

Two consequences of the hypothesis that we are  
within the world

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# The hypothesis that we are within the world

“An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed”

**Inside the world? Outside it?**

As vast as the world itself (contains as much information)

Could not be a proper part of the world (unless both are infinite)

Outside the world

Looks at the world like a chemist at her test tubes: from outside

# Quantum physics (in the Copenhagen interpretation)

Consistent with this viewpoint

- ▶ Observers and measuring instruments **outside** the observed system
- ▶ Physical laws (the Schrödinger equation) apply to the system but not to the measuring instruments and observers
- ▶ Privilege to evolve in a non deterministic way and to reduce the state vector of the system instantaneously

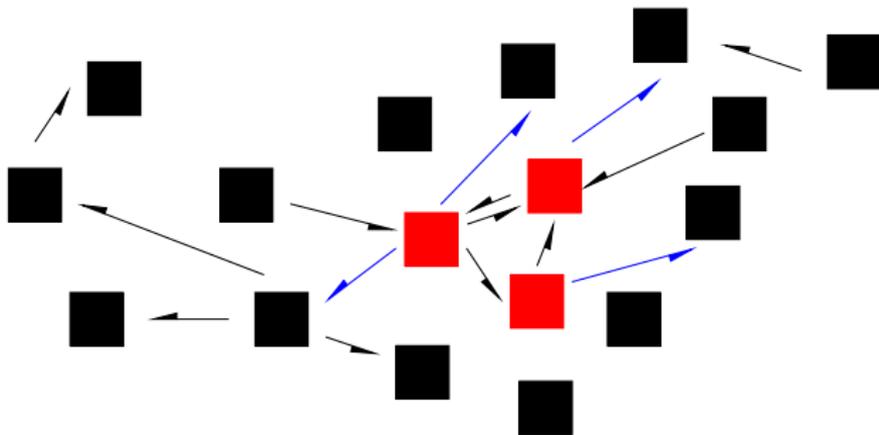
# Idealism

Puts the soul **outside** the material world

(Even if we claim not to subscribe to this viewpoint) **used to consider the interactions between ourselves and the world as if we were not part of it**

Examples: Laplace, quantum physics (in the Copenhagen interpretation)

What does it mean to be within the world?



In red: I

# This talk

The hypothesis that we are within the world: two unexpected consequences

- ▶ freedom is a consequence of determinism
- ▶ predictability of the future is not a consequence of determinism

I. Freedom as a consequence of determinism

# Determinism

The thesis that the state of the world at any future date: a function of its current state

Implies that all the actions we will perform tomorrow are already determined, already written

Seems to allow no room for free action

Relief when replaced by its exact negation: randomness

More compatible with our idea of freedom

Dictionaries: freedom: undetermined character of the human will

# Freedom

Randomness well defined  
But not freedom

(dictionaries) link between freedom and will  
Define will before

# Will

A primitive notion or a derived one?

If primitive: introduce, in language, a modality “ $x$  wants  $A$ ” and rules or axioms expressing its meaning

$x = \text{Alice}$

$A = \text{“Alice wants to go to Jerusalem tomorrow”}$

“Alice wants to go to Jerusalem tomorrow”

Should we state (not not) an axiom expressing that if Alice wants to go to Jerusalem tomorrow and if she can, then she will?  
Constraining character of will?

## Instead: derived

A more primitive modality: “ $x$  can  $A$ ”

Define “ $x$  wants  $A$ ” as “if  $x$  can  $A$  then  $A$ ”

“Alice wants to go to Jerusalem tomorrow”

synonymous (by definition) of

“If Alice can go to Jerusalem tomorrow, then she will”

Solves the problem of the constraining character of will

Alice not constrained by her will

But: if she can go to Jerusalem tomorrow, and she does not, it means she did not want to

## A theorem

“ $x$  can  $A$ ” equivalent to “if  $x$  wants  $A$  then  $A$ ”

Will and possibility symmetric

Possibility coincides with the accomplishment of will

# Possibility

Now: need to define “ $x$  can  $A$ ”

Related to the modality of possibility  $\diamond$  but different

“It is possible that lightning strikes at Alice’s house tomorrow”

and

“Alice can make lightning strike at her house tomorrow”

# Possibility

◇A: A holds in at least one possible world

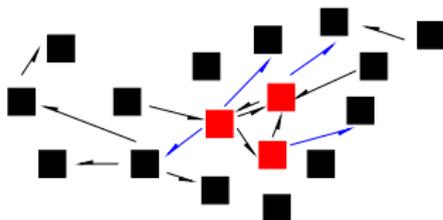
Here: not only A is true at a possible world, but also x can make such a world happen

Describe the way x acts in order to make such a world happen

Description of the way x acts on the world very different if we consider x inside the world, or outside

## $x$ acting on the world

Her action: the information emitted by  $x$ , in the direction of the rest of the world



“ $x$  can  $A$ ” holds if there exists information that, if emitted by  $x$ , would drive the world in a state in which  $A$  holds

## The evolution of a cell

- ▶ Deterministic: function  $f$  mapping current state  $e$  and received information  $i$  to state  $f(e, i)$
- ▶ Random: a function  $f$   $e$  and  $i$  to **set of possible states**  $f(e, i)$

A set always the image of a function

A function  $g$  mapping  $e$ ,  $i$ , and  $\omega$  in a **source of randomness**  $\Omega$  to state  $g(e, i, \omega)$

Future state of the world: function of its current state (deterministic case) of its current state and  $\omega$  in  $\Omega$  (random case)

Isolate a person  $x$  from the rest of the world

The future state of the **rest of the world**:  $F(E, I)$  or  $G(E, I, \omega)$

## From possibility to freedom

$x$  is freer than  $y$ : everything  $y$  can,  $x$  also can

For instance: you are freer listening to this talk than a prisoner in a dungeon: you can leave the room, go have a coffee...

As “ $x$  can  $A$ ” equivalent to “if  $x$  wants  $A$  then  $A$ ”, freedom is the accomplishment of will

## The question

- ▶ Is  $x$  freer in a random world or in a deterministic one?
- ▶ Can  $x$  more in a random world or in a deterministic one?
- ▶ Is the will of  $x$  more often accomplished in a random world or in a deterministic one?

Answer: exact negation of the thesis sketched above:

$x$  can more in a deterministic world, than in a random one

# An example

A lamp with a contact failure

Future less determined, less written...

Each time we press the switch, two states of the world can happen

Does this make us freer?

No: our will is less often accomplished

# Fortunately

The world is **not too much random** (at usual scales)

We can build deterministic lamps  
and switch them on and off when we want

## Freedom of action and freedom of will

Also need to examine the idea that **the freedom of  $x$  come from the randomness of the evolution of  $x$**  (not of the rest of the world)

Tomorrow, I decide to become the follower of some new age guru

A consequence of the fact that the spin of some electron, in some of my neurons took randomly the value  $-1/2$  or  $1/2$

Freedom?

## What if we were not within the world?

Isolate a person  $x$  from the rest of the world

The future state of the **rest of the world**:  $F(E, I)$  or  $G(E, I, \omega)$

Hypothesis that  $x$  is part of the world is not universally accepted:  
idealism puts  $x$  outside the material world

Not use the expression **“the rest of the world”** but simply **“the world”**

## What if we were not within the world?

The future state of the **the world**:  $F(E, I)$  or  $G(E, I, \omega)$   
 $I$  and  $\omega$ : two sources that influence the evolution of the **world**

Lamp turns depends on its current state and

- ▶ the action  $I$  of  $x$
- ▶ the element  $\omega$  describing the contact failure

Both description random

Two sources of “randomness”: action of  $x$  and **pure** randomness  $\omega$

Transposition of the argument above:

The freedom of  $x$  does not come from  $\omega$  but from  $I$  (freedom comes from **a very special form of** randomness)

## One step further than idealism

Identify  $I$  and  $\omega$  (drop  $\omega$ )

Randomness: always the influence of the consciousness of a person

Interpretations of quantum physics where the result of a measurement is determined by the **consciousness** of the observer

A caricature that blossomed from time to time: the Cordoba interpretations of quantum physics

In such a framework (and in such a framework **only**) freedom is a consequence of the randomness of measurement

Possible to assume that we are outside the world and that freedom is a consequence of randomness

But difficult to assume **both** that we are within the world and that freedom is a consequence of randomness

II. Predictability of the future is not a consequence of determinism

## Determinism implies predictability (Laplace again)

“if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the world and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.”

But this requires this intellect to be **outside** the world

Laplace seems to have seen the problem: “vast enough to submit these data to analysis”

According to Laplace, this is because we are not such a vast enough intellect, that we need probabilities

# Computational irreducibility

Even if

- ▶ the state of the world tomorrow is a function of its state today
- ▶ this function is computable

impossible to deduce we can predict the state of the world tomorrow

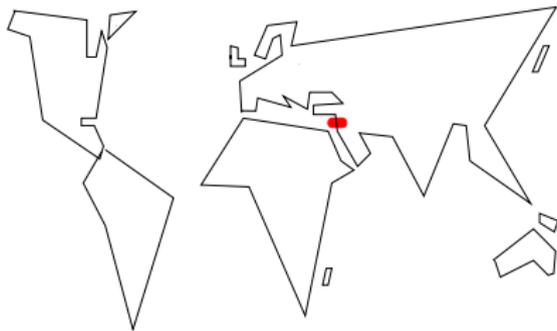
**Pre-dict: say before it happens**

Time of the evolution of a system and time needed to simulate it  
(origin of Feynman's idea of a quantum computer)

Wolfram's computational irreducibility: a phenomenon no  
simulation shorter than its evolution

# Computational irreducibility of the evolution of the world

An intellect predicting each day the state of the world the next one  
Displays each prediction as an image

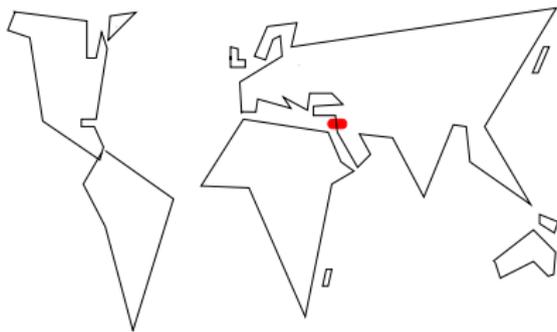


The state of the world today

Zoom

# Computational irreducibility of the evolution of the world

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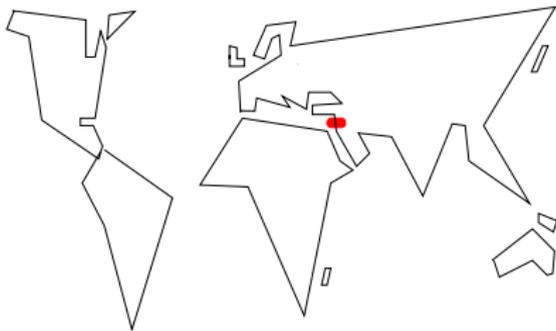


The state of the world tomorrow

Zoom again

# Computational irreducibility of the evolution of the world

An intellect predicting each day the state of the world the next one  
Displays each prediction as an image



The state of the world the day after tomorrow

Zoom again

...

Predicting the state of the world tomorrow requires to predict that of the world the day after tomorrow, and the day after...

Infinite amount of computation, **impossible to execute** in finite time

## To wrap up

Both the theses that

- ▶ freedom is a consequence of randomness
- ▶ determinism implies the predictability of the future

presuppose that we are outside the world

If we assume that we are **within** the world

- ▶ freedom is a consequence of determinism
- ▶ predictability of the future is not