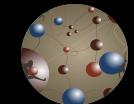


# Connecting people: network of Learners without borders



Openflights, moovellab

Liubov Tupikina





$$\begin{aligned}\dot{P}_{x_0 \bar{x}}(t) = & \frac{d}{dt} \int_0^t \left( \frac{1}{2} \sum_{x'=\bar{x}\pm 1} M_{x'}(t-t') P_{x_0 x'}(t') - \right. \\ & \left. - M_{\bar{x}}(t-t') P_{x_0 \bar{x}}(t') \right) dt'.\end{aligned}$$

What people usually think  
mathematicians are working on?

$$\begin{aligned}& - \left[ \left( \frac{e^{\frac{s^2 t \sigma^2 x \sigma + 2 s (tp + i k t \sigma x \sigma - tp t \sigma x \sigma) - k (k t \sigma x \sigma^2 - 2 i x p (-1 + t \sigma x \sigma))}{-2 + 2 t \sigma x \sigma}}}{\sqrt{2} \sqrt{\frac{-1 + t \sigma x \sigma}{t \sigma^2 x \sigma}} (tp - tp t \sigma x \sigma + t \sigma (i k + s t \sigma) x \sigma)} \right. \right. \\ & \left. \left. - 1 + \operatorname{Erf} \left[ \frac{-1 + t \sigma x \sigma}{\sqrt{-2 + 2 t \sigma x \sigma}} \right] \right) \right] \\ & \left. \left( 2 \sqrt{\sigma} \sqrt{\frac{1}{x \sigma}} \sqrt{\frac{-1 + t \sigma x \sigma}{t \sigma^2 x \sigma}} \right) \right]\end{aligned}$$



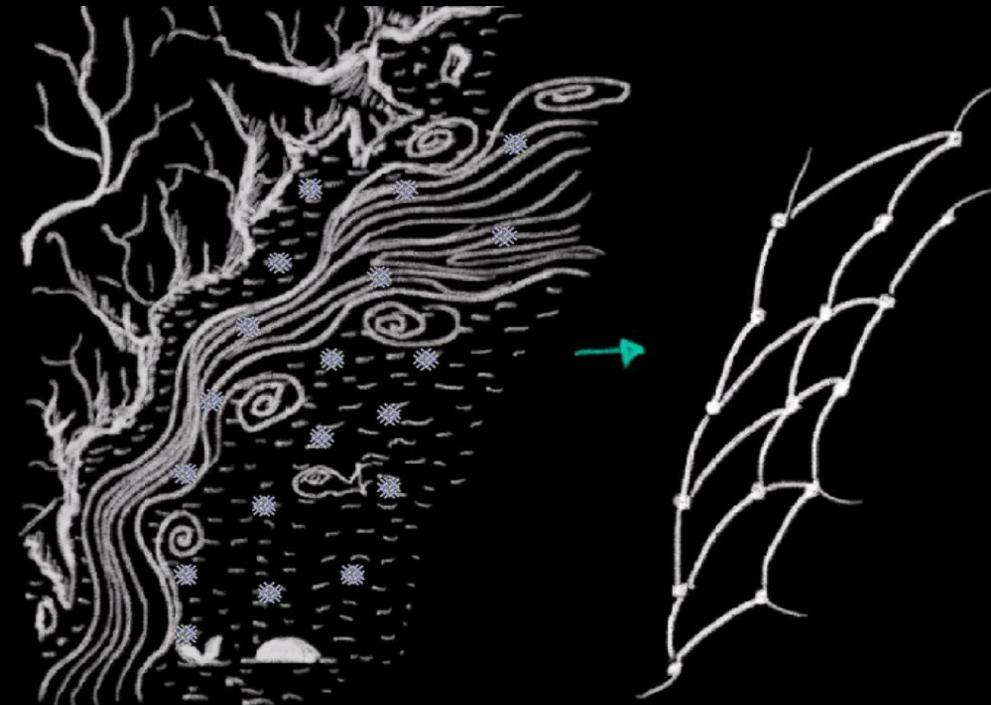
$$\dot{P}_{x_0 \bar{x}}(t) = \frac{d}{dt} \int_0^t \left( \frac{1}{2} \sum_{x'=\bar{x}\pm 1} M_{x'}(t-t') P_{x_0 x'}(t') - M_{\bar{x}}(t-t') P_{x_0 \bar{x}}(t') \right) dt'.$$

...on translating this into something else

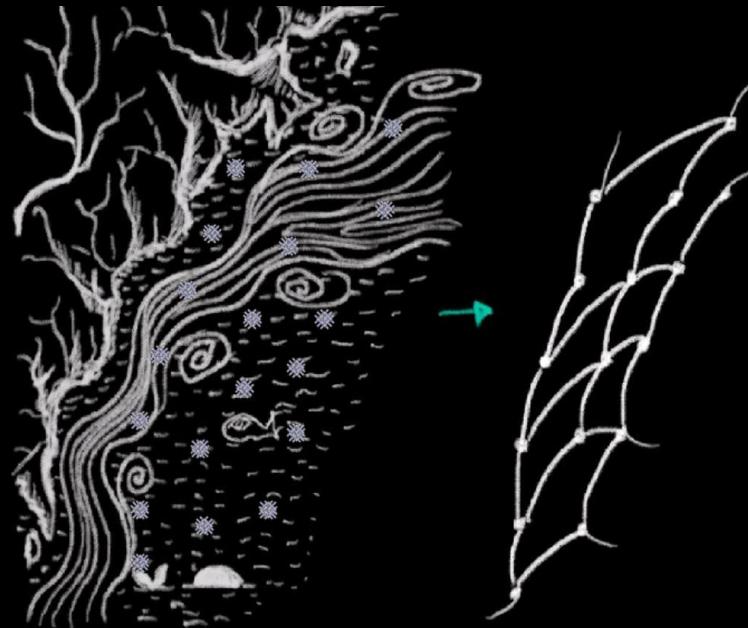
$$- \left[ \left( \frac{e^{\frac{s^2 t \sigma^2 x \sigma + 2 s (tp + i k t \sigma x \sigma - tp t \sigma x \sigma) - k (k t \sigma x \sigma^2 - 2 i x p (-1 + t \sigma x \sigma))}{-2 + 2 t \sigma x \sigma}}}{\sqrt{2} \sqrt{\frac{-1 + t \sigma x \sigma}{t \sigma^2 x \sigma}} (tp - tp t \sigma x \sigma + t \sigma (i k + s t \sigma) x \sigma)} - 1 + \text{Erf} \left[ \frac{\sqrt{2} \sqrt{\frac{-1 + t \sigma x \sigma}{t \sigma^2 x \sigma}} (tp - tp t \sigma x \sigma + t \sigma (i k + s t \sigma) x \sigma)}{-2 + 2 t \sigma x \sigma} \right] \right) \right]$$

$$\left( 2 \sqrt{\sigma} \sqrt{\frac{1}{x \sigma}} \sqrt{\frac{-1 + t \sigma x \sigma}{t \sigma^2 x \sigma}} \right)$$

# Can we use **network theory** and data analysis for social good?



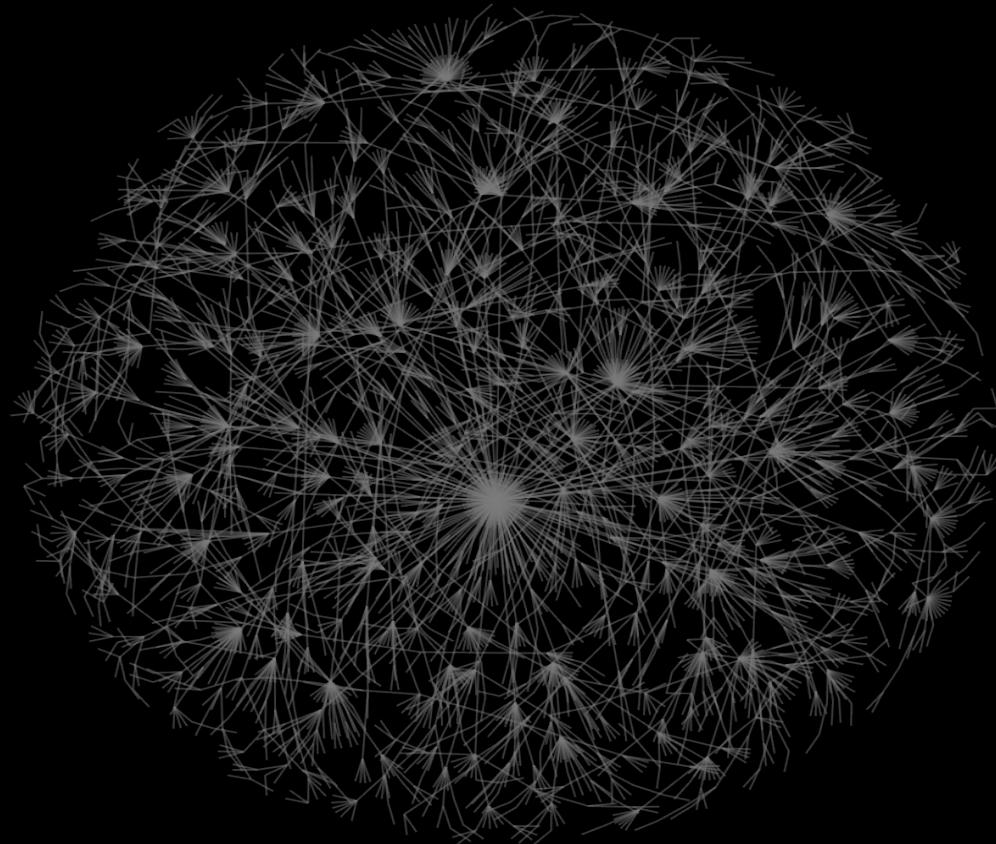
# Can we use **network theory** and data analysis for **social good**?



...but first let's dig into each of the terms separately

# What is a **network**?

1. heart of any complex system
2.  $G(N,L)$
3. group of somehow connected people

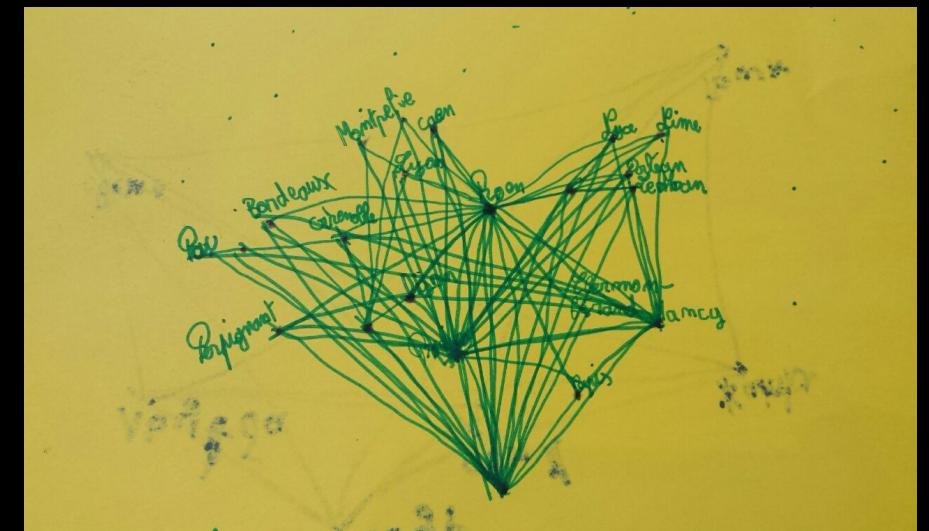
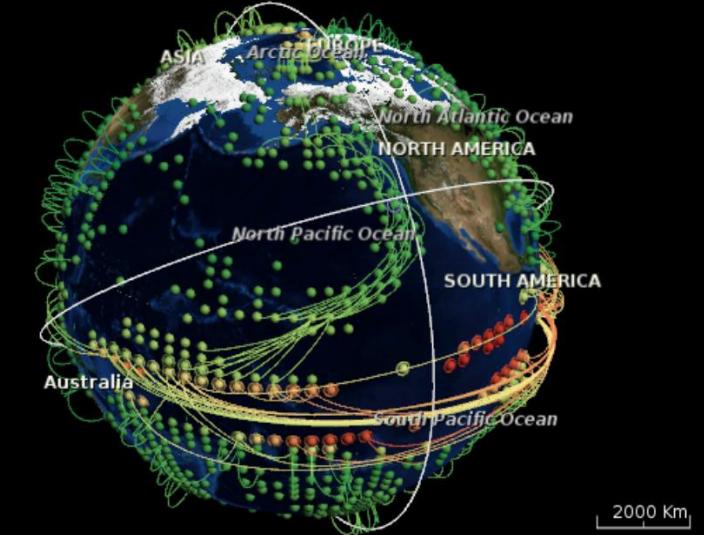


# What is a network?

1. Heart of any complex system
2.  $G(N,L)$
3. Group of people linked

Which systems CANNOT be represented as a network?

1. Solar system
2. Dreams
3. Climate



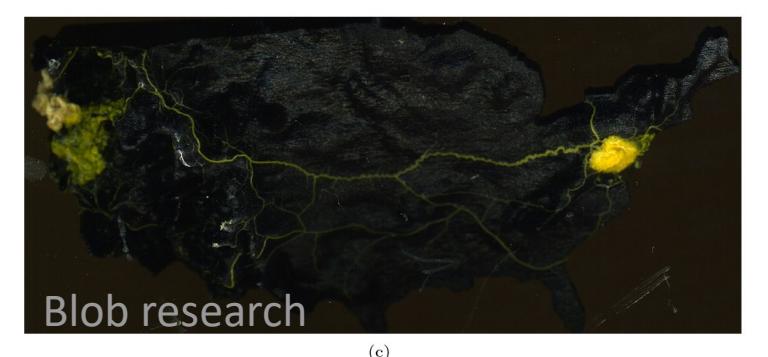
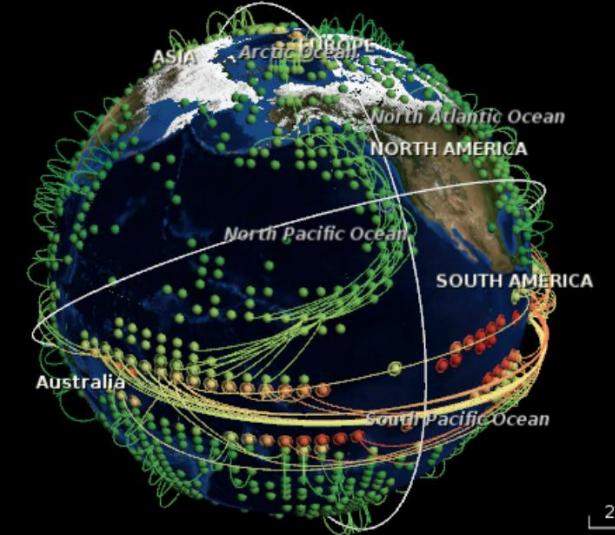
# What is a network?

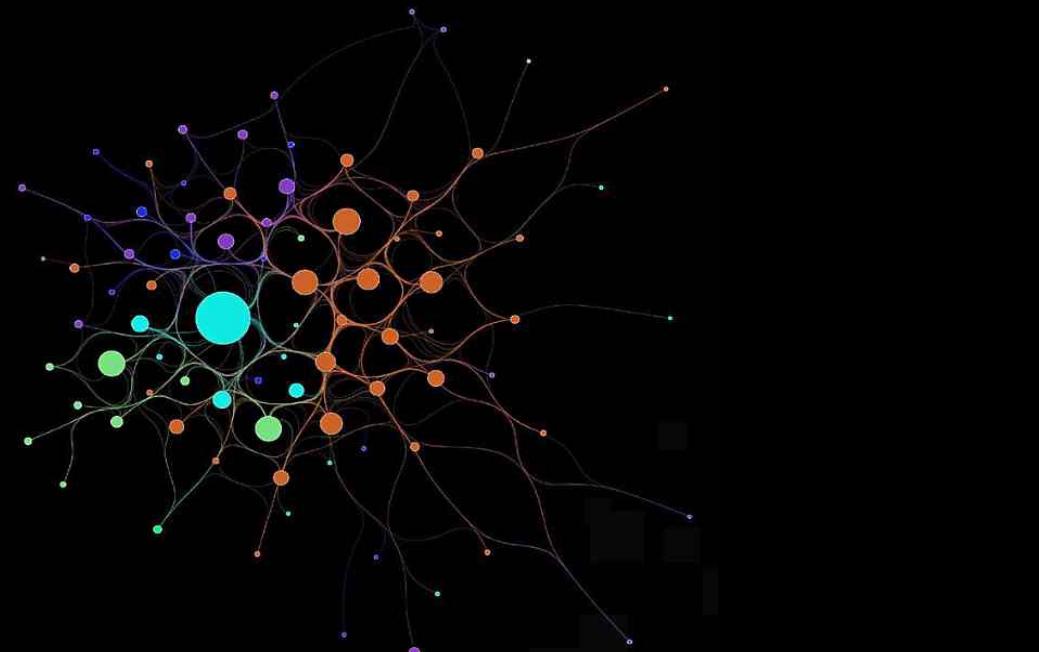
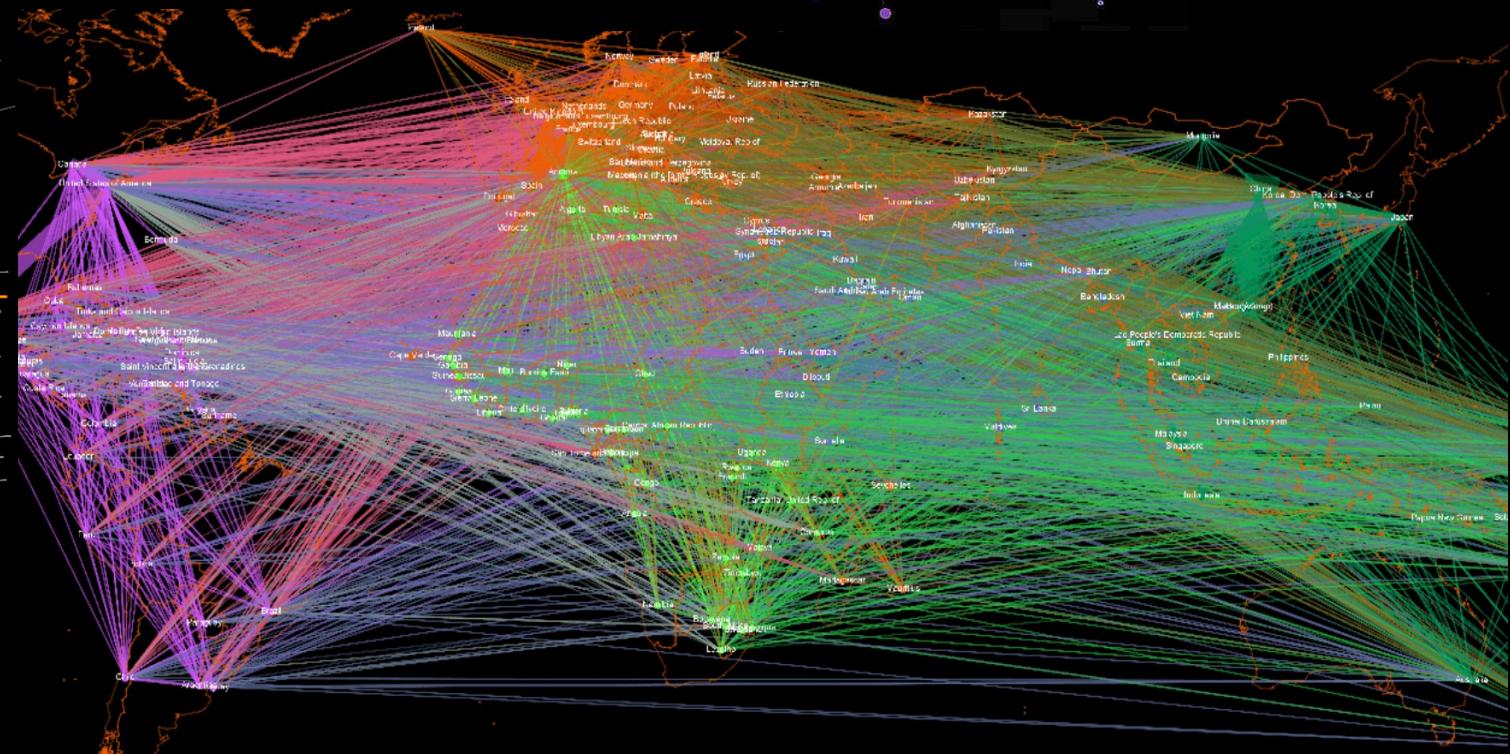
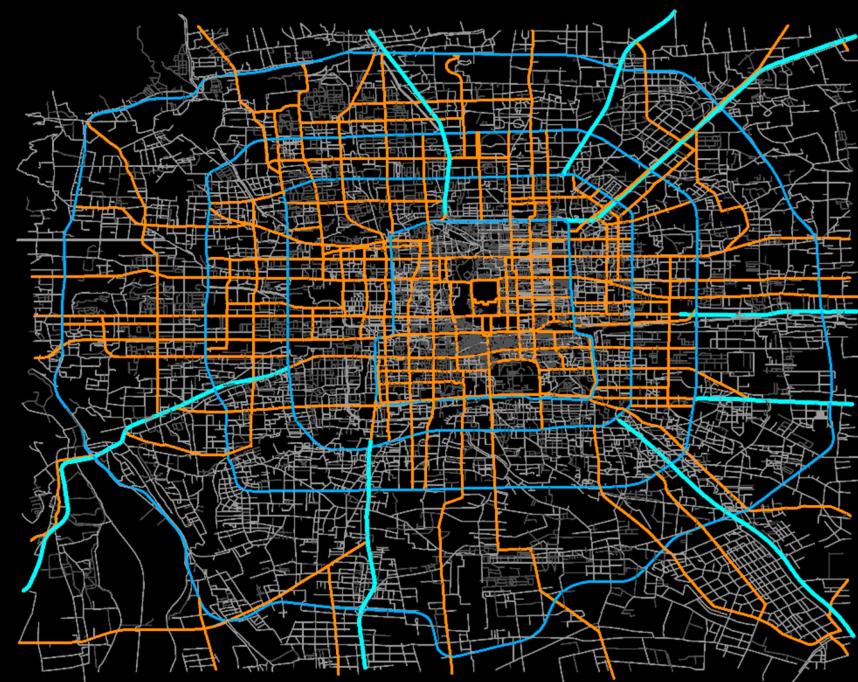
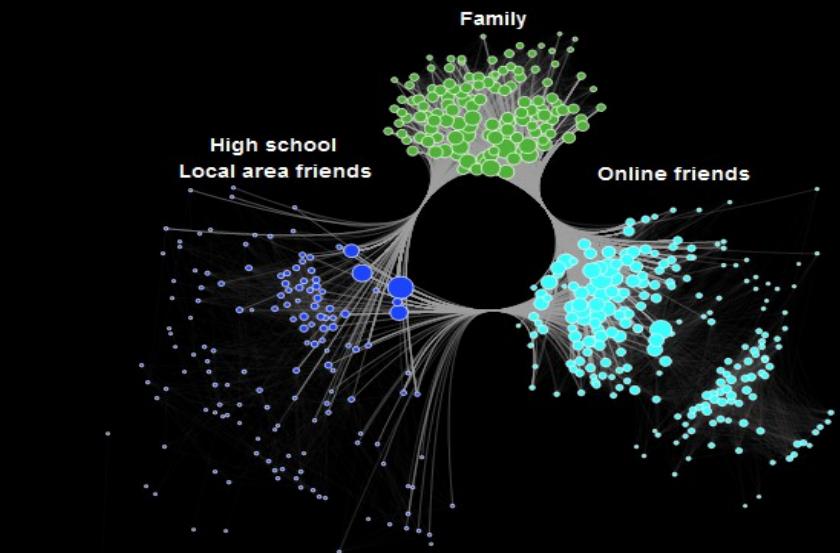
1. Heart of any complex system
2.  $G(N,L)$
3. Group of people linked

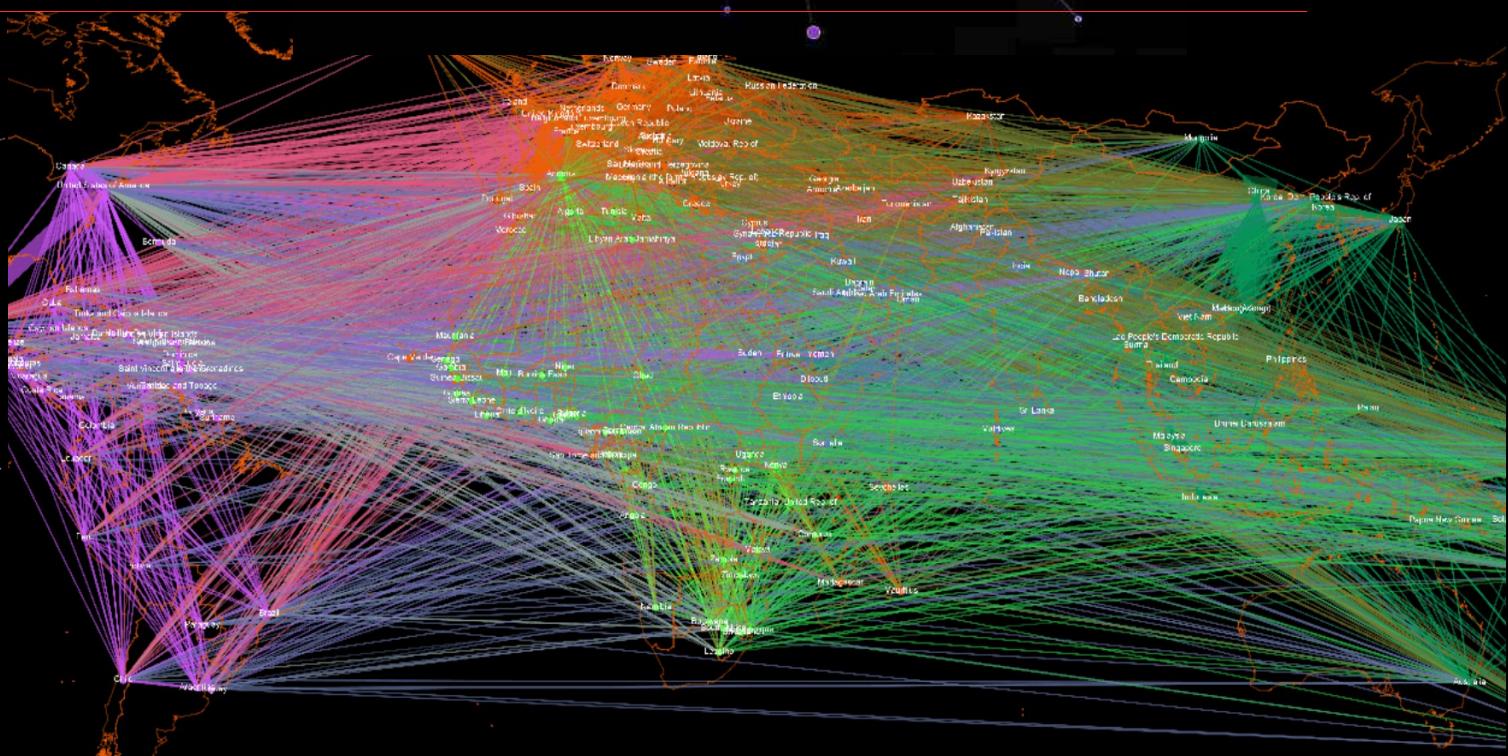
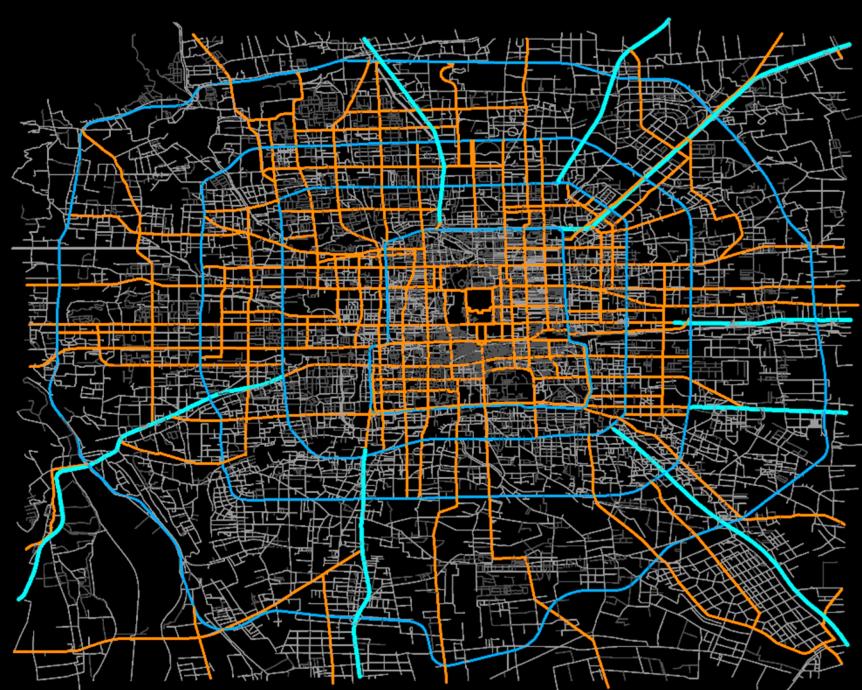
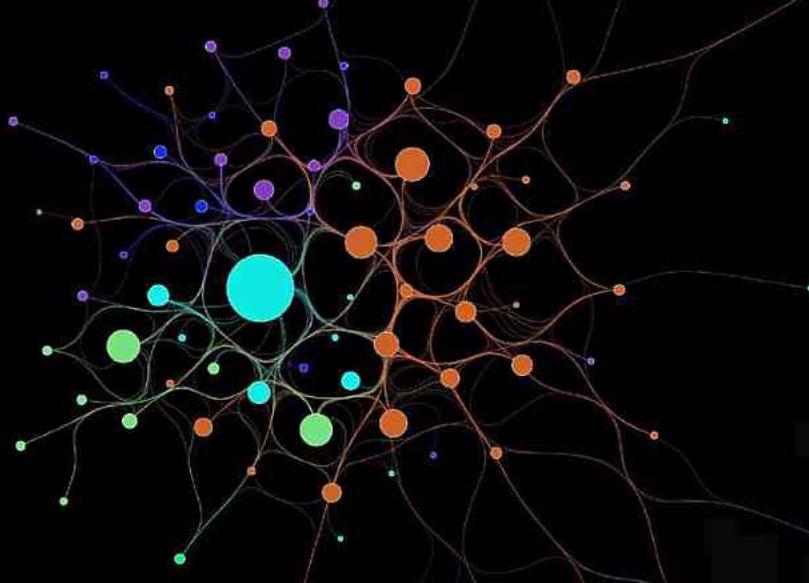
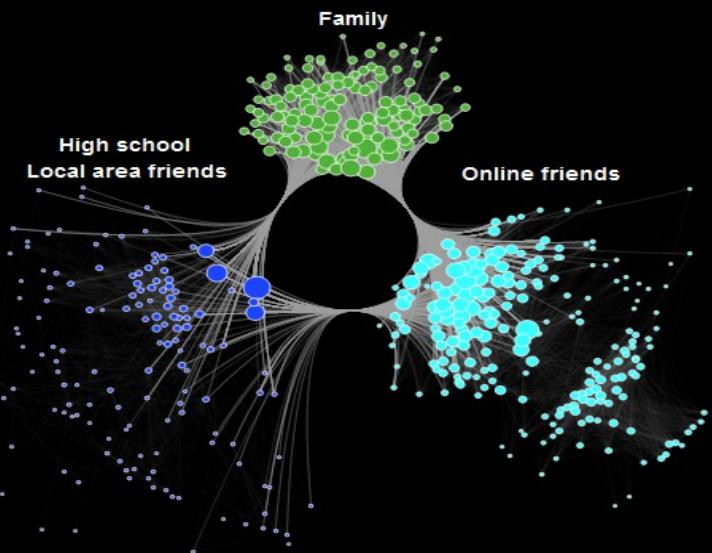
Which systems CANNOT be represented as a network?

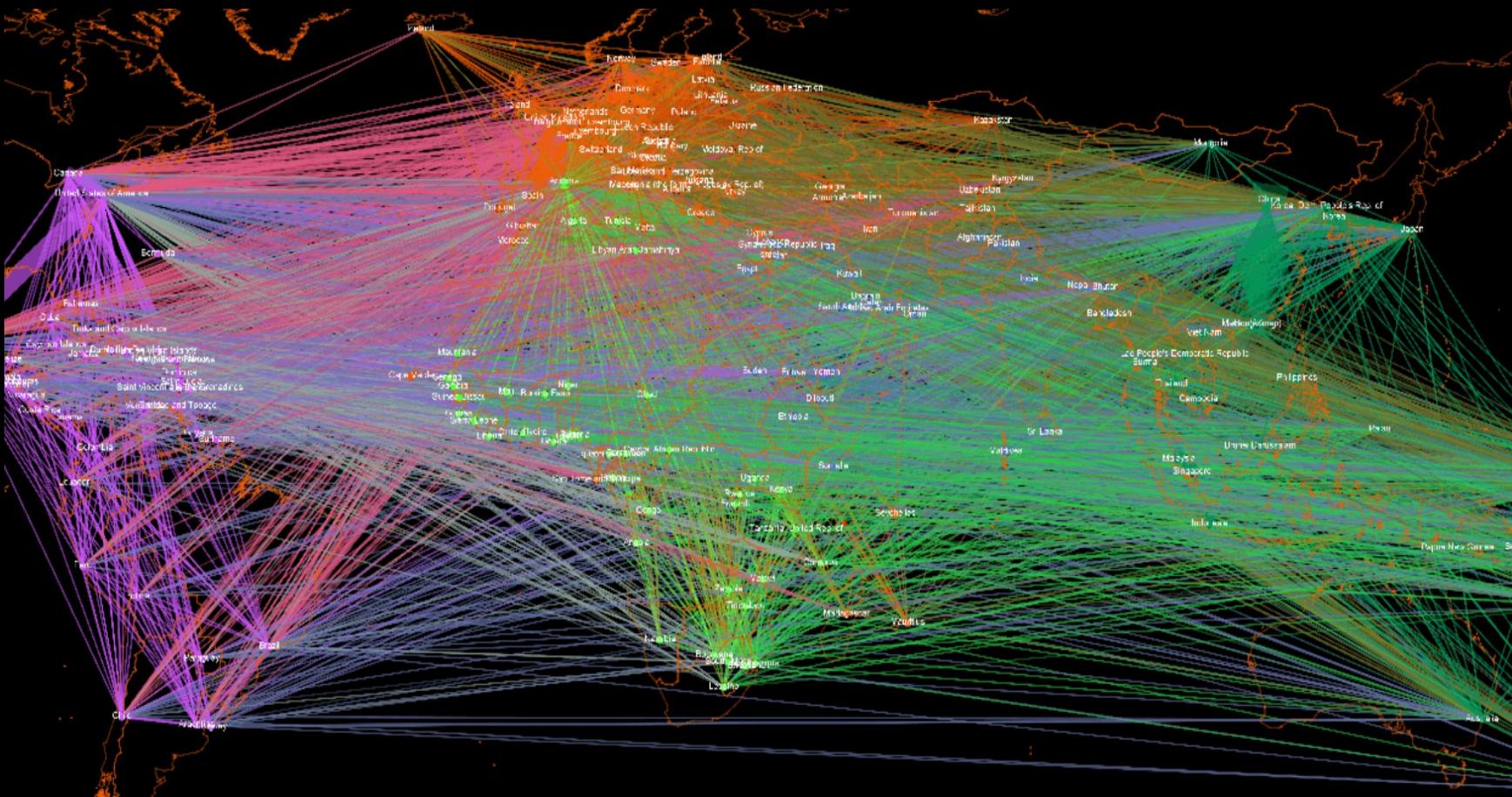
1. Solar system
2. Dreams
3. Climate

Which types of networks you can find in our society?

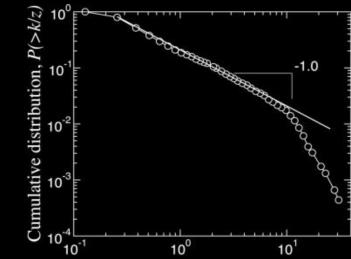




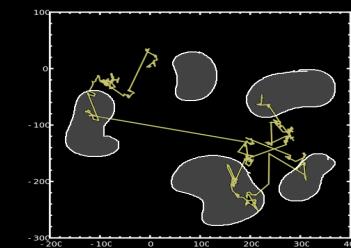


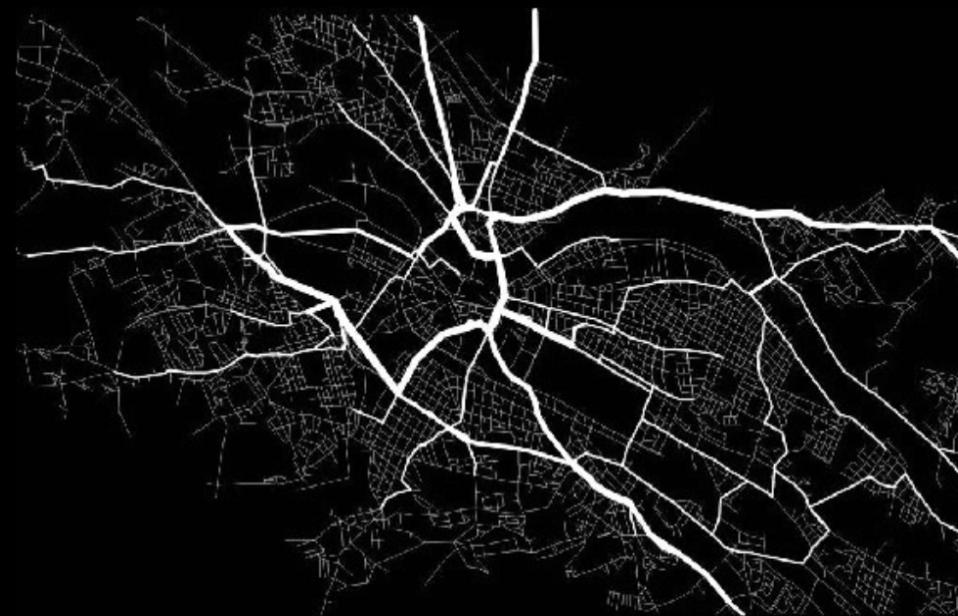
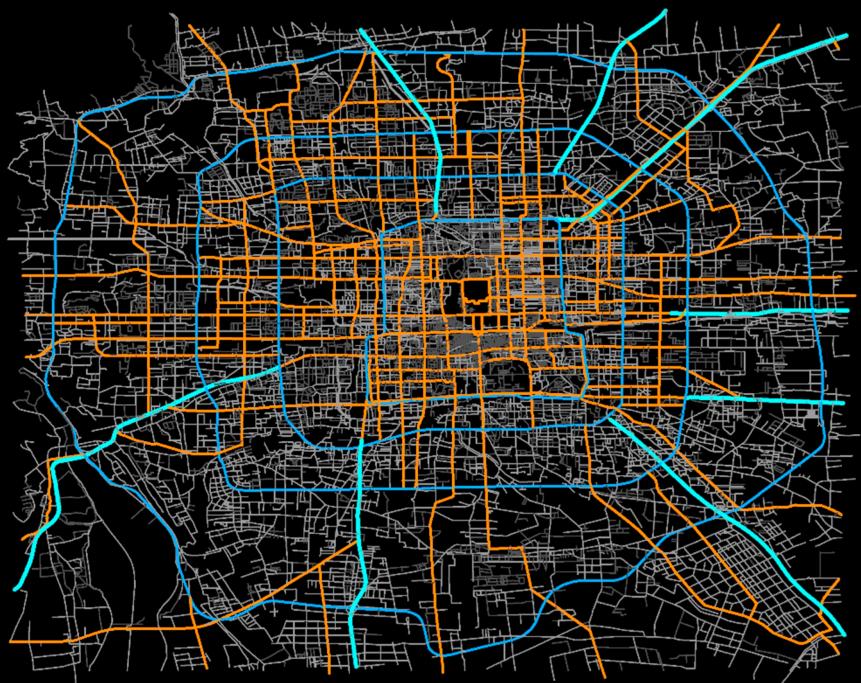


Properties of global transportation network: degree distribution, mobility patterns [Brockmann 2015, Recci 2019].  
 Source: Global Transnational Mobility Dataset



$$P(>k) \propto k^{-\alpha}$$

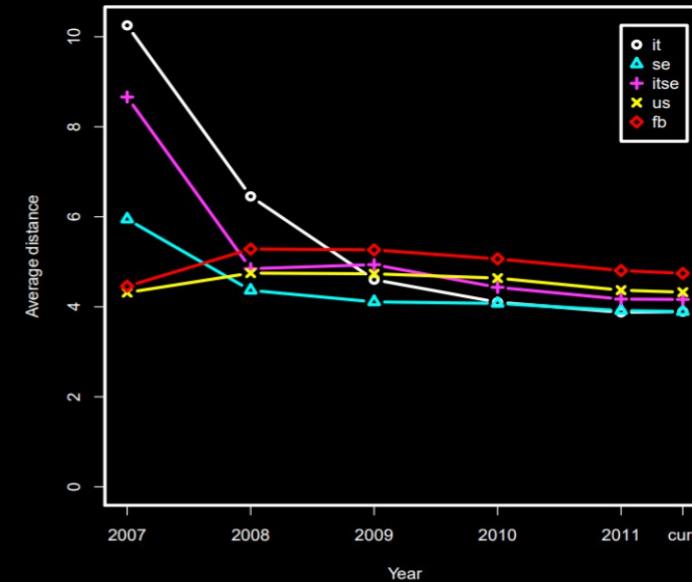
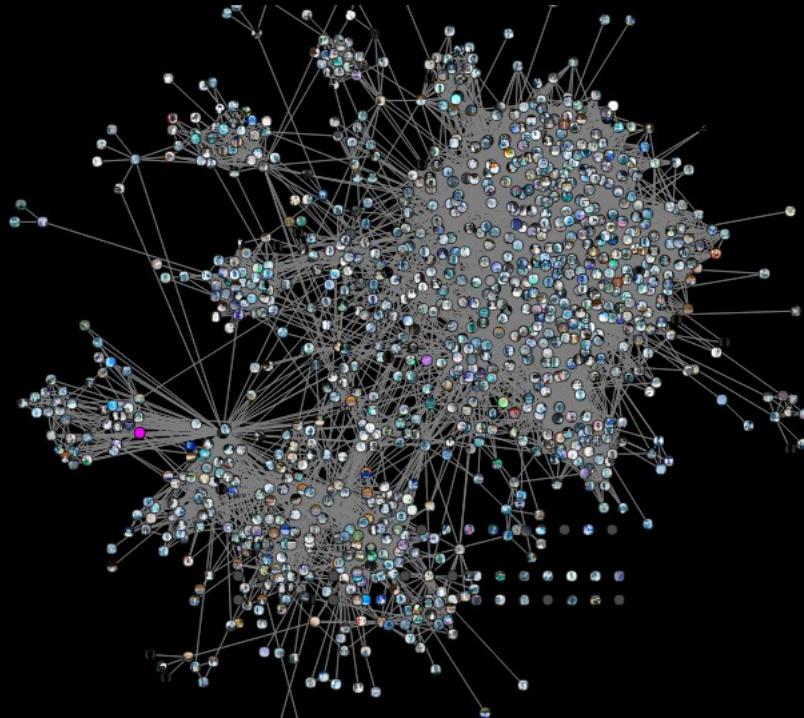




Properties of global transportation networks:  
betweenness highlights main arteries,  
networks for different cities are similar - universal [Barthelemy 2015].  
Source: mdpi



Facebook has ≈ 721 million friends, ≈ 69 billion friendship links).



Properties of social networks:

my psychological “portret” using network communities. Source: my facebook friends

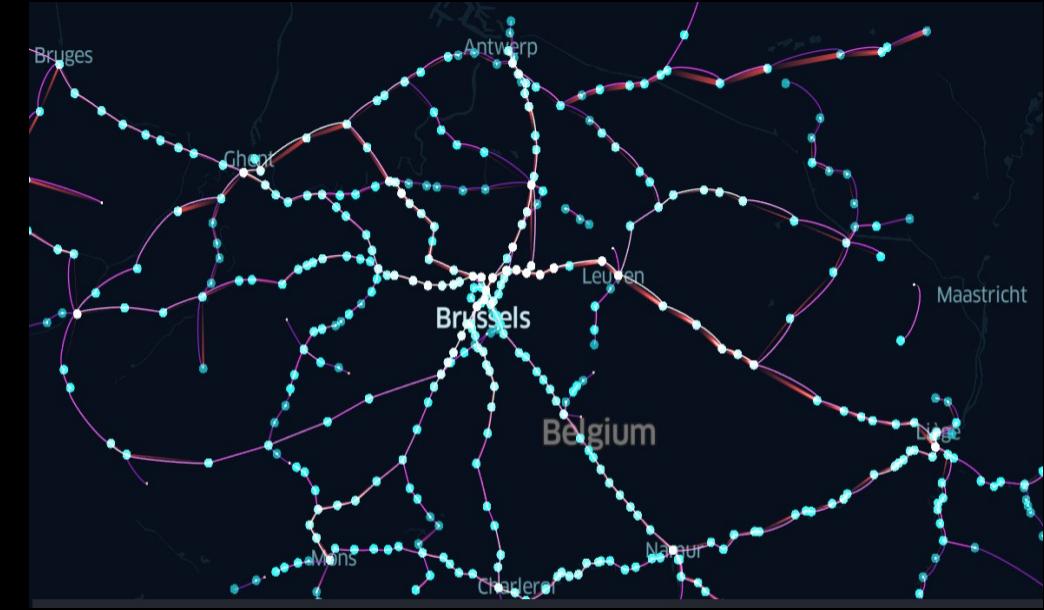
Offline behaviour of online friends [Lehmann 2018]. Four degrees of separation [S.Vigna, 2012]



How difficult it is to get the data?

Where surfers go? #surf

**Any examples of social problems?**



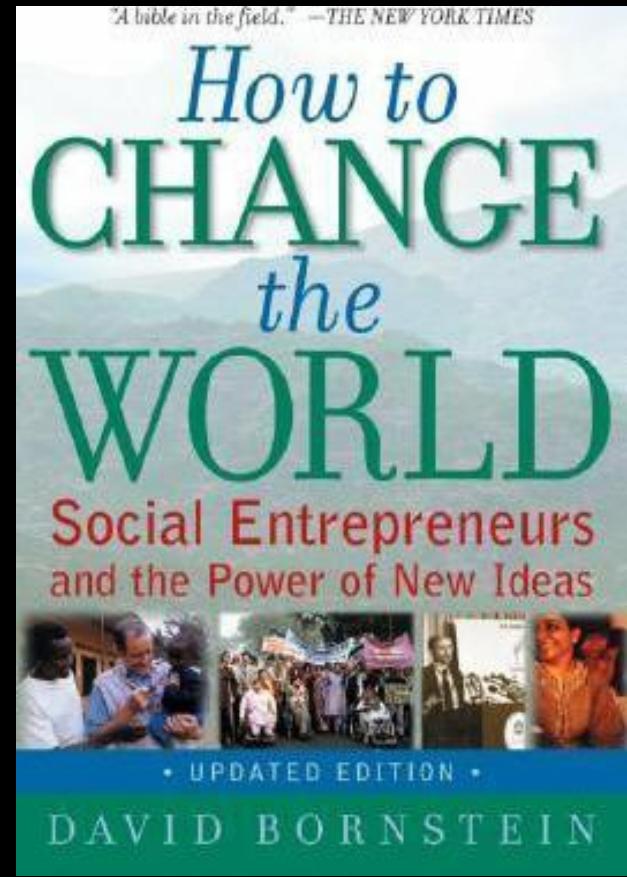
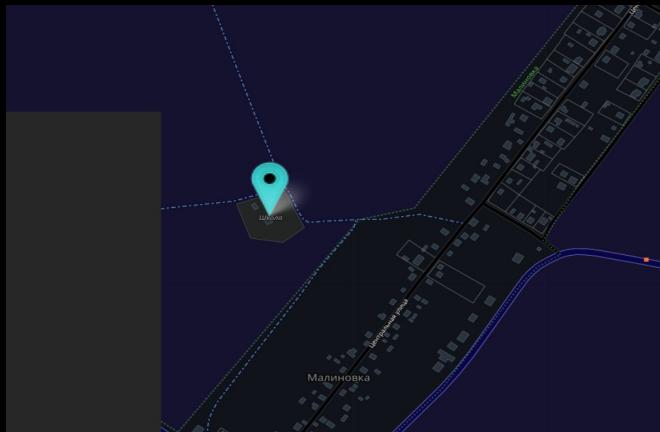
Transport networks: network scientists are able to predict delays in trains, spreading of diseases, inequality in cities...



is there a network of associations?

**Challenge:**

how to analyze data from “network of Saints”?  
[Drayton “Ashoka fellows”], [Bornstein “Change the world”]





## Network of associations: S-OL project

?

Is there big data for solving big problems?



# Do we know how much we travel?

1. once per year
2. 2-5 times
3. more than 5 times



# How much do you travel?

1. once per year
2. 2-5 times
3. more than 5 times

## Data:

8.9 mill. passengers per day

61 mill. children out of schools world wide,

2500 people ↔ 1 school on average



[dosomething.org](http://dosomething.org)

"All flights lead to Roma" [lab.moovel.com](http://lab.moovel.com)

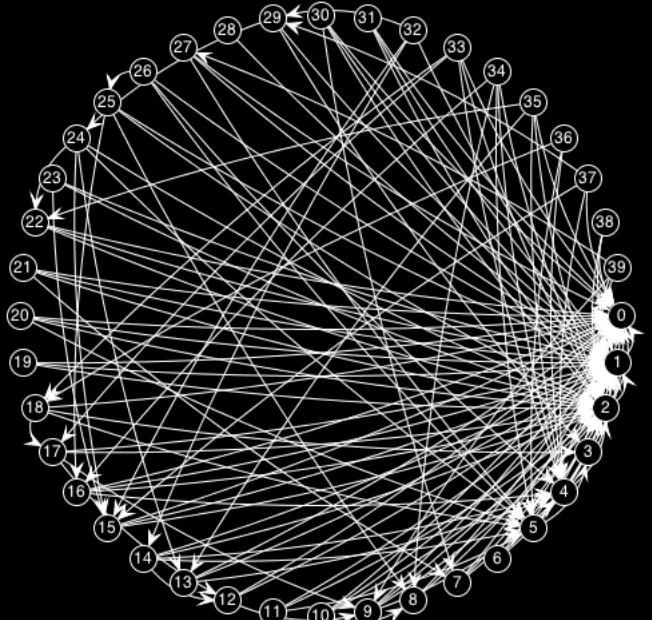
# Main idea of Lecturers without borders

How to make it work together?

Institutions, universities, schools  Traveling experts, lecturers...



# Researchers network

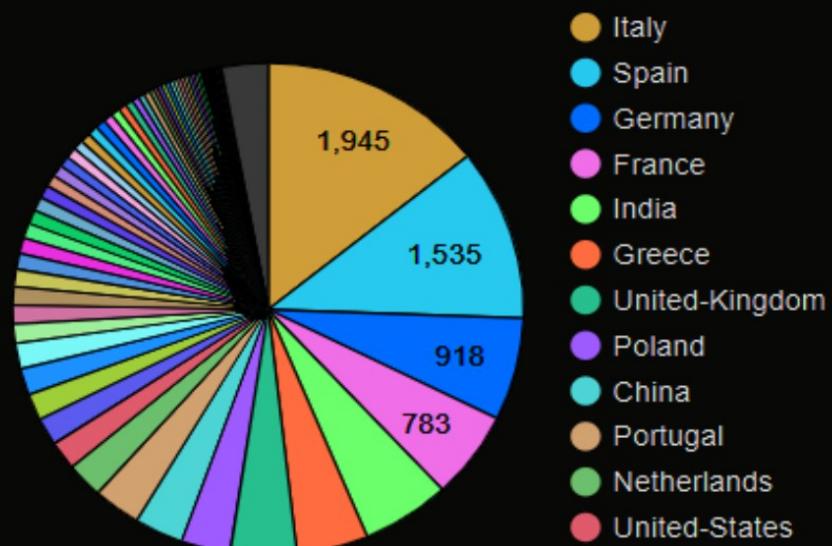


How likely the traveler can pass some place where he/she may share experience?

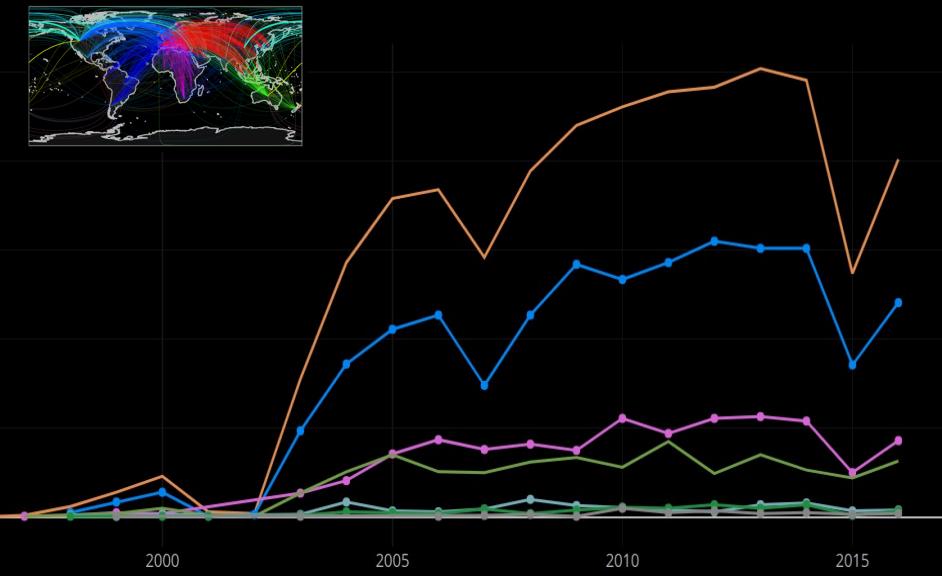


Video of the game youtube  
Small world researchers network [Mendes, Dorogovtsev]

# Researchers network

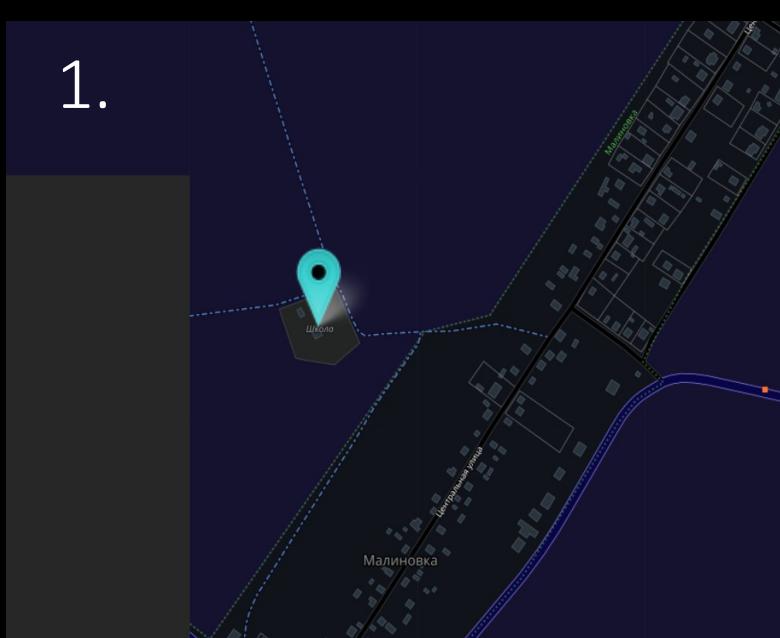


Number of conferences per year

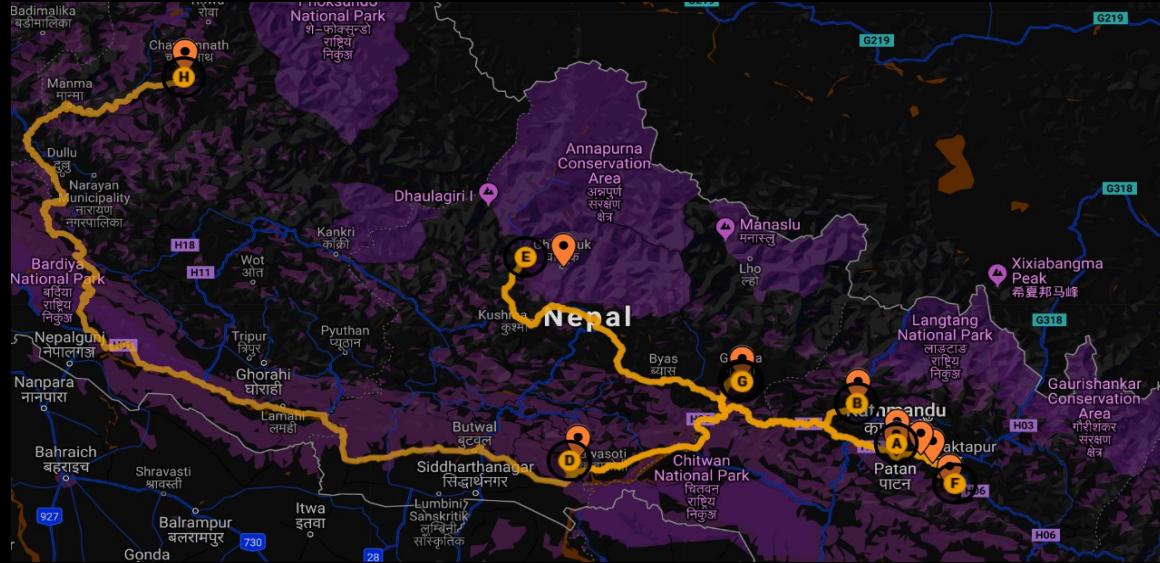
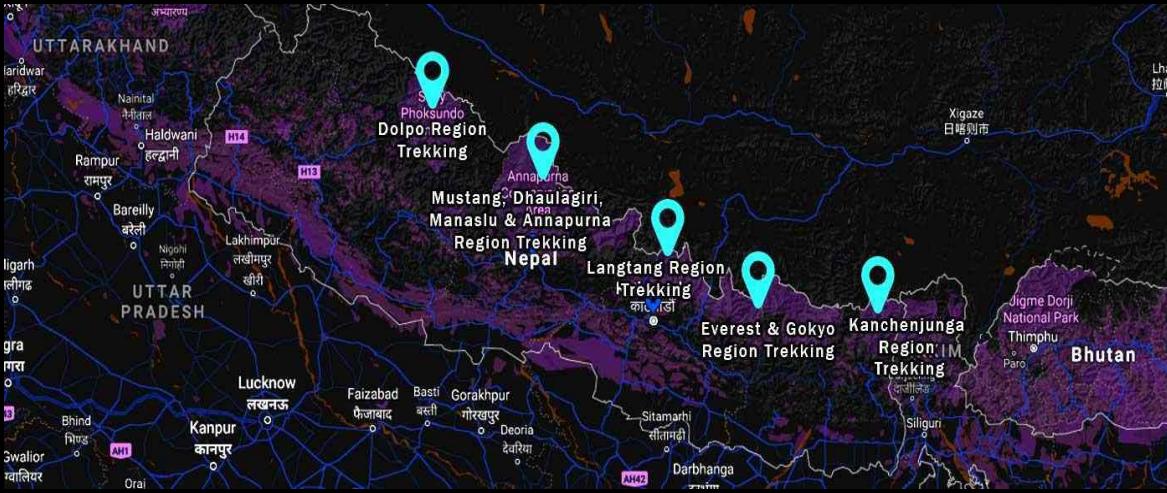


## How it works?

1. Finding a school that matches traveling lecturer
2. Putting in contact and making lecture



# Lecturers without borders: Why it works?

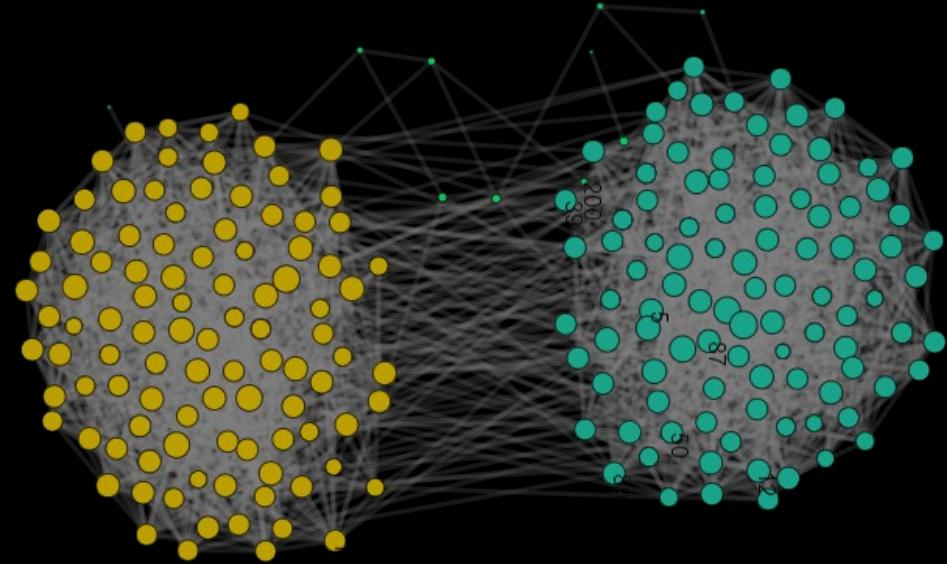


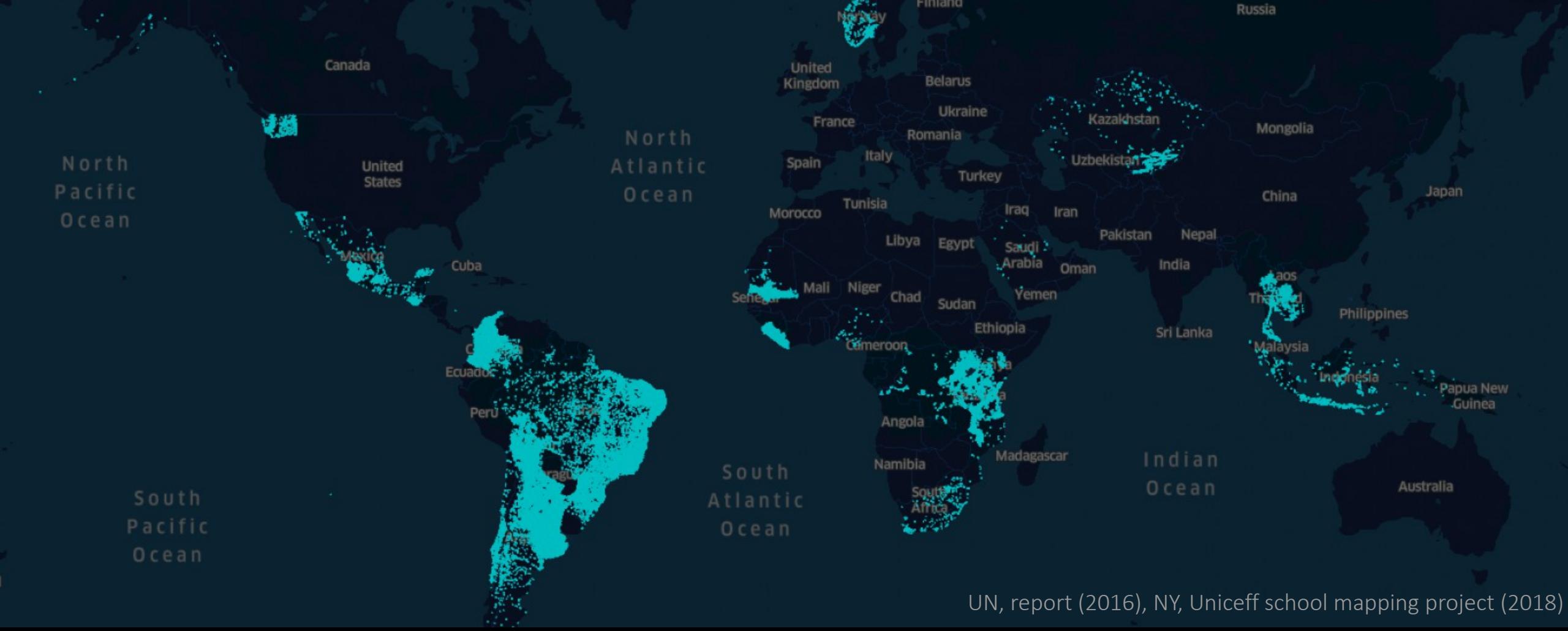
Open network of educators and researchers  
[www.scied.network](http://www.scied.network)

# Lecturers without borders: 2017-2019



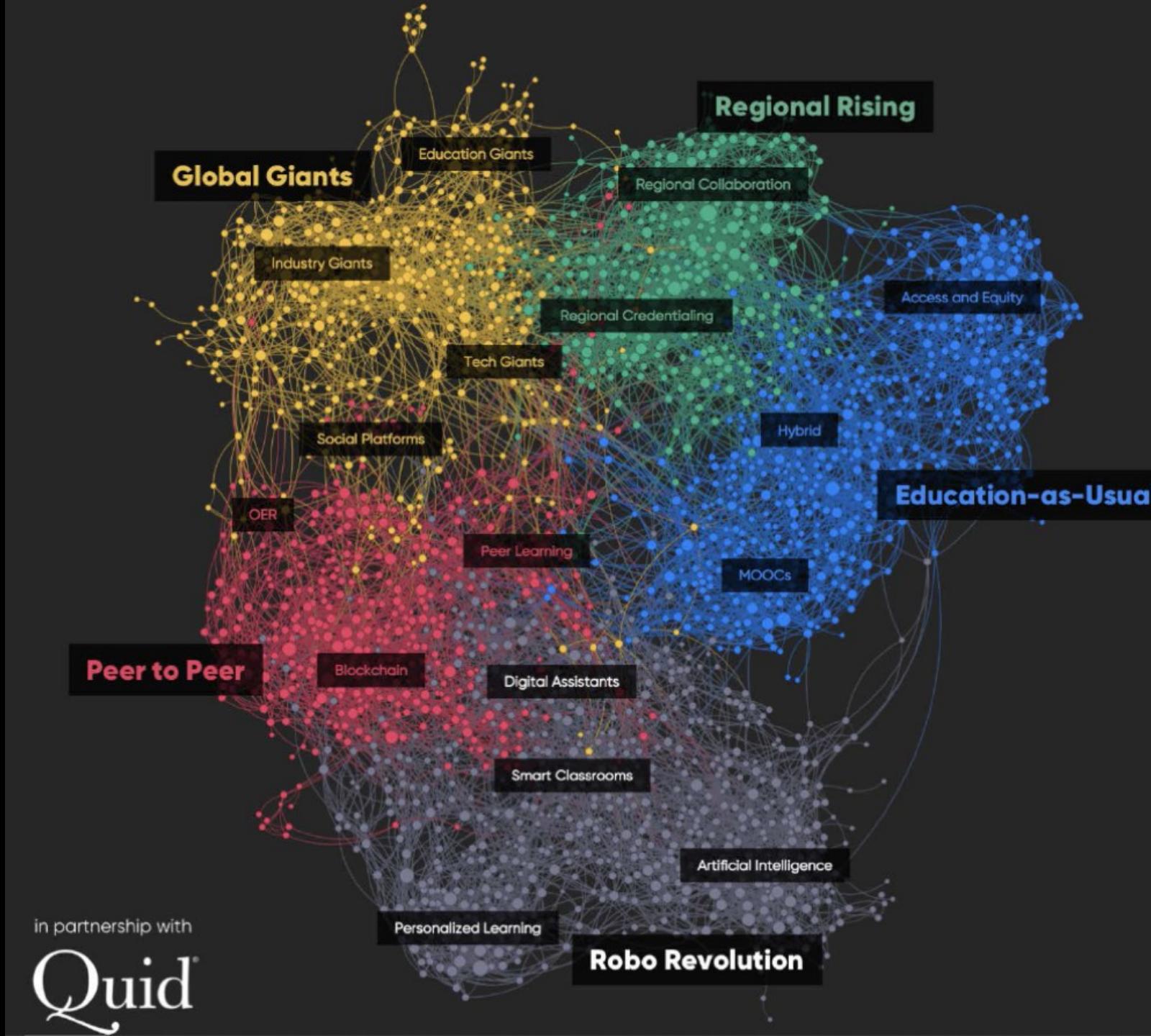
Do you want to join  
projects on networks for social good?



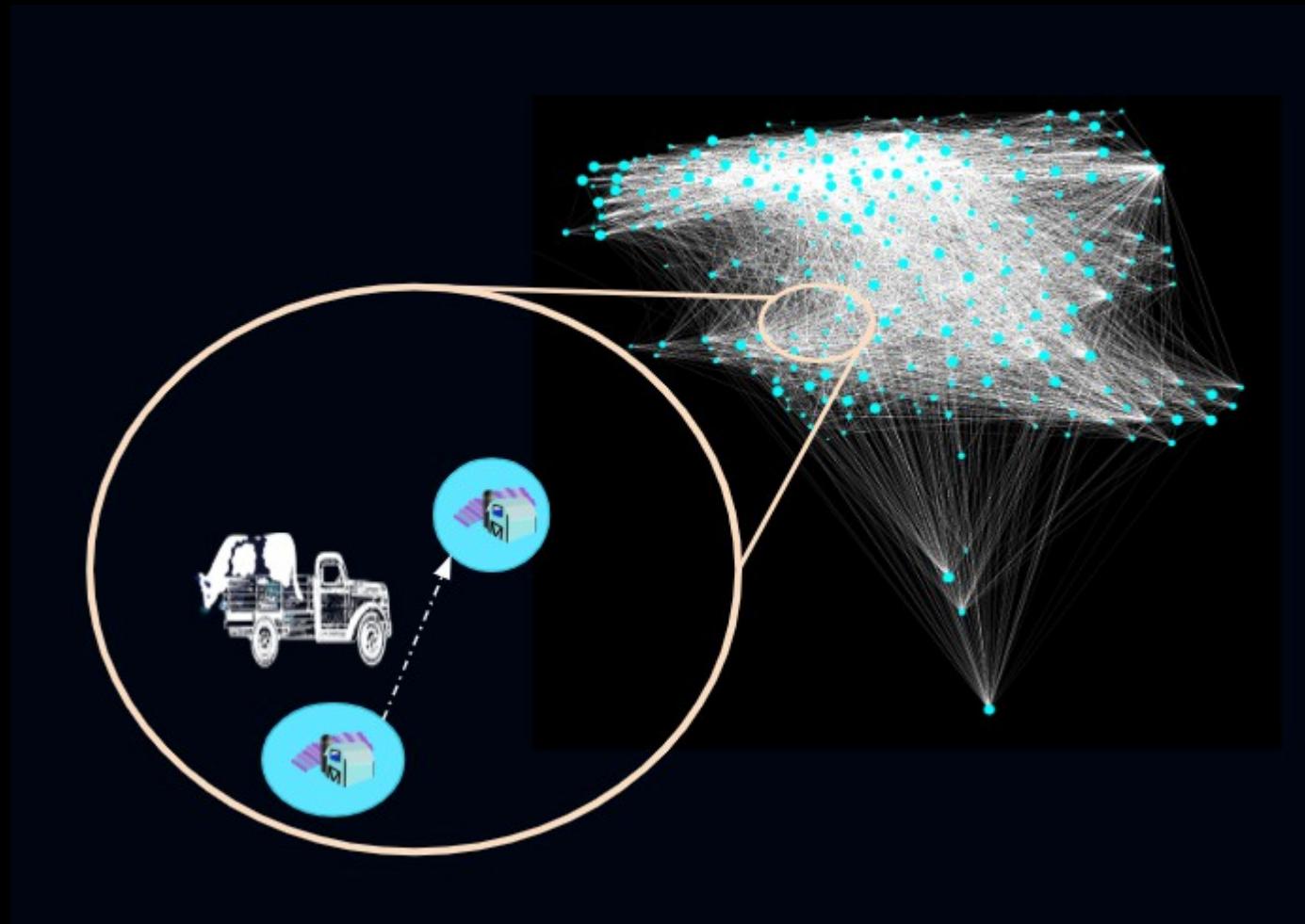


Around 69 millions teachers are needed in the world.  
By the end of 2030 1 billion of learners is expected to join the world.

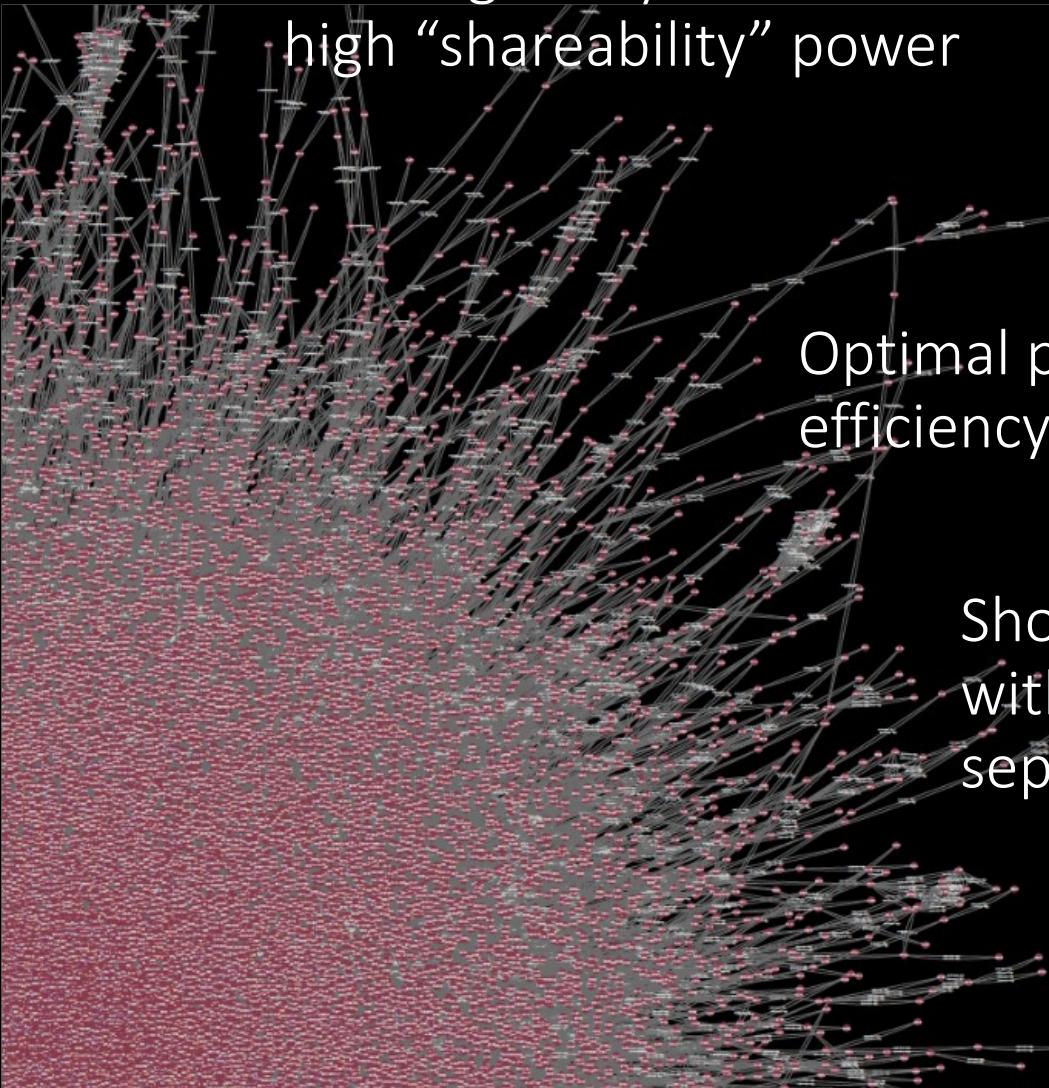
Other examples of projects:  
HolonIQ mapping  
educational projects  
in 2030



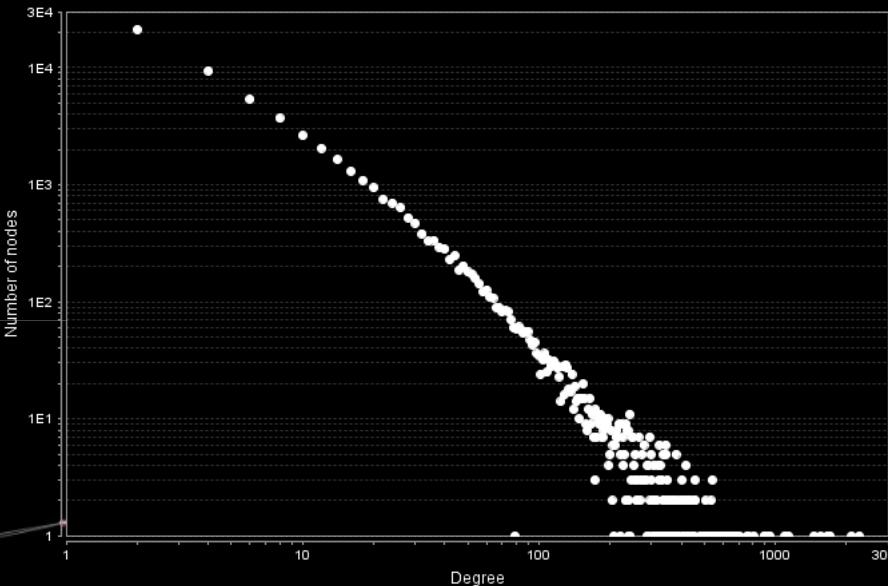
Example of projects:  
networks for social good:



# Data analysis

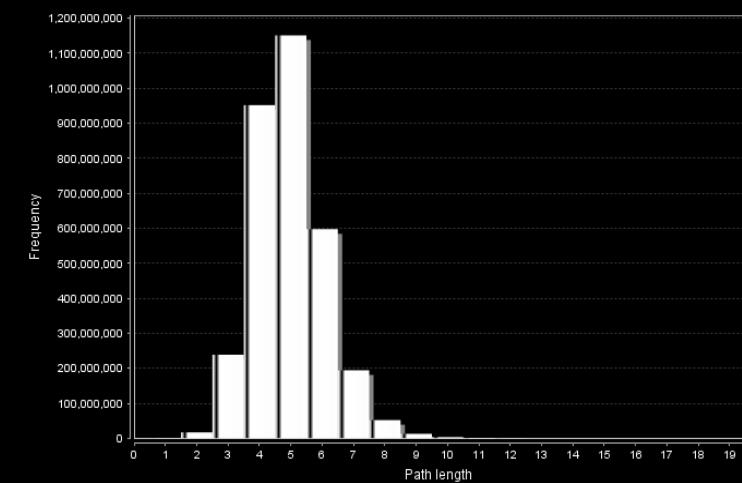


Heterogeneity and  
high “shareability” power



Optimal properties:  
efficiency for information spreading

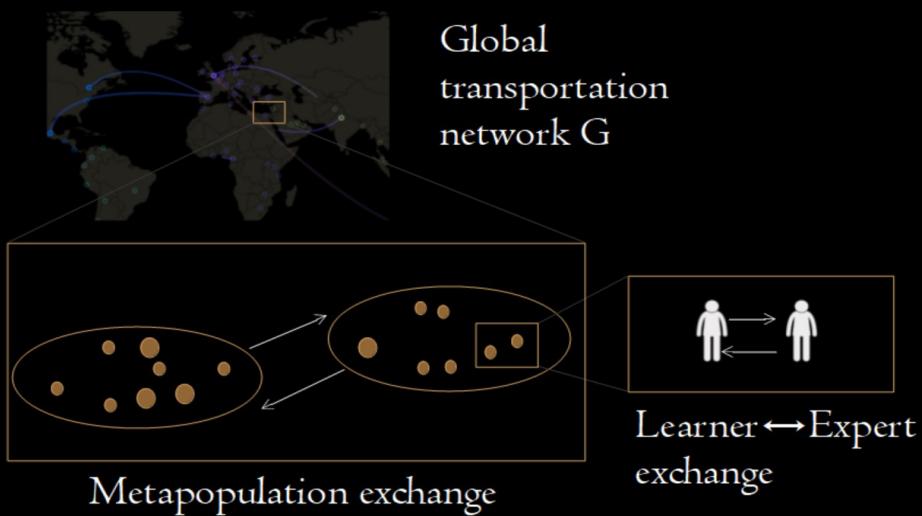
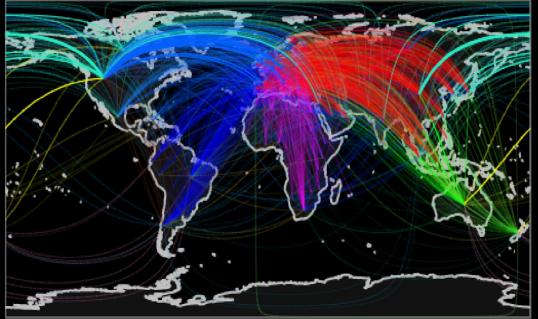
Shortest distances:  
with 58228 nodes degree of  
separation is 5 on average



Test on real Facebook graph  
[S.Vigna et al.] 4 degrees of  
separation (on average)

Can networks be used for social good?

# Can networks be used for social good?



Yes, but...

Lack of OPEN structured datasets,

Learner  $\leftrightarrow$  Expert  
exchange

Lack of COLLABORATIVE projects;

Also there are still borders between countries...

# Takehome-s

“**Making bridges**” can make a difference for our society.

**Network analysis** shows paradoxical advantages of potential of human interactions.



S. Sangaro

“Everyone has equal right for the education”

Tree of knowledge, North Kenya

# Resources, books

“**Making analysis yourself**” <http://networkrepository.com/>

**Network analysis with** gephi, python, cytoscape

**Theory of networks:** Barabasi book

About associations networks:

[www.hangemakers.org](http://www.hangemakers.org)

Other links

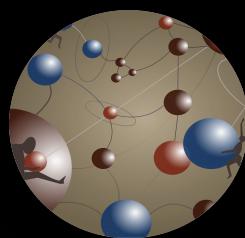
Lecturers without borders [www.scied.network](http://www.scied.network)

CRI Paris [www.cri-paris.org](http://www.cri-paris.org)

Contact @lyuibov



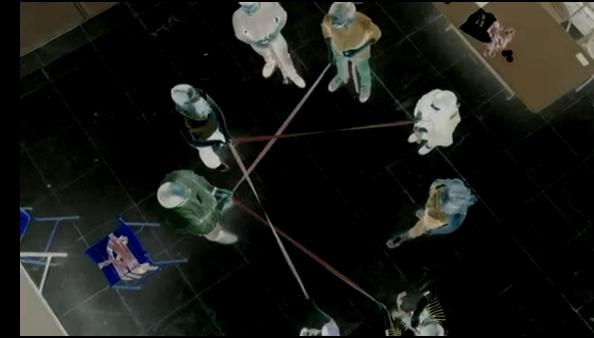
# Collaborations



Animath



Bell Labs

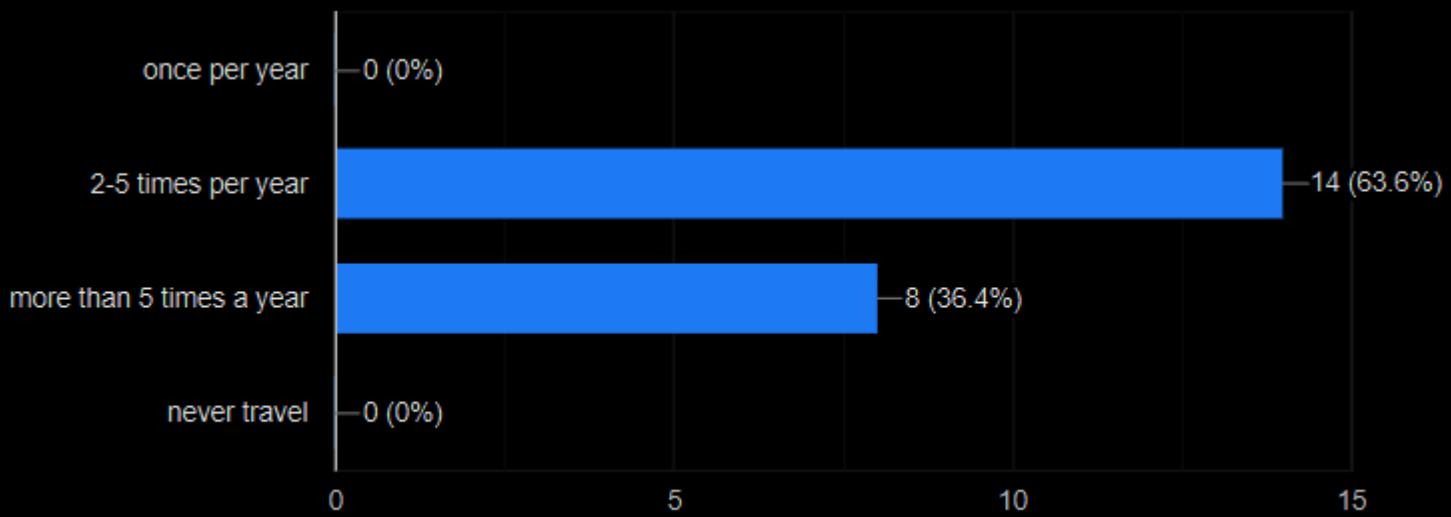




„If what you are doing is not important, and if you don't think it is going to lead to something important, why are you working on it?”

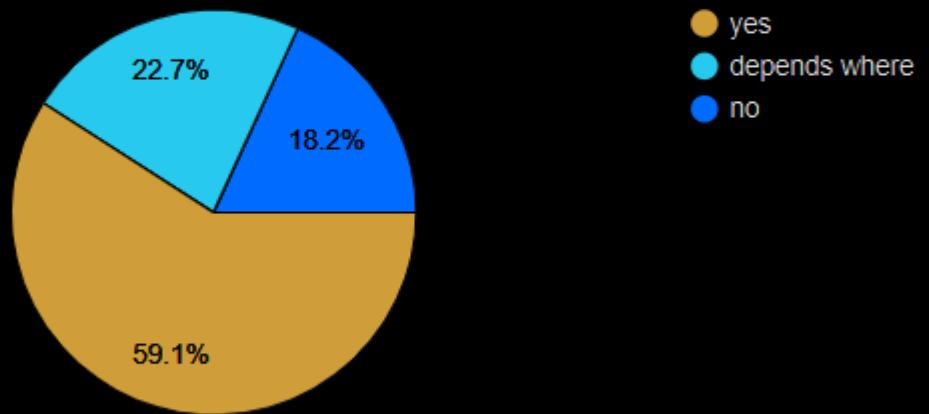
R.Hamming



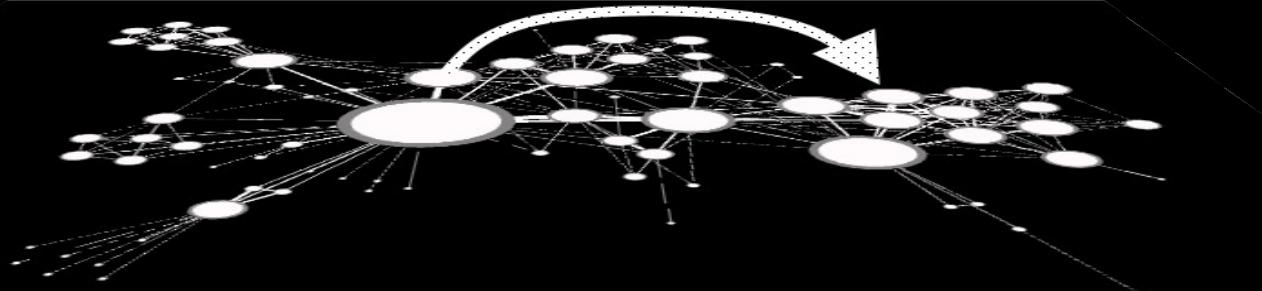


Would you like to make a lecture in a local university or school?

22 responses



# Lecturers without borders: How it works?



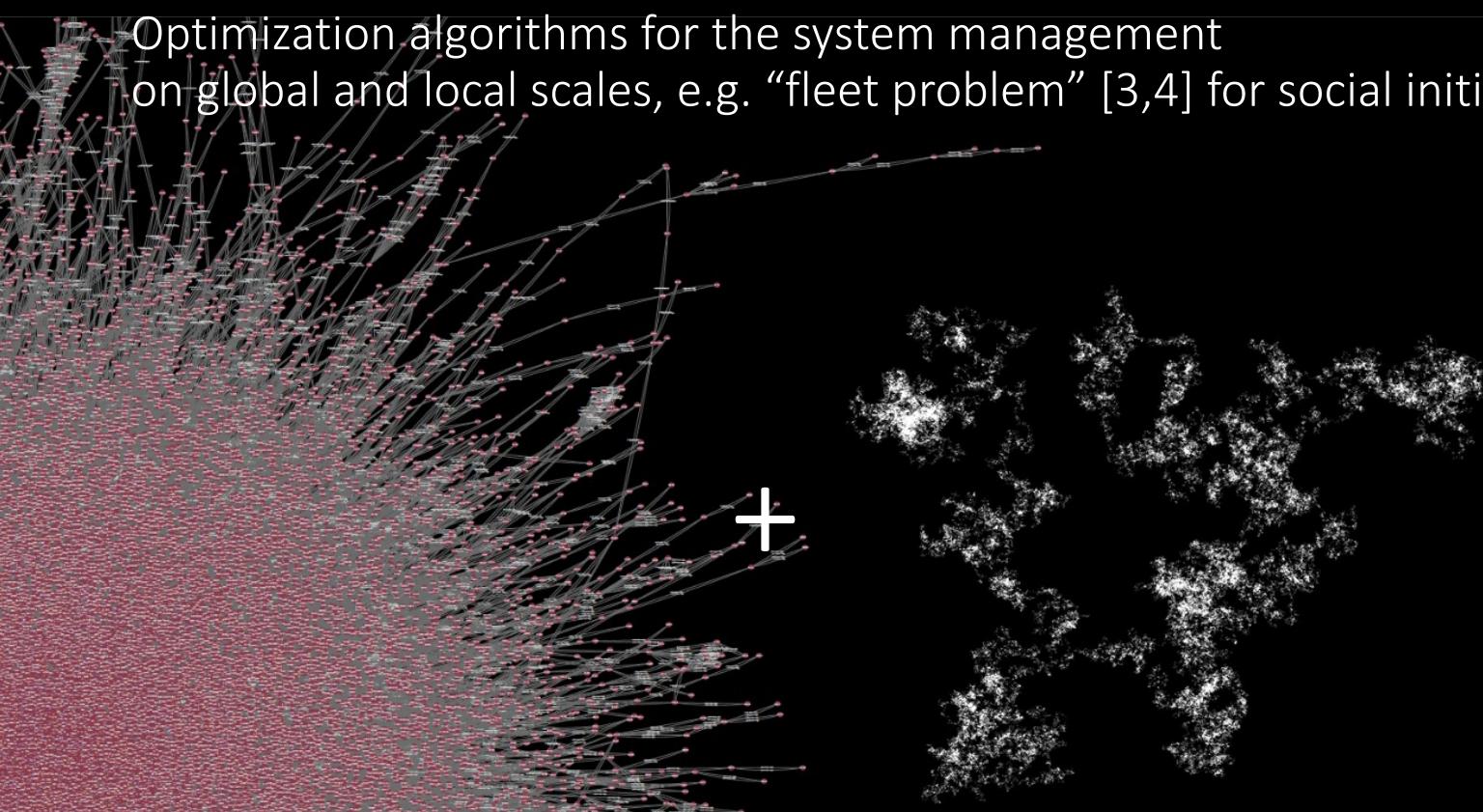
Open network of educators and researchers  
[www.scied.network](http://www.scied.network)

## Methods:

Analytical techniques for identification of important nodes in human networks, estimation speed of information spreading [1,2];

Numerical analysis of human trajectories in N-dimensional metadata space, inference methods, predictions of the outcome [2];

Optimization algorithms for the system management on global and local scales, e.g. “fleet problem” [3,4] for social initiatives.



- [1] Kitsak et al. Nature, 2010
- [2] Gardiner Springer, 2009
- [3] senseable.mit.edu
- [4] Stanford soc.geoloc.database



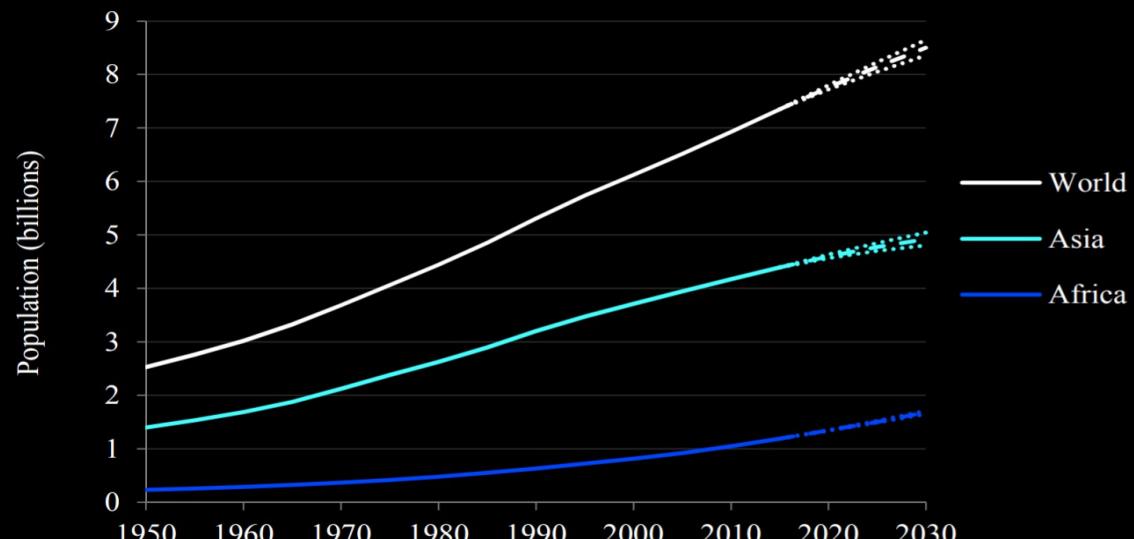
The full potential stemming from our connectedness is untapped. [Open flights lab.moovel.com](http://Open flights lab.moovel.com)

Numerous initiatives, associations, fighting against common problems.

Human travels follow quite particular patterns [Brockmann Nature 2006].

1 billion of learners is expected to join the world by the end of 2030.

60 million will be joining from African and Asian countries each year.



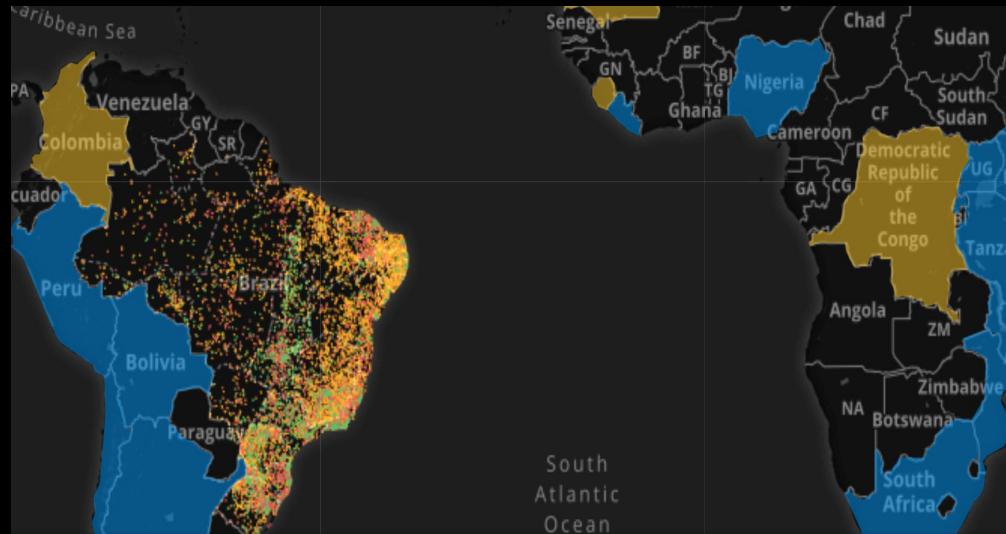
UN, report 2016, NY

# Solutions?

Online courses

Challenges for building stable 5G networks

Many programs from various associations...



However many challenges  
to make Open network (of learners)...  
to combine the untapped opportunity of traveling experts;  
to study what is the best way to actually tackle this problem using network theory and optimisation methods;  
to use data analysis collected on these two datasets for social good.