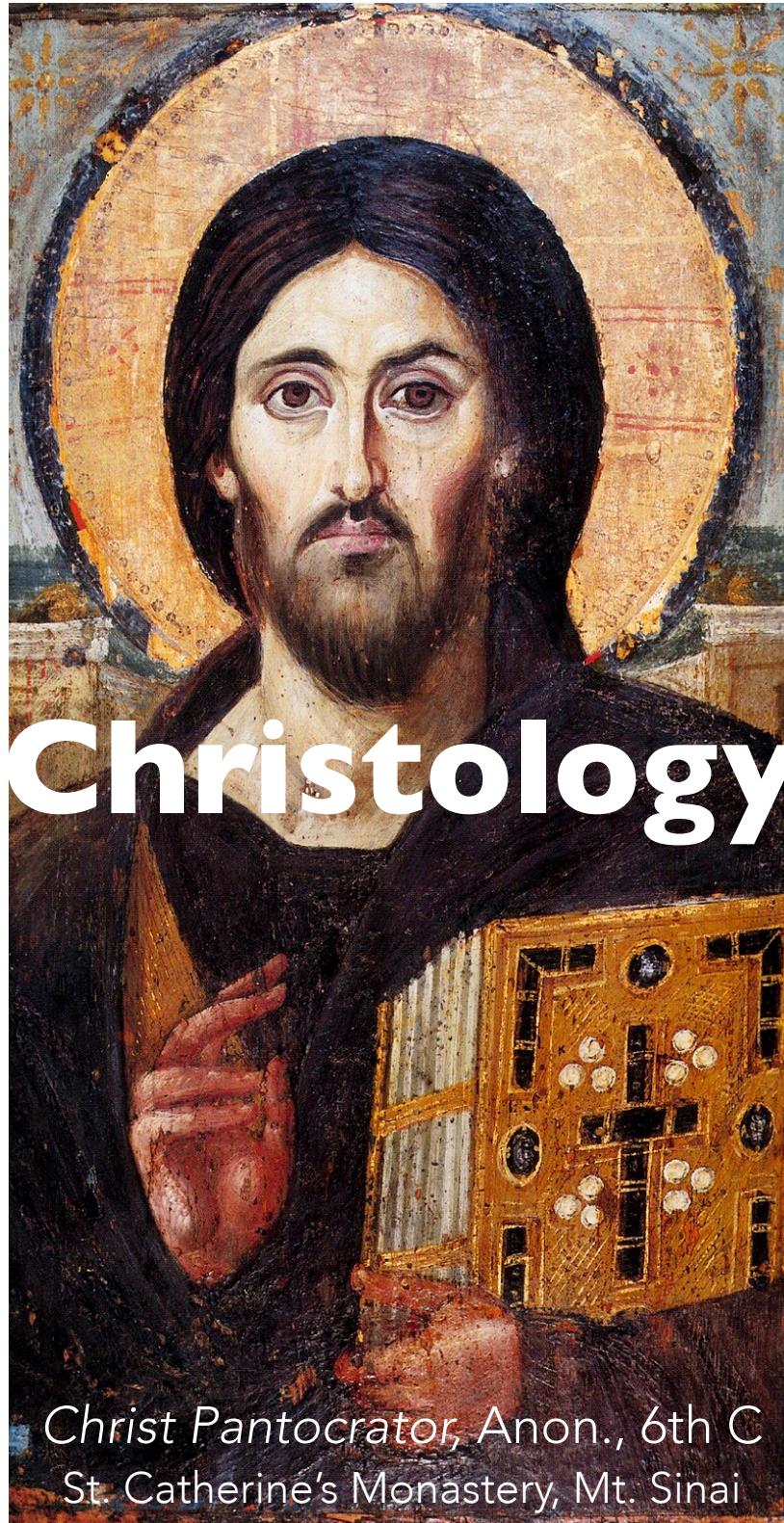
Steps to a Probably Approximately Correct Theory of Culture

POETICS 2018



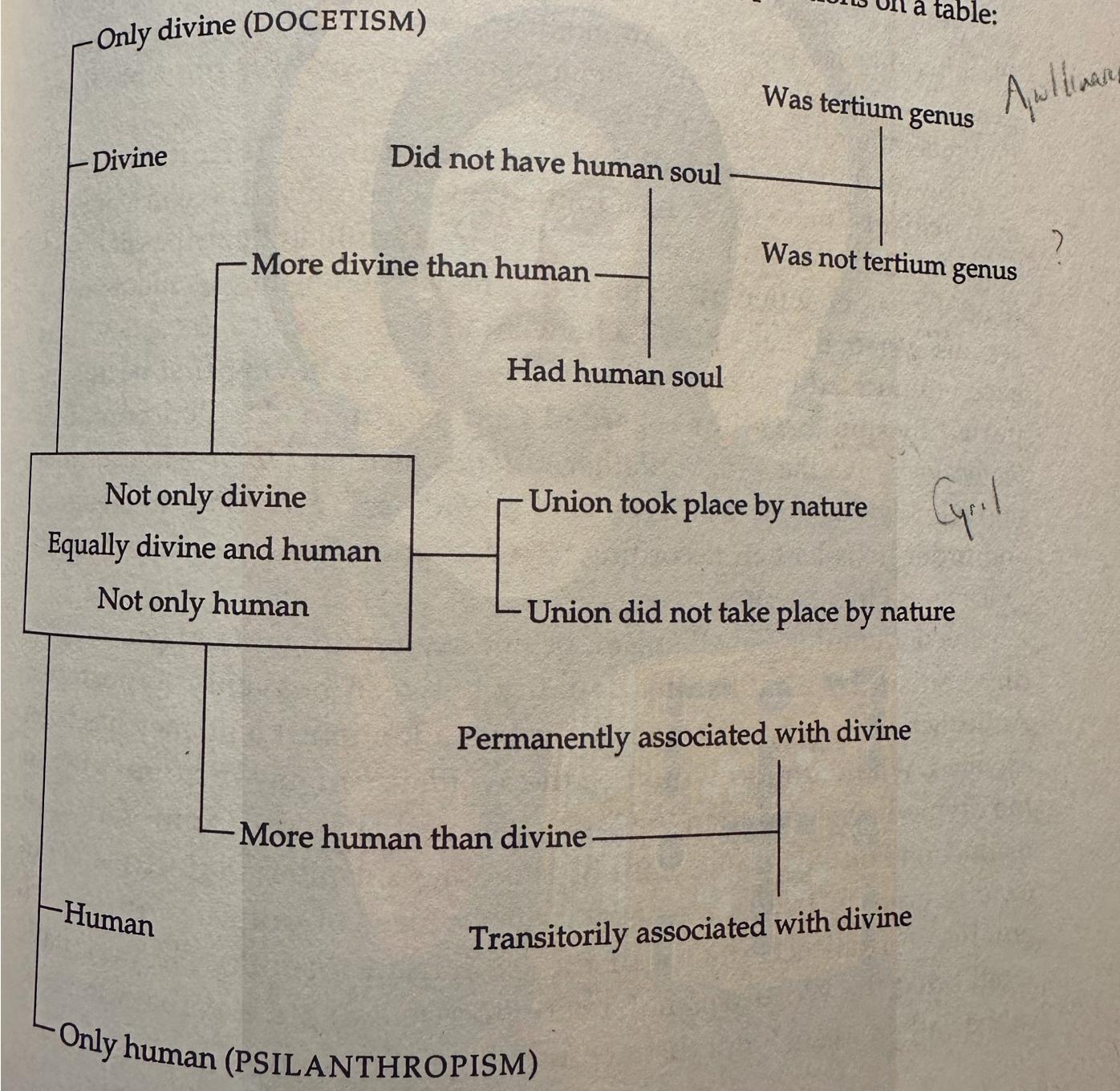
[HTTPS://DOI.ORG/10.1016/J.POETIC.2018.04.007](https://doi.org/10.1016/j.poetic.2018.04.007)

Monophysism

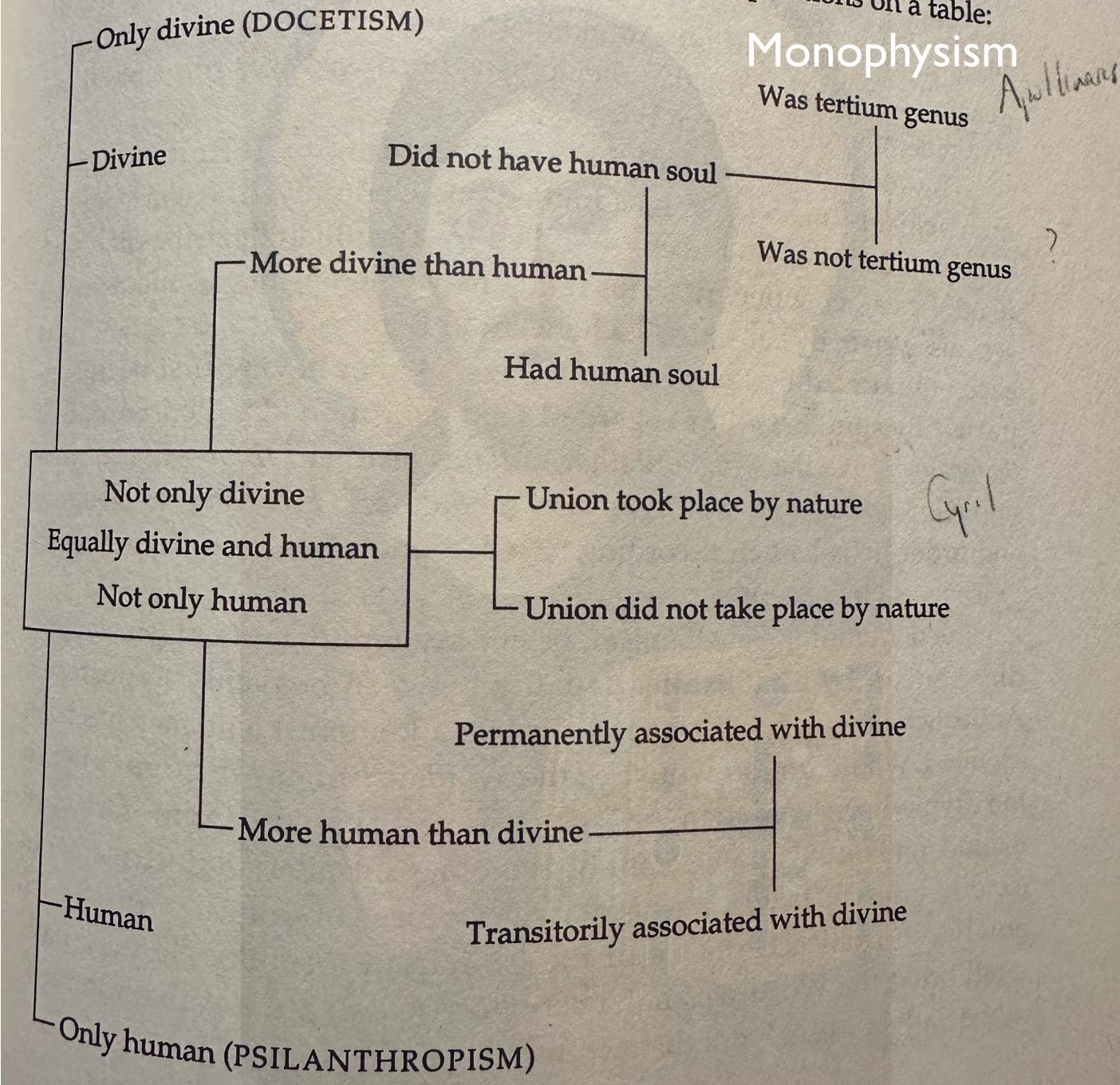


Christ Pantocrator, Anon., 6th C
St. Catherine's Monastery, Mt. Sinai

These were a few relevant dichotomies according to which the system works. It would be easier to trace the binary oppositions on a table:



These were a few relevant dichotomies according to which the system works. It would be easier to trace the binary oppositions on a table:



Trinitarian? Y/N
Equal? Y/N
Distinct? Y/N

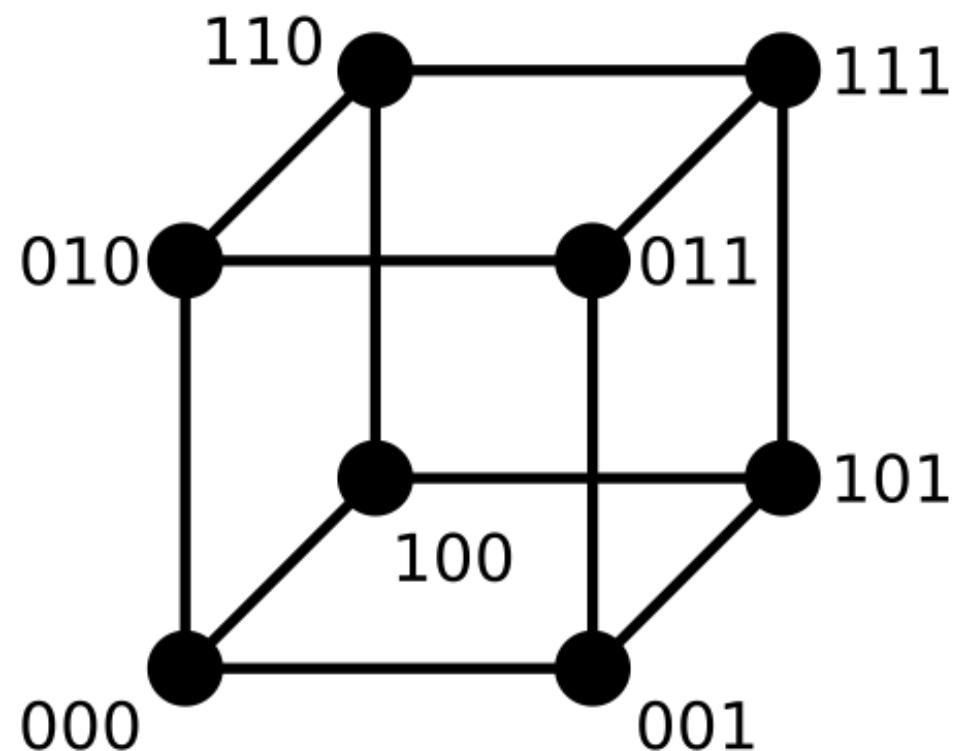


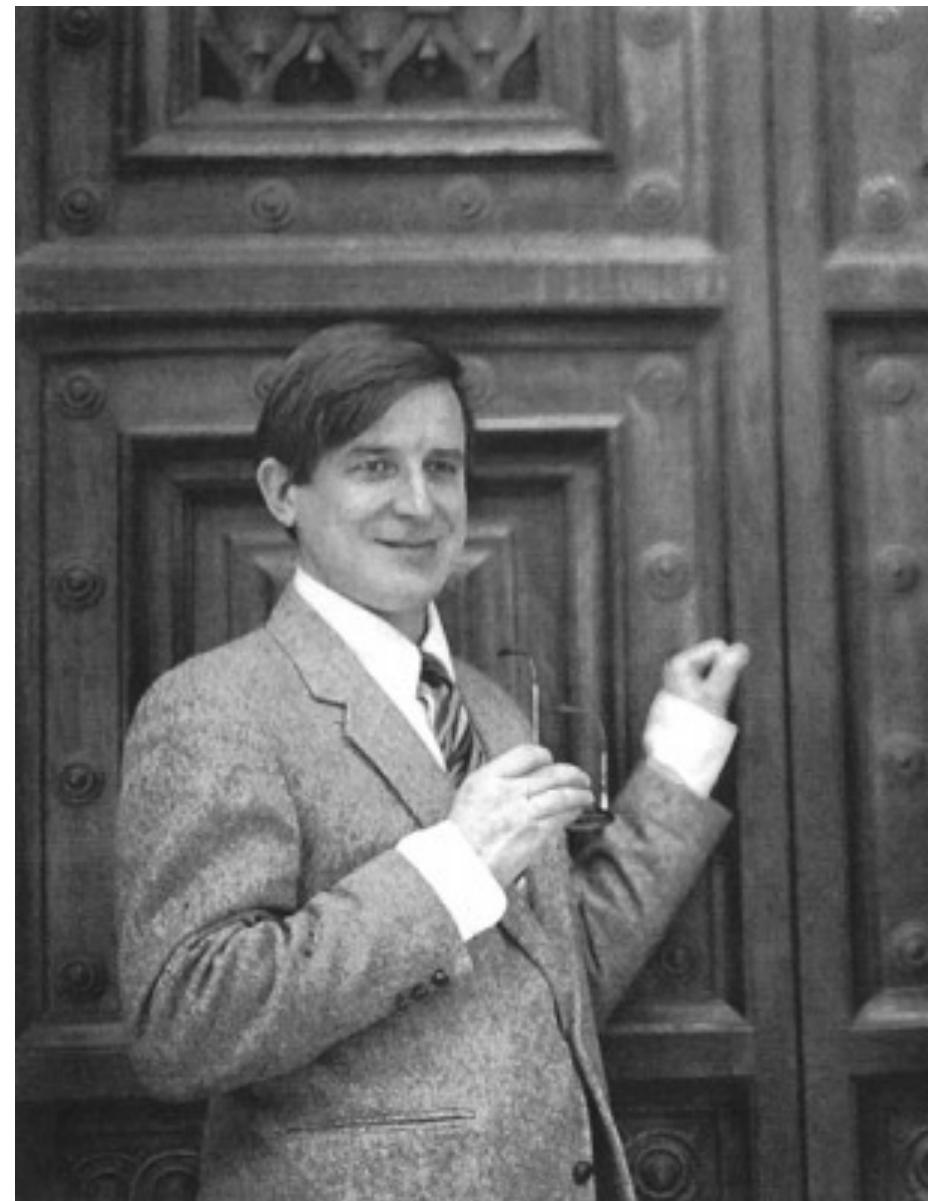
Trinity Sarcophagus
c. 350 CE

Trinitarian? Y/N

Equal? Y/N

Distinct? Y/N





"A profound study of Western religious dualism: an immensely learned chronicle of Gnosis and the varieties of Gnosticism."

—Harold Bloom, author of *The Book of J*

The Tree of Gnosis



Gnostic Mythology from Early Christianity to Modern Nihilism

• • •

Ioan P. Couliano

Ideal objects



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The Tree of Gnosis



Gnostic Mythology from Early Christianity to Modern Nihilism

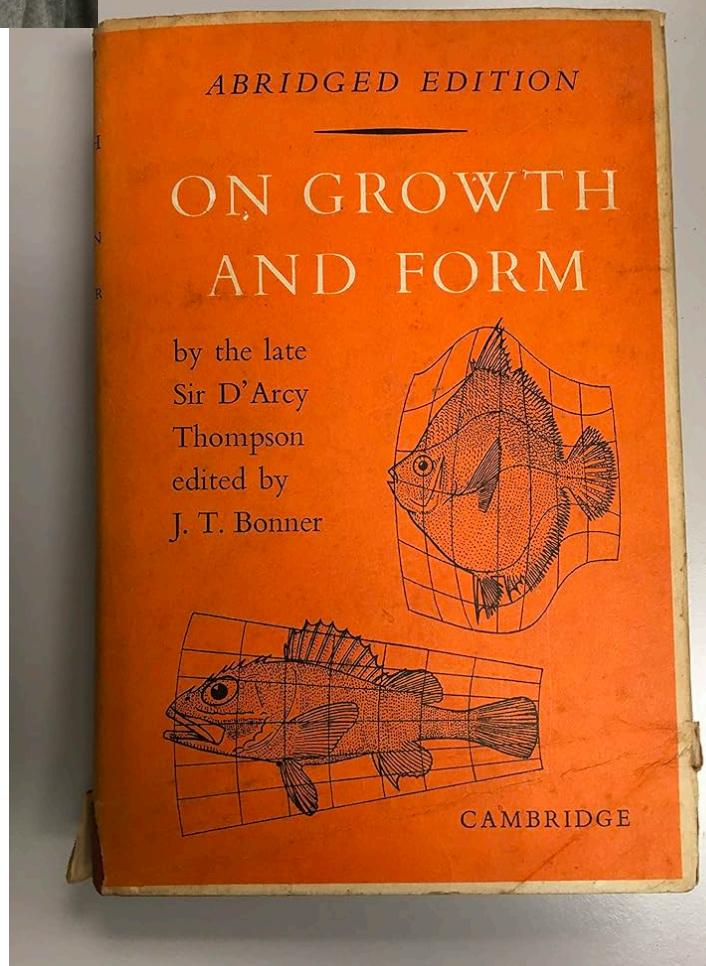
• • •

Ioan P. Couliano

Ideal objects

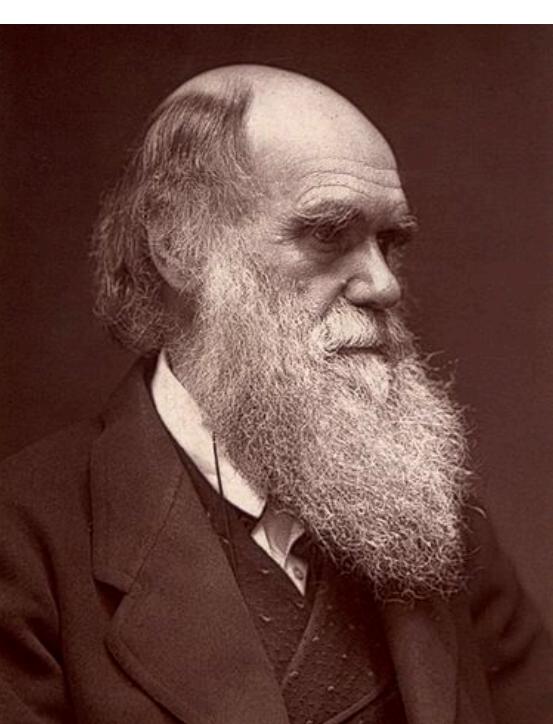


"Systems of ideas that exist in their 'logical dimension.'"

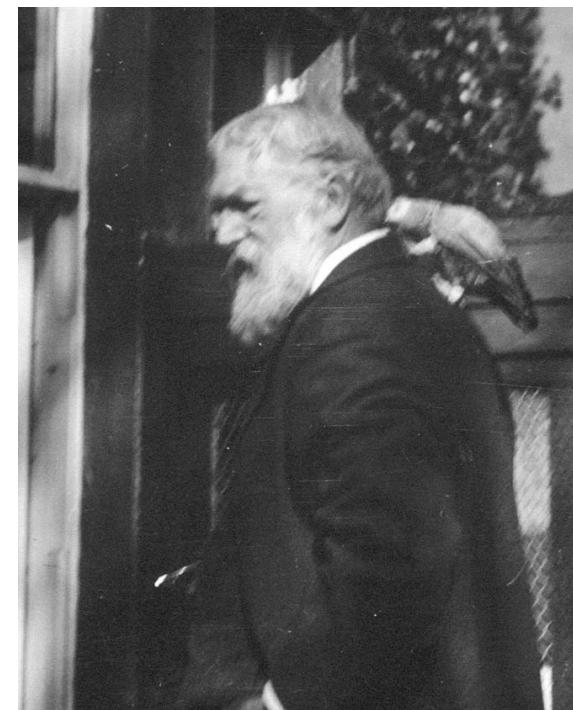
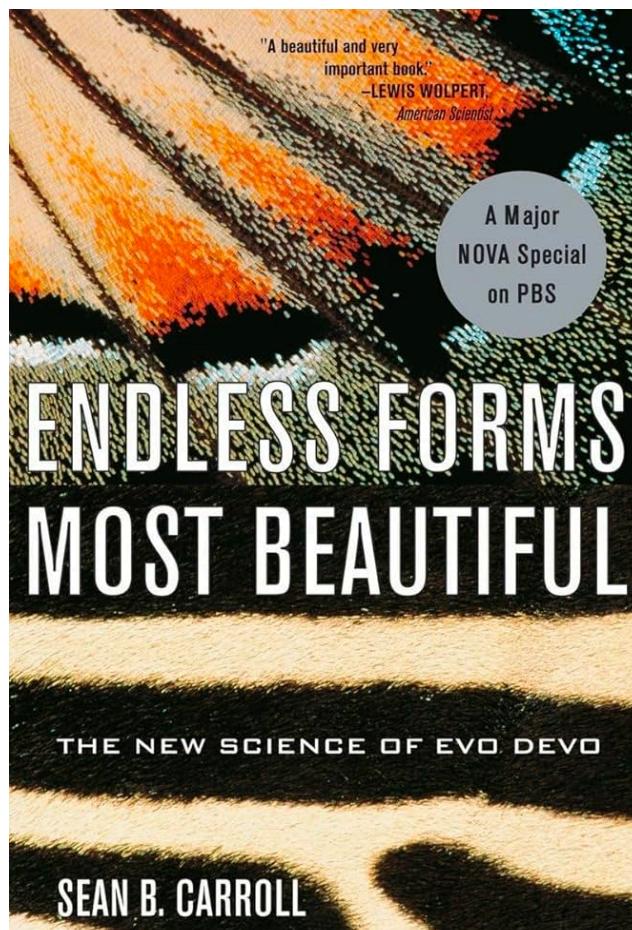
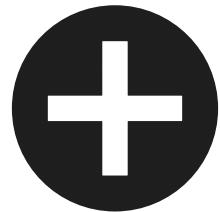




Morphodynamics



==



Cultural evolution
needs to go **evo-devo**

Parallel evolution of marsupial and placental mammals

▲ short-headed glider, sugar glider, flying phalanger, flying possum (*Petaurus breviceps*)



▲ marsupial mole (*Notoryctes typhlops*)



▲ thylacine, Tasmanian wolf, Tasmanian tiger (*Thylacinus cynocephalus*)



▲ marsupial
● placental

▲ crest-tailed marsupial mouse, mulgara (*Dasyurus cristicauda*)

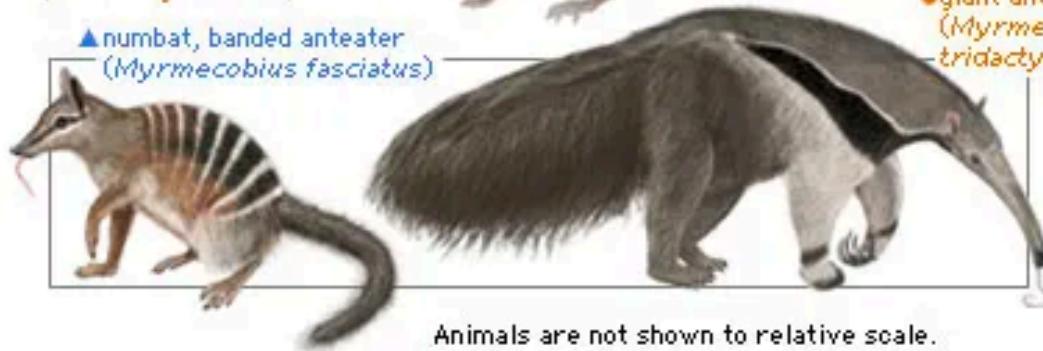


● European mole (*Talpa europaea*)



● southern flying squirrel, North American flying squirrel (*Glaucomys volans*)

▲ numbat, banded anteater (*Myrmecobius fasciatus*)



● giant anteater (*Myrmecophaga tridactyla*)

▲ spotted-tailed native cat, tiger cat (*Dasyurus maculatus*)

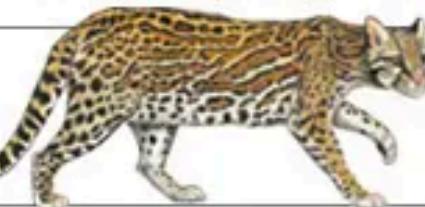


▲ common wombat (*Vombatus ursinus*)

● woodchuck, groundhog, marmot (*Marmota monax*)



● ocelot (*Felis*, or *Leopardus*, *pardalis*)



Animals are not shown to relative scale.

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Diverged > 100 Million Years ago

Ecological demands plus generative resources



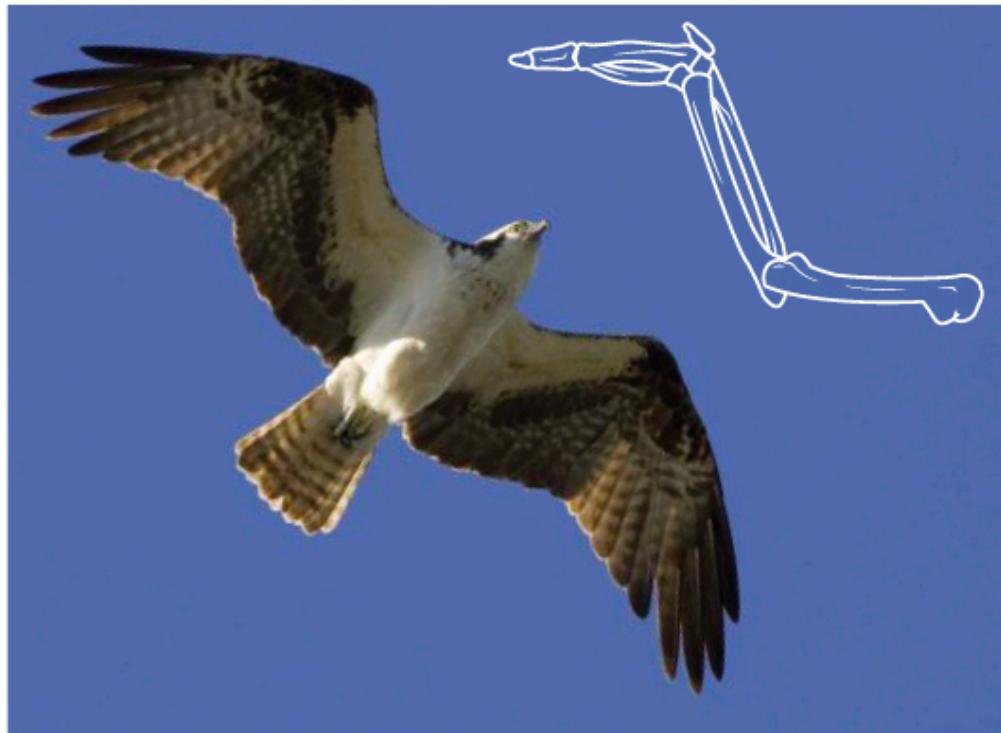
Feigin et al., 2019

Ecological demands plus generative resources

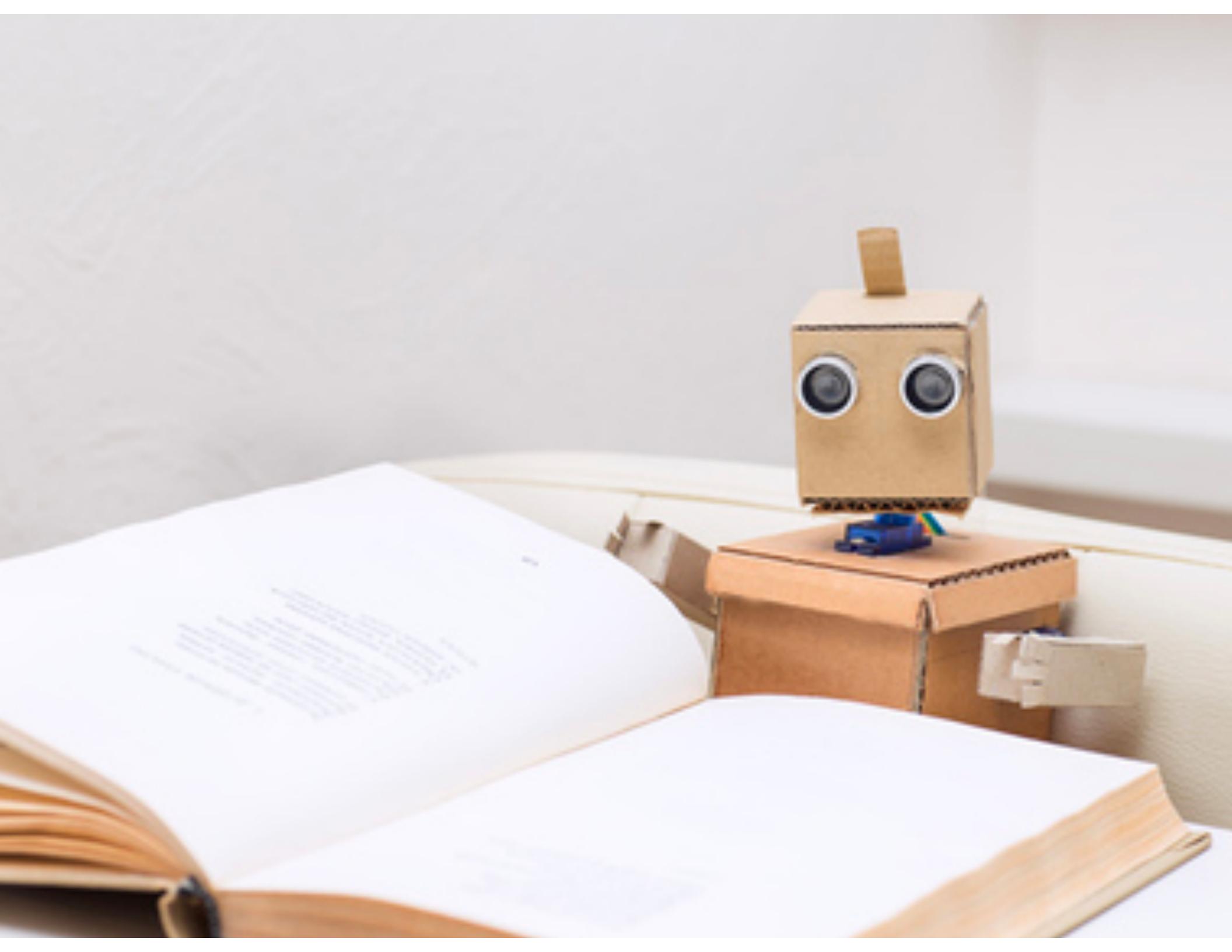


SMBC-Comics, 2009

Ecological demands plus generative resources



Foster (2017) in *Trajectories*
commenting on Emigh et al., *How Societies and States Count*





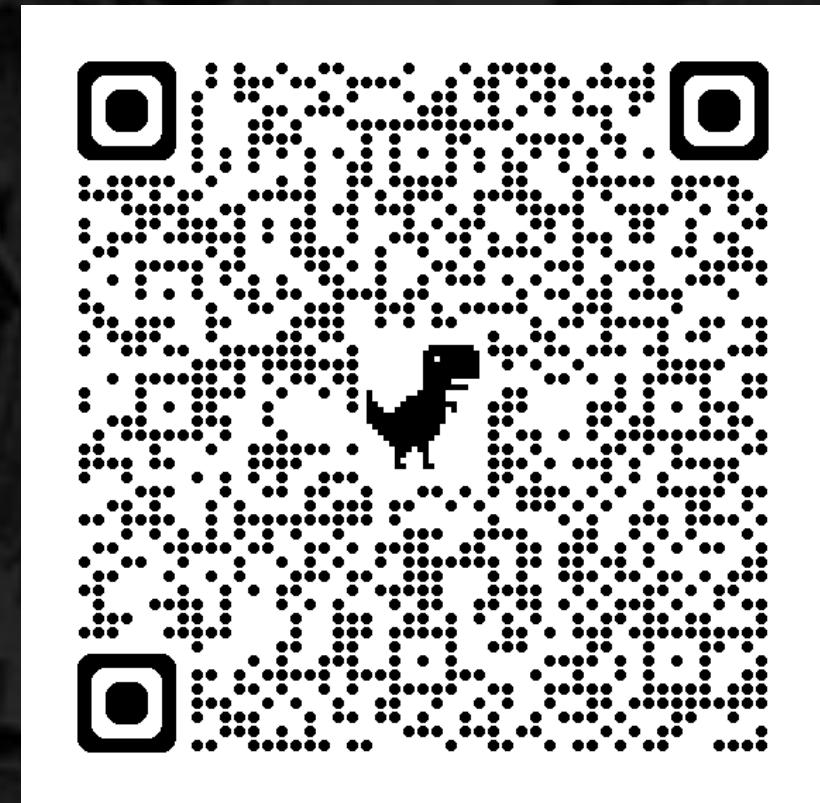
EVOLUTIONARY DYNAMICS OF CULTURAL CHANGE

W/ BERNARD KOCH AND DANIELE SILVESTRO

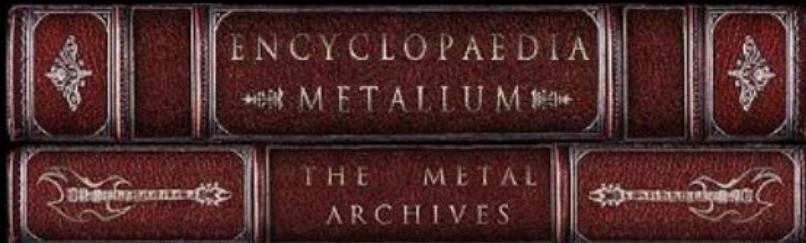


Conditionally accepted at *American Journal of Sociology*

EVOLUTIONARY DYNAMICS OF CULTURAL CHANGE



The data



Search:

Band name

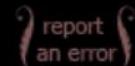
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SUBMIT

[HELP](#) [RULES](#) [FORUM](#)

[FAQ](#) | [SUPPORT US](#) | [ADD-ONS](#)

AMORPHIS



Country of origin: Finland

Genre:

Progressive/Death/Doom Metal (early);

Location: Helsinki, Uusimaa

Melodic Heavy Metal/Rock (later)

Status: Active

War, Legends (early); Death, Finnish legends,

Formed in: 1990

Kalevala

Years active: 1990-present

Nuclear Blast

The first band added to the Metal Archives.

Amorphis is derived from the Greek 'amorphous' which means without determinate form, shapeless.

With Violent Solution's break-up, Jan Rechberger and Esa Holopainen formed Amorphis in 1990 with Jan on drums, Esa on lead guitars, Tomi Koivusaari as vocalist, and Olli-Pekka Laine as bassist. Soon after signing with Relapse Records (which would remain

...

[READ MORE](#)

amorphis



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[LIVES](#)

[DEMOS](#)

[MISC.](#)

Name

Dismantle of Soul

Type

Year

Reviews

Demo

1991

2 (73%)

Amorphis

Single

1991

1 (85%)

The Karelian Isthmus

Full-length

1992

11 (85%)

Buy their stuff

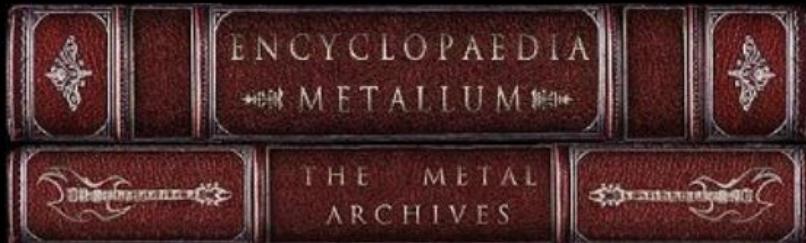
Search on eBay [more... >>](#)

Search on Amazon.com [more... >>](#)

Buy from No Remorse

The data

Thanks to our anonymous informant, HellBlazer



Search:

Band name

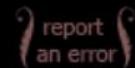
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AMORPHIS



Country of origin: Finland
Location: Helsinki, Uusimaa
Status: Active
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Years active: 1990-present

Genre: Progressive/Death/Doom Metal (early);
Melodic Heavy Metal/Rock (later)
Lyrical themes: War, Legends (early); Death, Finnish legends, Kalevala
Current label: Nuclear Blast

The first band added to the Metal Archives.

Amorphis is derived from the Greek 'amorphous' which means without determinate form, shapeless.

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[DEMOS](#)

[MISC.](#)



Name

Dismant of Soul

Amorphis

The Karelian Isthmus

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Buy their stuff

Search on eBay [more... >>](#)

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Buy from No Remorse

birth:



$$\lambda_t \rightarrow$$



$$+$$



death:



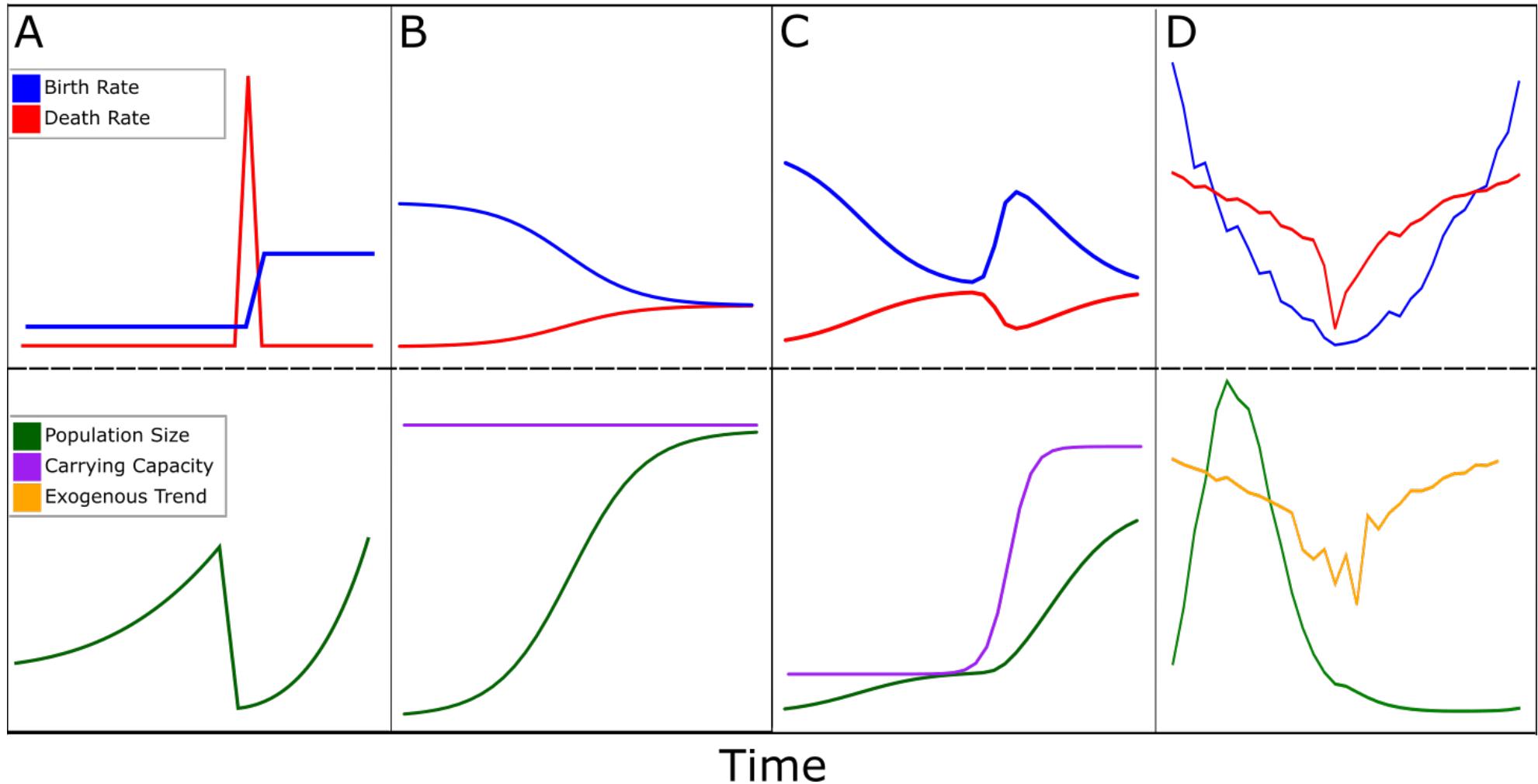
$$\mu_t \rightarrow \emptyset$$

Bands compete for...

Bands compete for...



Evolutionary mechanisms



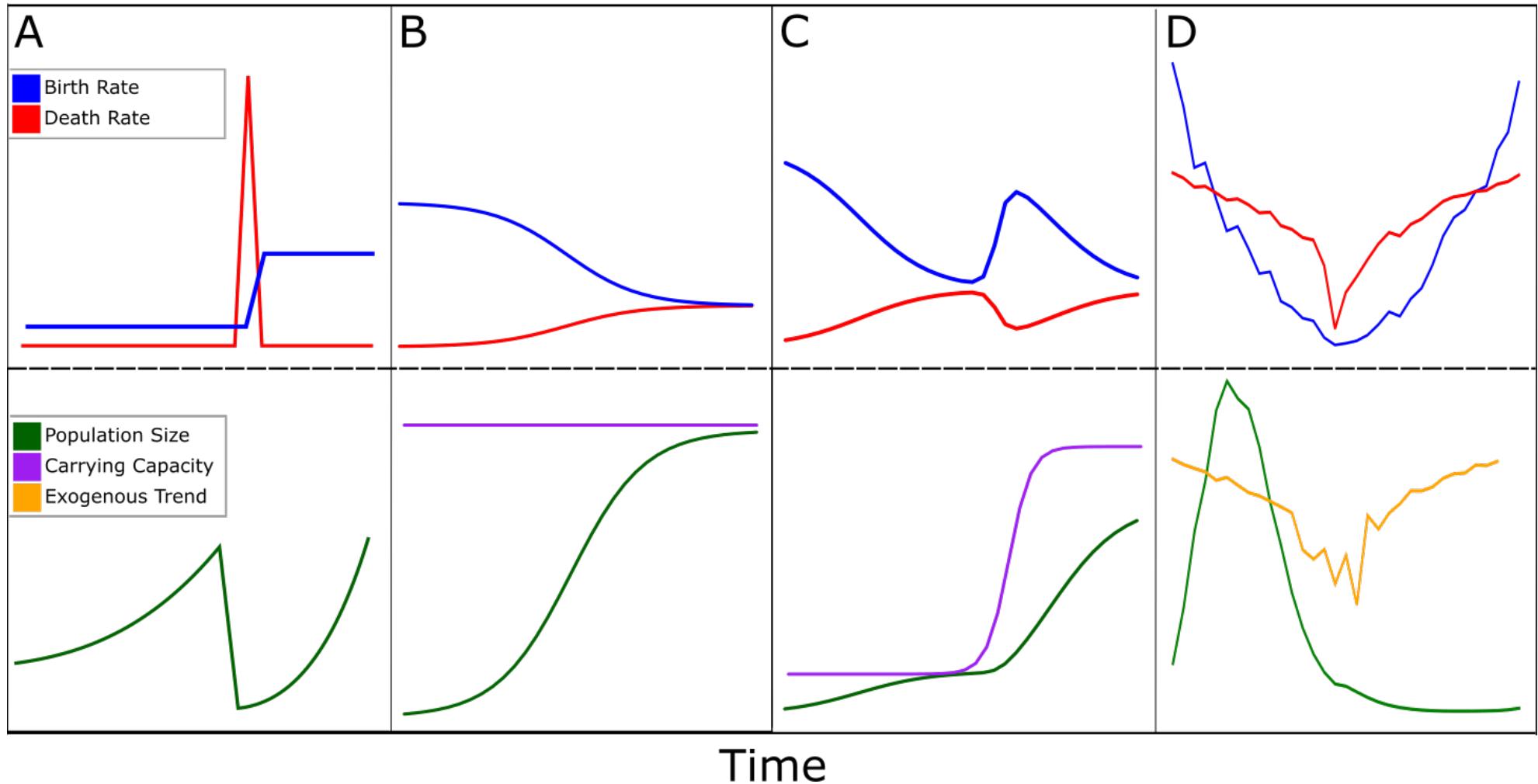
Mass extinction

Competition

Key innovation

Exogenous forcing

Evolutionary mechanisms



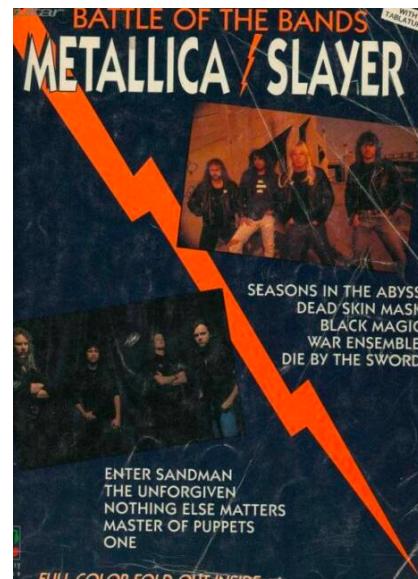
Mass extinction

Competition

Key innovation

Exogenous forcing

Evolutionary mechanisms



Mass extinction

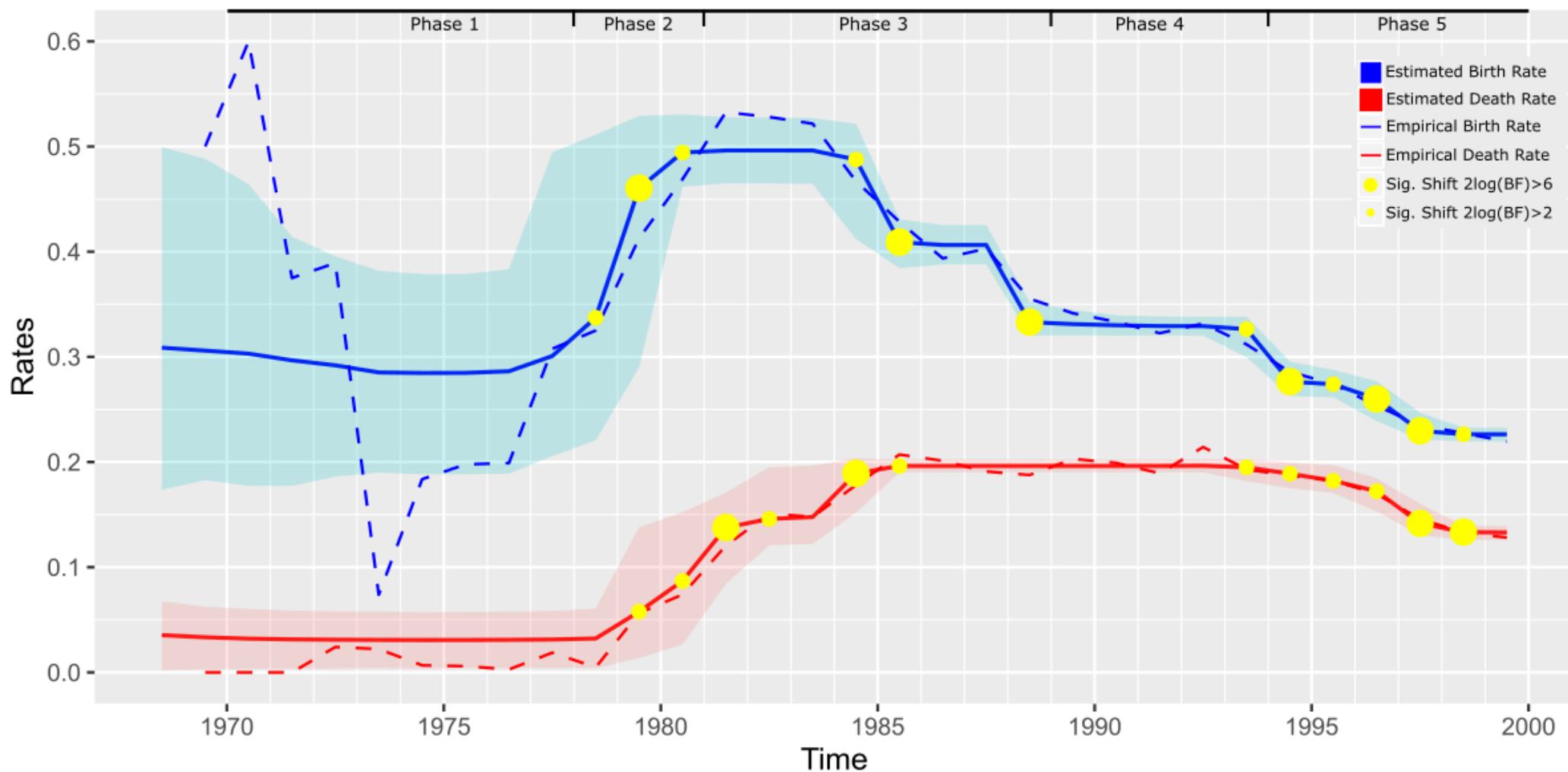
Competition

Key innovation

Exogenous forcing

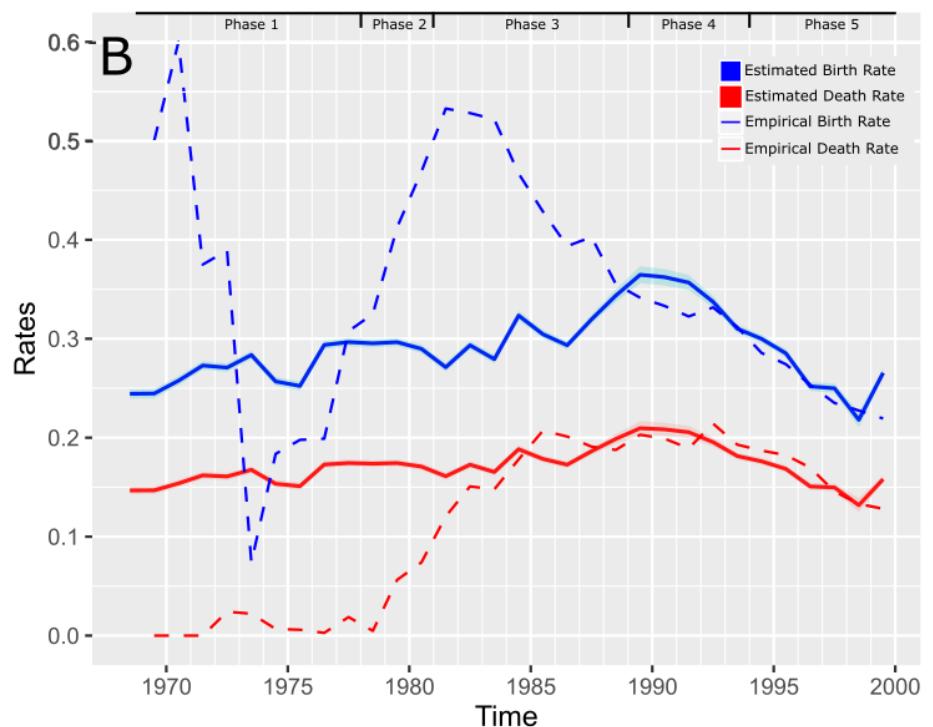
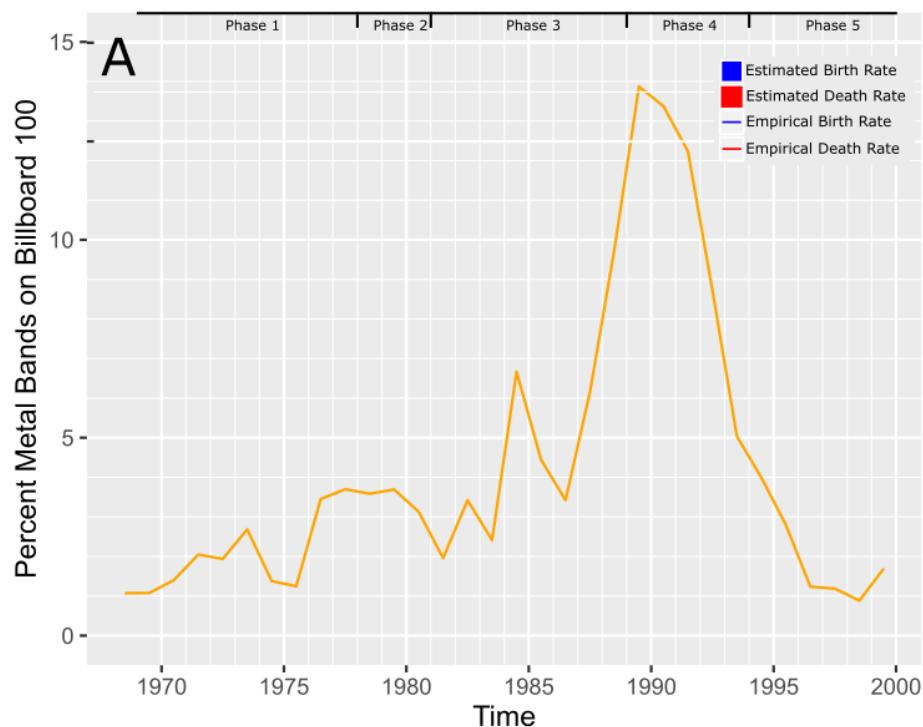
Billboard
HOT 100

No evidence for mass extinction

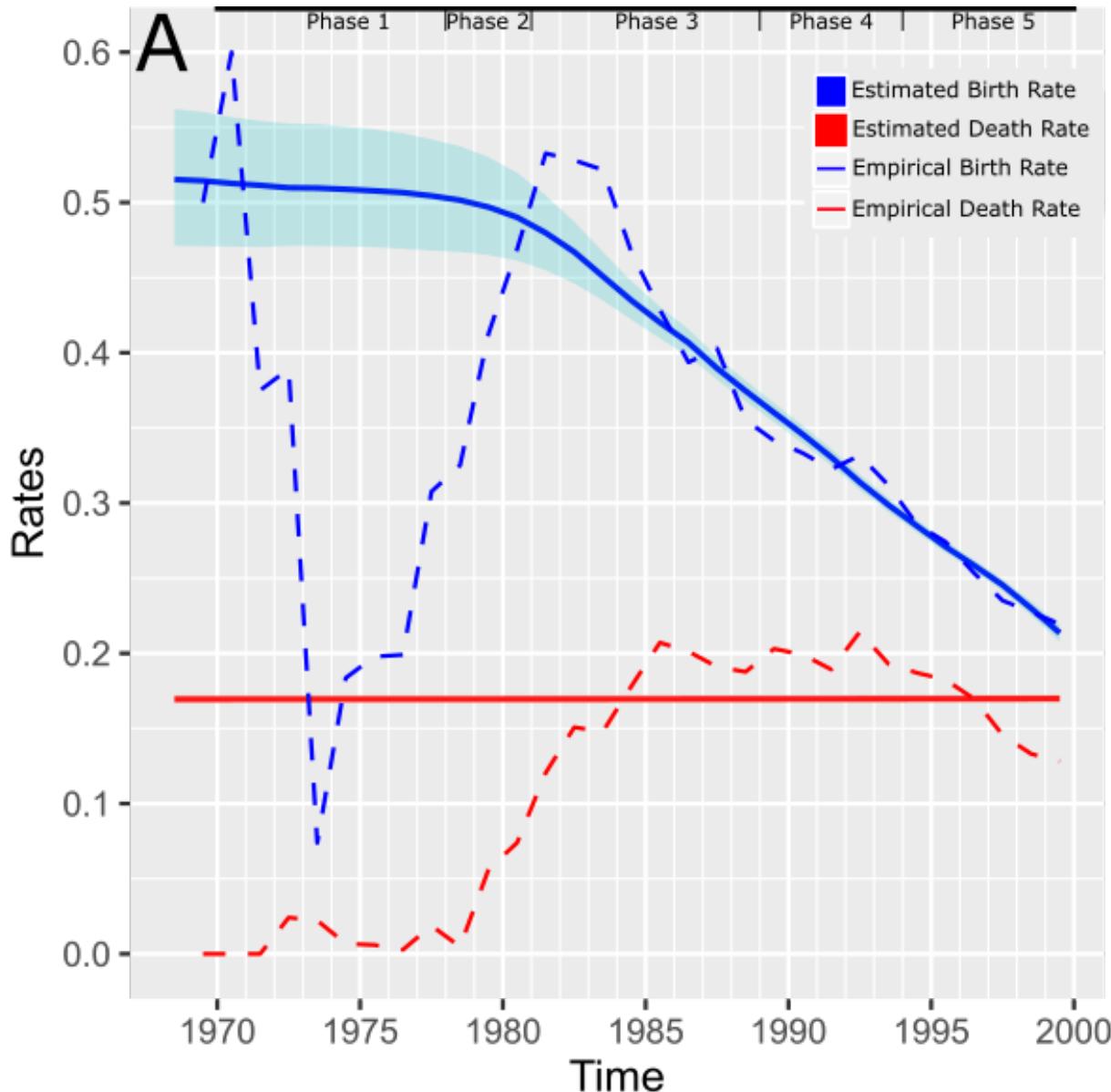


with **RJMCMC** (minimal assumptions)

rejecting a crude economic story



not just competition



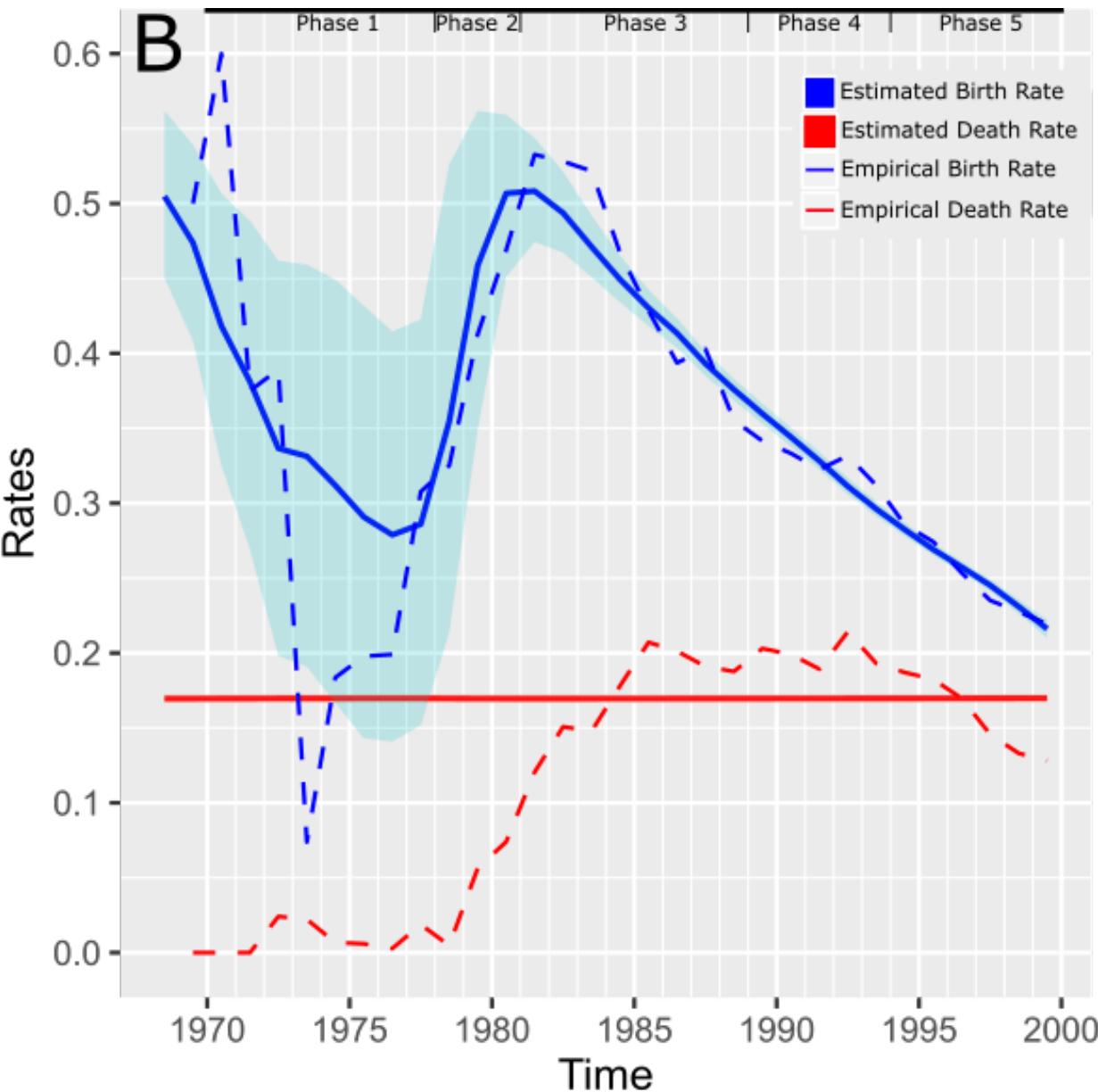
$$\lambda(t) = \lambda_{\max} - (\lambda_{\max} - \kappa) \left(\frac{D(t)}{K} \right)^{\delta}$$

$$\mu(t) = \mu_{\min} + (\kappa - \mu_{\min}) \left(\frac{D(t)}{K} \right)^{\gamma}$$

birth & death rates
converge as **carrying capacity** filled



innovation relaxes competition

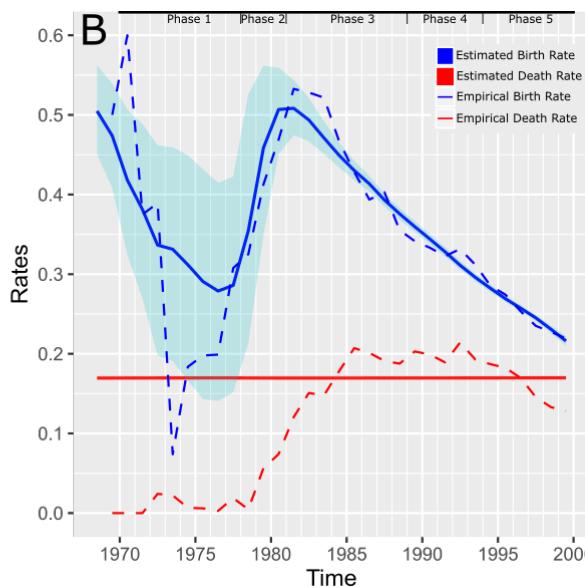


$$\lambda(t) = \lambda_{\max} - (\lambda_{\max} - \kappa) \left(\frac{D(t)}{K(t)} \right)^{\delta}$$

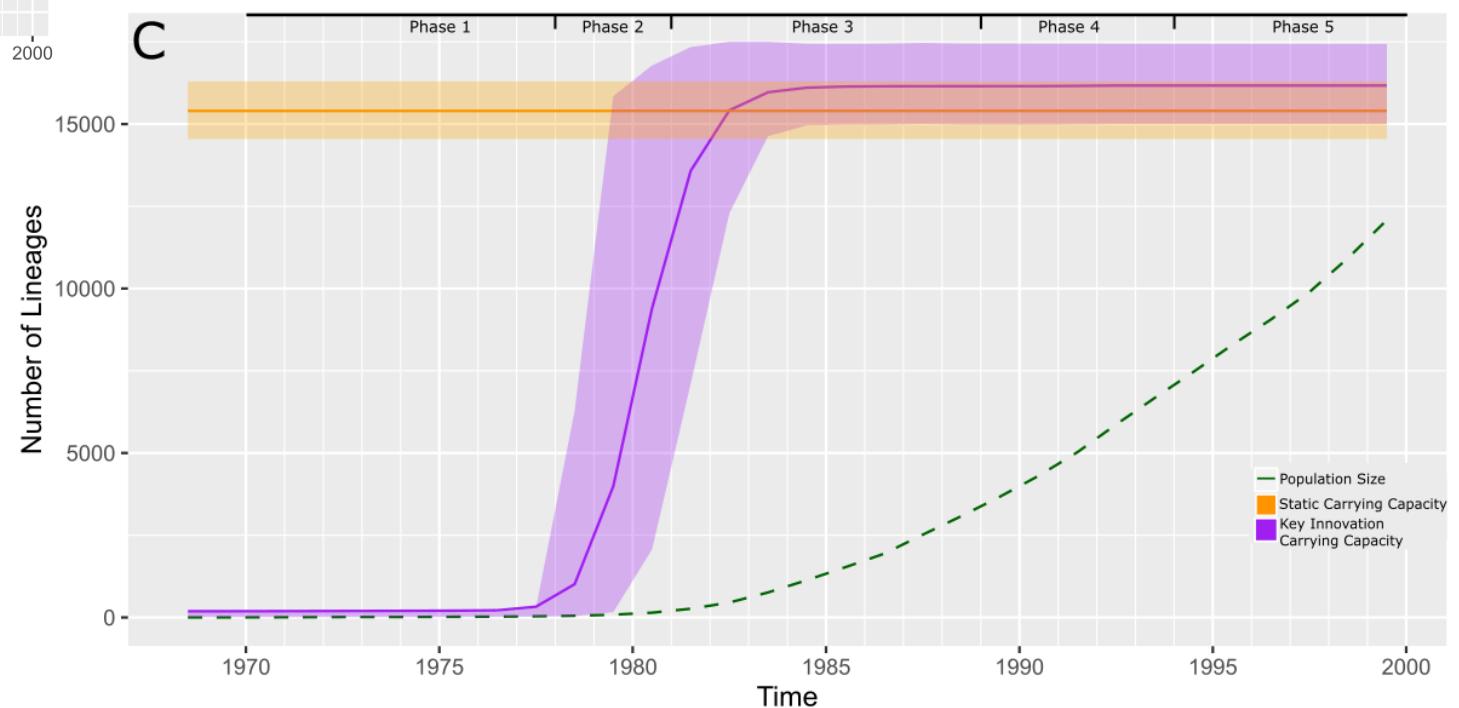
$$\mu(t) = \mu_{\min} + (\kappa - \mu_{\min}) \left(\frac{D(t)}{K(t)} \right)^{\gamma}$$

birth & death rates
converge as **carrying capacity** filled
but carrying capacity is **dynamic**

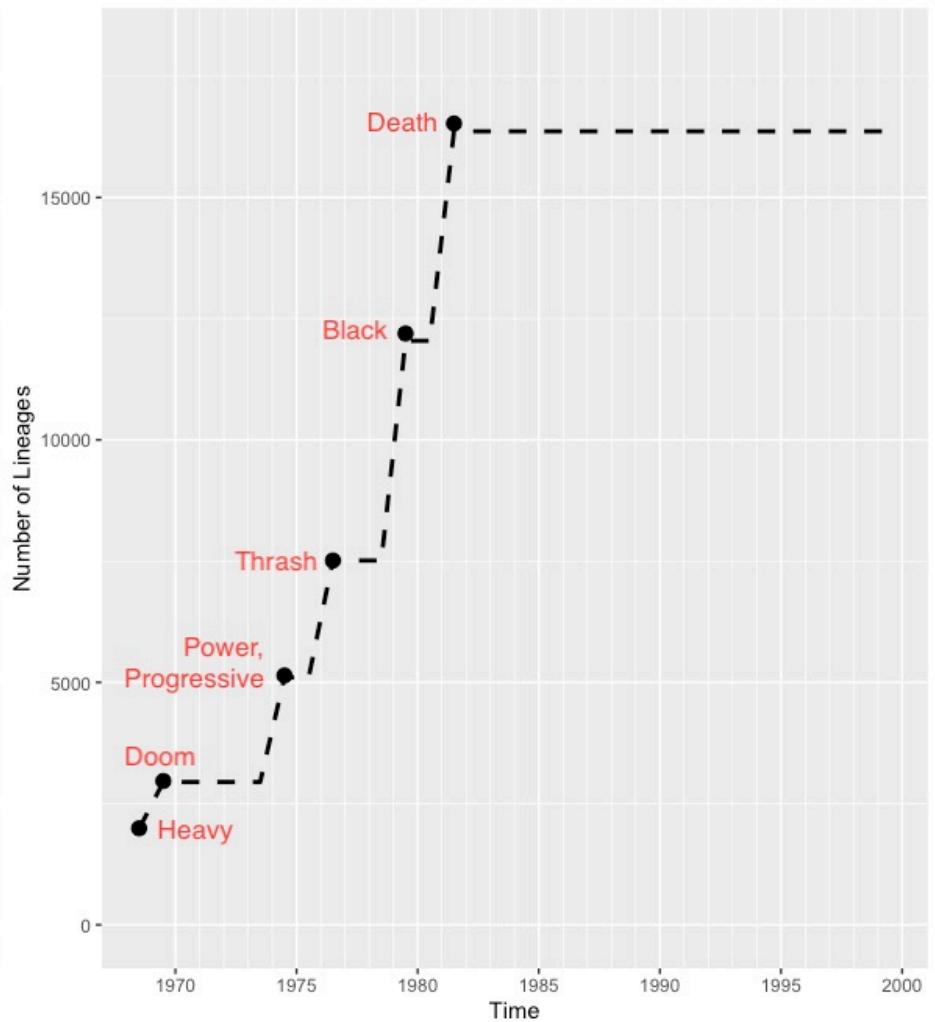
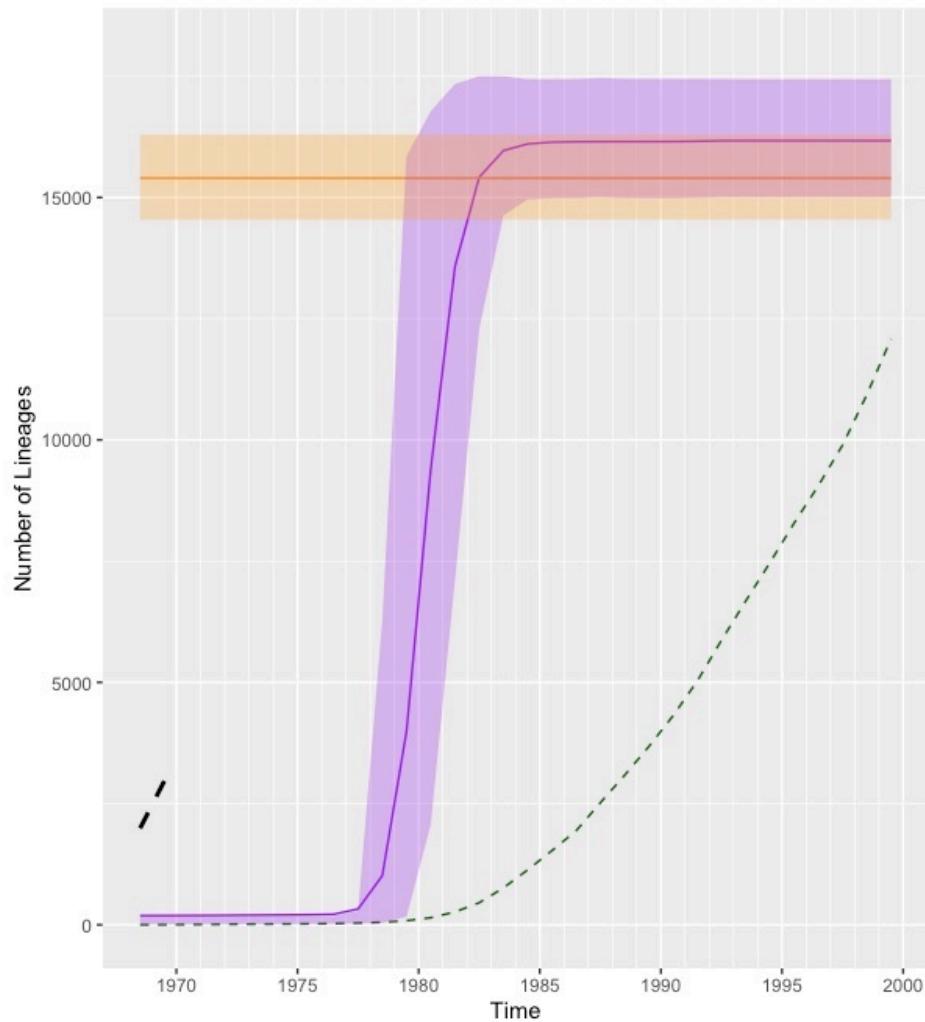
innovation relaxes competition by expanding carrying capacity



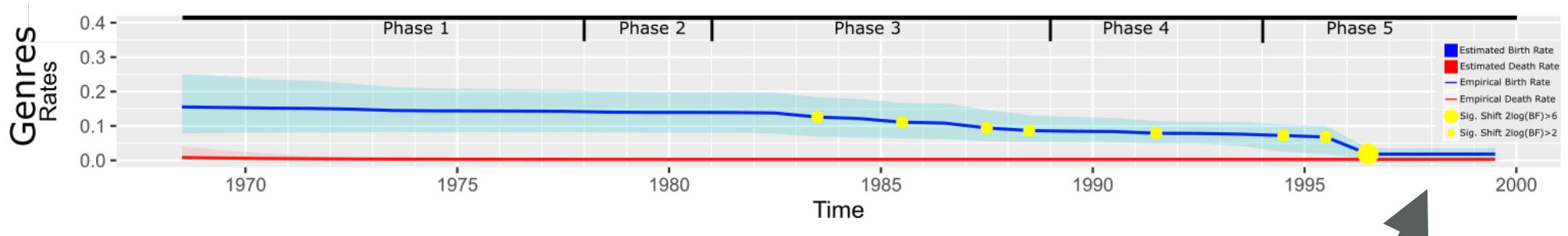
(note this model is more parsimonious than direct rate modeling)



new genres build up the niche

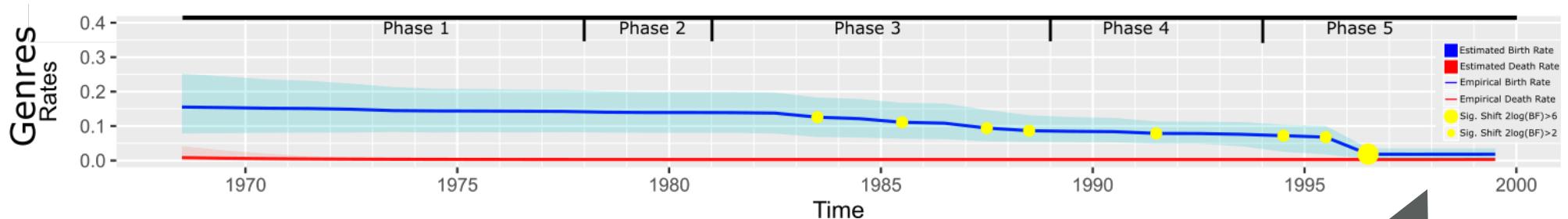


niche expansion through novelty



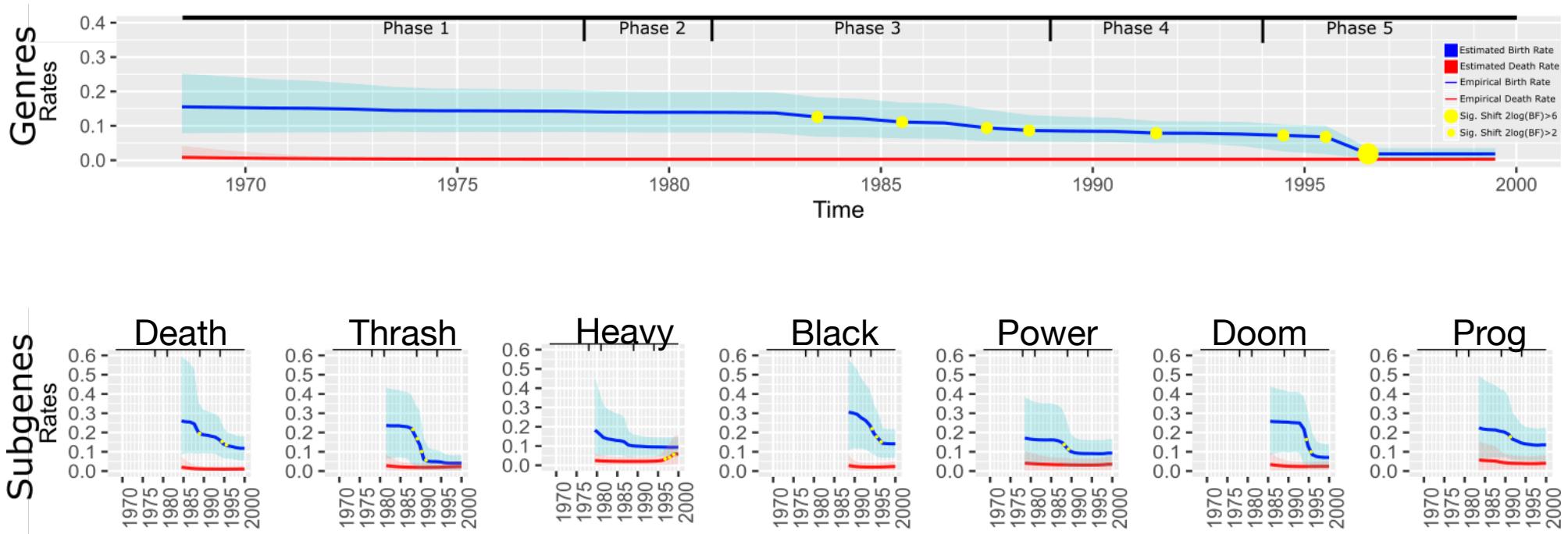
exhaustion of
the form

niche expansion through novelty



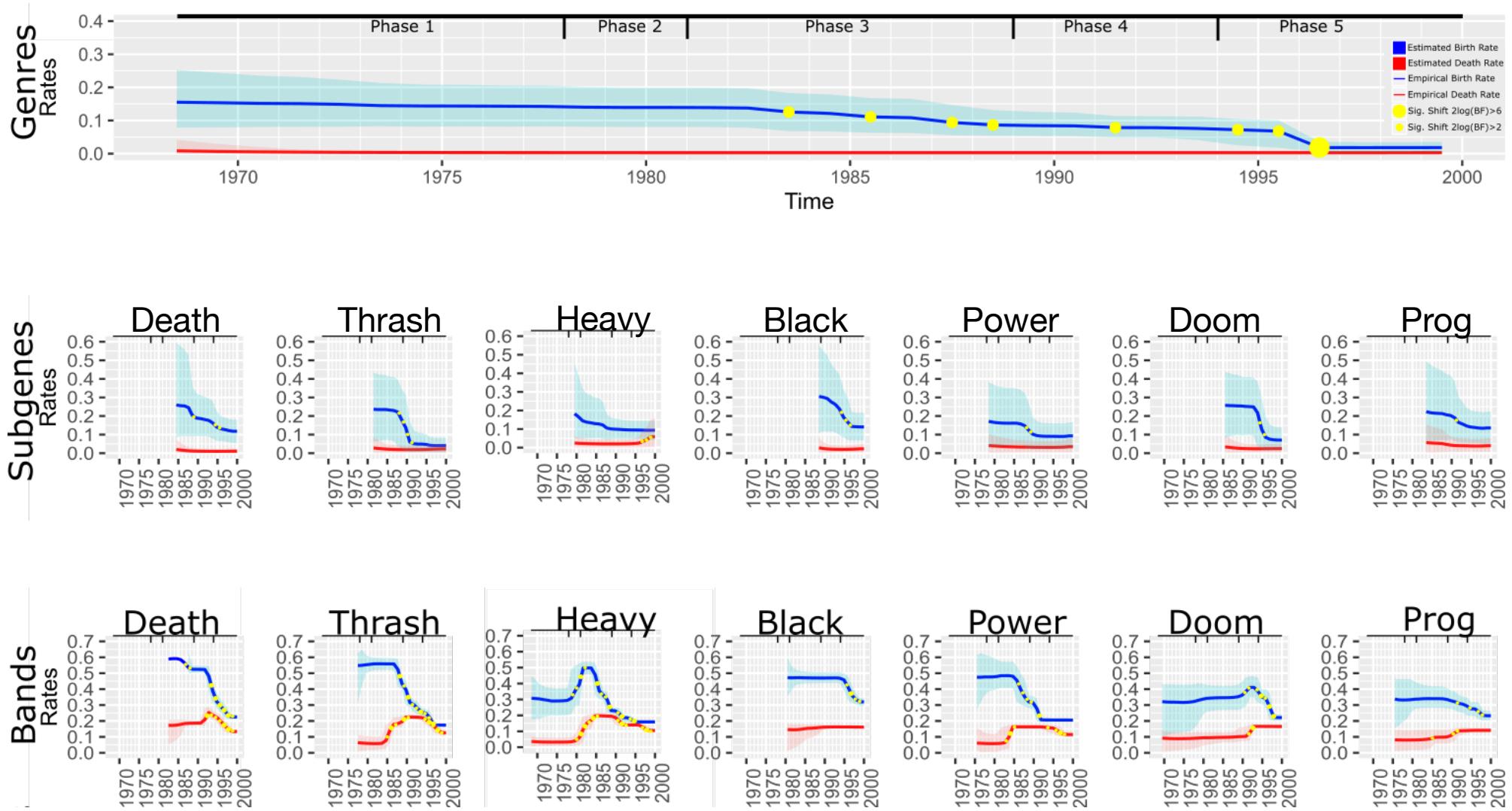
Limits of
the ideal object

niche expansion through novelty



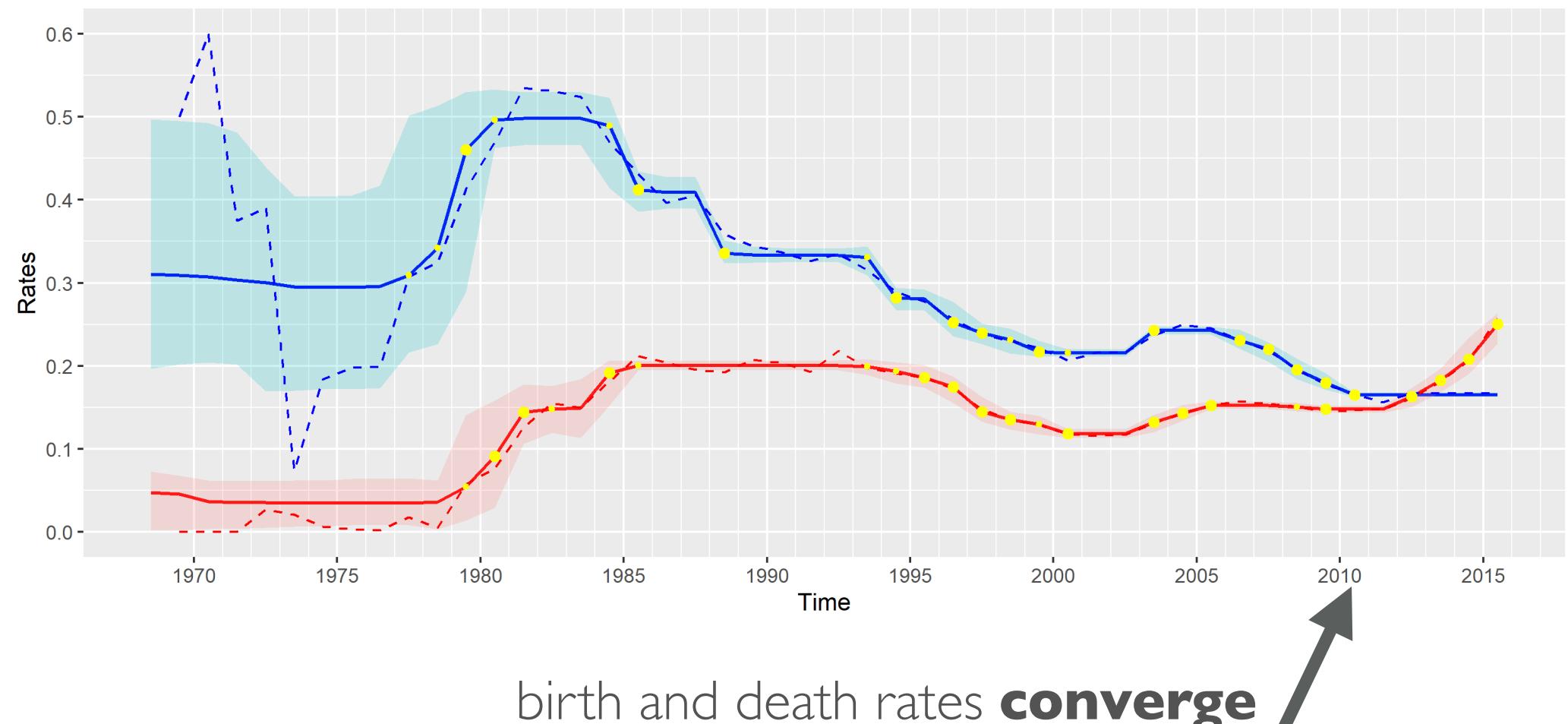
(note: similar genre and sub-genre dynamics)

niche expansion through novelty

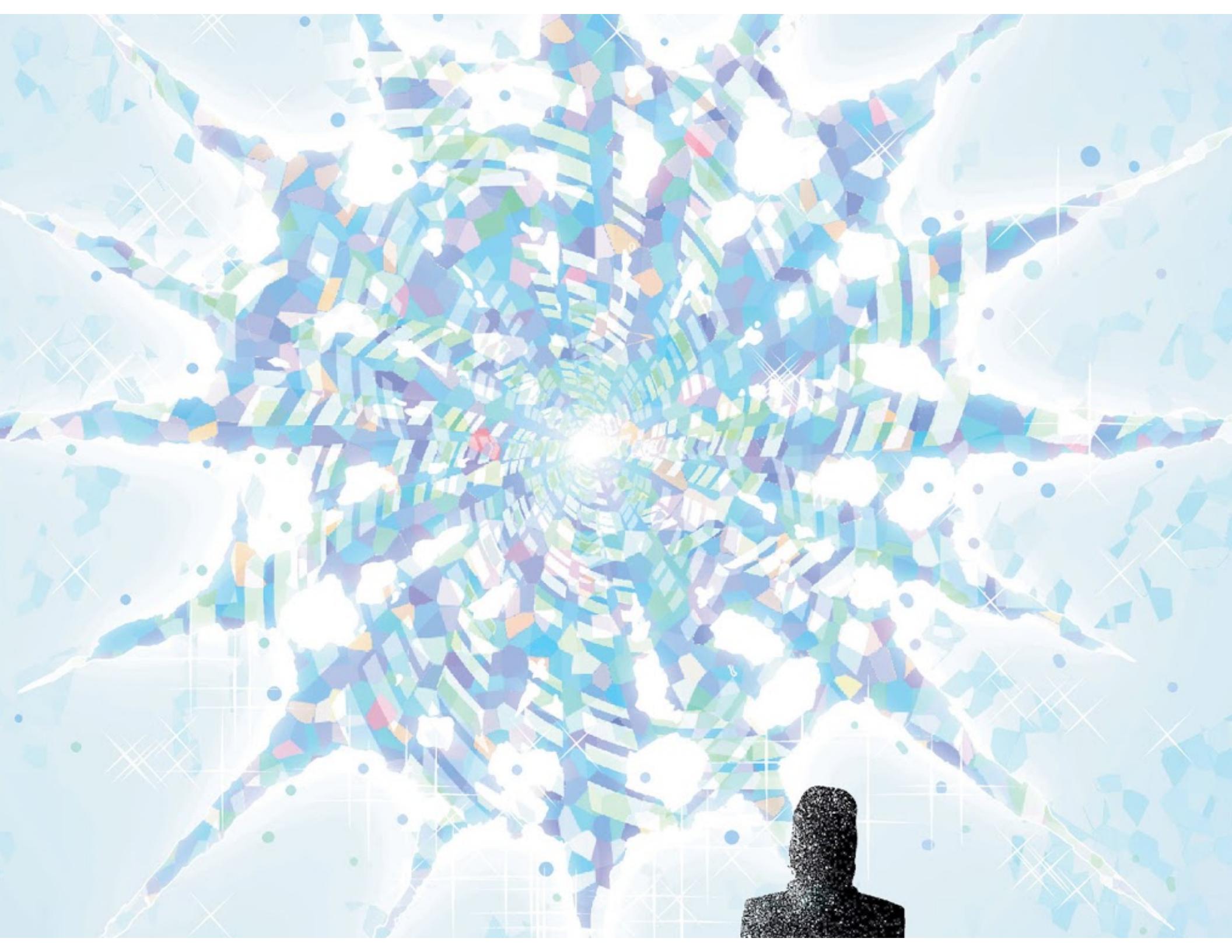


(note: similar genre and sub-genre dynamics)

a prediction borne out



birth and death rates **converge**
consistent with carrying capacity being met
and no further innovations to expand niche



Different kinds of creativity

- Exploratory
- Combinatorial
- Transformational

Margaret Boden



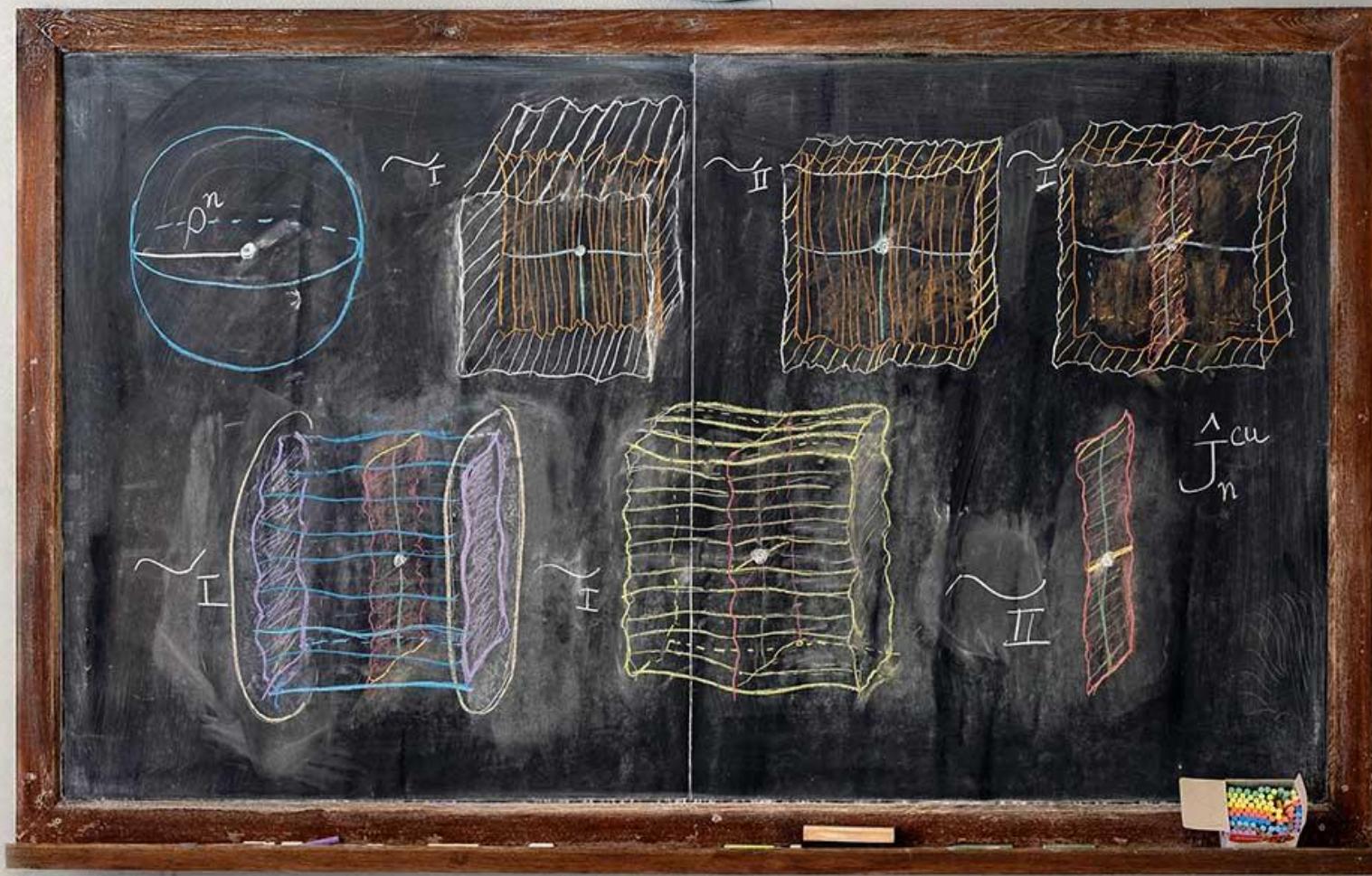
THE
MATHEMATICAL
EXPERIENCE

Philip J. Davis
Reuben Hersh



'AN INSTANT CLASSIC. IT DESERVES TO BE READ BY
EVERYONE WITH AN INTEREST IN THE FUTURE OF THE
HUMAN RACE' - NEW SCIENTIST

Mathematics is the study of
mental objects with
reproducible properties.

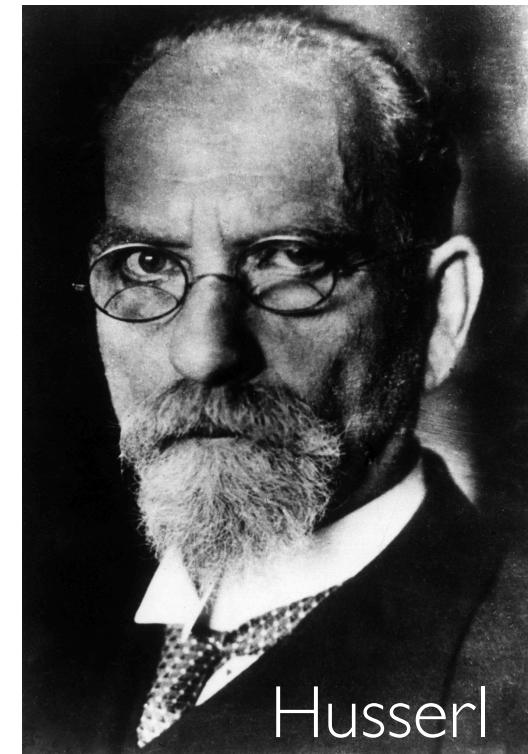


Amie Wilkinson's chalkboard, from *Do Not Erase* (PUP, 2021)

Intentionality:

What the mind does when it's directed toward something under a particular aspect... the “aboutness” of mental activity, the directness of the mind toward meaning, identification, recognition, purpose...

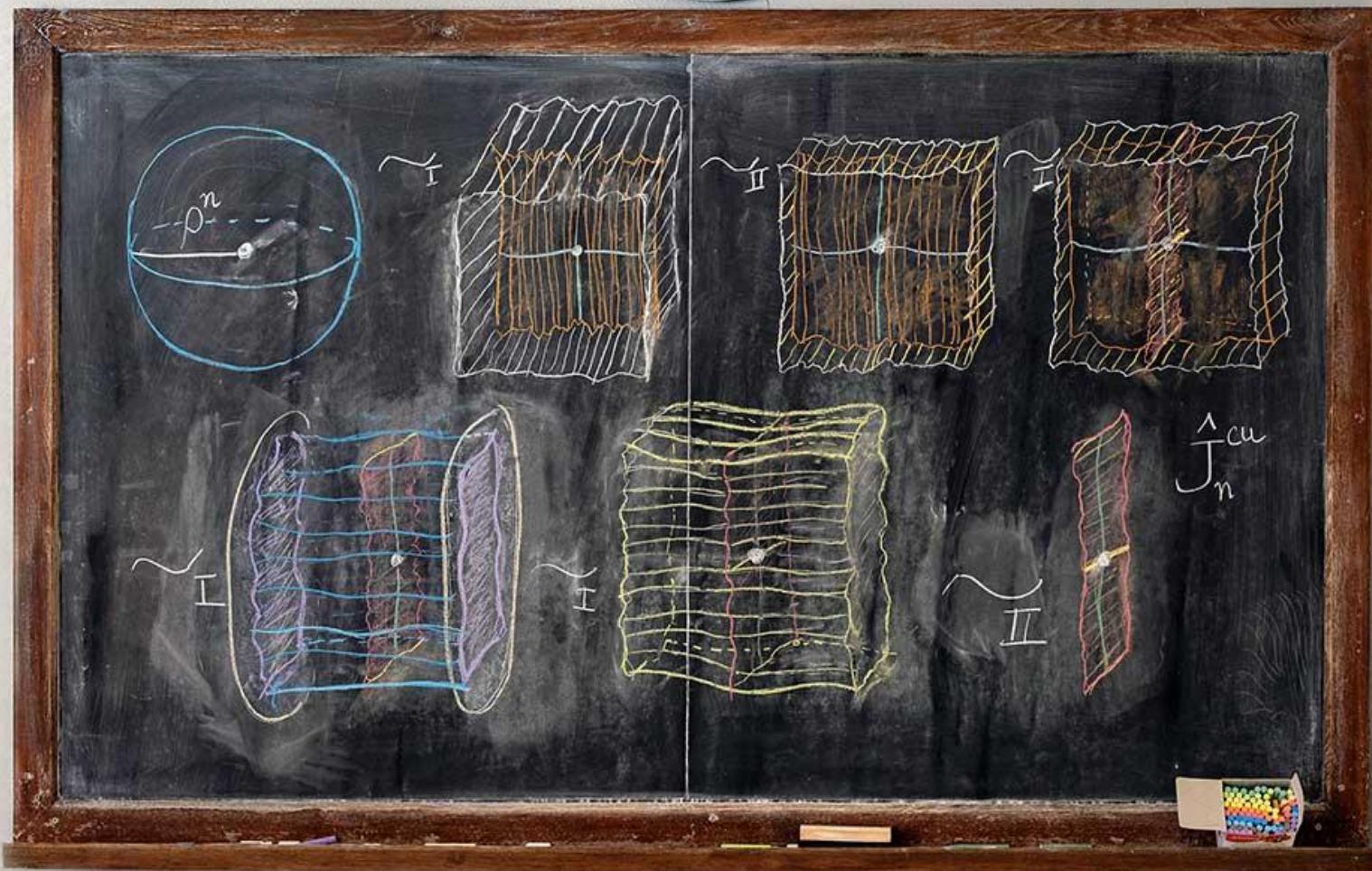
—David Bentley Hart,
All Things Are Full of Gods

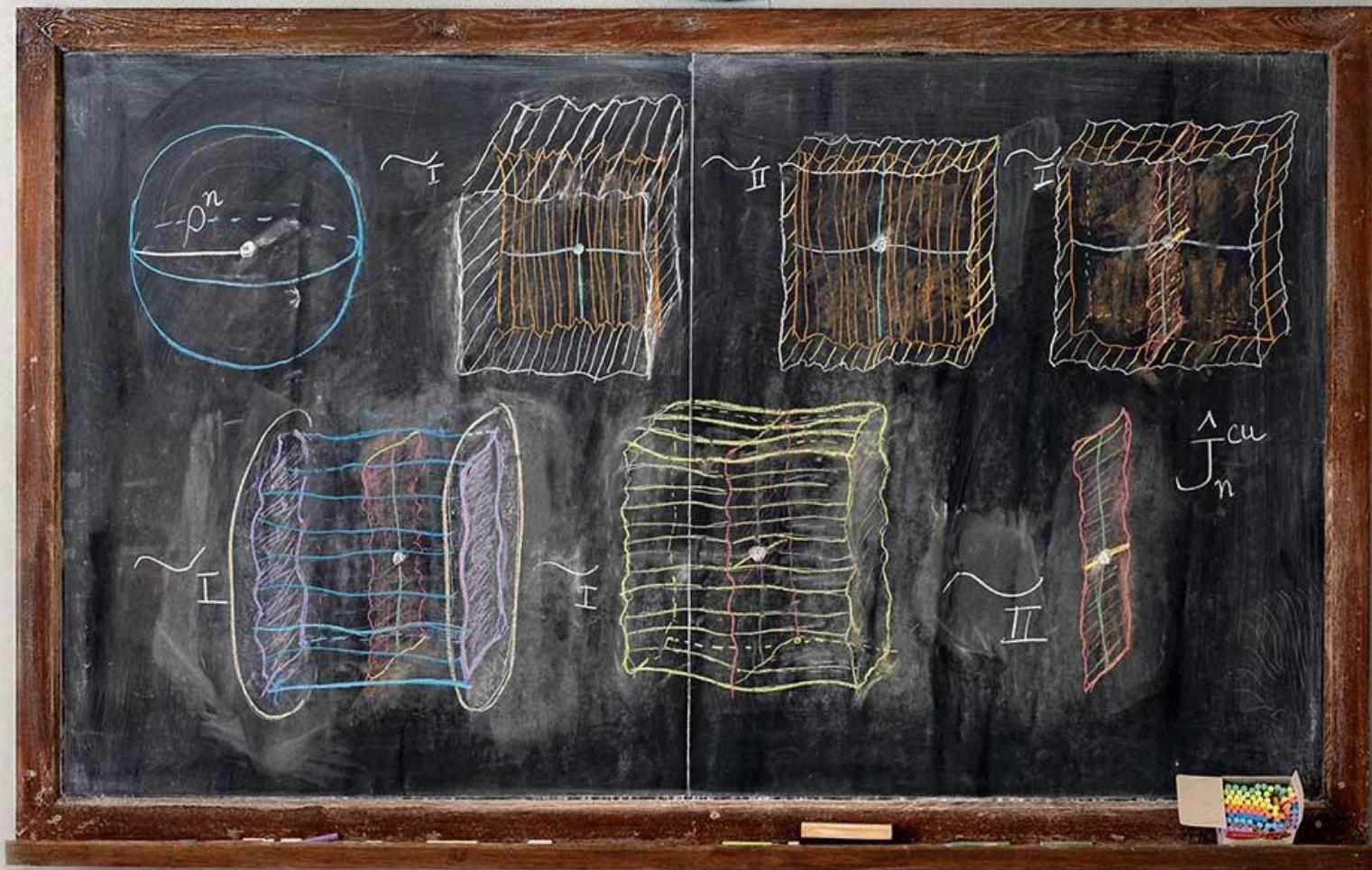


Husserl



Brentano





How do mathematicians point their minds at the
SAME mental object?

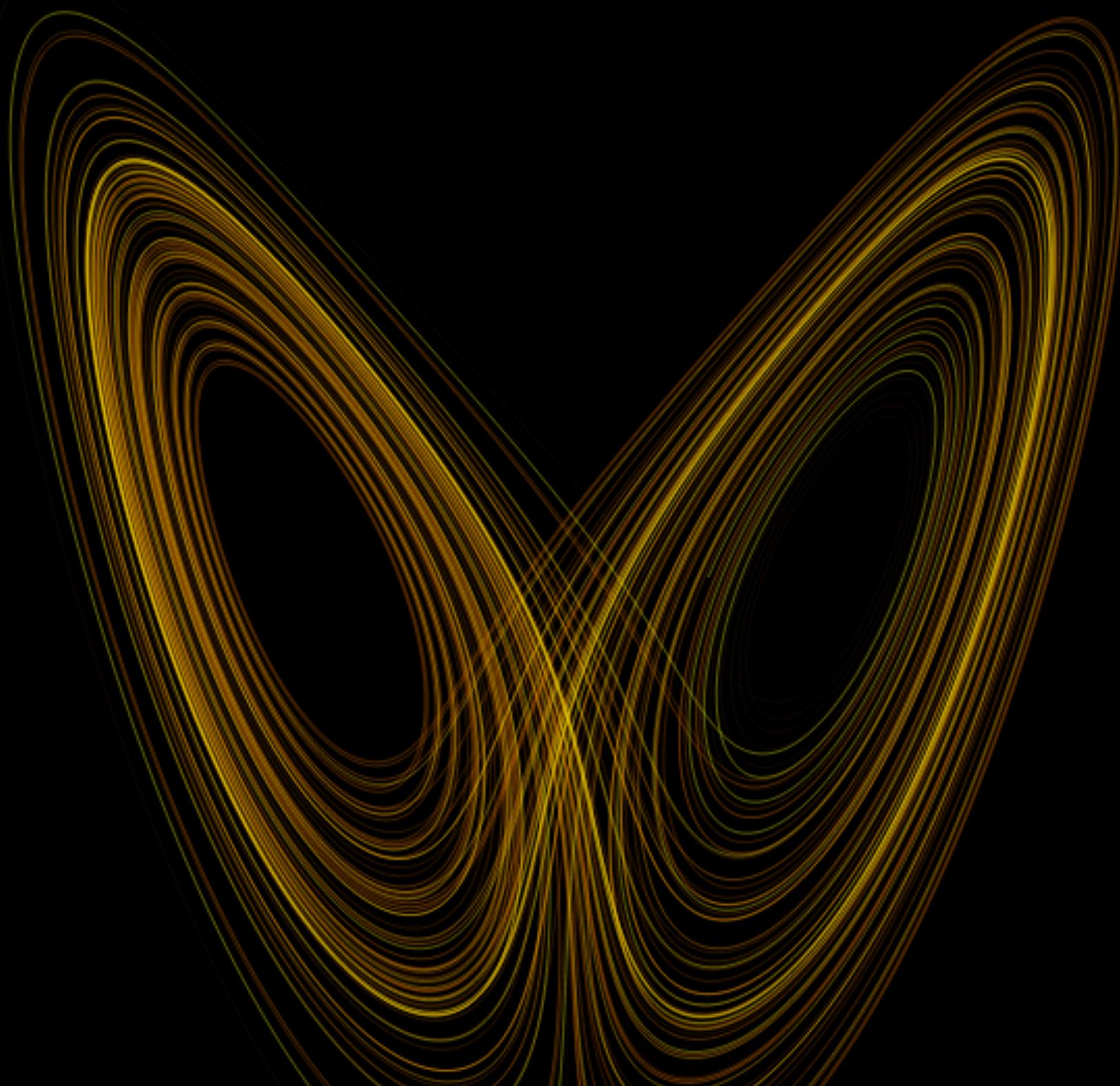
USING ONLY

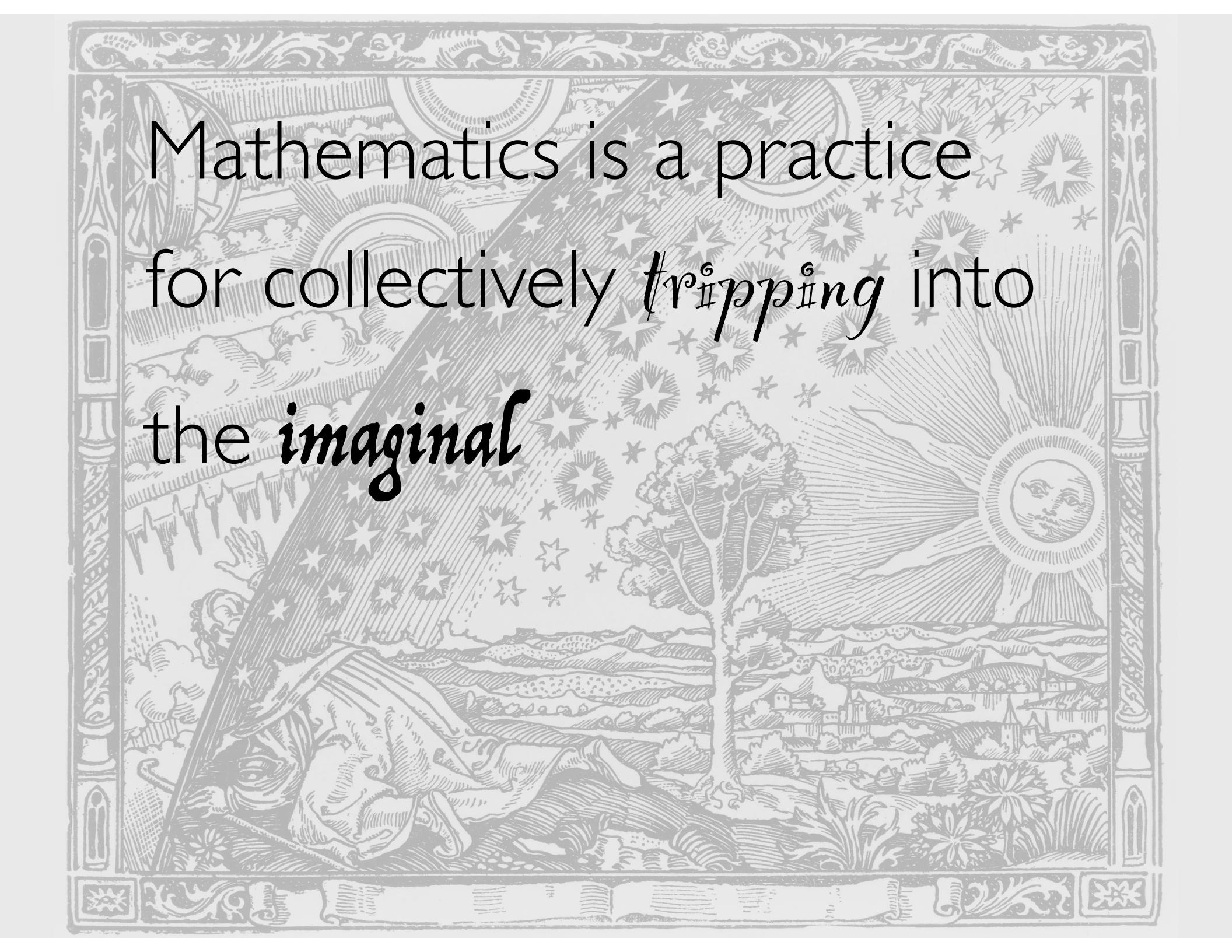
- Natural language
- Formal language
- Pictures
- Computer exploration (nowadays)
- And of course lots of prior training

Mathematics seems to be a limit case of (all?) other cases of collective intentionality.

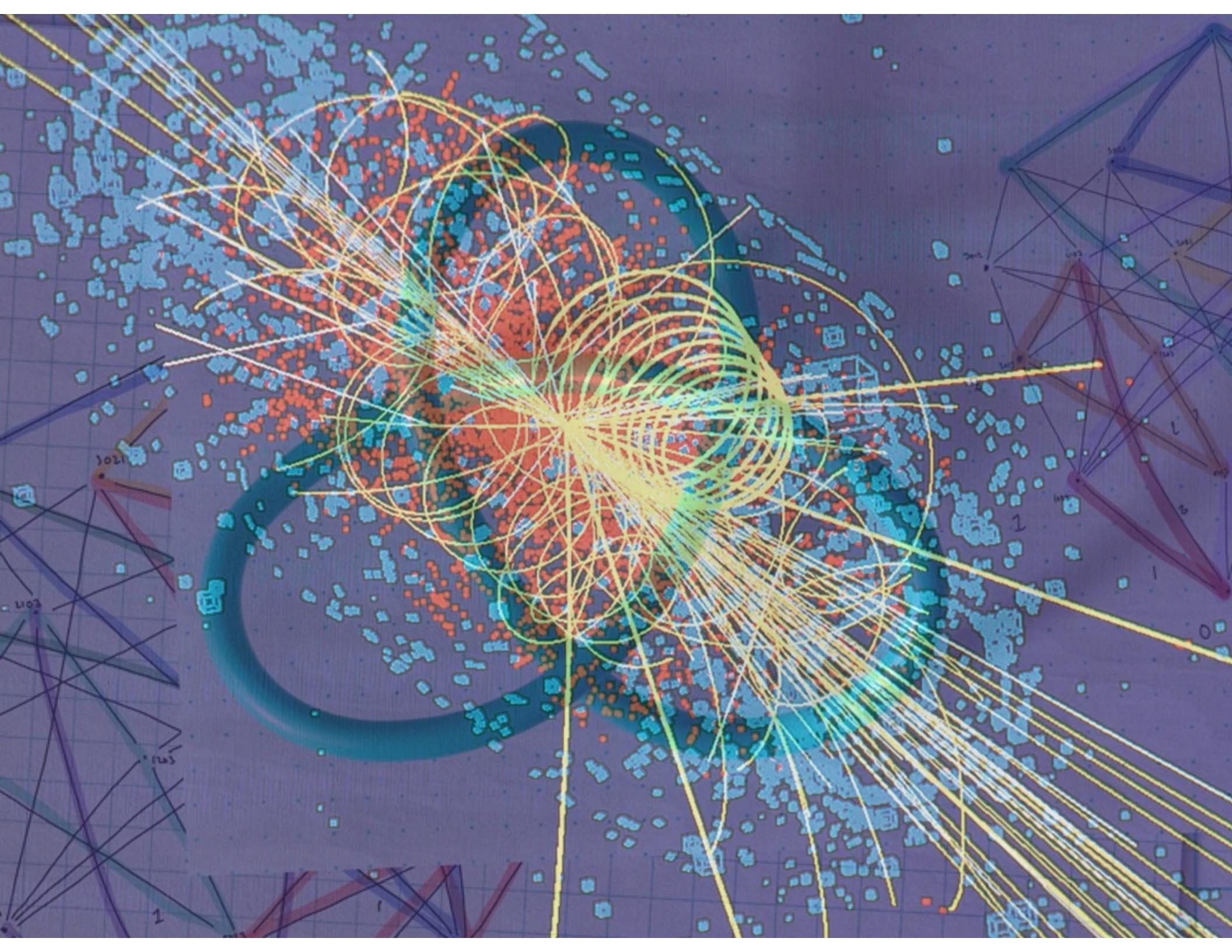
It is also a data-rich
example of Couliano's
ideal object —

It is also a data-rich
example of Couliano's
ideal object —
as well as his notion of
mind games



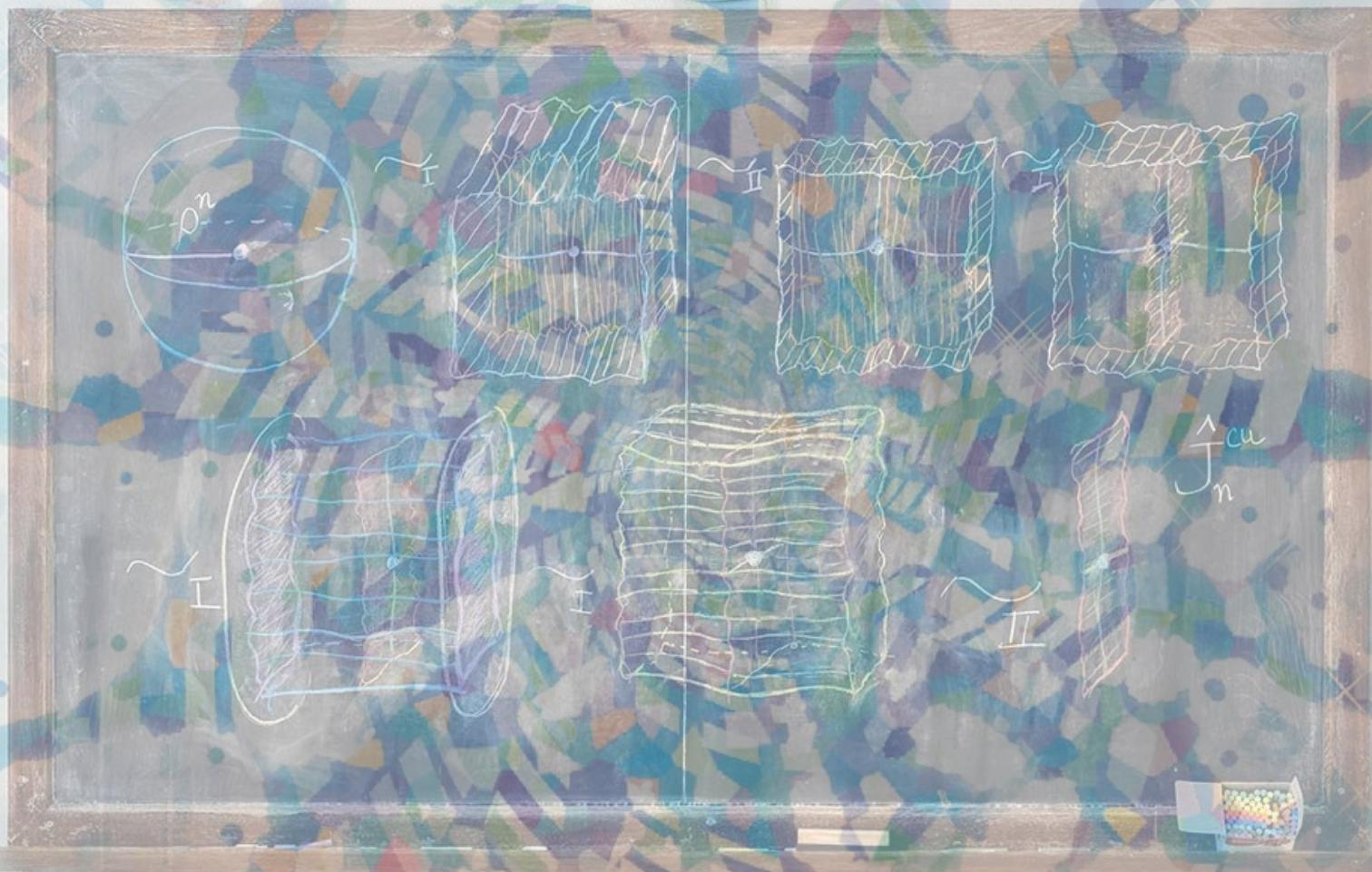
A black and white woodcut-style illustration. In the foreground, a person with a large, detailed headpiece and a long, flowing robe is shown from the side, looking towards the horizon. The landscape features rolling hills and a small town with buildings and towers in the distance. The sky is filled with stylized clouds, several five-pointed stars, and a large sun or moon with a face and rays of light. The entire scene is framed by a decorative border with floral and geometric patterns.

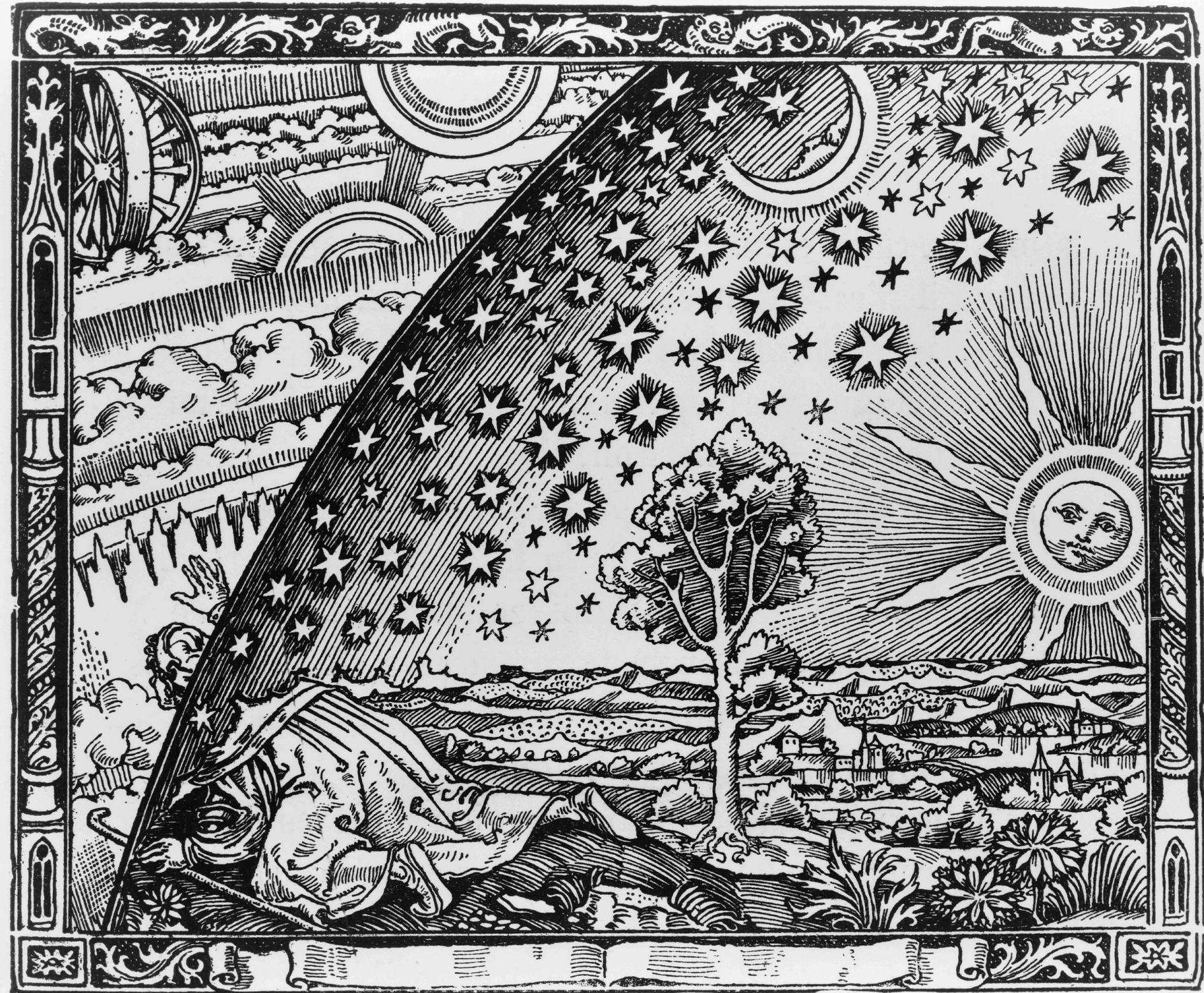
Mathematics is a practice
for collectively *tripping* into
the *imaginal*













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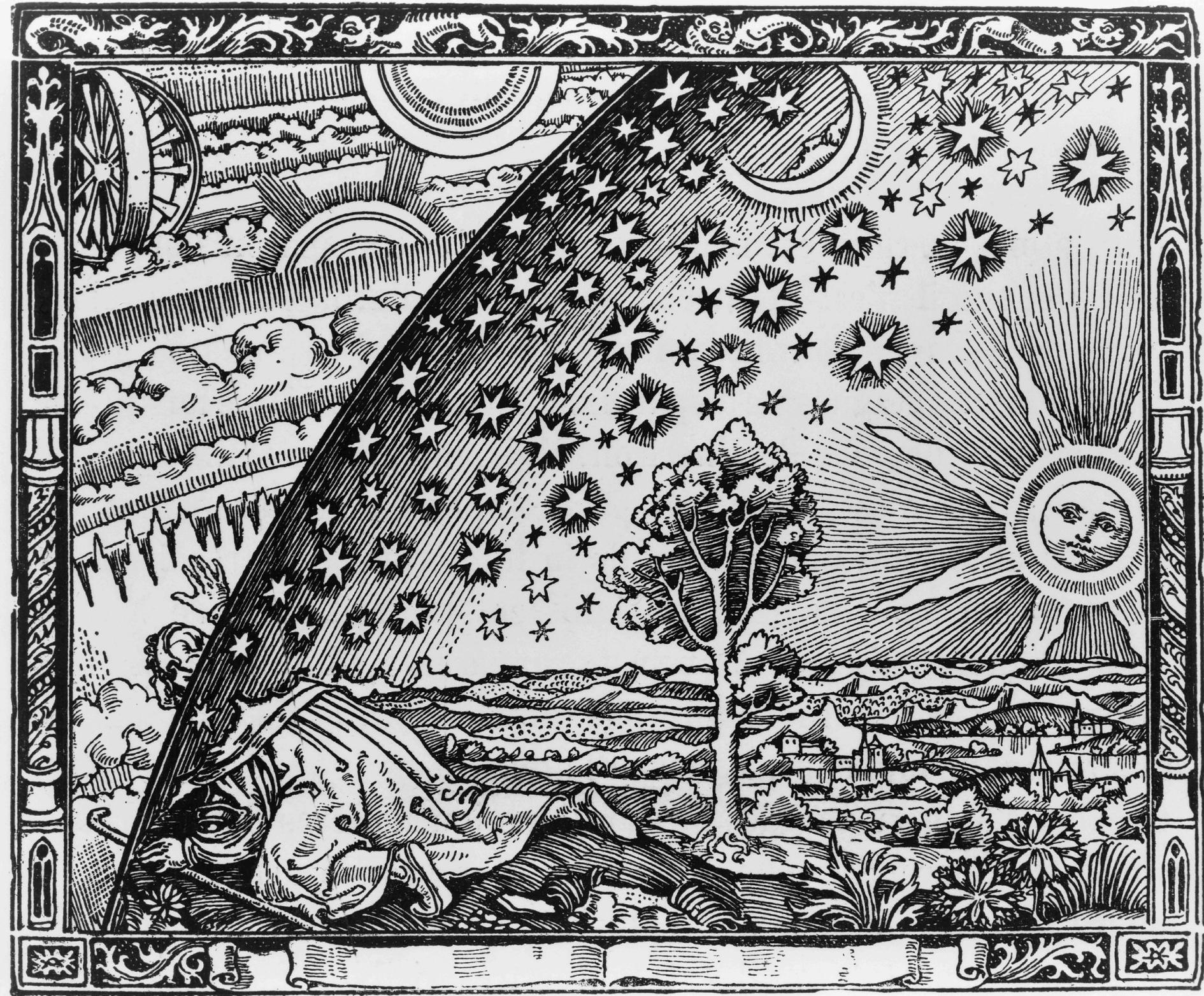
dinodinap@aol.com



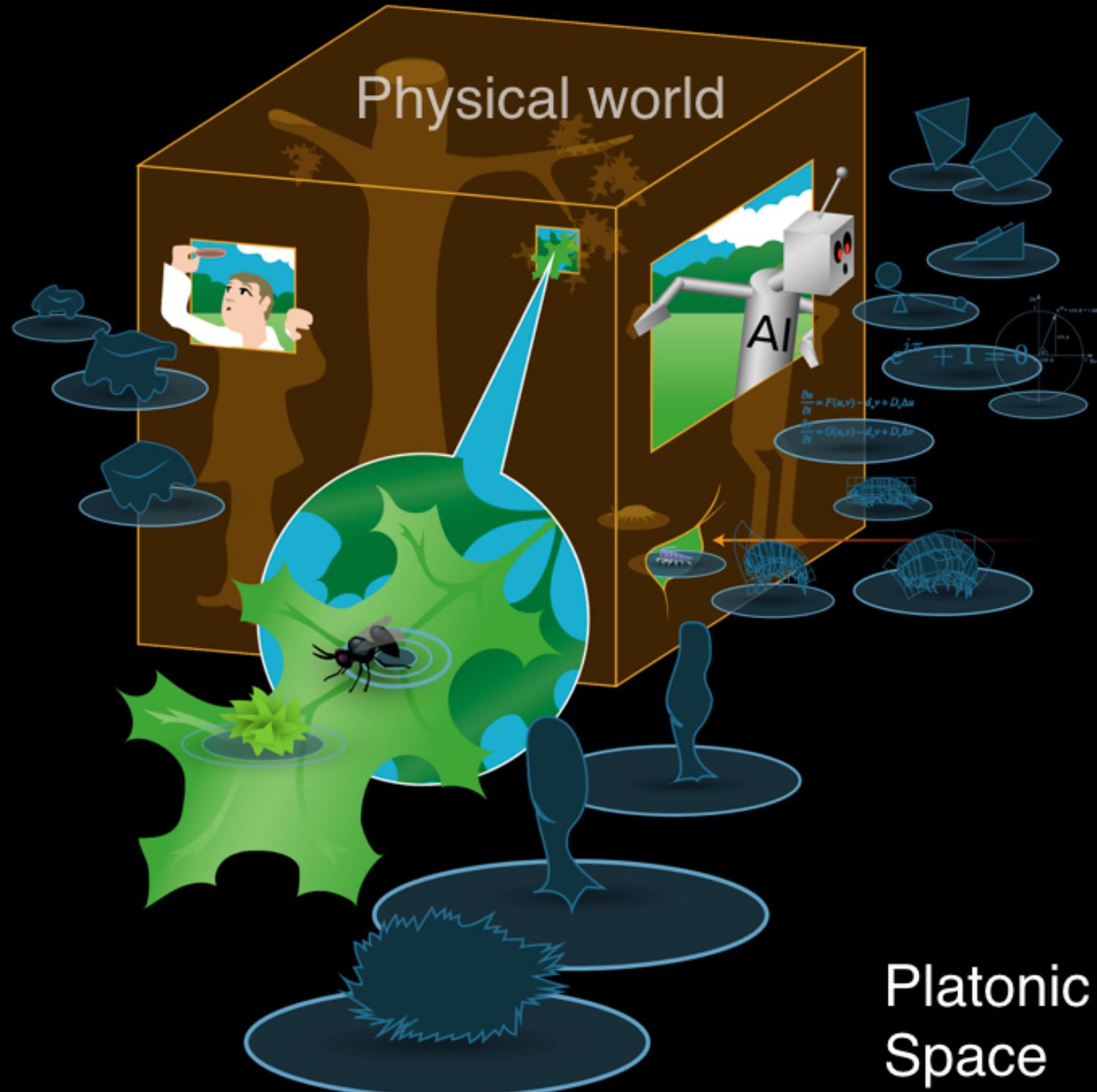
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Physical world



Platonic Space

$$MSE = \frac{1}{n} \sum_{i=1}^n (Y_i - \hat{Y}_i)^2$$



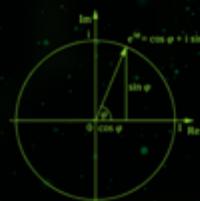
$$e^{i\pi} + 1 = 0$$

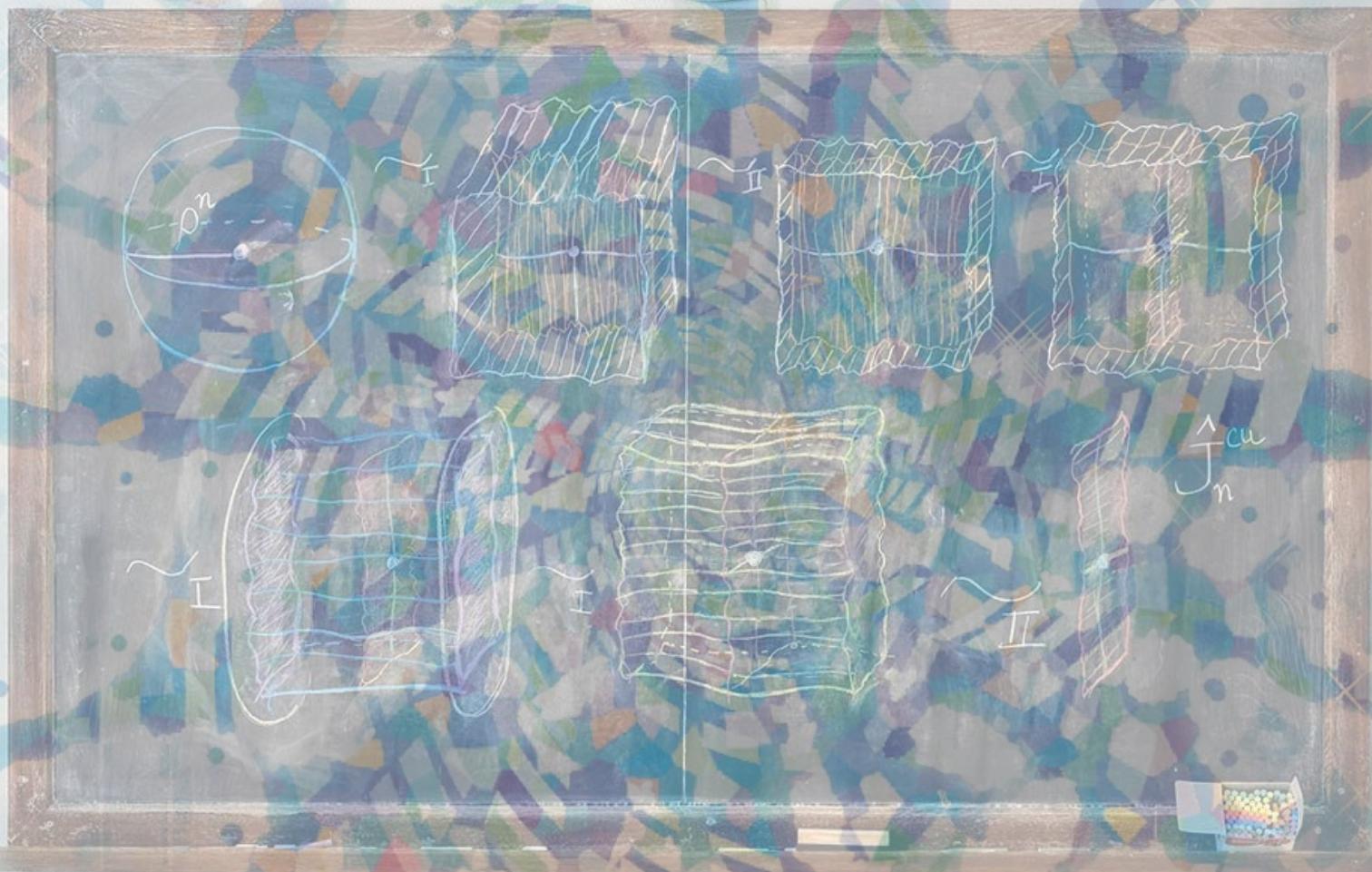


$$\begin{aligned}\frac{\partial u}{\partial t} &= F(u, v) - d_u v + D_u \Delta u \\ \frac{\partial v}{\partial t} &= G(u, v) - d_v u + D_v \Delta v\end{aligned}$$



$$c = \sqrt{a^2 + b^2}$$







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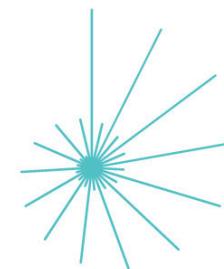
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SCIENCES



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I'm here to apply

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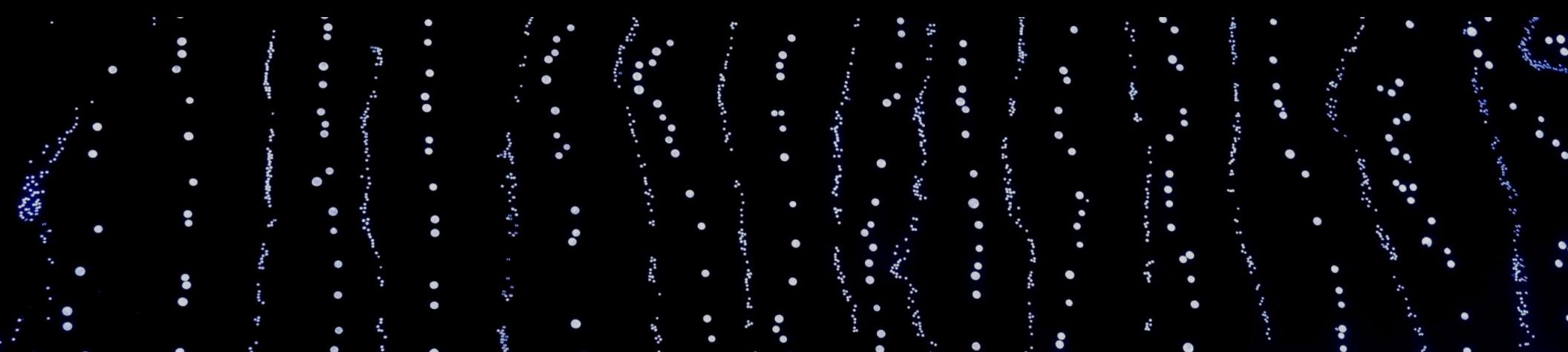
Meet our alumni

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THANK YOU!

