What is this thing called complexity, and why does it matter?

Workshop session at AgileTour Sydney, November 2015

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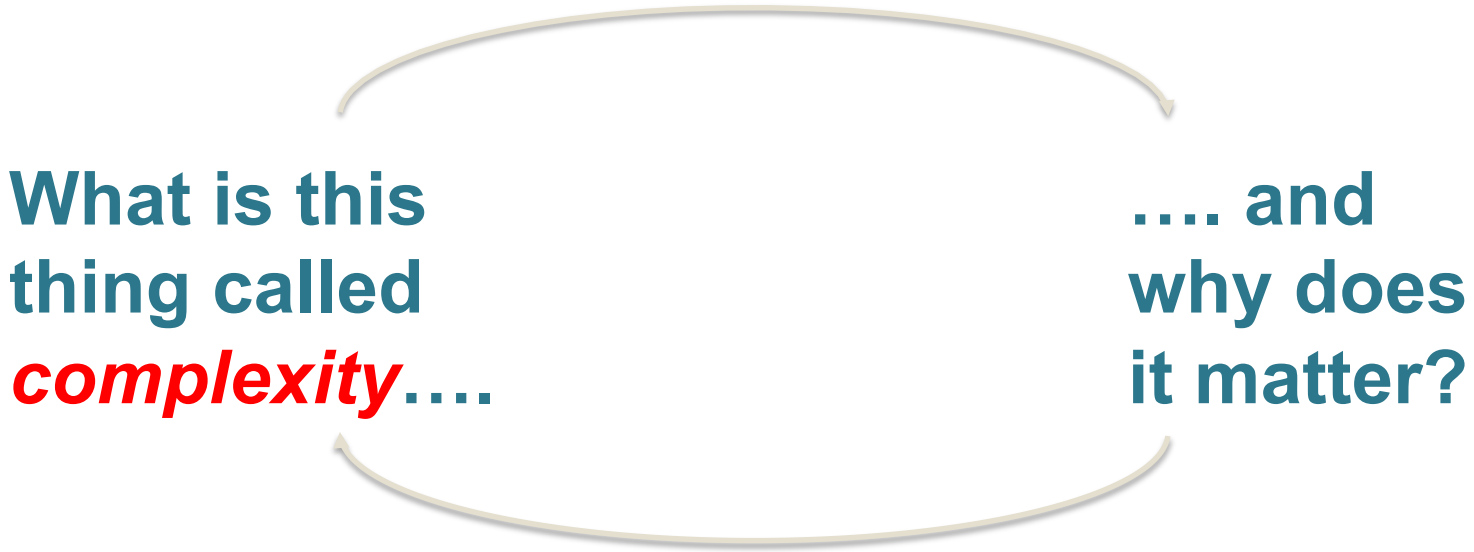
What is this thing called *complexity*….
…. and why does it matter?

What is this thing called *complexity*….

…. and why does it matter?

These two halves of the question are deeply intertwined – in answering either one, we have to answer the other….

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Complexity

From Wikipedia, the free encyclopedia

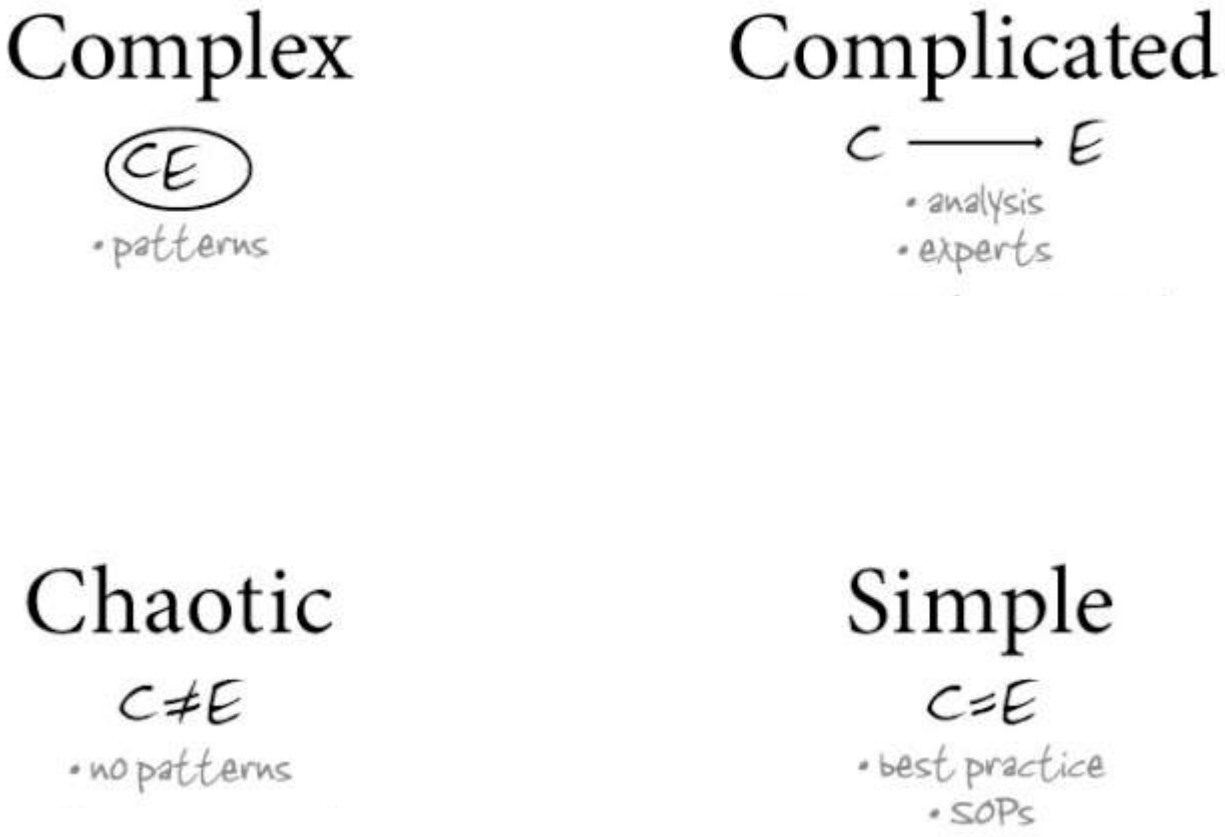
“There is no absolute definition of what complexity means; the only consensus among researchers is that there is no agreement about the specific definition of complexity.”

This article may need to be **rewritten entirely** to comply with Wikipedia's quality standards. You can help. The discussion page may contain suggestions. *(June 2013)*

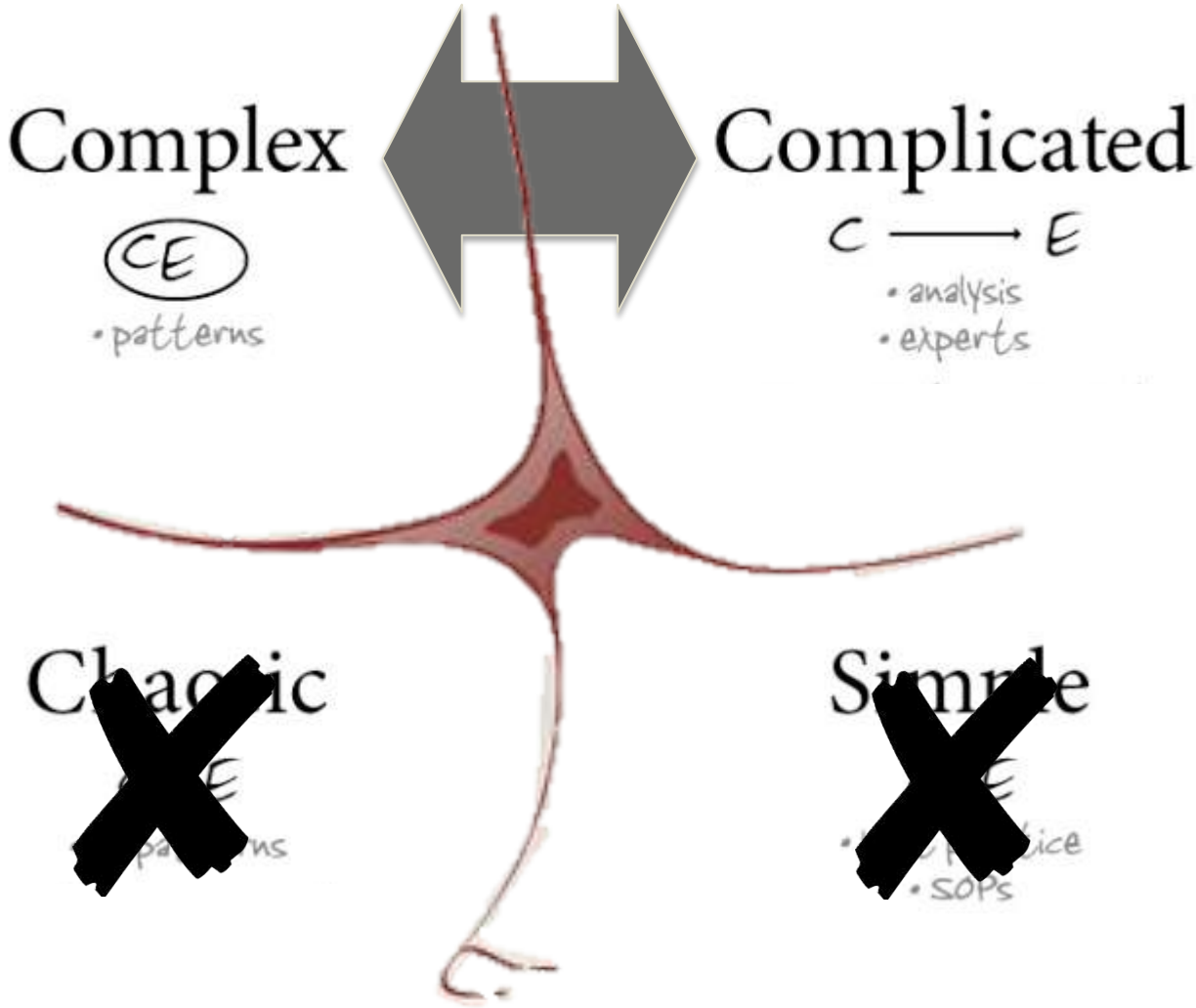
Complexity is understood in many ways

For *todays* purposes, it is most usefully and useably understood by **contrast** to other ways “things” relate and are organised in the world.

Different classes of systems need different kinds of methods to be effective – the Cynefin typology



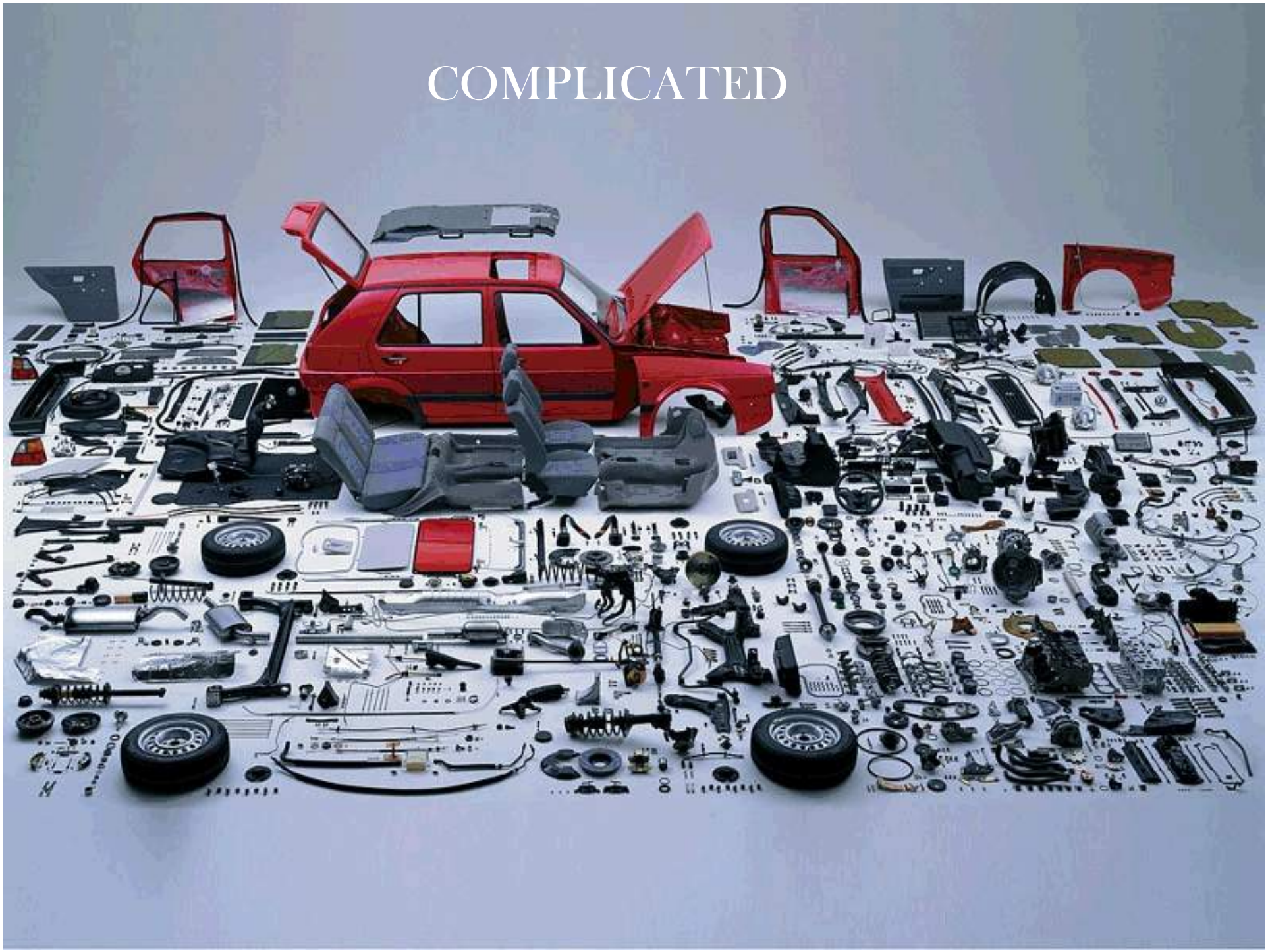
We are focussing on the difference between “complex” and “complicated”



Complex vs Complicated

COMPLEX	COMPLICATED
There is no “it”!	Decompose it
You don’t even know what it “it” is, and when you do, it’s changed…	Deconstruct it Disassemble it
Nothing will hold still long enough to be analysed, and the entities at stake (eg emotions) might not even yield to analysis	Analytic techniques work fine, even if they need great computational power

COMPLICATED



Car

+

Driver
states:

- Learner
- P-plater
- Exiting funeral
- Sunday hat
- Drunk
- Prescription drugged

→ Driverless Car

→ Increased complicatedness

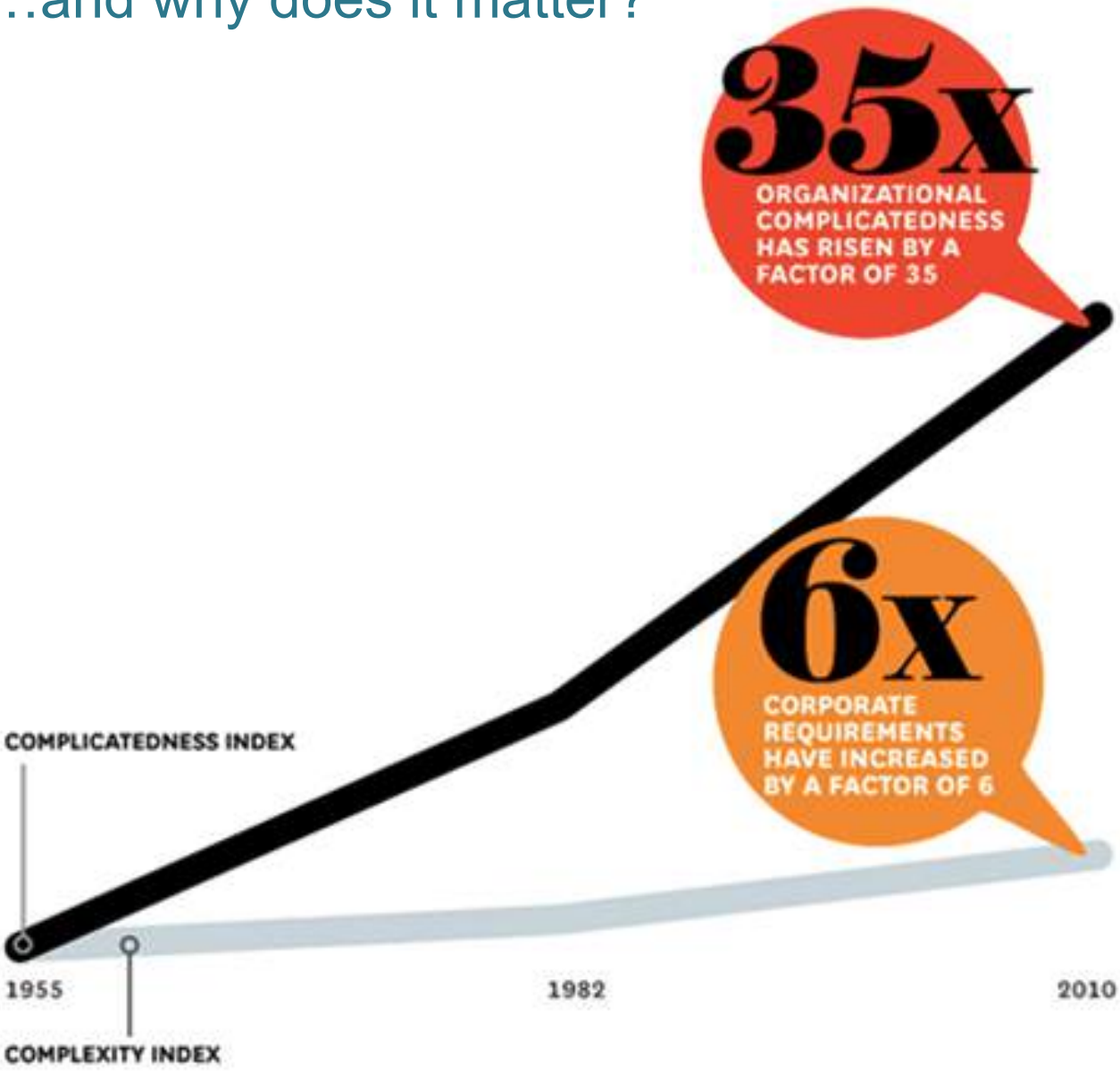
→ Decreased complexity

…and why does it matter?

What we got trained to be good at:	But now we face complex real-world problems, which are/have:	What we now find out we need to be good at:
Reductionist thinking	Connected to other problems	Systems thinking
Context free problems	Constrained by ideological, cultural, political, economic factors	Context dependent problems
Value free puzzles	Multiple value conflicts	Contested values
Controlled change	Resistant to change	Uncontrolled change
Moving from unknowns to knowns	Data uncertain or missing, considerable uncertainty and ambiguity	Unknowns that must be accepted or exploited et cetera
Creating clear, perfect solutions	Contradictory solutions, numerous possible intervention points, consequences difficult to imagine	Limited to “best possible” or “least worst” solutions

After Gabrielle Bammer, ANU

…and why does it matter?



…the number of procedures, decision approvals, interfaces, coordination bodies, vertical layers

…the number of requirements a company has to satisfy

Source: BCG Analysis

"Complexity":

The property of certain "systems" that we observe that have many connected parts which can be expressed in a huge diversity of states or modes of behaviour.

Most human systems are complex.

Think of a teacher and a classroom:

- Diversity of states - e.g. the patterns we see in Years 1, 2, 3……12
- Diversity of behaviours – e.g. just before or just after holidays; early vs late in the year….

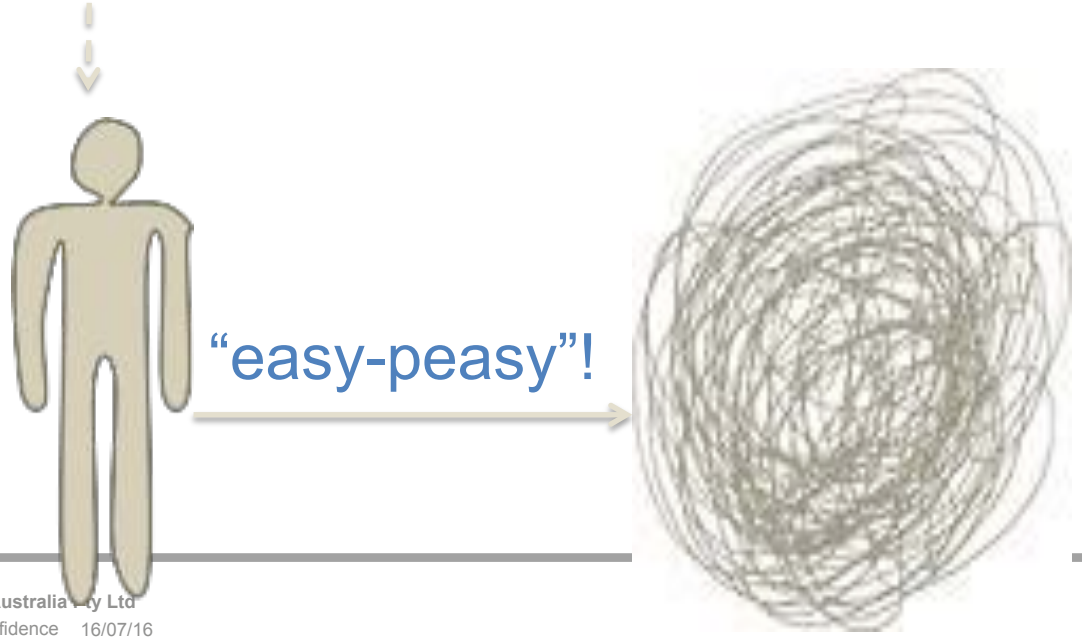
Two strategies:

amplify

attenuate

Choice 1:

"Amplify" your own variety



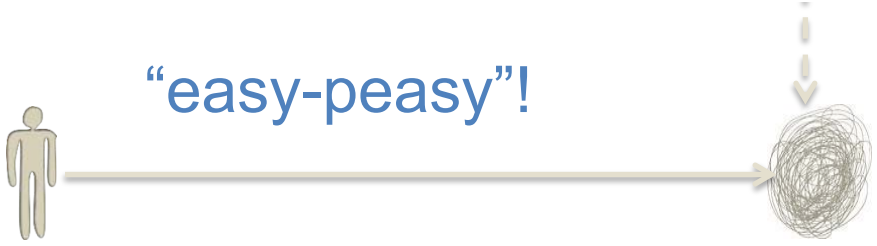
Choice 1:

"Amplify" your own variety

Enhance your repertoire of behaviours in response. But beware – you are adding complexity to someone else's system!

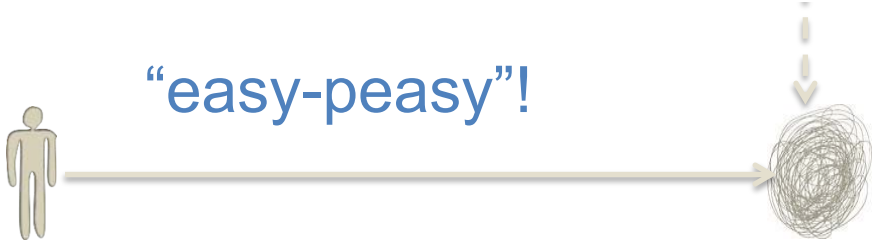
Choice 2:

“Attenuate” the external, environmental variety



Choice 2:

"Attenuate" the external, environmental variety



Simplest mechanism – clarify your purpose!

Purpose is powerful because it attenuates the variety of *states* before it attenuates the variety of *elements* – i.e. it drives things toward complicated….

Still stuck on the distinction?

If you can't get it clear in your mind, then

a) That's because it **isn't** clear – there is no knife you can use that will cut neatly between the two.

b) You are facing one of the reasons this matters – which is that we have to break old thinking moulds to perform in these spaces.

“The Sydney Harbour Bridge was complicated, not complex”

Agree or disagree?

“The Sydney Harbour Bridge was complicated, not complex”

Agree or disagree?

Depends on how you answer the question:
“What is the Sydney Harbour Bridge?”

Complicated	Complex
World’s largest steel arch bridge - riveted steel and sandstone structure with a 1,149m span	A bridge that spanned between Milson’s Point and Miller’s Point Sydney, socially uniting North and South of the harbour; creating real-estate and business model fortunes, and destroying others; creating electoral winners and losers; including e.g. military and resource futures e.g. links to Newcastle’s shale oil for warships…

A Management (human) definition of complexity

"Complexity is the number of variables operating in a situation, the ambiguity of these variables, the rate at which they are changing and the extent to which they are interwoven so that they have to be unravelled in order to be seen."

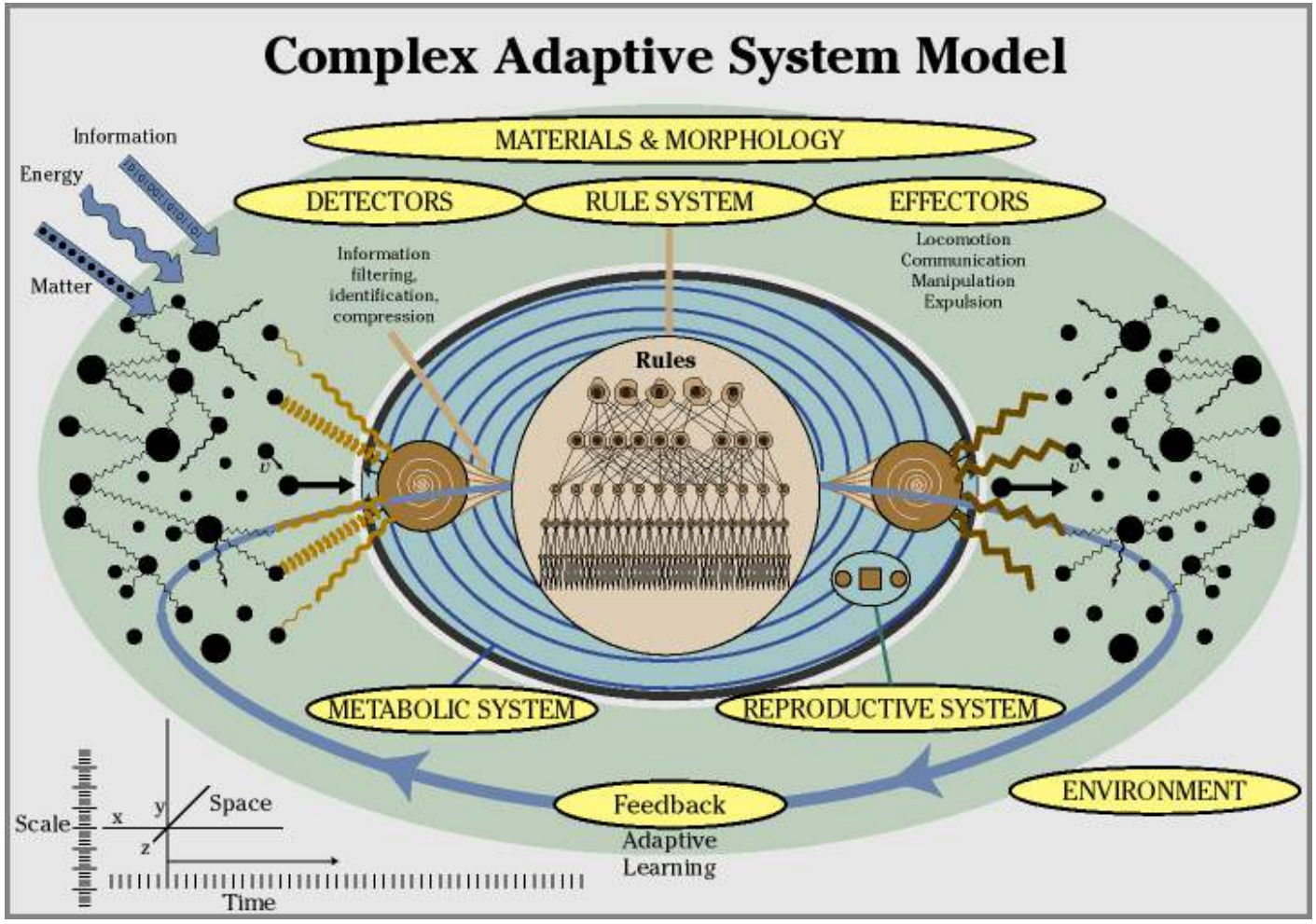
Jaques and Clement, "*Executive Leadership: A Practical Guide to Managing Complexity*", Blackwell Publishing, 1991, 1994

A sociologists definition of complexity

"Complex space is where the parts of the system are so interdependent that the relationship between them will at best be partially known (or not known at all), where the characteristics or attributes that arise from the interaction are not predictable or 'controllable' (emergence).

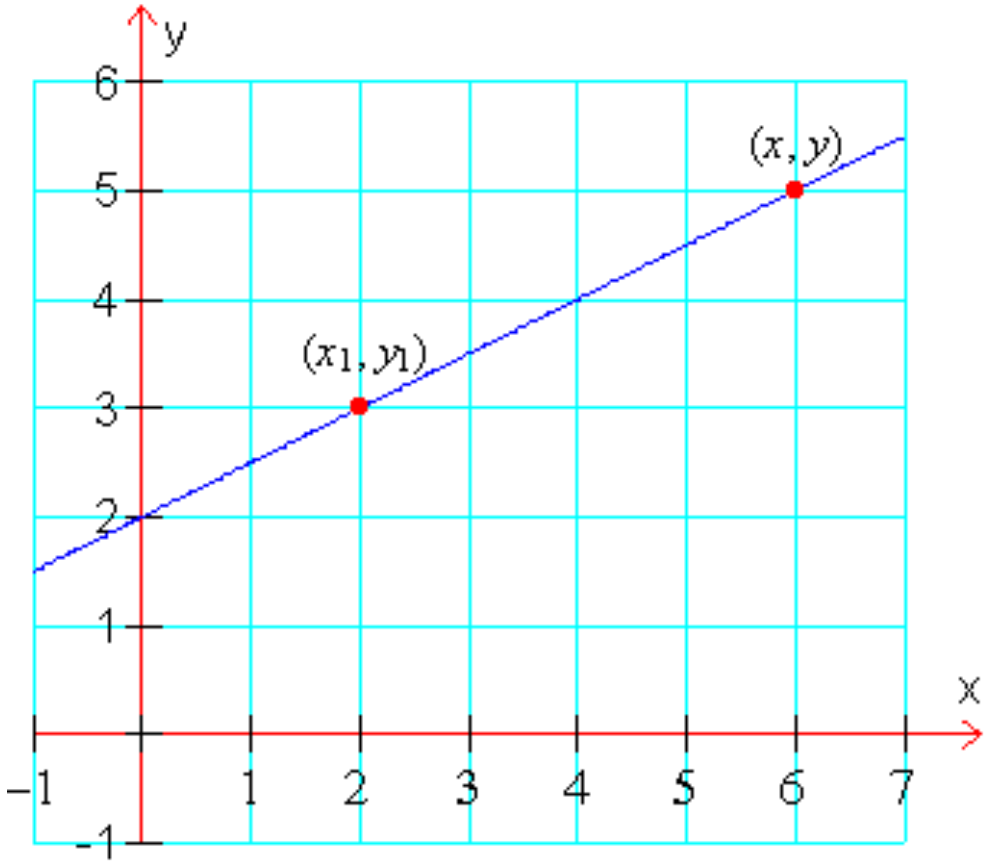
There are multiple options and possibilities, and CONTEXT will determine what options emerge in a particular situation."

A biologists definition of complexity

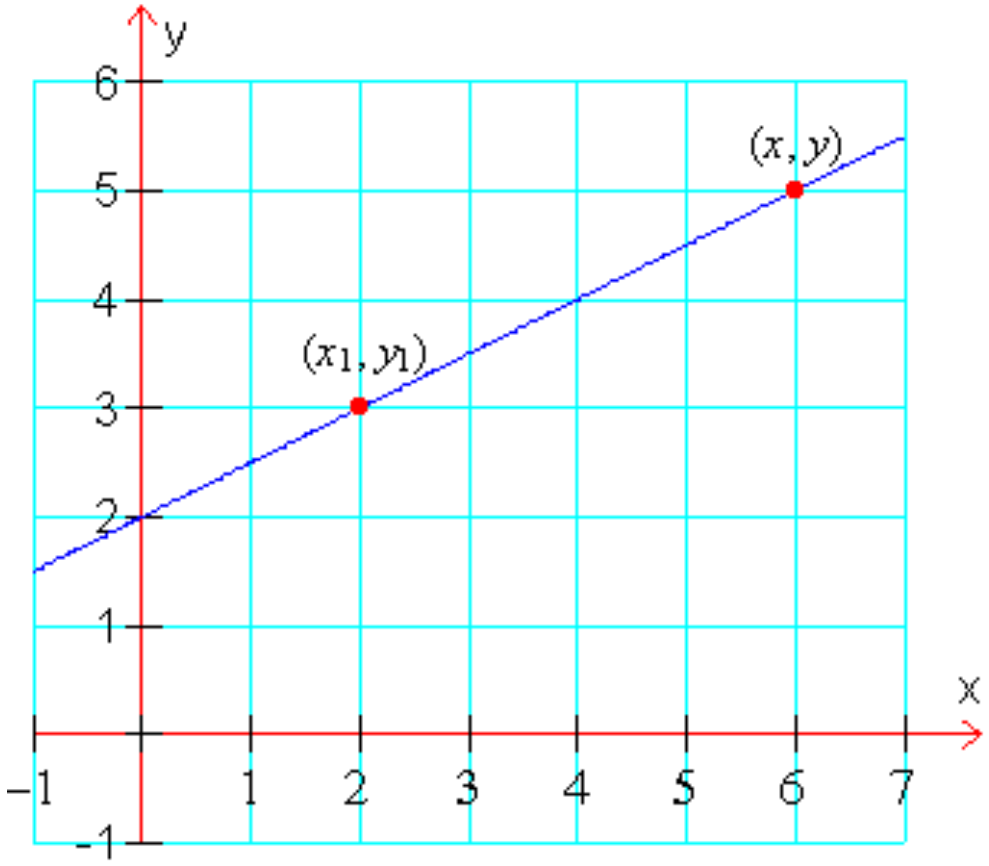


What is a “strange attractor”

The “pattern” behind a line…

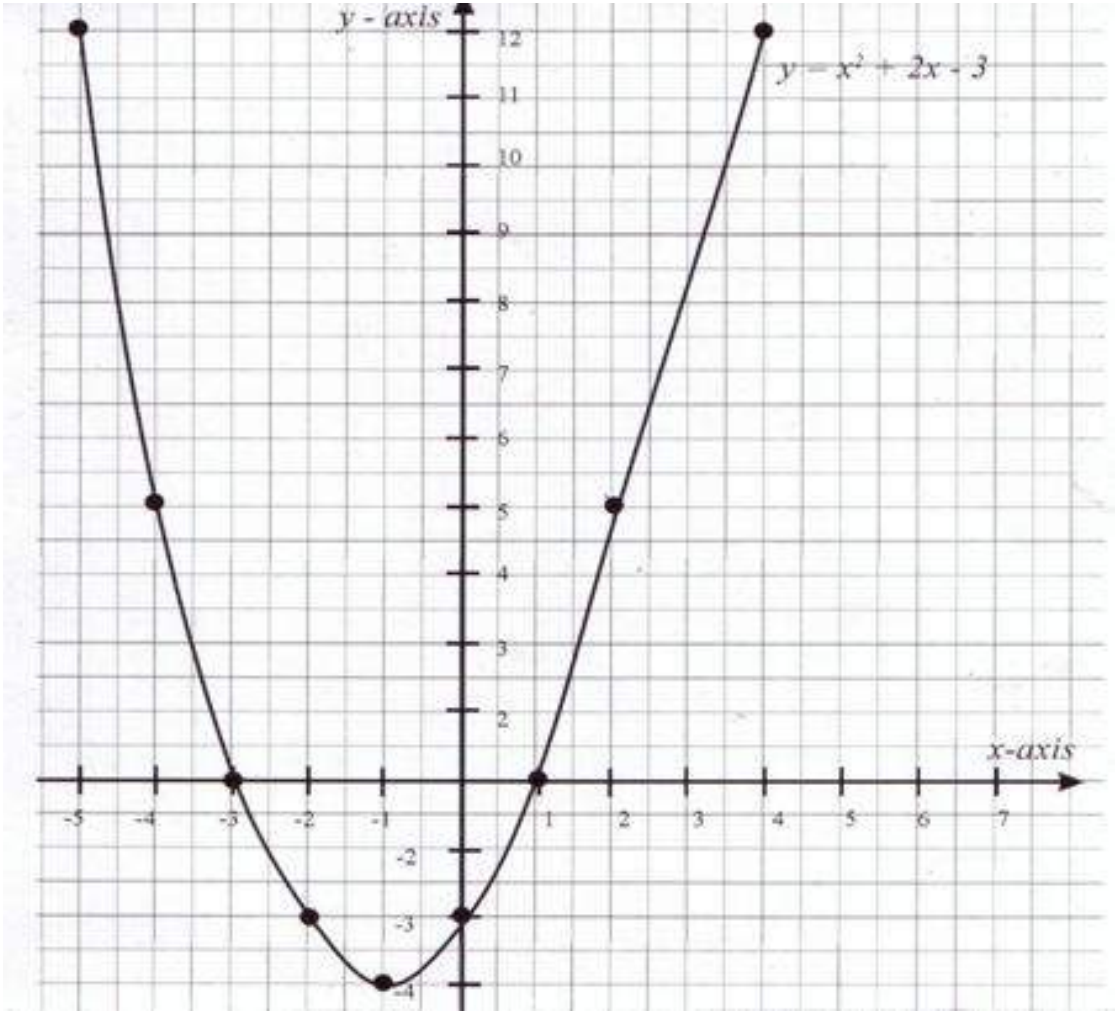


The “pattern” behind a line…



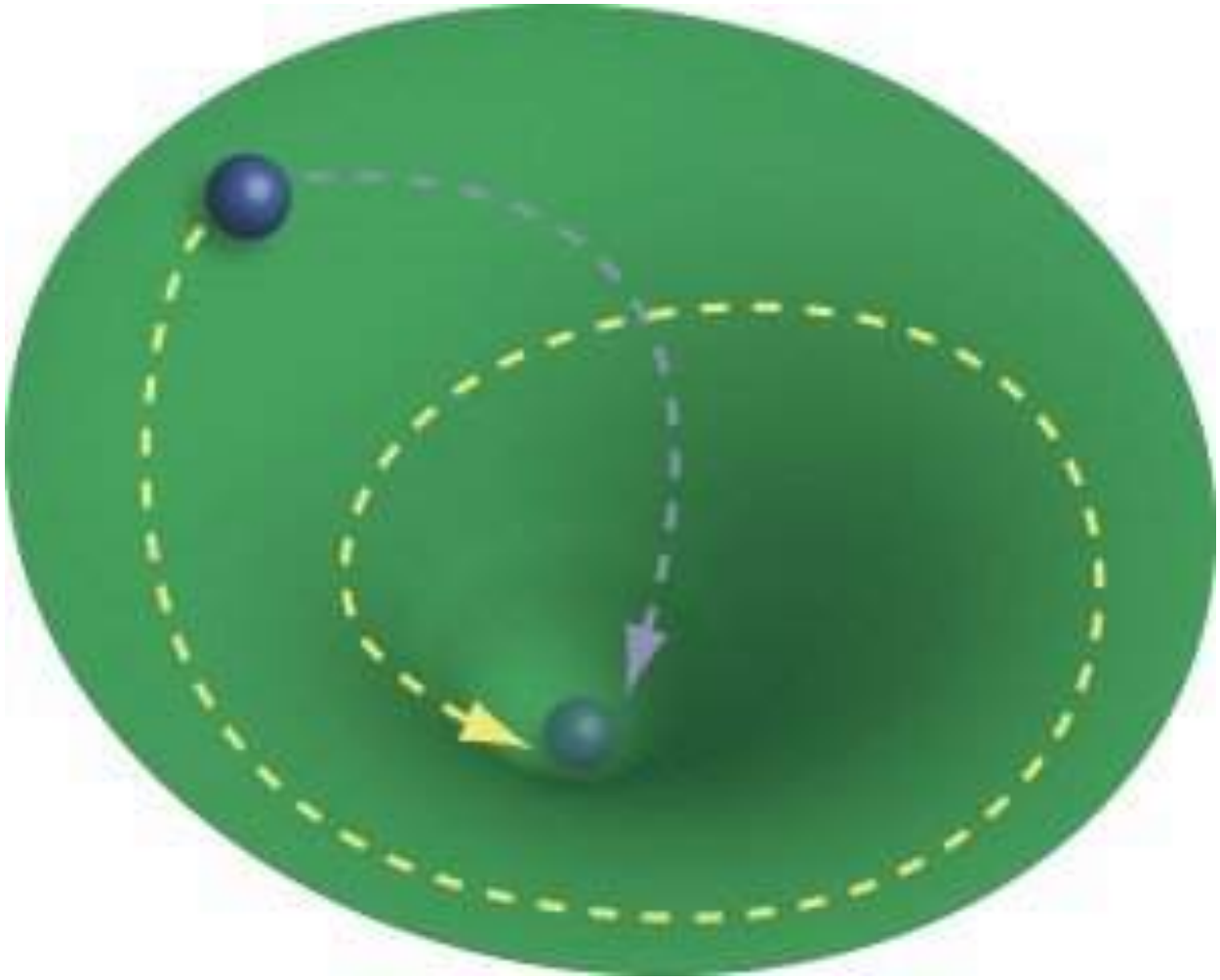
$y=mx + c$

The “pattern” behind a parabolic line…

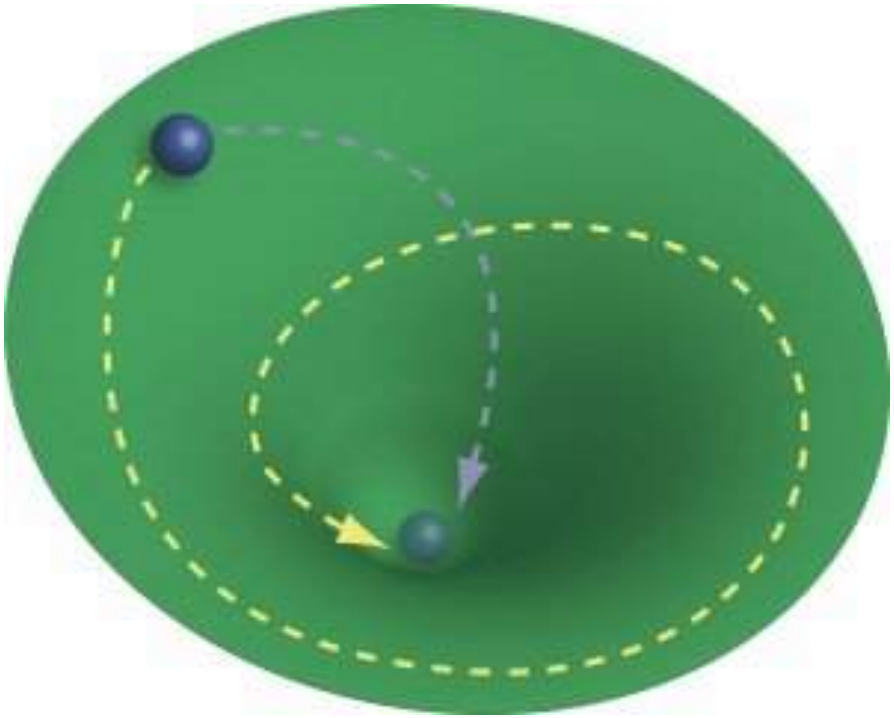


$$y = ax^2 + bx + c$$

A marble in a bowl....



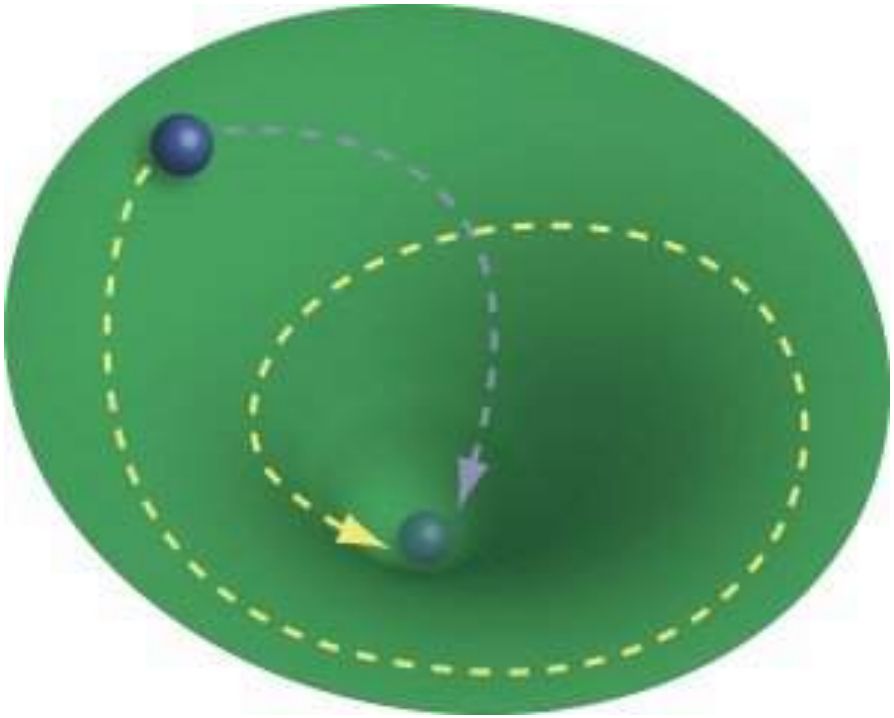
http://newswise.com/legacy/image.php?image=/images/uploads/2008/05/22/fullsize/Image_1-MarblesNT2.jpg&width=320&height=240



This is a “point attractor – no matter what the journey, the marble ends up in the bottom of the bowl.

Death is like that.

Death is a point attractor in the complex adaptive system we call life…



The pathway maps out all possible solutions that the system can take and thus reveals to us the invisible bowl that is controlling the way the marble rolls.

The system may be **sensitive to its initial conditions** - in other words the way the marble rolls to the bottom will take a very different path depending on whether we give it a little push, or change the angle that we drop it in from.

Nevertheless the system will reveal **the attractor and boundaries** within which it operates

Attractors

A system may be inclined to move toward a certain state and stay there, this state is called an attractor

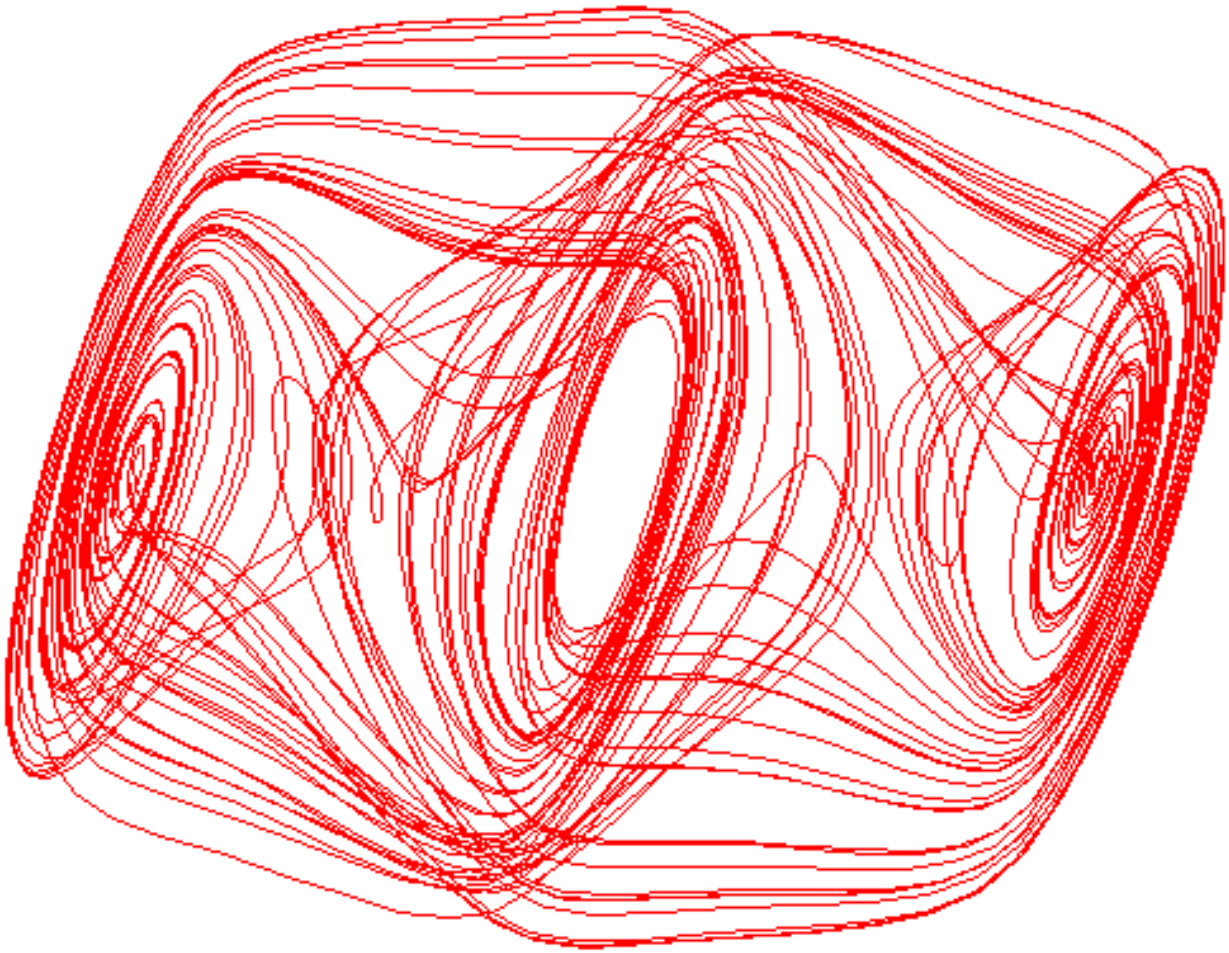
Different types exist:

- fixed point,
- periodic and
- strange attractors

“Strange attractors” appeared disorganised until plotted

Systems with attractors are more resistant to change.

Strange attractors can have multiple “sinks”



A 3-spiral strange attractor exhibited by the modified Chua's circuit
http://lmah.univ-lehavre.fr/~alaoui/sp_gallery_chua.html

What is a "complex adaptive system"

A complex *adaptive* system has three parts:

Third, the structure that emerges behaves like a higher-level system and has properties and characteristics that are distinct from those of the underlying agents themselves.

No additivity

Second, these agents interact with one another, and their interactions create structure — this is called emergence. The whole is greater than the sum of the parts.

First, there is a group of *heterogeneous* agents. These agents can be neurons in your brain, investors in a market, or people in a city. Heterogeneity means each agent has different and evolving decision rules that both reflect the environment and attempt to anticipate change in it.

Phase transitions and bifurcations

- complex systems can abruptly transition between different states
- transitions are often not analytically predictable beforehand
- a very small change might cause a system transition
- systems can generally transition between four states: stable, periodic, complex or random

Nonlinearity

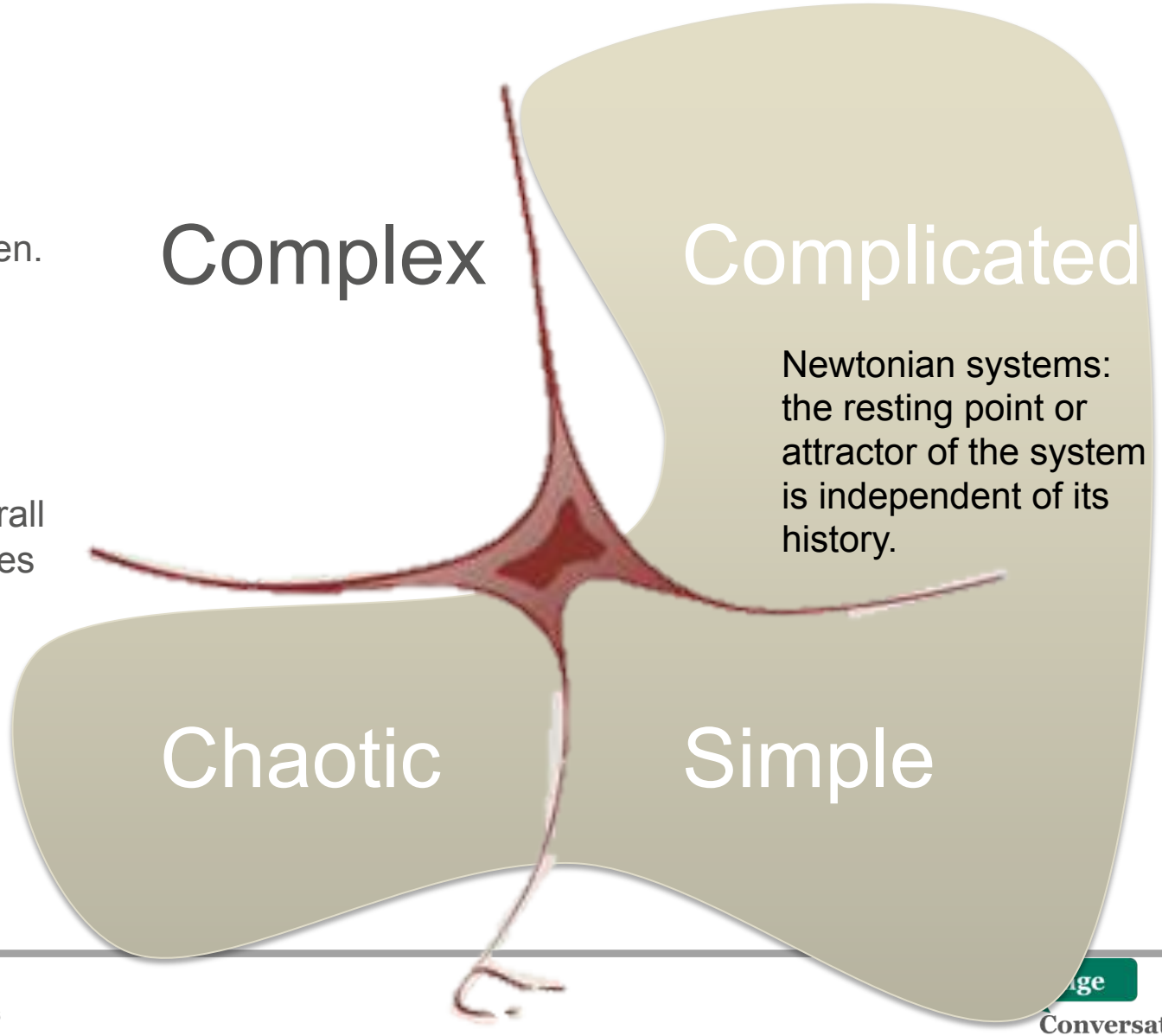
- implies that the whole is different to the sum of the parts
- fundamental to understanding complexity
- non-linear relationships can't be graphed in straight lines
- "the act of playing the game has a way of changing the rules" James Gleick

Self-organization and emergence

- an organised pattern can “emerge” in a complex system purely as a result of the interactions of the elements
- requires no central control or set of instructions
- “nobody controls everything, nobody understands everything and yet (the system) has coherent behaviour” Igor Nikolic
- order arises despite a interacting element having only limited knowledge of the system

Complex systems are “indeterminate”

Complex adaptive systems are *history dependent*: they are shaped by where they have been. Understanding the history is key to understanding the current position and future potential. The attractor has an overall shape and boundaries but you can’t predict where it will form.



Complex systems are “history dependent”

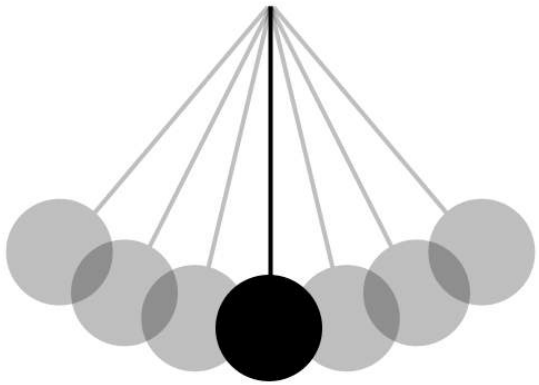
Complex

Complex adaptive systems are *history dependent*: they are shaped by where they have been.

Understanding the history is key to understanding the current position and future potential. The attractor has an overall shape and boundaries but you can’t predict where it will form.

Complicated

Newtonian systems: the resting point or attractor of the system is independent of its history.



Dynamical Systems

Linear Systems
The parts add up to the whole

Non-Linear Systems
Inputs are not proportional to outputs

A small intervention can have a big result, and vice versa – and neither might be expected

Systems with complex features

[other]

Chaos
Deterministic systems with one or a few definable variables whose dynamics can be traced and whose trajectories diverge exponentially over time

Confusingly, sometimes called "high dimensional chaos".

Complex Adaptive Systems
Many variables, with many degrees of freedom and with varying degrees of dependence/ independence

Iteration of a simple rule leads to a complicated outcome.

A system is *closed* (i.e. we don't consider the system/environment interactions. The notional boundary of the phase space is closed.)

Here it sounds like we are talking about disorder but we are not.

Emergent properties could not have been deduced from the subunits and their interactions.

in my use, the phase space is open – to the next recursion of system, which is *like* the one we are looking at.

Here we *are* talking about disorder – i.e. the utter unpredictability of the environment from the point of view of the system