

The Power of Reflection

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Introduction

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

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.

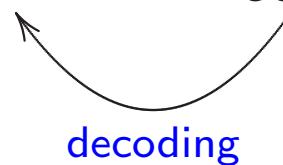
Robert Musil:
Der Mann ohne Eigenschaften [1930/1932]

Reflection

Actors: active objects

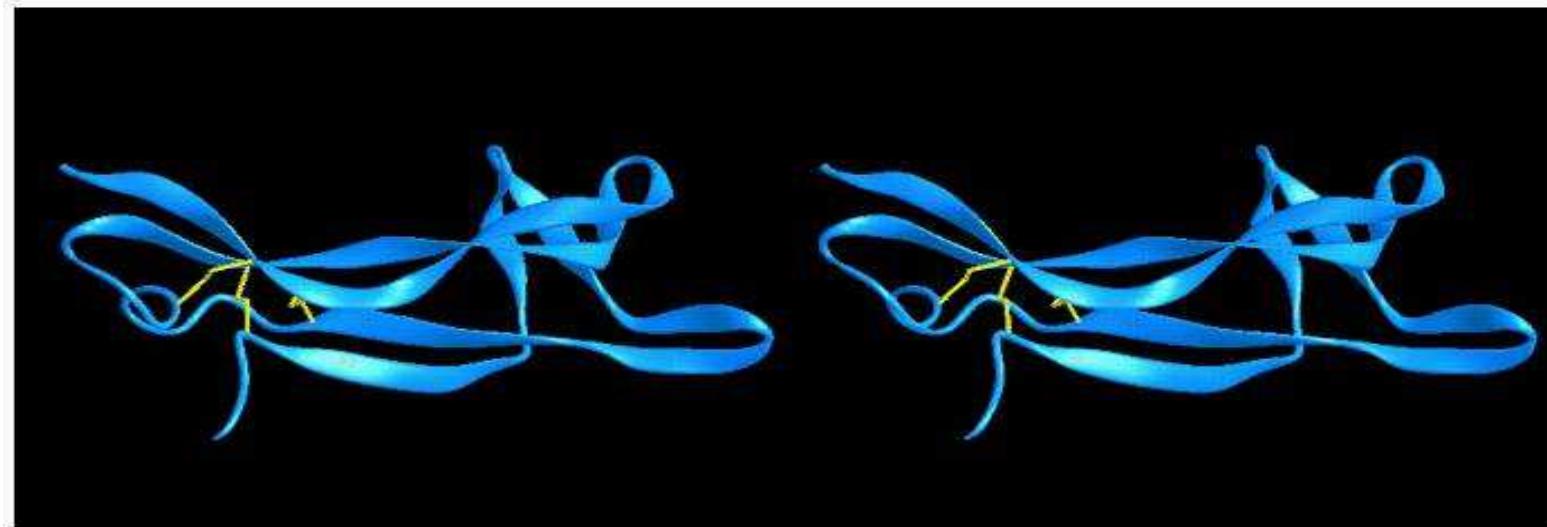
Codes: usually passive; can be decoded to become actors

Interaction: actors → codes



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

Reflection in biology



NGF_Homo_Sapiens (Nerve Growth Factor)

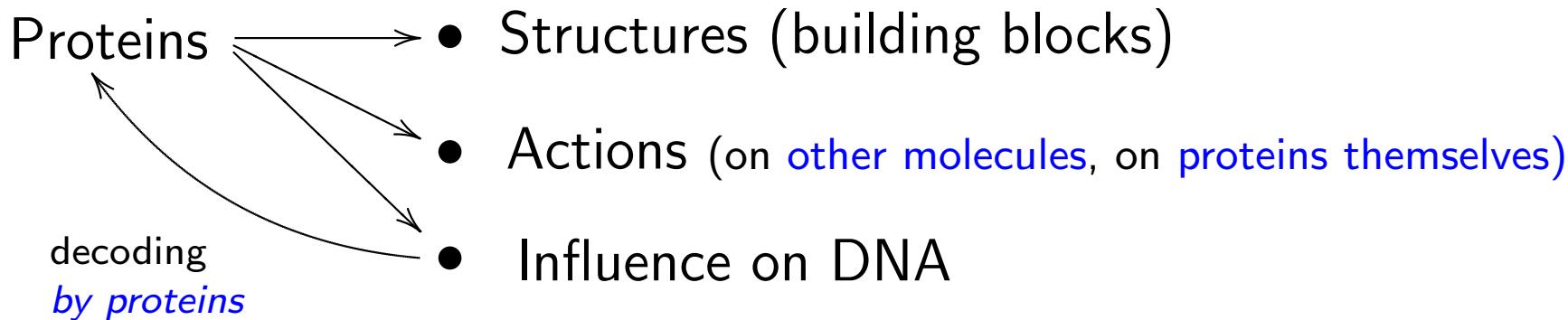
Reflection in biology

ACGT-chain: length 1047 base pairs
www.ebi.ac.uk/cgi-bin/expasyfetch?X52599

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gtaaattattt	ttaaattata	aggactgcat	ggtaatttat	agtttataca	gttttaaaga	1020
atcattattt	attaaatttt	tggaagc				1047

Genetic code of NGF_Homo_Sapiens

Reflection in biology



proteins influence DNA for

- selection
- correction
- duplication
- decoding

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

Reflection in language

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

Look at mathematical expressions

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

→ new results

For quantitative expressions: algebra

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

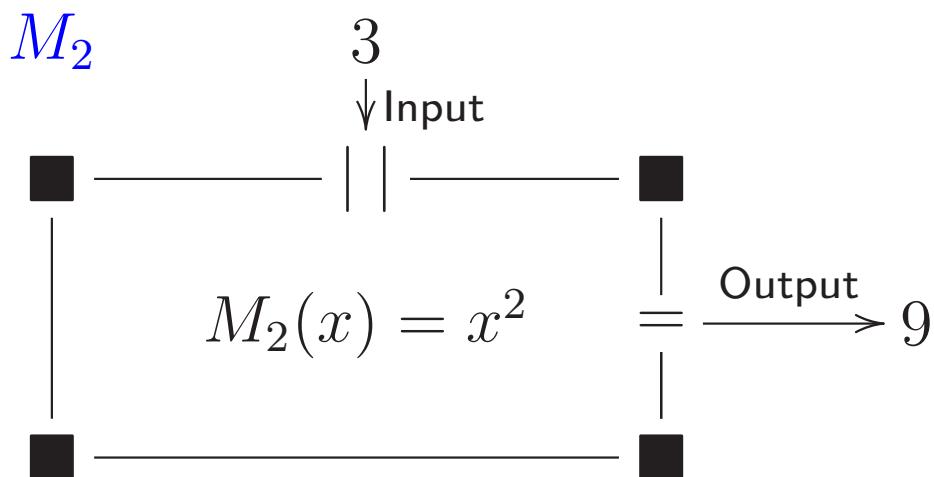
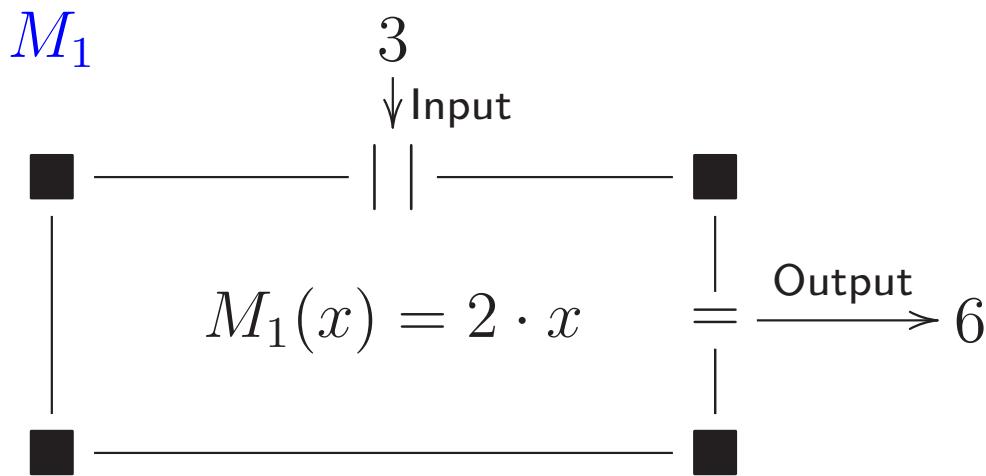
For qualitative expressions:

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

Duality in planar projective geometry:

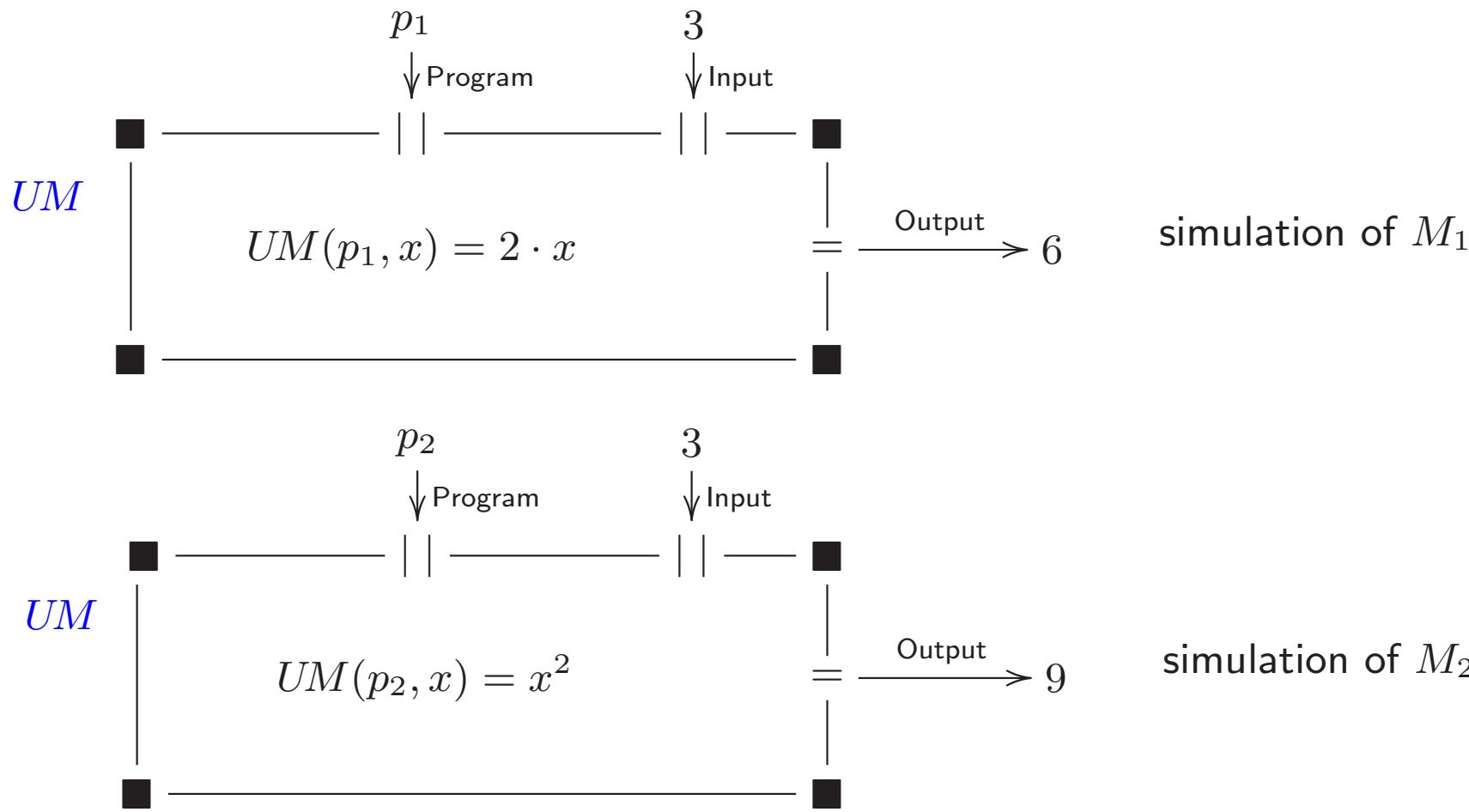
A result remains valid if we interchange the notions of 'point' and 'line'

Reflection in informatics



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

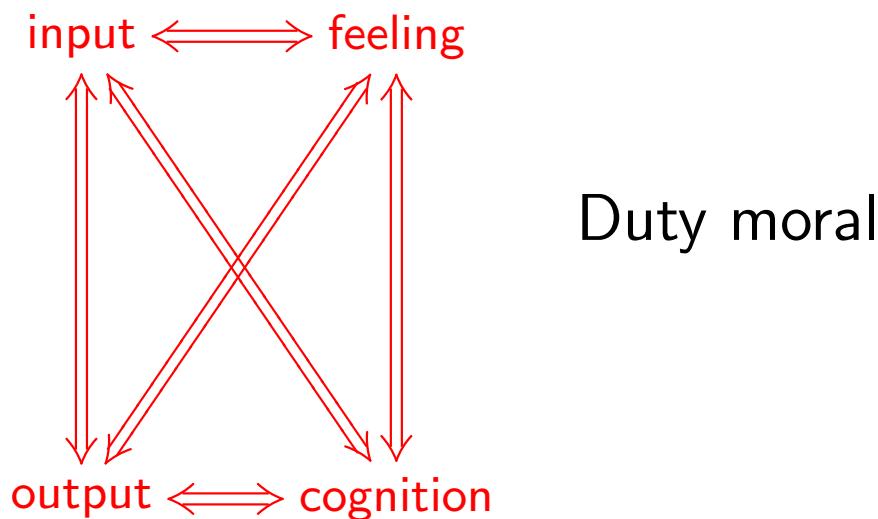
reality	language
■	square
square	'square'

reality	consciousness
	experience (colour)
experience (of colour)	experience of experience

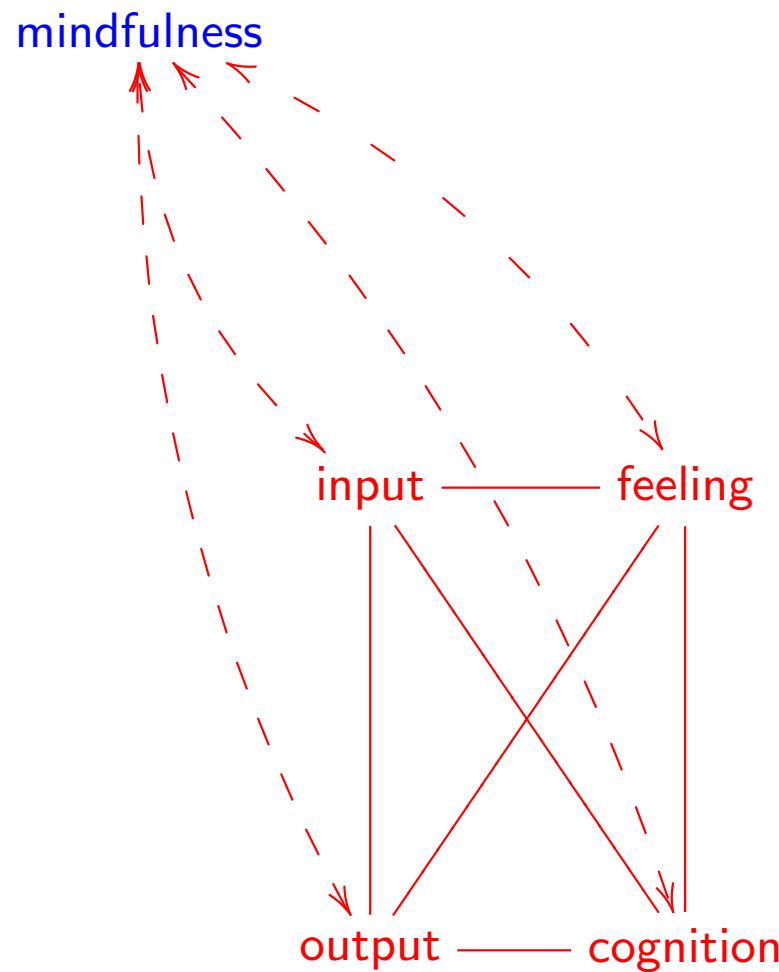
Reflection in consciousness

States of consciousness are active
→ *Conditioning*

Spinoza described this problem
his solution: ethics



Reflection in consciousness

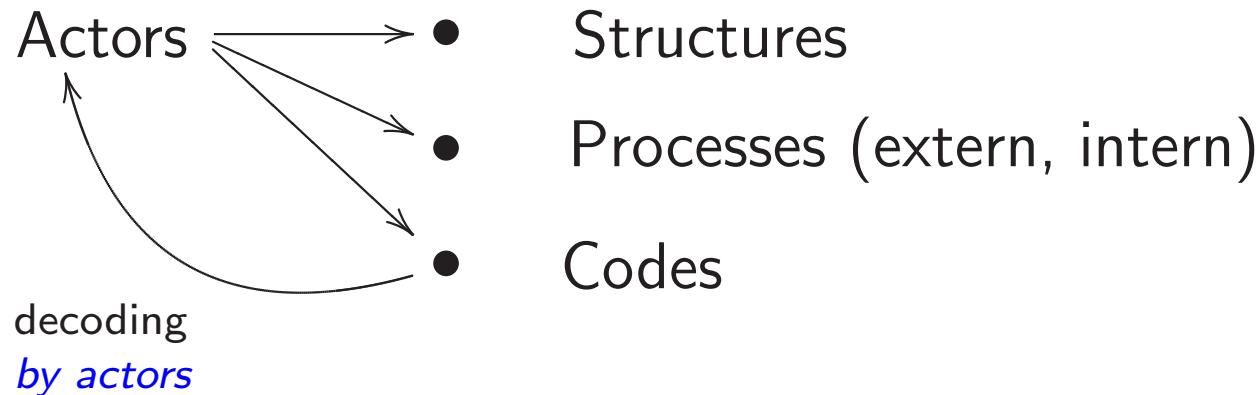


Mindfulness is non-active
→ less conditioning

Virtue moral

Reflection summarized

Global feedback



Power and drawback of reflection

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