Complex Systems and its Applications

Spontaneous emergence of order

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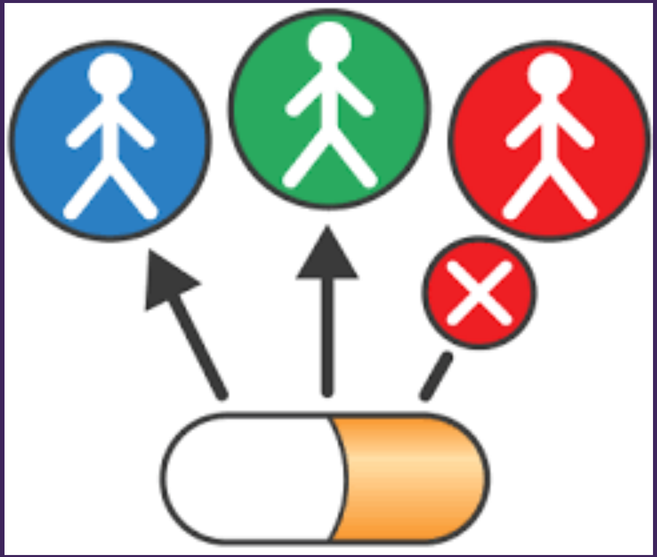
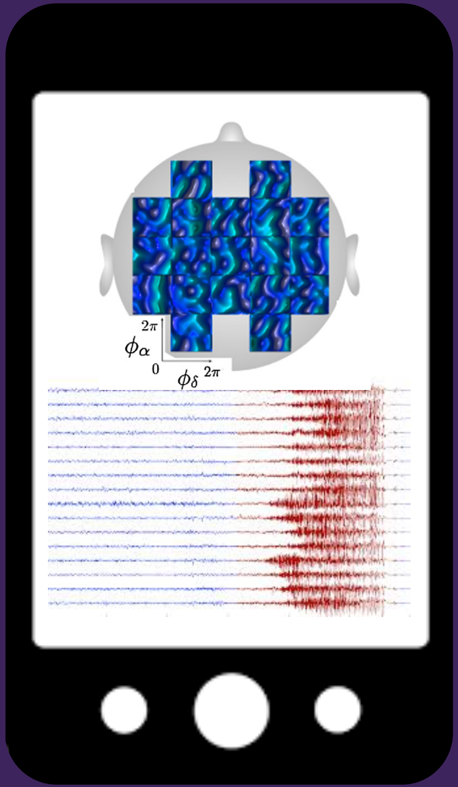
Personalised Treatments

Personalised Treatment



Access to data

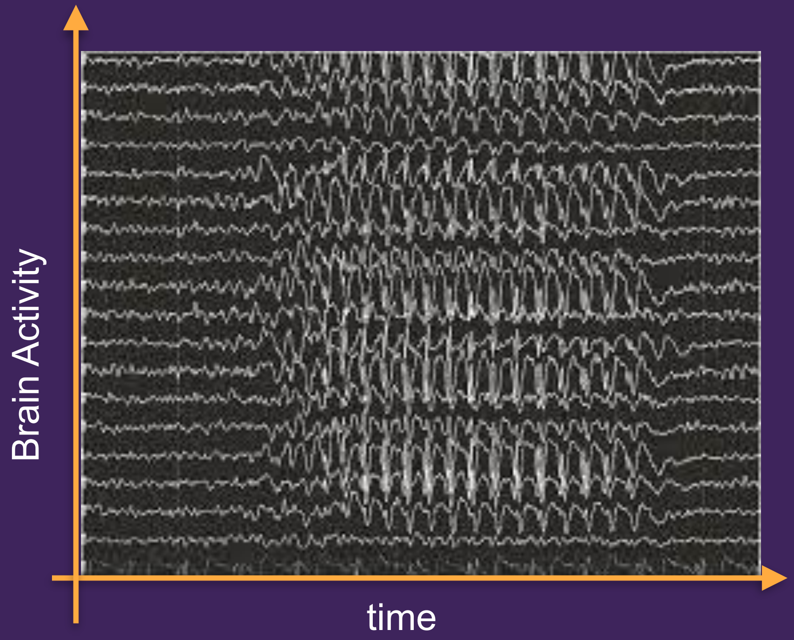
Access to data



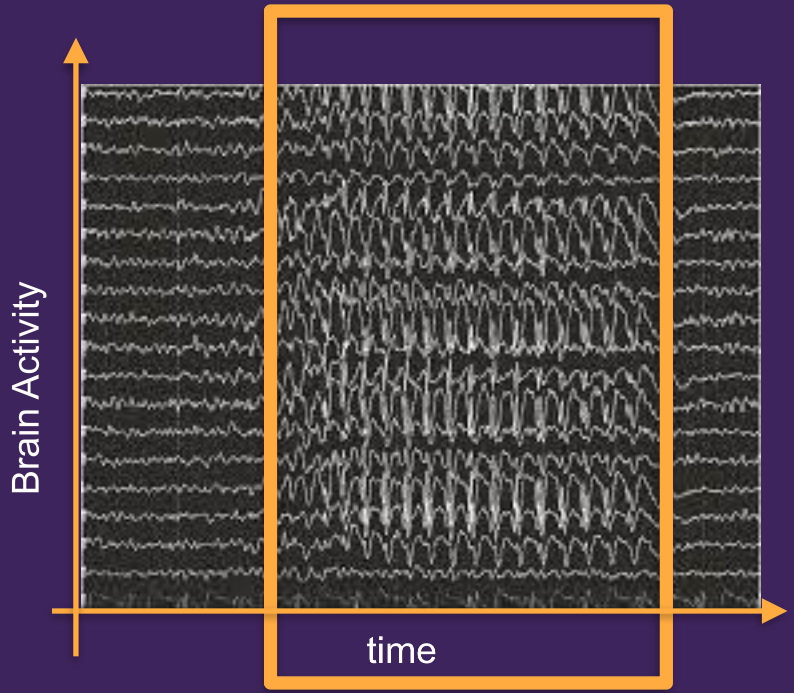
Understanding its behaviour

Too much data…

Uncovering patterns

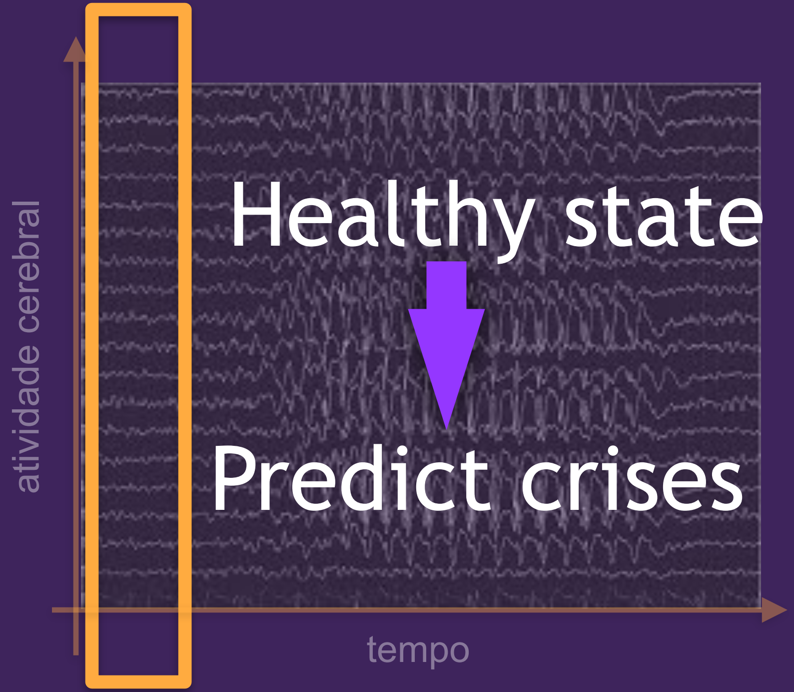


Uncovering patterns



Seizure

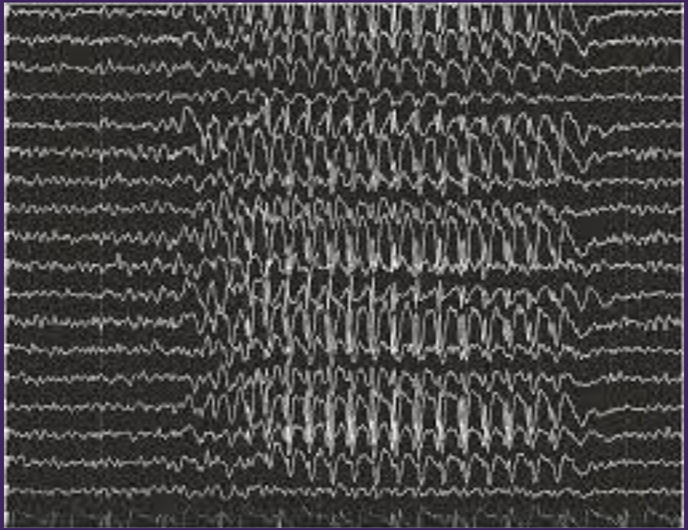
Uncovering patterns



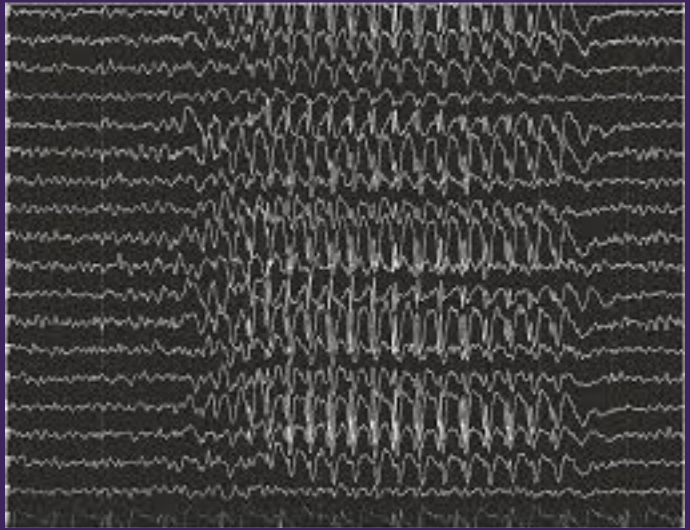
Personalised treatment

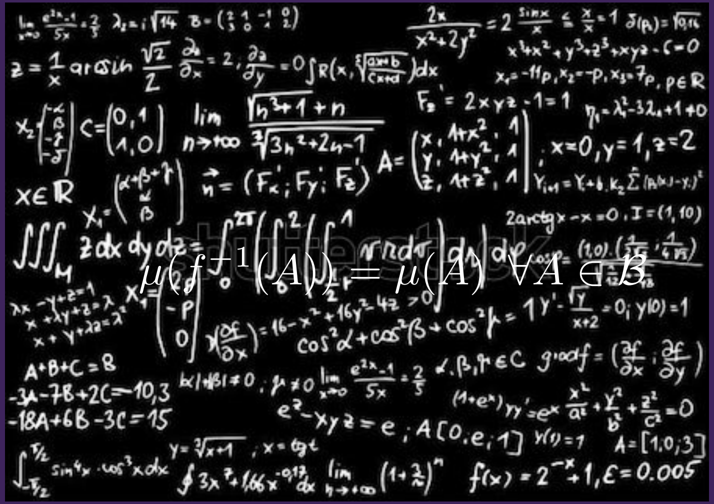
What is the best treatment for you?

Uncovering rules

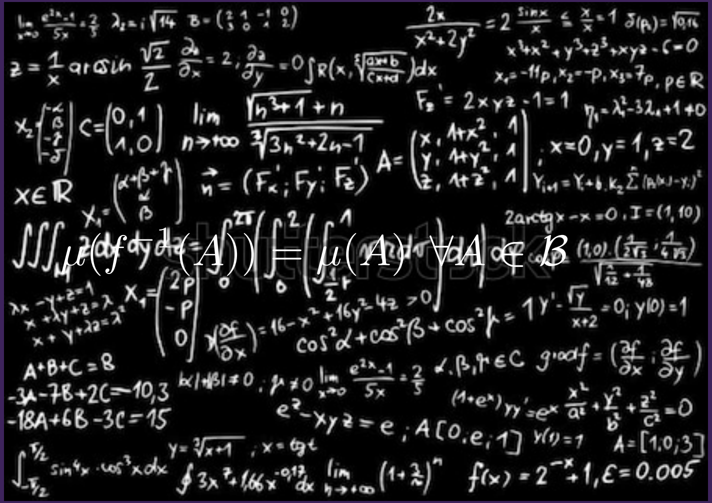


Uncovering rules





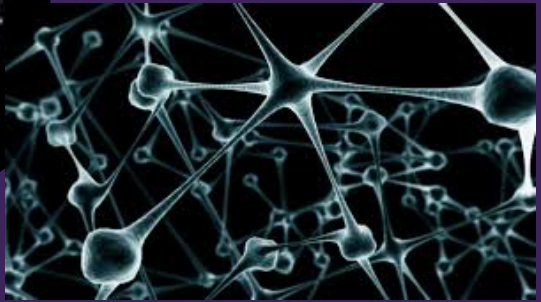
Uncovering rules



Predict transitions

Treatments

Big challenge: Many parts



A 400 years old journey

from parts to the whole

In the Asian banks

Philip Laurent paper in Science in 1917

A phenomenon discussed for 300 years

single

lots

In the Asian banks

In the Asian banks

tendency to order

only an illusion?

In the Asian banks

1917 to 1930 we had 20 papers

In the Asian banks

Does Nature longs for order?

Nature longs for order

John Buck in 1960

Nature longs for order

Buck realised the order was emergent

first pairs and trios

In the lab

Buck confirmed the phenomenon

Christiaan Huygens

First to use mathematics

Christiaan Huygens

Pendulum clock

Christiaan Huygens


CHRISTIANI
HVGENII
ZVLICHEMII, CONST. F.
HOROLOGIVM
OSCILLATORIVM
SIVE
DE MOTV PENDVLORVM
AD HOROLOGIA APTATO
DEMONSTRATIONES
GEOMETRICÆ
PARISIIS,
Apud F. Muguet, Regis & Illustrissimi Archiepiscopi Typographum, via Citharæ, ad insigne trium Regum.
MDCLXXIII
CVM PRIVILEGIO REGIS.

Christiaan Huygens

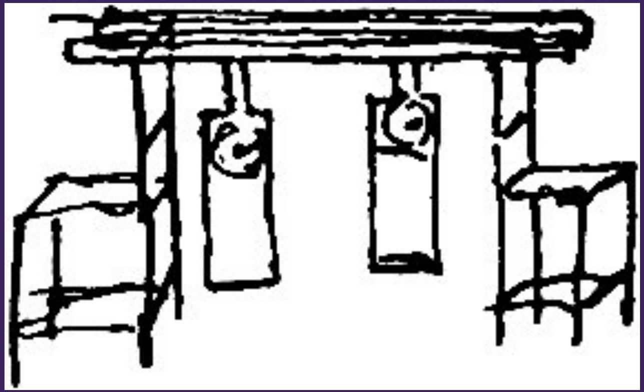
But

Christiaan Huygens

Christiaan Huygens

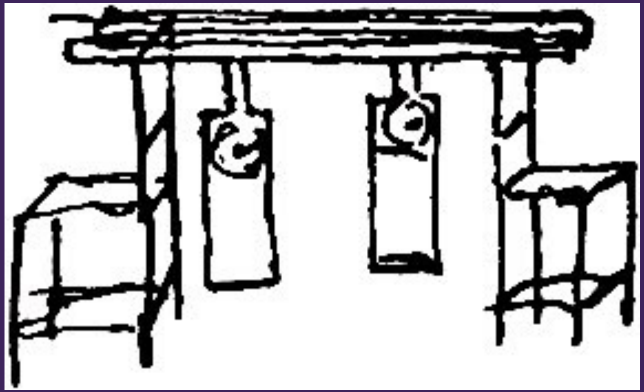
in the mist of dreams

Christiaan Huygens



Pendulum in sync

Christiaan Huygens



Pendulum in sync

Christiaan Huygens

Modern version

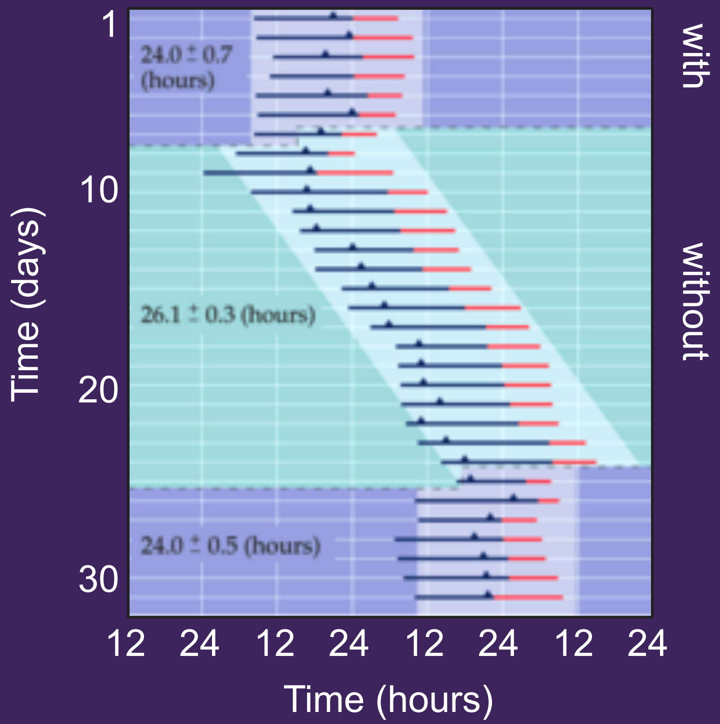
Christiaan Huygens

Tendency towards order

menstrual cycle

Tendency towards order

Circadian



Tendency towards order

Mystery

Why does order emerges spontaneously?

Tendency towards order

Mathematics describes
all these phenomena

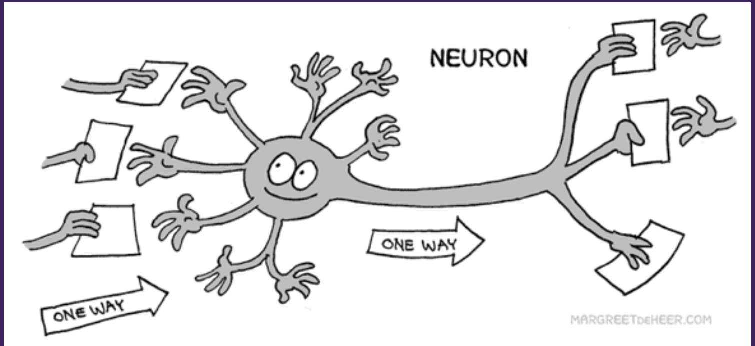
Tendency towards order

Predict when order will appear

Order is not always good

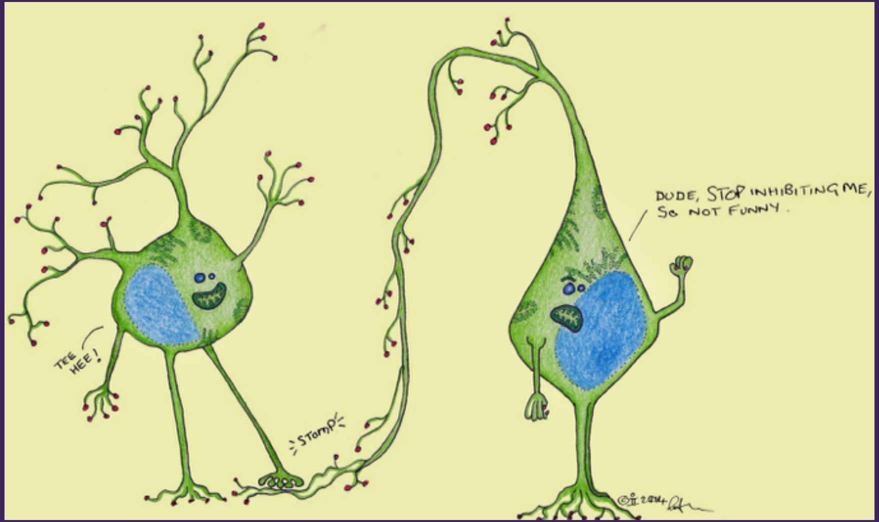
In the brain

neurons

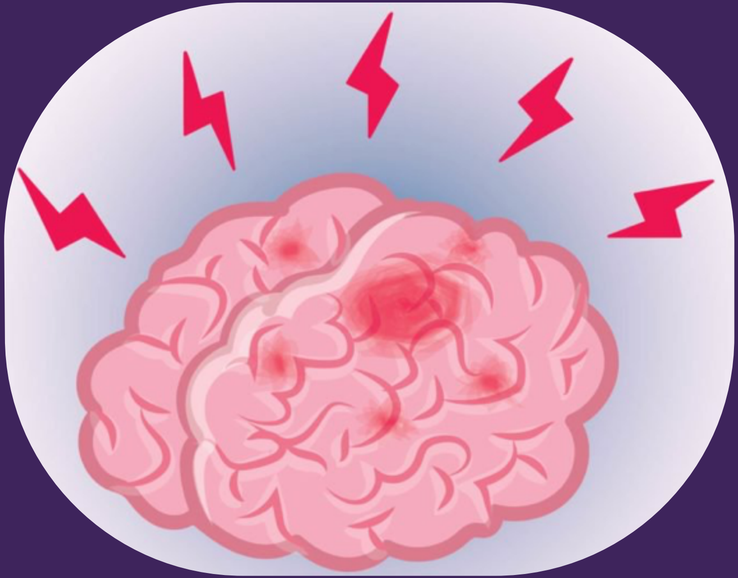


In the brain

neurons talk to each other



neurons can synchronize



Parkinson

Parkinson

electrical activity in the brain

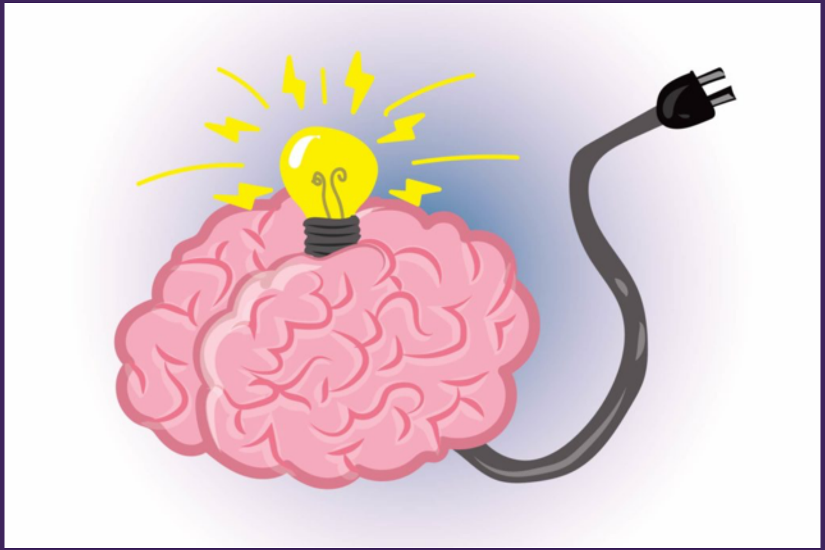
Parkinson

Why not to provide a small shock

Parkinson

Parkinson

Shocking all day long



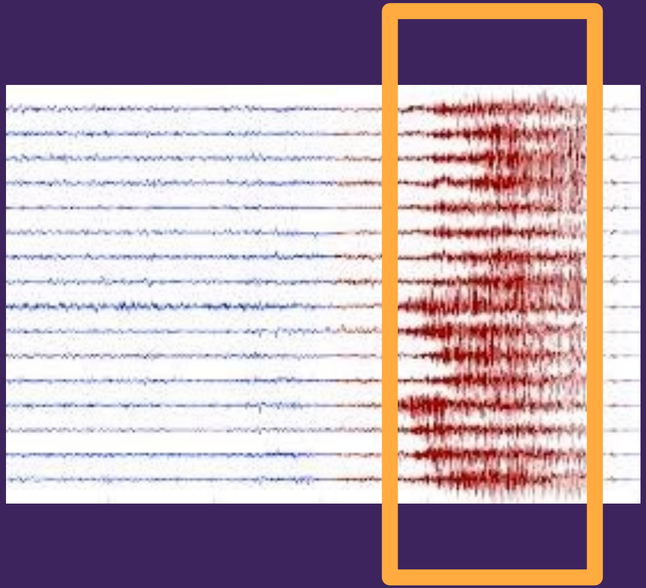
Parkinson

Obtain the equations that rule the system

Parkinson

Least intervention

Epilepsy



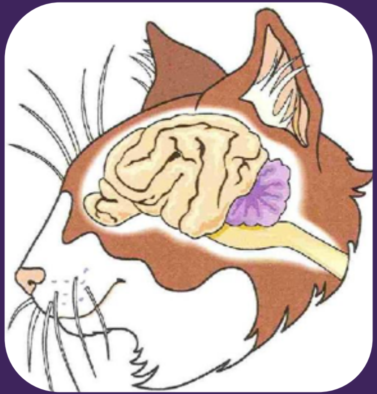
Synchronization

A study case

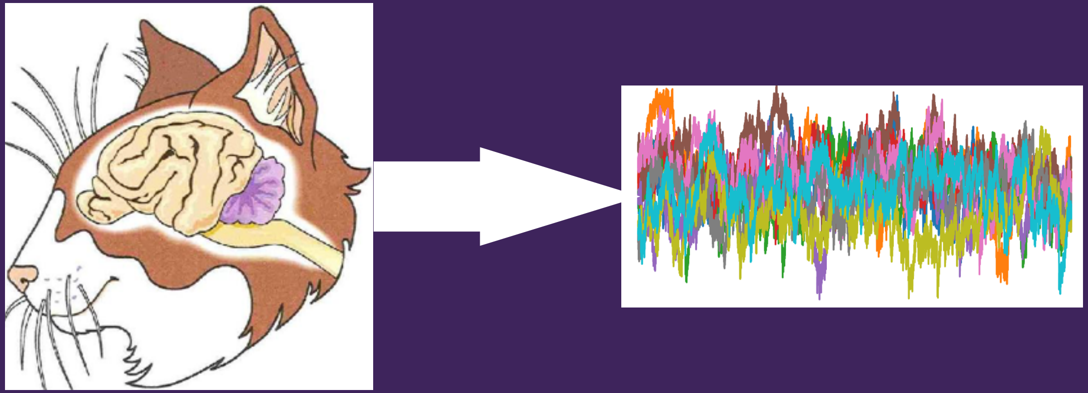

CAT PRIORITY LOBES
WOOL
CATNIP
CHASING STUFF
MICE!
"WHAT WAS THAT NOISE?"
SLEEP-ING
LOYALTY
MORE SLEEPING
EXPLO-RING
JUMP!
HIDING
FEED ME

Together with Deniz

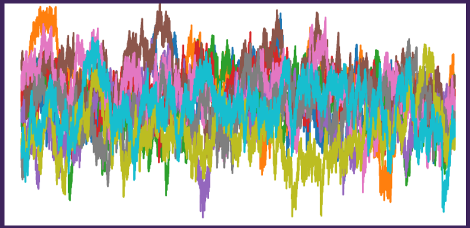
to

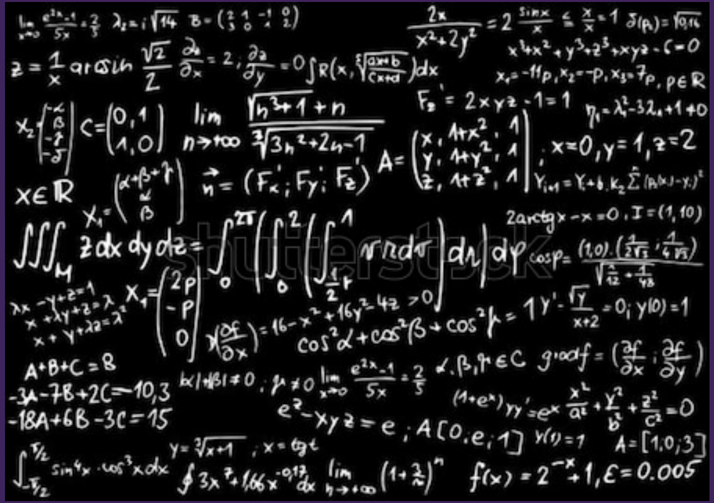


Simulate the system in a computer

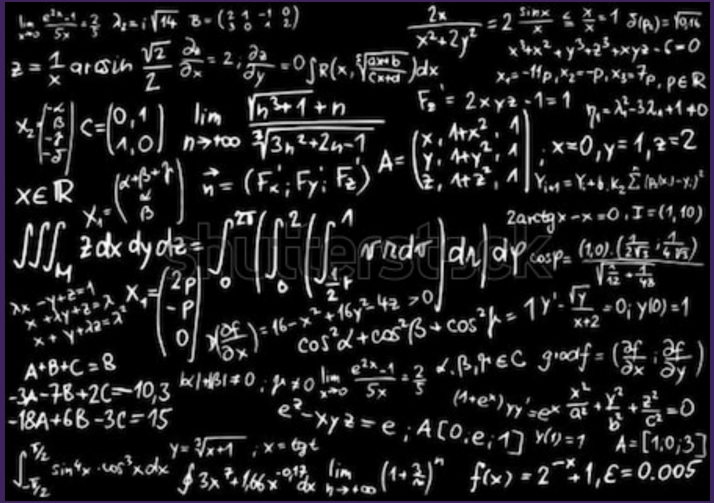


From data to rules



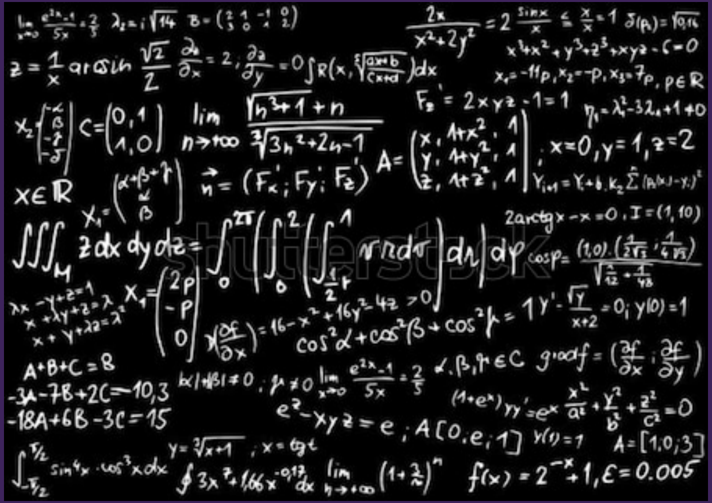


From data to rules



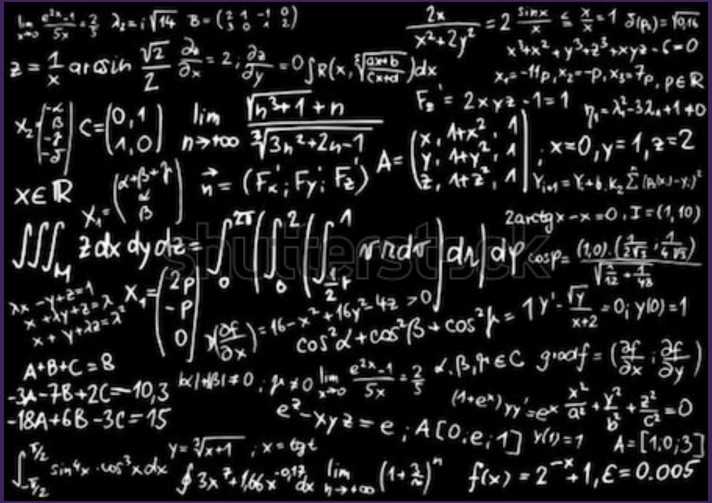
From rules to prediction

From data to rules



From rules to prediction

From data to rules



Best treatments

A big puzzle

The future

depends on maths