

Digital Social Science Lab – Copenhagen University

Opening Reception, 18th Feb 2015

# From Counting to Connecting

Network Visualisations and Complex Social Systems



Network Insights for Collaborative Sustainable Production

Danmarks  
Tekniske  
Universitet



# About me

Pedro Parraguez

Postdoc – DTU Management Engineering

## PhD Thesis

A Networked Perspective on the Engineering Design Process:  
At the Intersection of Process and Organisation Architectures





Socio-technical data-driven approach  
to understand and support complex  
engineering systems

***Division leader:  
Prof Anja M. Maier***

# From Counting to Connecting

Network Visualisations and Complex Social Systems

Case 1

Danish Cleantech  
Industry

Case 2

DTU's Knowledge  
Landscape

Wrap up

# Introduction

Network Visualisations and  
Complex Social Systems



# From Counting



# to Connecting

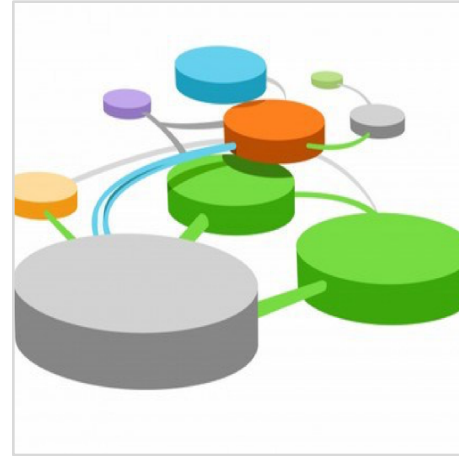


# From counting to connecting [building blocks]

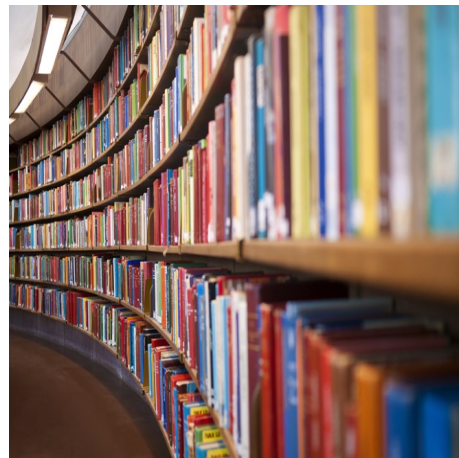
Data-driven



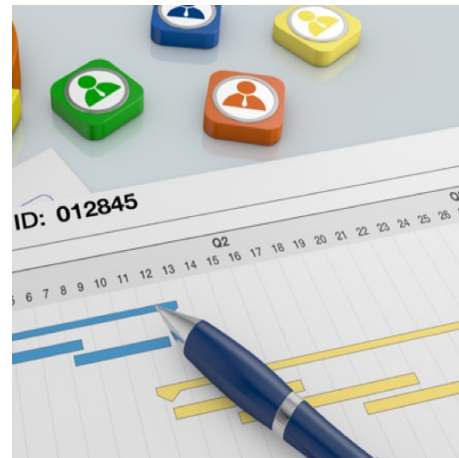
System thinking



Exploration



Understanding





# From top-down expert opinions to data-driven insights



# From Units to System(s)



# From Search to Discovery



# From KPI's to Key Performance Predictors



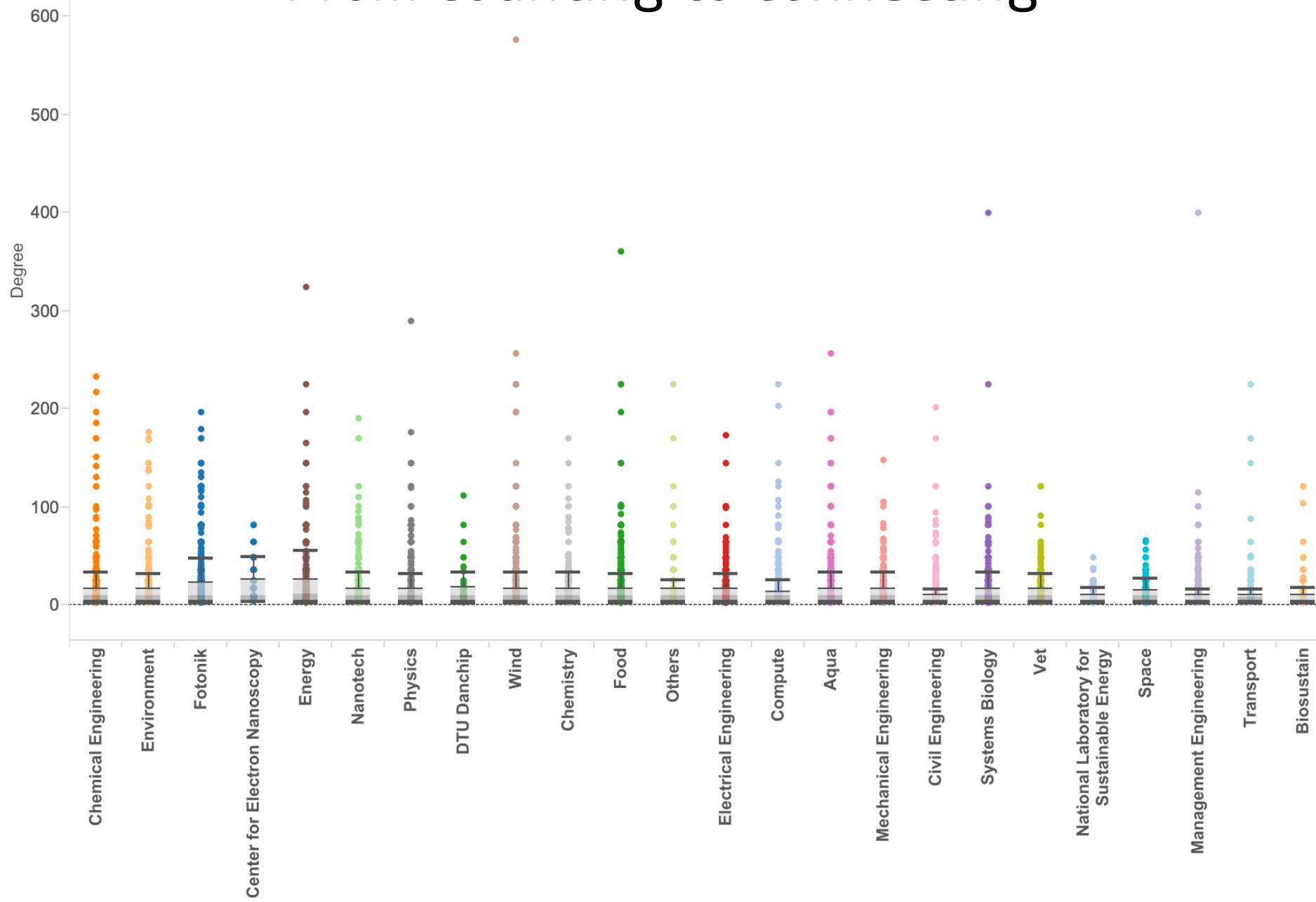
# From counting to connecting

## Publication types - 2015 - DTU Orbit (13/02/2016)

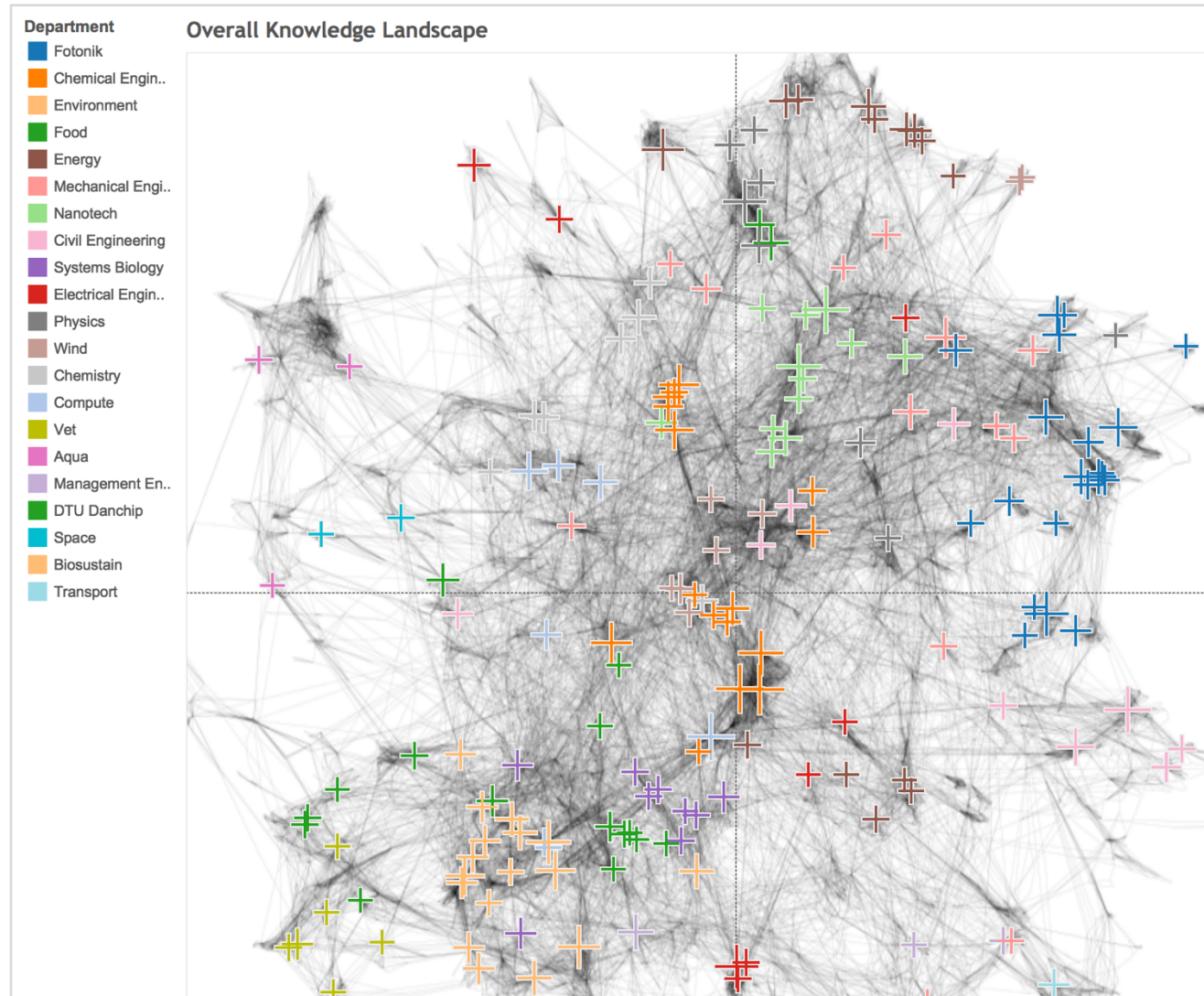
### 1. Publication types (DTU records)

		Count
No. 1	Contribution to Journal	3718
No. 2	Book/anthology/thesis/report	751
No. 3	Contribution to book/anthology/report	1838
No. 4	Contribution to conference	857
No. 5	Working paper	4
No. 6	Contribution to newspaper	46
No. 7	Memorandum/exposition	8
No. 8	Contribution to memorandum/exposition	2
No. 9	Net publication	73
No. 10	Patent	61
No. 11	Non-text contribution	206
No. 12	Other	1

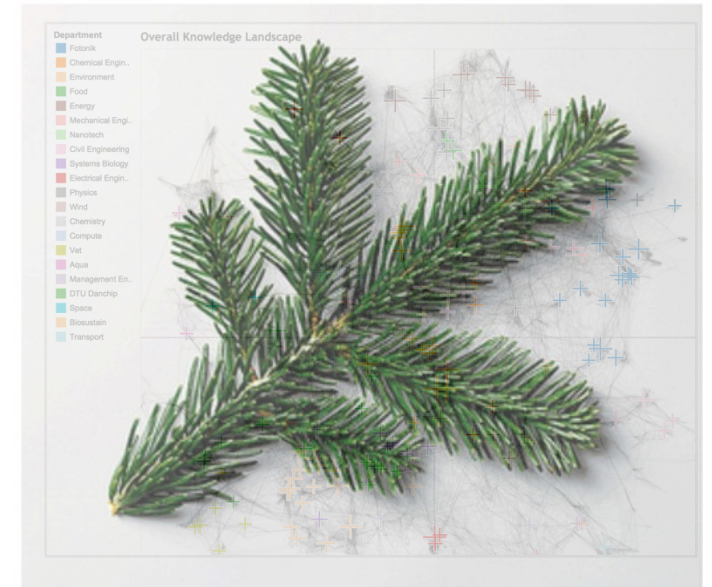
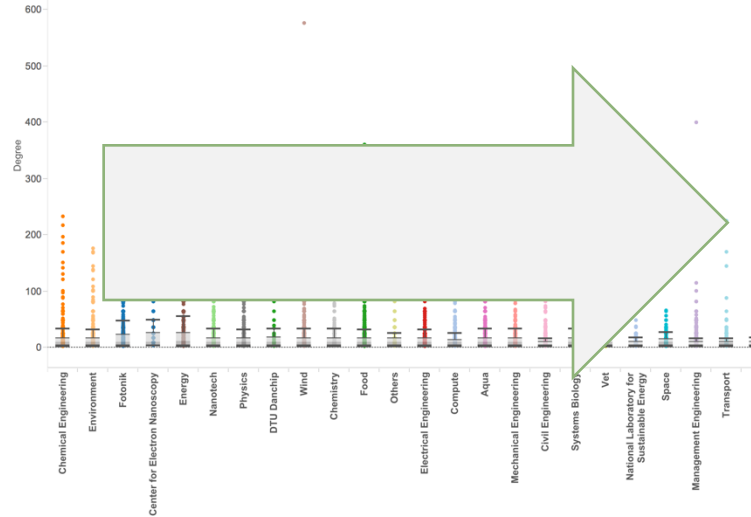
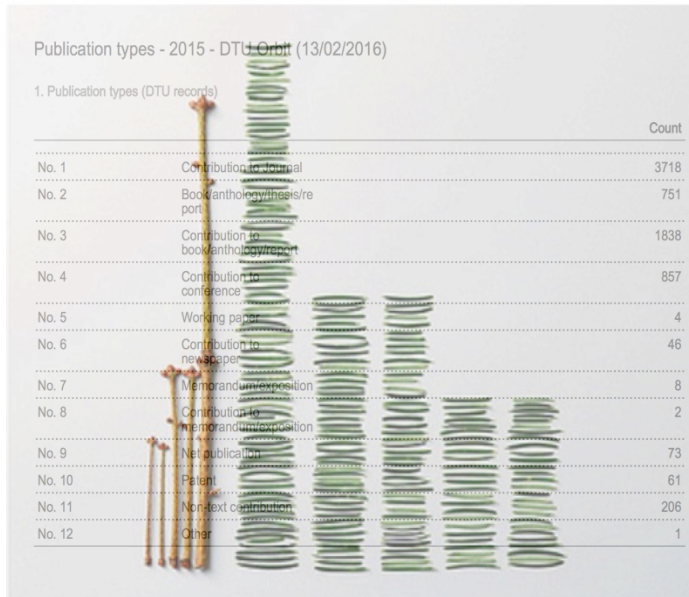
# From counting to connecting



# From counting to connecting



# From counting to connecting [From tables to networks]





# Case 1

Net-Sights: Network Insights for  
Collaborative Sustainable Production



# Net-Sights

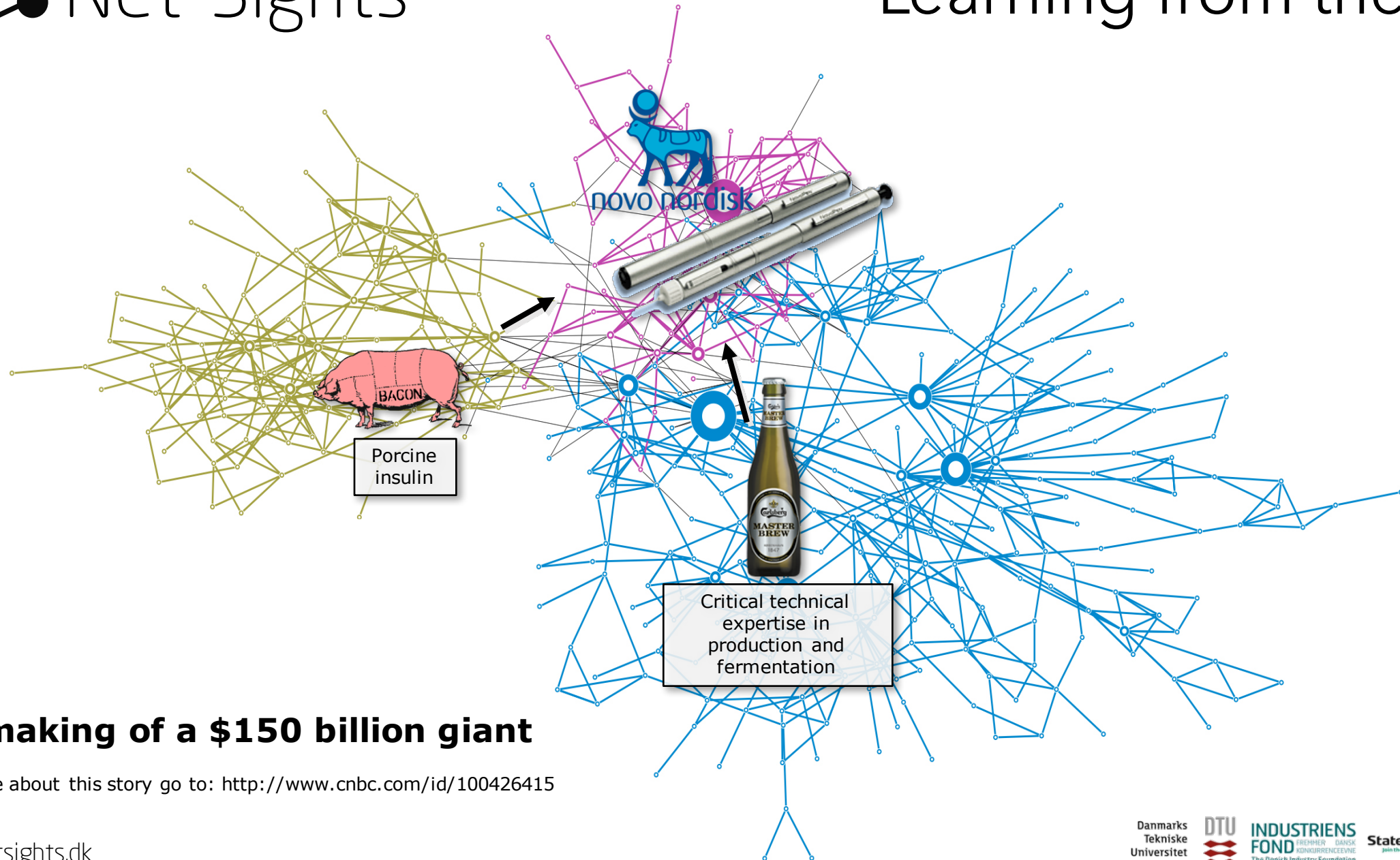
Network Insights for Collaborative  
Sustainable Production

Finding the right partner

The urgent need for sustainability





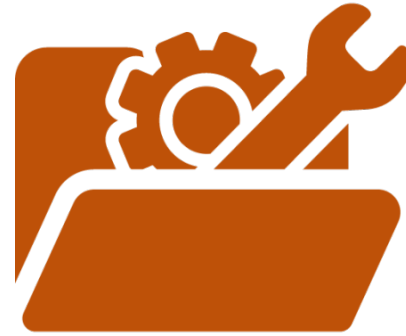


## The making of a \$150 billion giant

For more about this story go to: <http://www.cnbc.com/id/100426415>

**Challenge:** Proactively identify collaboration partners to develop and deploy innovative and sustainable solutions to market.

# Four factors for successful collaborations



Technological  
closeness



Relational  
closeness

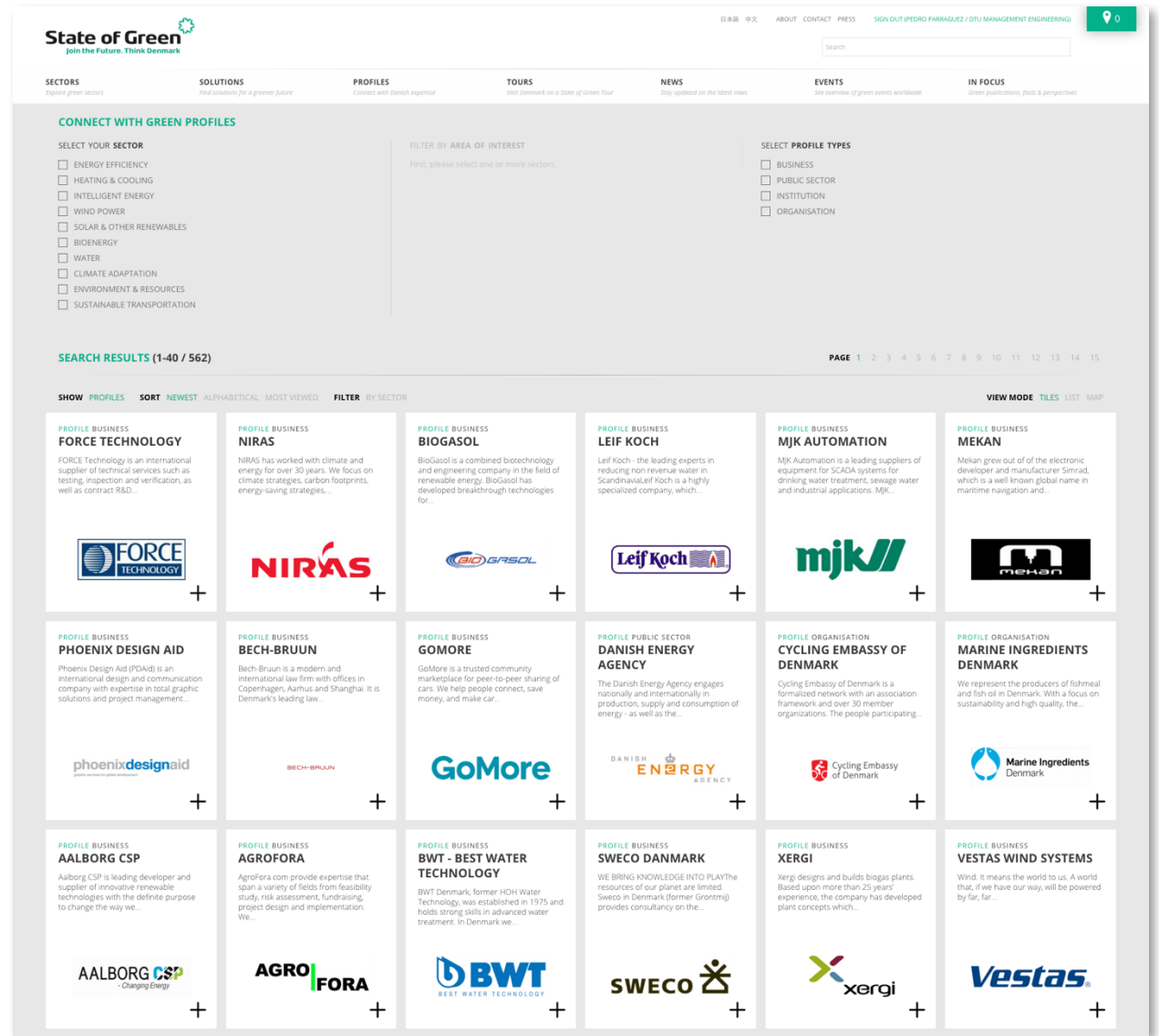


Geographical  
closeness



Organisational  
variables

# Turning rich data into network insights



**State of Green**  
Join the Future. Think Denmark

日本語 中文 ABOUT CONTACT PRESS SIGN OUT (PEDRO PARRAGUEZ / DTU MANAGEMENT ENGINEERING)

SECTORS SOLUTIONS PROFILES TOURS NEWS EVENTS IN FOCUS

### CONNECT WITH GREEN PROFILES

**SELECT YOUR SECTOR**

- ENERGY EFFICIENCY
- HEATING & COOLING
- INTELLIGENT ENERGY
- WIND POWER
- SOLAR & OTHER RENEWABLES
- BIOENERGY
- WATER
- CLIMATE ADAPTATION
- ENVIRONMENT & RESOURCES
- SUSTAINABLE TRANSPORTATION

**FILTER BY AREA OF INTEREST**



















First, please select one or more sectors.

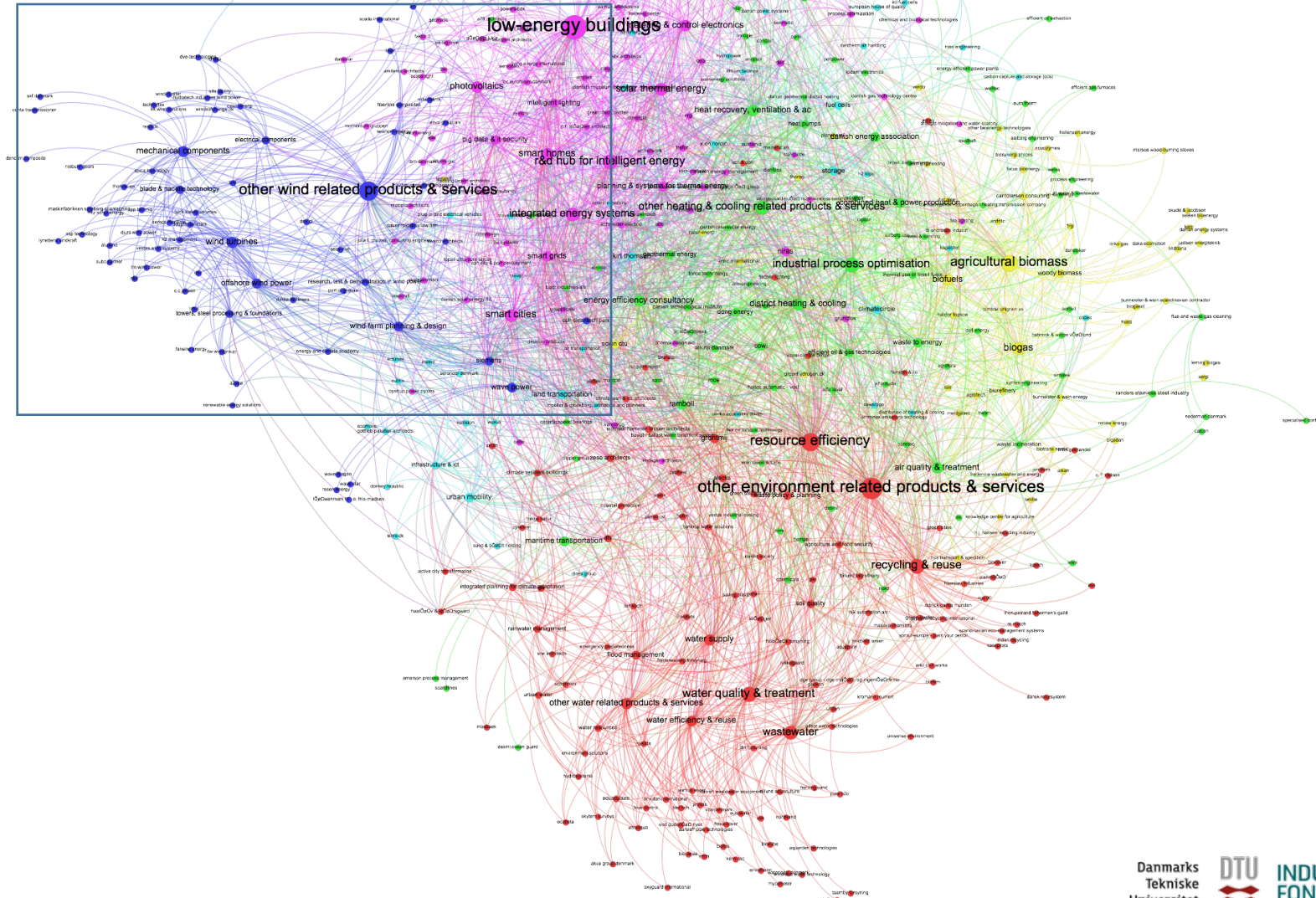
**SELECT PROFILE TYPES**

- BUSINESS
- PUBLIC SECTOR
- INSTITUTION
- ORGANISATION

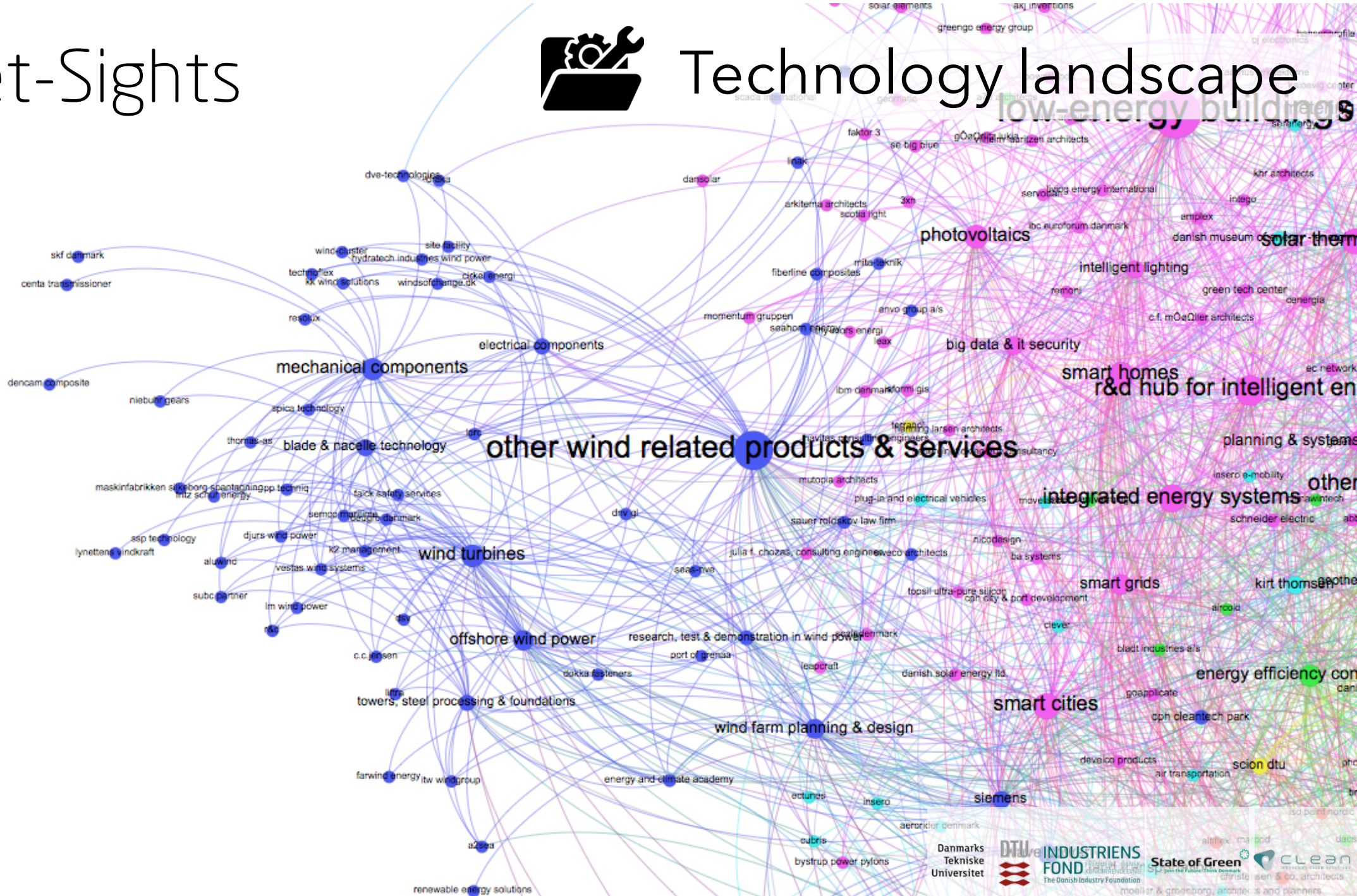
**SEARCH RESULTS (1-40 / 562)** PAGE 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

SHOW PROFILES SORT NEWEST ALPHABETICAL MOST VIEWED FILTER BY SECTOR VIEW MODE TILES LIST MAP

<p><b>PROFILE BUSINESS</b> <b>FORCE TECHNOLOGY</b></p> <p>FORCE Technology is an international supplier of technical services such as testing, inspection and verification, as well as contract R&amp;D.</p> 	<p><b>PROFILE BUSINESS</b> <b>NIRAS</b></p> <p>NIRAS has worked with climate and energy for over 30 years. We focus on climate strategies, carbon footprints, energy-saving strategies, ...</p> 	<p><b>PROFILE BUSINESS</b> <b>BIOGASOL</b></p> <p>BioGasol is a combined biotechnology and engineering company in the field of renewable energy. BioGasol has developed breakthrough technologies for.</p> 	<p><b>PROFILE BUSINESS</b> <b>LEIF KOCH</b></p> <p>Leif Koch - the leading experts in reducing non revenue water in Scandinavian.Leif Koch is a highly specialized company, which...</p> 	<p><b>PROFILE BUSINESS</b> <b>MJK AUTOMATION</b></p> <p>MJK Automation is a leading suppliers of equipment for SCADA systems for drinking water treatment, sewage water and industrial applications. MJK...</p> 	<p><b>PROFILE BUSINESS</b> <b>MEKAN</b></p> <p>Mekan grew out of the electronic developer and manufacturer Simrad, which is a well known global name in maritime navigation and...</p> 
<p><b>PROFILE BUSINESS</b> <b>PHOENIX DESIGN AID</b></p> <p>Phoenix Design Aid (PDAid) is an international design and communication company with expertise in total graphic solutions and project management...</p> 	<p><b>PROFILE BUSINESS</b> <b>BECH-BRUUN</b></p> <p>Bech-Bruun is a modern and international law firm with offices in Copenhagen, Aarhus and Shanghai. It is Denmark's leading law...</p> 	<p><b>PROFILE BUSINESS</b> <b>GOMORE</b></p> <p>GoMore is a trusted community marketplace for peer-to-peer sharing of cars. We help people connect, save money, and make car...</p> 	<p><b>PROFILE PUBLIC SECTOR</b> <b>DANISH ENERGY AGENCY</b></p> <p>The Danish Energy Agency engages nationally and internationally in production, supply and consumption of energy - as well as the...</p> 	<p><b>PROFILE ORGANISATION</b> <b>CYCLING EMBASSY OF DENMARK</b></p> <p>Cycling Embassy of Denmark is a formalized network with an association framework and over 30 member organizations. The people participating...</p> 	<p><b>PROFILE ORGANISATION</b> <b>MARINE INGREDIENTS DENMARK</b></p> <p>We represent the producers of fishmeal and fish oil in Denmark. With a focus on sustainability and high quality, the...</p> 
<p><b>PROFILE BUSINESS</b> <b>AALBORG CSP</b></p> <p>Aalborg CSP is leading developer and supplier of innovative renewable technologies with the definite purpose to change the way we...</p> 	<p><b>PROFILE BUSINESS</b> <b>AGROFORA</b></p> <p>AgroFora.com provide expertise that span a variety of fields from feasibility study, risk assessment, fundraising, project design and implementation. We...</p> 	<p><b>PROFILE BUSINESS</b> <b>BWT - BEST WATER TECHNOLOGY</b></p> <p>BWT Denmark, former HOH Water Technology, was established in 1975 and holds strong skills in advanced water treatment. In Denmark we...</p> 	<p><b>PROFILE BUSINESS</b> <b>SWECO DANMARK</b></p> <p>WE BRING KNOWLEDGE INTO PLAY!The resources of our planet are limited. Sweco in Denmark (former Grommij) provides consultancy on the...</p> 	<p><b>PROFILE BUSINESS</b> <b>XERGI</b></p> <p>Xergi designs and builds biogas plants. Based upon more than 25 years' experience, the company has developed plant concepts which...</p> 	<p><b>PROFILE BUSINESS</b> <b>VESTAS WIND SYSTEMS</b></p> <p>Wind. It means the world to us. A world that, if we have our way, will be powered by far...</p> 



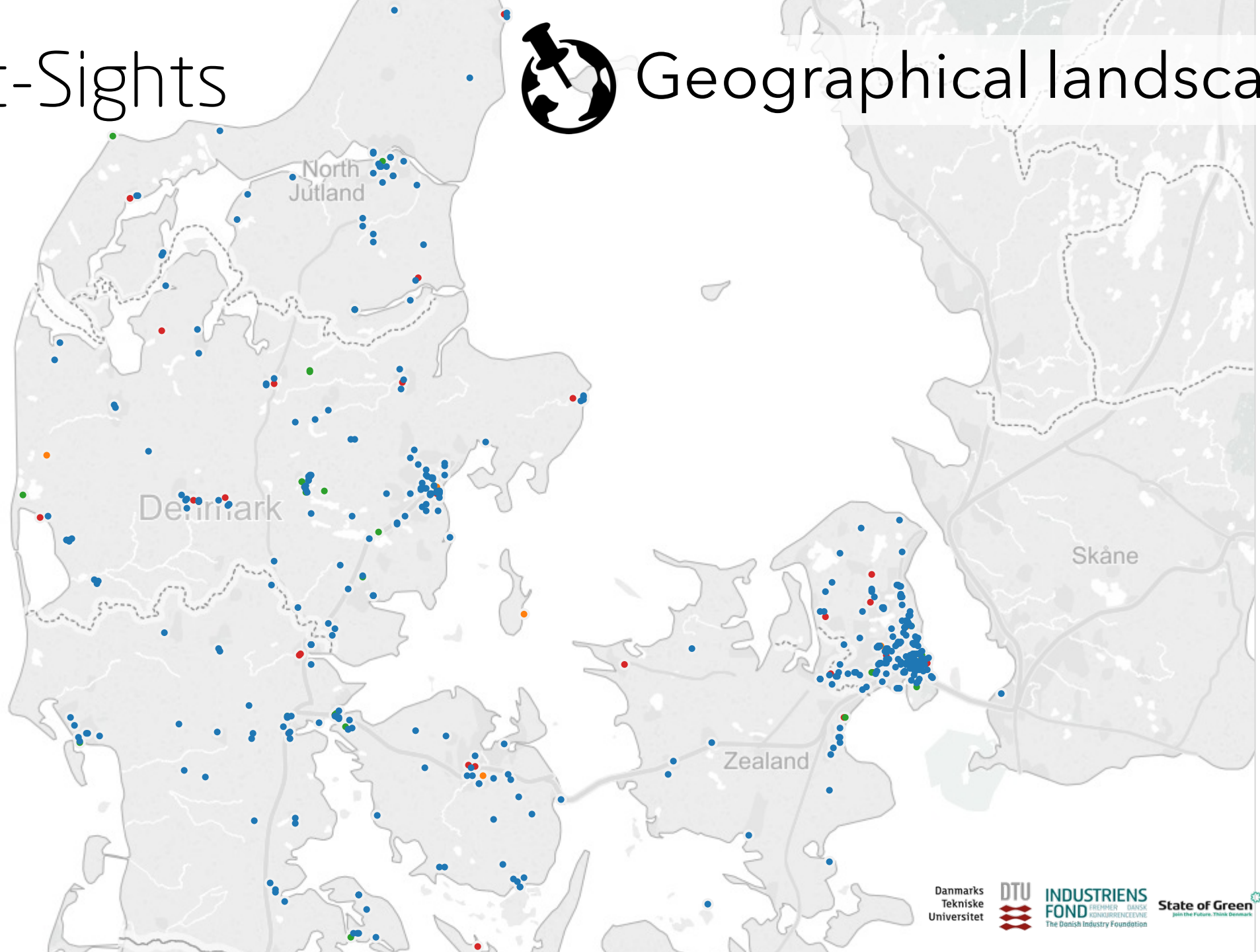


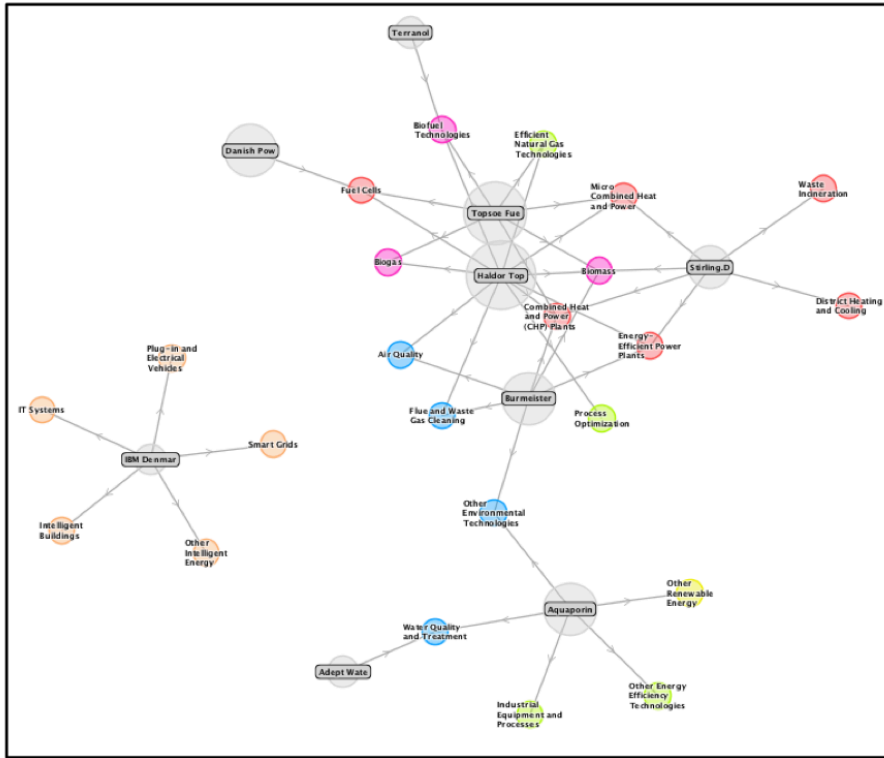




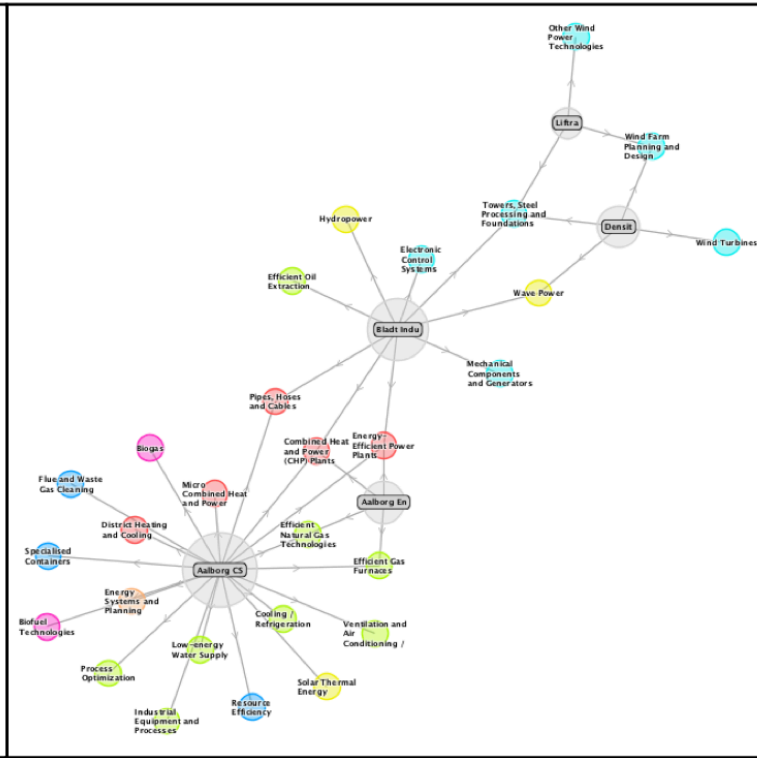
### Profile Type / Tags

- Business
- Institution
- Organisation
- Public sector

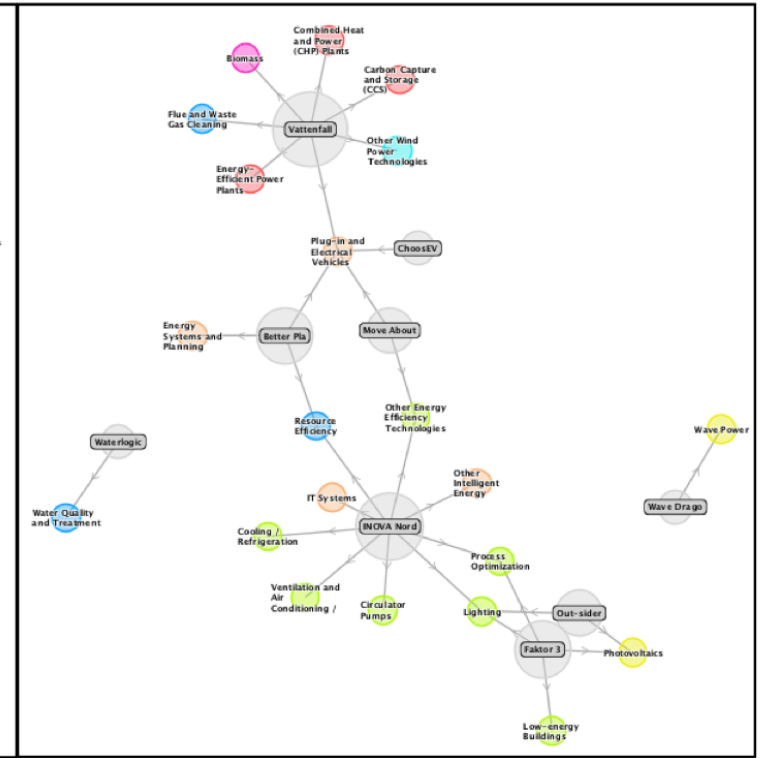




Lyngby



Aalborg

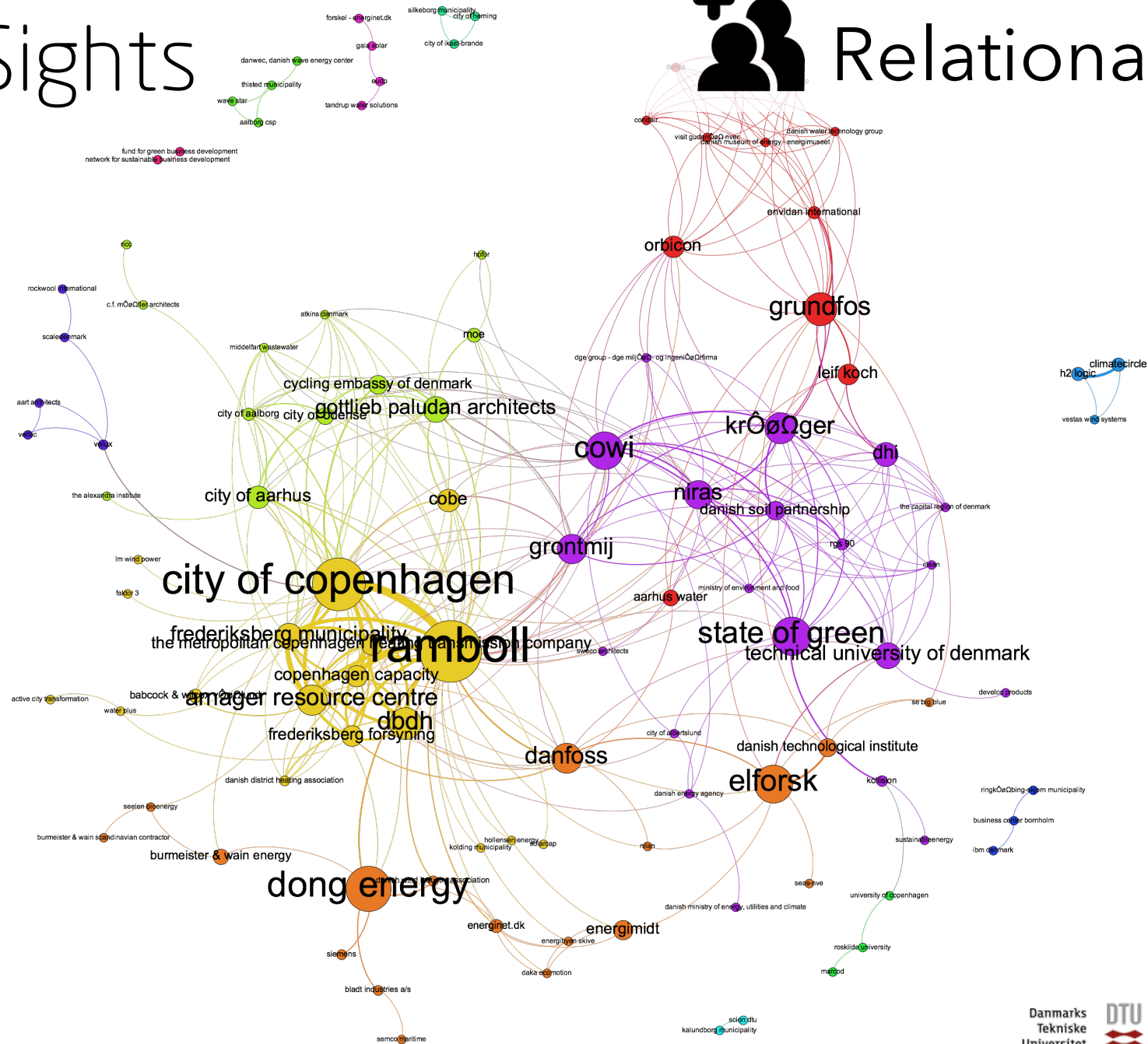


Copenhagen

# Net-Sights



# Relational landscape



Cannot read property 'subsectors\_ids' of undefined

```

JSBox
1 function(node0, node1){
2   return mo.TableOperators.cosineSimilarityDataTables(
3     node0.wordsTable,
4     node1.wordsTable
5   );
6 }

```

Cannot read property 'wordsTable' of undefined

```

JSBox
1 function(node0, node1){
2   return 1/(1+mo.GeoOperators.geoDistance(
3     new mo.Point(node0.long, node0.lat),
4     new mo.Point(node1.long, node1.lat)
5   ));
6 }

```

Cannot read property 'long' of undefined

# The platform

builds weights table

```

JSBox
18 weigntfunc = weigntfunctions[1];
19
20 weightsTable[i] = new mo.NumberList();
21 weightsTable[i].name = names[i];
22
23 for(j=0; j<n-1; j++){
24   node0 = net.nodeList[j];
25   for(k=j+1; k<n; k++){
26     node1 = net.nodeList[k];
27
28     weight = weightFunc(node0, node1);
29
30     weightsTable[i].push(weight);
31
32   }
33 }
34
35 ranked = mo.NumberListOperators.normalizeToInterval(
36   mo.ListOperators.getRankings(weightsTable[i], true, tr
37   new mo.Interval(-1, 1)
38 );
39
40 nR = weightsTable[i].length;
41
42 normalizedWeightsTable[i] = new mo.NumberList();
43 normalizedWeightsTable[i].name = weightsTable[i].name;
44
45 for(j=0; j<nR; j++){
46   normalizedWeightsTable[i][j] = weightsTable[i][j]==-1?
-1:ranked[j];
47 }
48
49 }
50
51 return [normalizedWeightsTable,
normalizedWeightsTable.getTransposed(), weightsTable];
52 }

```

Cannot read property 'nodeList' of undefined

names

"people","solutions","sectors..." #L

sup thresholds

0.9,0.9,0.9,0.9,0.9 #L

colors

[[0,255,255],[255,0,255],[255... #T

inf thresholds

0,0,0.01,0.01,0.01 #L

build net and nodes

```

JSBox
34 node.solutions_ids = company.solutions;
35 node.sectors_ids = [];
36
37 node.x = (node.long-12.51)*100;
38 node.y = (55.78 - node.lat)*100;
39
40 node.wordsTable = mo.StringOperators.getWords(
41   mo.StringOperators.cleanText(node.description)

```

builds network

```

JSBox
48 for(j=0; j<n-1; j++){
49   r = Danmarks
50   f = DTU
51   node1 = INDIUSTRIENS
52   if(weights[index].weight>threshold){
53     relation = new mo.Relation(" "+node0.id+" "+

```

```

ject.companies;
ch;

s[i].description;

www.netsights.dk

```

# Case 2

DTU's Knowledge Landscape

# A socio-technical process of information transformation

Danmarks  
Tekniske  
Universitet



Education

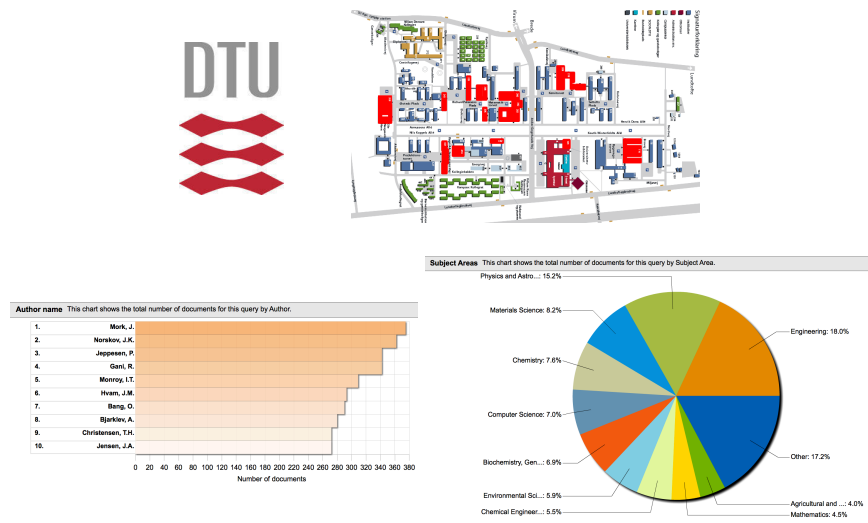
Innovation

Scientific advice

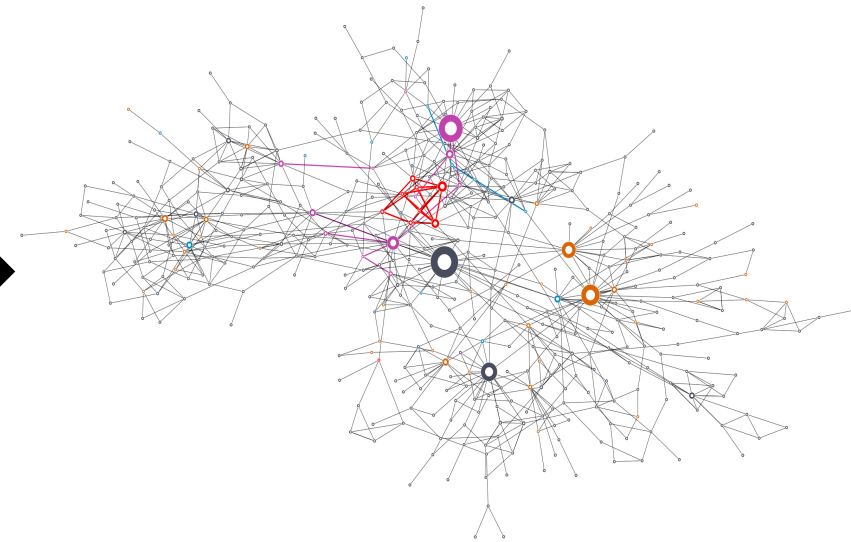
Research

**Engineering system:** 'A class of systems characterized by a high degree of technical complexity, social intricacy, and elaborate processes, aimed at fulfilling important functions in society' (de Weck et al., 2011, p. 31).

# From counting to connecting



Knowledge census

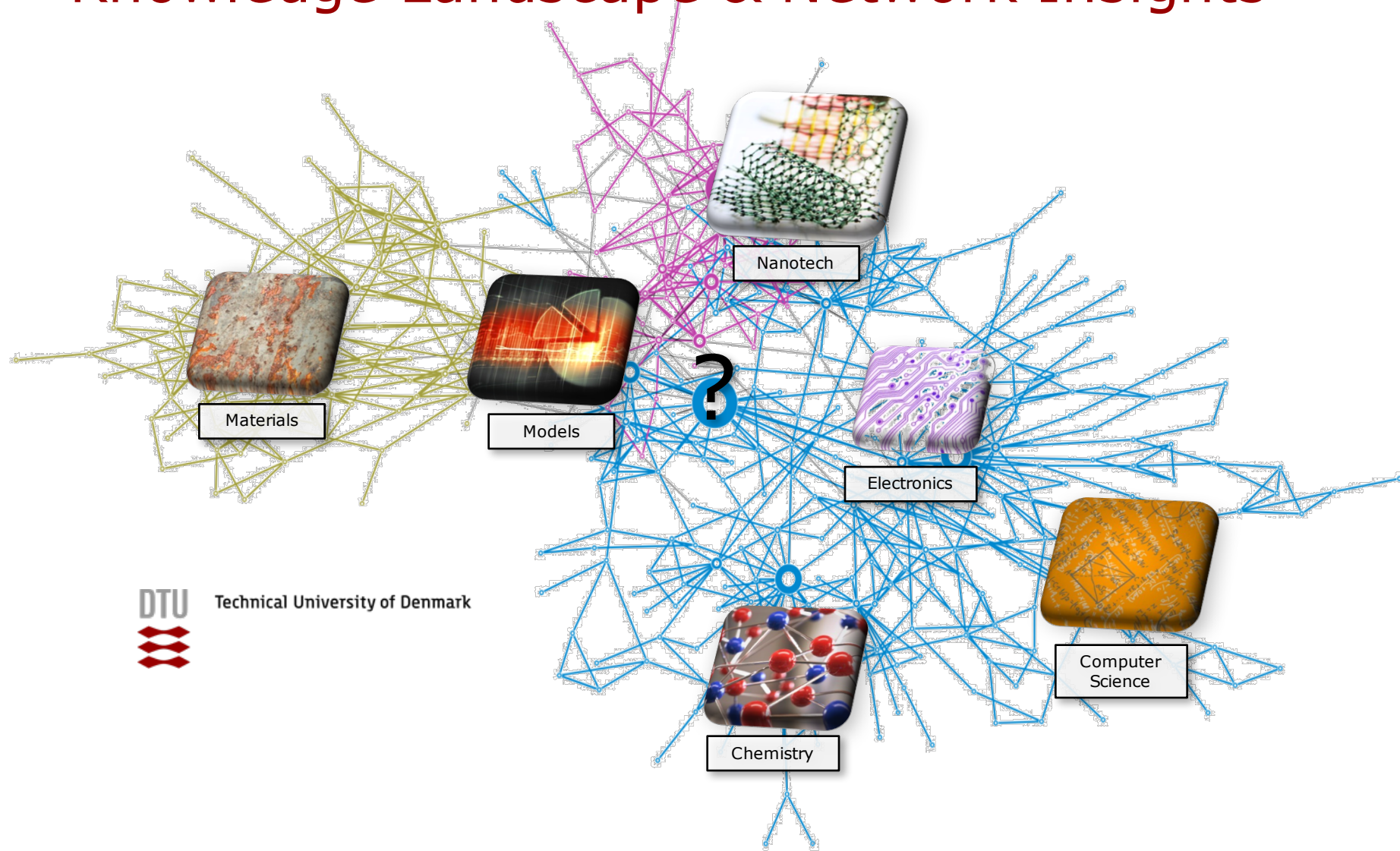


Knowledge landscape



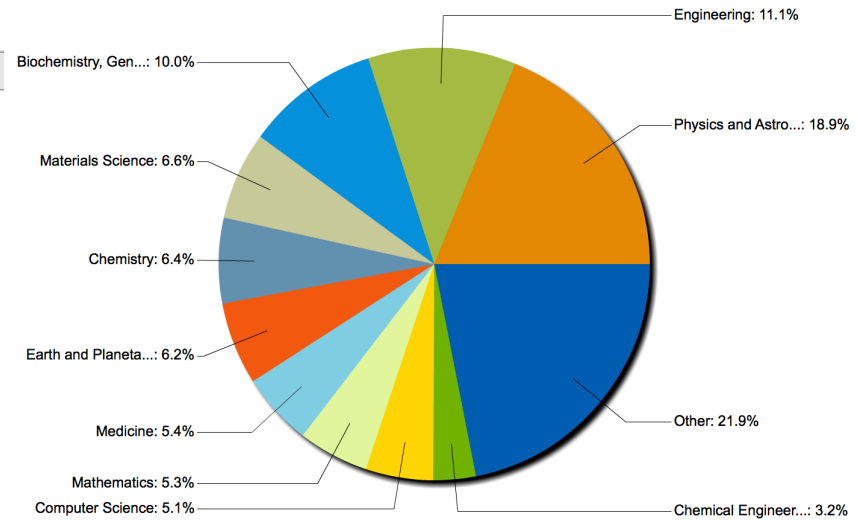
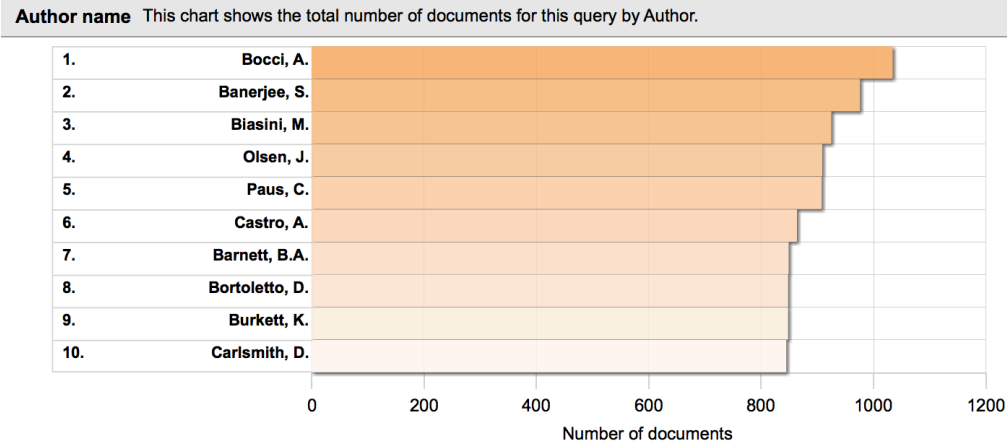
# From counting to connecting

## Knowledge Landscape & Network Insights



**DTU** Technical University of Denmark

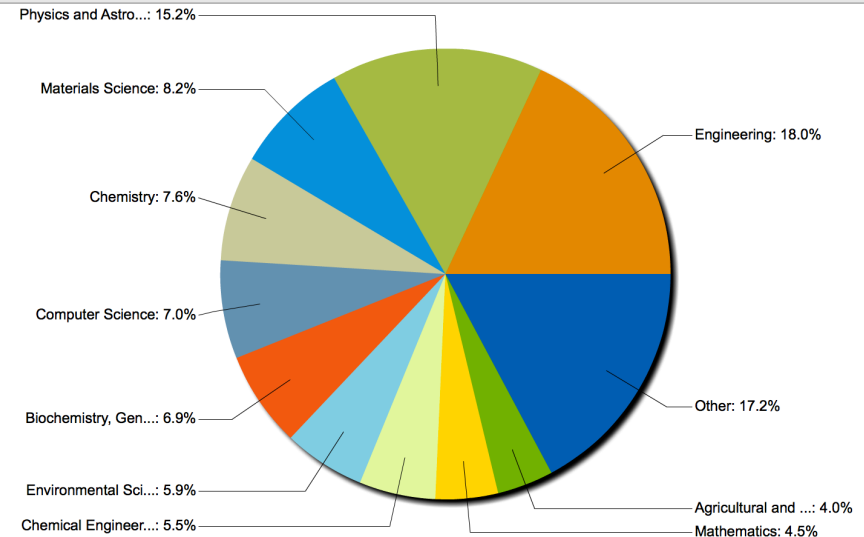
# Holistic knowledge mapping VS counting



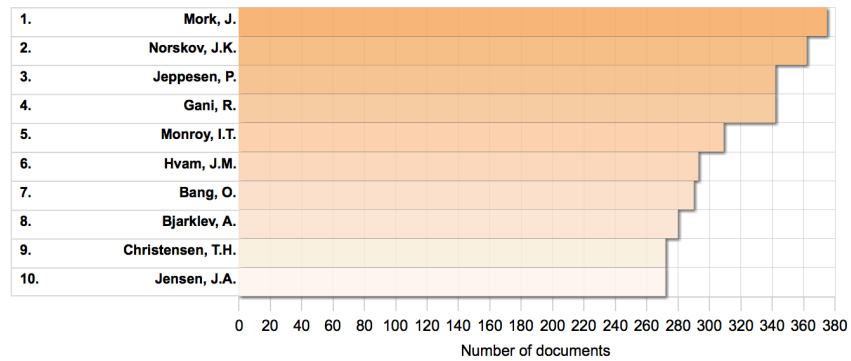
# Holistic knowledge mapping VS counting



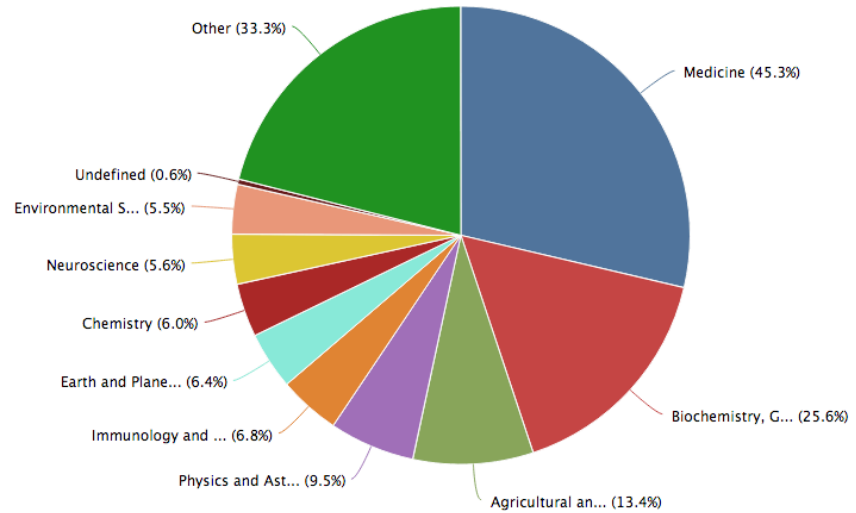
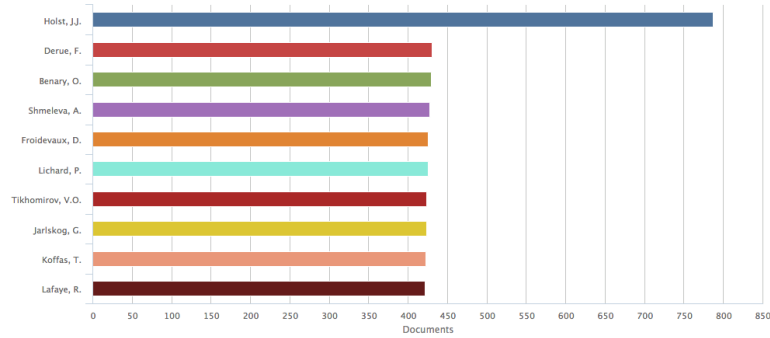
**Subject Areas** This chart shows the total number of documents for this query by Subject Area.

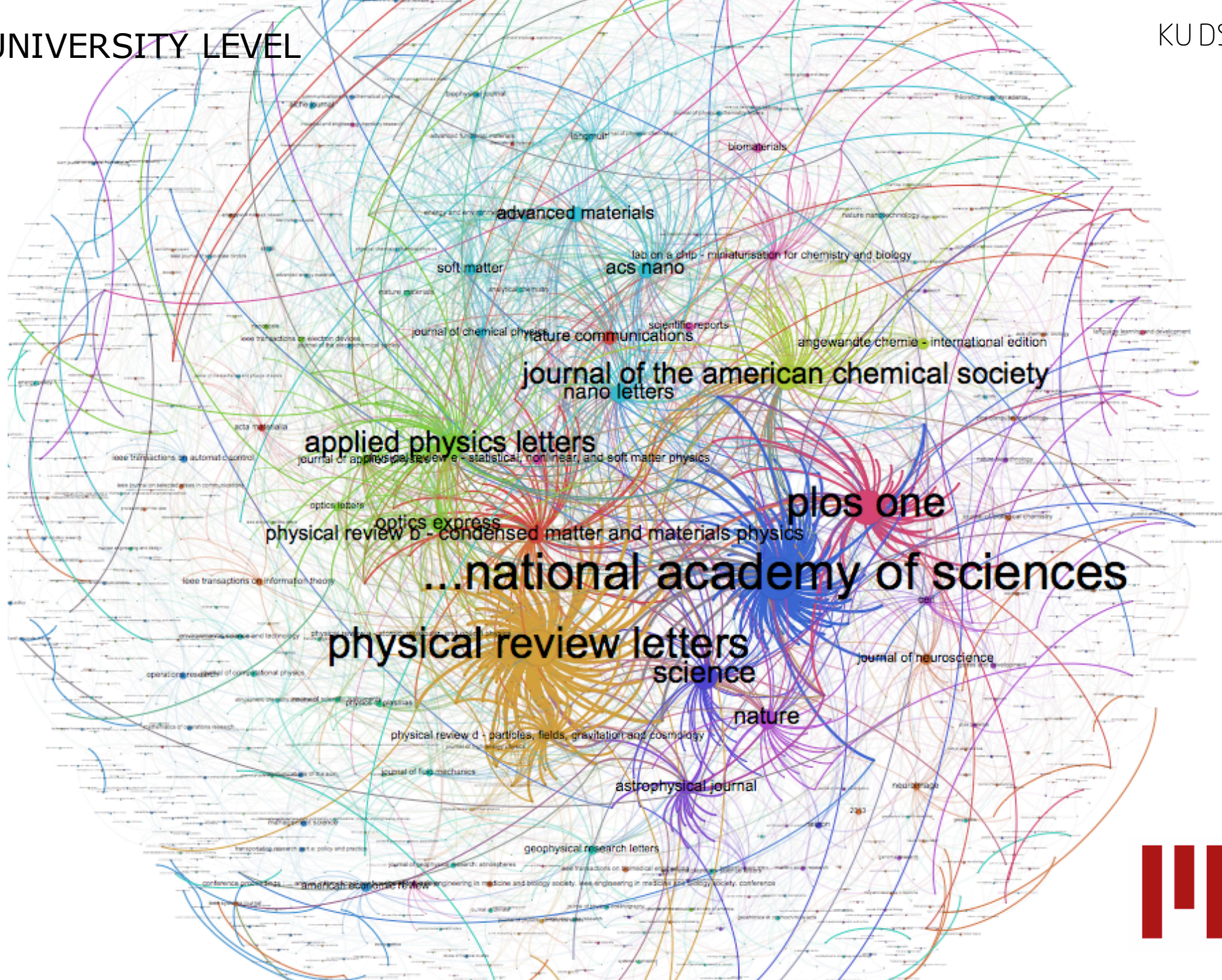


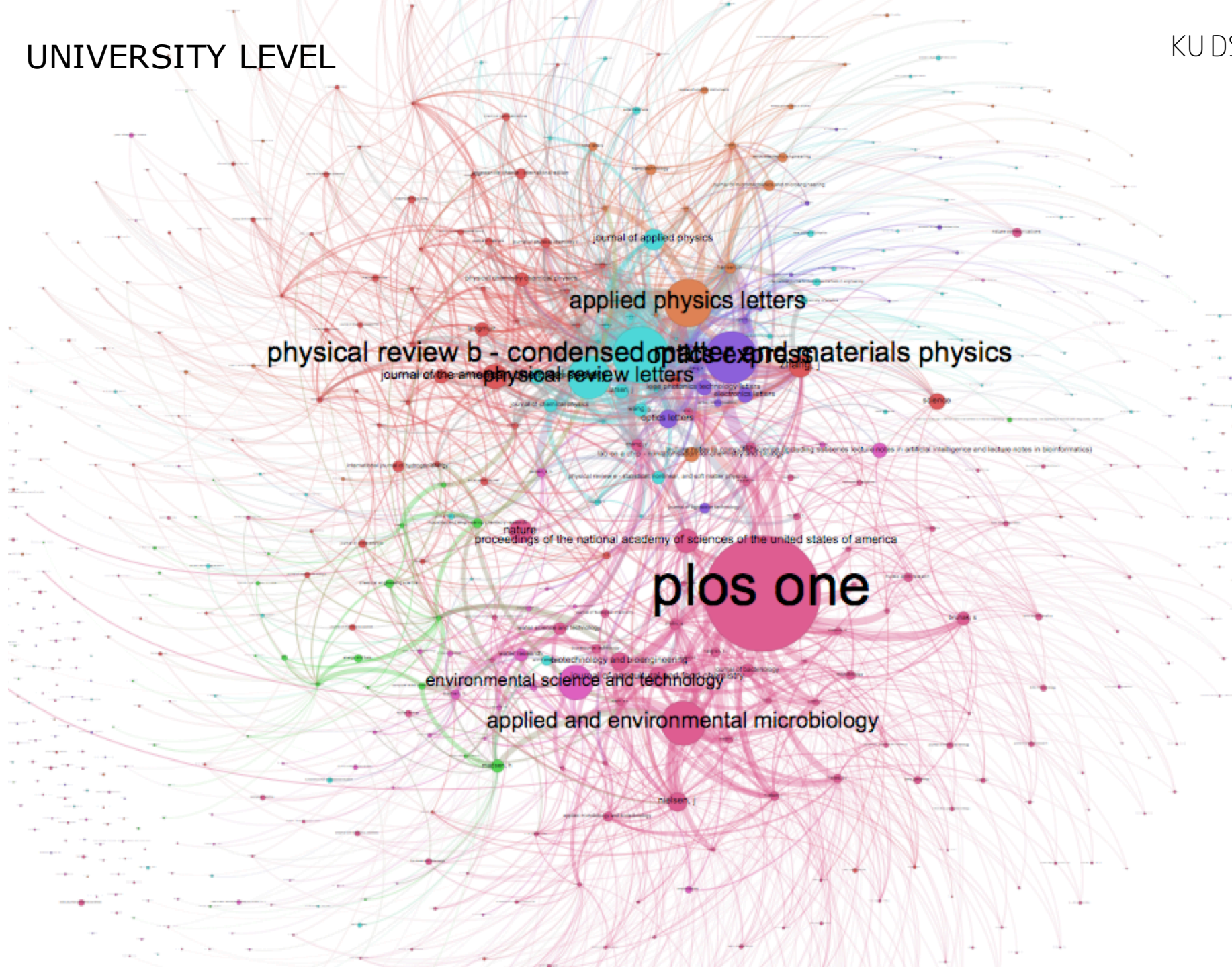
**Author name** This chart shows the total number of documents for this query by Author.

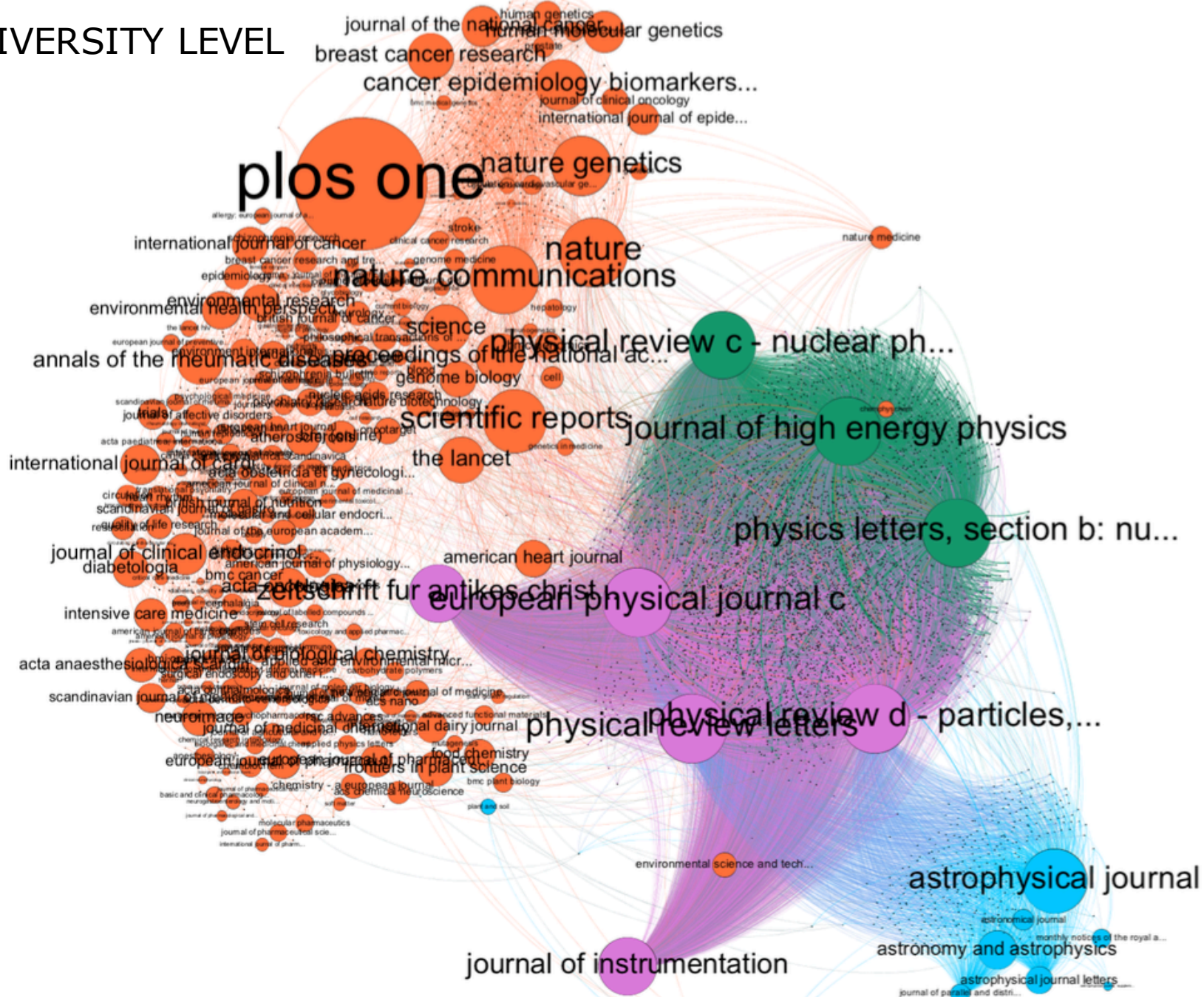


# Holistic knowledge mapping VS counting



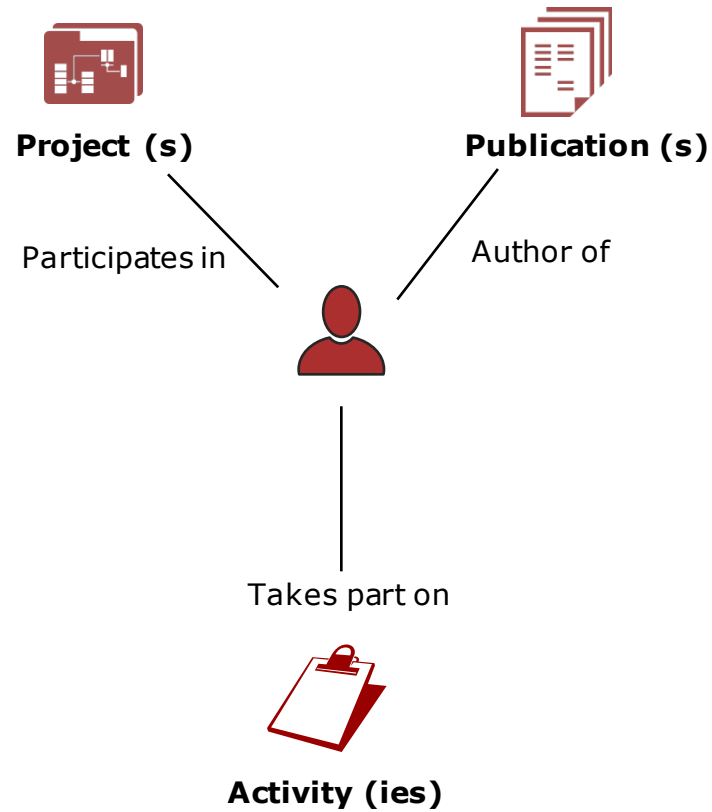






# Baseline network model

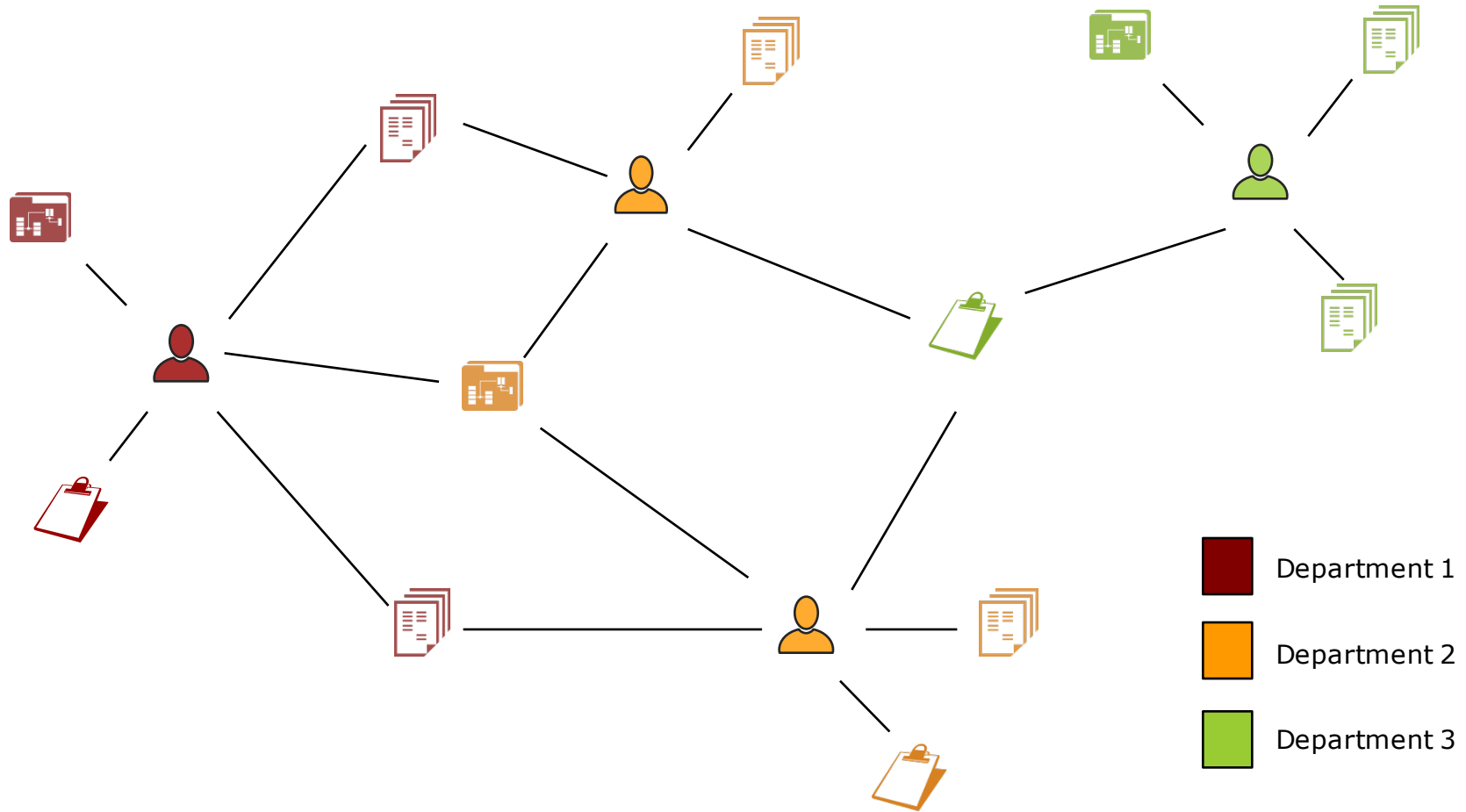
## Knowledge Landscape





# Baseline network model

## Knowledge Landscape



# Source Data

## Knowledge Landscape

### ORBIT

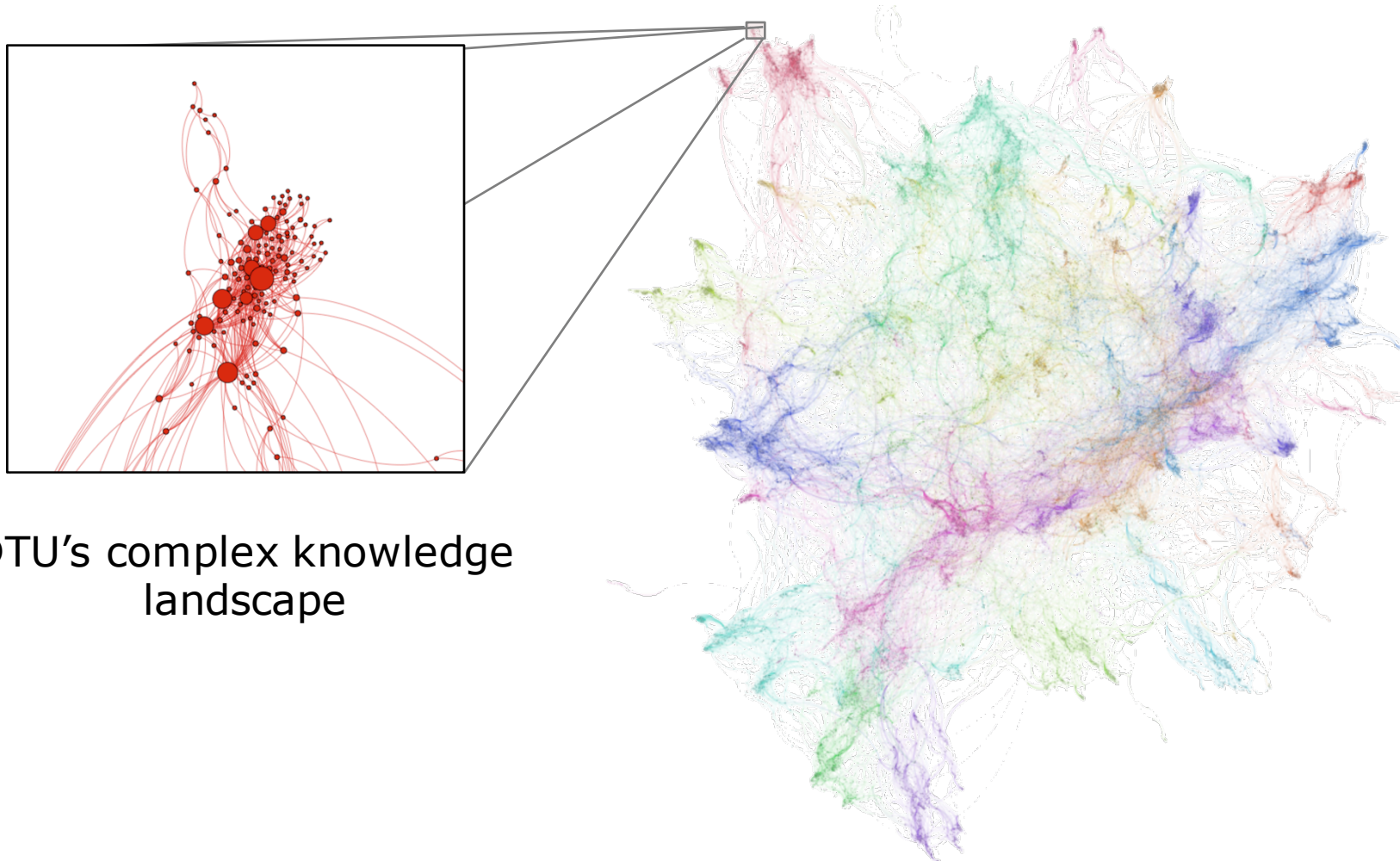
2009 - 2015

#### Entity Type

Activities	655
People	7,293
Projects	7,472
Publications	13,256

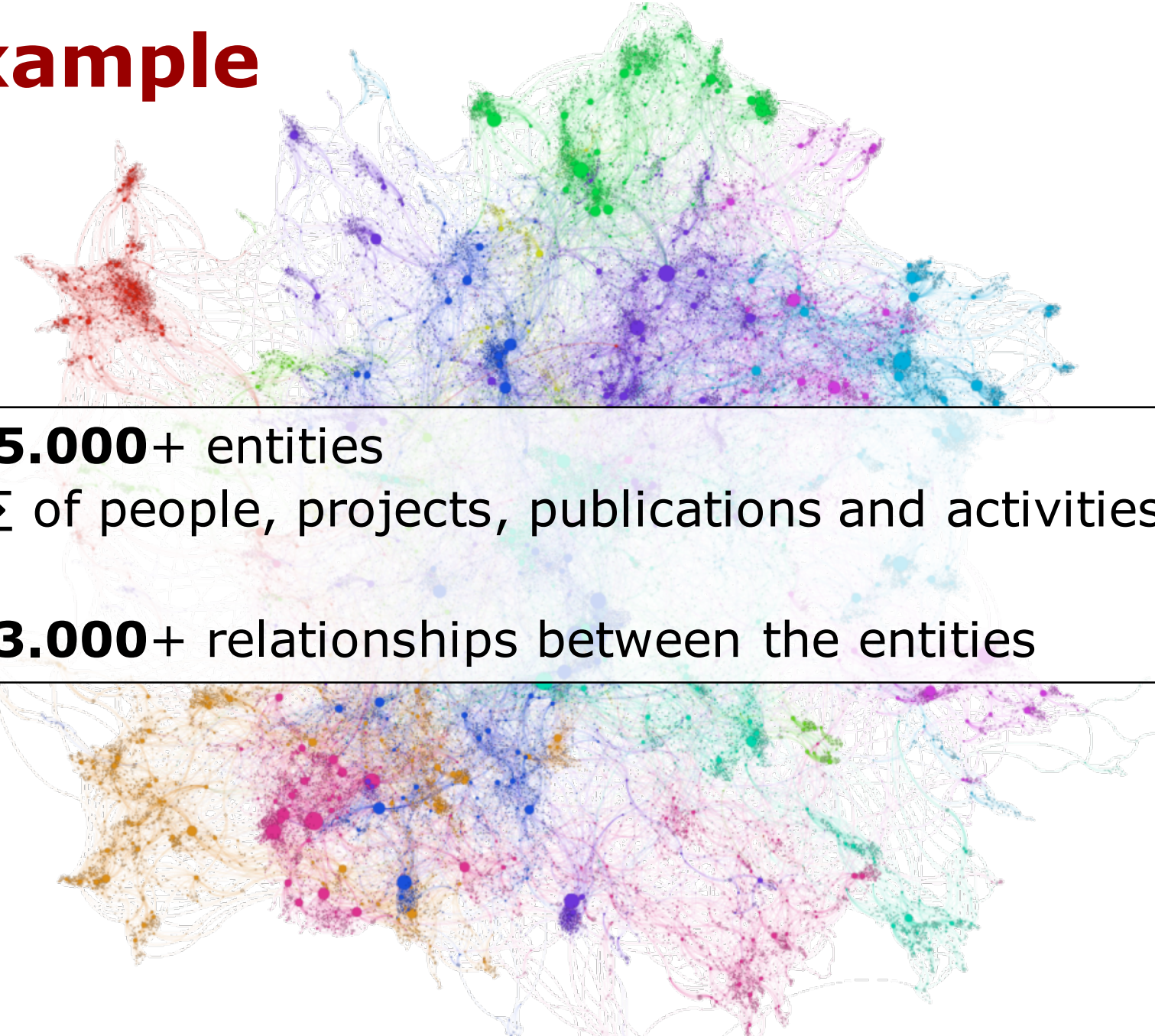
# A networked and systemic perspective

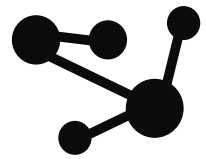
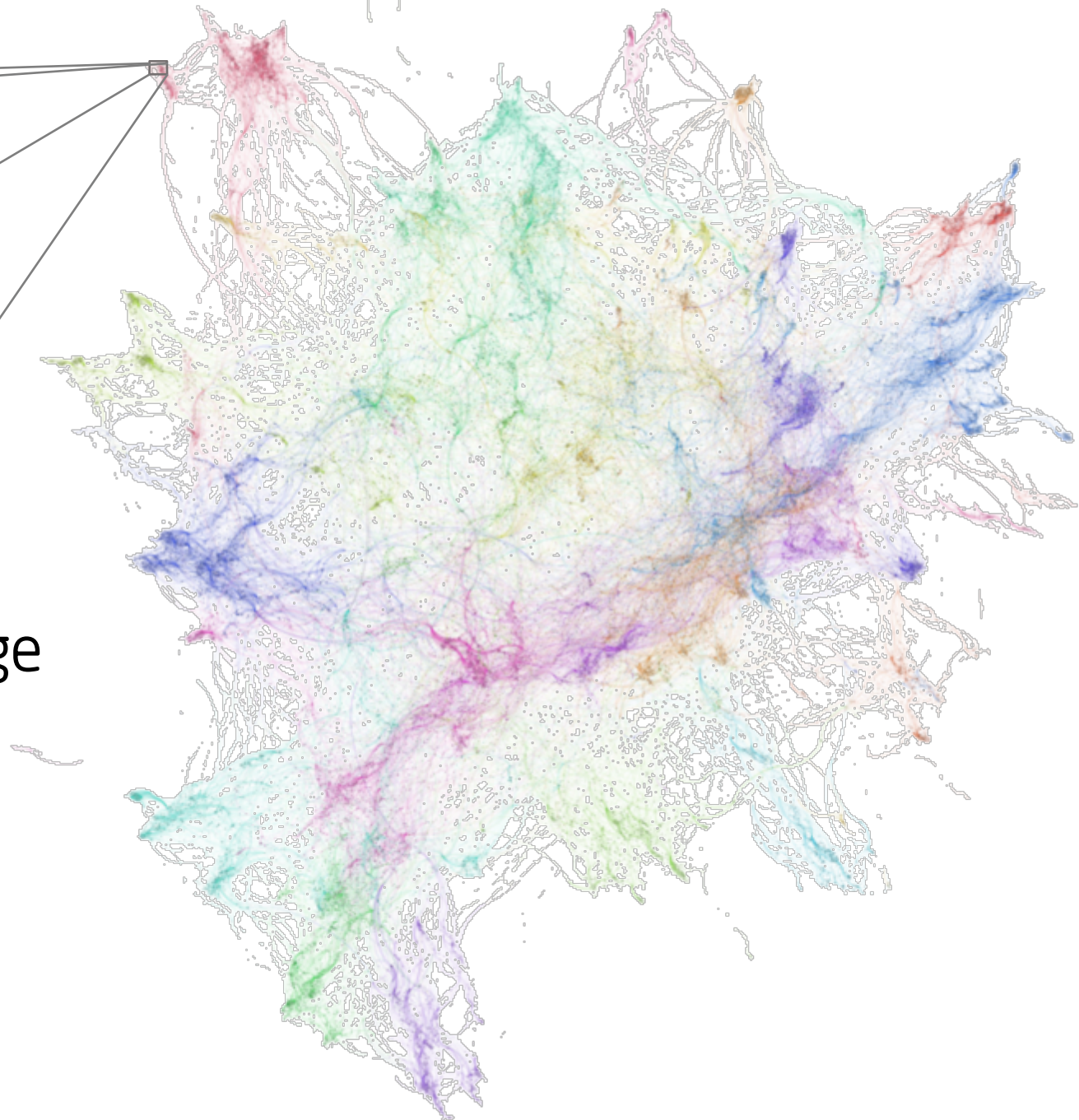
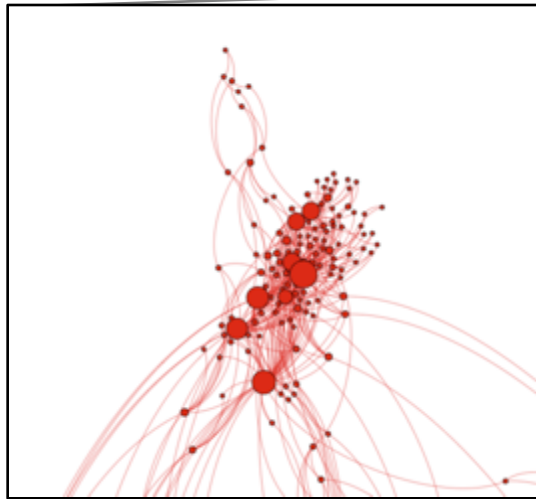
Actual network model with 25.333 entities



DTU's complex knowledge landscape

# Example

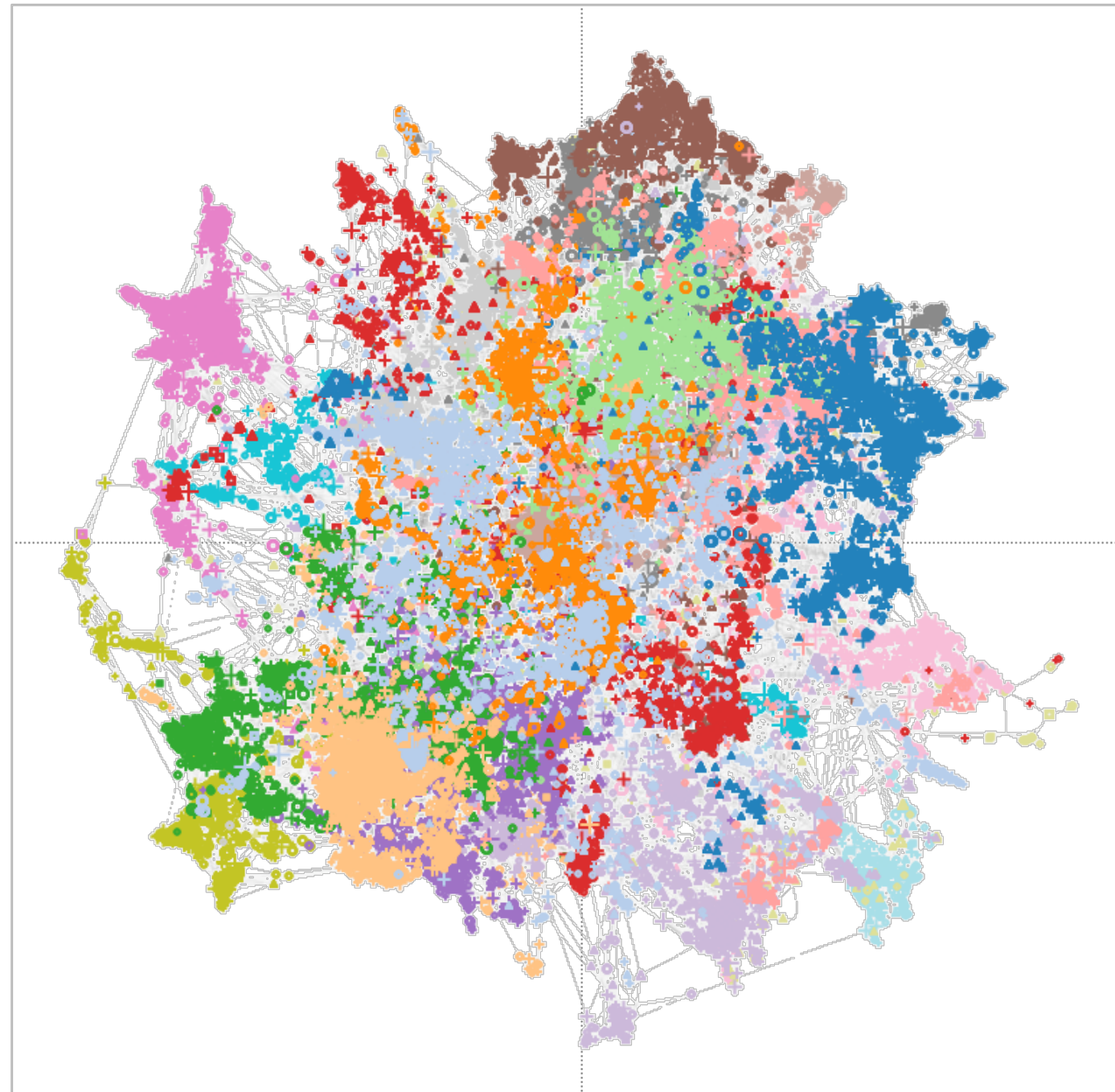
- 
- **25.000+** entities  
( $\Sigma$  of people, projects, publications and activities)
  - **73.000+** relationships between the entities



DTU's Knowledge  
Landscape

# Overall Knowledge Landscape

- Department**
- Fotonik
  - Compute
  - Chemical Engin..
  - Environment
  - Food
  - Nanotech
  - Electrical Engin..
  - Mechanical Engi..
  - Systems Biology
  - Management En..
  - Energy
  - Wind
  - Aqua
  - Civil Engineering
  - Physics
  - Chemistry
  - Vet
  - Others
  - Space
  - Transport
  - Center for Electr..
  - National Laborat..
  - Center for Nucle..
  - Biosustain
  - DTU Danchip



## Entity Type

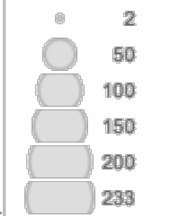
- (All)
- Activity
- Person
- Project
- Publication

## Description search..

## Refine descriptio..

## Name search

## # Connections



## Entity Type

- Activity
- Person
- Project
- Publication

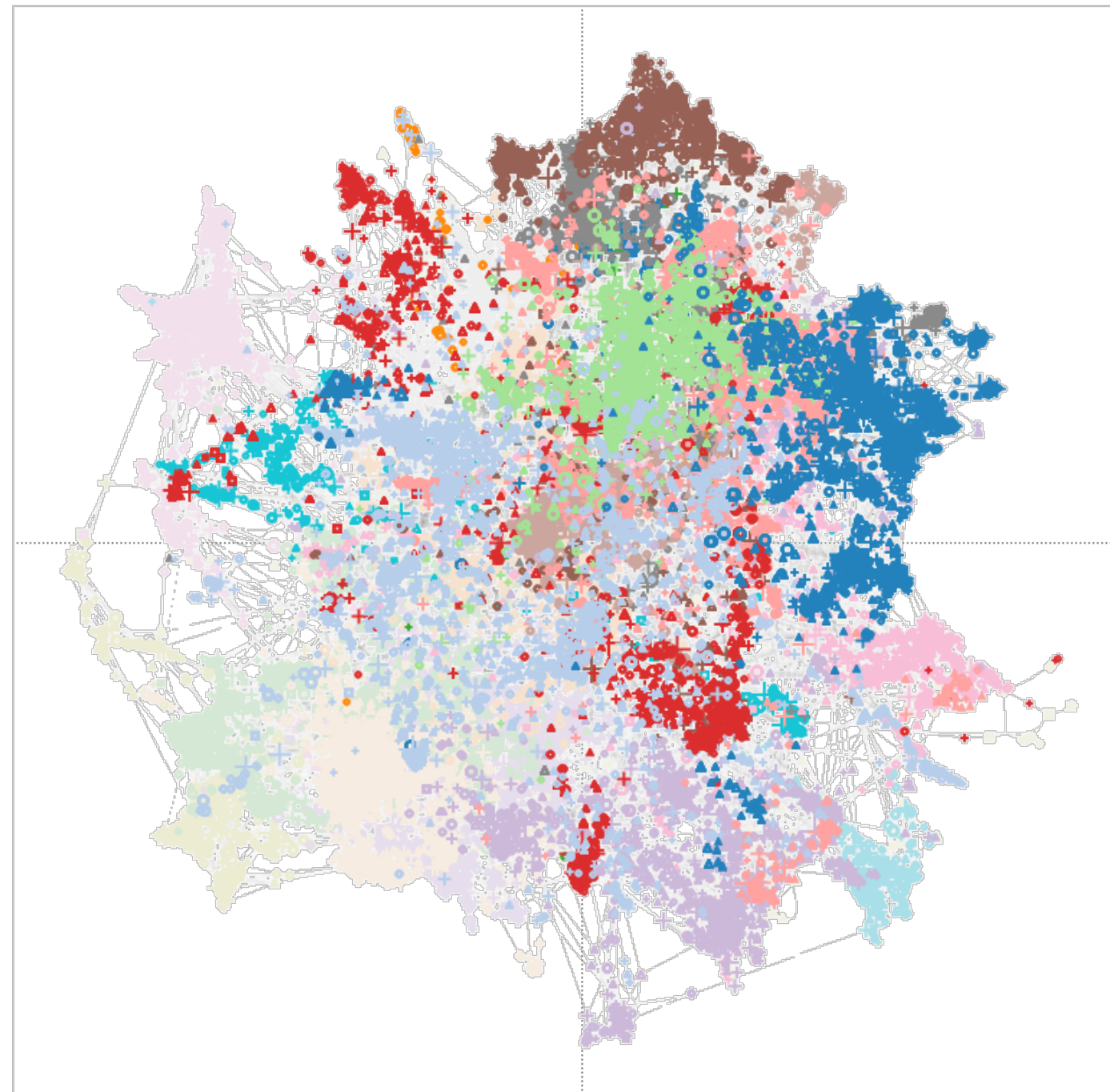
## # Connections



# Overall Knowledge Landscape "Dry Labs"

## Department

- Fotonik
- Compute
- Chemical Engin..
- Environment
- Food
- Nanotech
- Electrical Engin..
- Mechanical Engi..
- Systems Biology
- Management En..
- Energy
- Wind
- Aqua
- Civil Engineering
- Physics
- Chemistry
- Vet
- Others
- Space
- Transport
- Center for Electr..
- National Laborat..
- Center for Nucle..
- Bioasstain
- DTU Danchip



## Entity Type

- (All)
- Activity
- Person
- Project
- Publication

## Description search..

## Refine descriptio..

## Name search

## # Connections

- 2
- 50
- 100
- 150
- 200
- 233

## Entity Type

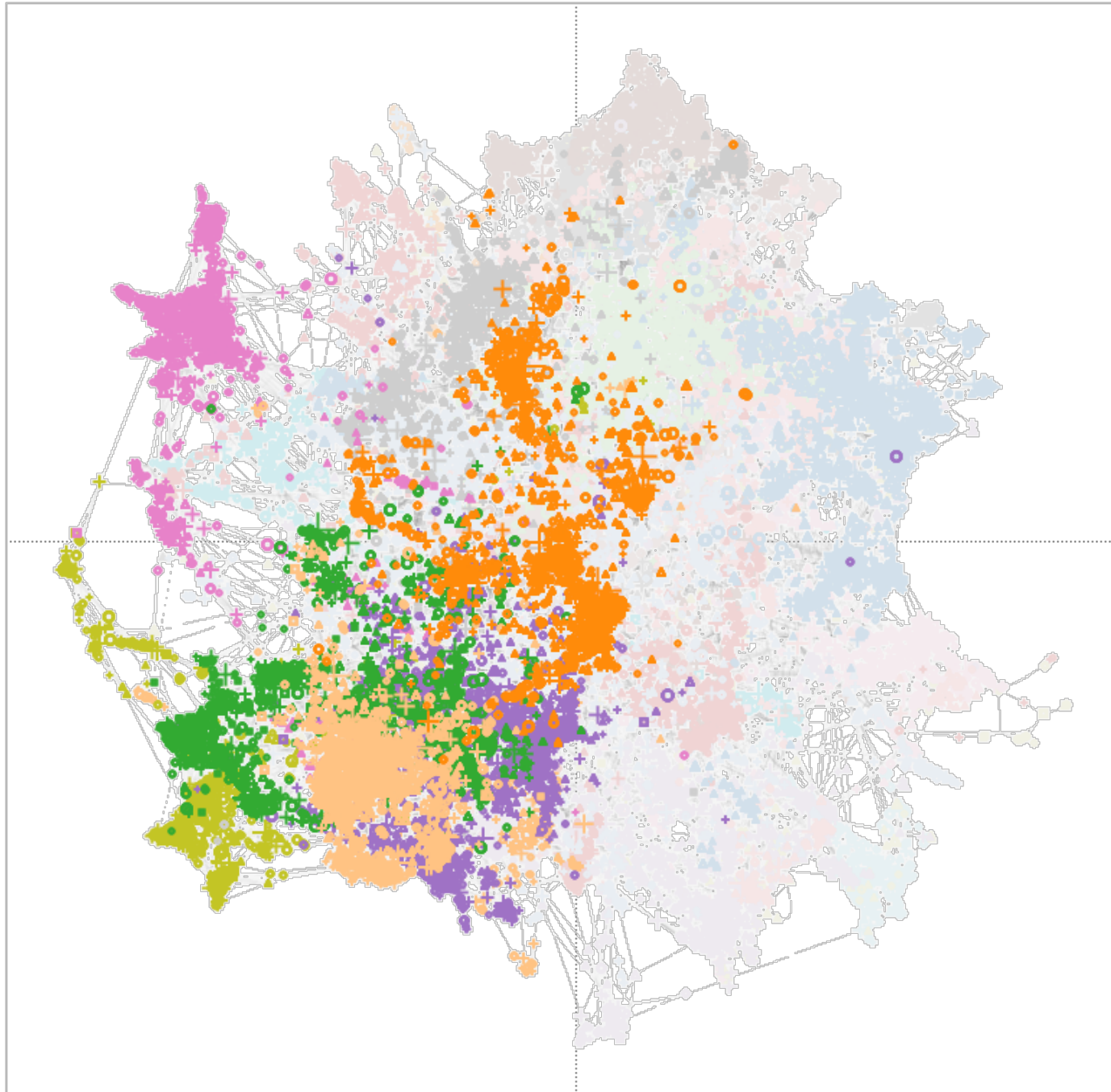
- Activity
- Person
- Project
- Publication

## # Connections



# Overall Knowledge Landscape "Wet Labs"

- Department**
- Federik
  - Compu...
  - Chemical Engn..**
  - Environment
  - Food**
  - Nanotech
  - Electrical Engn..
  - Mechanical Eng..
  - Systems Biology**
  - Management En..
  - Energy
  - Wind
  - Aqua**
  - Civil Engineering
  - Physica
  - Chemistry**
  - Vet**
  - Others
  - Space
  - Transport
  - Center for Electr..
  - National Laborat..
  - Center for Nuclea..
  - Bioustain**
  - DTU Danchip

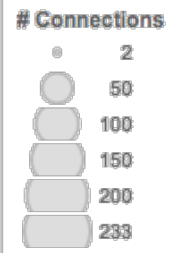


- Entity Type**
- (All)**
  - Activity
  - Person
  - Project
  - Publication

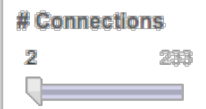
Description search..

Refine descriptio..

Name search



- Entity Type**
- Activity
  - +** Person
  - △** Project
  - Publication

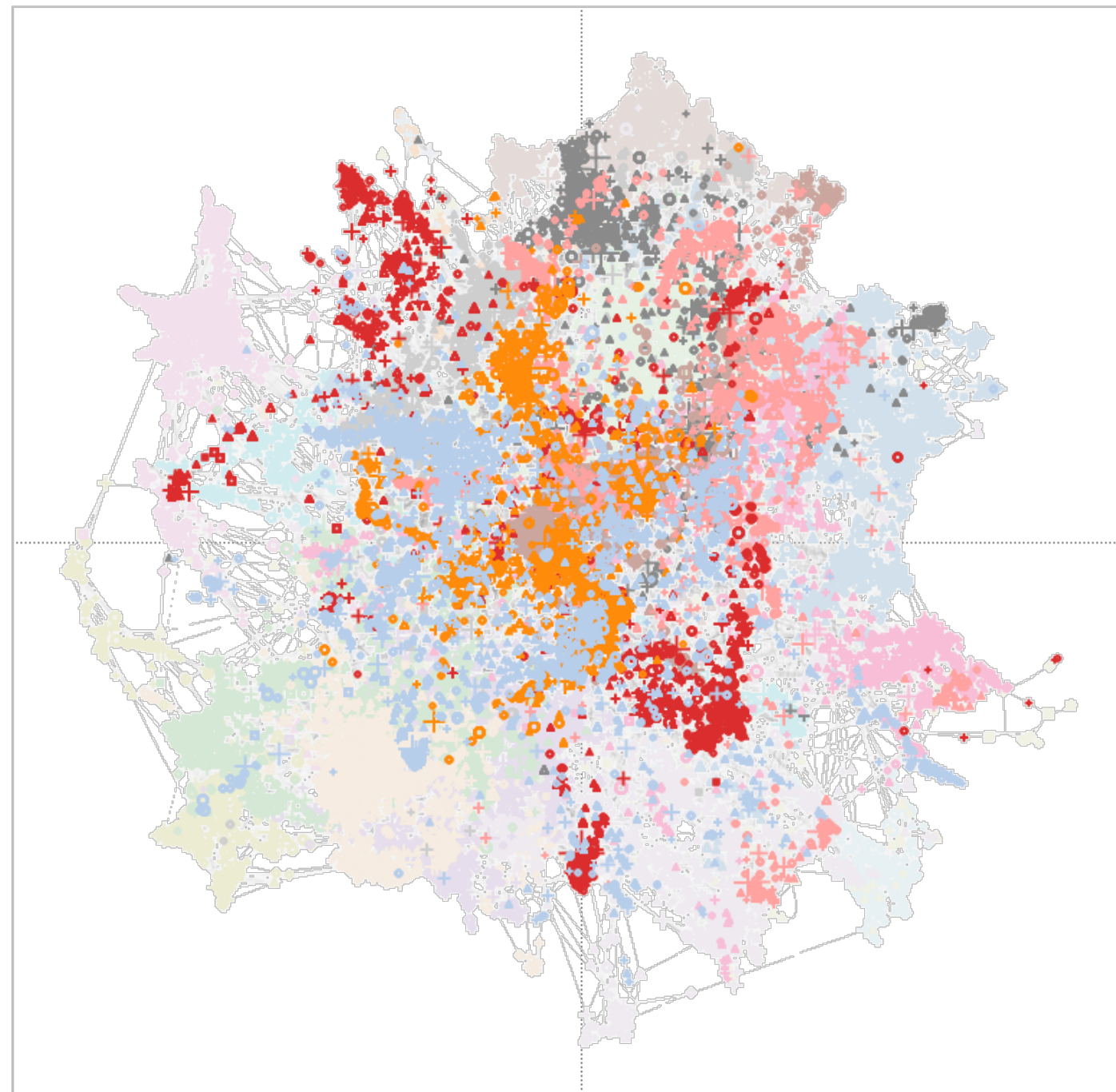




# Overall Knowledge Landscape "Distributed" Departments

## Department

- Federik
- Compute
- Chemical Engn..
- Environment
- Food
- Nanotech
- Electrical Engn..
- Mechanical Engn..
- Systems Biology
- Management En..
- Energy
- Wind
- Aqua
- Civil Engineering
- Physics
- Chemistry
- Vet
- Others
- Space
- Transport
- Center for Electr..
- National Laborat..
- Center for Nuclea..
- Biozustain
- DTU Danchip



## Entity Type

- (All)
- Activity
- Person
- Project
- Publication

Description search..

Refine descriptio..

Name search

# Connections

- 2
- 50
- 100
- 150
- 200
- 233

Entity Type

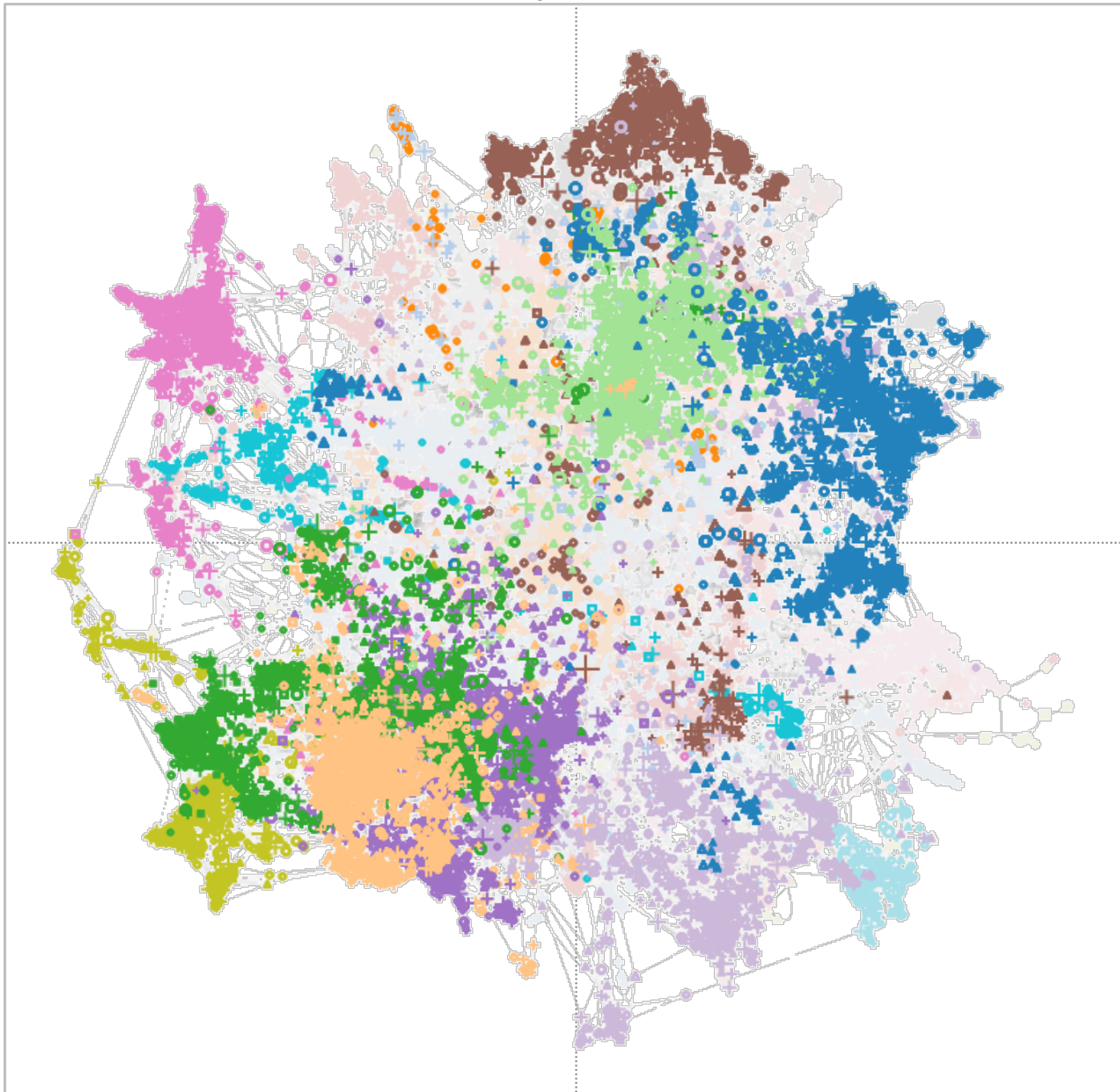
- Activity
- Person
- Project
- Publication

# Connections



# Overall Knowledge Landscape "Focused" Departments

- Department**
- Fotonik
  - Compute
  - Chemical Engn.
  - Environment
  - Food
  - Nanotech
  - Electrical Engn.
  - Mechanical Engn.
  - Systems Biology
  - Management En..
  - Energy
  - Wind
  - Aqua
  - Civil Engineering
  - Physics
  - Chemistry
  - Vet
  - Others
  - Space
  - Transport
  - Center for Electr..
  - National Laborat..
  - Center for Nucle..
  - Bioeustain
  - DTU Danchip



**Entity Type**

- (All)
- Activity
- Person
- Project
- Publication

**Description search..**

**Refine descriptio..**

**Name search**

**# Connections**

- 2
- 50
- 100
- 150
- 200
- 233

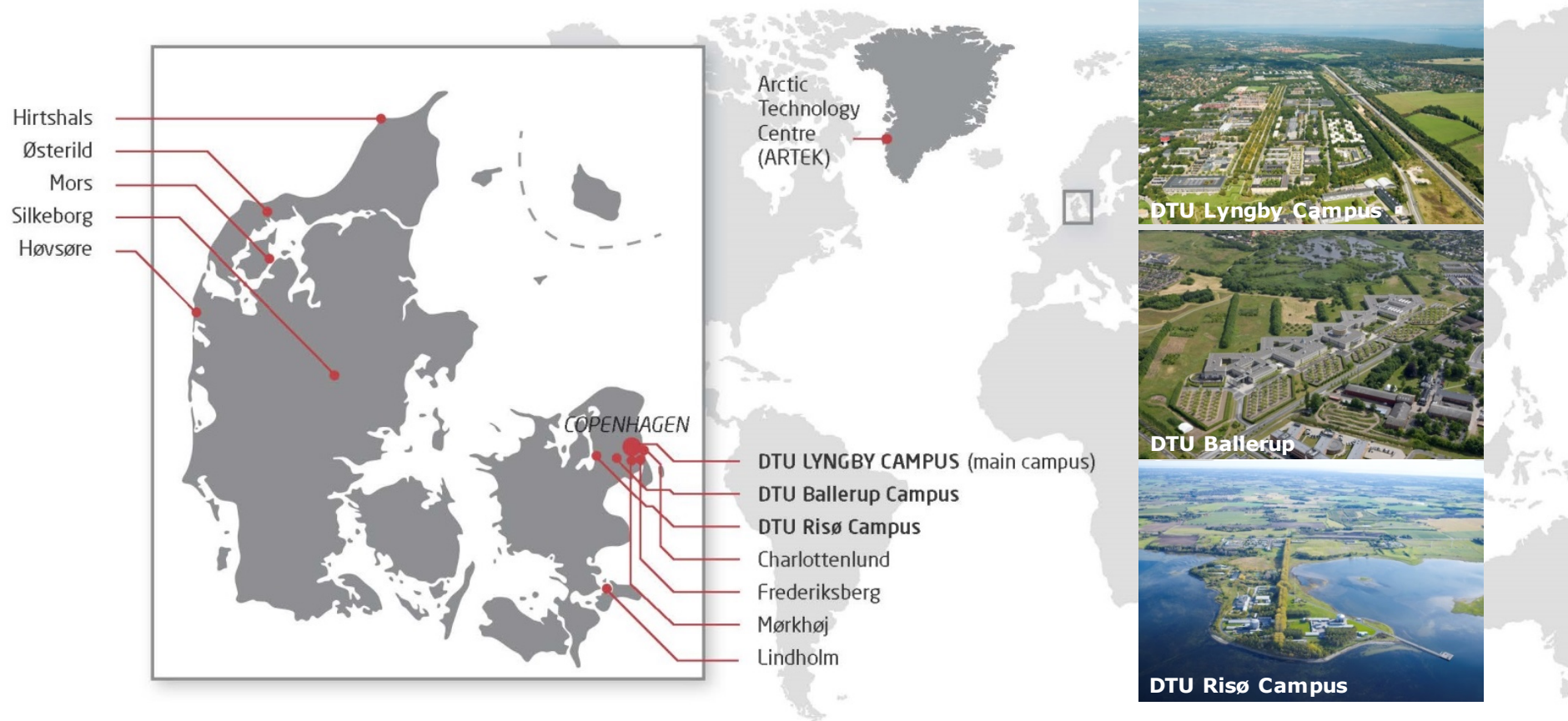
**Entity Type**

- Activity
- Person
- Project
- Publication

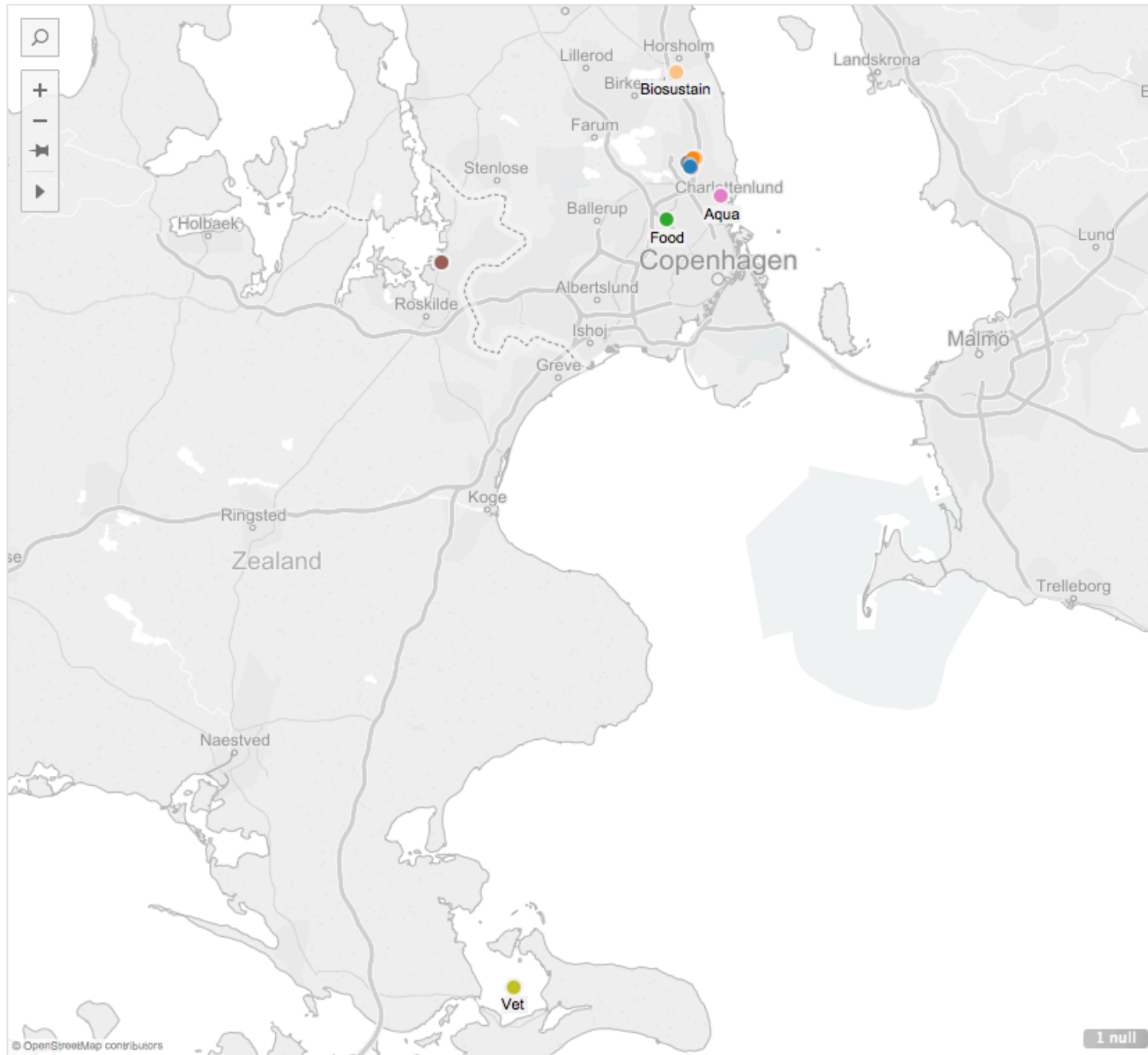
**# Connections**

2 233

# One university



# Geo Map



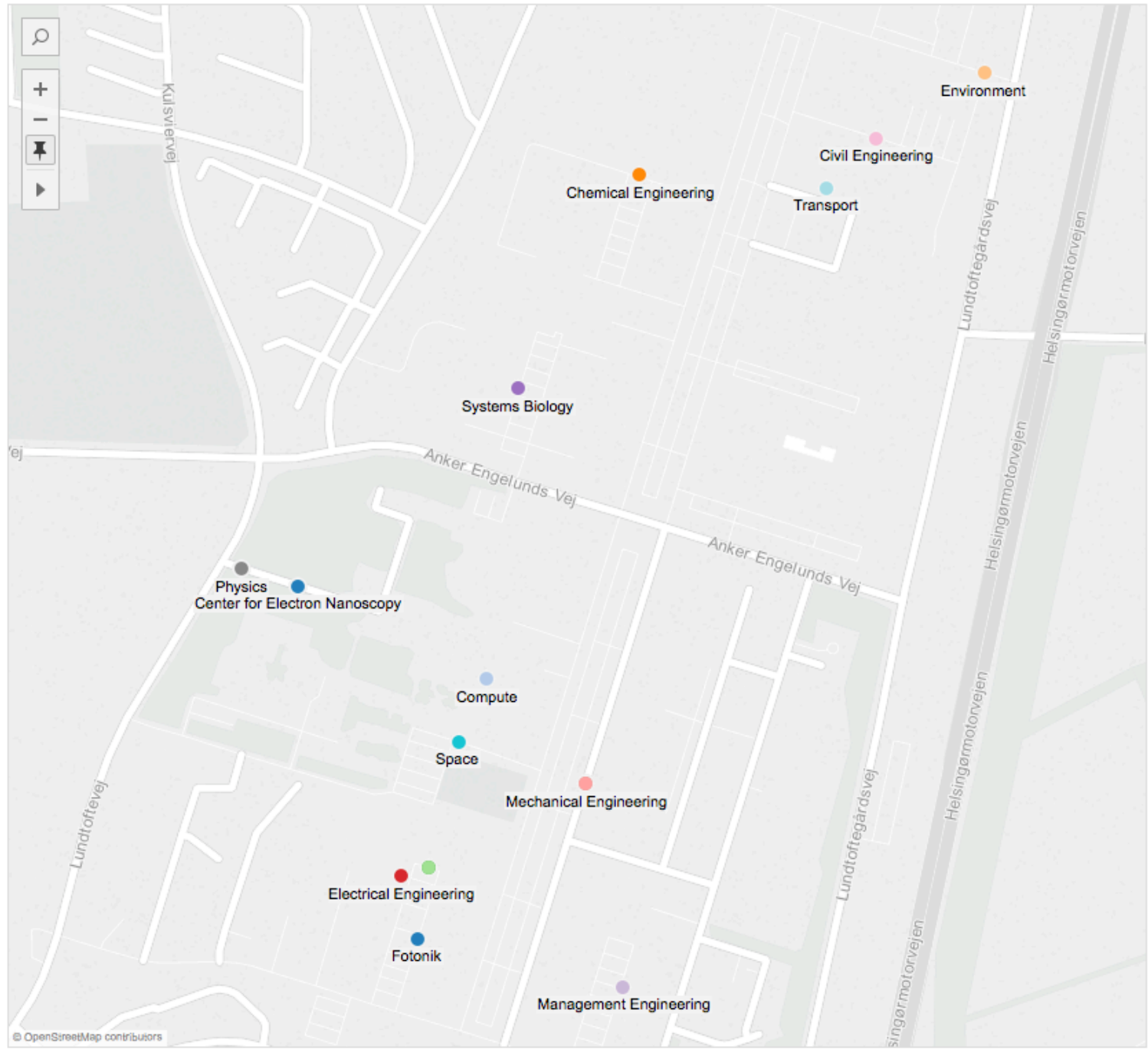
## Owner (group)

- Fotonik
- Compute
- Chemical Engineering
- Environment
- Food
- Nanotech
- Electrical Engineering
- Mechanical Engineering
- Systems Biology
- Management Engineeri..
- Energy
- Wind
- Aqua
- Civil Engineering
- Physics
- Chemistry
- Vet
- Others
- Space
- Transport
- Center for Electron Nan..
- National Laboratory for ..
- Center for Nuclear Tec..
- Biosustain
- DTU Danchip

## Department filter

(All) ▾

# Geo Map



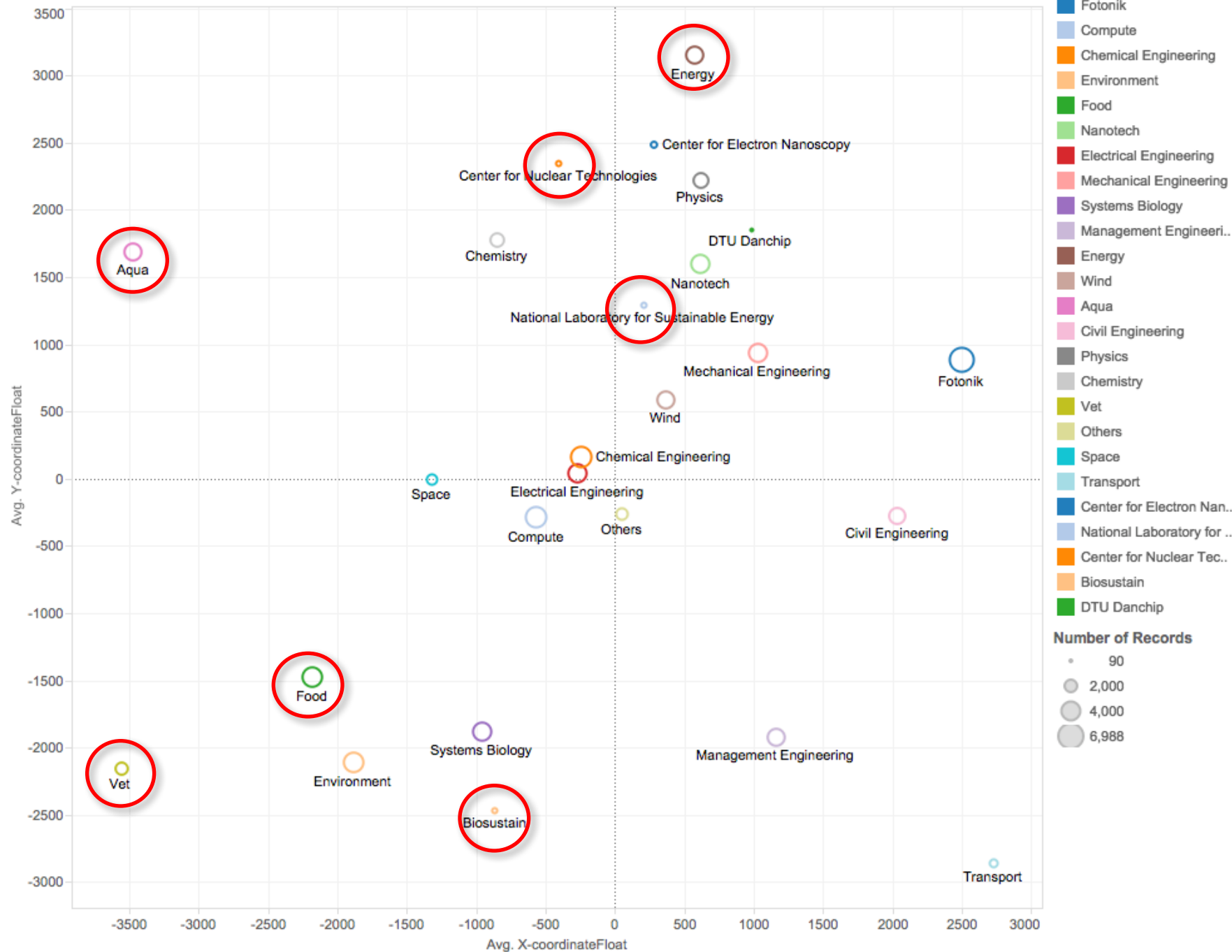
## Owner (group)

- Fotonik
- Compute
- Chemical Engineering
- Environment
- Nanotech
- Electrical Engineering
- Mechanical Engineering
- Systems Biology
- Management Engineeri..
- Wind
- Civil Engineering
- Physics
- Chemistry
- Space
- Transport
- Center for Electron Nan..
- DTU Danchip

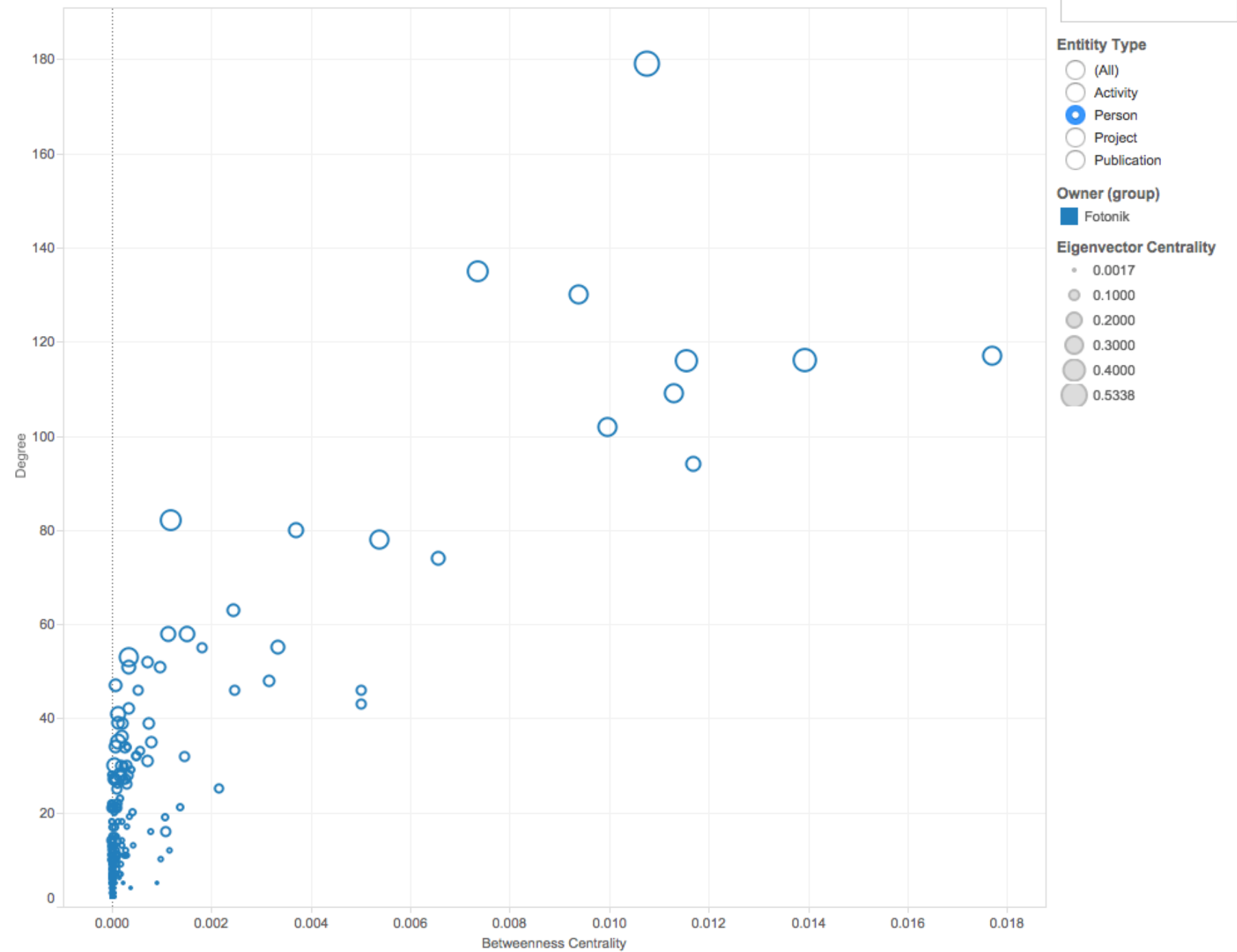
## Department filter

(All) ▾

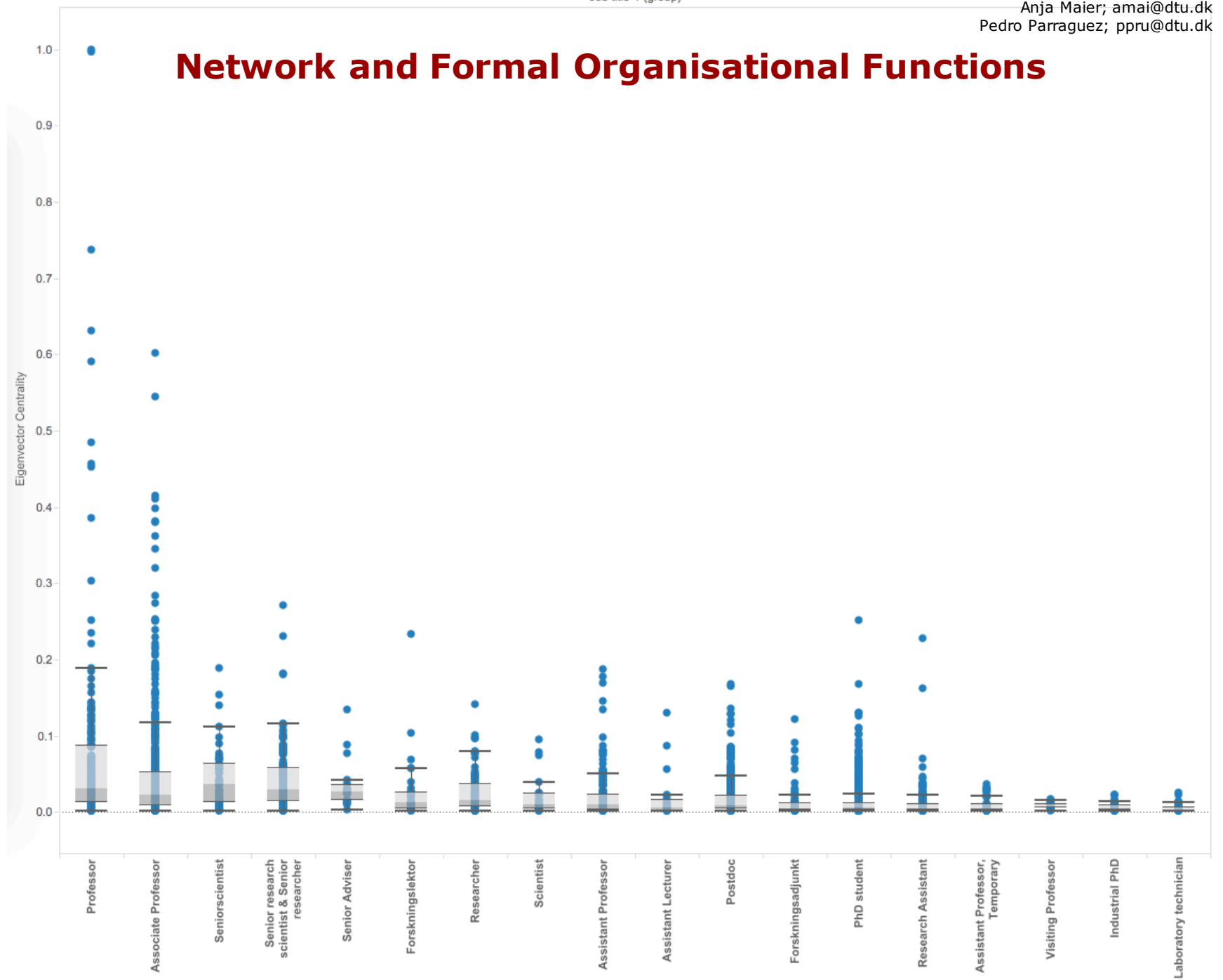
# Simplified Knowledge Landscape



Centrality plot

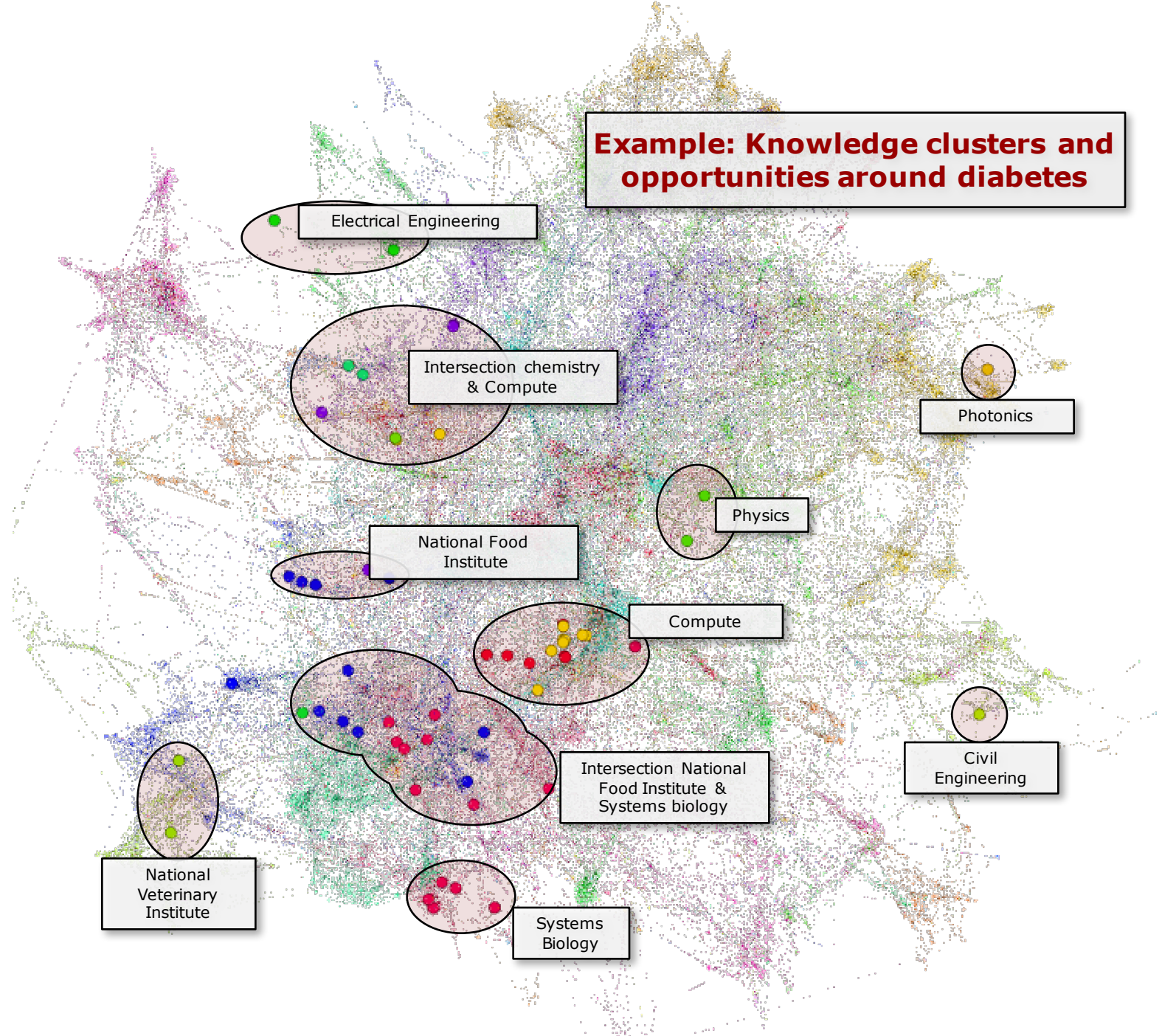


# Network and Formal Organisational Functions





**Example: Knowledge clusters and opportunities around diabetes**



**Electrical Engineering:**  
e.g. Internal strain estimation for quantification of human heel pad elastic modulus... changes in heel pad elasticity, as seen in e.g. long-distance runners, **diabetes patients**...

Intersection chemistry & Compute

**Physics:**  
e.g. ...The typical biphasic insulin secretion pattern observed with a square **wave glucose stimulation**

**Photonics:**  
*POF based **glucose sensor** incorporating grating wavelength filters*

National Food Institute

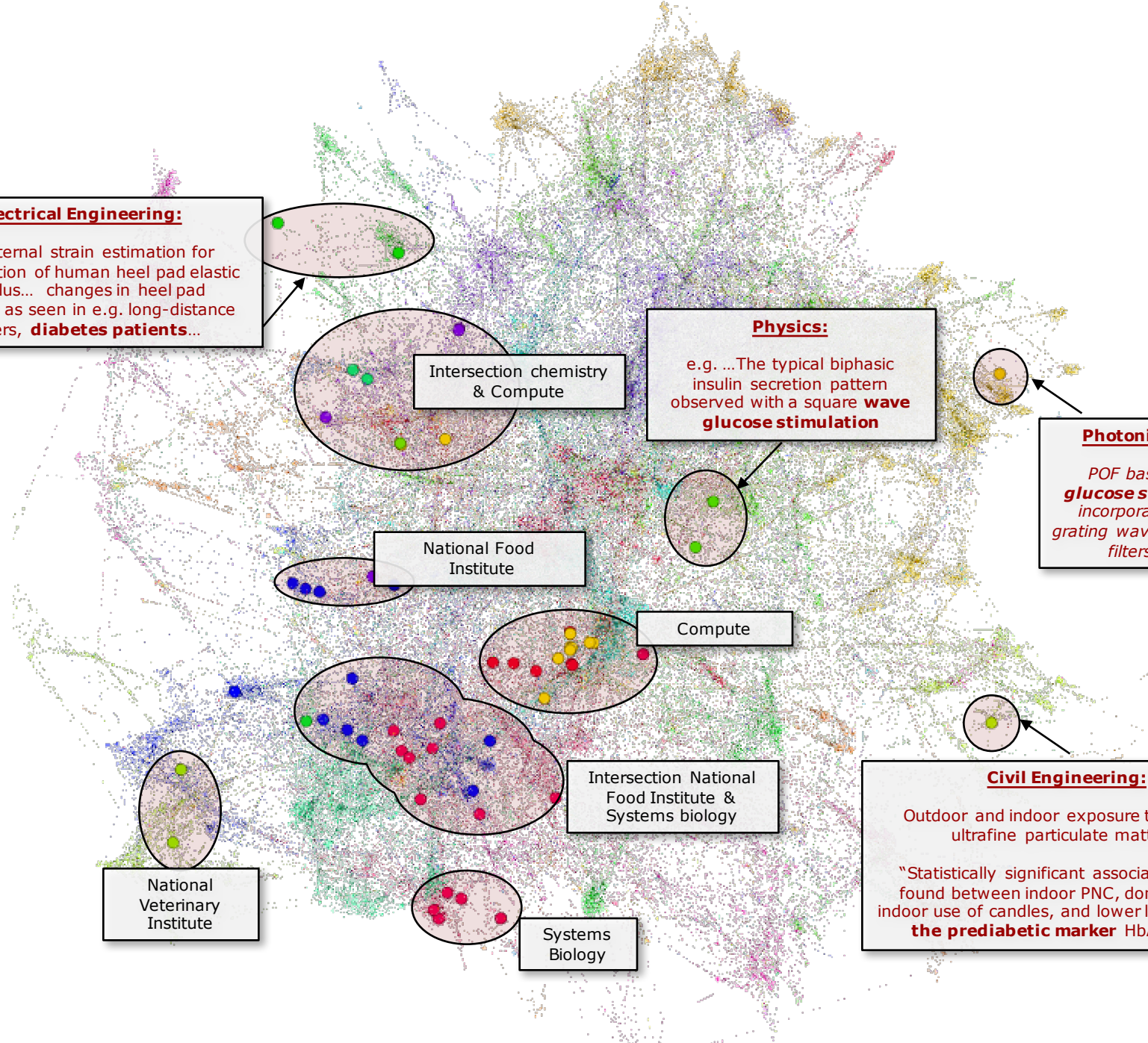
Compute

Intersection National Food Institute & Systems biology

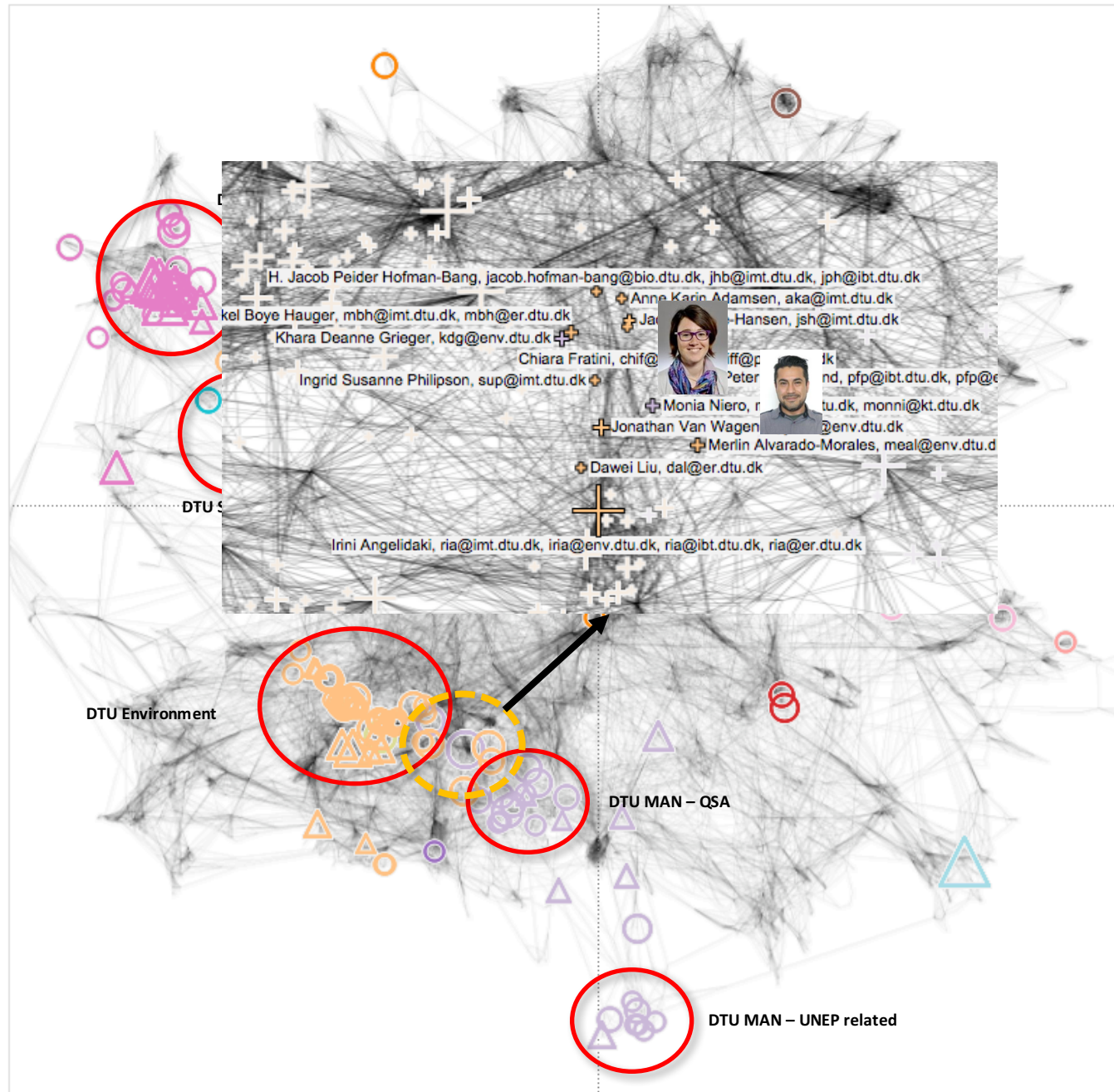
**Civil Engineering:**  
Outdoor and indoor exposure to fine and ultrafine particulate matter...  
"Statistically significant associations were found between indoor PNC, dominated by indoor use of candles, and lower lung function, **the prediabetic marker HbA1c** and..."

National Veterinary Institute

Systems Biology



# Overall Knowledge Landscape : "Climate Change"



## Entity Type

- (All)
- Activity
- Person
- Project
- Publication

## Description search..

## Refine descriptio..

## Name search

## # Connections

- 2
- 5
- 10
- 15

## Entity Type

- Project
- Publication

## # Connections



## Department

- Environment
- Aqua
- Management En..
- Chemical Engin..
- Civil Engineering
- Space
- Transport
- Electrical Engin..
- Others
- Energy
- Center for Nucle..
- Mechanical Engi..
- Systems Biology

# Wrap up

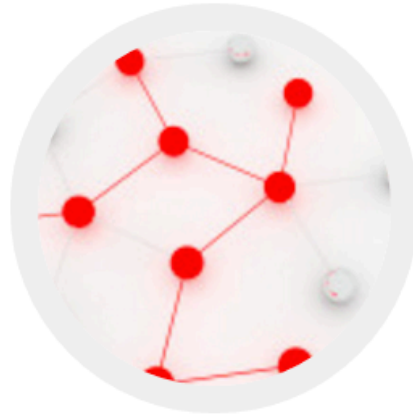
Vision and Opportunities



### DATA-DRIVEN

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We believe in a bottom-up approach driven by large amounts of data to generate new insights



### FROM COUNTING TO CONNECTING

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Our goal is to reveal the hidden connections and opportunities between otherwise disconnected possibilities



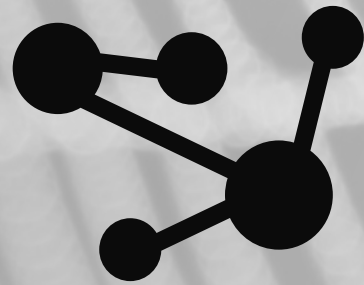
### FROM ORGANISATIONS TO ECOSYSTEMS

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Recombinant innovation requires to shift the focus from individual organisations to industrial ecosystems

Thanks!

Learn more at: [www.netsights.dk](http://www.netsights.dk)



# Net-Sights

Network Insights

Danmarks  
Tekniske  
Universitet

