



Warsaw University of Technology



RESEARCH
UNIVERSITY
EXCELLENCE INITIATIVE

Presented at the FIG Congress 2022,
11-15 September 2022 in Warsaw, Poland



TRENDS IN THE DEVELOPMENT OF SPATIAL DATA VISUALIZATION METHODS

Robert Olszewski



XXVII FIG CONGRESS
11-15 SEPTEMBER 2022
Warsaw, Poland



Volunteering
for the future –
Geospatial excellence
for a better living

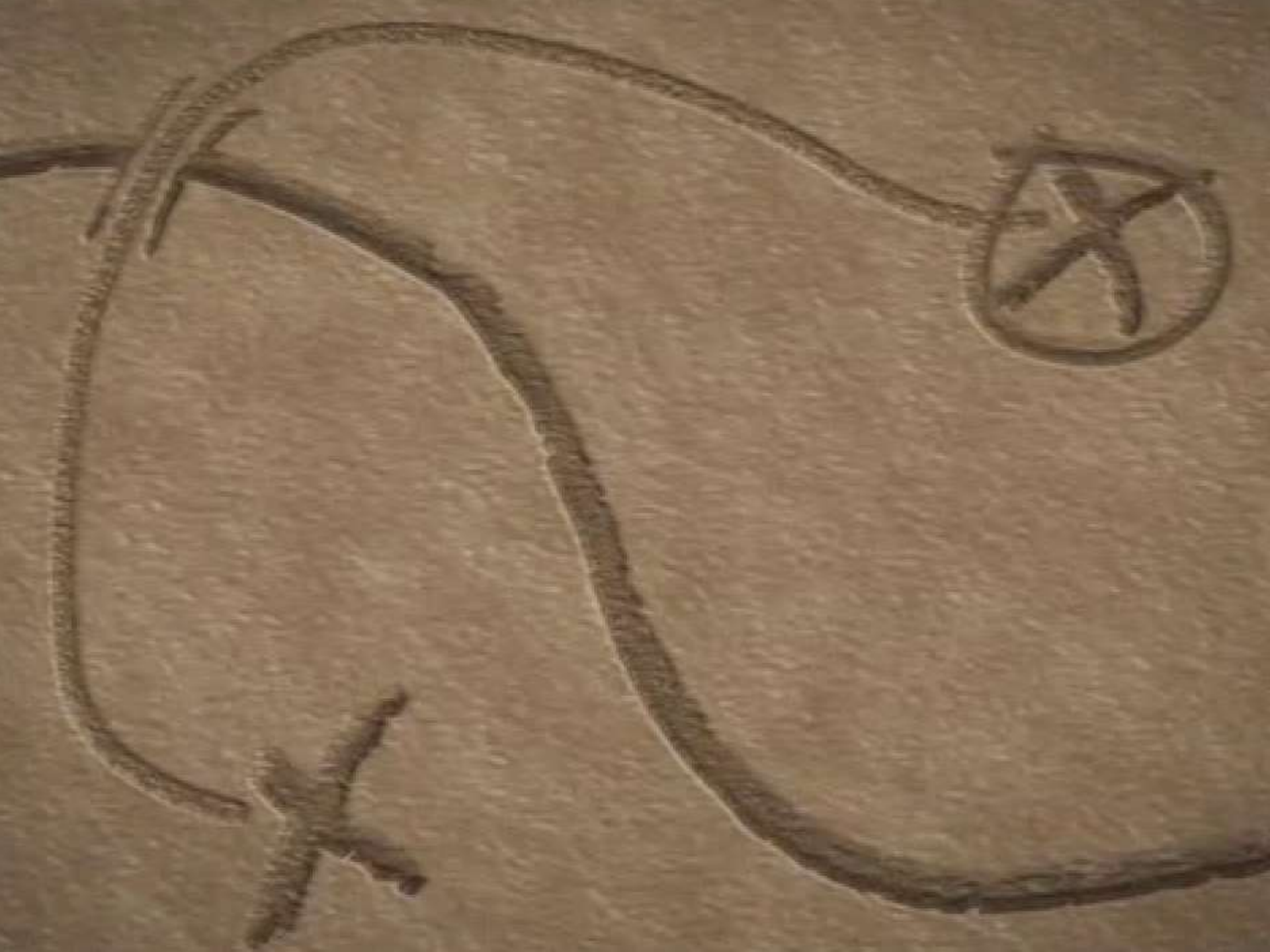


A satellite night view of Earth, showing the continents and oceans illuminated by city lights. The lights are concentrated in the eastern United States, Europe, and parts of Asia, creating a glowing pattern against the dark background of the planet.

mapping
is fundamental
to the process of lending order
to the World

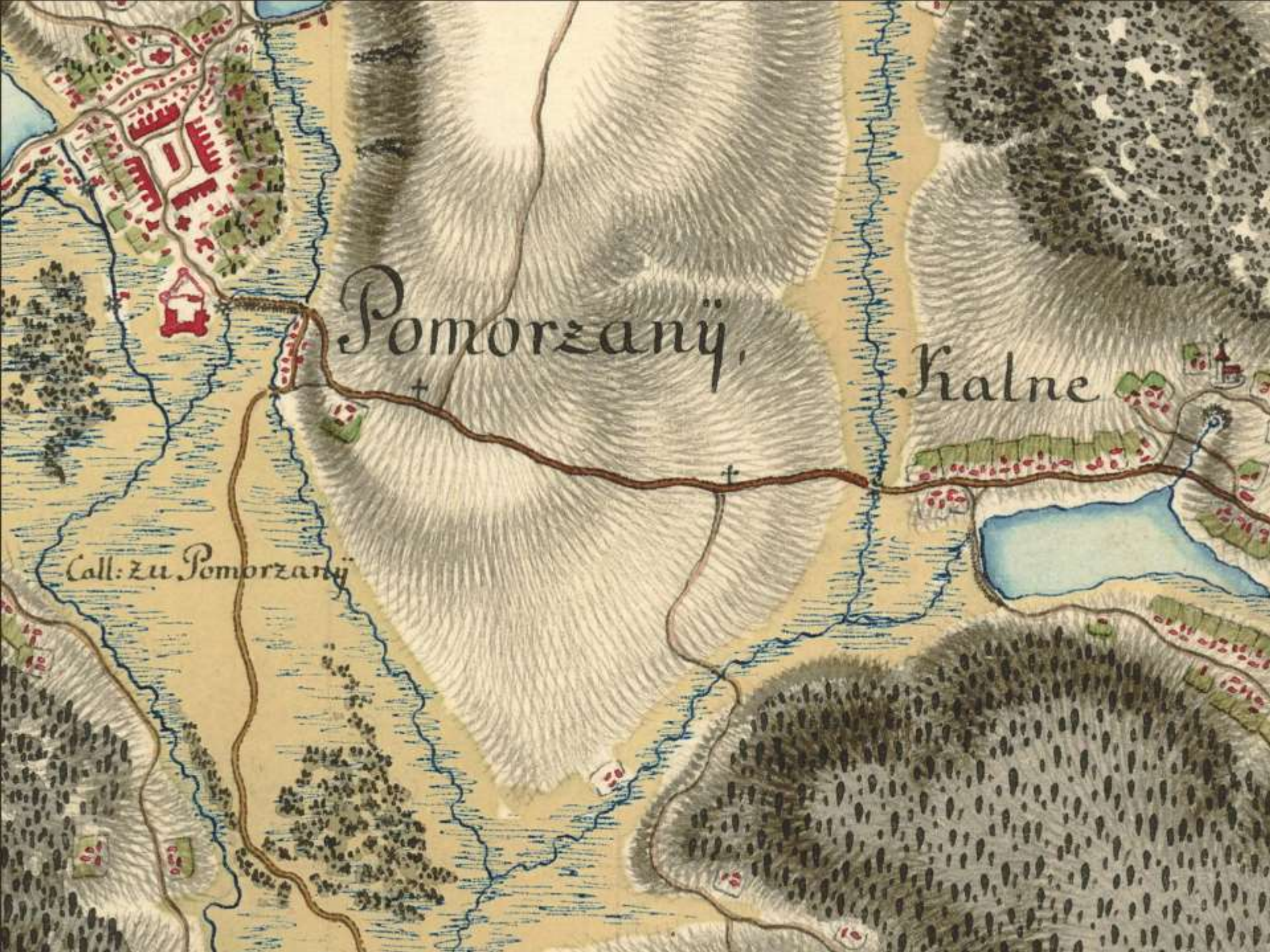
R. Rundstrum, 1926

Department of Cartography





Saint-Bélec Slab (2,2 x 1,53 m)



Pomorzanij

Kalne

Call: zu Pomorzanij



The Seer Speaks...

Yénillor morne
tulinte l quettar
tercáno nuruva
Hlasta! Qyetes
Hfirimain:



THE WORLD IS CHANGED



THE WORLD IS CHANGED







***THE WORLD
IS CHANGED***



INNOVATE OR DIE



*When the winds of
change blow, some
people build walls
and others build
windmills.*

CHANGE

AHEAD



TIME TO

THINK

BIG!

I f

the earth were only a
few feet in diameter, floating a
few feet above a field somewhere,
people would come from everywhere to
marvel at it. People would walk around it
marveling at its big pools of water, its little
pools and the water flowing between the pools.
People would marvel at the bumps on it, and the
holes in it, and they would marvel at the very thin
layer of gas surrounding it and the water suspended in
the gas. The people would marvel at all the creatures
walking around the surface of the ball, and in the water.
The people would declare it precious because it was the
only one and they would protect it so that it would not
be hurt. The ball would be the greatest wonder
known, and people would come to behold it, to be
healed, to gain knowledge, to know beauty and
wonder how it could be. People would love it,
and defend it with their lives, because they
would some how know that their lives,
their own roundness, could be nothing
without it. If the earth were
only a few feet in
d i a m e t e r.

Author unknown

Special thanks to John McConnell,
Founder of Earth Day, for this submission.
January 2000





technology



3D
IoT
cloud
AI&ML
AR&VR
big data
data mining

what's the question?

How to obtain data?

***How to process data to
obtain spatial information
and knowledge?***



Big Data

challenges in the era of big data

How to visualize the data?

How to analyze data?

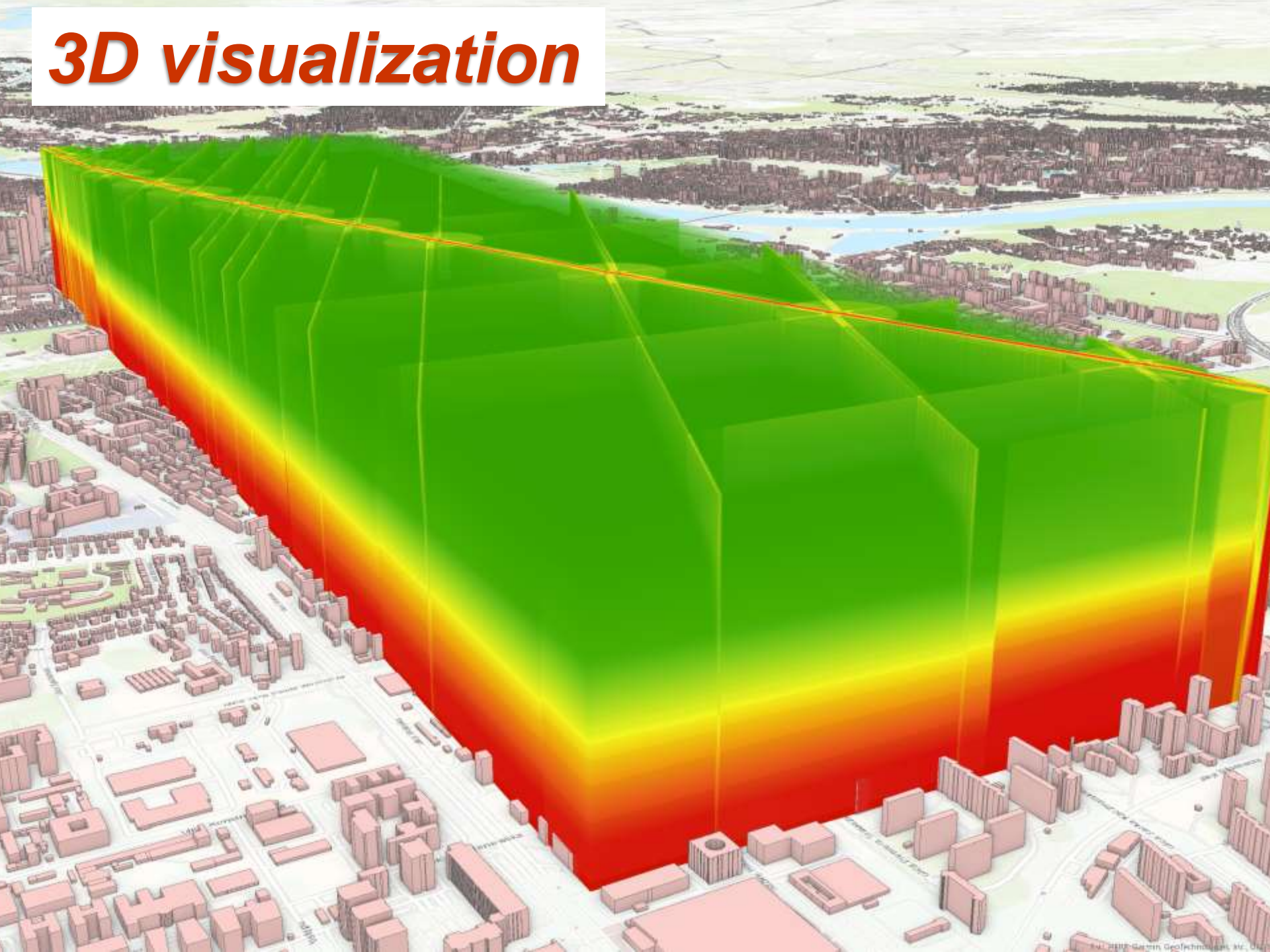
***How to use artificial intelligence and
VR/AR to process spatial data?***

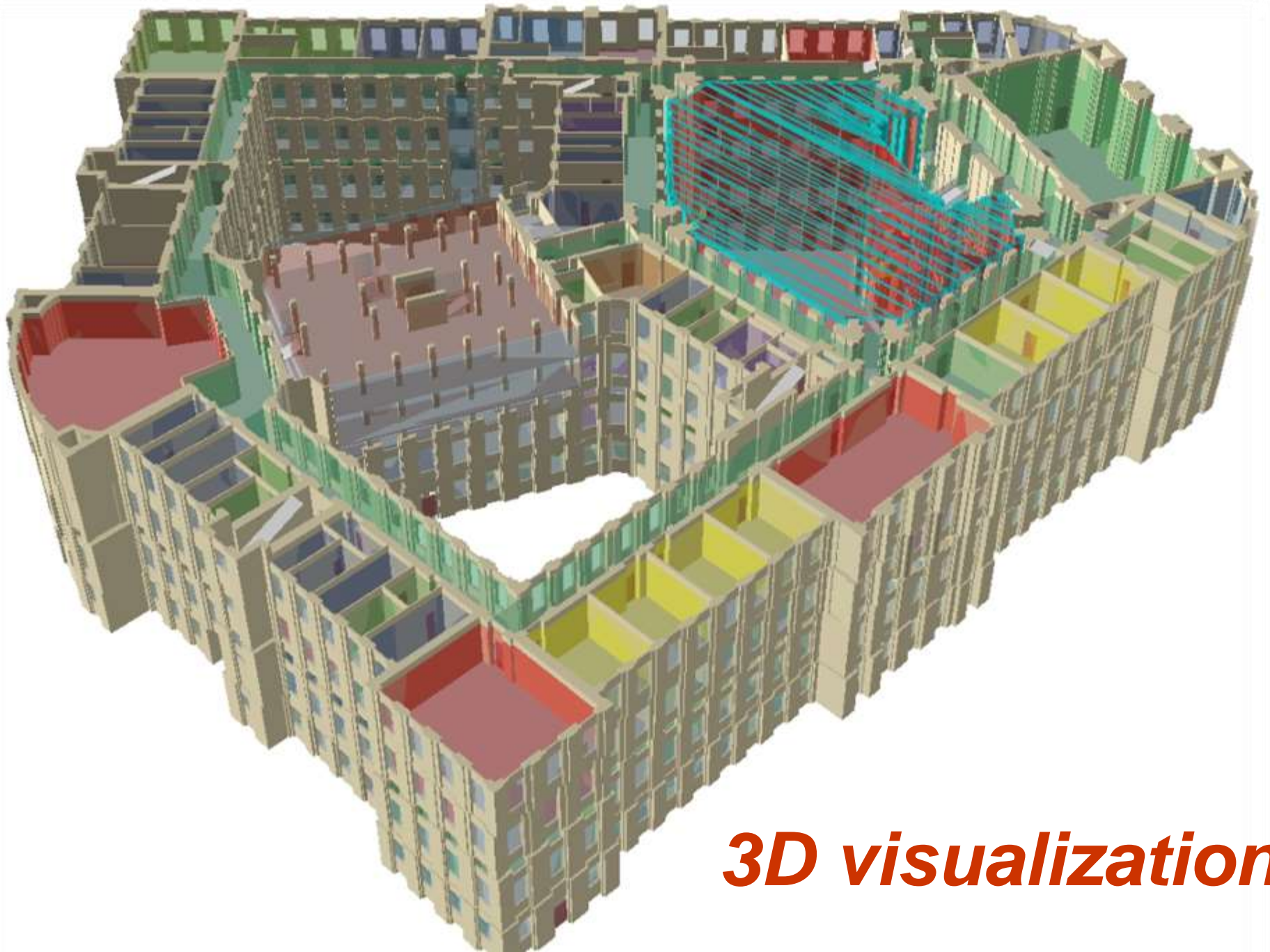
***How to create simulation models and
digital twins?***

3D visualization



3D visualization





3D visualization

spatial data visualization in game engines



UNREAL
ENGINE



MINECRAFT

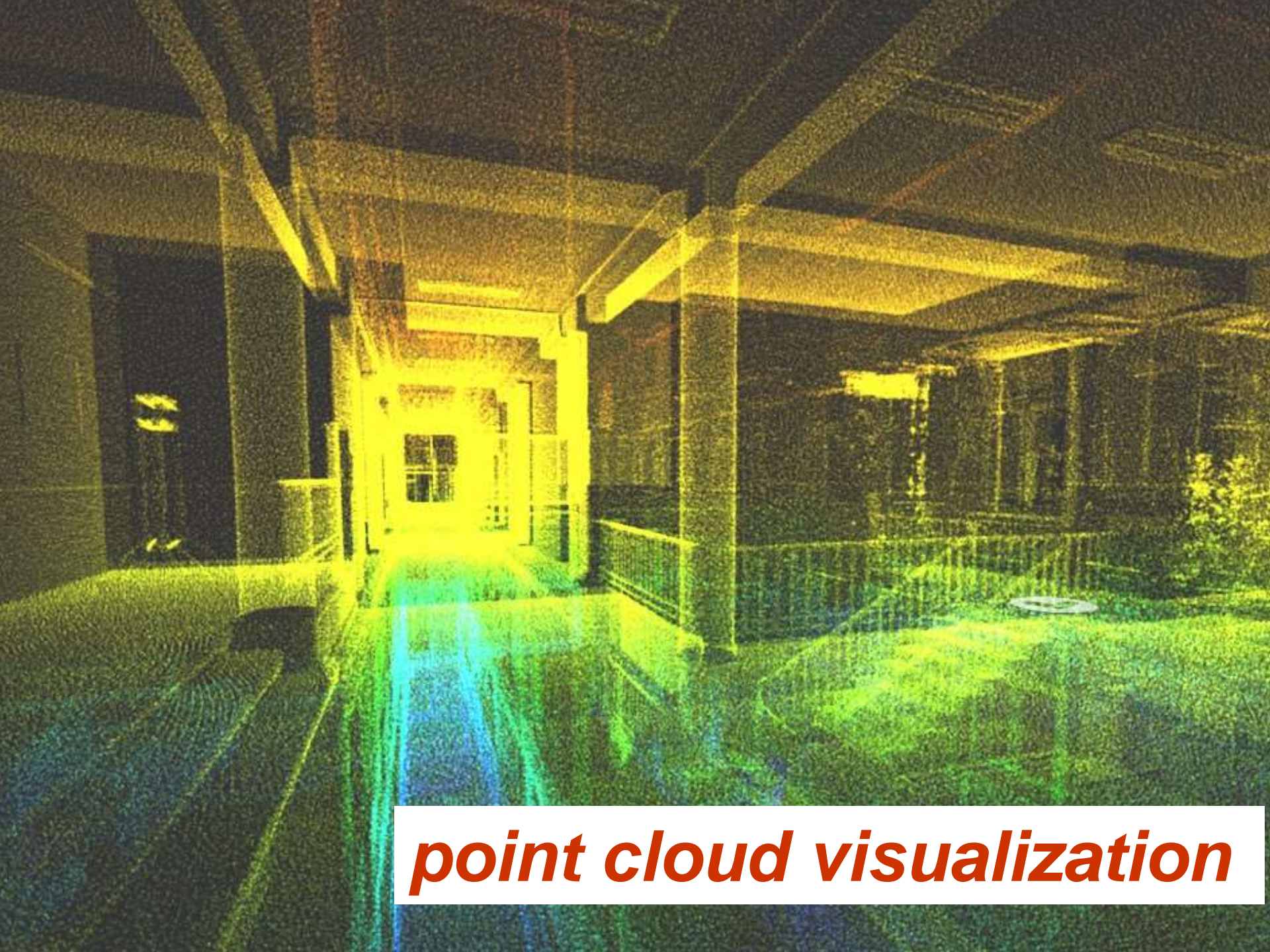
DENMARK



MINECRAFTXL.COM







point cloud visualization

holographic visualization







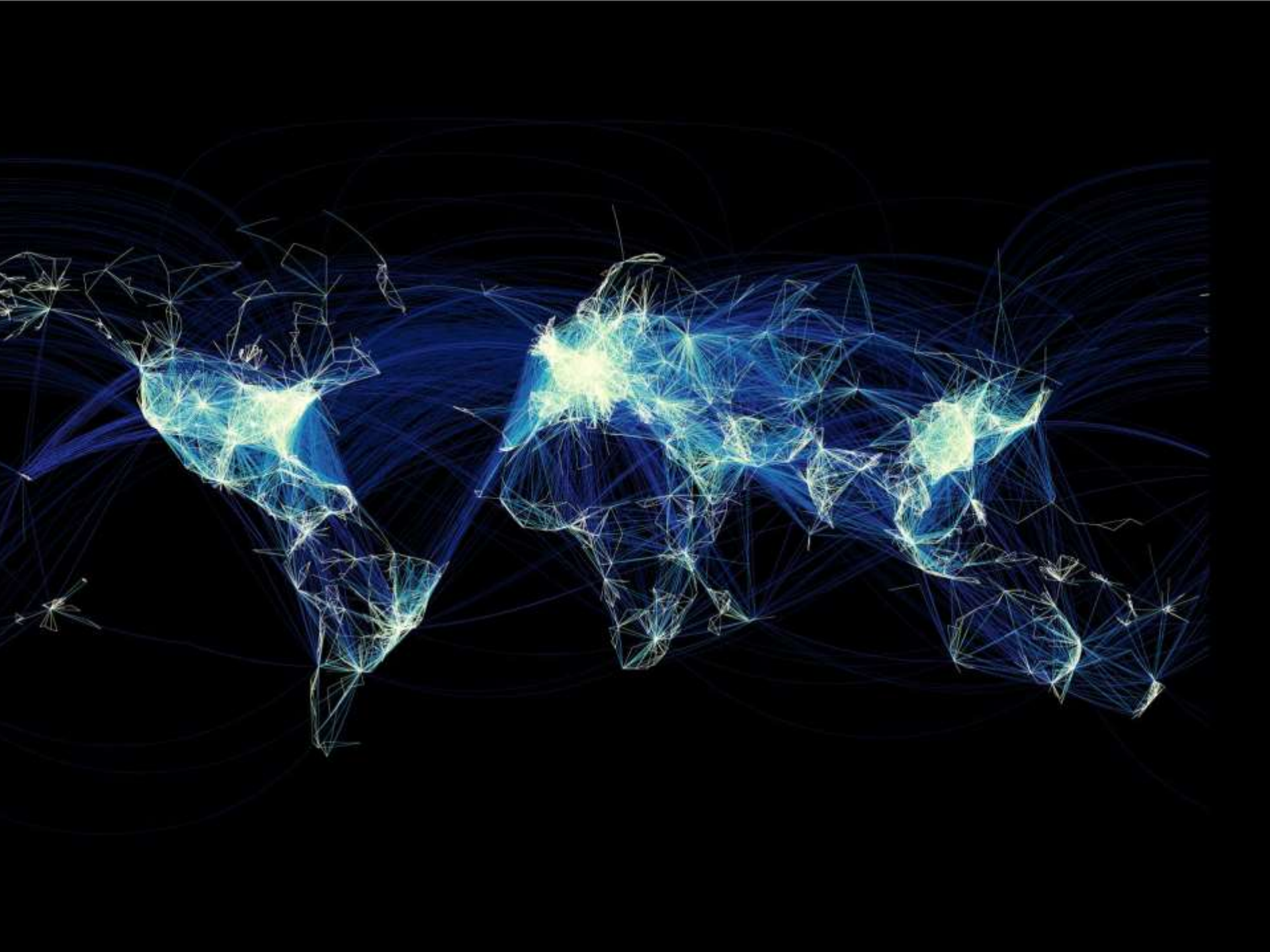


AR/VR visualization



AR/VR visualization





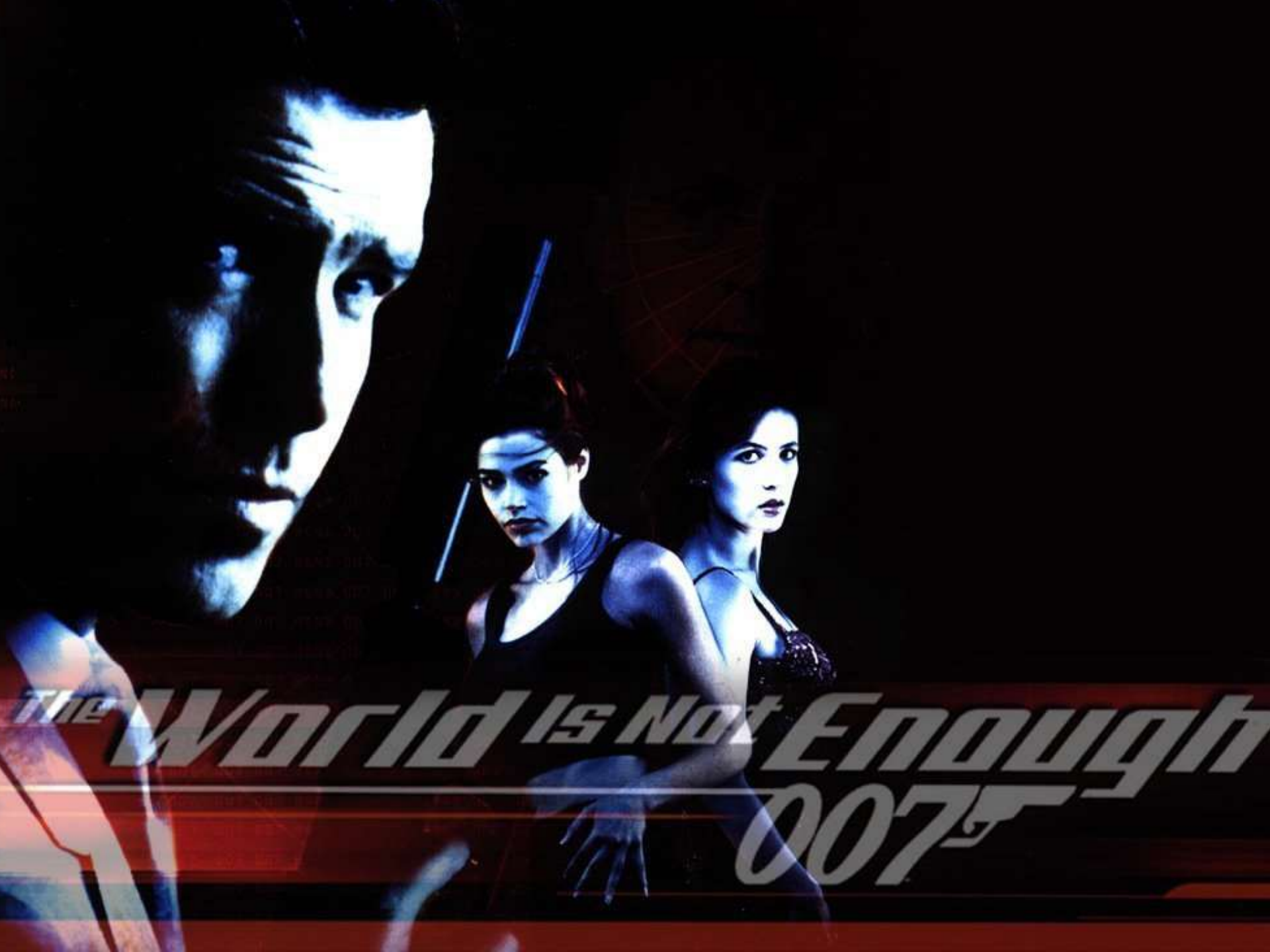
challenges in the era of big data

How to visualize the data?

How to analyze data?

*How to use artificial intelligence and
VR/AR to process spatial data?*

*How to create simulation models and
digital twins?*



The World Is Not Enough
007









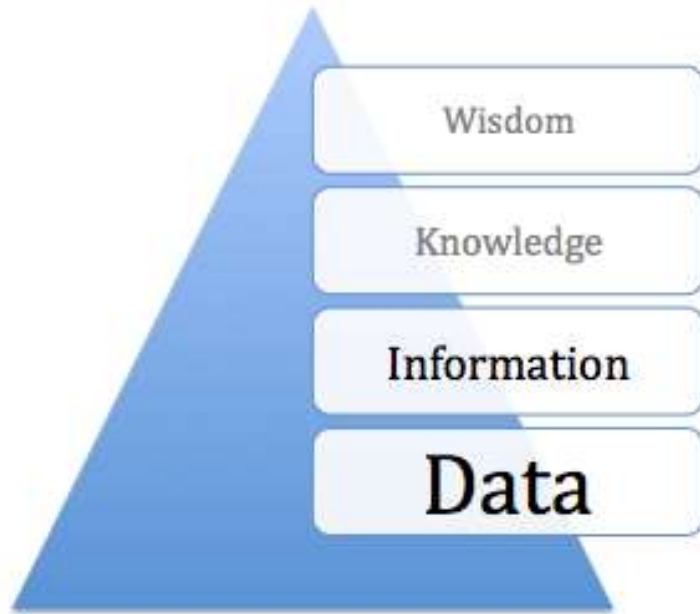
DATA MINING





**the paradox of the great civilization change consists
in the fact that we have practically unlimited access
to information and data and yet we are nearly
unable to use it in any way**

Manuel Castels " *The Information Age* "



**Data is a new oil.
Models are the new gold...**

Clive Humby

"DATA IS THE NEW OIL"

From the beginning of recorded time until 2003, we created **5 exabytes** of data.

In 2011 the same amount was created every two days.

By 2014, it's reported that the flow will triple to 15 exabytes.

Every hour, we create enough internet traffic to fill **7 billion DVDs**.

That's why, that's what's making things the height of Facebook.

Compared to 2008 by China. During a British data communication entrepreneur, the new services provided were introduced by the World Economic Forum in a 2011 report, which predicted that the use of social networks would, by 2014, be the most common activity on the web.

There are nearly as many bits of information in the digital universe as there are stars in our entire universe.

As of August 2012, there were just over **4 million** websites in the English language.

There are **133 million BLOGS** on the web.

80% of all business e-mail is made up of spam. Out of 2 billion e-mails, 1 billion are unwanted. In Singapore, 60% of e-mails are unwanted (spam).

English is the dominant language of the web. But by 2014 it will be **Chinese**. If the current rate of business continues.

The language use of the web (by 2014)



247 billion EMAILS are sent every day. 60% are spam.

10% of all photos ever taken were taken in 2011.

60% of all tweets in 2010, 100,000 text messages were sent every second.

High-frequency traders.

With the help of microsecond algorithms, use Big Data to follow trends and to act quickly on that trading.

These specialized algorithms make split-second decisions to buy or sell a commodity. New cables being laid across the Atlantic will shave **1 millisecond** from the current 60 milliseconds it takes for trading instructions to travel between New York City and London.

With new fiber-optic cable.

The round trip time between New York and London will be 90.9 milliseconds.

This 0.9-millisecond saving is worth many millions of dollars to the trading firms who use the cable (and who will pay millions to do so).

How they save 0.9 milliseconds

The depth of the Atlantic Ocean varies.

The new cable will be an average of the ocean floor that are up to 1,000 feet shallower than the current fastest cable. By taking a different route, the new cable is shorter, meaning that the time it takes for messages to travel along it is shortened.



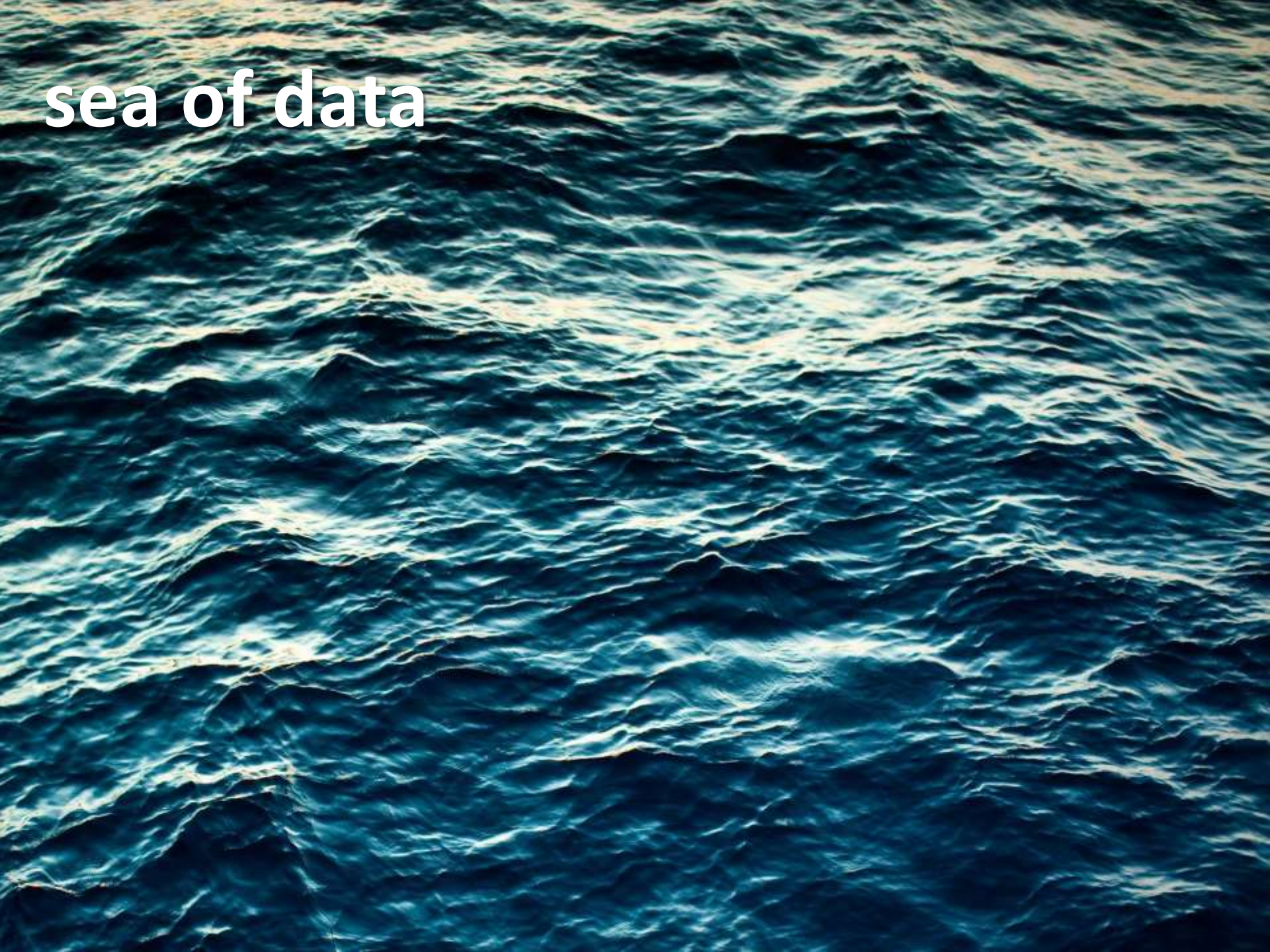
50% of 6-year-old data in the U.S. are gone because in a smartphone.



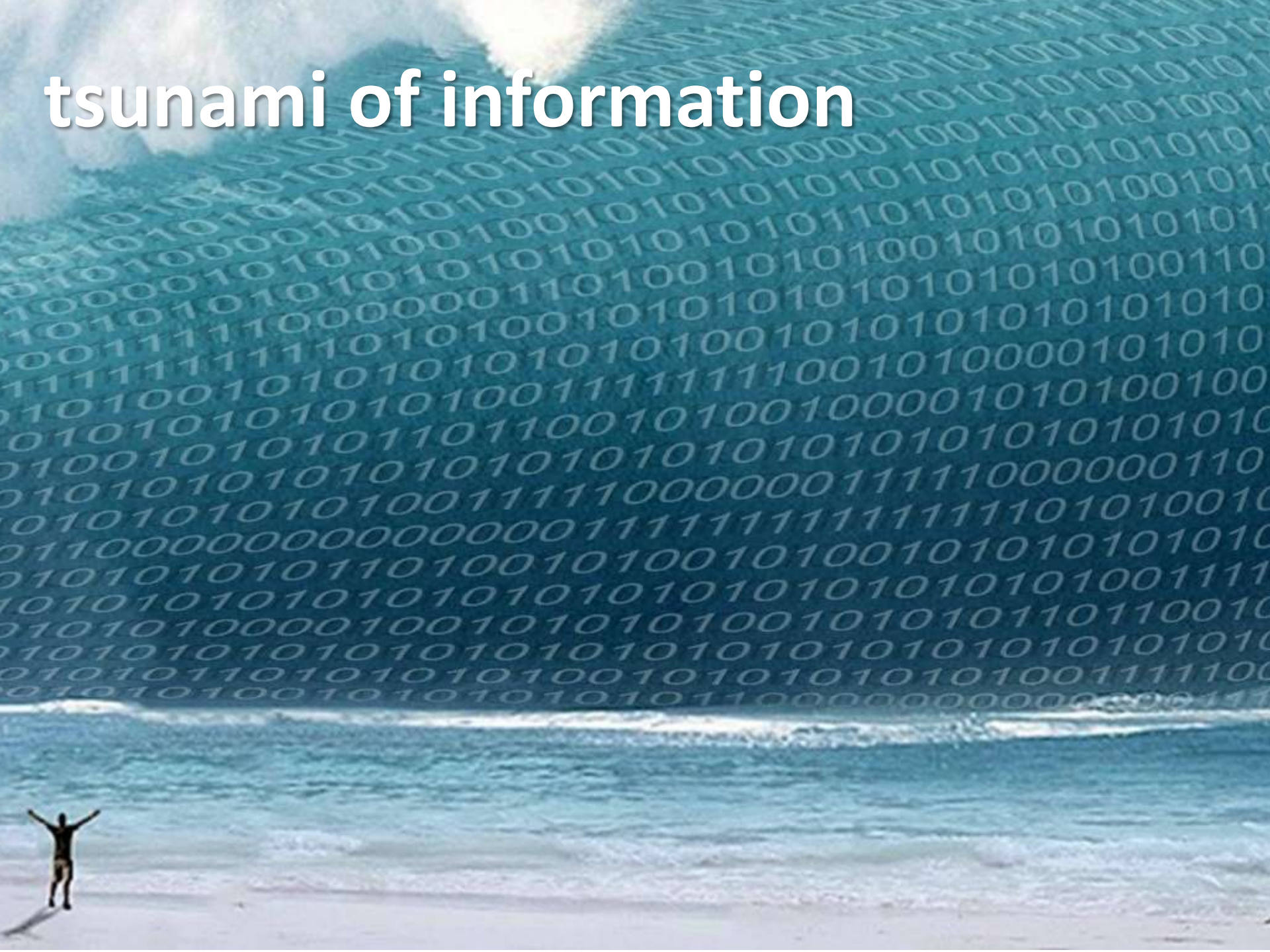


Data is the oil that fuels A.I.

sea of data



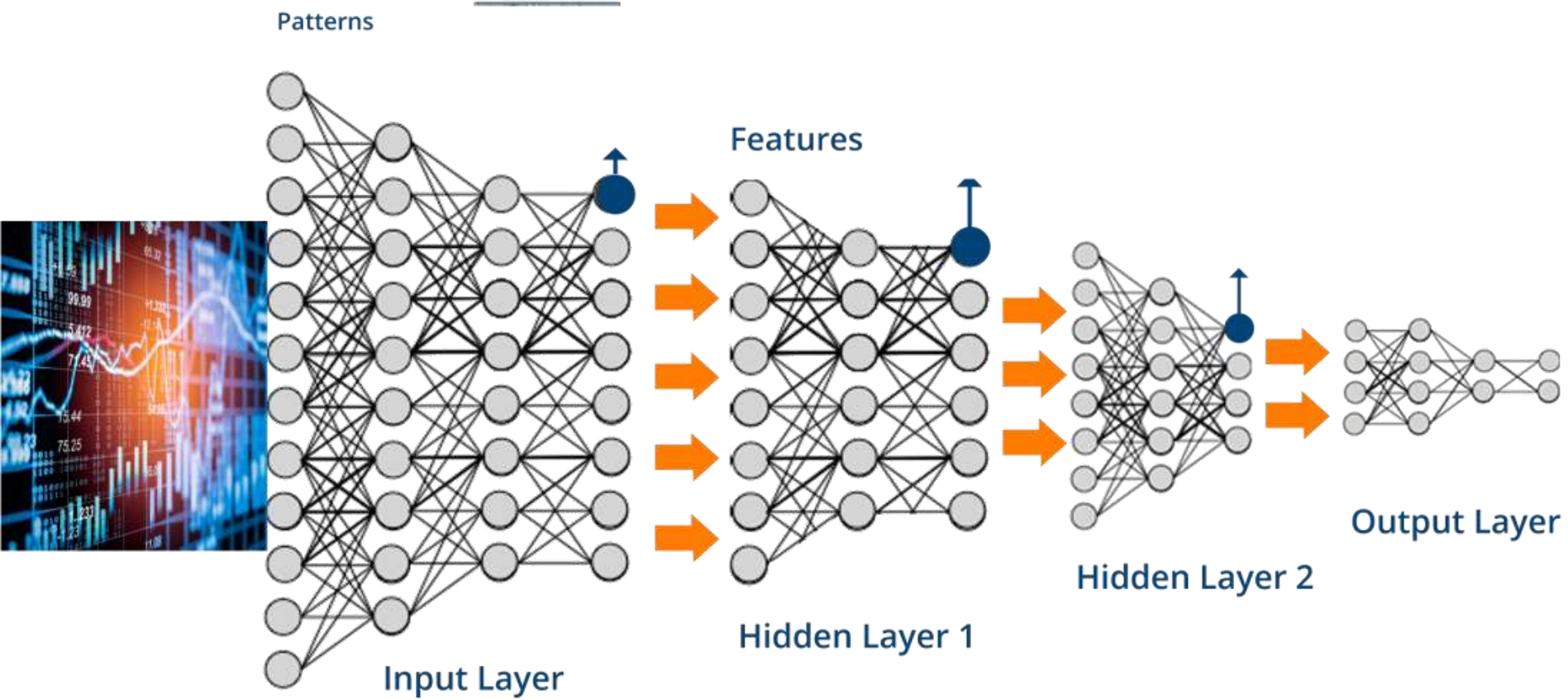
tsunami of information



fishing net



neural network





COVID-19

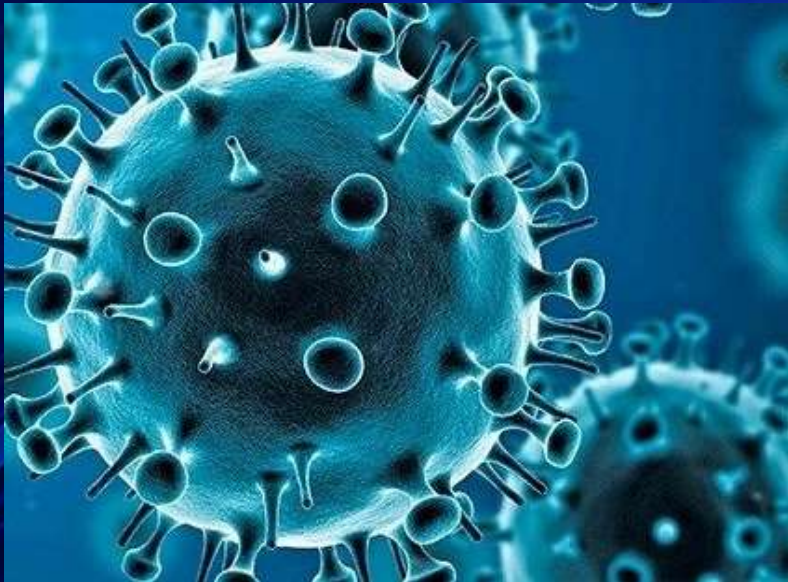
MARCO



MARCO



Methods of spatial **A**nalysis, forecasting
and **R**ecommendation in preventing
the spread of **C**COVID-19



GOALS



- development of a methodology for time-space analysis of simulations of the development of various types of epidemics (including COVID-19) enabling the construction of a decision support system for social distancing
- extraction of knowledge from source data by building simulation models using: (i) multi-agent modeling, (ii) deep learning, (iii) Monte Carlo simulations
- development of models and algorithms for optimizing social distancing recommendations and effective methods for geovisualization of pandemics

Agent-based models



Development of an agent-based simulation model to enable time and space simulations of the spread of a pandemic

Agent-based models



Agent

- has personal characteristics (age range, gender)
- lives, works, heals, ... in a particular building
- shops, visits friends, museums, parks, ... according to the cycle of the day/week
- specific state on COVID-19: (SEAIRPD)

- transitions between states:
- S->E: when contacting people in states A, I, P
- E->A / E->I: draw after incubation period σ
- A->R, I->R, P->R: after recovery period γ_A , γ_I , γ_P
- I->P: recognition with probability ϵ_I
- I->D, P->D: death with probability d_I , d_P

* Trivedi, Ashutosh & Sreenivas, Nanda & Rao, Shrisha. (2020). Modeling the Spread and Control of COVID-19

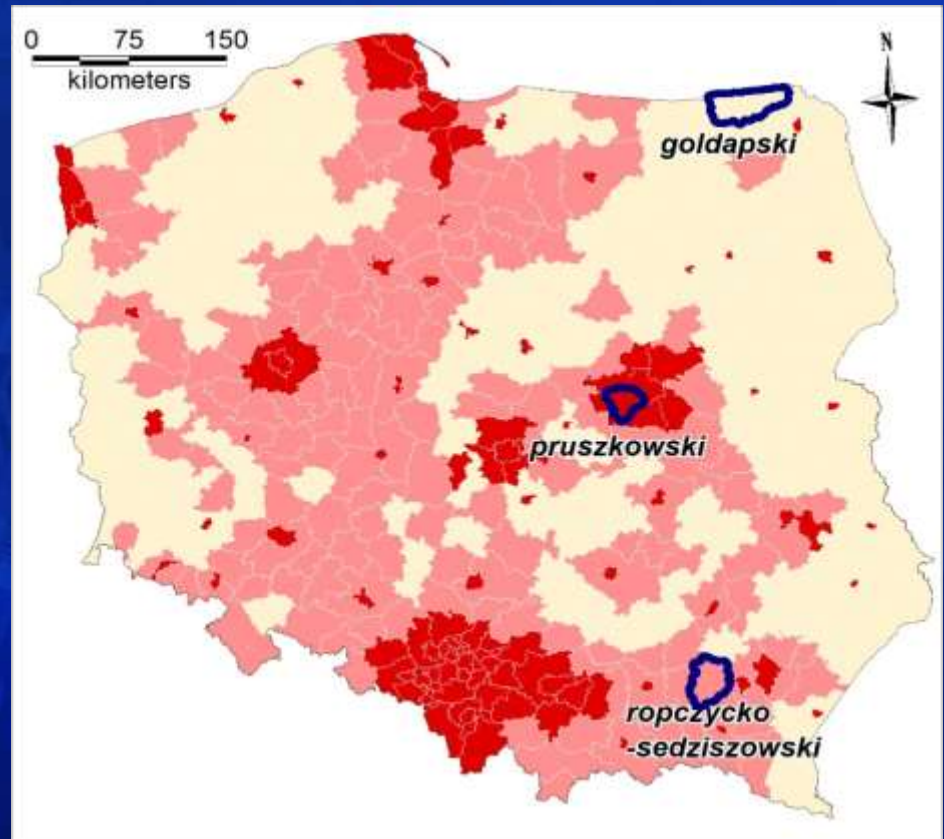
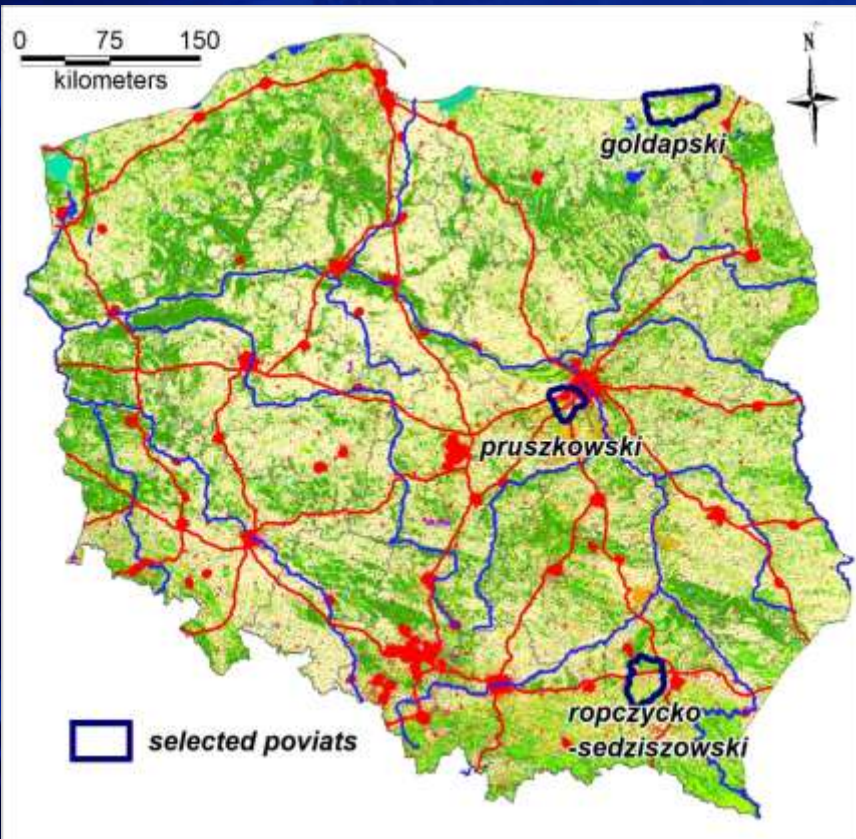
** Volpatto, Diego Tavares, et al. "Spreading of COVID-19 in Brazil: Impacts and uncertainties in social distancing strategies." *medRxiv* (2020))

Selected parameters of the model

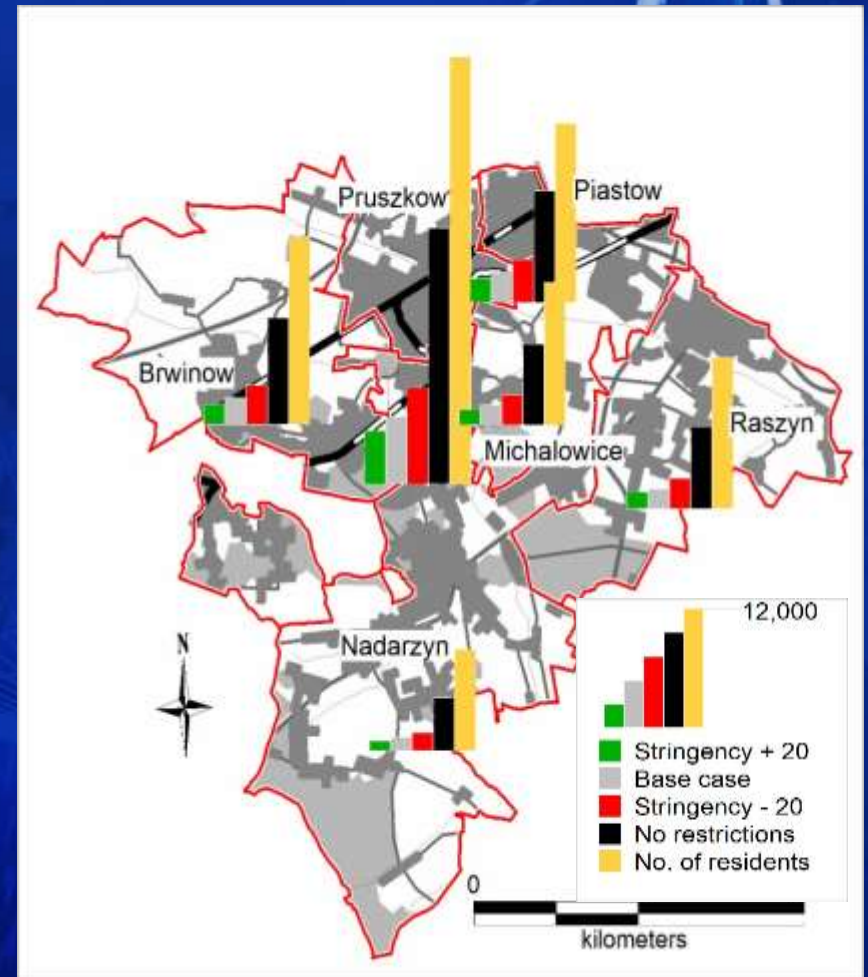
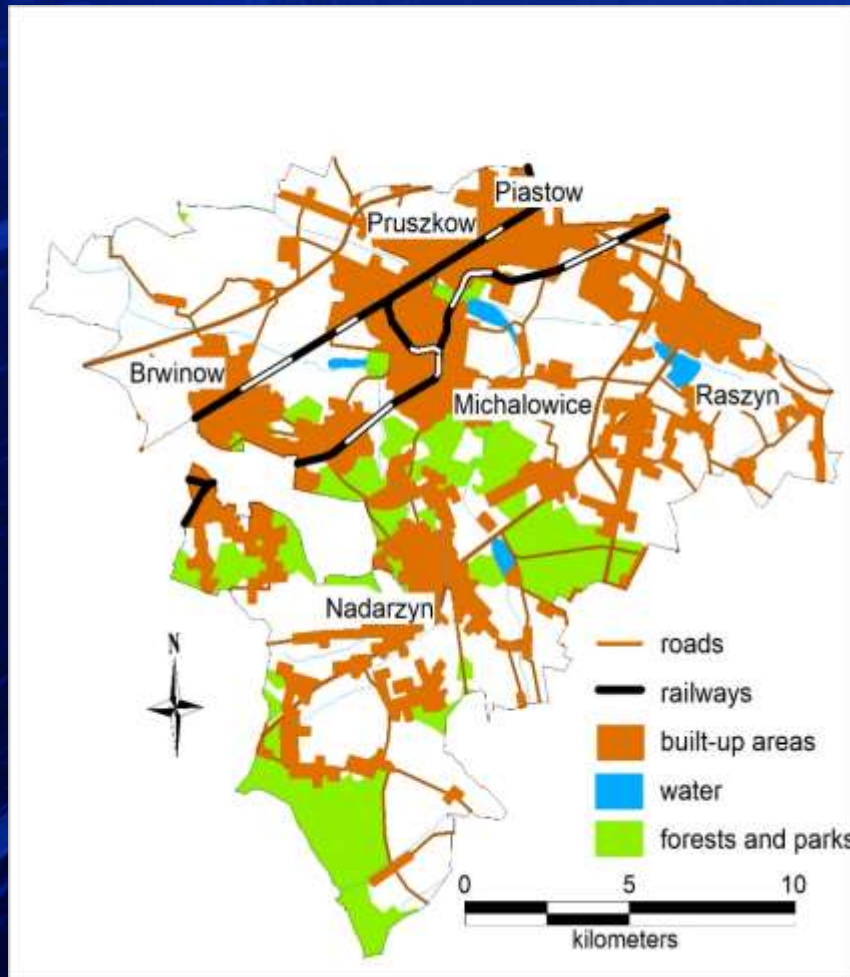


- β - Infectivity coefficient on contact with a symptomatic infected person (0.00026)
- μ - Coefficient of infectivity on contact with an asymptomatic infected person (0.00026)
- σ - Disease incubation period $\sim U(4.5, 5.8)$ days
- ρ - Percentage of asymptomatic infected (80%)
- ϵ_I - Recognition rate of hospitalized individuals (0.5)
- γ_A - Recovery period of asymptomatic infected $\sim U(10, 14)$ days
- γ_I - Recovery period of symptomatically infected $\sim U(10, 14)$ days
- γ_P - Recovery period of hospitalized patients $\sim U(10, 14)$ days
- d_I - Mortality rate of hospitalized patients (0.01356770)
- d_P - Mortality rate of those with symptoms of infection (0.0041681711)
- time from infection to death: $\sim U(3, 14)$ days
- time/(distribution) of diagnosis: $\sim U(1, 3)$ days

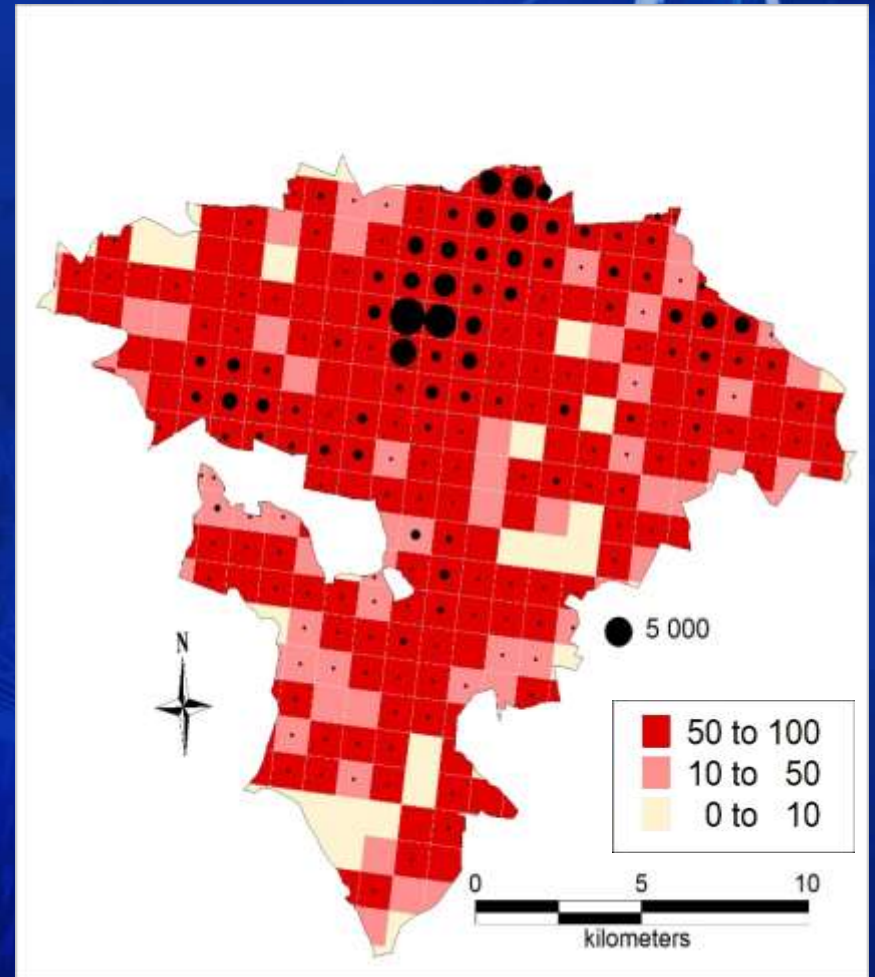
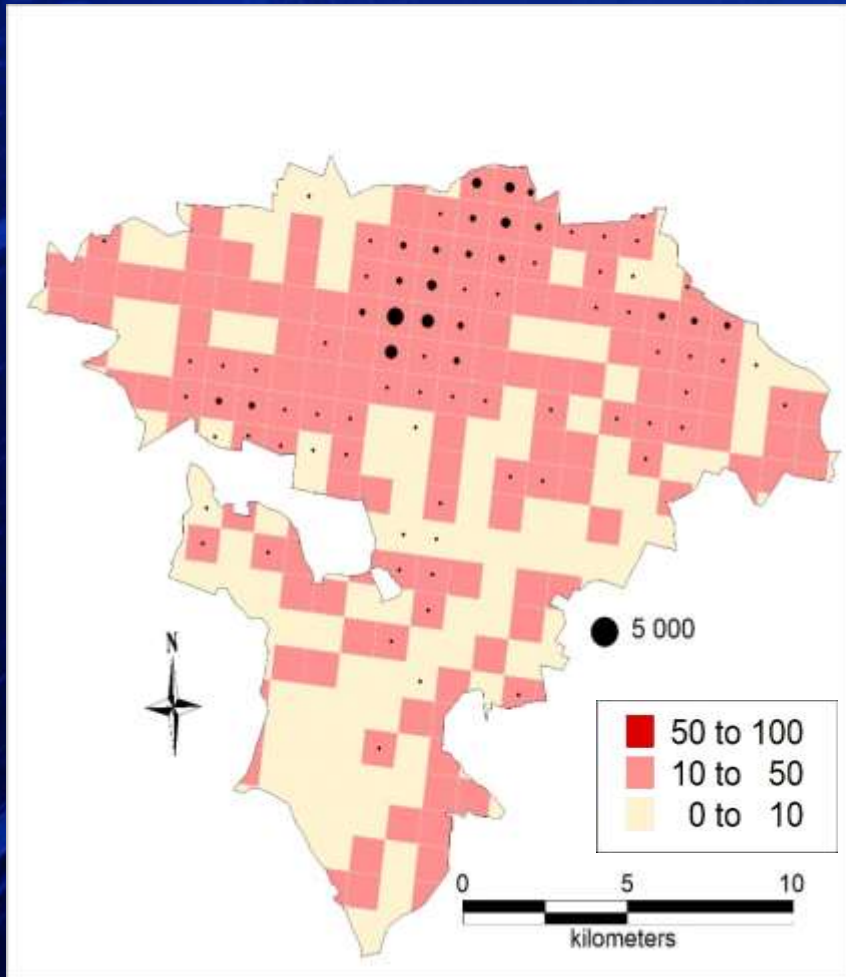
Research areas



Results



Results



INSPIRATION

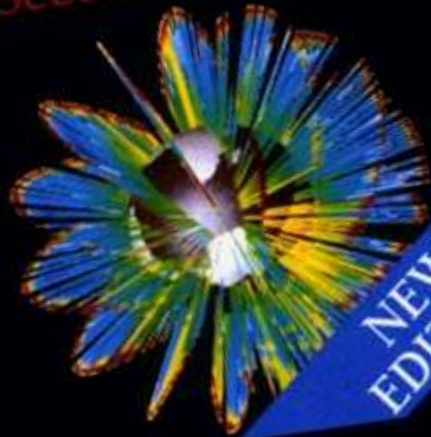
***to be imprecisely right
is better than to be precisely
wrong***



THE INFORMATION AGE:
ECONOMY, SOCIETY AND CULTURE
Volume 1

THE RISE OF THE NETWORK SOCIETY

Second Edition



NEW
EDITION

Manuel Castells



By KARL R. POPPER

The Open Society and Its Enemies

2 Hegel and Marx

(geo)information society

***A society that makes
extensive use of geo-information
obtained through widely available
geo-information infrastructure
services***

Society 5.0



[source: CAO,Japan]

ASK
yourself



***ask not what your country
can do for you
– ask what you can do
for your country***

President John F. Kennedy, Inaugural Address

*ask not what the world
can do for you
– ask how **YOU** can create
the model of our world*

XXVII FIG Congress



Warsaw University of Technology



THANK YOU FOR YOUR ATTENTION

Robert Olszewski

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*Volunteering
for the future –
Geospatial excellence
for a better living*