

# The Power of Reflection

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## Introduction

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Can the brain in principle fully understand itself?

We do not know

Some would say “No: In order to understand a system  $S$  one always needs a system more complex than  $S$  itself!”

There is, however, a mechanism, called *reflection*, showing that there are systems powerful enough to describe themselves

Reflection occurs in the living cell, in natural language, in mathematics, in computers and in consciousness

In all cases reflection has outright dramatic effects: respectively life, language, science, ICT, and intelligence/wisdom

Where there is something powerful, there often is a backside

In the mentioned examples these are:

viruses, paradoxes, *incompleteness*, undecidability, and existential fear

## Sneak preview

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*It is understandable that an engineer is preoccupied by his specialty instead of coming into the freedom and space of the world of ideas, even if his machines are delivered to the furthest corners of the world; because he does not need to be more able to apply the daring and novel aspects of the soul of his technique to his personal soul as that a machine is capable to apply the infinitesimal equations on which it depends to itself.*

*About mathematics one cannot say this; it is the new method itself, the spirit itself, in it lay the sources of time and the origin of an immense transformation.*

Robert Musil:

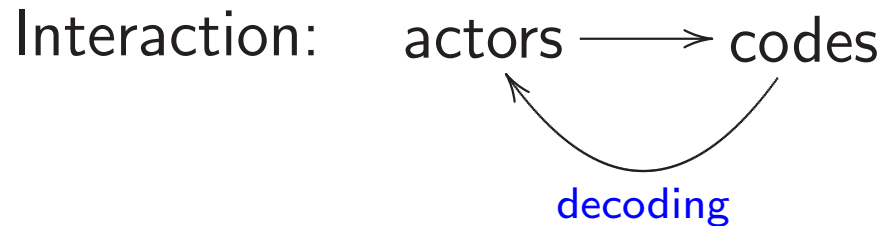
Der Mann ohne Eigenschaften [1930/1932]

# Reflection

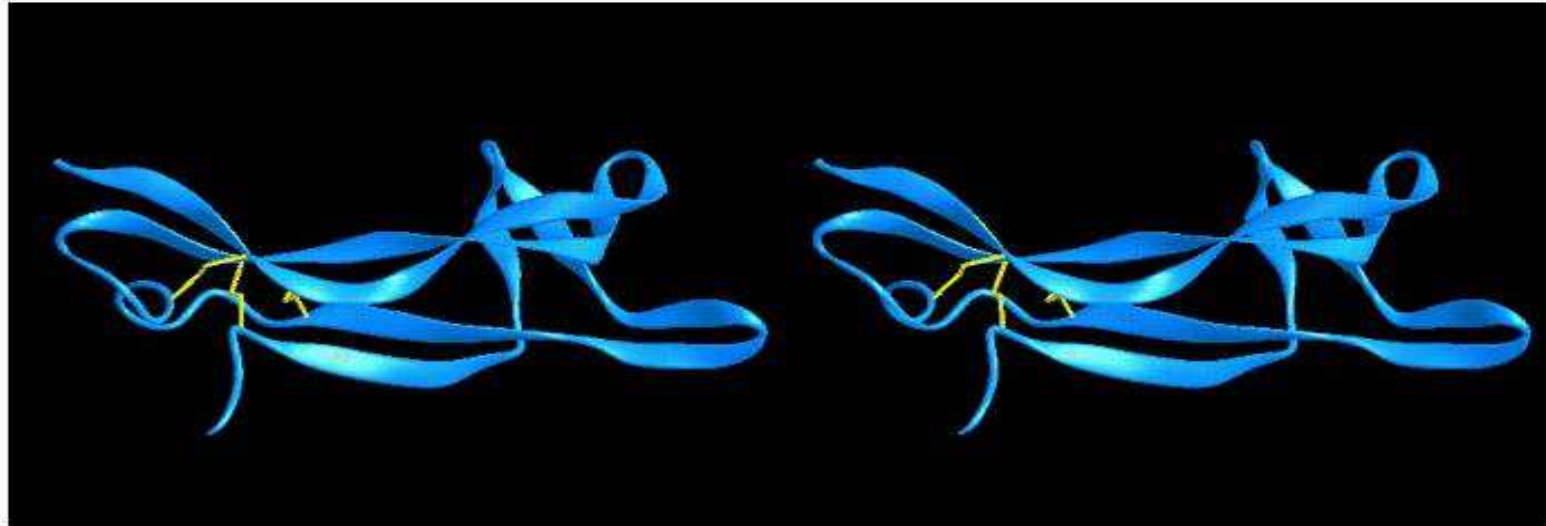
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Actors: active objects

Codes: usually passive; can be decoded to become actors



Topic	Actors	Codes
Biology	proteins	DNA
Language	sentences	'citations'
Mathematics	statements	numbers
Informatics	computable functions	programs
Consciousness	mind states	mindfulness



NGF\_Homo\_Sapiens (Nerve Growth Factor)

# Reflection in biology

ACGT-chain: length 1047 base pairs

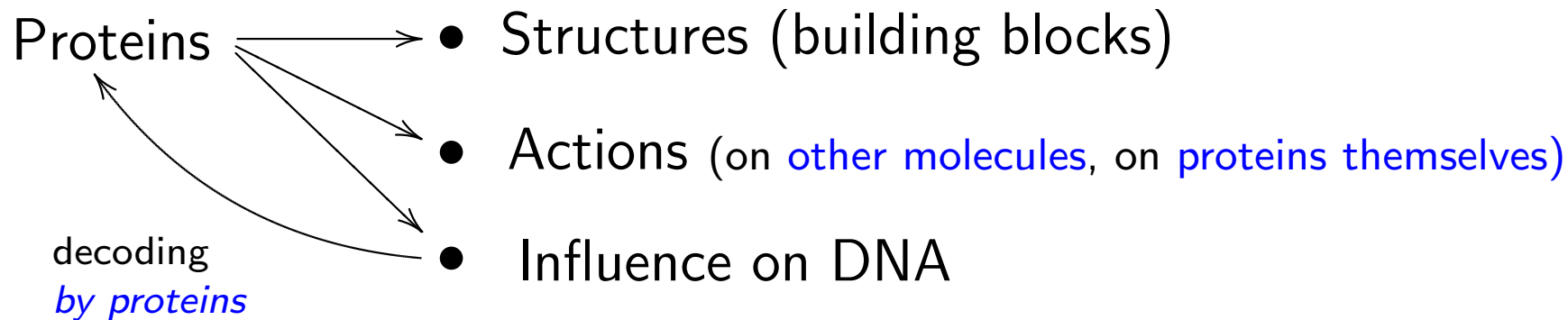
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atcattatth	attaaattht	tggaagc				1047

Genetic code of NGF\_Homo\_Sapiens

# Reflection in biology

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proteins influence DNA for

- selection
- correction
- duplication
- decoding

*thus influence themselves*, essential for the (eukaryotic) cell, for life

## Reflection in language

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Language is active      She: Will you visit me tonight?  
   He: Yes. Unless it rains.

Language has a coding-mechanism (Tarski [1933])

- Maria is a nice girl
- 'Maria' consists of five letters

Interaction

Mother, what is the meaning of the word 'curious'?

Important for language **acquisition**, **analysis** and **extension**

The sentence 'I am sad today' has by itself no emotional value as I didn't state it!



# Reflection in mathematics

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Look at mathematical expressions

not for their *meaning*  
but for their *syntactic form*

⟶ new results

For **quantitative** expressions: algebra

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

For **qualitative** expressions:

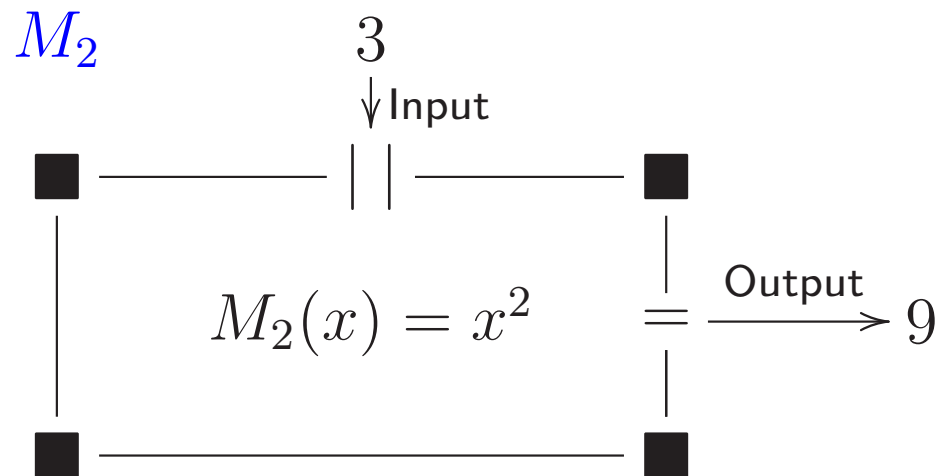
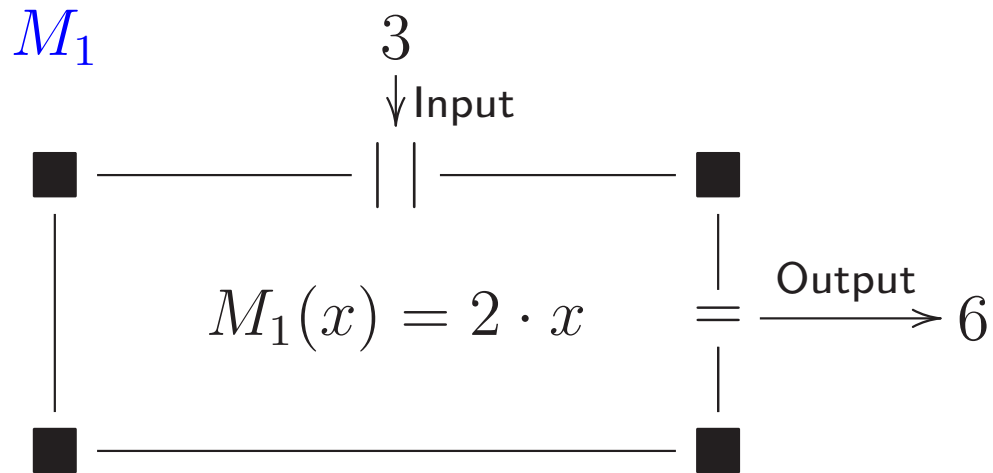
De functie  $\tanh(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$  is continu

**Duality in planar projective geometry:**

A result remains valid if we **interchange** the notions of 'point' and 'line'

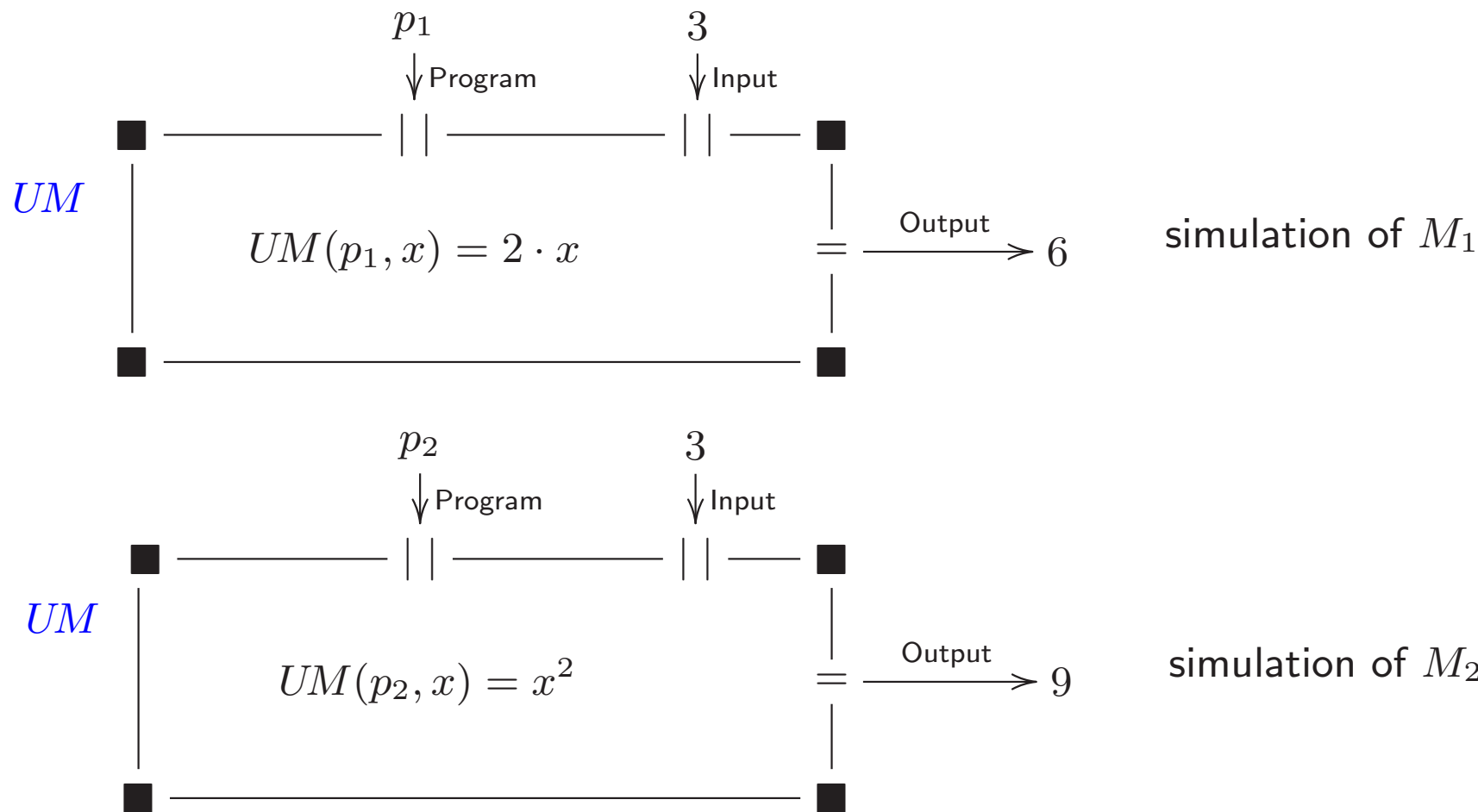
# Reflection in informatics

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Two *ad hoc* machines:  $M_1$  for doubling and  $M_2$  for squaring

# Reflection in informatics




One Universal Machine  $UM$  with programs that simulate  $M_1$  and  $M_2$   
 $M_2$  can act on the code of  $M_1$  or even on that of itself:

$M_2(p_1)$  or  $M_2(p_2)$

# Reflection in consciousness

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reality	language
■	square
square	'square'

reality	consciousness
	experience (colour)
experience (of colour)	<u>experience of experience</u>
	'mindfulness'

event       $\mapsto$       sadness  
sadness    $\mapsto$       mindfulness of sadness  
                  $\neq$       sadness

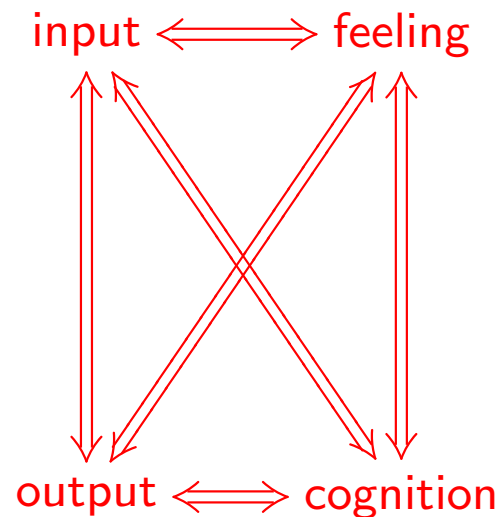
# Reflection in consciousness

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States of consciousness are active

↳ *Conditioning*

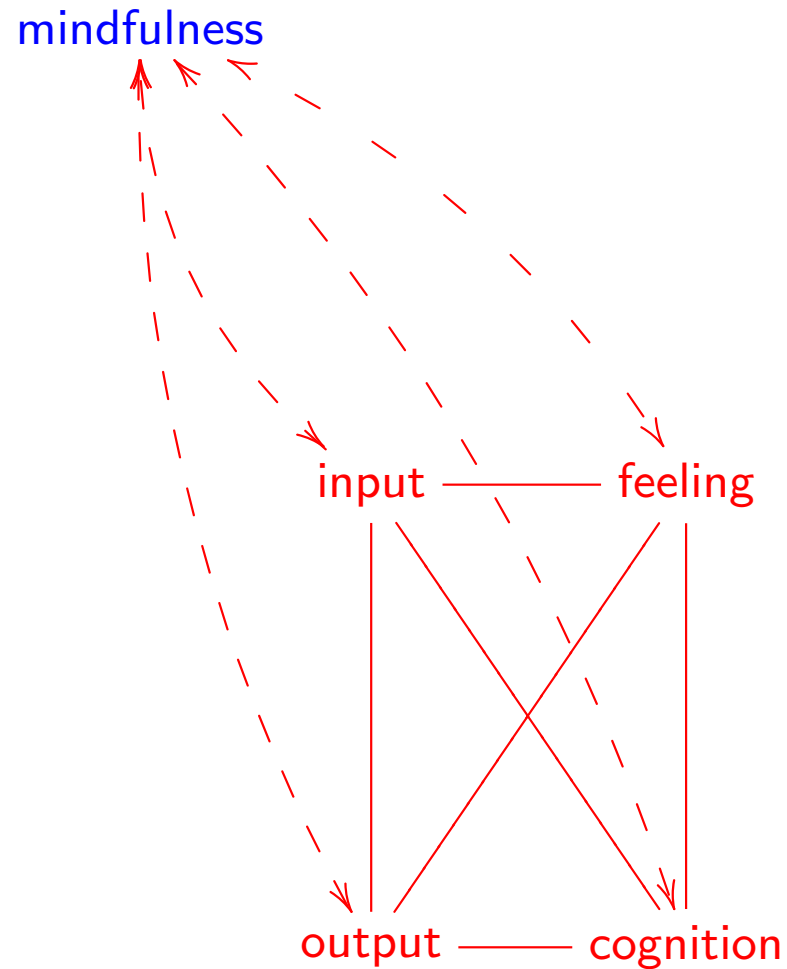
Spinoza described this problem  
his solution: ethics



Duty moral

# Reflection in consciousness

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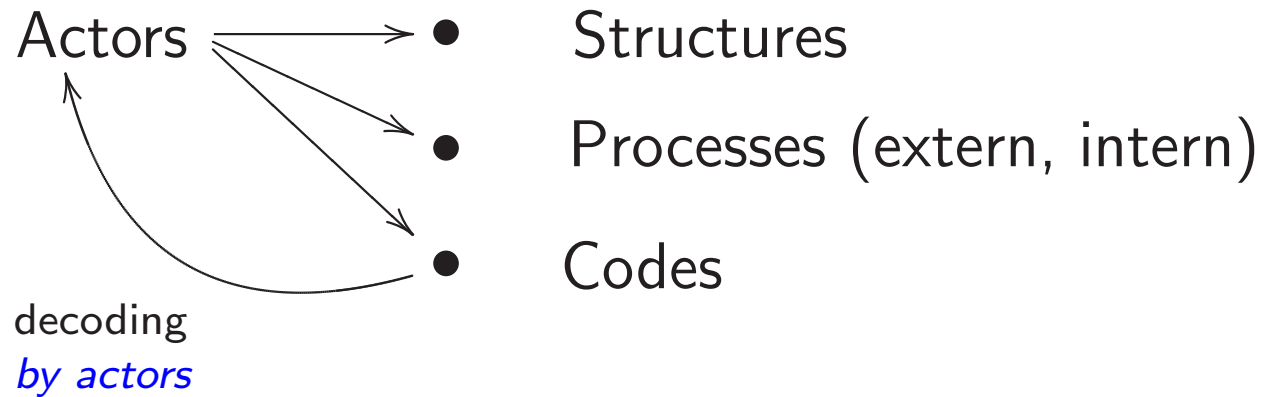
Mindfulness is non-active  
↳ less conditioning

Virtue moral

# Reflection summarized

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## Global feedback



## Power and drawback of reflection

Topic	'desired' effect	'undesirable' effect
Biology	life	virusses
Language	homo sapiens	paradoxes
Mathematics	science	incompleteness
Informatics	IT	undecidability
Consciousness	purification	existential fear