

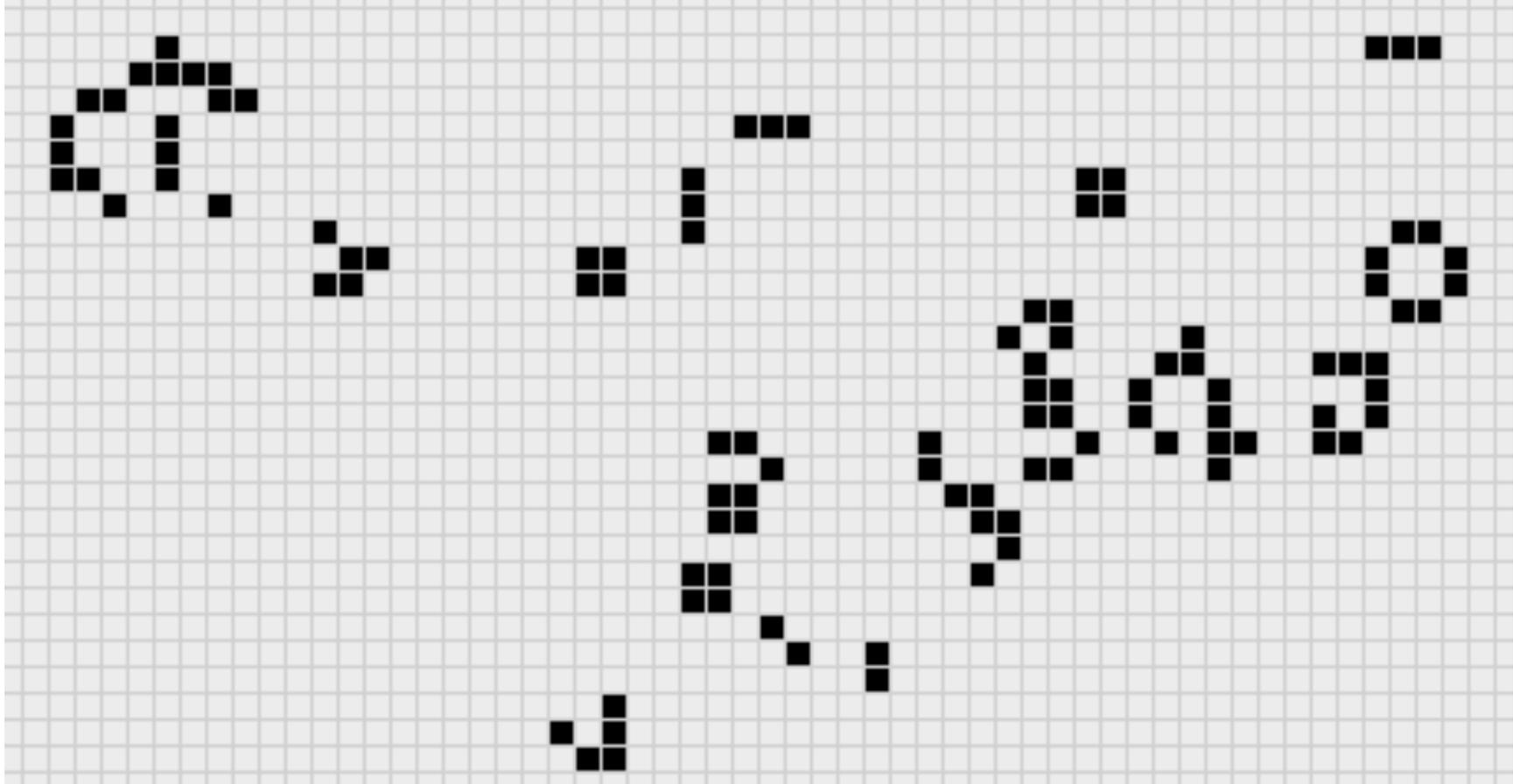
# Digital Ontology and Structural Realism

David Chalmers

# Digital Ontology

- Digital ontology (Zuse, Fredkin, etc): Physics based on the interaction of bits (“it from bit”).
- Aim: explore structural realism about digital ontology
- This simple case may help illuminate more general issues about structural realism.

# Conway's Game of Life



# Rules of Life

- Infinite rectangular grid of live/dead cells
- A cell at time  $t+1$  is live iff at  $t$  it is
  - (i) dead and has 3 live neighbors or
  - (ii) live and has 2 or 3 live neighbors.

# Game of Life



# Structural Realism: Varieties

- Epistemological structural realism: All knowable scientific truths are structural.
- Conceptual structural realism: All (good) scientific concepts are structural.
- Ontological structural realism: The complete (fundamental) truth about reality is structural.

# Structural Truths

- Structural truths: those containing only structural expressions (= expressing only structural concepts), and possibly meeting certain further constraints.

# Structural Expressions

- Logical:  $\sim$ ,  $\&$ ,  $\exists$ ,  $=$ , ...
- Mathematical:  $0$ ,  $\mathbb{R}$ ,  $\in$ , ...
- Categorical: object, property, quantity, instantiate
- Nomic: law, cause, power
- Fundamentality: fundamental, natural, ground
- Mereology (?): part

# Nonstructural Expressions

- Red, green
- Conscious
- Mass, charge, spin
- Space, time
- Everything else...

# Further Constraints

- Structural truths are invariant under (certain) symmetries and translation schemes [all of them? or which, exactly?]
- Structural truths can't concern objects?? [No use of the object quantifier  $\exists$ ?  
My view: this issue is a red herring.]

# Structural Realism: Motivations

- Carnap: objectivity, communicability
- Russell: knowability
- Worrall: continuity
- Ladyman/etc: parsimony, naturalism

# Nonstructural Realism about Life

- Liveness = an intrinsic nonstructural property e.g. redness, consciousness
- Deadness = another e.g. blueness, nonconsciousness
- Neighbor = spatial neighbor
- Time = time

# Epistemological Structural Realism

- All knowable Life truths are structural
- Liveness and deadness are only known structurally (although they may have some nonstructural nature).
- Space and time too.

# Conceptual Structural Realism

- The Life theory is a structural theory
- Liveness and deadness are structurally analyzable concepts
- Space and time too.

# Ontological Structural Realism

- The complete truth about the Life world is structural.
- All properties are structural properties.
  - No intrinsic nature for live/dead
  - No special nature for space/time.

# How Does Life OSR Work?

- Question: How does ontological structural realism about life work?
- What is the structuralist life universe fundamentally like?
- How can we recover the manifest image from this structural scientific image?

# Ramsey Sentence Method

- Ramsify the rules: There are two fundamental properties, L and D [and “neighbor” and “time”?] that satisfy the life rules  $R(L,D)$ .
- $R(L,D)$ :  $\mathbb{Z}^* \mathbb{Z}$  grid of L/D objects, an object at time  $t+1$  is L iff at  $t$  it is (i) D and has 3 L neighbors or (ii) L and has 2 or 3 L neighbors.

# Problem for Ramsified OSR

- This is fine for conceptual and epistemological structural realism, but problematic for ontological structural realism
- What are the witnessing properties L,D? (nonstructural properties?)
- Whatever they are, the Ramsey sentence description alone seems incomplete.

# Thin Quiddities

- Maybe the witnessing properties are just Lewis's thin quiddities: numerically distinct properties without a further nature?
- But on Lewis's view, there are worlds where these are swapped, contrary to OSR.
- And if they can't be swapped, their necessary connection to roles needs explaining.

# Existence Method

- A cell  $c$  has  $L$  = there's an object at  $c$
- A cell  $c$  has  $D$  = there's no object at  $c$
- Problem: Doesn't generalize to non-binary quantities or multiple quantities.

# Difference Method

- Use same/different as fundamental notions.
- Characterize state at a time in terms of same/difference relations between neighboring cells.
- For nonbinary quantities: use metrics (there exist fundamental metrics  $a, b, c \dots$ )

# Problem: Determinism

- Problem for difference/metric method:  
An initial state and its live/dead invert will satisfy the same same/difference characterization.
- But they yield different consequences
- So we can't get deterministic rules this way.

# Game of Life



# Power Method

- Every cell has one of two fundamental powers:
  - a power L to produce the same power iff 2 or 3 neighbors have the same power, and to produce the other power otherwise
  - a power D to produce the same power iff 0-4 or 6-8 neighbors have the same power and to produce the other power otherwise.
- The most promising strategy for OSR?

# Worries

1. Recursive — maybe that's OK.
2. Primitive sameness/difference — OK?
3. Primitive notion of power — OK for nonHumean structural realists.

# Humean Structural Realist?

- Powers are OK for a nonHumean, but what should a Humean structural realist say?
- Same/diff state at  $t+1$  could depend on state at  $t$  and prior states, but we'll still have nondeterminism at  $t=1$ .
- Maybe  $t=1$  and  $t=2$  serve as initial conditions?

# Function/Quotient Method

- World state is a function from objects (in  $Z^*Z^*Z^+$ ) to  $(0, 1)$
- Deterministic and Humean!
- But:  $(0, 1)$  is arbitrary. Need to quotient over equivalences between functions from objects to any other ordered pair
- Is quotiented state deterministic and Humean?

# What about Objects?

- Treatment so far has taken objects for granted: e.g. there exists an infinite number of objects in  $Z^*Z$  structure.
- The quantified fact is primitive, not the witnessing truths about specific objects?
- The objects have only structural properties.

# Doing without Objects

- If one wants to dispense with fundamental objects (even quantified over):
- Have state be function from  $Z^*Z$  to  $(0,1)$  [or: a bipartition of  $Z^*Z$ ].
- Laws concern evolution of that function.
- Legitimate?

# Doing without Space and Time

- Don't mention “time” (or “space”) in rules — just characterize them structurally.
- E.g. world is a function from  $Z^*Z^*Z^+$  to  $\{0, 1\}$ , or a bipartition of  $Z^*Z^*Z^+$ .
- Rules of life (plus initial conditions) are constraints on the function.

# Recovering Space and Time

- How to recover spatiotemporal facts in a structuralist life world?

# Spatiotemporal Functionalism!

- Time = dimension of determination (one that yields useful dynamic equations)
  - The  $Z^+$  dimension
- Distance = what there's less action at (nexus of causal interaction)
  - The “neighbor” metric on  $Z^*Z$

# Structural Realism and Spacetime Functionalism

- I think: any wholehearted structural realist should be a spacetime functionalist, to avoid taking nonstructuralist notions of space and time as fundamental.

# Recovering Observation

- There's always a gap between structure and consciousness (unless one is functionalist about consciousness)
- But one can assume bridging principles, e.g. square structures look square (or: certain processes yield square experiences) to recover observation and experience.

# Options for Consciousness

- Ontological structural realism about consciousness (functionalism)
- Ontological structural realism about physics, nonstructuralism about consciousness (property dualism)
- Epistemological structural realism about physics, with consciousness as realizer (panpsychism)

# Life and Levels

- As with any physical theory, the Life theory could turn out to be nonfundamental, realized by lower levels.
- If structural realism about Life is correct, to realize Life, the lower levels must simply embody the right structure.

# Simulation and Realization

- Any computer running the Life program will realize the structural Life theory.
- So any simulated Life world will be a (nonfundamental) Life world.

# Structural Realism and Skepticism

- So: a putatively skeptical scenario that we live in a merely simulated Life world is one where the Life theory is correct.
- Structural realism makes skepticism about science (and about reality more generally) harder to sustain!

# Conclusion

- Some versions of ontological structural realism may be true in some Life worlds.
- What follows for actuality?