

Oxford Internet Institute
University of Oxford



Coordination, Semantics, and Autonomy

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① Four kinds of complexity: a unified view

② Coordination complexity

③ Semantic web and coordination complexity

④ Predictable autonomy?

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"'Tis plain it is not the idea of extension. For the idea of extension consists of parts."

Hume D. 1978, *A Treatise on Human Nature*, ed. by L. A. Selby-Bigge, second edition with text revised and variant readings by P. H. Nidditch Clarendon Press, Oxford (first pub. 1739): p. 38

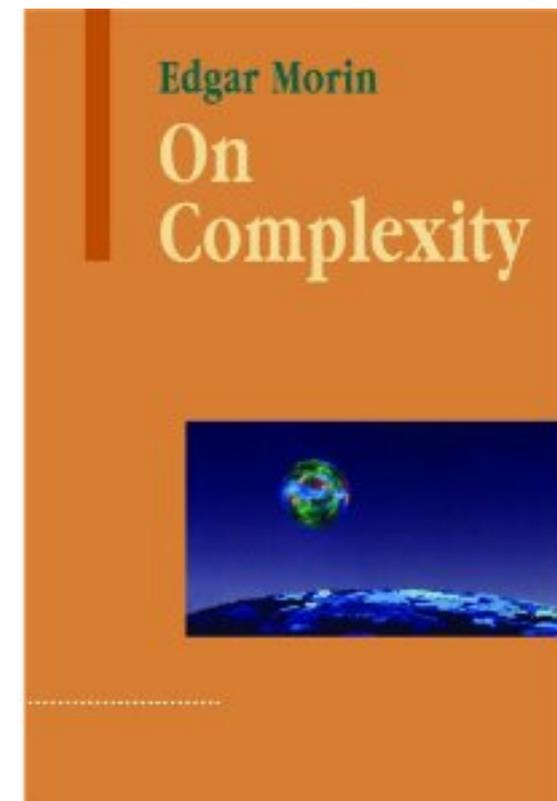
Self-referential complexity less trivial than it looks: Gödel's incompleteness theorem and Turing's halting problem.

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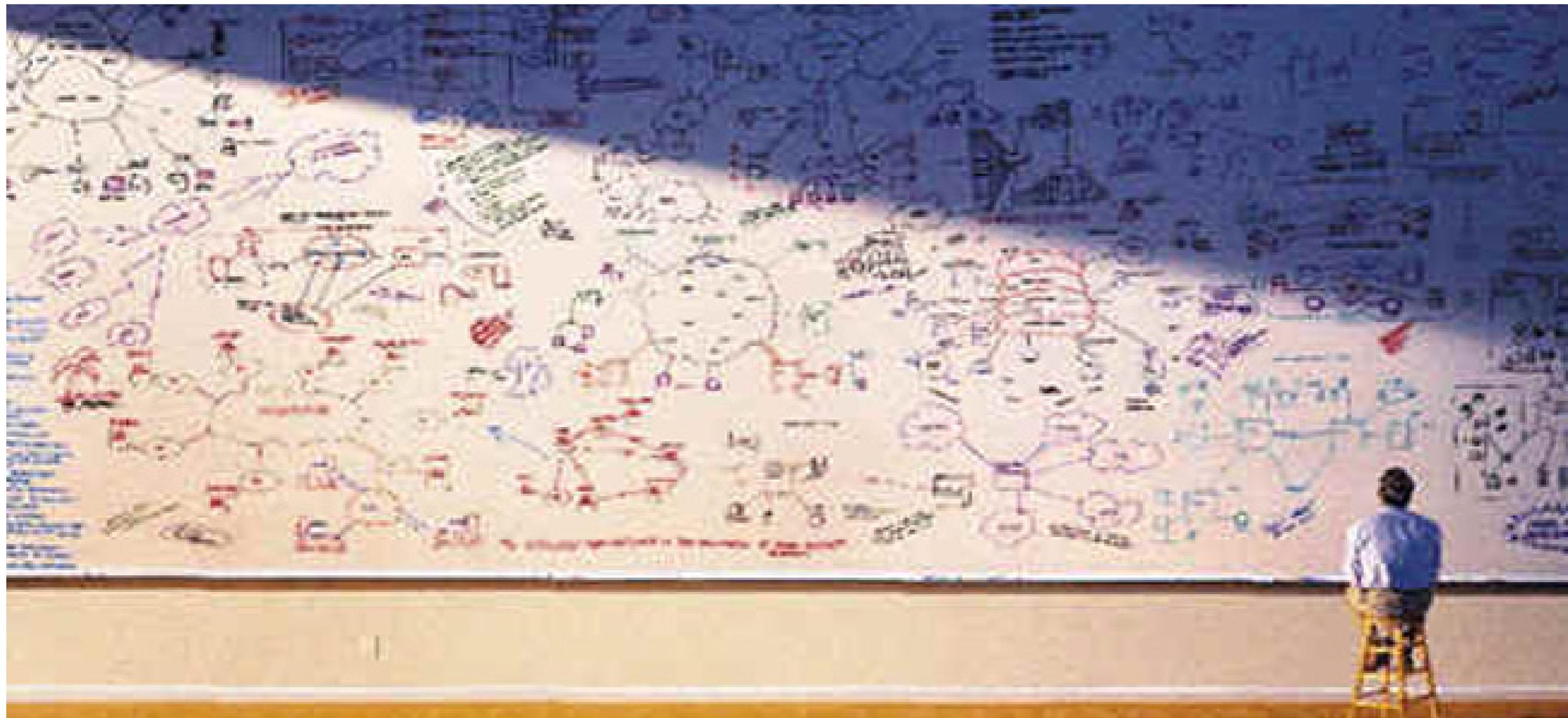
However, it is a mistake to endorse it as a conceptual constraint.

"There are two preliminary difficulties when we want to talk about complexity. [...] The second difficulty is of a semantic nature. If it were possible to define the notion of complexity in a clear way, it would clearly follow that the word [i.e. "complexity"] would not be complex".

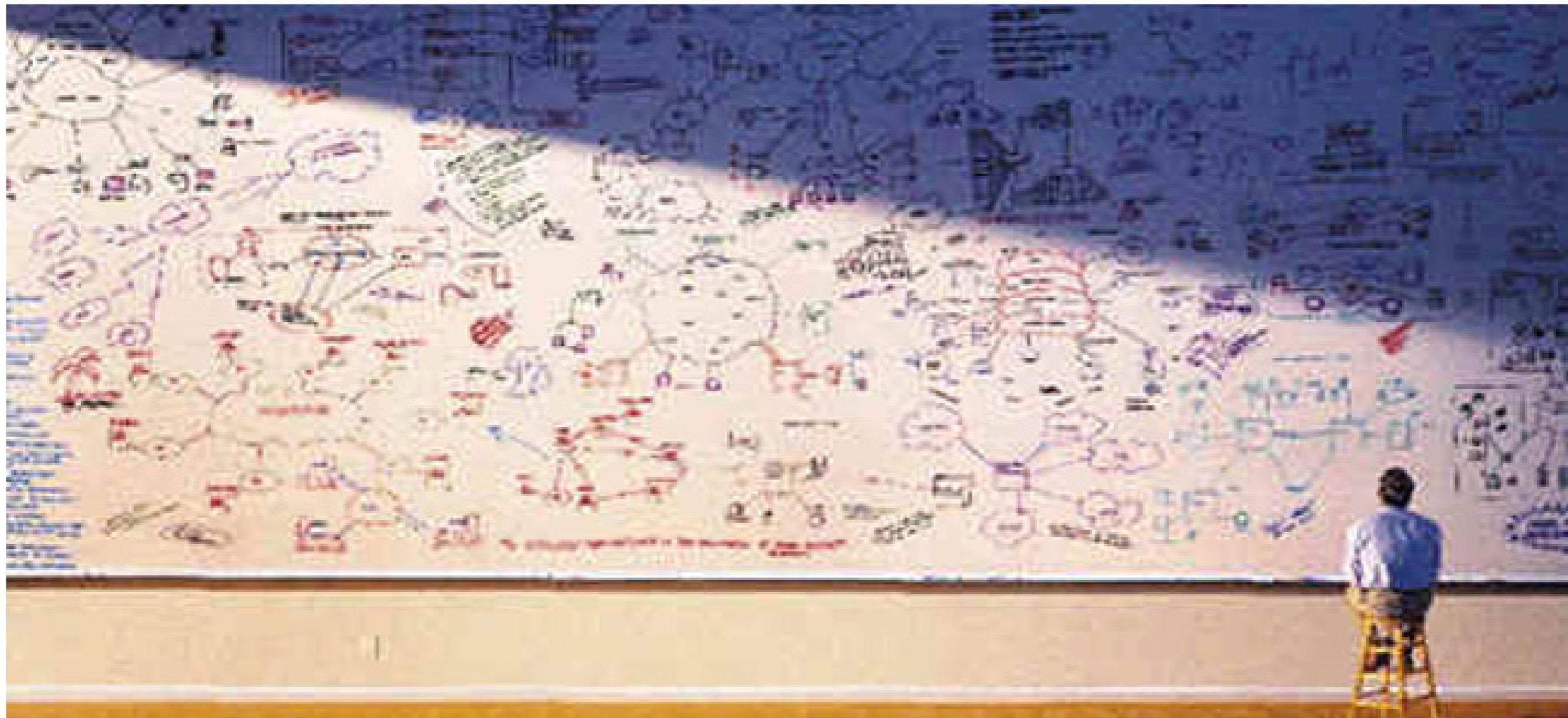
Edgar Morin "Le Vie della Complessità",
La Sfida della Complessità,
Feltrinelli Milano 1985, pp. 49-60.



Complexity concerns a system, its components, their relations and process (state spaces). So LoA essential. Conclusions should be loosely applicable to other systems as well.



Our LOA: quantitative not qualitative complexity (e.g. number of moves, not complex relationship), and about computational systems.



Kolmogorov C: what it takes to generate S.

Amount of resources required to specify (generate) S, aka "descriptive complexity" (Kolmogorov–Chaitin complexity, algorithmic entropy, or program-size complexity).

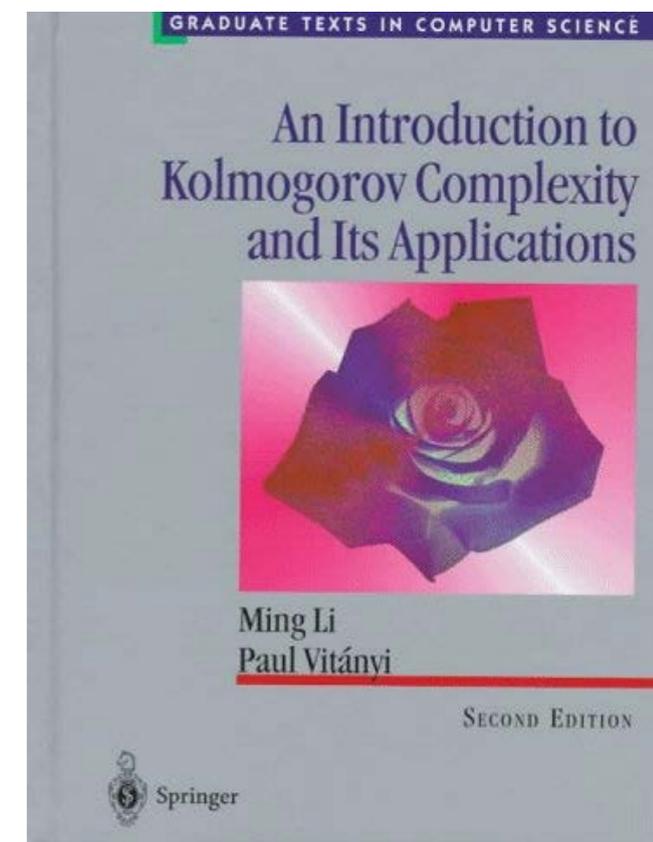
Necessary condition: same descriptive language.

Main issue: **compression**.

Example: ababababab = 5 times ab

89f74bfl84 = **random**

higher complexity because the shorter program is the description itself.

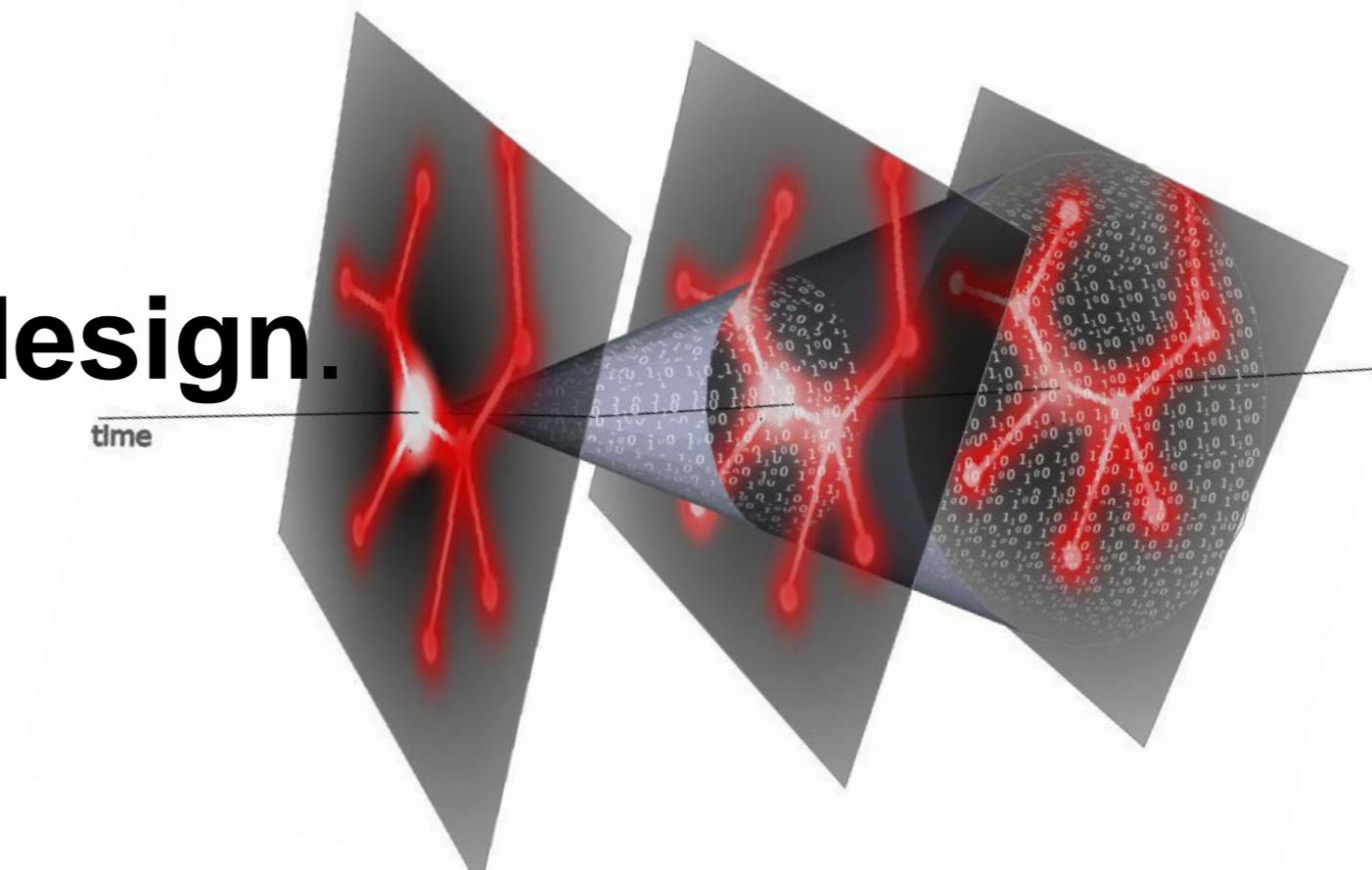


State C: how complicated S is.

In information processing, a measure of the total number of properties transmitted by an object and detected by an observer.

Such a collection of properties is often referred to as a state.

Main issue: **interface design.**



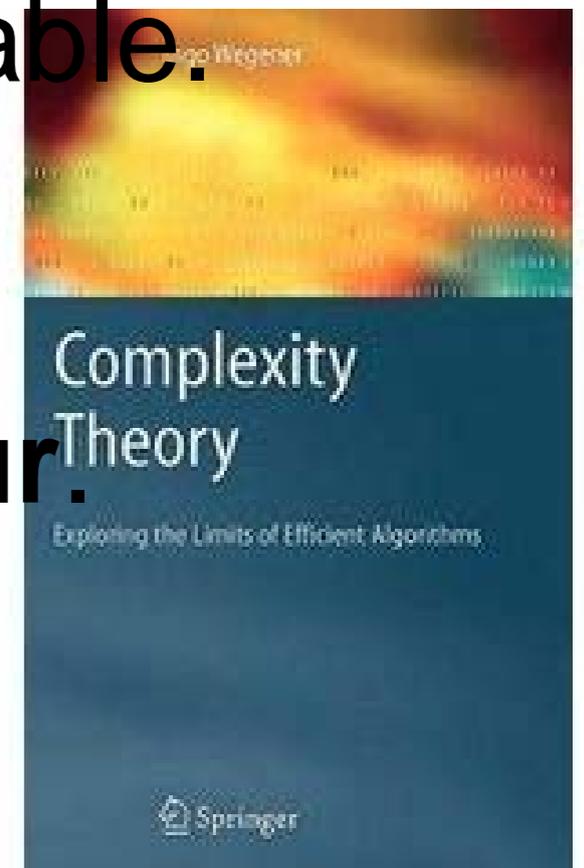
Programming C: how complicated S' dynamics is.

In software engineering, programming complexity a measure of the interactions of S' elements (normally software).

Many metrics but none easily quantifiable.

Main issue:

how to design/optimize S' behaviour.



Computational C: what it takes for S to solve P.

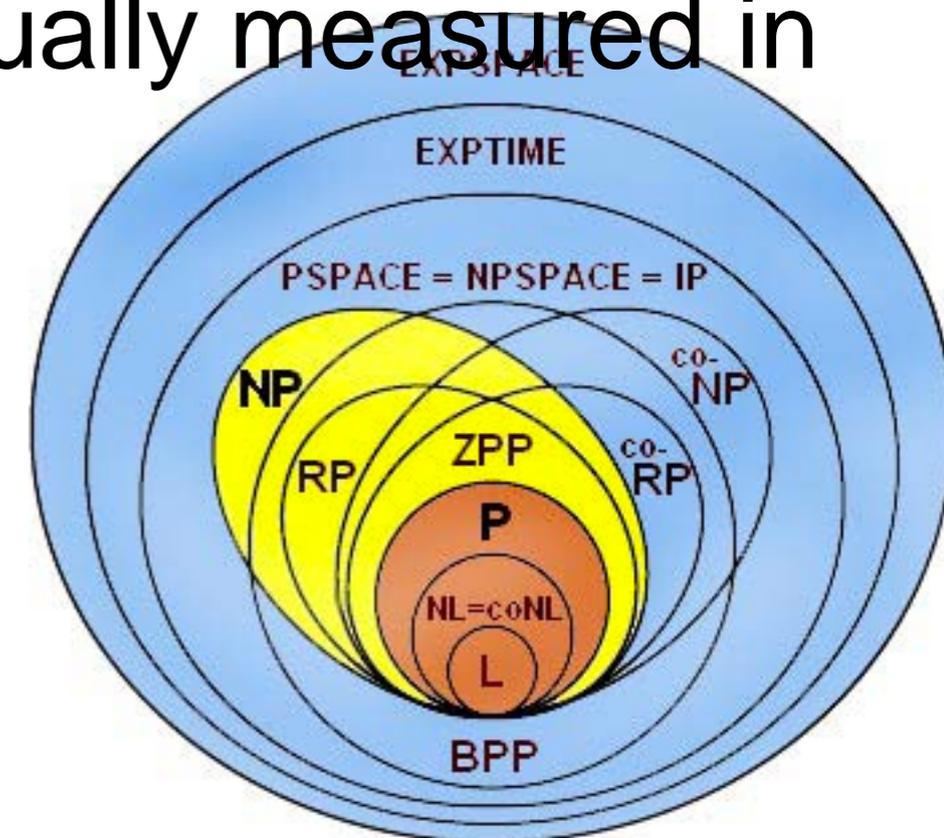
Resources required for execution of algorithms.

Time = steps required by S to solve P as a function of the size of the input (usually measured in bits), using the most efficient algorithm.

Space = memory required by S to solve P as a function of the size of the input (usually measured in bits),

using the most efficient algorithm.

Computational problems classified by complexity class (such as P, NP ...).



Main issue: $P = NP$?

Easy to find = easy to check?

We think the answer is no.

Problems solvable in theory (e.g., given infinite time), but not in practice = intractable problems.

Problems with no polynomial-time solutions seem intractable for more than the smallest inputs. Cobham–Edmonds thesis: only problems solvable in polynomial time can be feasibly computed on some computational device.

- Housing accommodations for 400 students.
- Only 100 will receive places in the dormitory.
- List of pairs of incompatible students. No pair from the list appears in final choice.
- NP-problem: easy to check but generating such a list from scratch completely impractical.
- No supercomputer can solve it by brute force: the total number of ways of choosing 100 students from the 400 applicants greater than the number of atoms in the known universe.

A UNIFIED VIEW

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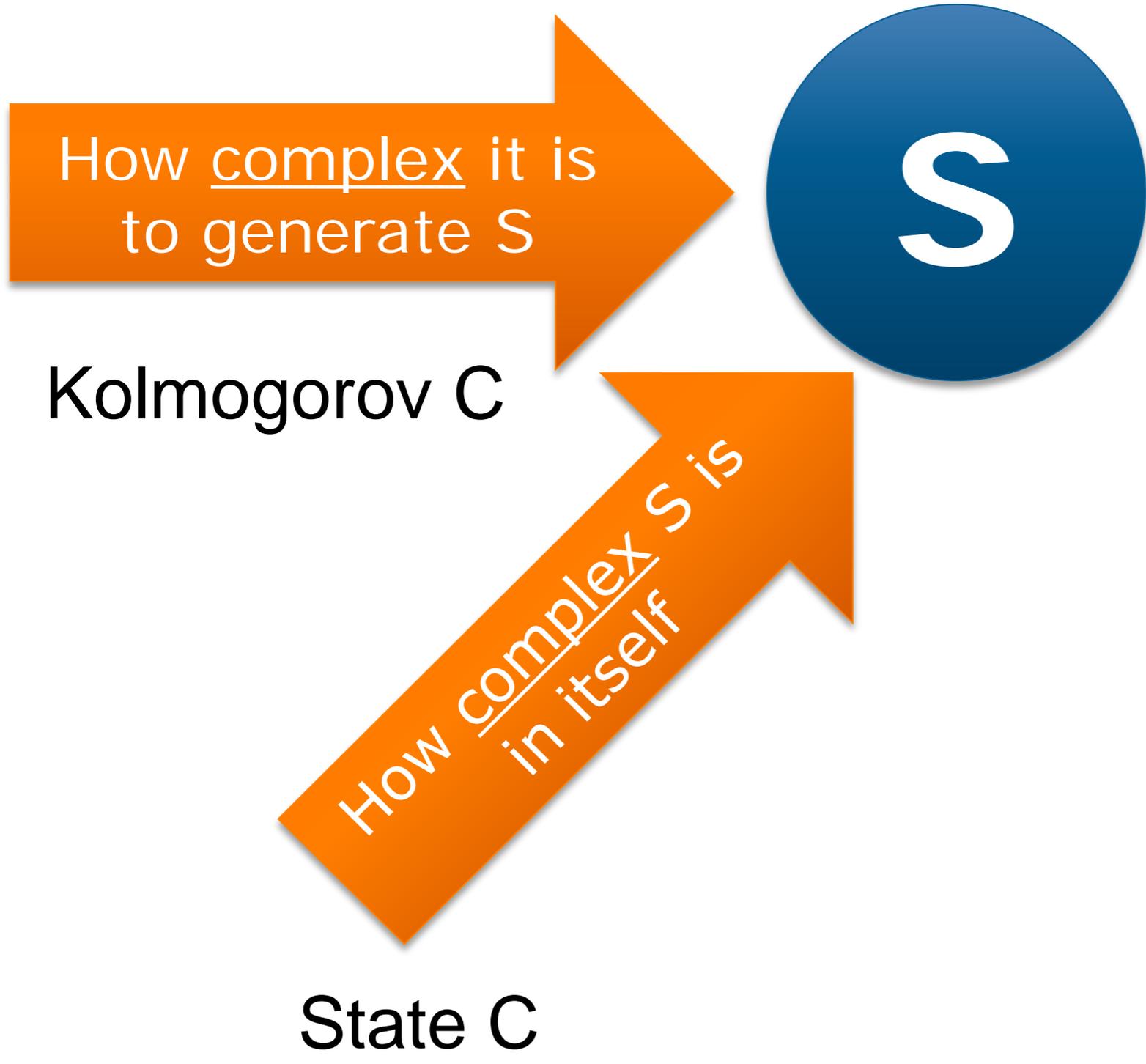
A UNIFIED VIEW

How complex it is
to generate S

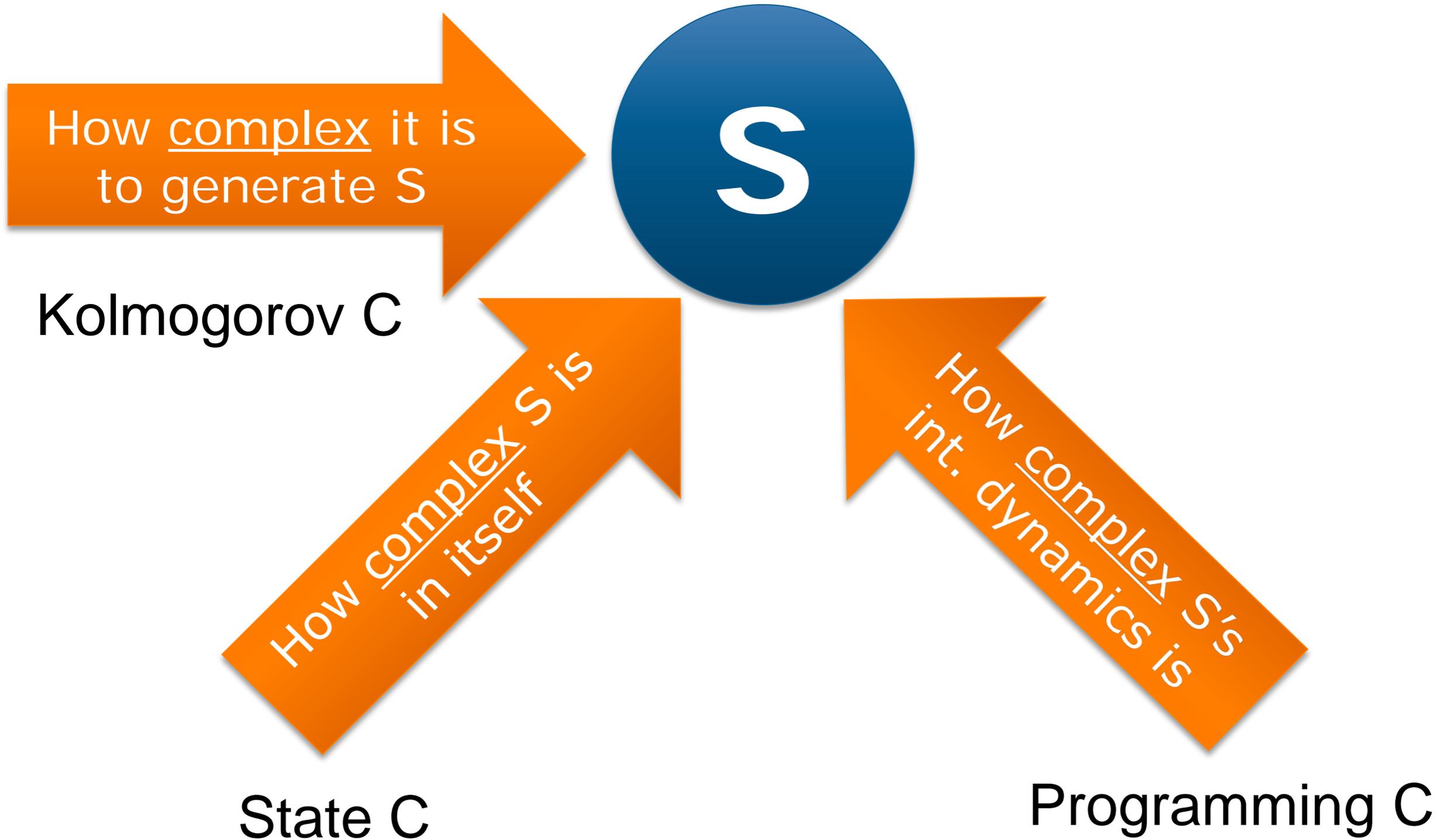


Kolmogorov C

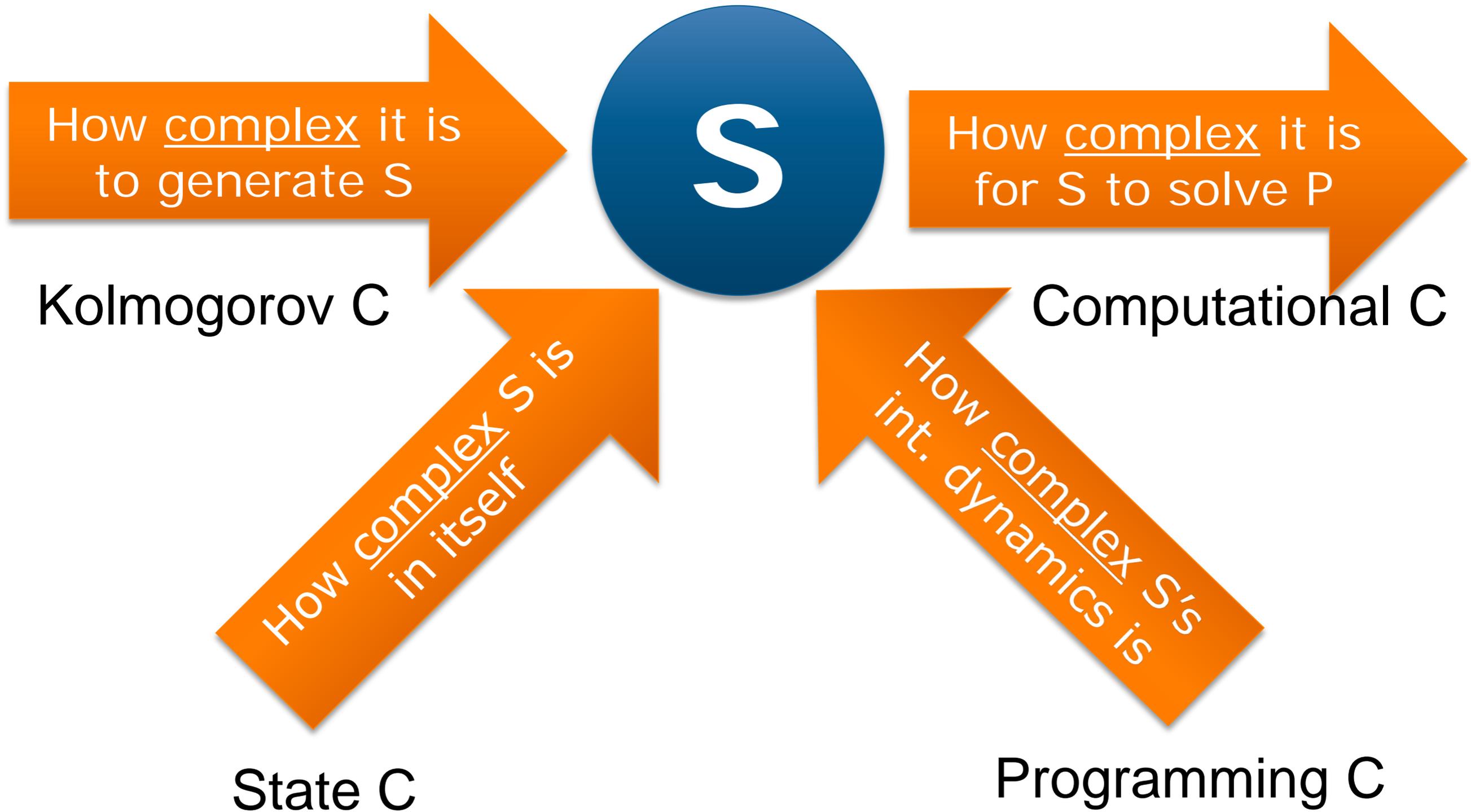
A UNIFIED VIEW



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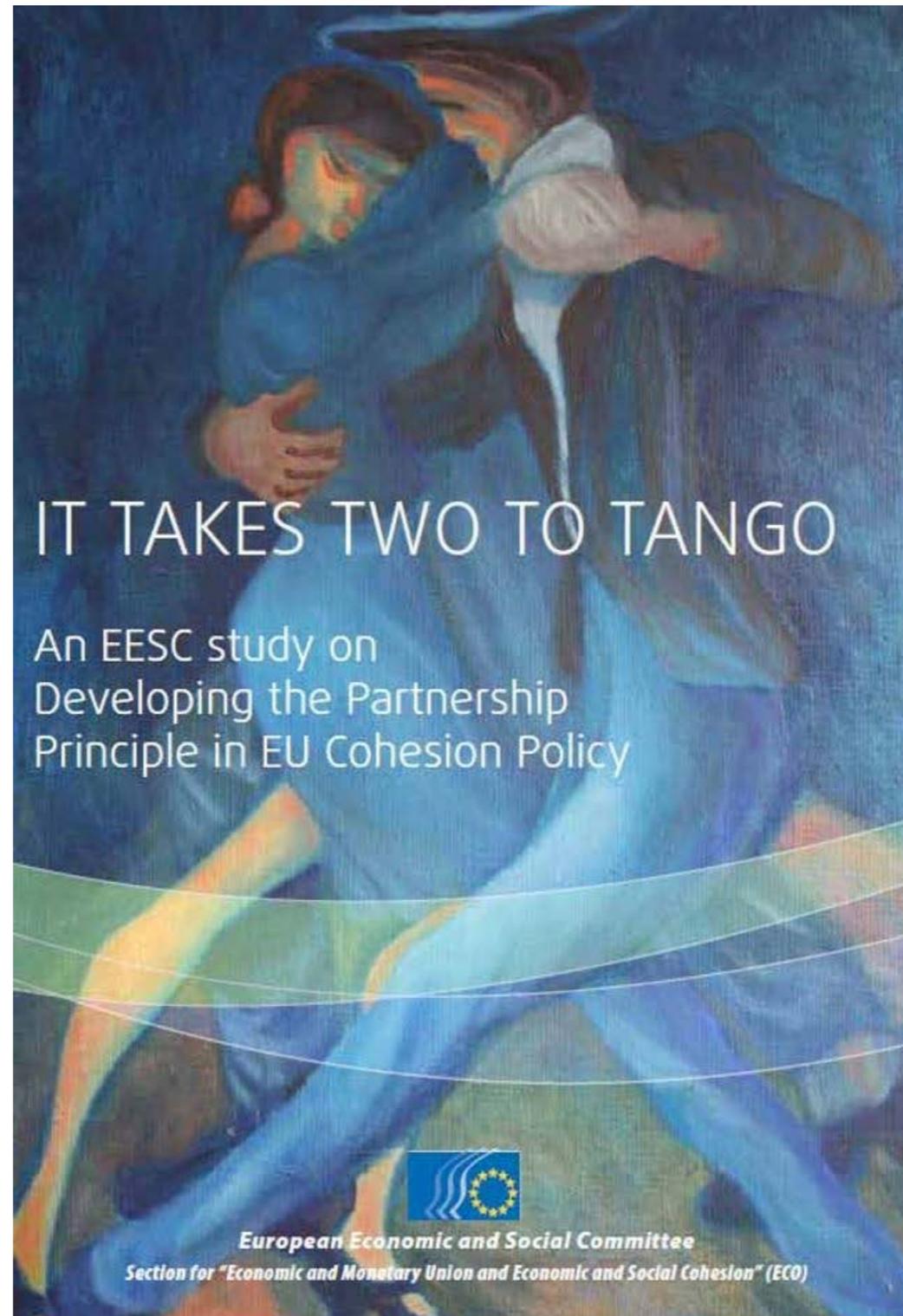
Coordination Complexity (CC)

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How many Ss does it take to solve a problem?



Coordination Complexity (CC)



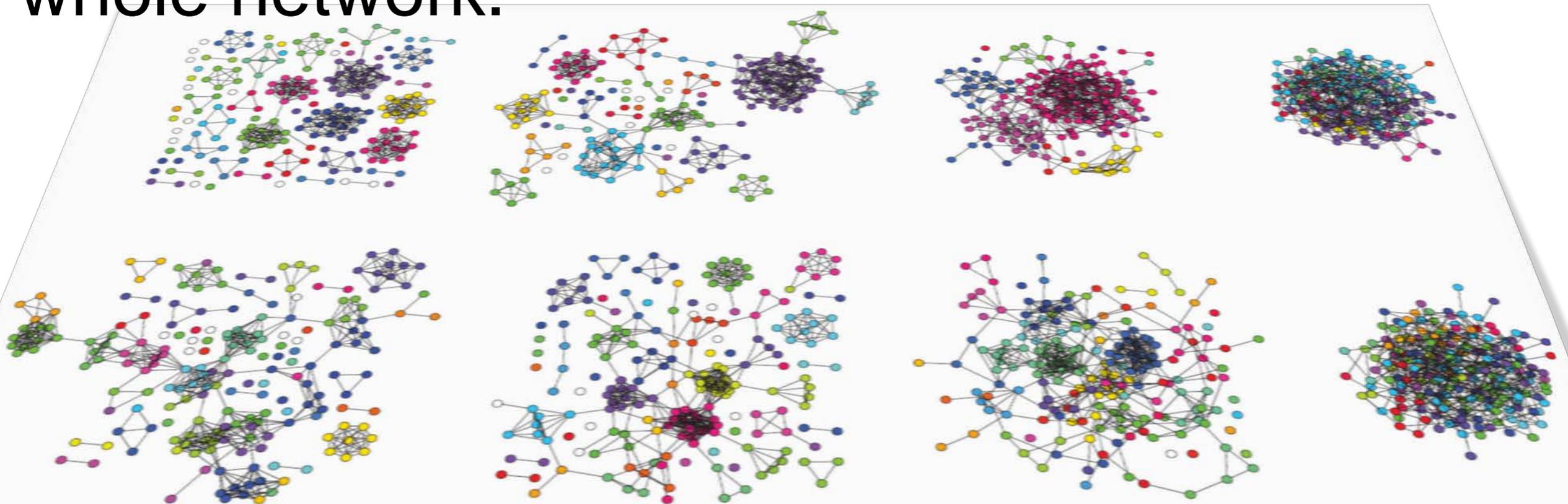
Coordination Complexity (CC)

IMPORTANT

Stay always close to the diver master you will enjoy it more. It takes two to SCUBA safely. Please preserve nature. Never forget: Don't hold your breath. While ascending, keep breathing.

Coordination Complexity (CC) = number and kinds of interactions, degrees of mutual influence and dependency, and scope of their consequences within a network of systems.

New challenge: problems have maximum degree of coordination-complexity iff unsolvable without the mobilization of the whole network.



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We make sense of reality as being made of things and properties but this is a construction.

By taking things as the ultimate furniture of the universe we commit the fallacy of misplaced concreteness.

Alfred North Whitehead



The very notion of an object at all, concrete or abstract, is a human contribution....

Science ventures its tentative answers in man-made concepts, perforce, couched in man-made language, but we can ask no better.



**Quine, W. V. (1992), *Structure and Nature*.
Journal of Philosophy, 89 (1), 5–9.**

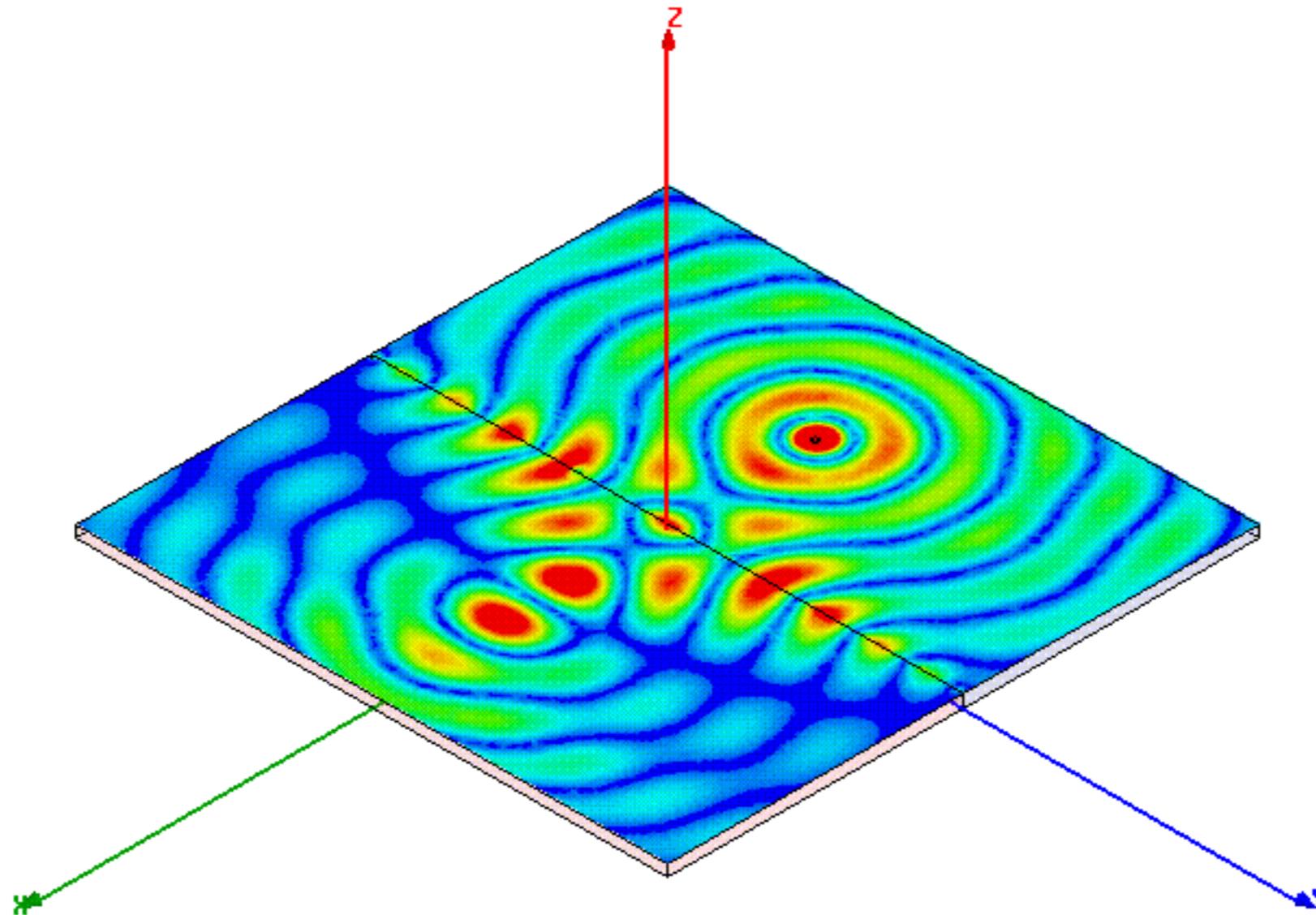
The very notion of object, or of one and many, is indeed as parochially human as the parts of speech; to ask what reality is really like, however, apart from human categories, is self-stultifying. It is like asking how long the Nile really is, apart from parochial matters of miles or meters.



Quine, W. V. (1992), *Structure and Nature*.
Journal of Philosophy, 89 (1), 5–9.

From things to interactions

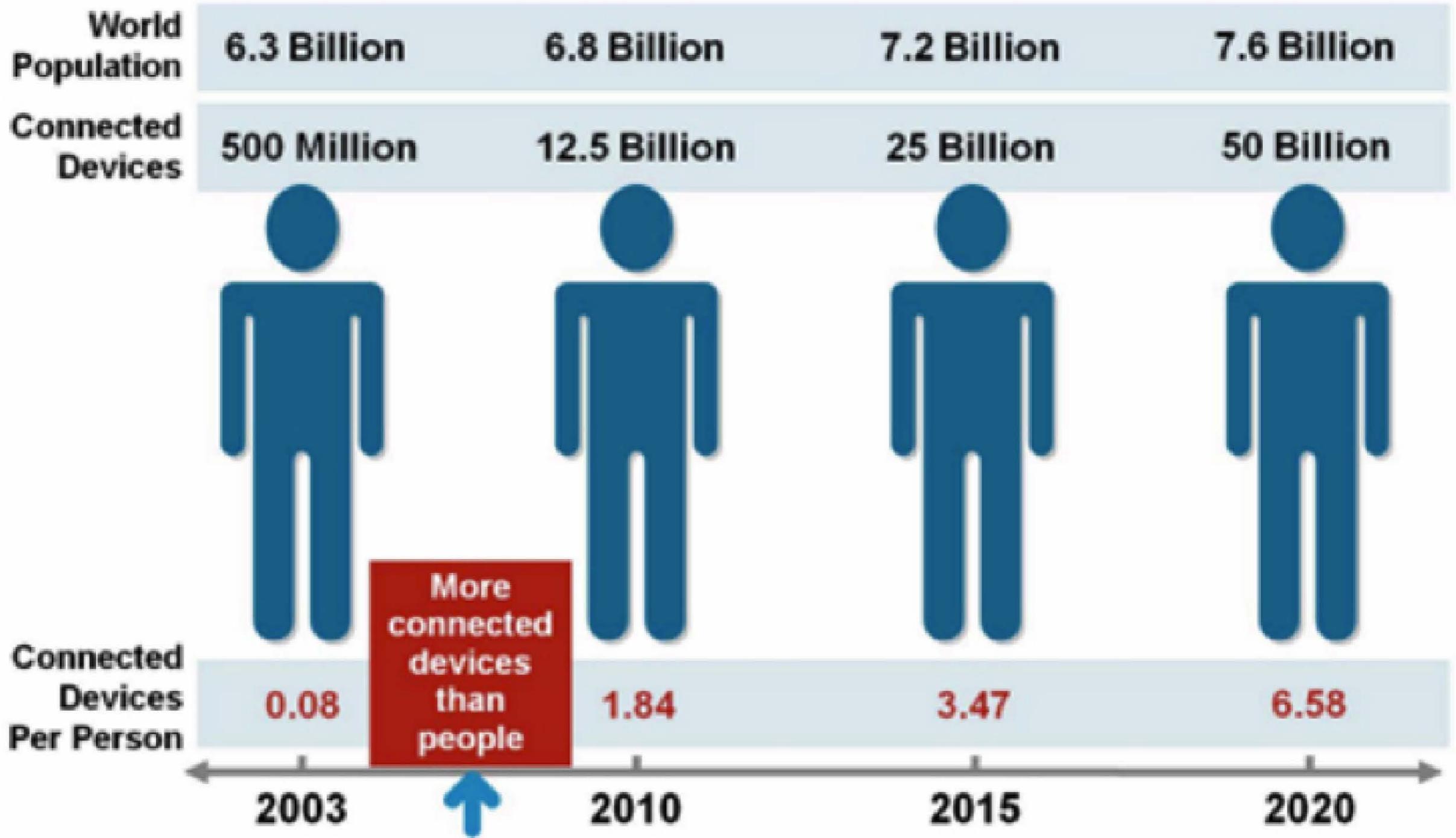
To be is to (be) interac(table).

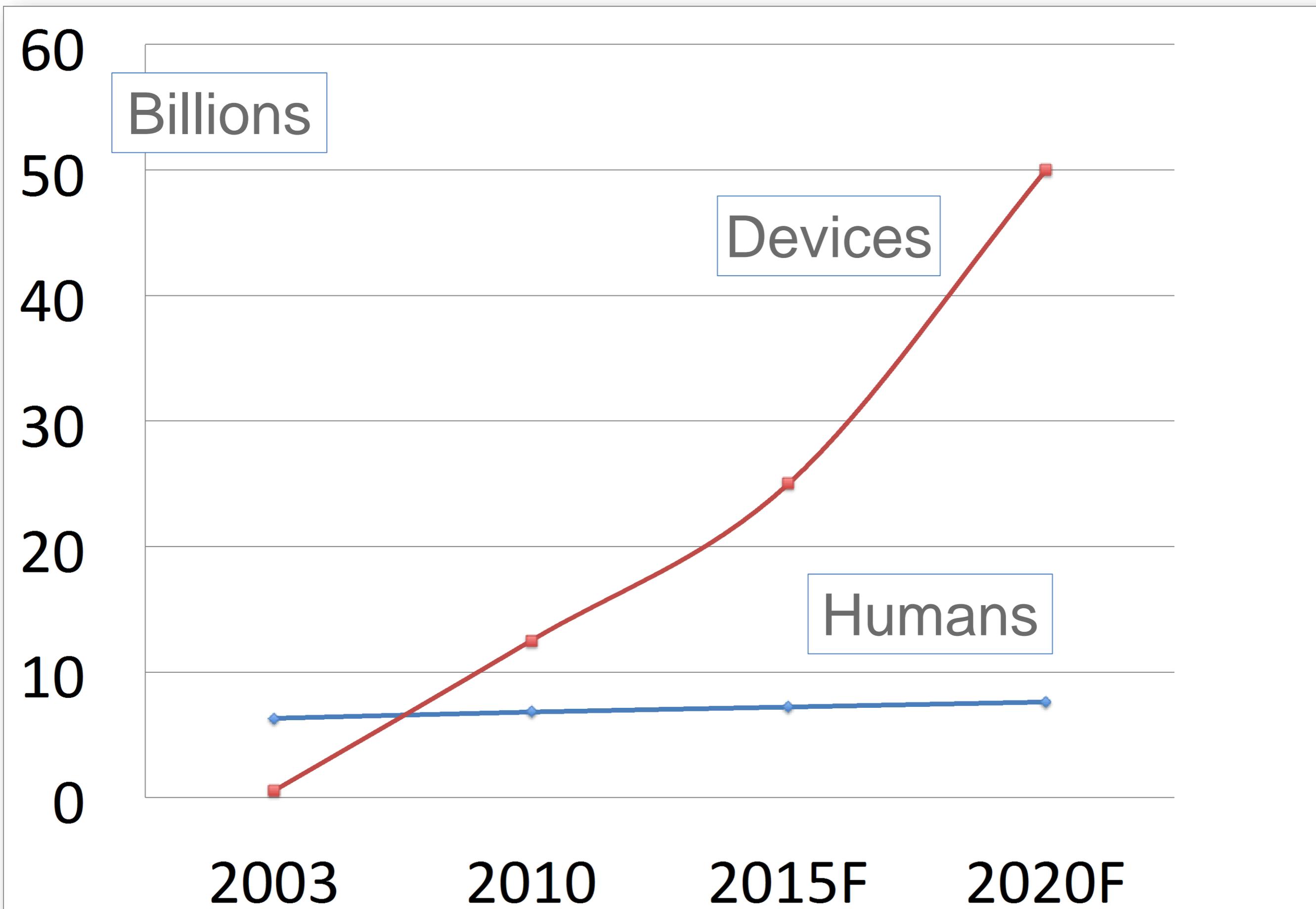


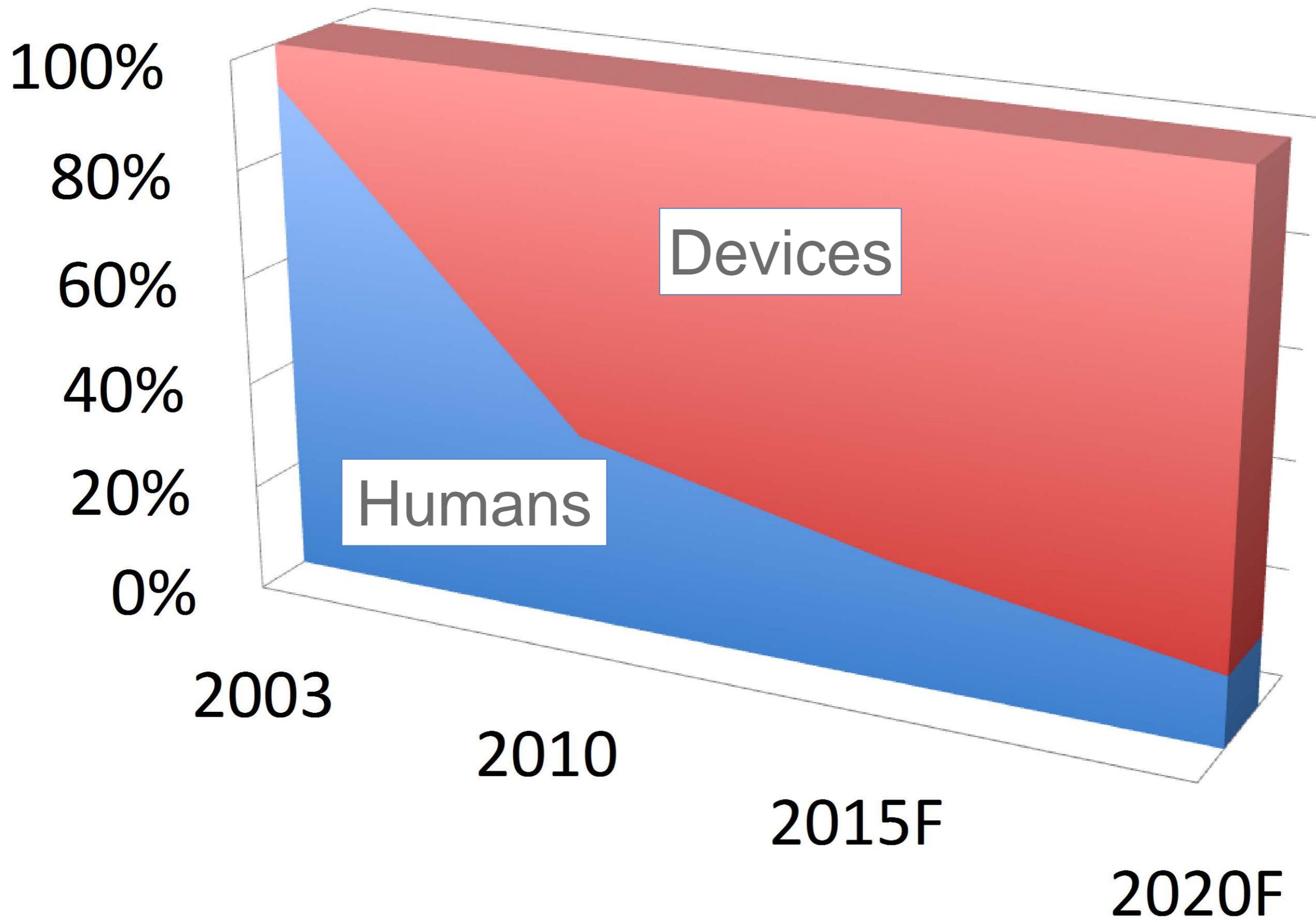
Things as roundabouts of relations and processes.

There are only –ings.









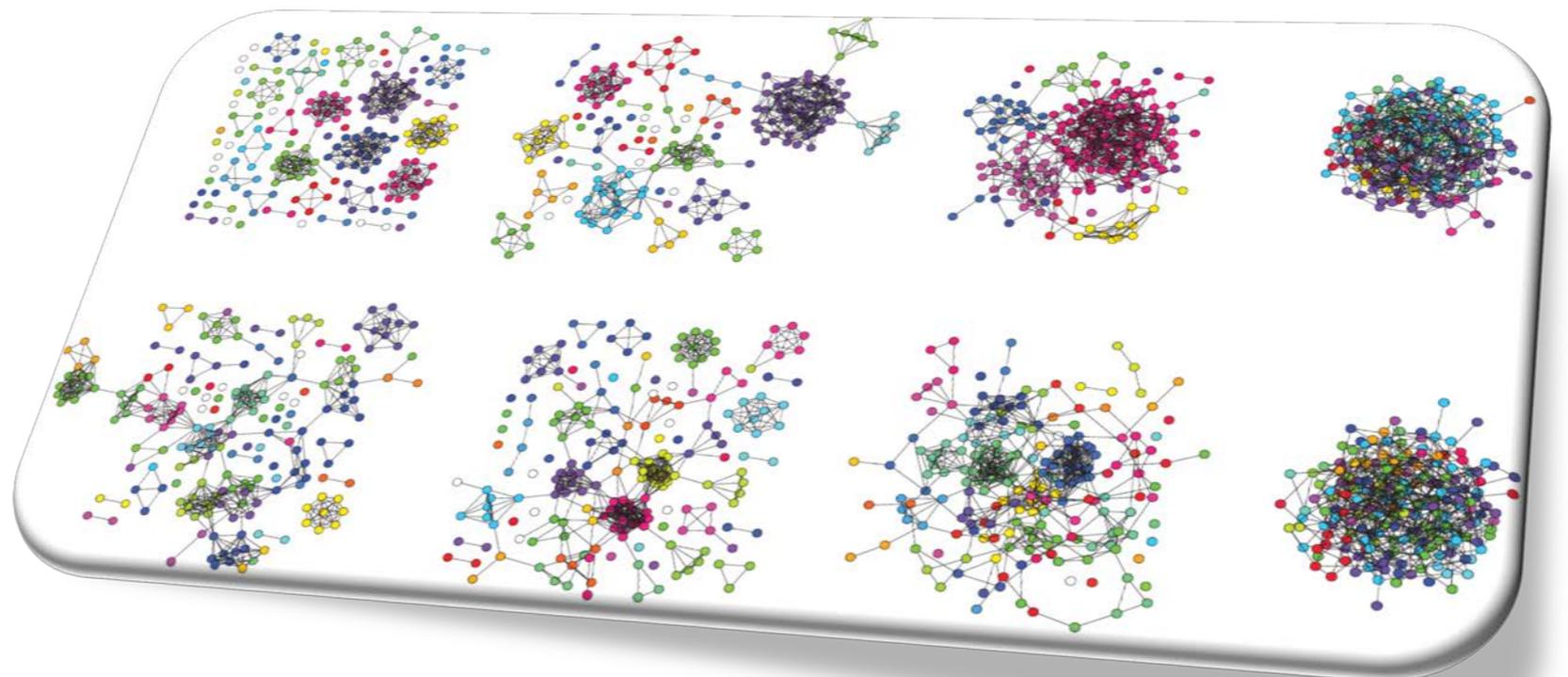
Coordination Complexity (CC)

Necessary condition: communication.

Plausible requirement: the harder the problem the more agents may be required to solve it.

Agents: biological and artificial.

Hypothesis: problems with high CC require human-machine communication and coordination.



Coordination Complexity (CC)

“The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries.”

What for?

To tackle problems with high CC.



- a) Global problems have high CC.
- b) Problems with high CC require the coordination of all agents involved.
- c) Coordination of all agents involved in solving high CC problems requires communication among these agents.
- d) The agents needed are both biological and non-biological.
- e) And the communication/coordination concerns the actions (the “ings” not the things).
- f) So global problems require a semantic web that can coordinate all the required “ings” to deal with their high CC.

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What if we succeed in coordinating “ings”?

A consequence of the potential success of the Semantic Web in tackling problems with high CC.

Human exceptionalism:

a) Intelligent

b) Free

c) Conscious

a) Smart

b) Autonomous

c) Self-monitoring



The freedom of the will consists in the fact that when the intellect presents us with a candidate for acceptance or denial, or for pursuit or avoidance, we have no sense that we are pushed one way or the other by any external force. I can be free without being inclined both ways.



Indeed, the more strongly I incline in one direction the more free my choice is – if my inclination comes from natural knowledge (that is, from my seeing clearly that reasons of truth and goodness point that way) or from divine grace (that is, from some mental disposition that God has given me).

Since 2008 predictive policing: predictive and analytical techniques in law enforcement to identify potential offenders.

Technology based on earthquake prediction.

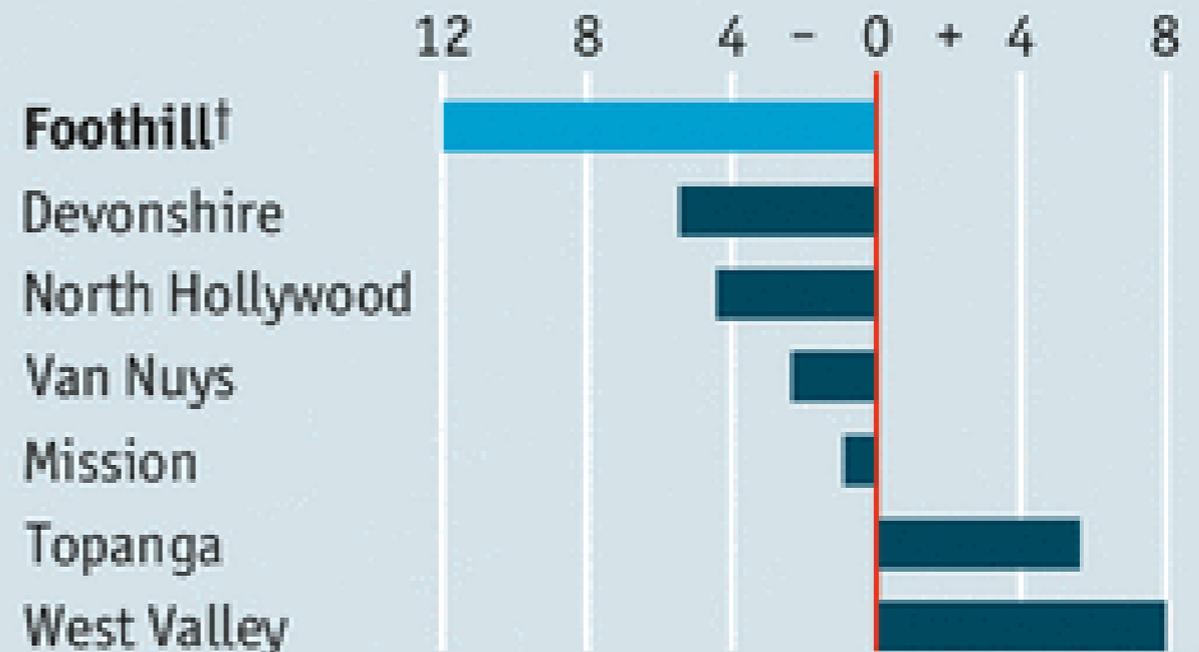
Effectiveness tested by Los Angeles Police Department.

Accuracy twice that of its current practices.



LA takedown

Crime* in selected LAPD divisions
% change 2010-11 to 2011-12



Source: Los Angeles Police Department

* Burglaries, vehicle theft and theft from vehicles
† Predictive policing used

DEPARTMENT OF CRIMINOLOGY

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Philadelphia Courts Begin Using Computer Forecasts to Predict Future Criminal Behavior

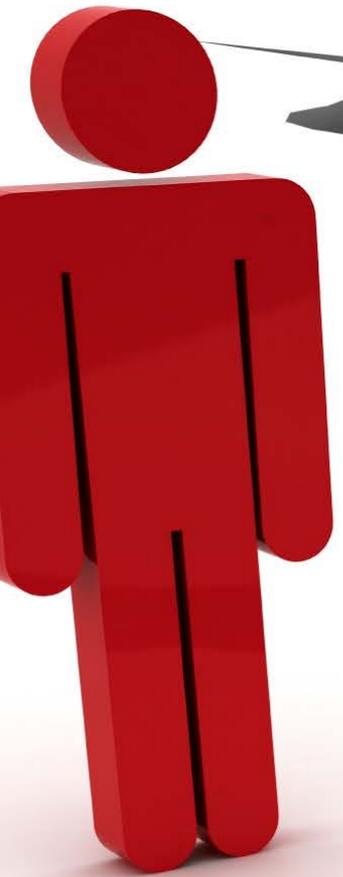
February 7, 2013

Computer forecasts created by Professor Richard Berk are now being used in Philadelphia Courts.

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Neo-dualism undermined



Data
Patterns
Syntax
Quantitative

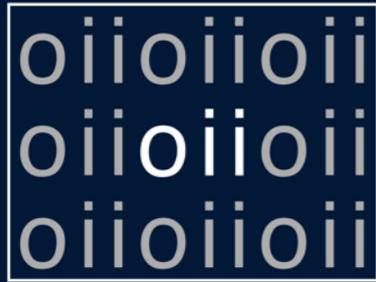
...



Information
Meanings
Semantics
Qualitative

...

We need a serious upgrade of our philosophical views about ourselves and of the human project.



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