Dirk Helbing (ETH Zurich)
dhelbing@ethz.ch

Nervousnet: A CERN for Society

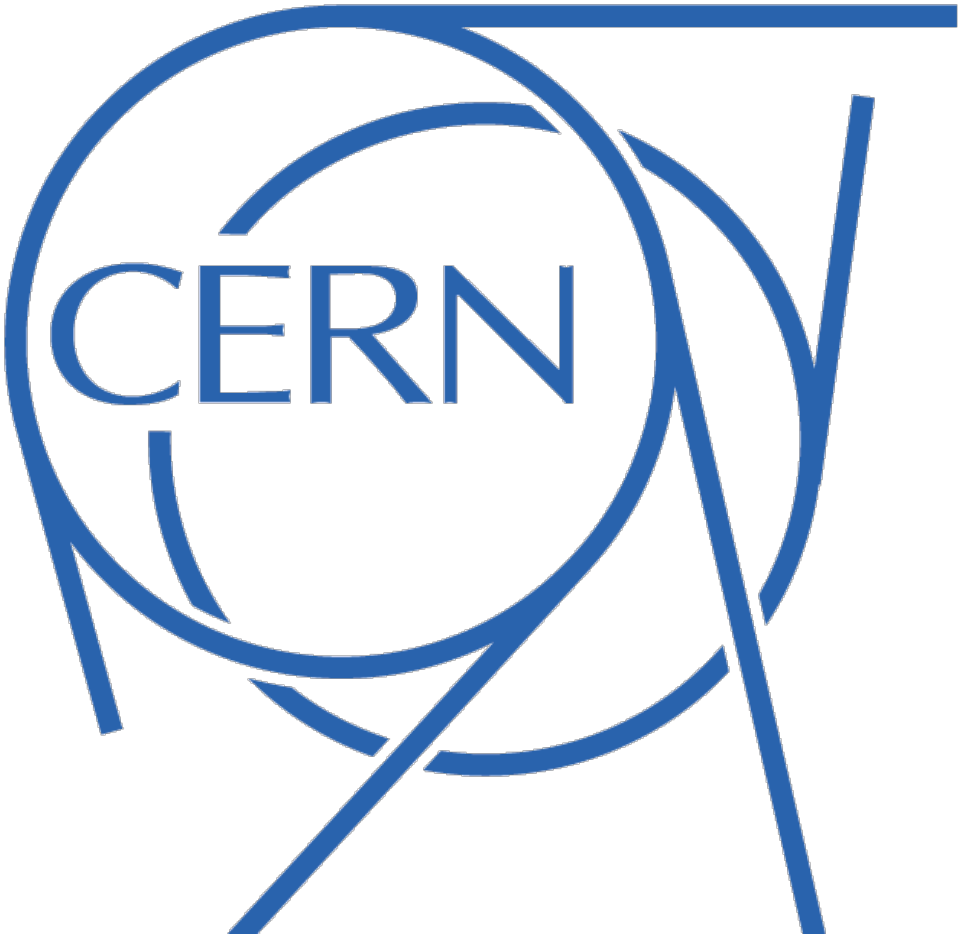
Follow FuturICT on

Scientific progress has been largely driven by data and experimentation. That‘s the basis to build theories on.

So far, however, we didn‘t have experimental approaches for socio-economic systems that were comparable to physics, chemistry, or biology.

This is now changing!

Can We Build a CERN for Society?



CERN deletes 99.9% of measurement data immediately

Today‘s Universal Tool

We Can Connect Smartphones to Build a Global Measurement System

Photo: apple iOS and android phones

But We Need A System We Can Trust …

Trust Requires Transparency

We Can Build A Planetary Nervous System as A Citizen Web

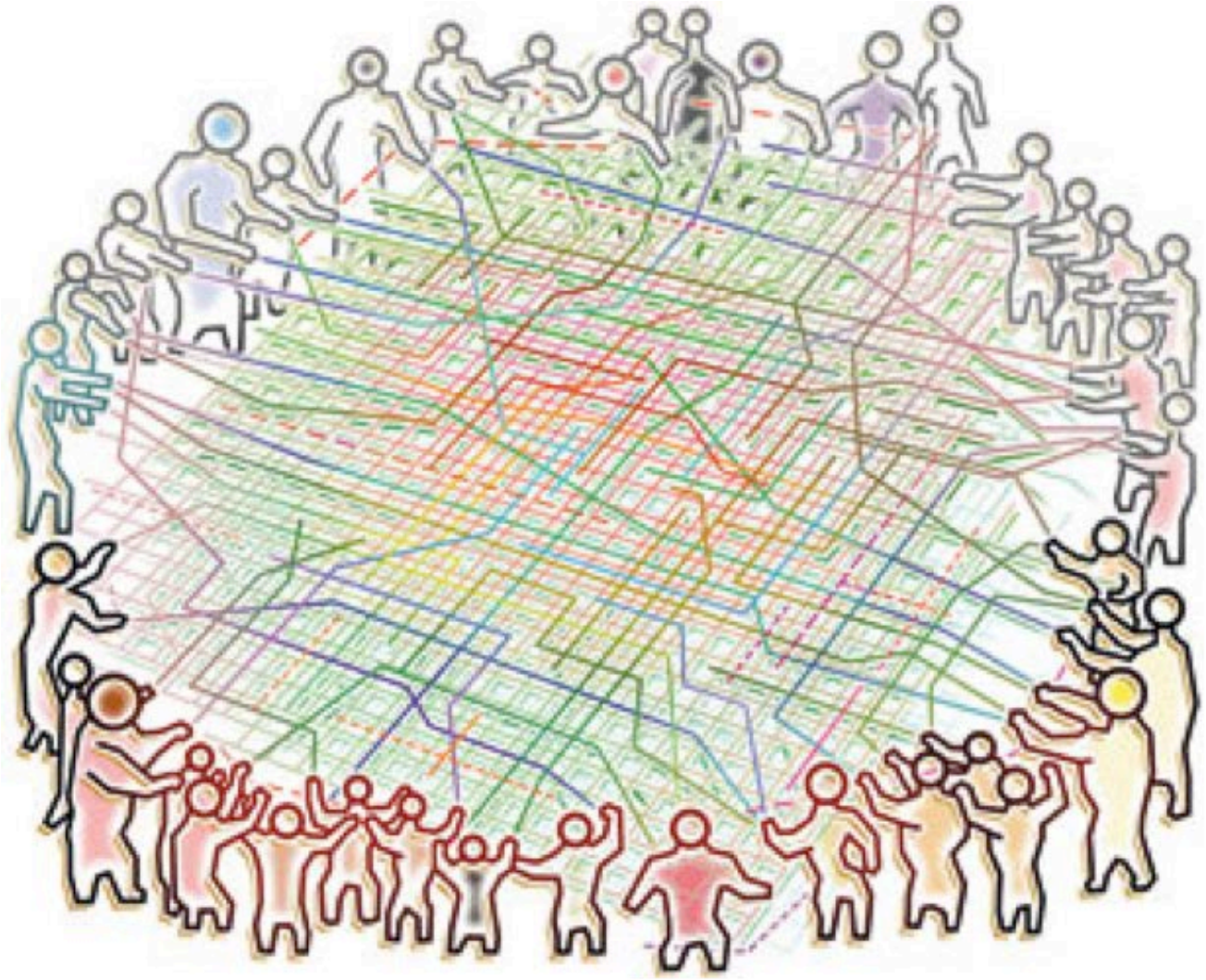
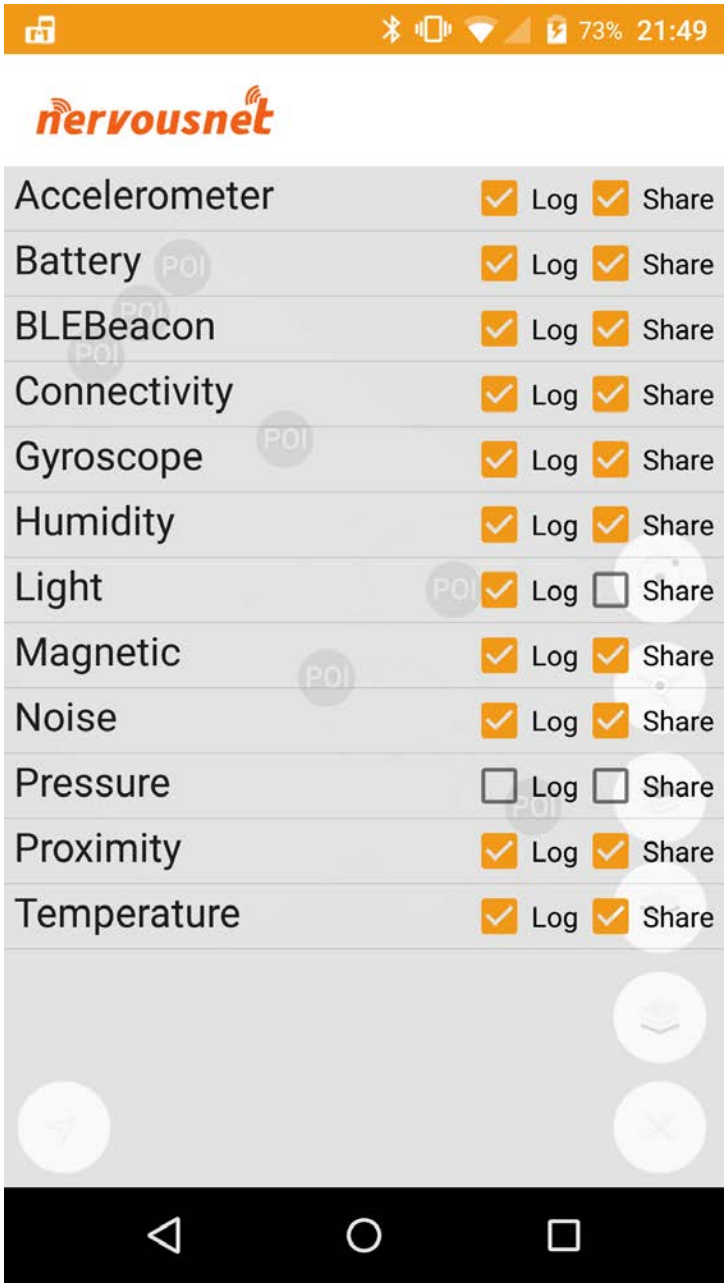
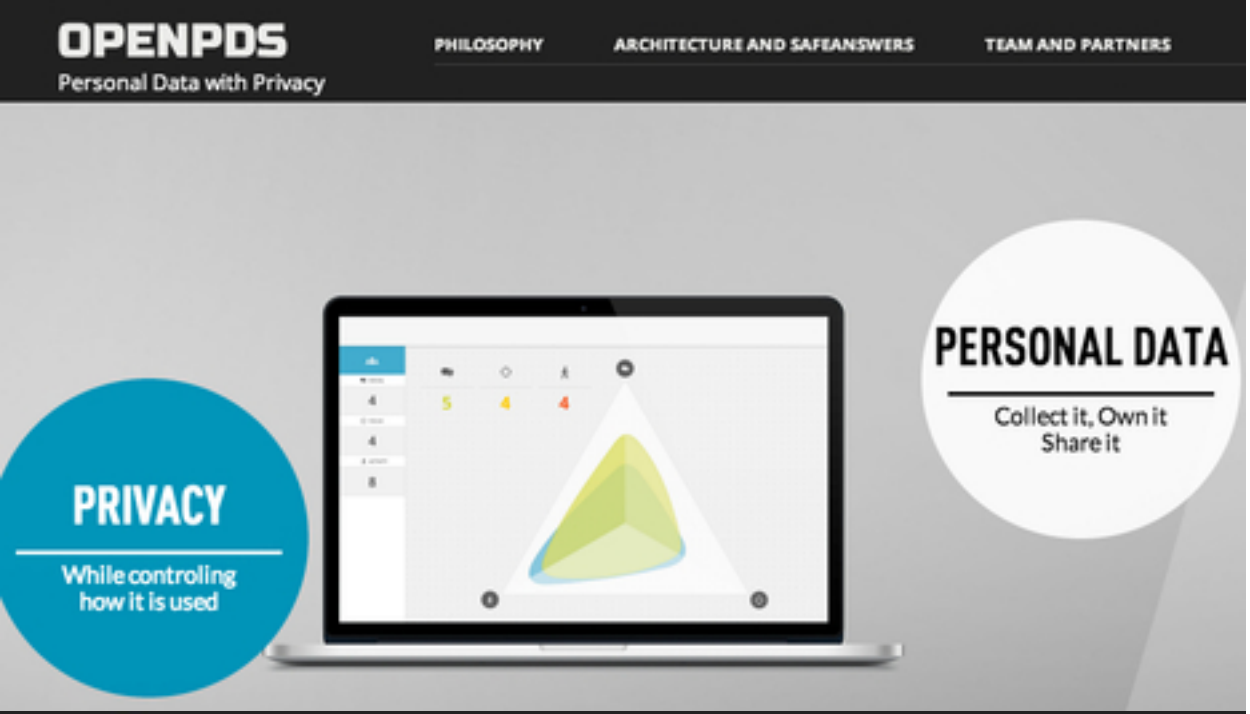


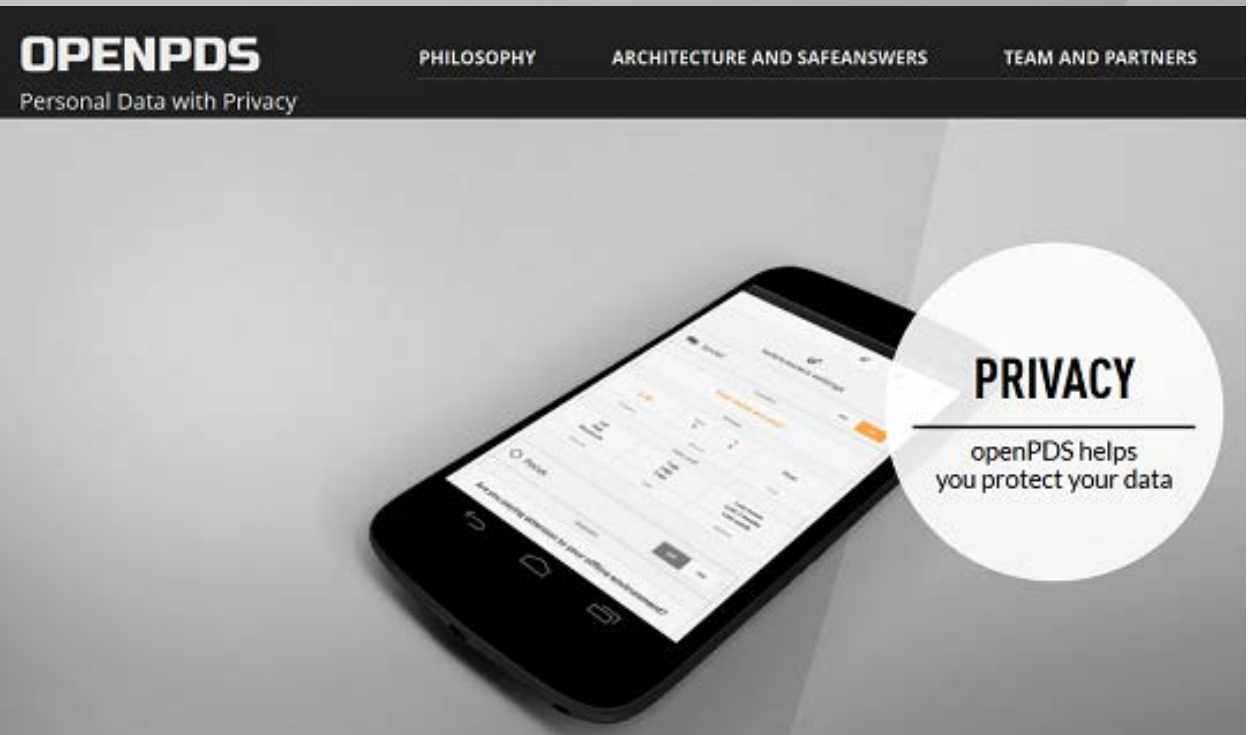
Illustration:
Jac Depczyk

http://www.thisviewoflife.com/index.php/magazine/articles/climate-change-and-inter-group-cooperation

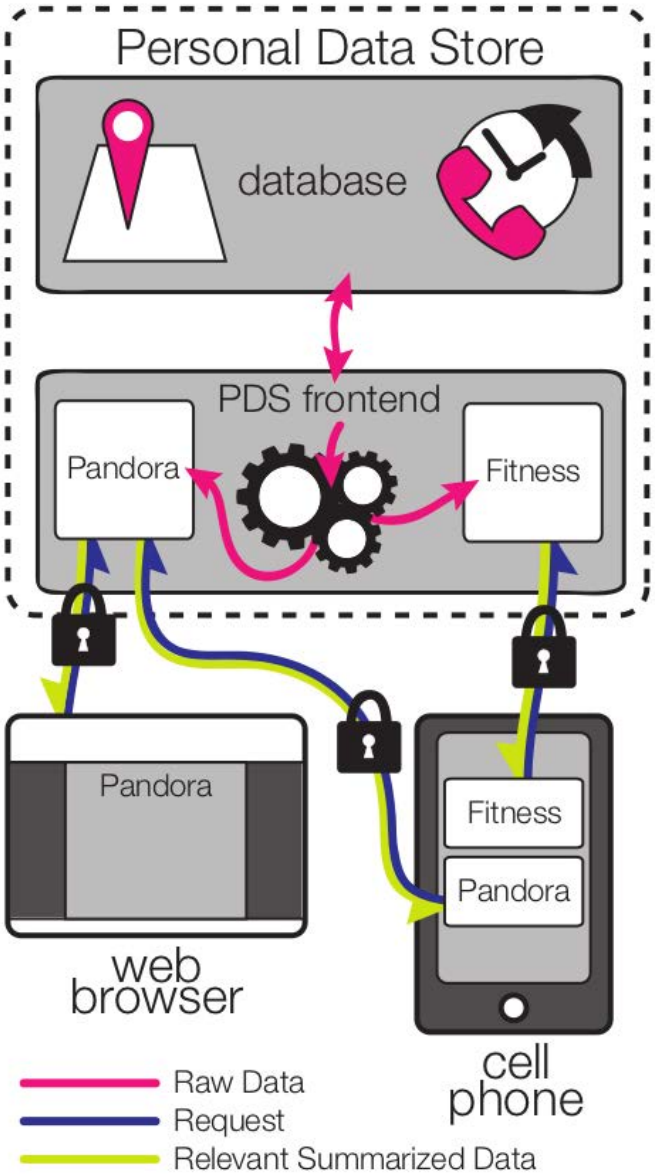
…an Information System Controlled by You!



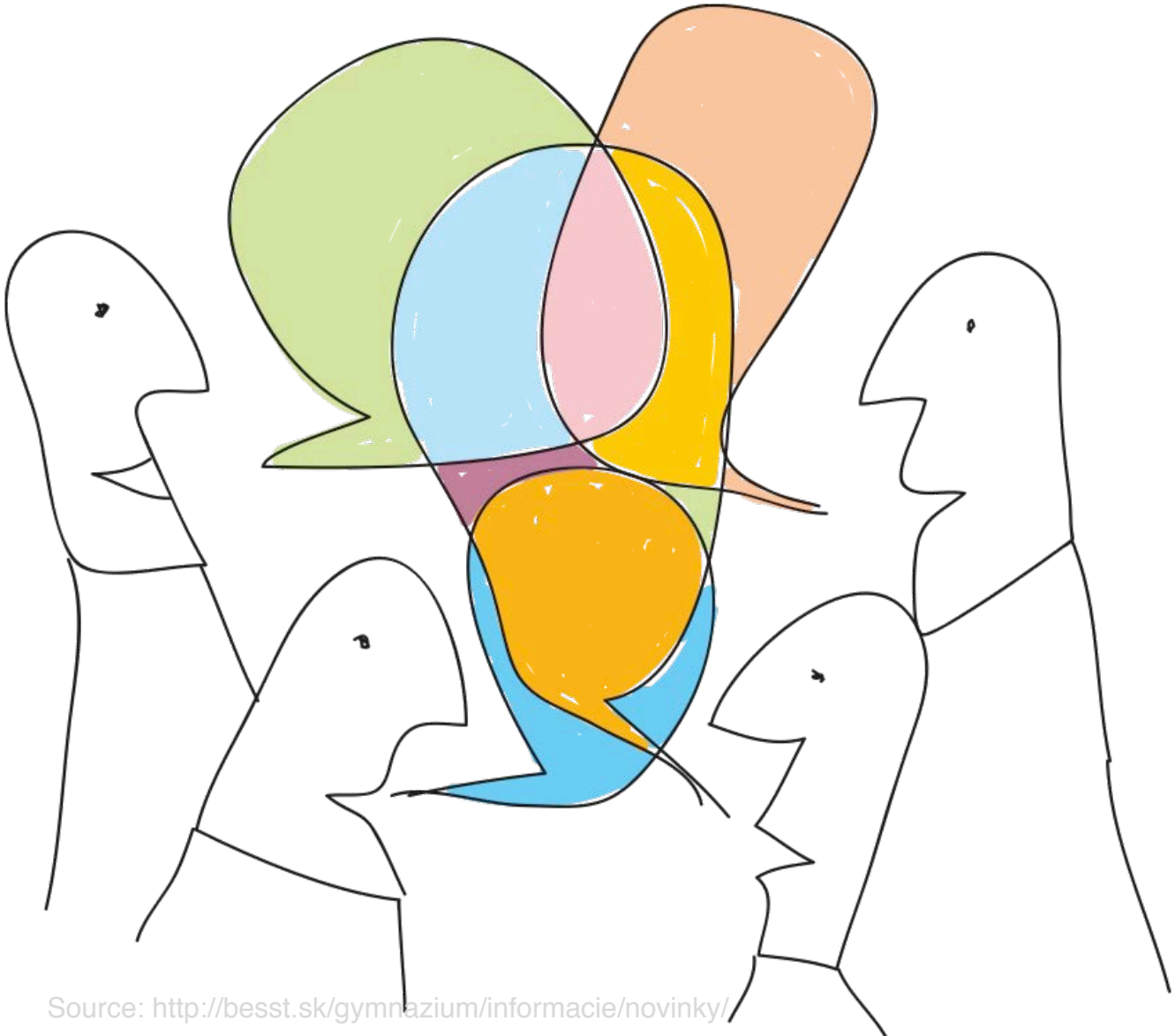




Privacy and Data Ownership



Let's Create A Participatory System



Source: http://besst.sk/gymnazium/informacie/novinky/

An Open Data Source, but Real Time

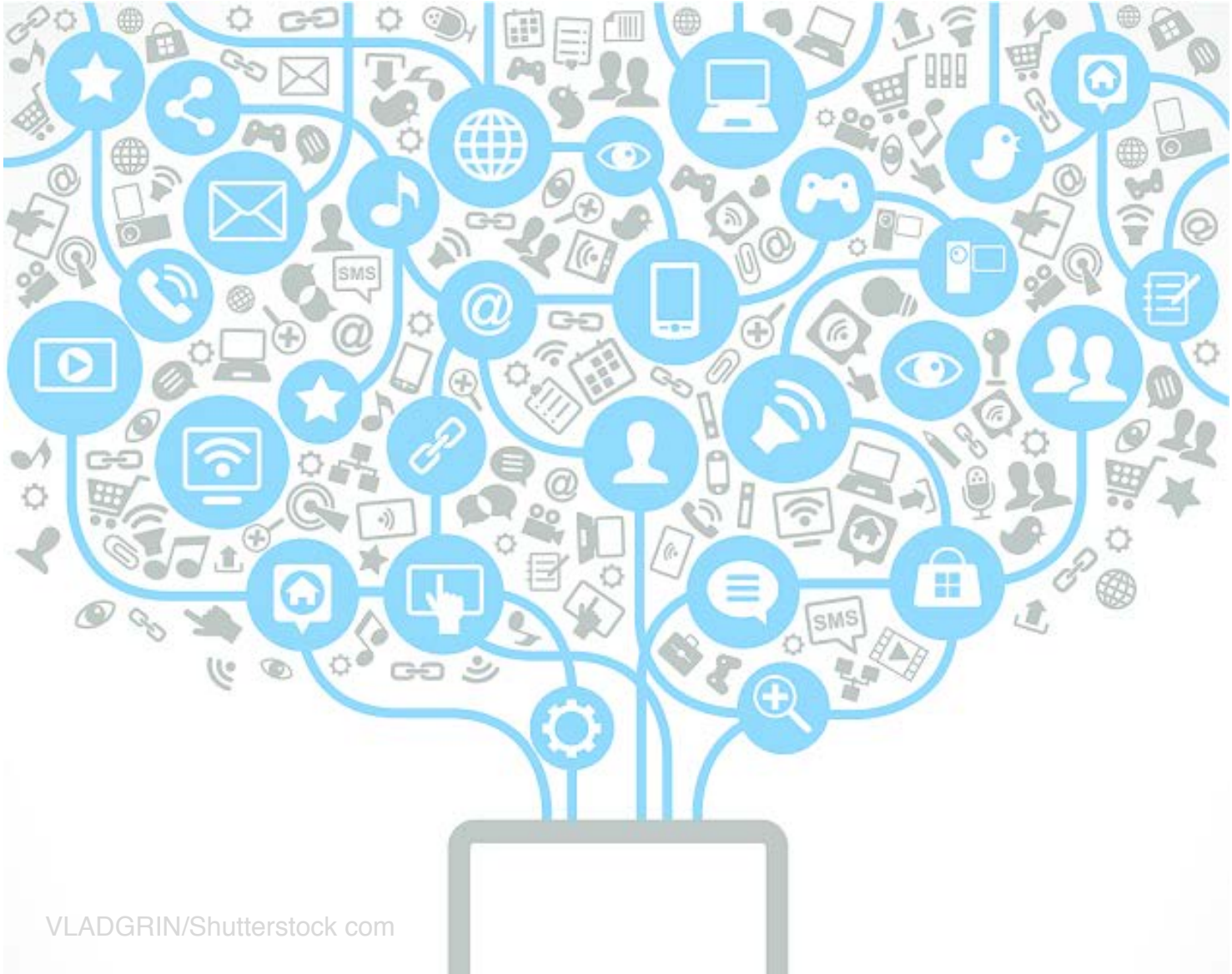
© Wikimedia Foundation, Inc.

Produce Our Own Open Data

Share Source Codes

http://it.com.mk/github-napolni-5-godini-i-ima-3-5-milioni-korisnitsi-i-6-milioni-repozitoriumi/github/

Let‘s Grow a Powerful Information and Innovation (Eco-)System Together ...



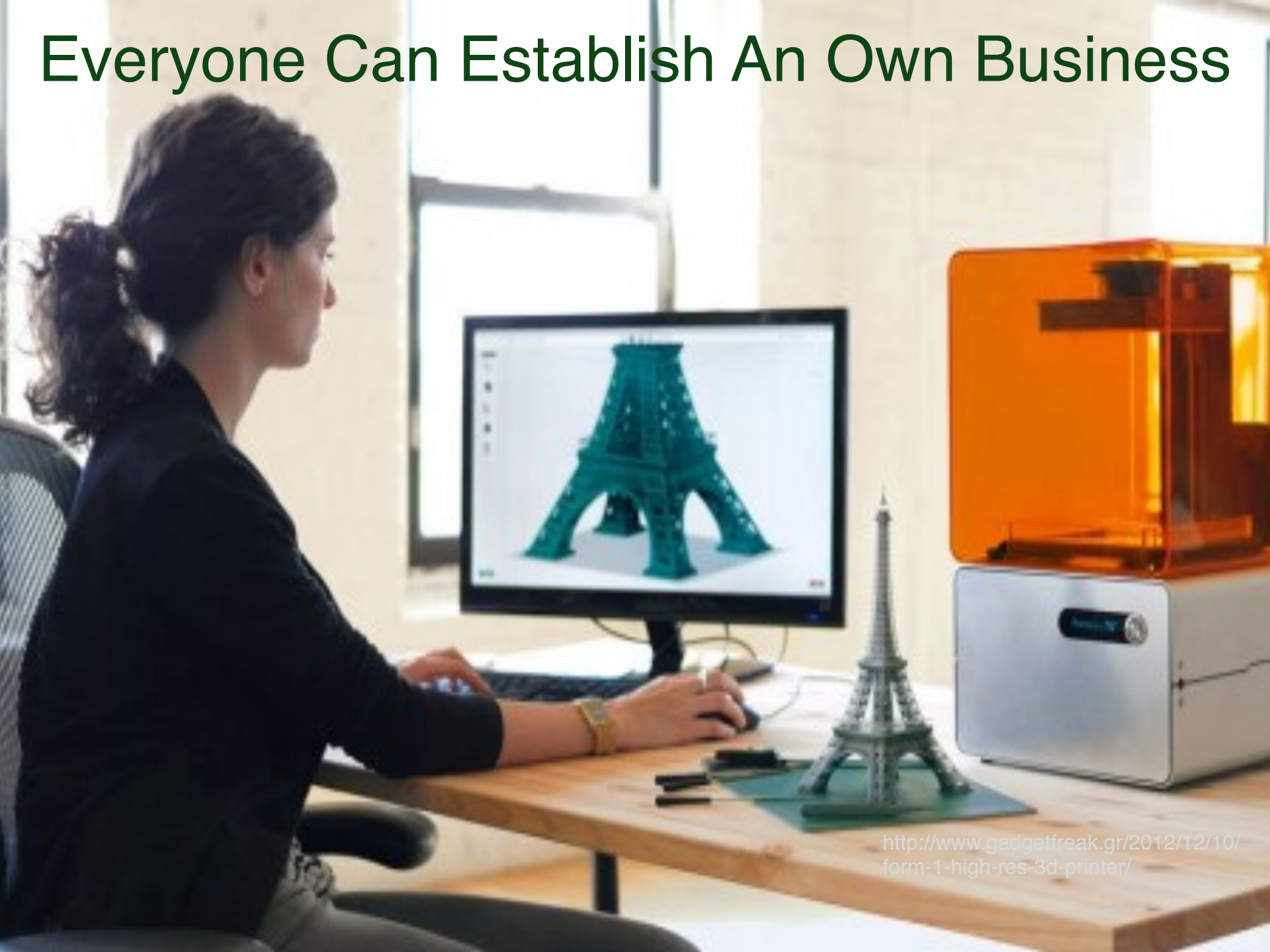
… and Create New Opportunities for Everyone

If set up well, enabling users, customers, citizens will lead to better services, better products, better businesses, better neighborhoods, smarter cities, smarter societies …

With A Micro-Payment System...

http://www.europaeum.org/europaeum/?q=node/533

Everyone Can Establish An Own Business



http://www.gadgetfreak.gr/2012/12/10/form-1-high-res-3d-printer/

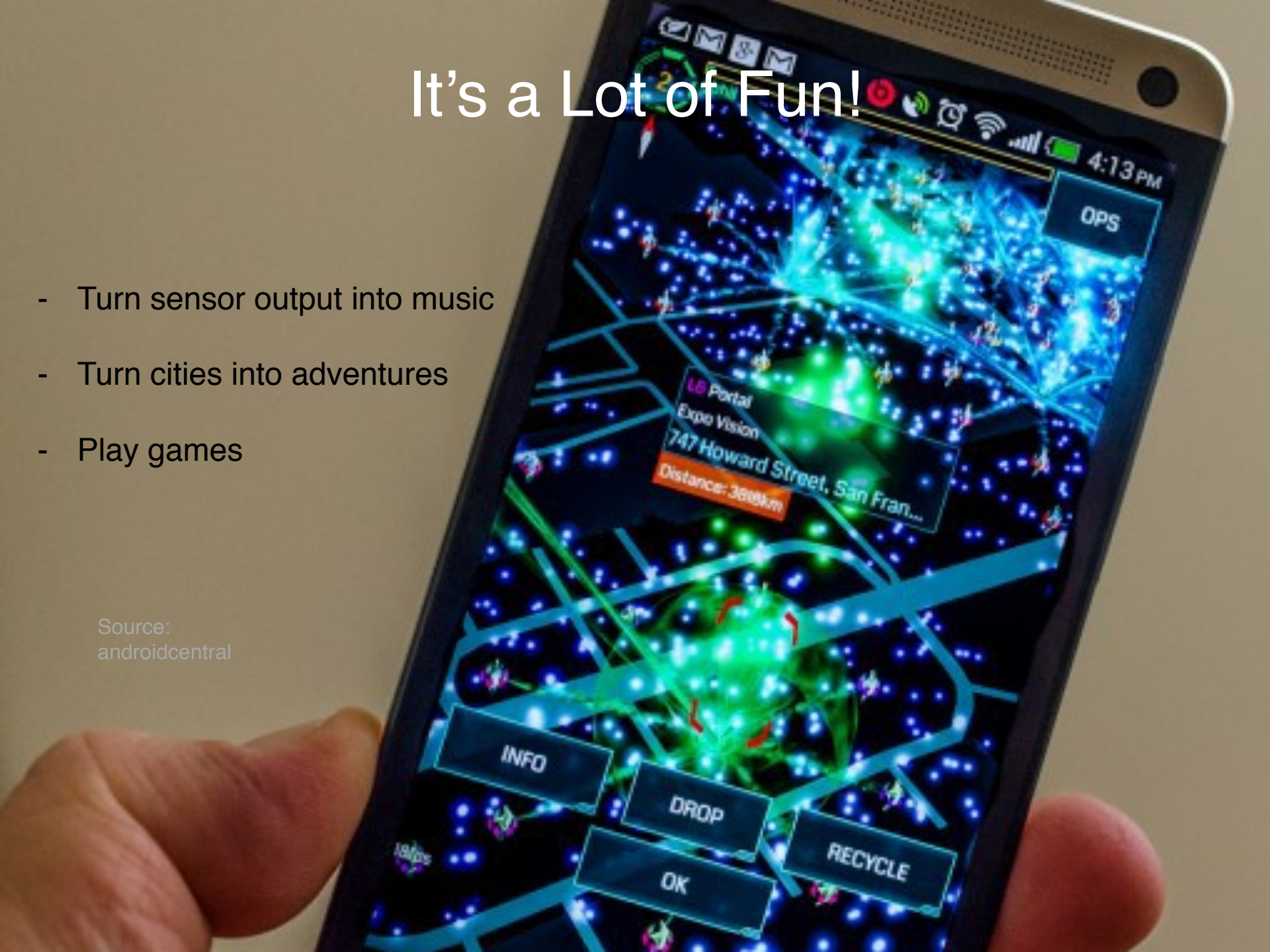
The nervousnet startup team
@ ETH Zurich

It’s Extremely Exciting!

It’s a Lot of Fun!

- Turn sensor output into music
- Turn cities into adventures
- Play games

Source:
androidcentral



TREASURE HUNT

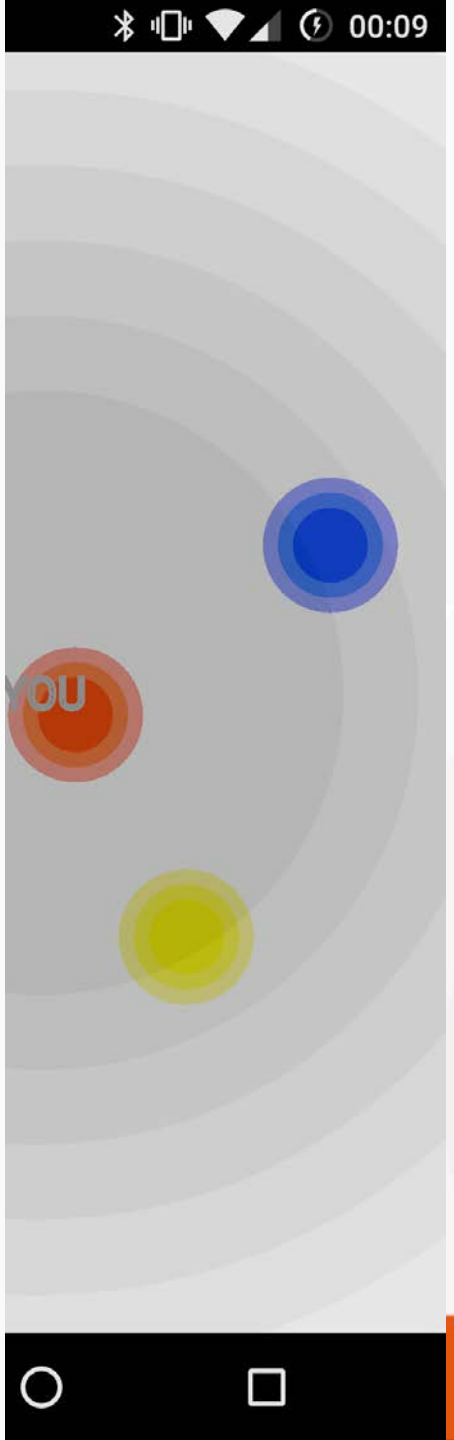
Move around!

The distance will get

smaller as you get closer

to finding the treasure.

START



TREASURE HUNT

SABOTAGE

YOU

Next treasure ~9m away

What the Planetary Nervous System Can Do for Us

Areas of application include

(1) the real-time measurement of the state of our techno-socio-economic-environmental systems,

(2) greater awareness of chances and risks to support everyone's decision-making,

(3) the development of a Global Systems Science to manage our world more successfully,

(4) the creation of self-organizing systems, and

(5) the support of collective intelligence.

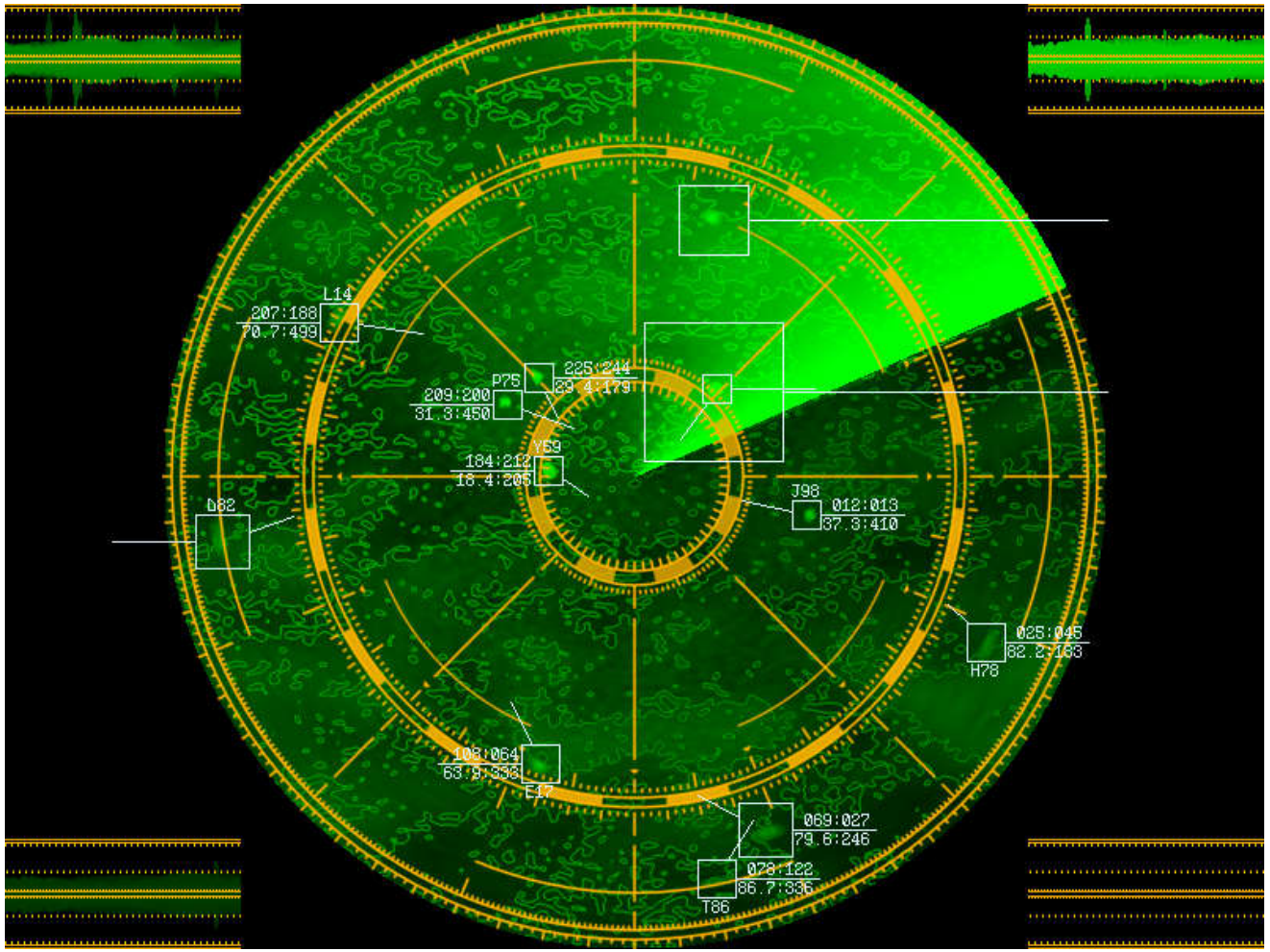
Measuring the world in real-time

Detecting Objects

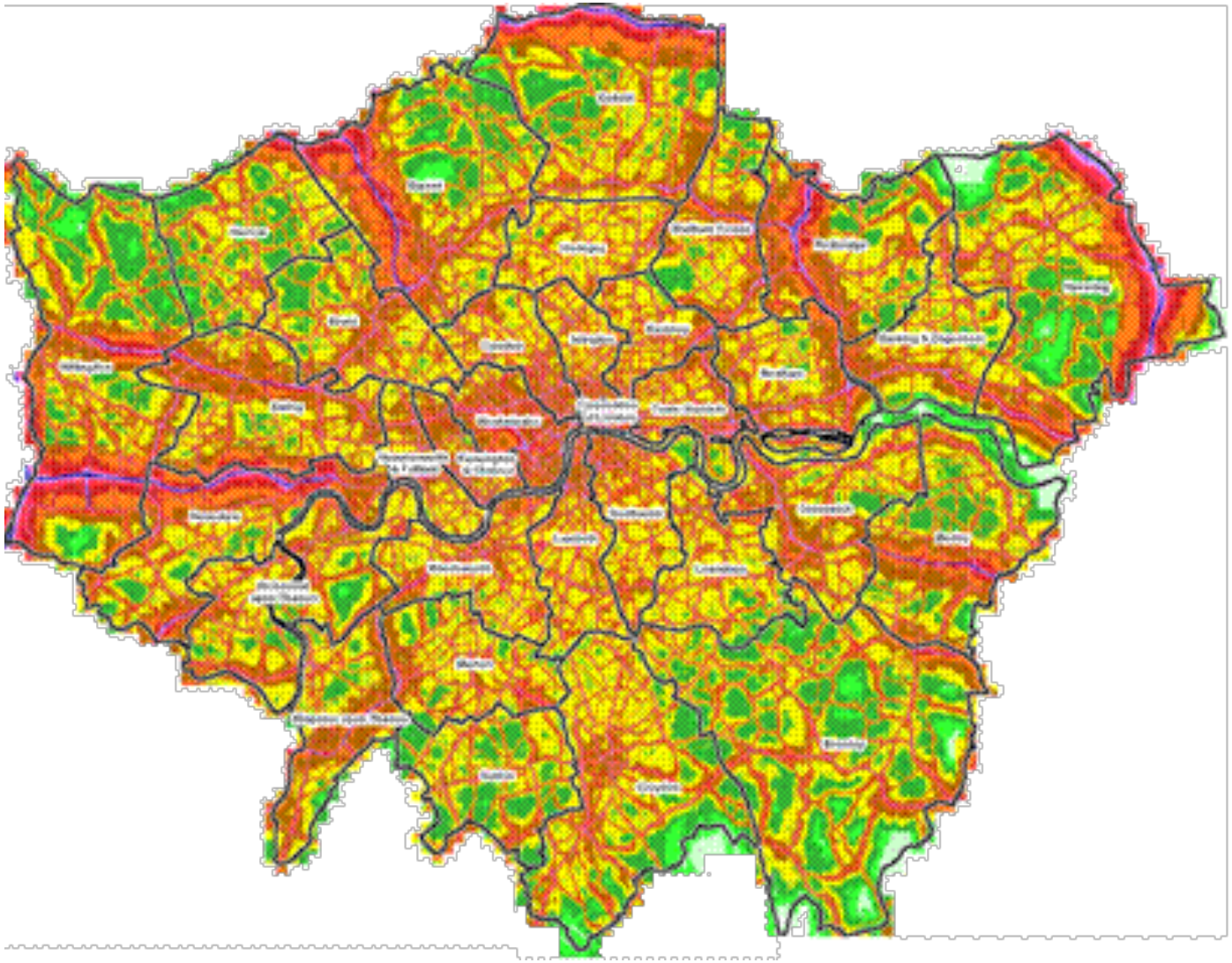
Detecting Objects

Measuring Distances

A Smartphone-Based “Radar” System

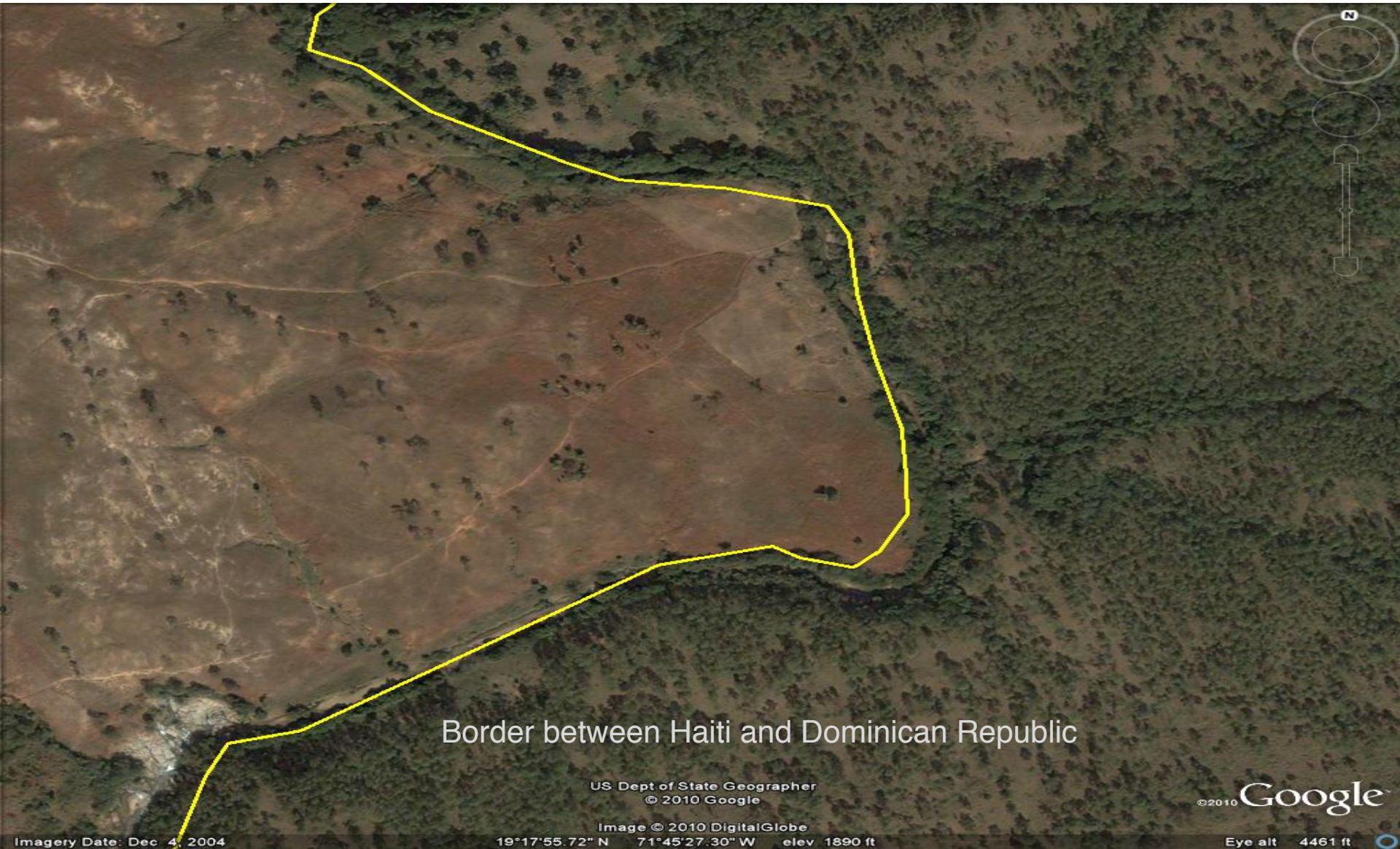


Noise Mapping



Luminosity Mapping

Map Environmental Change and Who Causes It



Map Resources and Who Uses Them

Would help to avoid shortages and recessions

Swarm
Pulse

mapping the world together

SHARE

Share light and sound sensor data, text messages, links and websites with users across the world.

VISUALIZE

Visualize light and sound levels in your city, view text messages and links shared by users over a map both in real time and in the past.

DOWNLOAD

Download the Android / iOS mobile app from the Google Play and Apple App Store respectively.

Available on the App Store

ANDROID APP ON Google play

www.swarmpulse.net
www.nervousnet.info

ETH zürich
Professorship of Computational Social Science (COSS)
Clausiusstrasse 50
8092 Zürich, Switzerland
Website: www.coss.ethz.ch

Carrier 4:39 PM

Back Visualisation

Mapping our Globe in 3D

Thanks to Marc Pollefeys

See also Open Streetmap - the free Wiki world map

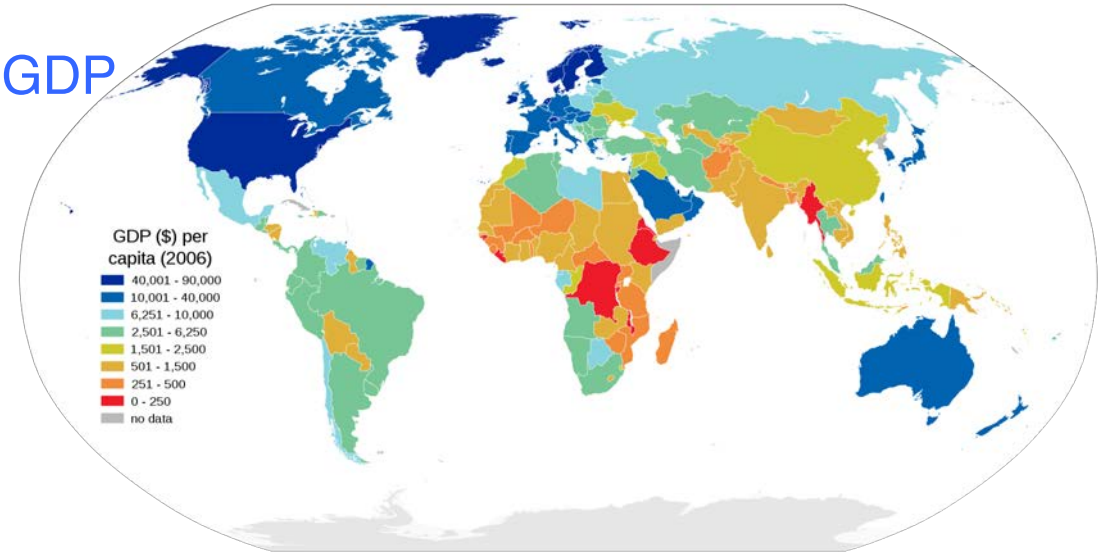
Creating more awareness to support better decisions, effective actions, and more responsible behavior

Create Awareness of Our Situation, and Our Impact on the World

Hand with Reflecting Sphere by
Maurits Cornelis Escher (1935)

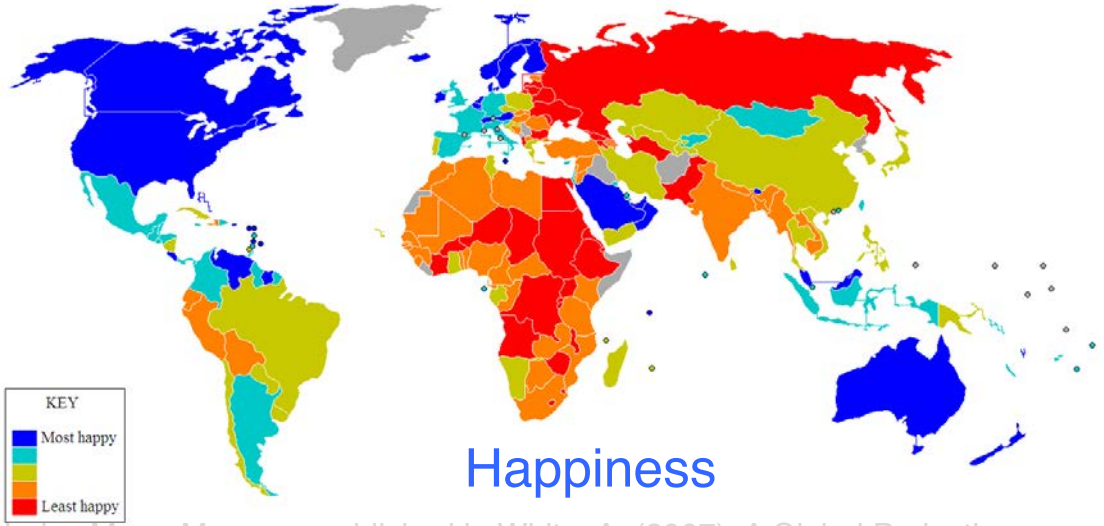
Create New Compasses for Decision-Makers

GDP



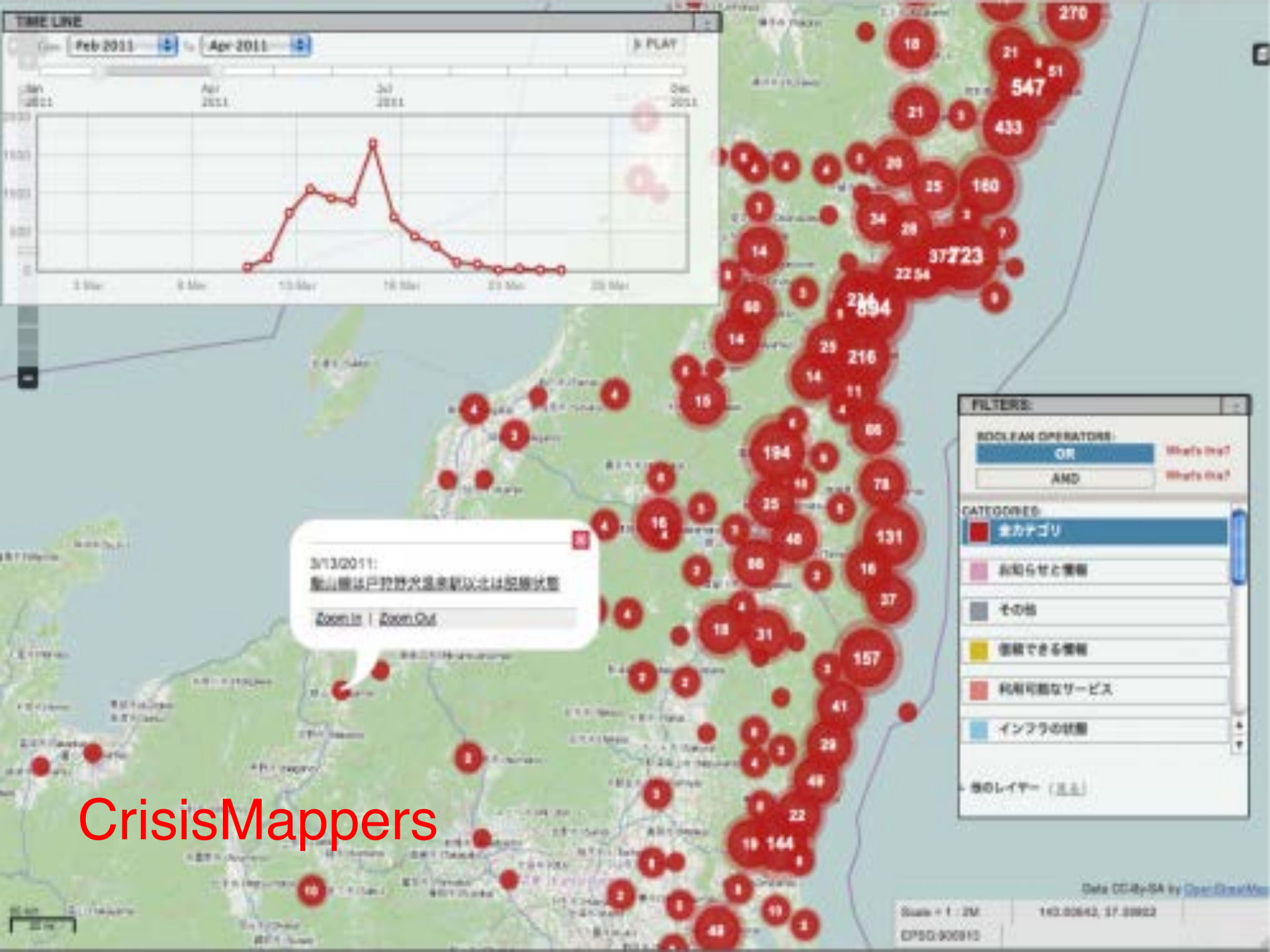
Gross Domestic Product per capita in 2006, world map. Bamse, CC-BY-SA 3.0. Wikimedia Commons.

Measure social capital: Reputation, trust, solidarity, compliance, …



Happiness

Satisfaction with Life Index Map - Map was published in White, A. (2007). A Global Projection of Subjective Well-being: A Challenge To Positive Psychology? Psychtalk 56, 17-20.


TIME LINE
Feb 2011
Apr 2011
PLAY
Jan 2011
Apr 2011
Jul 2011
Oct 2011
FILTERS:
BOOLEAN OPERATORS:
OR
AND
What's this?
What's this?
CATEGORIES:
全カテゴリ
お知らせと情報
その他
信頼できる情報
利用可能なサービス
インフラの状態
3/13/2011:
Zoom In | Zoom Out
CrisisMappers

swissnex San Francisco
730 Montgomery Street, San Francisco

Saturday, May 31, 2014
9:00 am – 9:00 pm

HACKATHON ON EARTHQUAKE RESILIENCE

WHAT IF THE BIG ONE HITS?

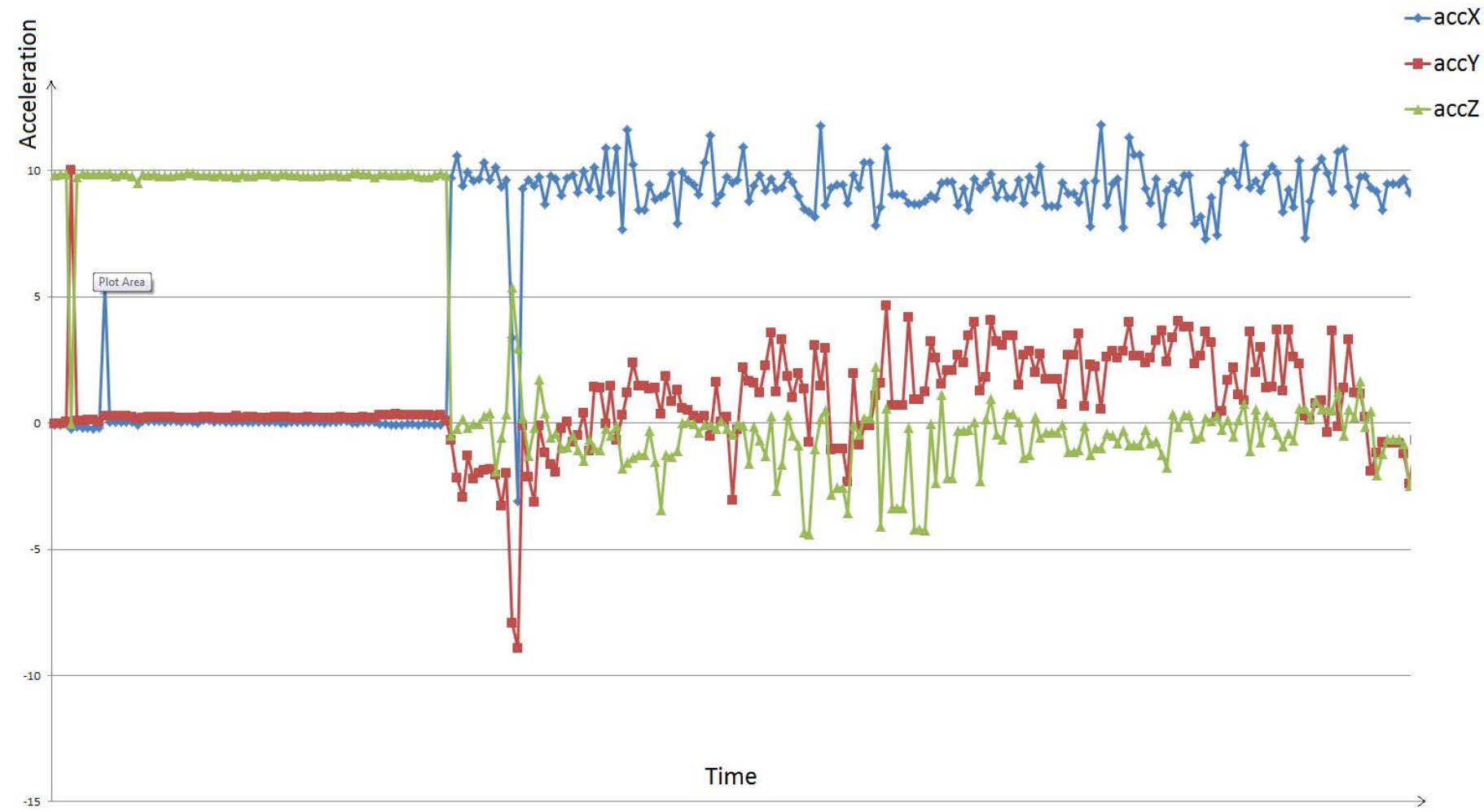
To cope with the Big One, preparation counts. Join the hacking community and data scientists from ETH FuturICT and UC Berkeley Smart Cities Research Center for a 12-hour hackathon to simulate and address post quake needs using information technologies and urban data.

PRIZES

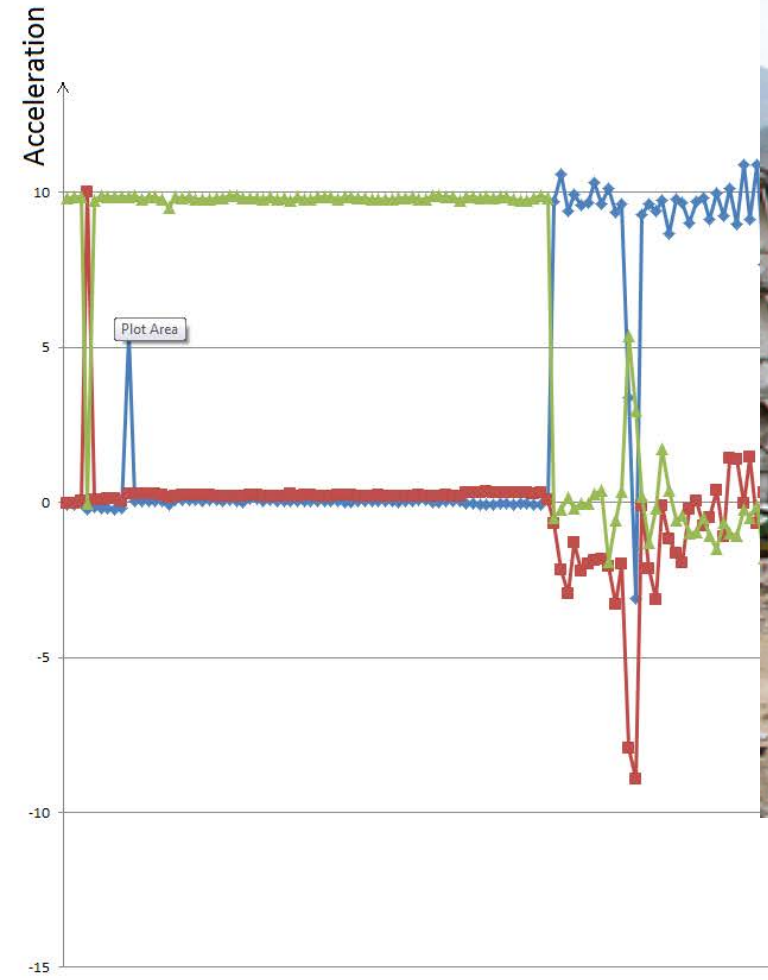
1st Fly to Switzerland to meet the FuturICT team
2nd & 3rd Present at netSci2014 conference

Graphic Design: Amanda Eisenhut

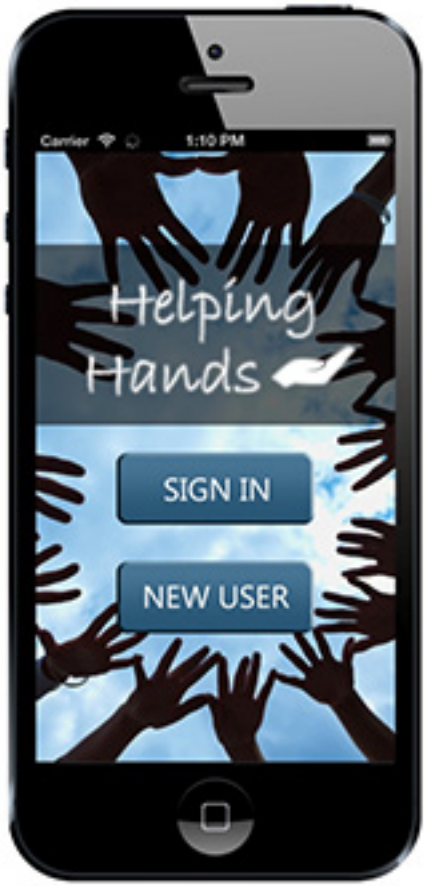
Visualization of Acceleration Data



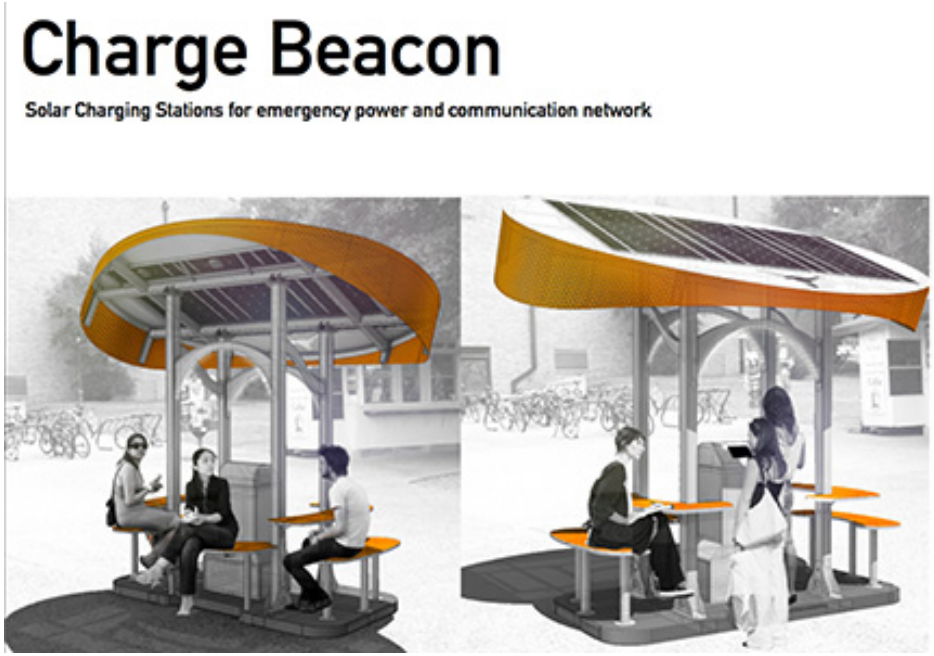
Detect Earthquakes and Warn Our Friends

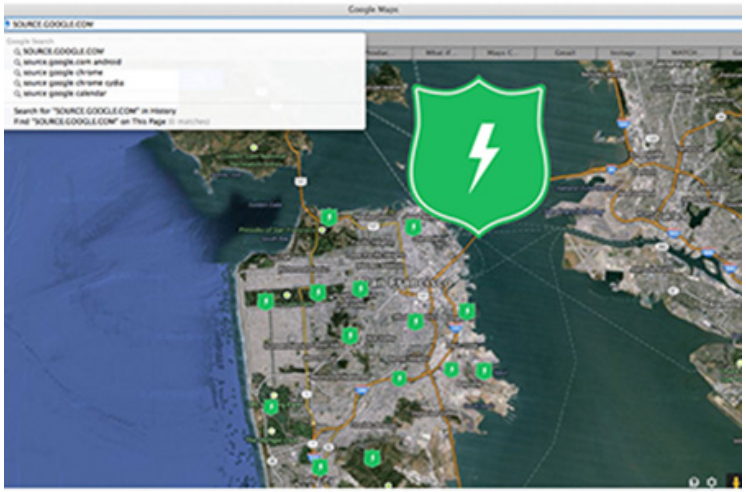


Participatory Disaster Response



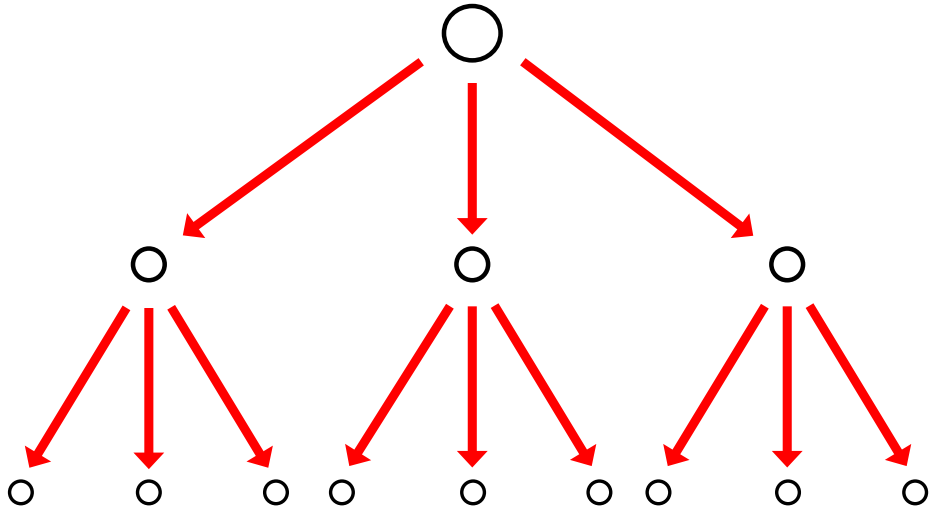
Helping Hands





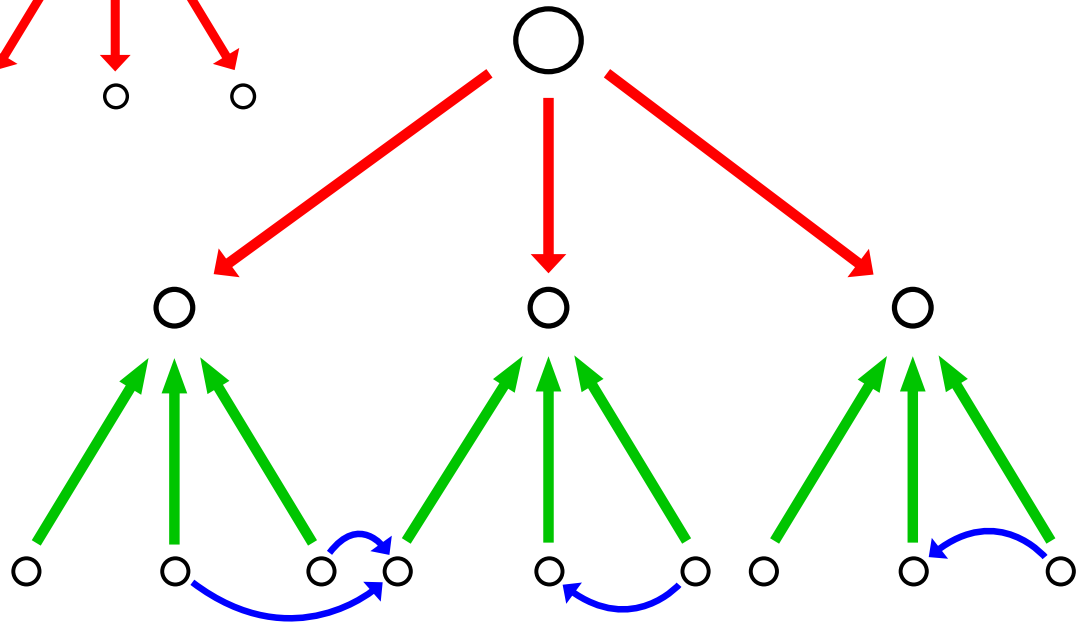
amigocloud

Paradigm Shift in Disaster Response Management: Bottom-Up Participation



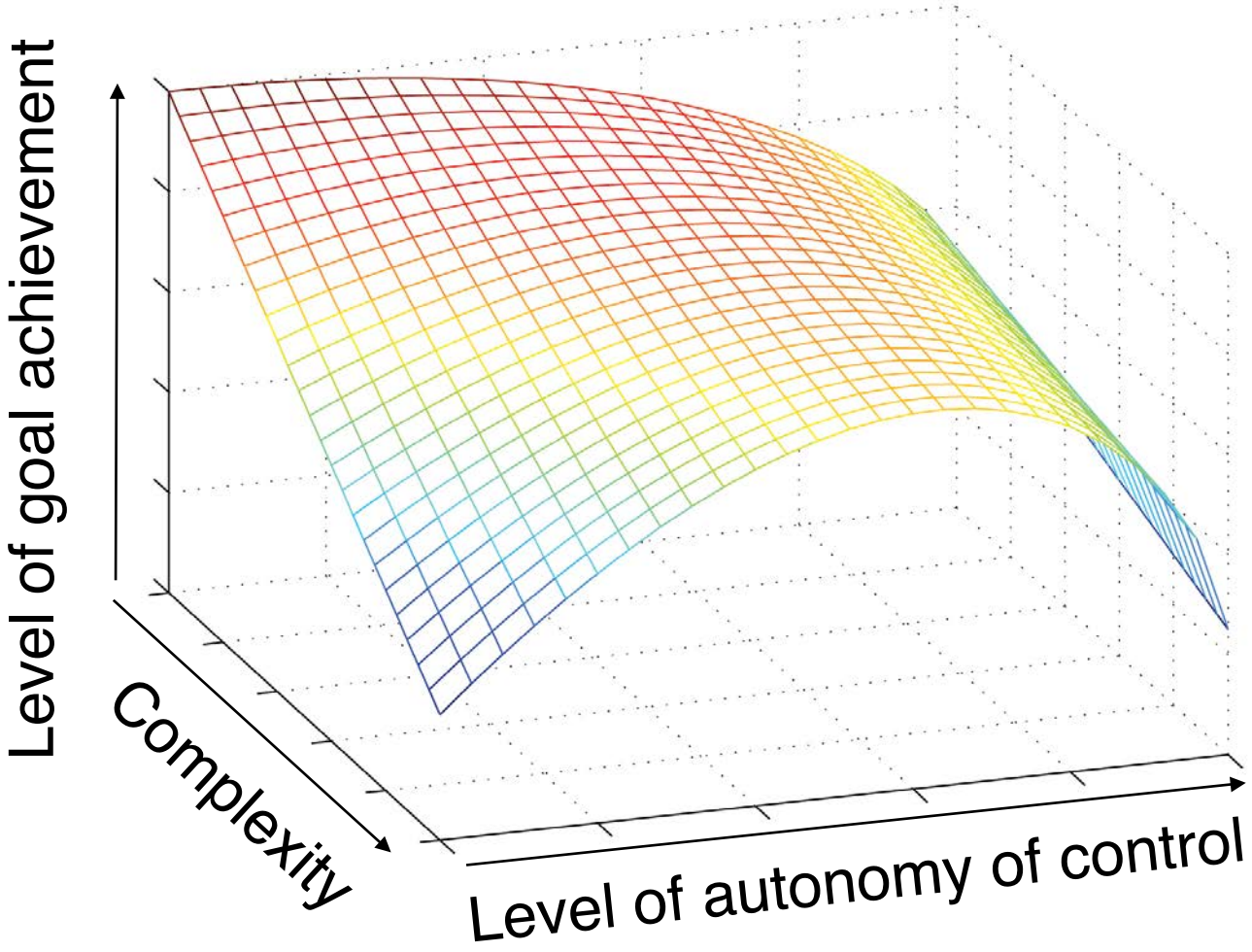
"Do this!"

In a quickly changing world, politics and business becomes increasingly similar to disaster response management!



"I can do this!"

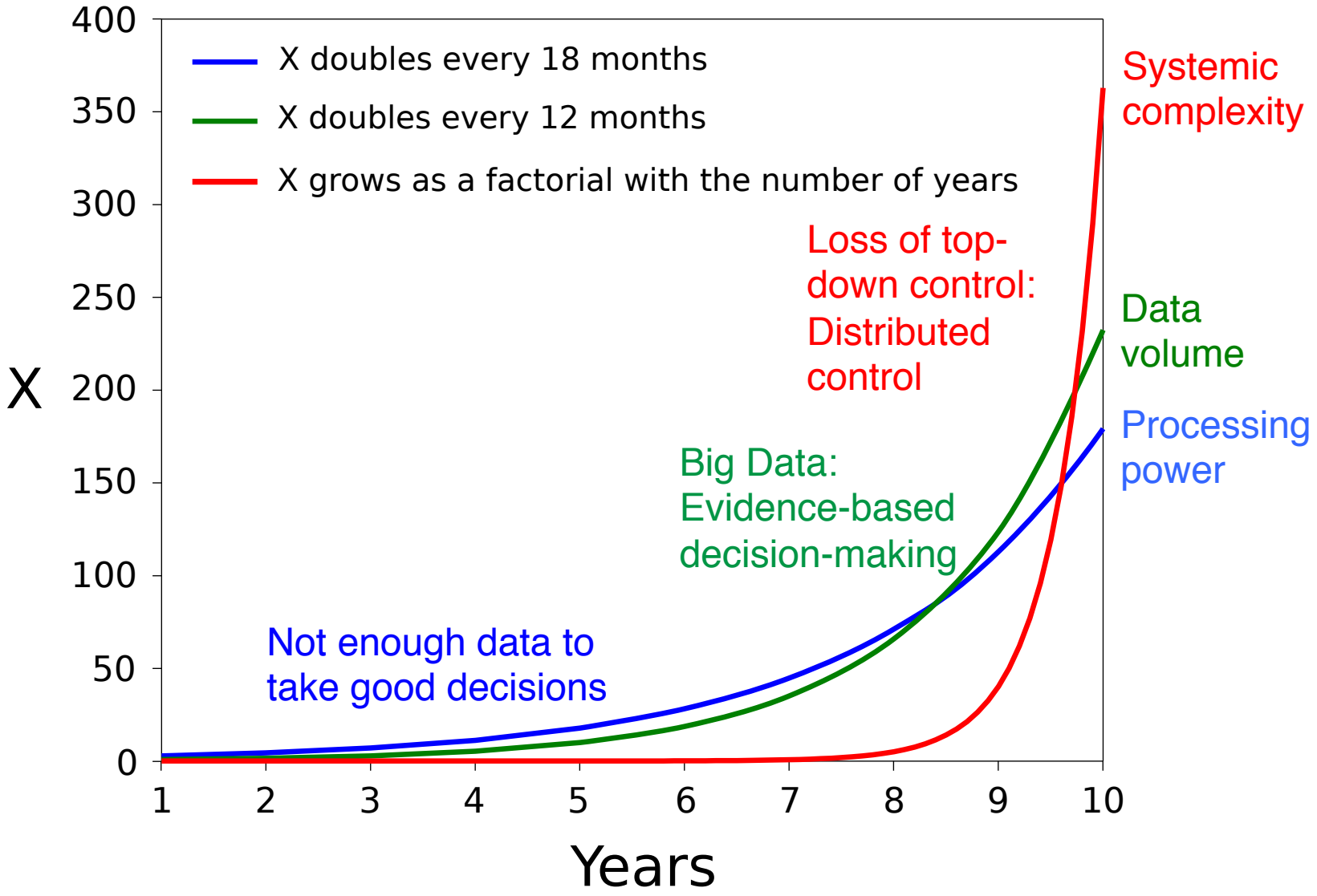
Better Performance of Complex Systems by More Autonomy + Suitable Interaction Rules



If complex dynamical systems vary a lot, are hard to predict and cannot be optimized in real-time, distributed control can outperform top-down control attempts by flexibly adapting to local conditions and needs.

(Windt, Böse, Philipp, 2006)

Exponential vs.Factorial Growth – Implications for the Governance of Complex Systems



Complexity and Global Systems Science can deliver explanatory models

More Wisdom Rather than More Power Needed

Minimally invasive
measures are advised!

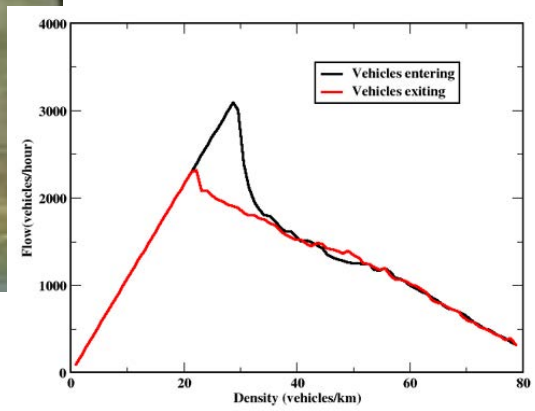
In complex systems,
more isn't better. It's often poisonous!

The big unsolved problems of the world result from systemic instabilities

„Phantom Traffic Jams“

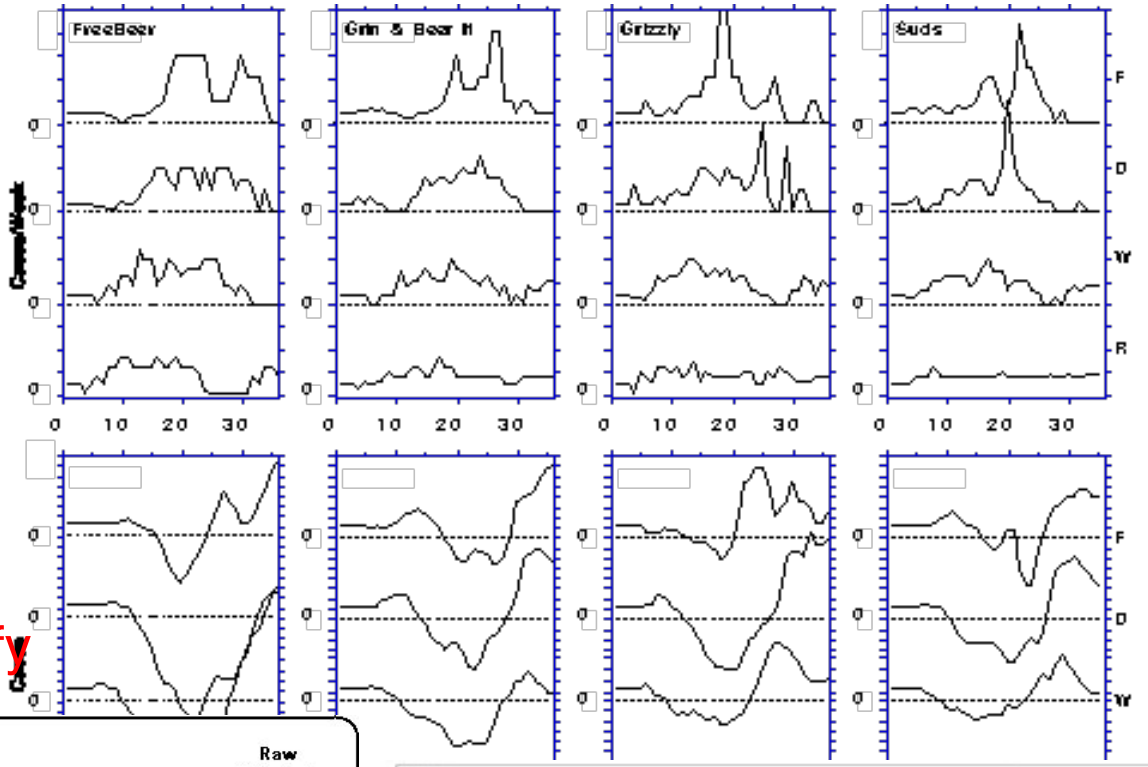
Thanks to
Yuki Sugiyama

Capacity drop,
when capacity
is most needed!

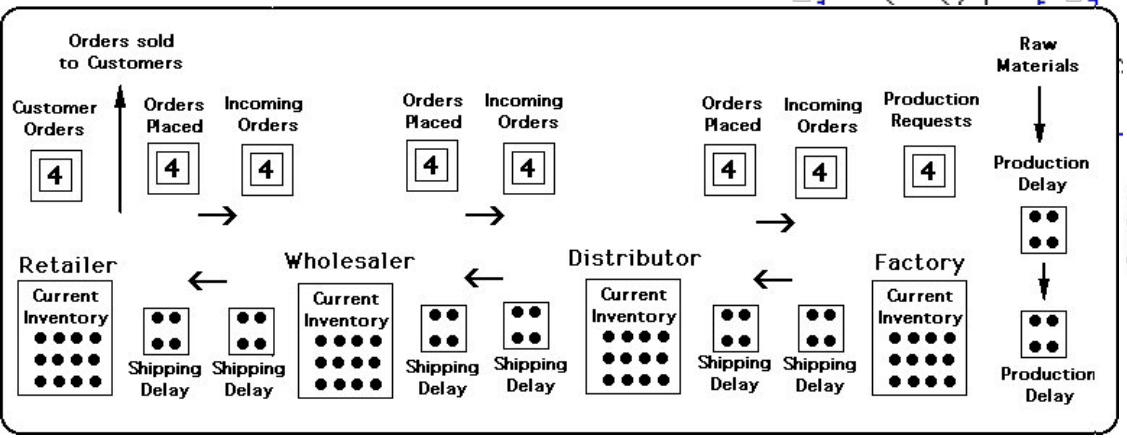


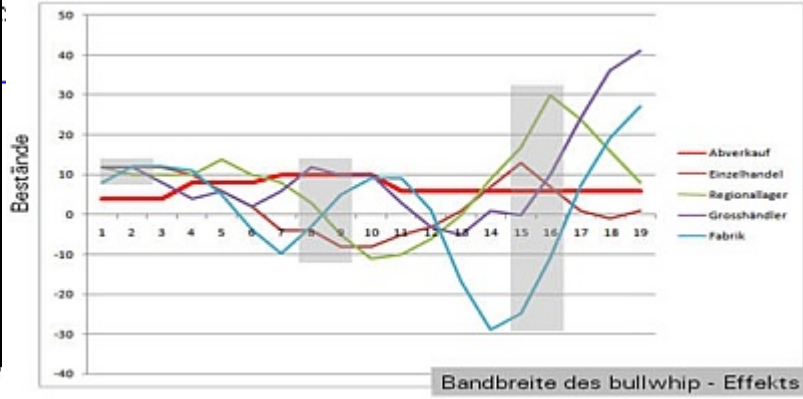
At high densities, free traffic flow is unstable:
Despite best efforts, drivers fail to maintain speed

Unstable Supply Chains: When Managers Lose Control

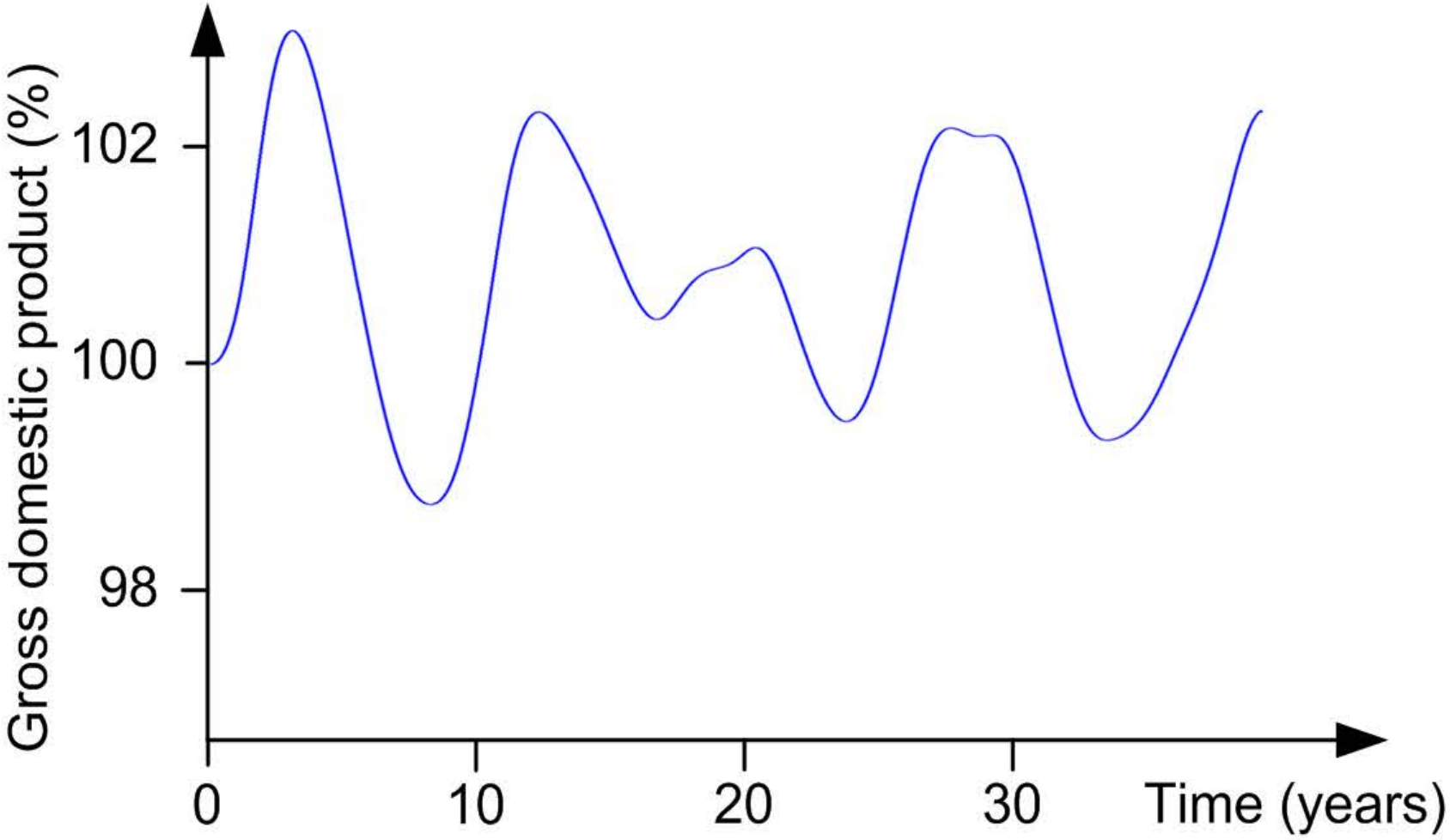


Perturbations in demand amplify





Economic Instability: Booms and Recessions



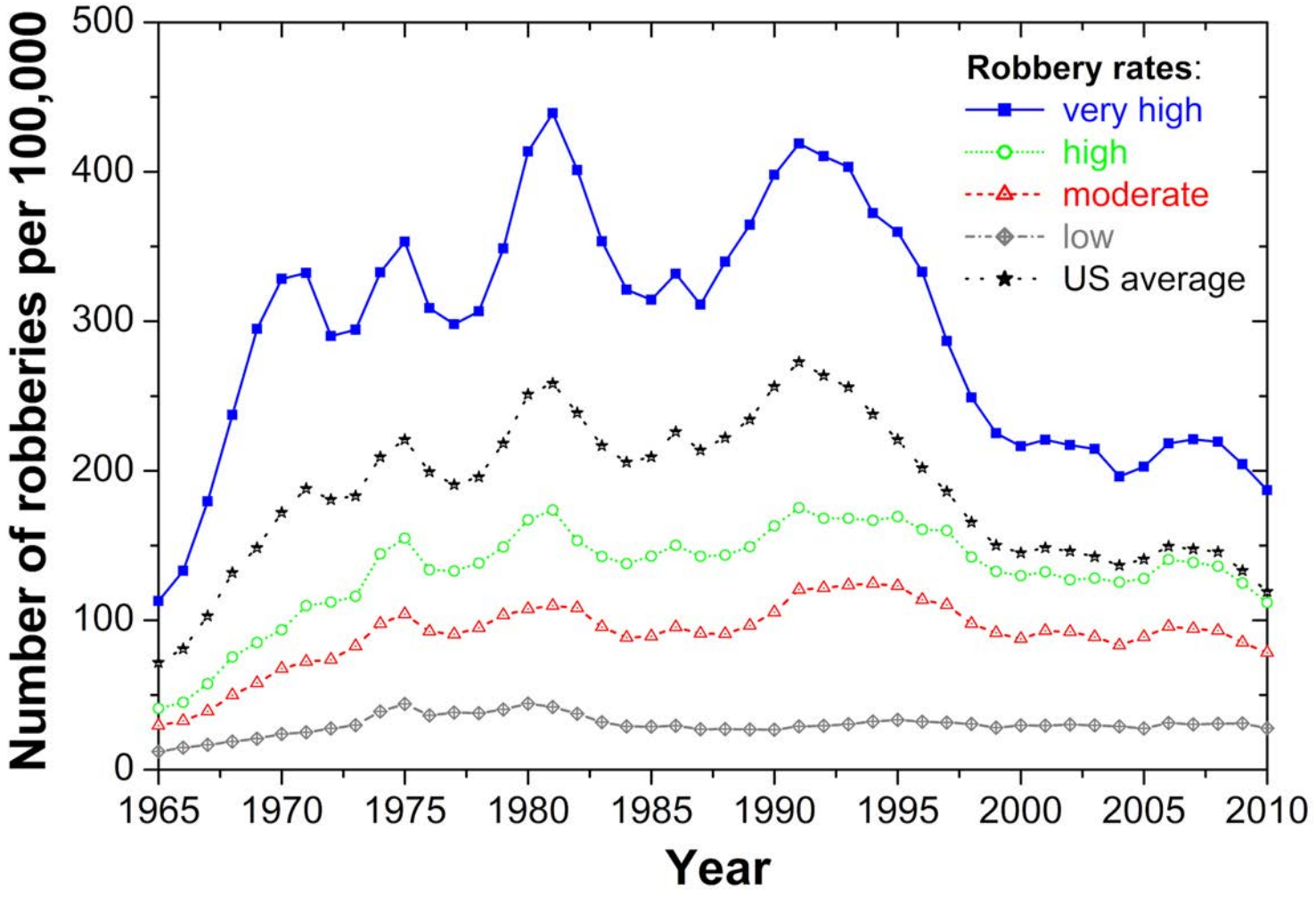
As Coupling Gets Stronger, System Behavior Can Change Completely: Crowd Disasters

At low densities:
self-organized lane formation,
like Adam Smith's invisible hand

Love Parade Disaster in Duisburg, 2010

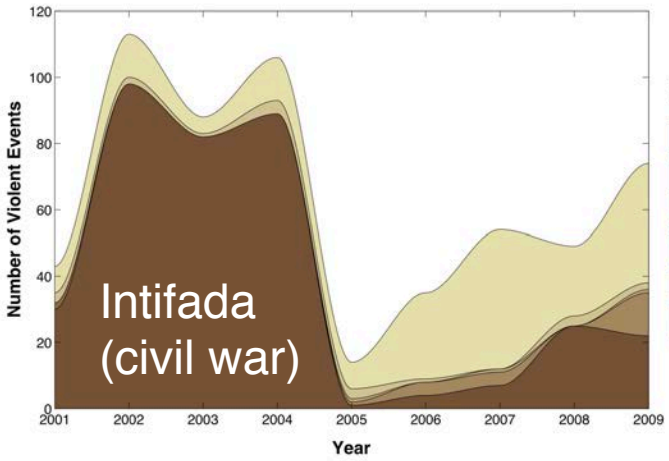
At large densities: coordination breaks down

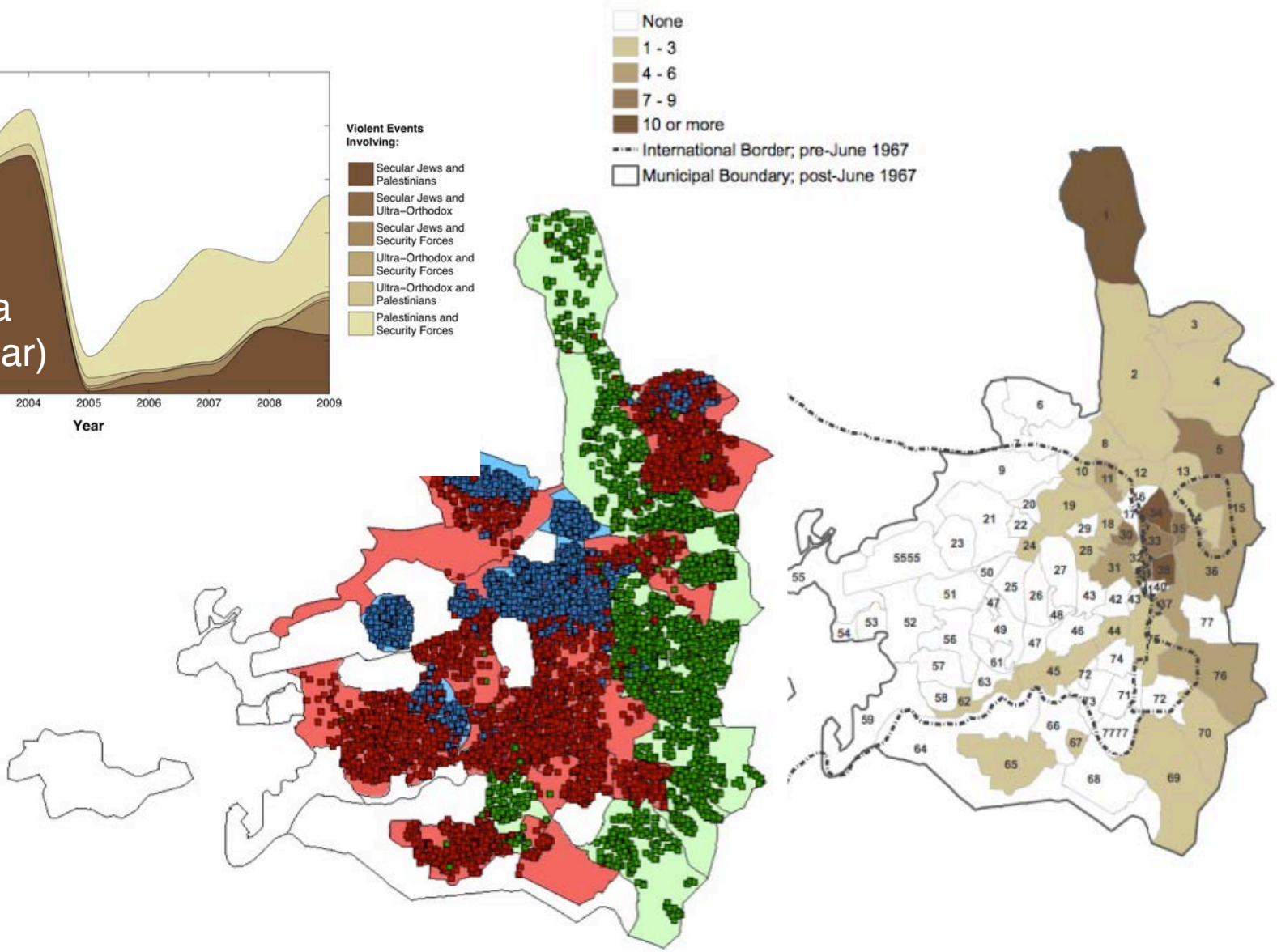
Unstable Social Dynamics and Spreading of Crime



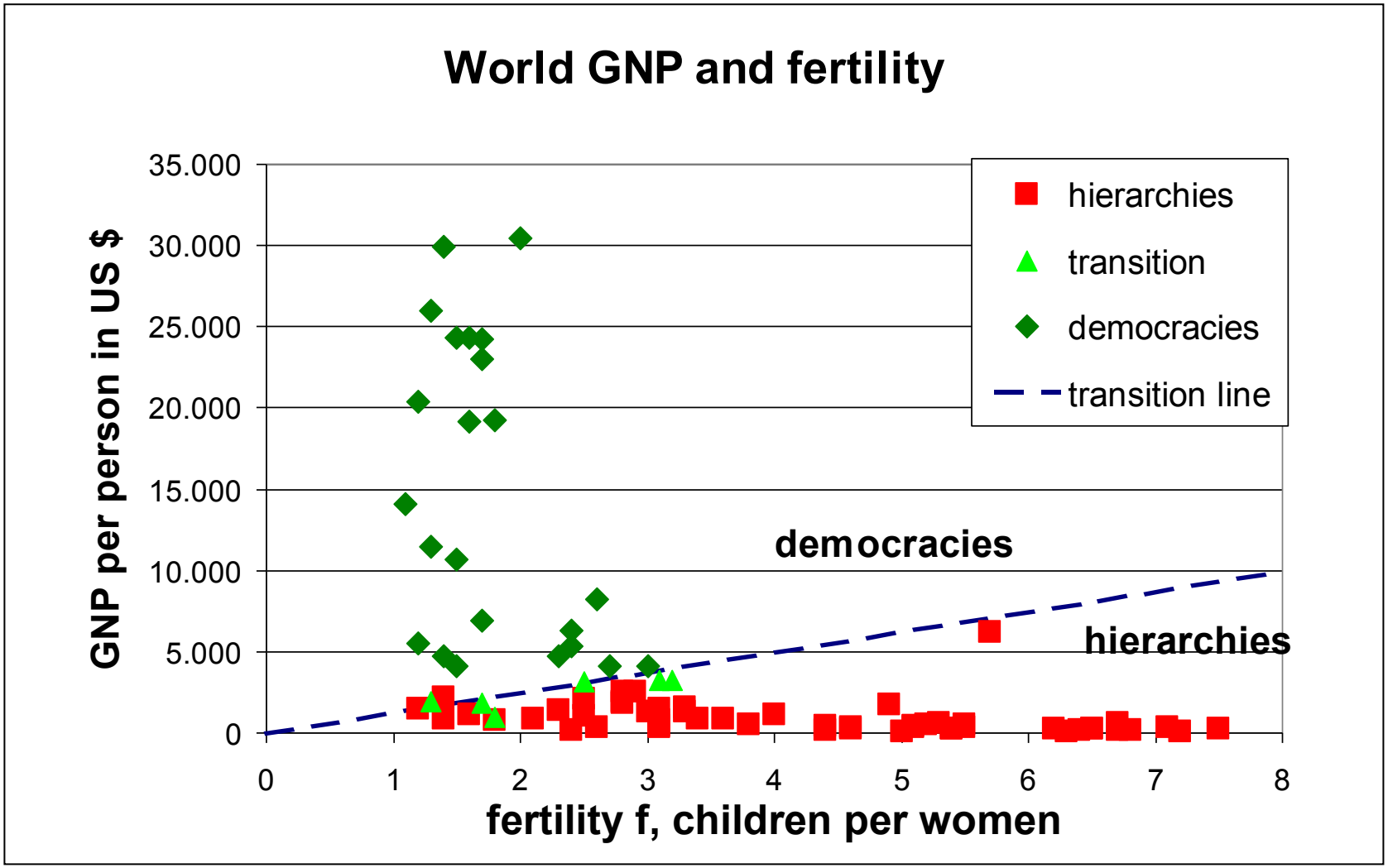
“Tragedies of
the Commons”,
e.g. Overfishing

Conflicts as Results of Social Instabilities



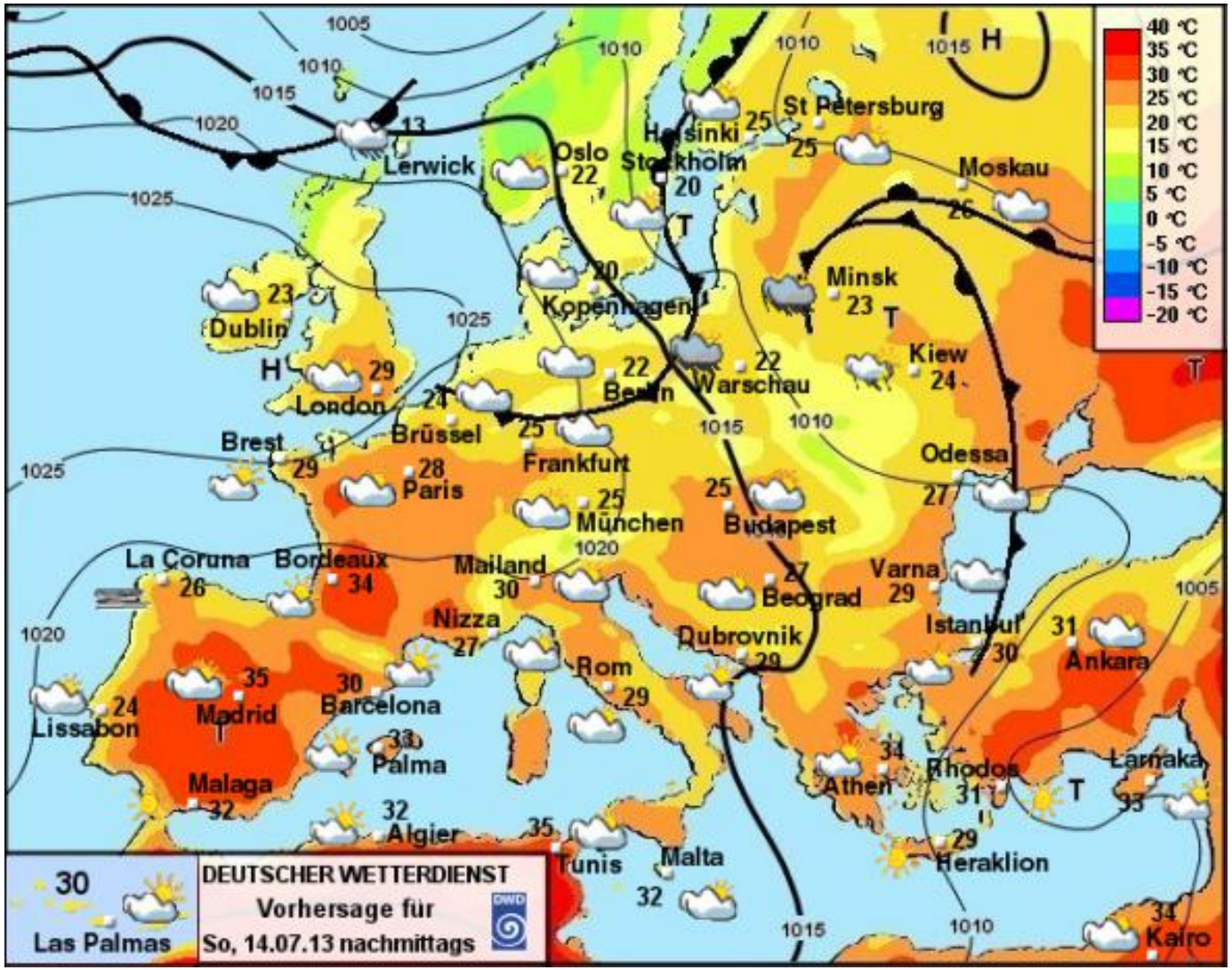


Revolutions: Role of GDP/Capital and Fertility



Source: Jürgen Mimkes

Complex Dynamical Systems: Limits of Predictability



Loss of Control through Cascade Effects

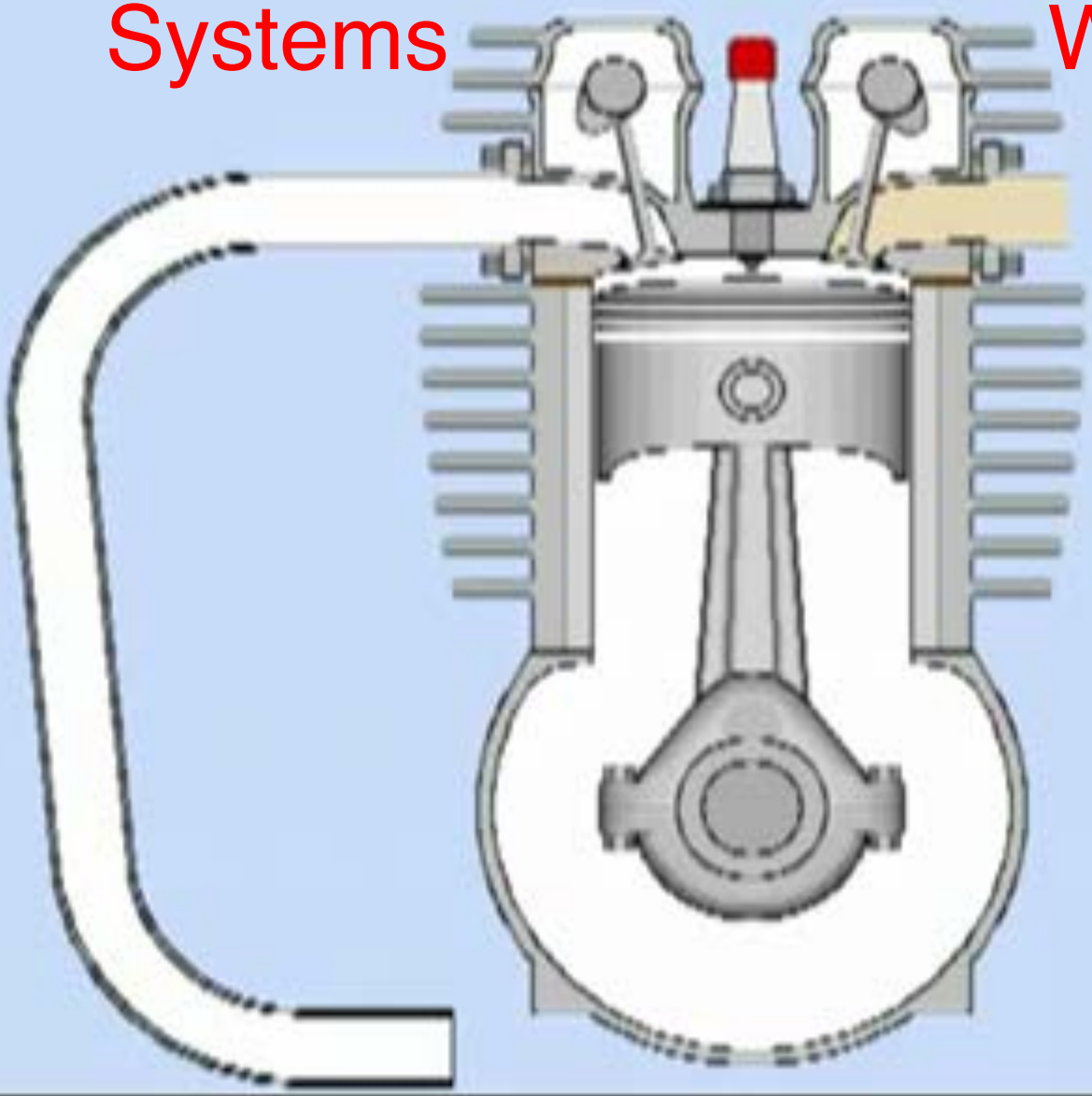
Mousetrap fission, by Gerhard G. Paulus, University of Jena, https://www.youtube.com/watch?v=Wiz1VVLYgl4

Cascading Effects During Financial Crises

Video by Frank Schweitzer et al.

Complexity Science allows us to use the hidden forces behind self-organization

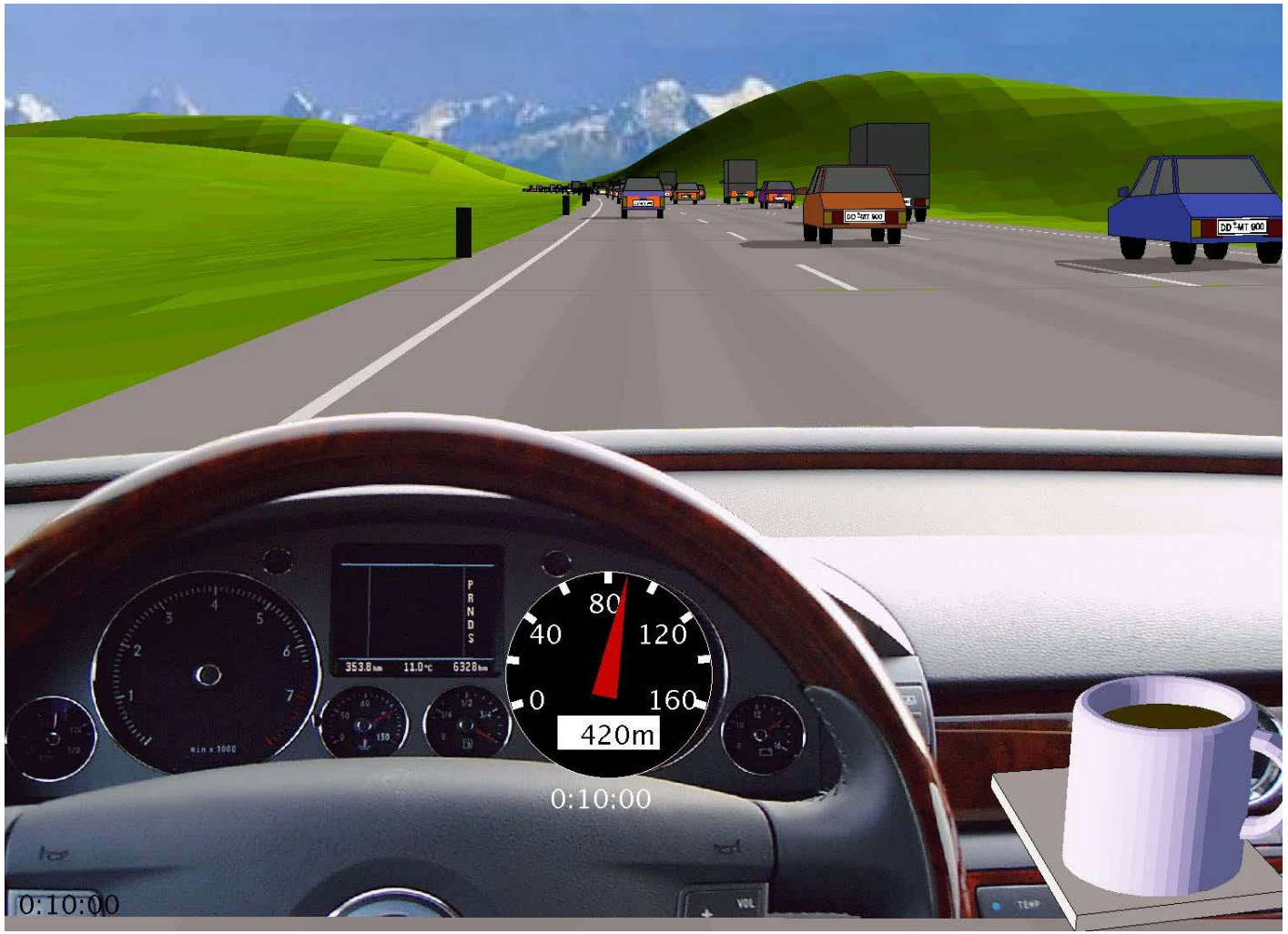
We Can Let Socio-Economic Systems Work for Us!



Asian Martial Arts
Use the forces to your own advantage!

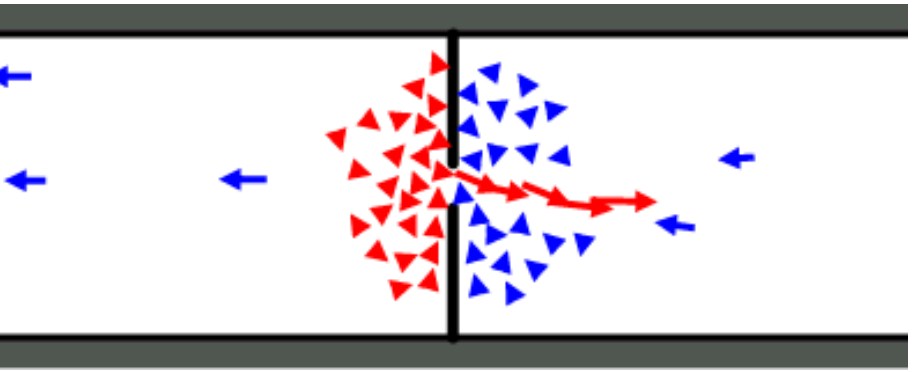
Complexity science offers new approaches to address long-standing problems

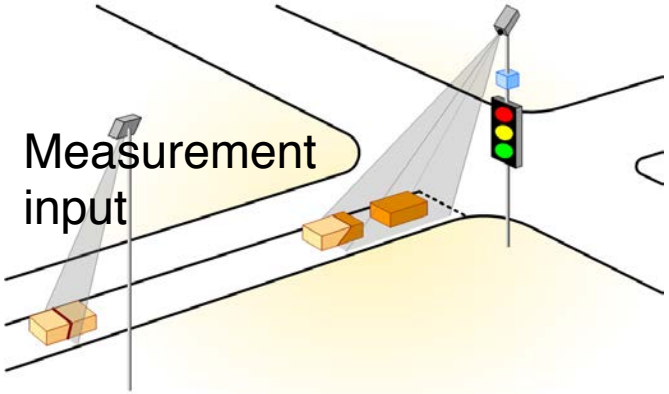
Overcoming Congestion by Real-Time Feedback



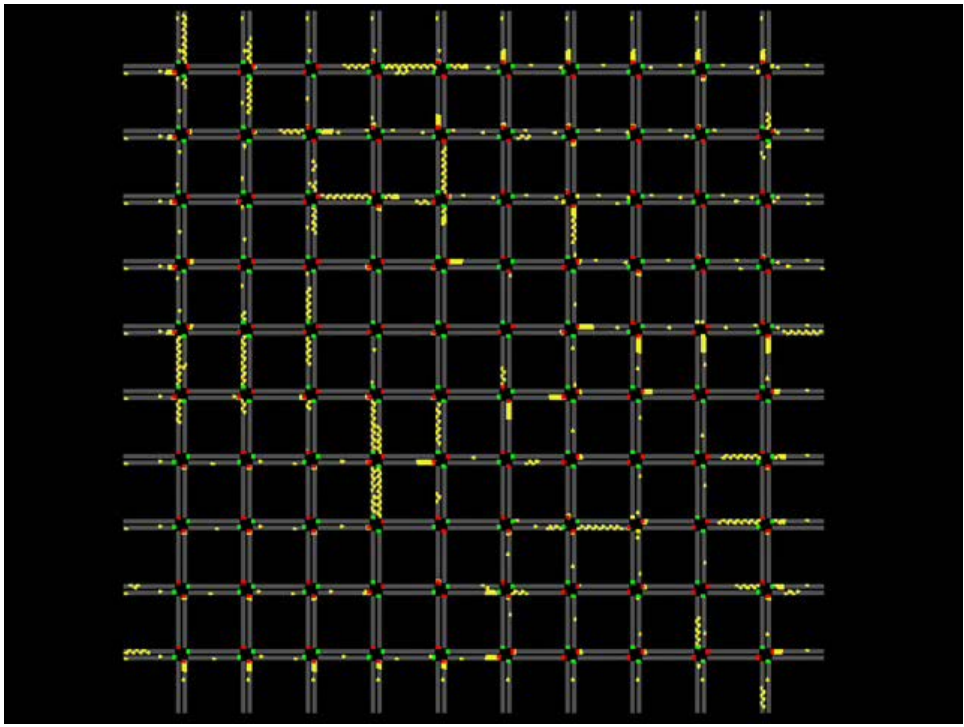
Decentralized Concept of Self-Organized Traffic Light Control

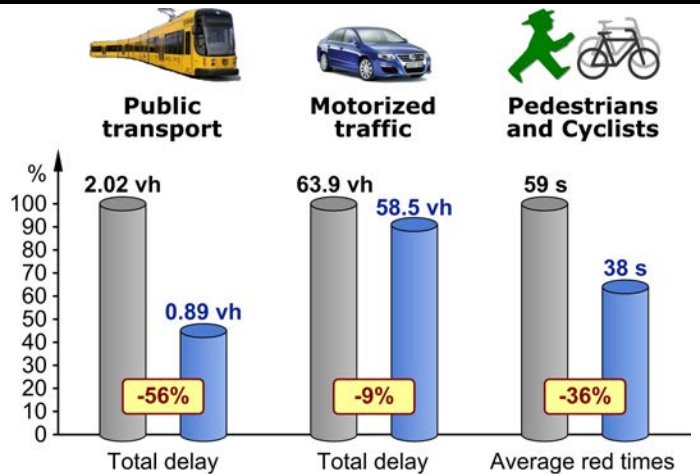
Inspiration: Self-organized oscillations at bottlenecks



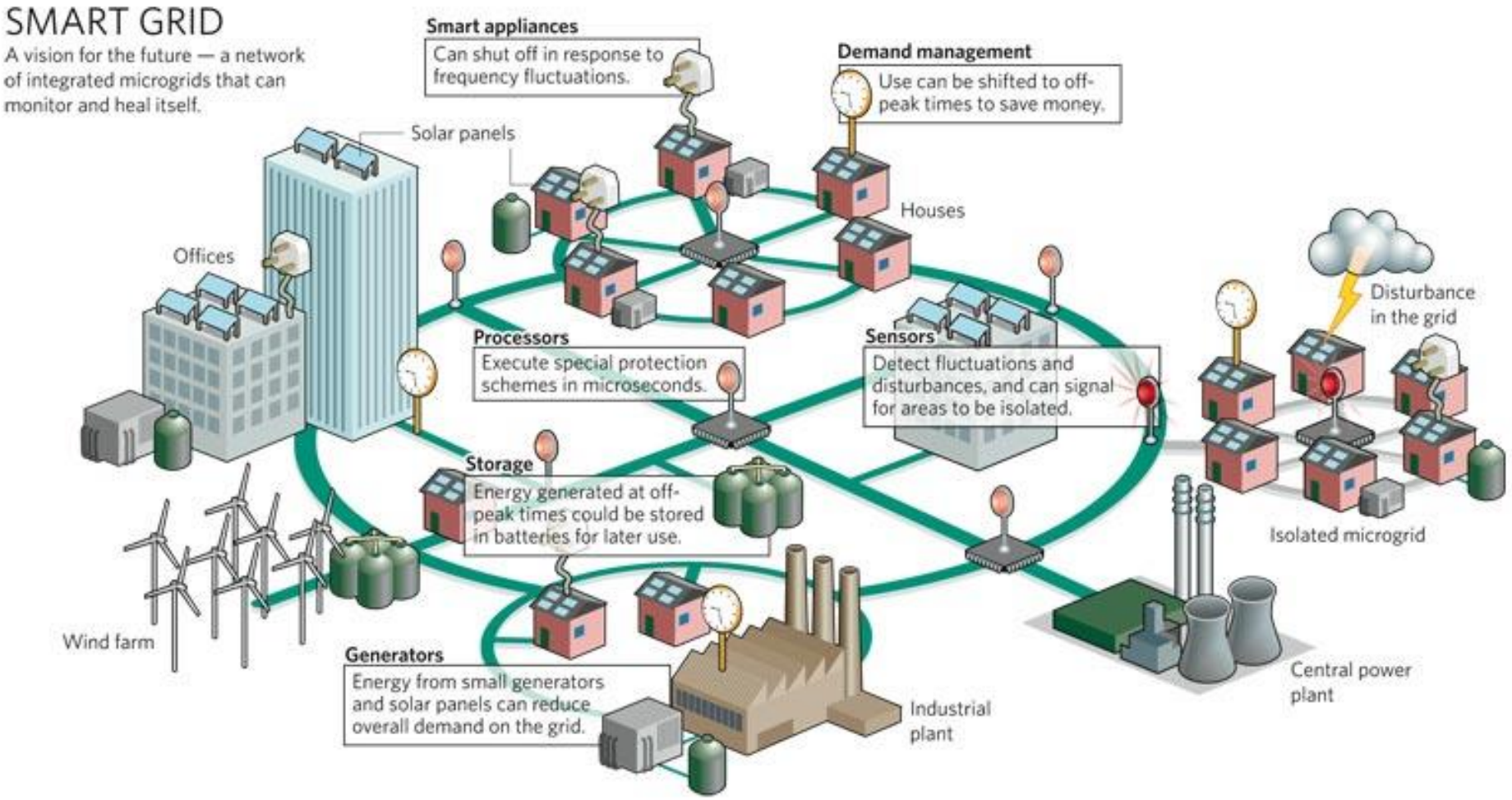


Published in *JSTAT* (2008)





Smart Grids: Decentralized Energy Production, Intelligent Consumption



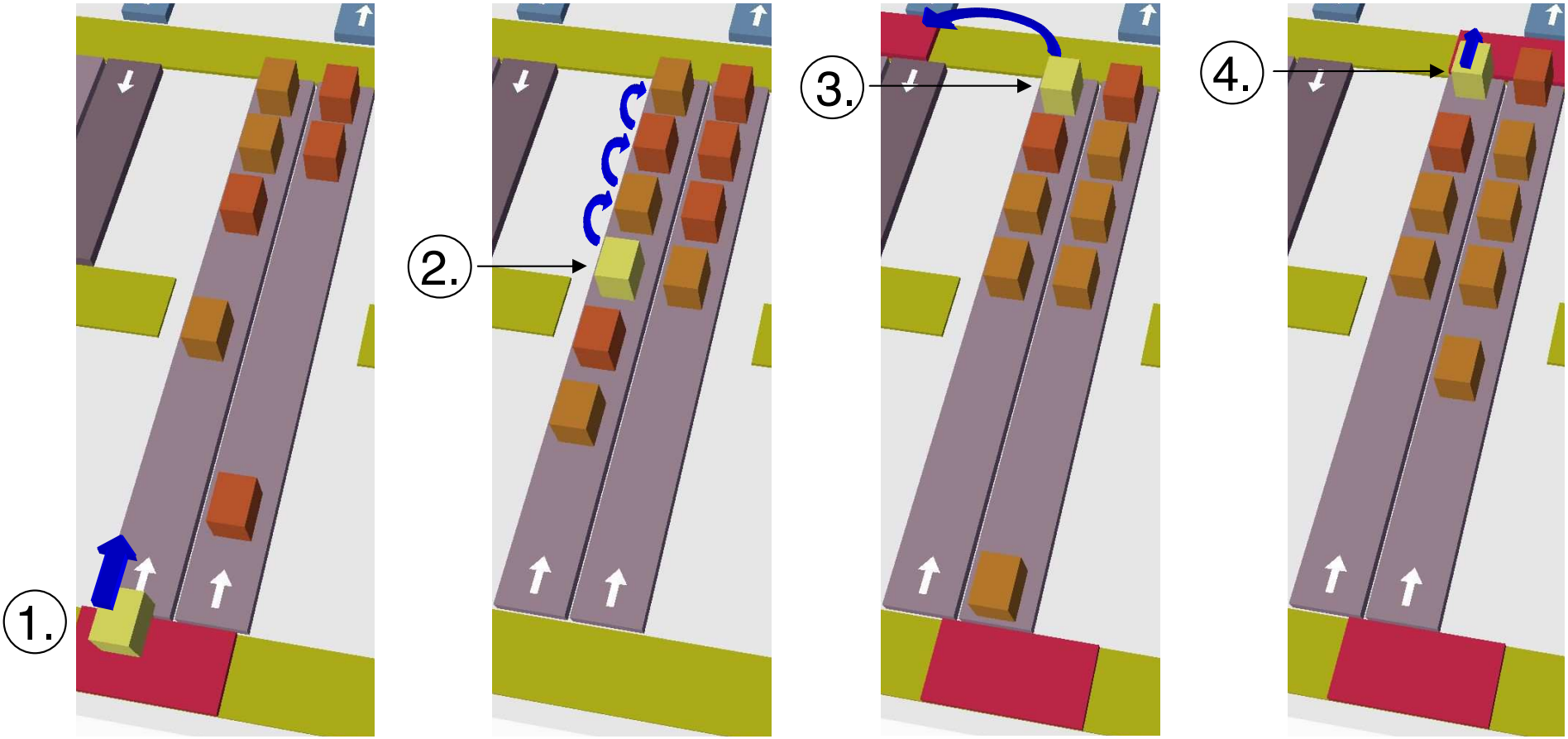
Industry 4.0: Specification of Information Flows and Interaction Rules

A unit enters the lane

It decides to exit the lane

It sends a request for a transfer car

The unit exits the lane



Suitable interaction mechanisms can also enable the self-organization of the economy and society

7-8

THE FABLE OF THE BEES: OR, *Private Vices Publick Benefits.*

LONDON:
Printed for J. ROBERTS, near the *Oxford Arms* in *Warwick Lane*, 1714.

[illegible]

ADAM SMITH, LL.D.

AN

INQUIRY

INTO THE

NATURE AND CAUSES

OF THE

WEALTH OF NATIONS.

By ADAM SMITH, LL. D.

WITH A LIFE OF THE AUTHOR,
AN INTRODUCTORY DISCOURSE, NOTES, AND
SUPPLEMENTAL DISSERTATIONS.

By J. R. M'CULLOCH, Esq.
PROFESSOR OF POLITICAL ECONOMY IN THE UNIVERSITY OF LONDON.

IN FOUR VOLUMES.
VOL. I.

EDINBURGH:
PRINTED FOR ADAM BLACK, AND WILLIAM TAIT;
AND LONGMAN, REES, ORME, BROWN, AND GREEN,
LONDON.

M.DCCC.XXVIII.

“Tragedies of the commons” and financial crises are examples illustrating that the “invisible hand” doesn’t always work

Enviromental Pollution

Can We Build Assistance Systems for Cooperation?

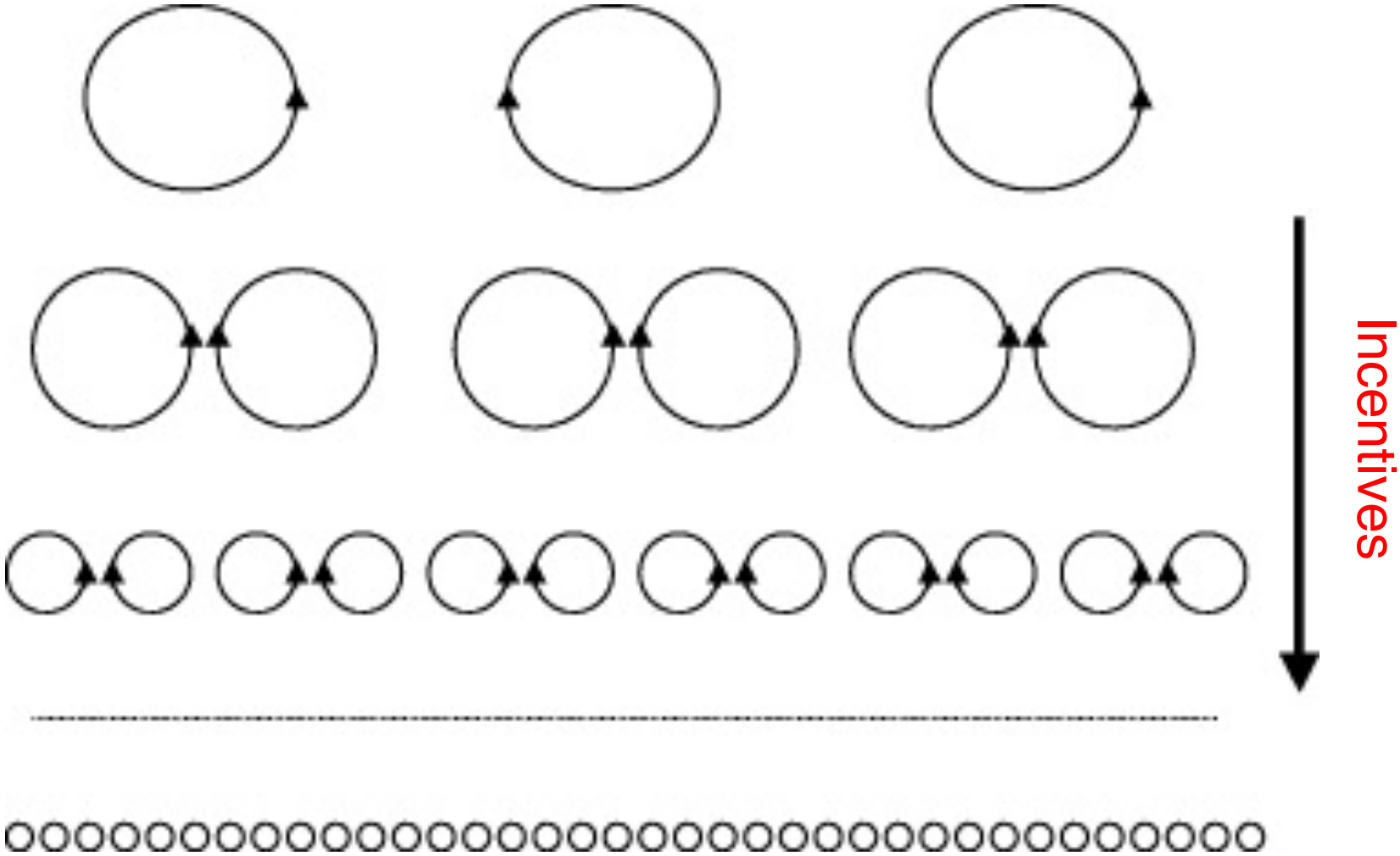
Empirical Studies of Self-Governance Confirm Efficiency, Given Proper Design Principles

Reputation Systems to Increase Quality

300 years after its invention, we can make the „invisible hand“ work, using the „Internet of Things“ to run self-organizing systems based on real-time measurements and adaptive feedback

Measure Externalities and Create Suitable Feedback Loops to Enable Self-Organization

Multi-Level Coordination



Technology-supported subsidiarity principle

We Need Multi-Dimensional Incentive and Value Exchange Systems

Multi-dimensional finance

In A Diverse World
We Need to Create Interoperability

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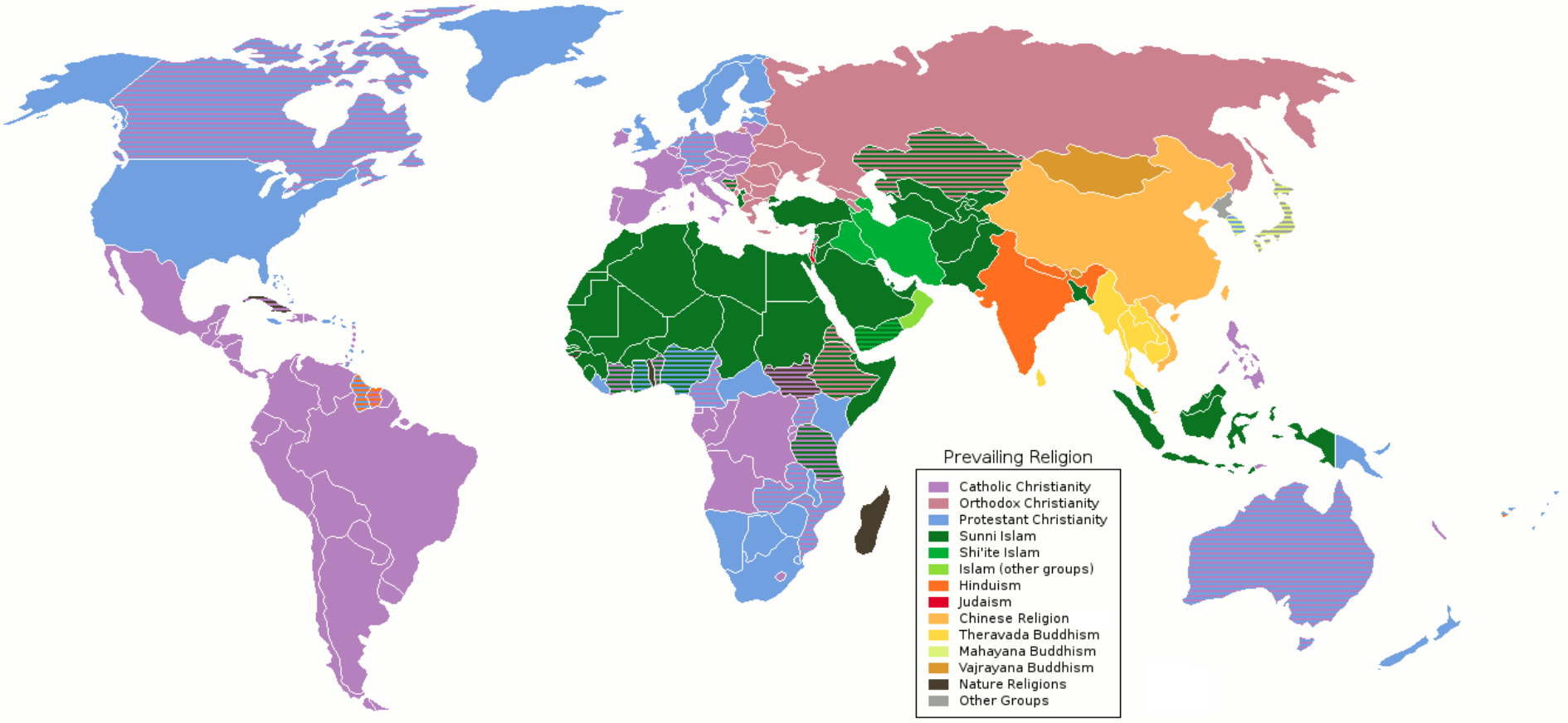
Discover, Use and Combine the Success Principles Underlying Different Cultures

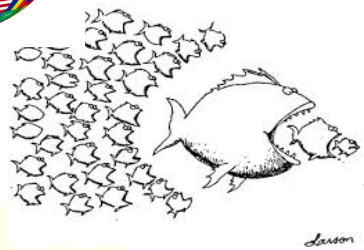


Overcome the large degree of “cultural analphabetism”

Image by LilTeK21 on commons.wikimedia.org, GNU Free Documentation License

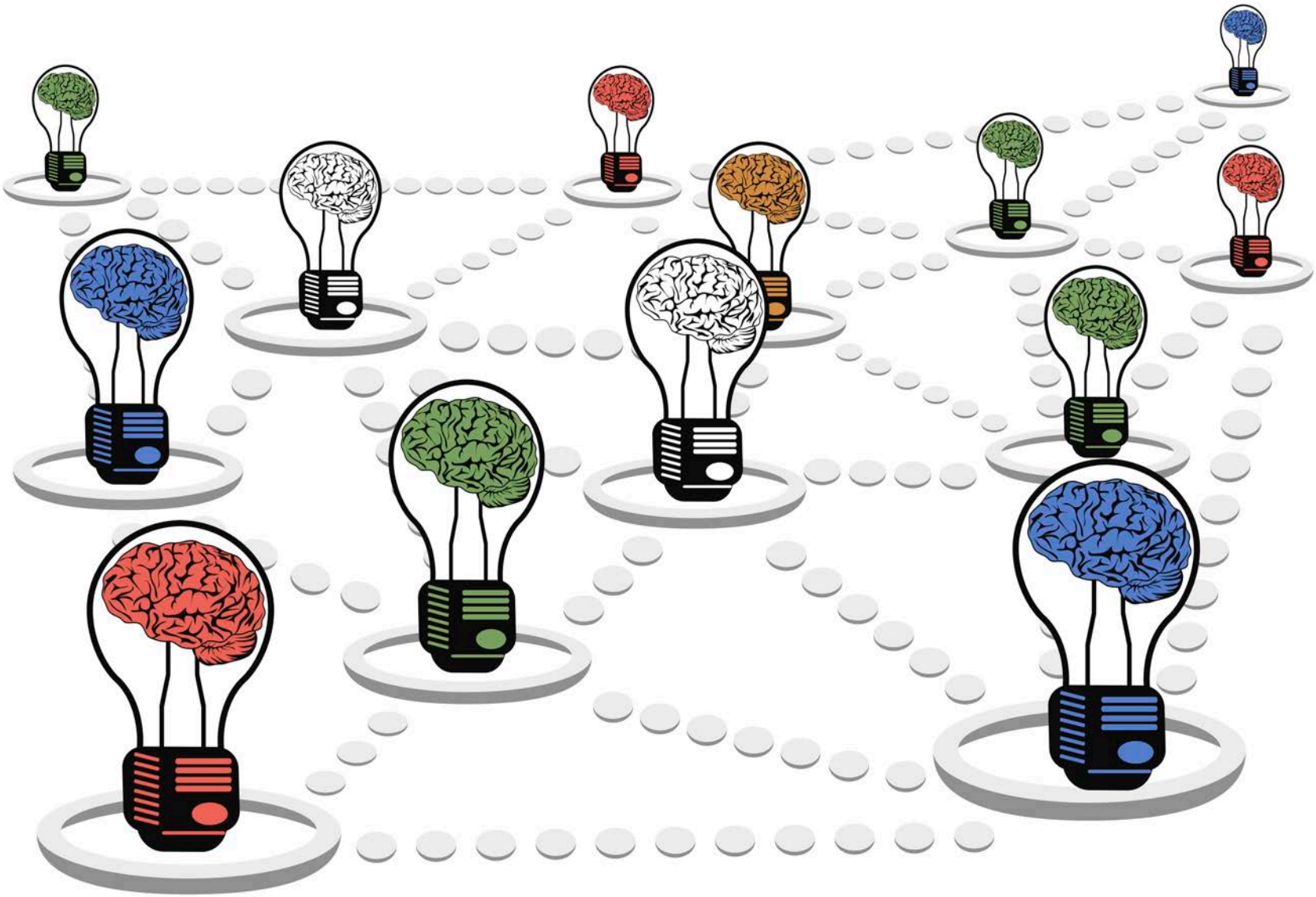
Support Favorable Interactions with Personal Digital Assistants

Task	Technology
Support situational / context awareness	**Social Mirror**
Facilitate profitable interactions	**Social Adapter**
Avoid lossful interactions	**Social Protector**
Incentivize favorable interactions / support value transfer	**Social Money**



Supporting Collective Intelligence

Bring the Best Ideas of Many Minds Together



http://medialniproroci.blogspot.ch/2013/04/sharing-is-new-shoppingand-working.html

Netflix Challenge: Diversity Wins, Not the Best

Leaderboard

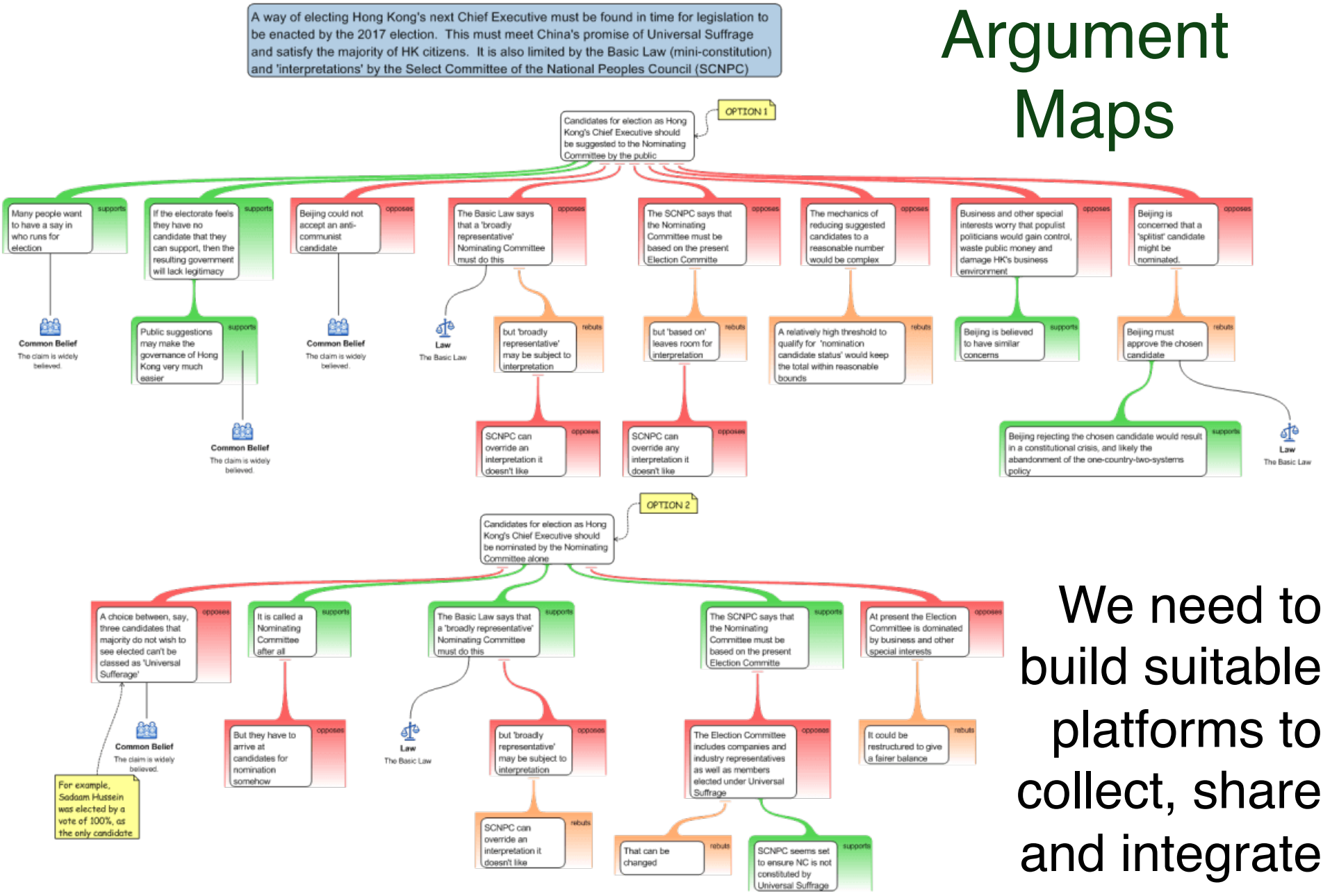
Display top 20 leaders.

Rank	Team Name	Best Score	% Improvement	Last Submit Time
1	BellKor's Pragmatic Chaos	0.8558	10.05	2009-06-26 18:42:37
Grand Prize - RMSE <= 0.8563				
2	PragmaticTheory	0.8582	9.80	2009-06-25 22:15:51
3	BellKor in BigChaos	0.8590	9.71	2009-05-13 08:14:09
4	Grand Prize Team	0.8593	9.68	2009-06-12 08:20:24
5	Dace	0.8604	9.56	2009-04-22 05:57:03
6	BigChaos	0.8613	9.47	2009-06-23 23:06:52
Progress Prize 2008 - RMSE = 0.8616 - Winning Team: BellKor in BigChaos				
7	BellKor	0.8620	9.40	2009-06-24 07:16:02
8	Gravity	0.8634	9.25	2009-04-22 18:31:32
9	Opera Solutions	0.8638	9.21	2009-06-22 05:53:30
10	xlvector	0.8639	9.20	2009-06-26 13:49:04
11	xiangliang	0.8639	9.20	2009-06-26 07:47:34
12	BruceDengDaoCiYiYou	0.8641	9.18	2009-06-02 17:08:31
13	Ces	0.8642	9.17	2009-06-24 14:34:14
14	majia2	0.8642	9.17	2009-06-23 08:07:50

Top-down and majority decisions obstruct collective intelligence

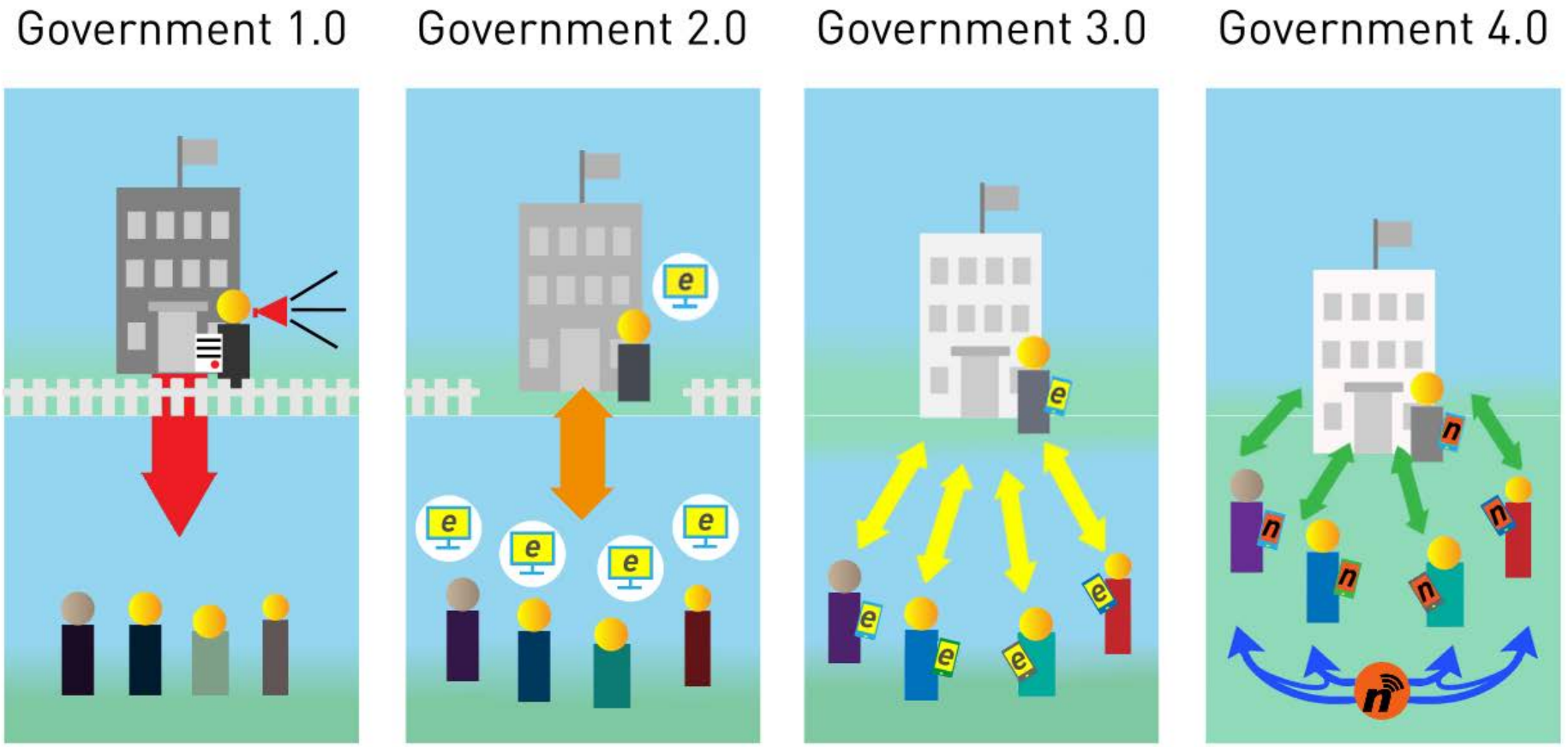
Wisdom of crowds requires independent exploration and then integration

Argument Maps



We need to build suitable platforms to collect, share and integrate ideas

New Information and Communication Technologies Allow to Improve Governance



IMAGINECHINA/CORBIS

Many choices that people consider their own are already determined by algorithms.

Build digital democracy

Open sharing of data that are collected with smart devices would empower citizens and create jobs, say **Dirk Helbing** and **Evangelos Pournaras**.

Summary: Information Technologies for a Smart Digital Society

1. Planetary Nervous System
2. Measurement of Externalities
3. Multi-Dimensional Feedbacks
4. Digital Assistants
5. Collective Intelligence

Can all be based on a distributed approach!

The countries implementing these new organizational principles first will be leading

A Networked and Well Coordinated System of Largely Autonomous Systems

How Finally Everything Comes Together: Science, Politics, Business, and Society

- Massively increased efficiency
- Self-organizing, self-improving systems
- Democratic principle of participation
- Individual autonomy of decision-making
- Free entrepreneurial activity and markets
- Consideration of externalities
- Other-regarding and fair
- Improving environmental issues
- Supporting cooperation, reducing conflict

Let‘s Do This Together!

Image Source: http://demosite.in/applicationdevelopment.php