identifying emergence in complex systems

@thejunglejane

if you put **50 ants** on a table

if you put **500,000 ants** on a table

adding more **ants**

relatively **simple**

foraging for **food**

building **nests**

raising **livestock**

waging **war**

burying their **dead**

innate immune system

adaptive immune system

take the **lower levels** for granted

principle of computational irreducibility

the collective is irreducible to the individual

the **whole** must be greater than the **sum of its parts**

emergence

disorganized v. organized complexity

Per Bak

Chao Tang

Kurt Wiesenfeld

self-organized **criticality**

simple

distributed

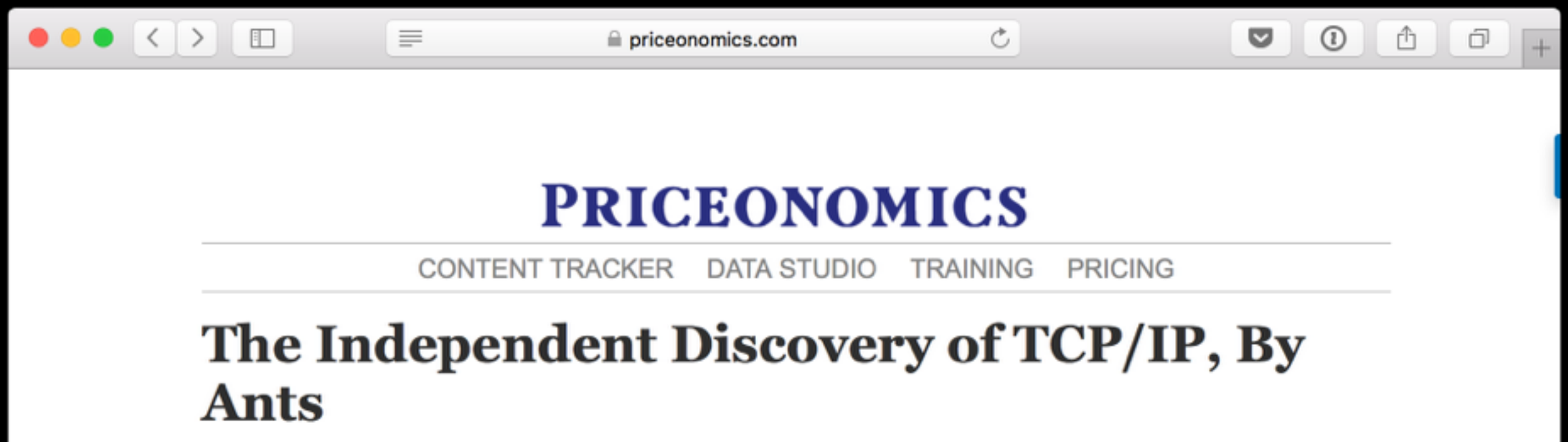
scalable

spend water to get water

collective regulation

ants are doing TCP

the independent discovery
of TCP/IP, by humans



David Winter

keepturningleft.co.uk

consensus

scale-free correlation

high signal-to-noise ratio

effective perceptive range

seven nearest neighbors

robustness

many evolutionary cycles

in many different environments

natural selection for **collective behavior**

we have many **biological analogs**
of computational problems

ants and congestion control

starlings and consensus

slime mold and network-routing

swarms and distributed search

neuronal spiking and probabilistic inference

fly brains and max independent sets

problem of **representation**

top-down **feedback**

simple and abstract

thank you