



Complex systems

Key concepts



Self organisation

Adaptation

Networks

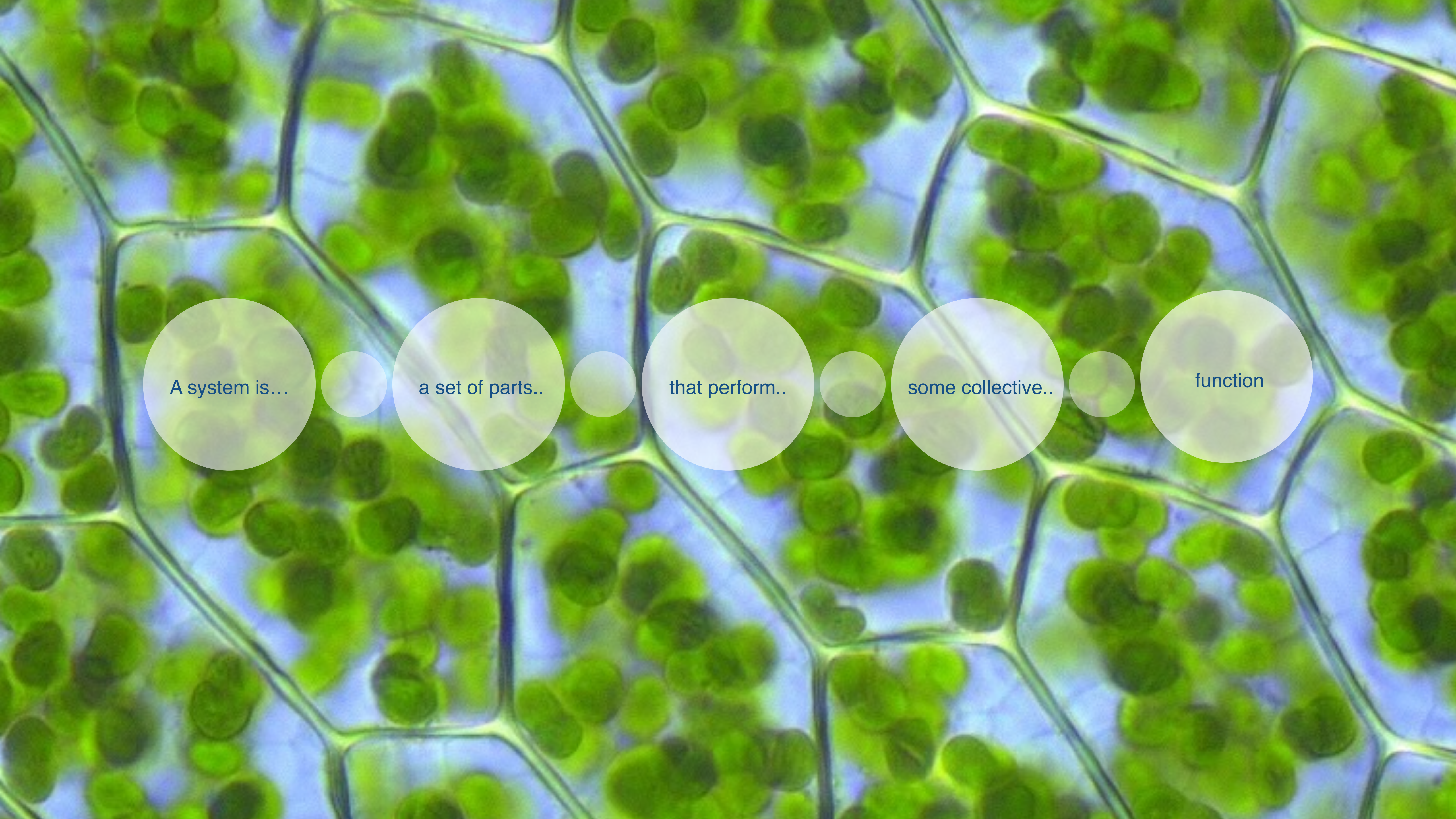
Non linearity

Systems



1 Systems

Complex systems are a type of system that is composed of many diverse parts that are highly interconnected and capable of adaptation



A system is...

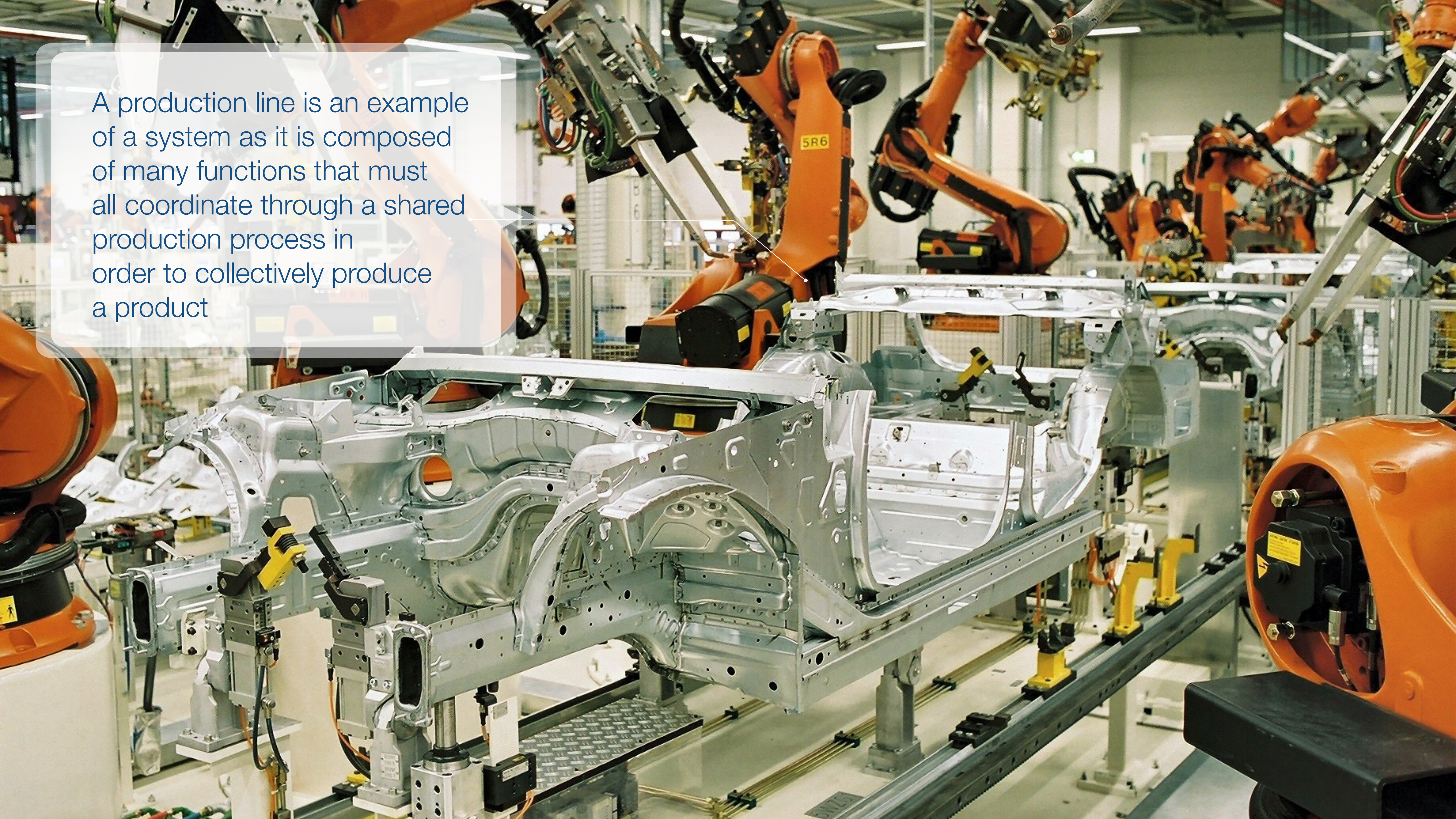
a set of parts..


that perform..

some collective..

function

A production line is an example of a system as it is composed of many functions that must all coordinate through a shared production process in order to collectively produce a product





Ecosystems are examples of systems, composed of many creatures that are interdependent and interact to create a unique overall state to the system

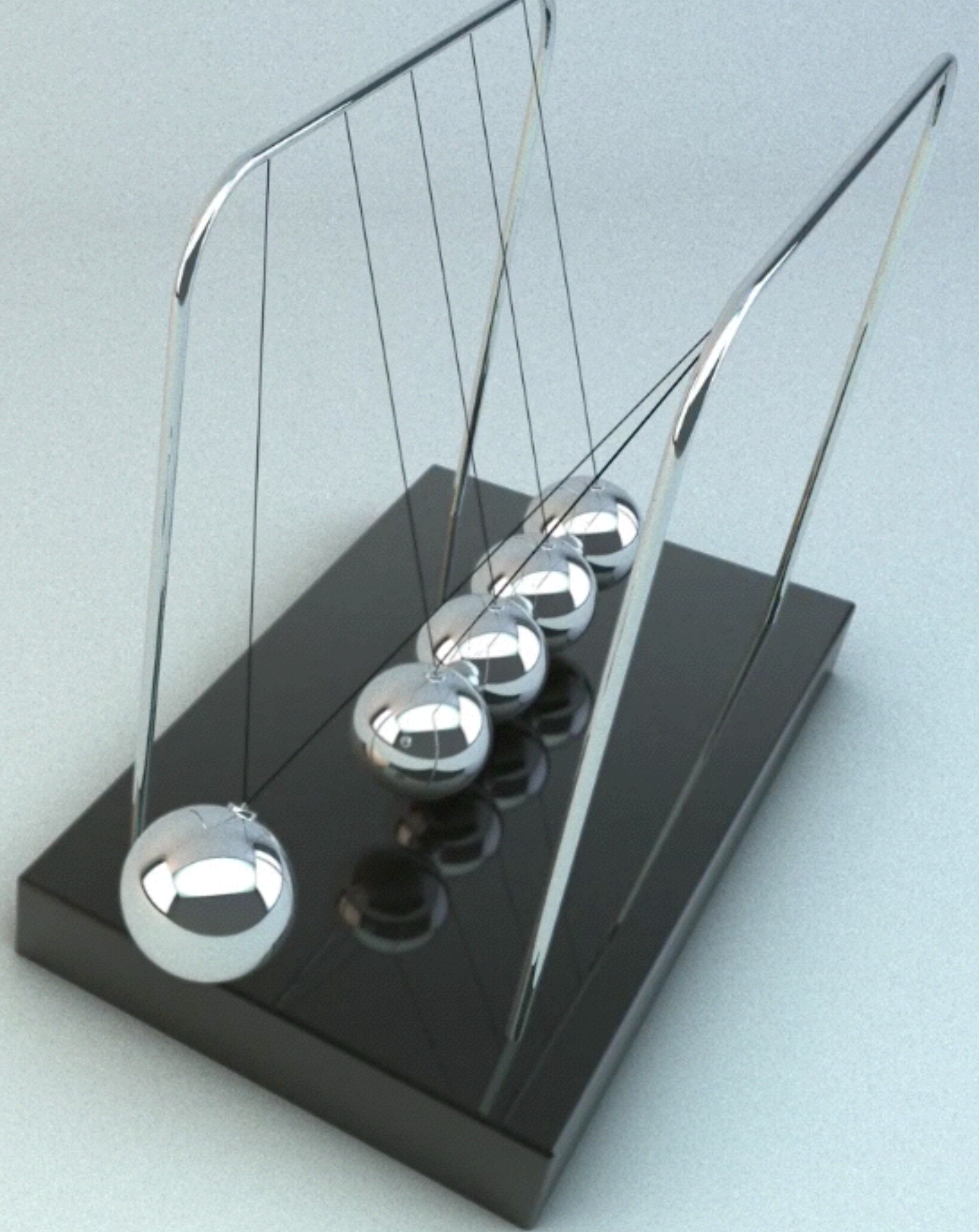



Social groups are examples of systems many individuals cooperating in order to achieve some collective result

2

Non-linearity

Linearity is the product of a direct linear relationship between one cause and one effect





Nonlinearity is an effect that is caused by multiple different interacting parts



Nonlinear systems show disproportionality of input to output due to the complex set of interconnections within the system. This is famously captured in the so called butterfly effect, where a butterfly flapping its wings in brazil may cause a hurricane in another part of the world a few months later

3. Networks

Complex systems are highly interconnected and thus we model them as networks of relations between nodes



Examples of networks

National transportation systems are networks of transport hubs with roads and rail lines interconnecting them



Financial systems

Financial systems are networks composed of many traders that are highly interconnected, acting and reacting to each others behaviour through a dense set of relations



4 Adaptation & Evolution

Elements within complex systems have the capacity to adapt and thus evolve over time



Adaptation...

is the capacity for a system to respond to some change in its environment

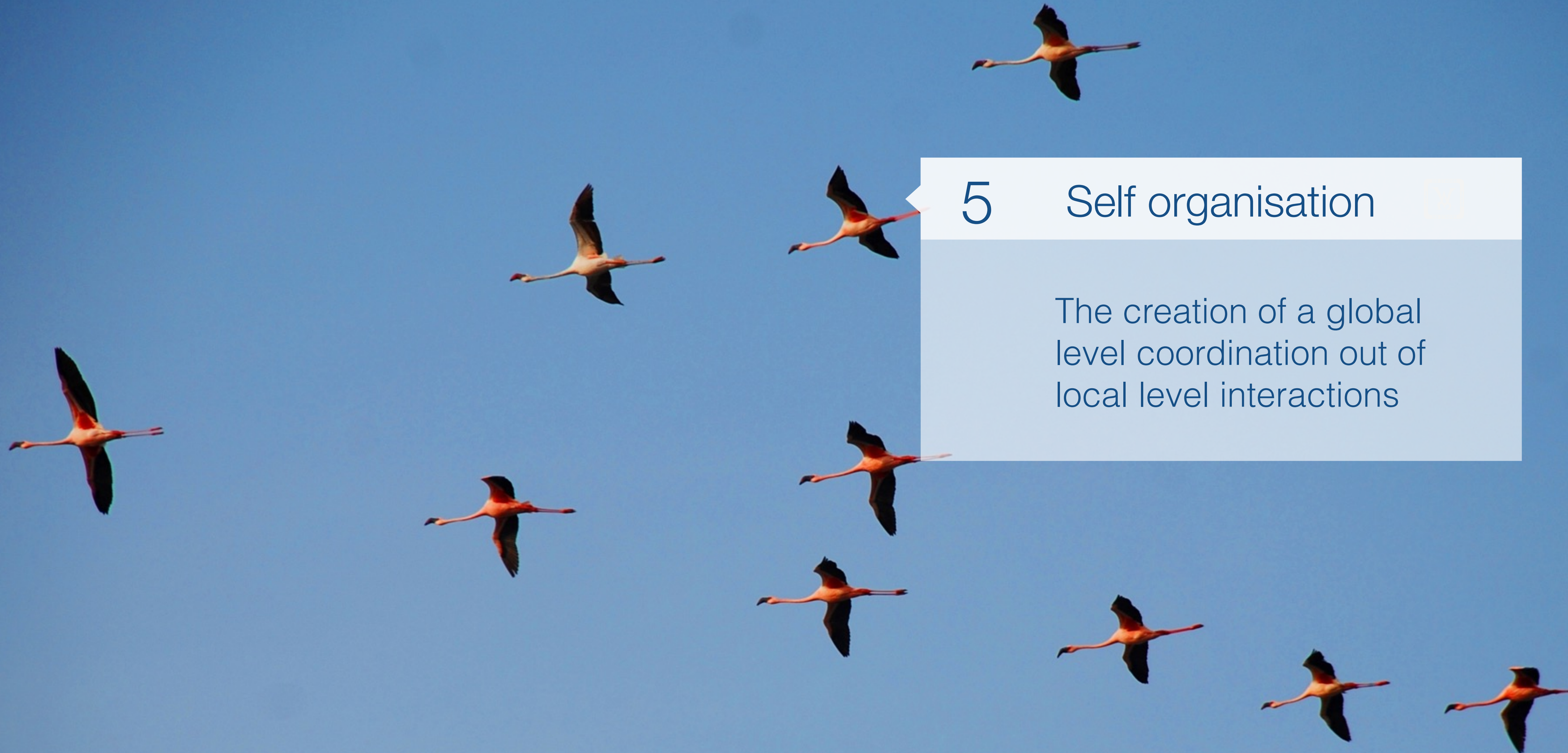
When systems have the capacity of adaptation they can evolve overtime in response to the actions of others and their changing environment



A photograph of a white lighthouse situated on a long, curved pier made of concrete and rocks. The pier extends from the foreground into the sea. The ocean is a deep teal color with white-capped waves crashing against the rocks. The sky is filled with large, dark, dramatic clouds, suggesting an overcast or stormy day. The lighthouse is a simple, cylindrical structure with a lantern room on top.

Uncertainty....?

Due to the complex set of interactions and adaptations within complex systems it is almost impossible to predict with any certainty the future state to a complex system




5

Self organisation


The creation of a global level coordination out of local level interactions

In complex systems there is no centralised coordinator





Patterns of
order emerge
from the bottom
up

A satellite view of Earth from space, showing the African continent on the left, Europe in the center, and parts of Asia on the right. The image captures the curvature of the planet, the deep blue of the oceans, and the intricate patterns of white clouds. A semi-transparent white speech bubble is positioned in the upper right quadrant, containing the text "Our world is a complex place".

Our world
is a complex
place

foton 
Labs

