

# Constructive Physics

or

## There's Only One Way to Build a Universe

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*"...I became convinced that the deepest of content is but form manifesting itself in an intricate way. Or, if you prefer, meaning is just fancy shape. Content is just fancy form.."*

*-- Douglas Hofstadter*



# Motivations

- New computing paradigm
  - Concurrent, distributed, live, interactive systems
- Reconfigurable “soft” hardware
- Unify hardware and software
- Requires re-examining foundations
- Physics and Computer Science
  - Physics: Understanding this Universe
  - Computer Science: Building new Universes
  - complementary - each informs the other
- Find out what is *so*, how things *are*



# What's really “Fundamental”?

- Basic, primary, ultimately simple
  - Indivisible: No parts, no explanation
  - Universal: Can be used to make everything
- The simplest thing? The answer is *Simplicity Itself*.
- Beneath logic, sets, etc, prior to Space and Time
- Not axioms, not a model, not a theory
  - (Theory: "a system of assumptions, accepted principles, and rules of procedure ...")
- Not invented, or discovered, but "remembered"
  - the way we created it already, by observing the way we do
- Begin not from first principles, but from *no* principles



# The Void

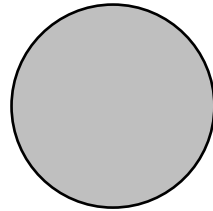
- Nothing (no-Thing), unique
- Not a spatial or mathematical object
  - not the vacuum, the empty set, a coord system
- No properties or attributes
  - not emptiness, no measure or dimensionality
- No consequences or effects
- Cannot be combined with anything
- Cannot be named or referenced
  - “The Tao that is named is not the Eternal Tao.”

*“God made everything out of nothing. But the nothingness shows through.”*  
-- Paul Valéry



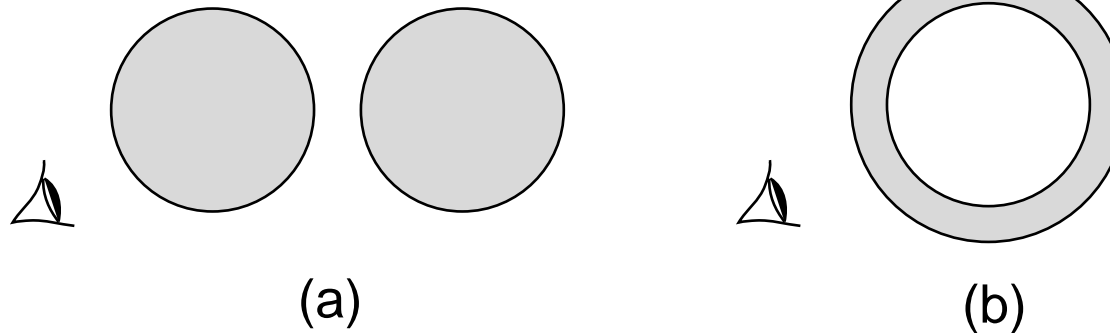
# First Distinction

- First Thing -- Simplicity Itself
- Pure difference, discrimination
- Pure form, no interpretation yet
- Smallest possible, unavoidable step from the Void
- Both object and action
- Beginning of the Combinatorial Hierarchy
- Big Bang?

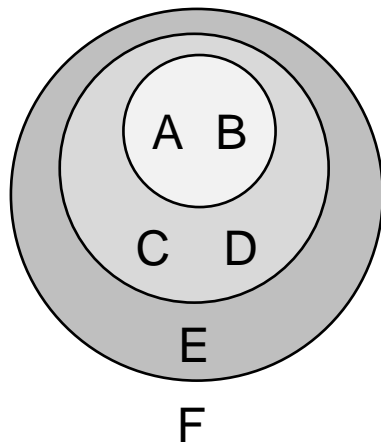
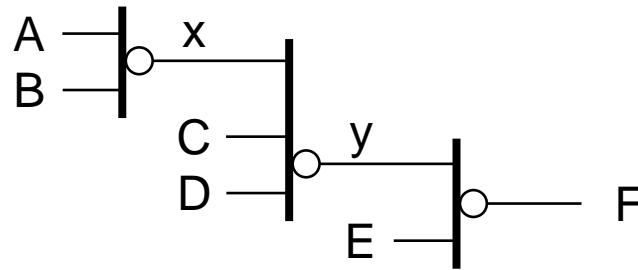


# Second Distinction

- Two possibilities
  - a) outside - symmetrical, cardinality
  - b) inside - asymmetrical, ordinality



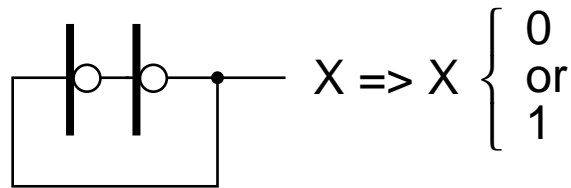
# Combinational Logic



$$F = \overline{\overline{((A \vee B) \vee C \vee D) \vee E}}$$

$$\begin{aligned} \Delta A < \Delta x, \quad \Delta B < \Delta x \\ \Delta x < \Delta y, \quad \Delta C < \Delta y, \quad \Delta D < \Delta y \\ \Delta y < \Delta F, \quad \Delta E < \Delta F \end{aligned}$$

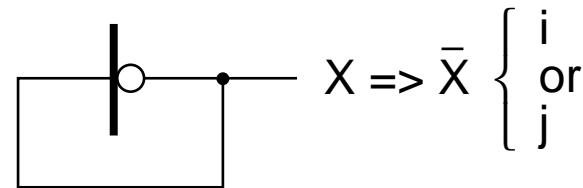
# Self-Reference

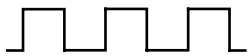


$X_{in}$  \_\_\_\_\_

$X_{out}$  \_\_\_\_\_

Autology (Memory)



$X_{in}$  

$X_{out}$  

Paradox (Clock)

$i : \text{Logic} :: \sqrt{-1} : \text{Reals}$

Logic

$$x = \sim x$$

$$x = i \text{ or } j$$

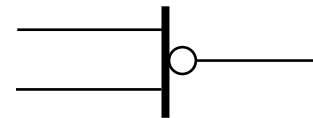
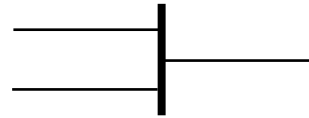
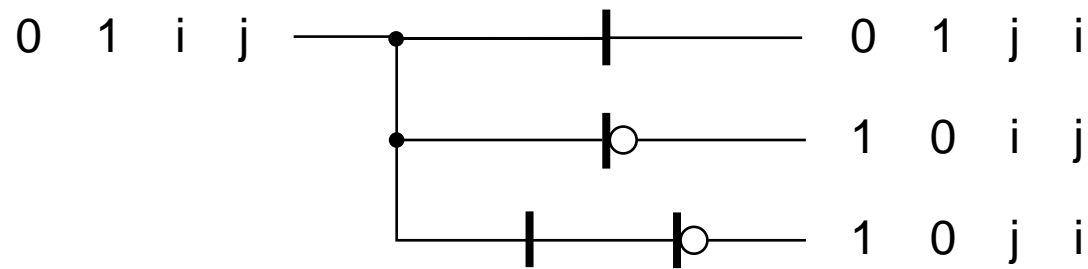
Real Numbers

$$x = -1/x \quad (x^2 = -1)$$

$$x = \pm\sqrt{-1}$$



# 4-Valued Logic Holds Paradox

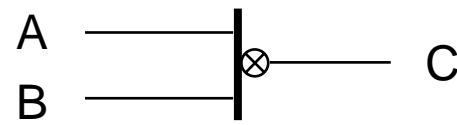


	0	1	i	j
0	0	1	j	i
1	1	1	1	1
i	j	1	j	1
j	i	1	1	i

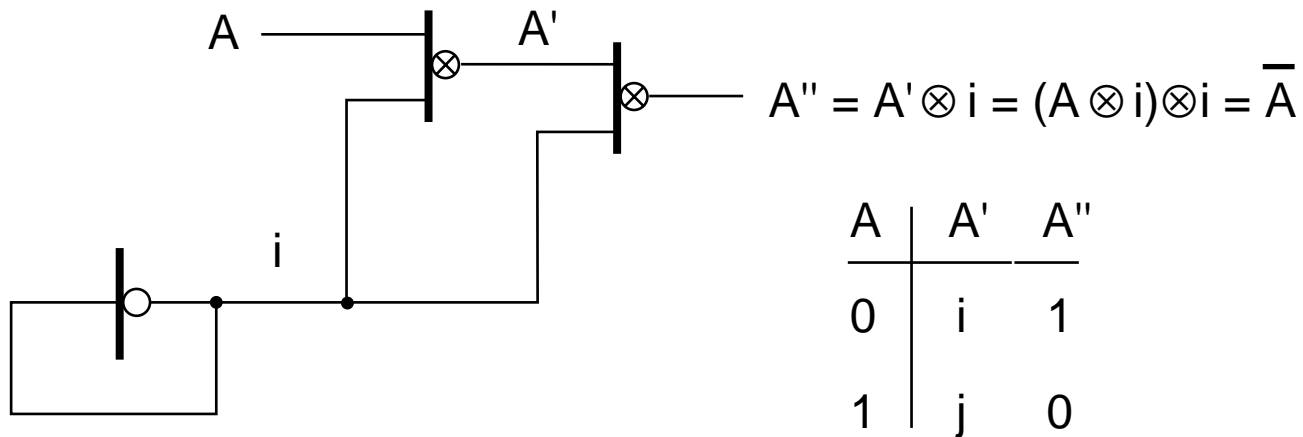
	0	1	i	j
0	1	0	i	j
1	0	0	0	0
i	i	0	i	0
j	j	0	0	j



# Square Root of NOT



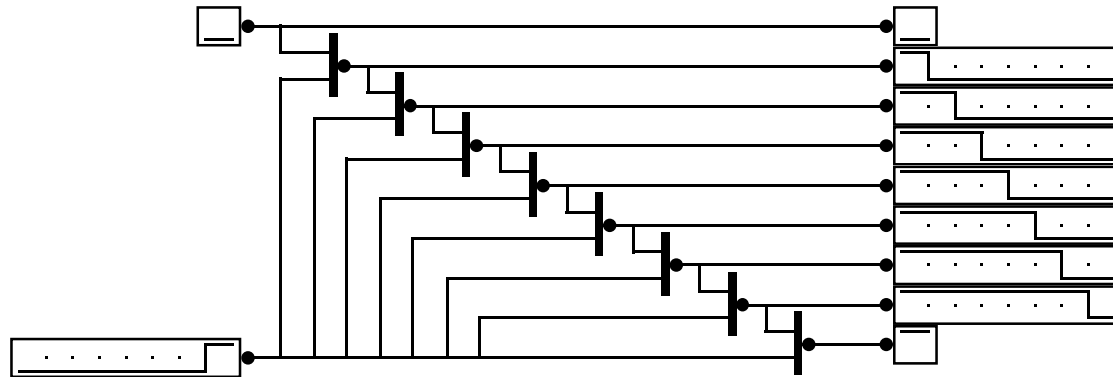
$\otimes$	0	1	i	j
0	0	1	i	j
1	1	0	j	i
i	i	j	1	0
j	j	i	0	1



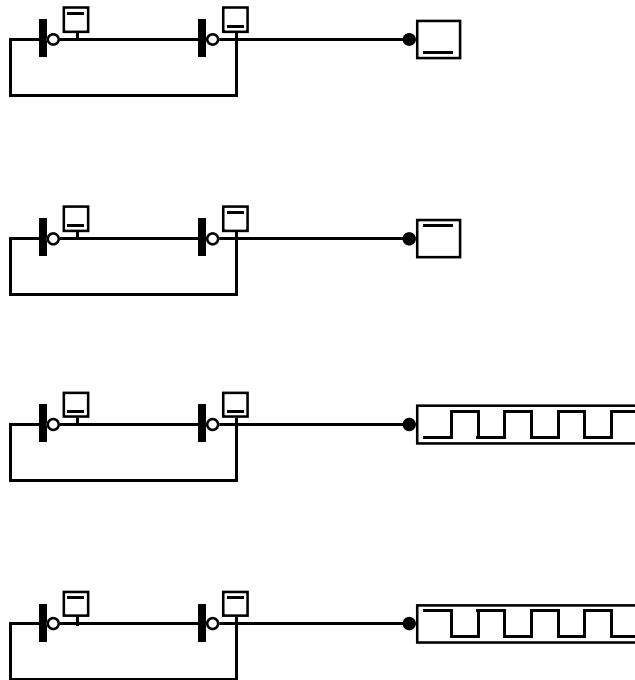
A	A'	A''
0	i	1
1	j	0



# Eighth Root of NOT



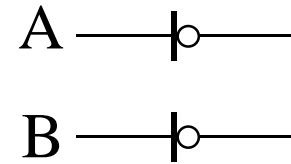
# Memory & Superposition



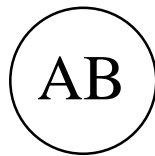
# Connection



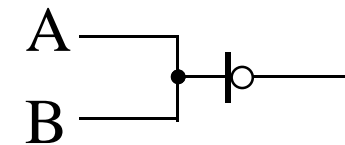
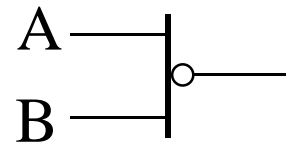
Separate ( $\overline{A}, \overline{B}$ )



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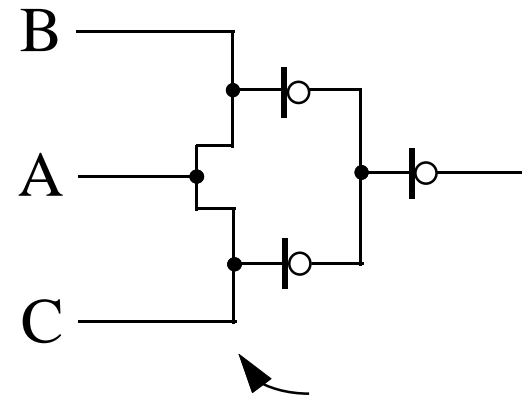
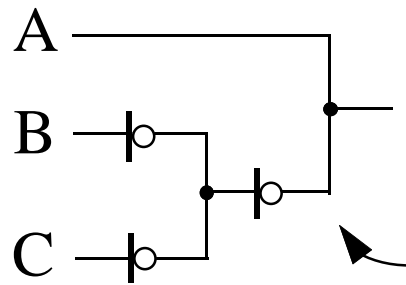
Connected ( $\overline{A \vee B}$ )



Connected ( $\overline{A \vee B}$ )

# Distribution

$$A \vee (B \wedge C) \stackrel{?}{=} (A \vee B) \wedge (A \vee C)$$



- Multiple reference in different contexts
- Problem is non-isolation, not distribution



# Functions vs Interactions

- Math has classical concepts embedded
  - Example: isolation of function parameters
  - Example: isolation of set elements
- Functions are “classical”, interactions are “quantum”
  - Example: Distribution
- New math: Interactions, with isolation explicit



# Four Important Ideas

- The Void
  - no-thing, no properties, no effects, not nameable
- Distinction
  - pure discrimination, both object and action
- Connection
  - non-isolating interaction
- Self-Reference
  - paradox, memory



# Boundary Math re Physics

- Casts one value into the Void
  - As simple as possible
  - Observer in the expression (QM)
  - Unifies Object and Action (QM)
    - e.g. state vectors -> density matrices
- Relativistic (expressions relative to observer)
- Quantum mechanical (connecting, non-isolating)
- Holds Paradox (QM superposition)



# New Theory Needed / Required

- Entirely discrete (distinction)
- Ultimately simple (one source)
- Isolated Universe (no inputs, no God)
- Nothing arbitrary (no randomness)
- All choices taken when none are preferred



# Completed Relativity

- Copernicus      our place is not special
- Newton        no place is special
- Einstein SR    no linear motion is special
- Einstein GR    no acceleration is special
- ( QM )        we are not special
- ( ?? )        nothing is special



# Emergence

- What accounts for the richness of the Universe?
  1. Information is injected via quantum randomness
  2. Information is supplied by the observer
  3. Information was supplied at the Big Bang
  4. Just the properties of the integers (determinism)
- Is this a particular Universe?
  - If it could be otherwise, info would have to be supplied.
  - This is the way it is, and it has no choice.
  - Long-range correlations, EPR
  - Problem of paranormal

