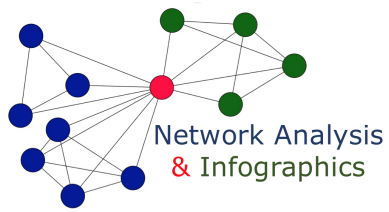
Introduction

Dr David Eggleton

SPRU (Science Policy Research Unit)
Business School
University of Sussex

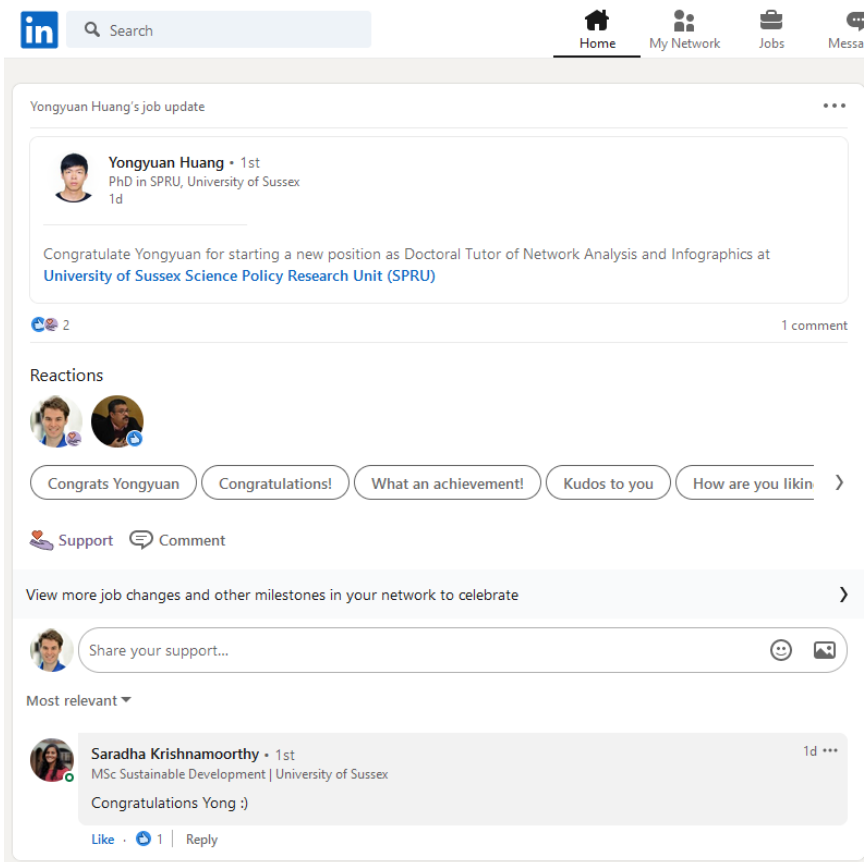


Week 1

Overview

1. Why network analysis?
2. Why infographics?
3. Overview of the module

Teaching team



Source: Linkedin

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(d.eggleton@sussex.ac.uk)

Yongyuan Huang
Seminars
(yongyuan.huang@sussex.ac.uk)

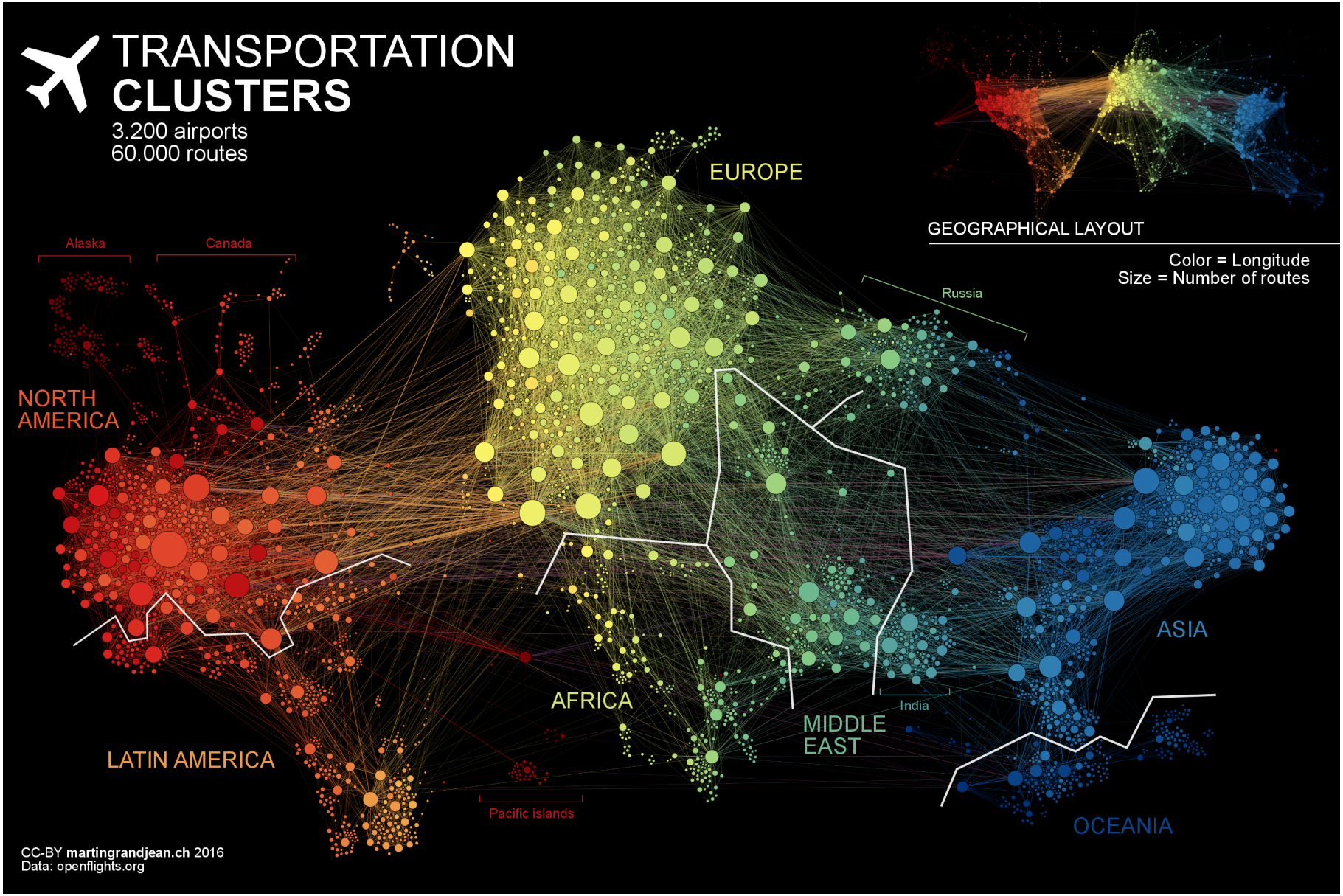
The future experts of Network Analysis and Infographics ...

Please introduce yourself

- Name and MSc course
- Why did you choose this module?
- What do you expect to achieve at the end of this module?

Why network analysis?

Why network analysis?

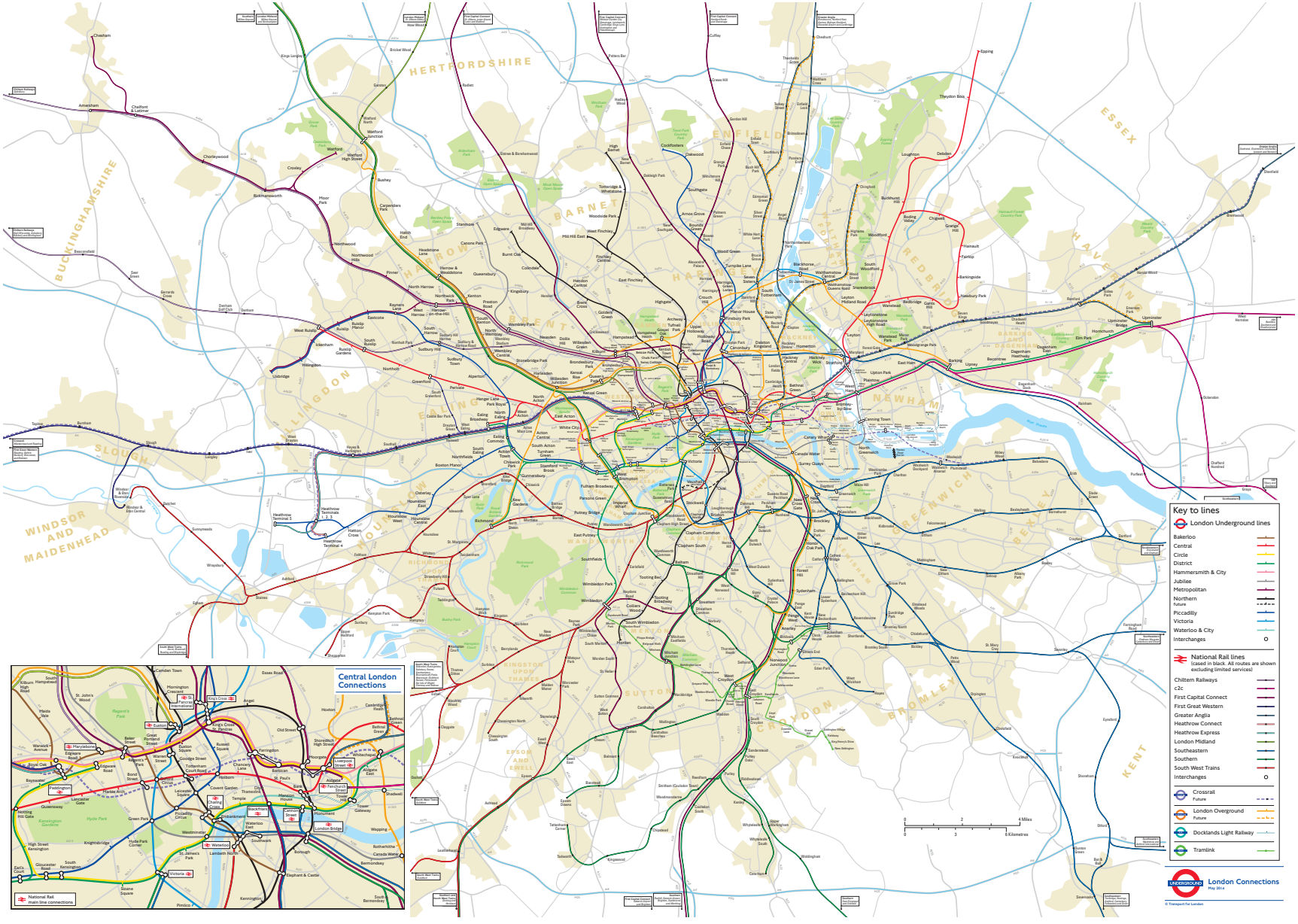


Source: Global transportation map of flight connections (`www.martingrandjean.ch`)

Why network analysis?

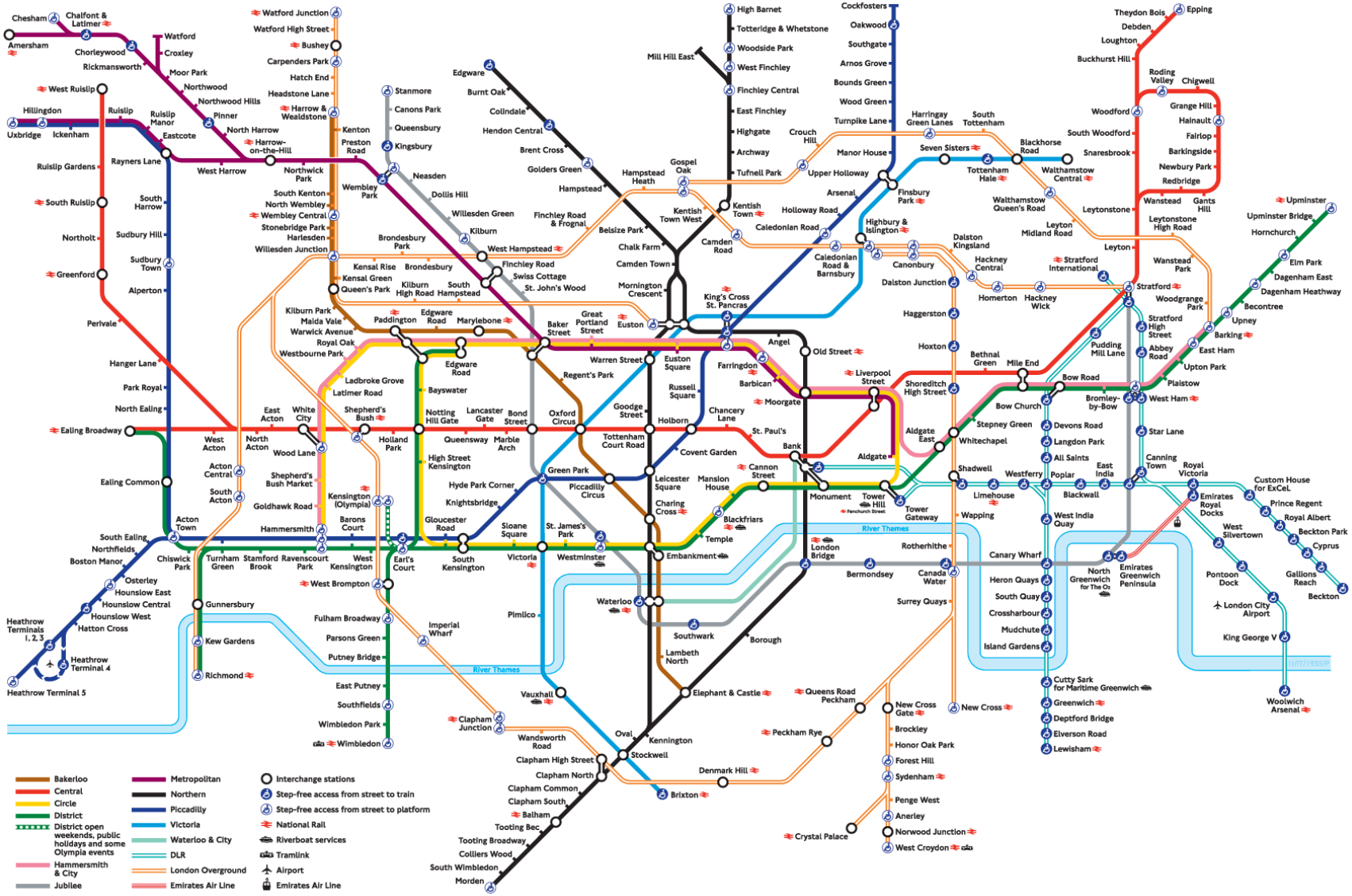
Source: Facebook (Mark Zuckerberg, Sept. 2013)

Why network analysis?



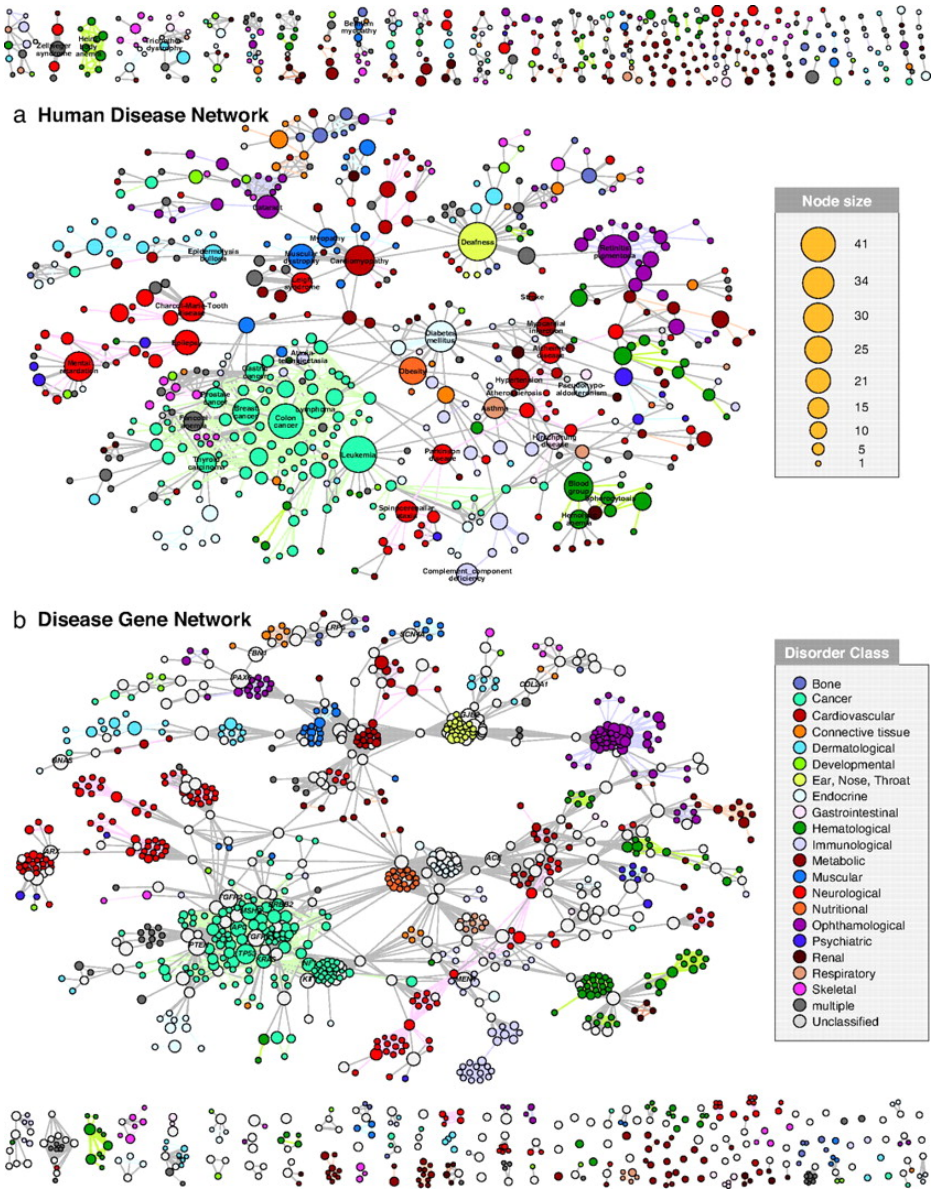
Source: TfL (https://tfl.gov.uk/corporate/transparency/freedom-of-information/foi-request-detail?referenceId=FOI-0525-1920)

Why network analysis?



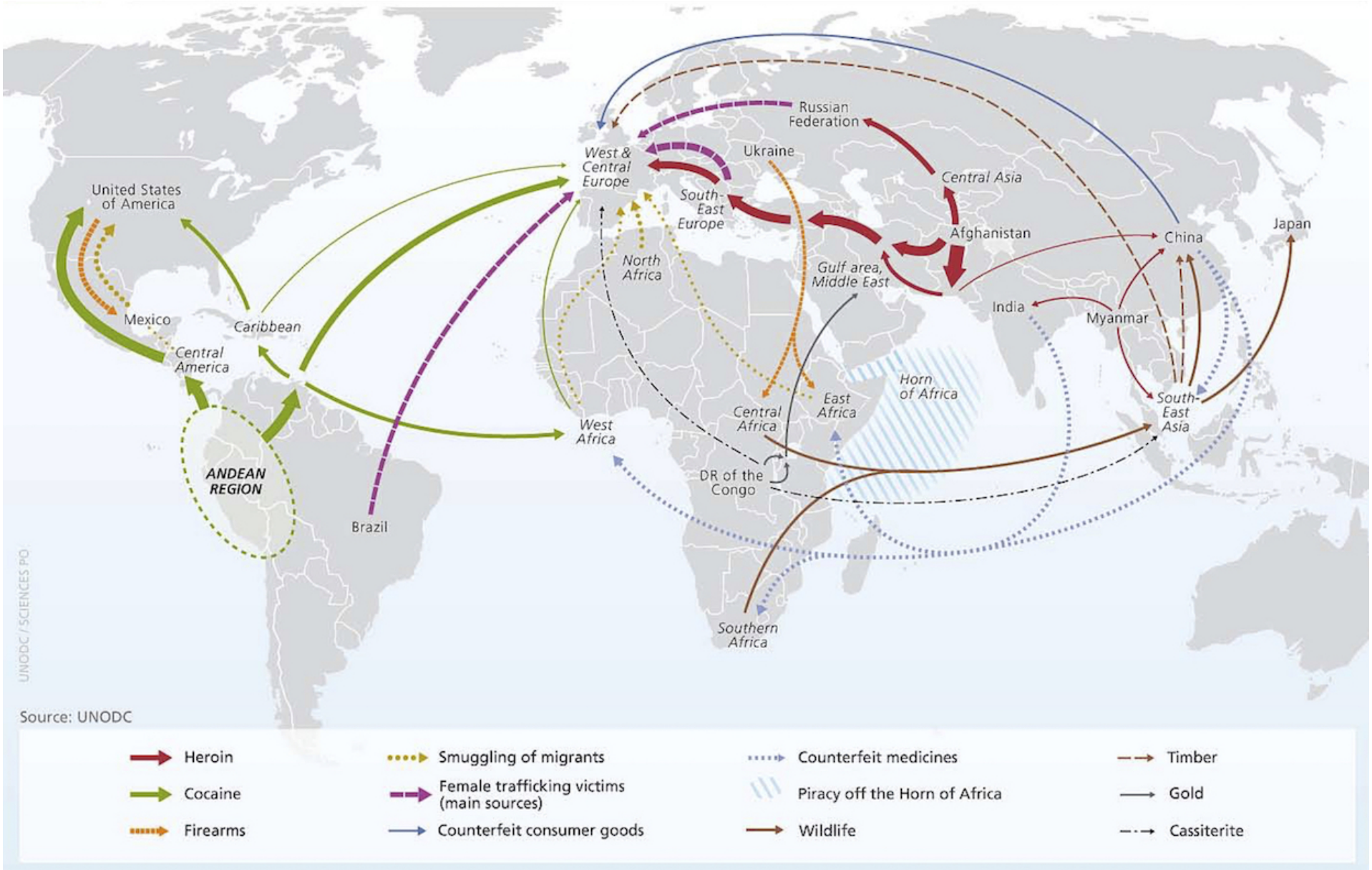
Source: TfL (https://tfl.gov.uk/modes/tube/)

Why network analysis?



Source: The disease-gene network [?]

Why network analysis?

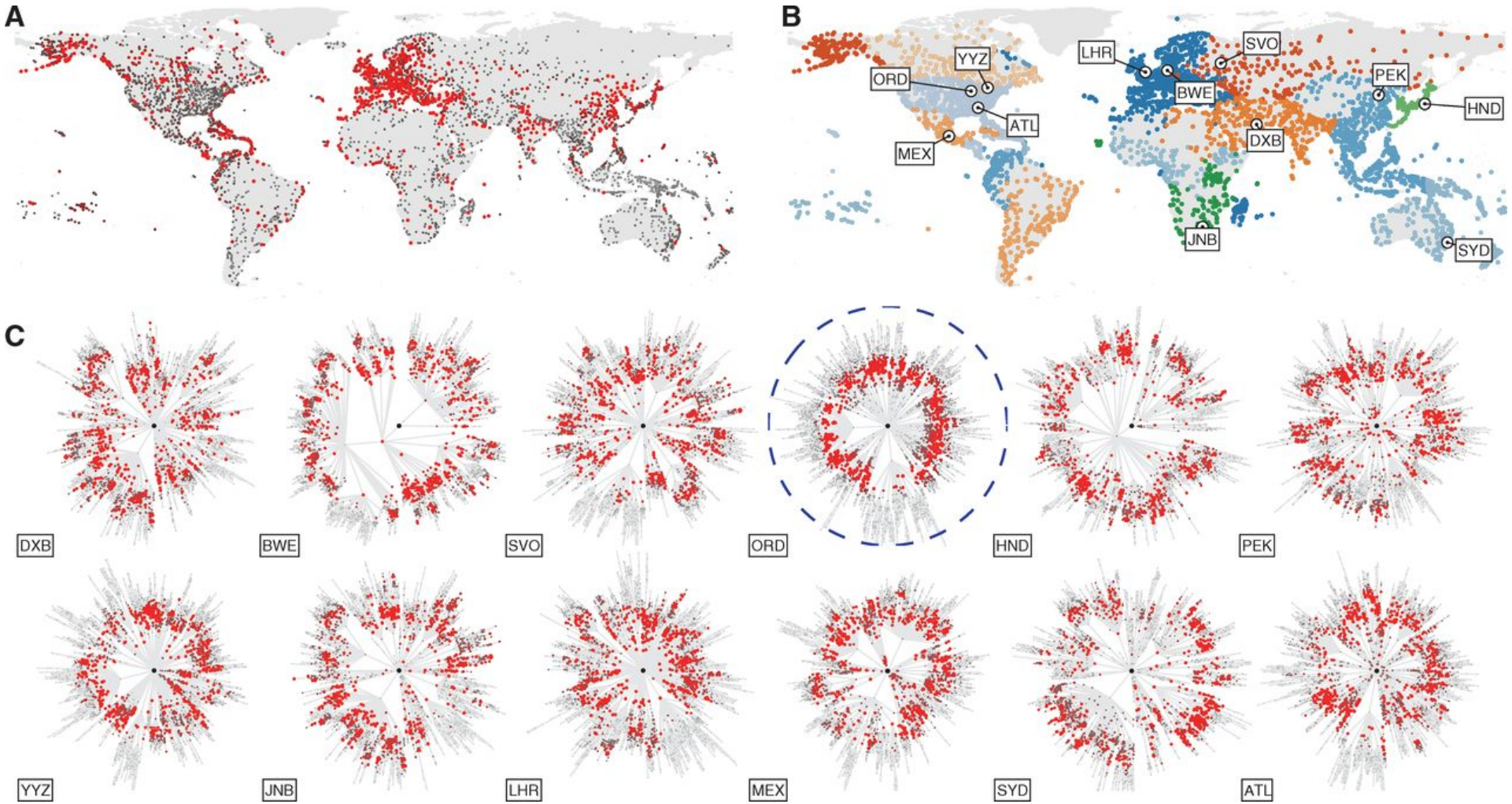


Source: Transnational organised crime flow (United Nations Office of Drugs and Crime)

Why network analysis?

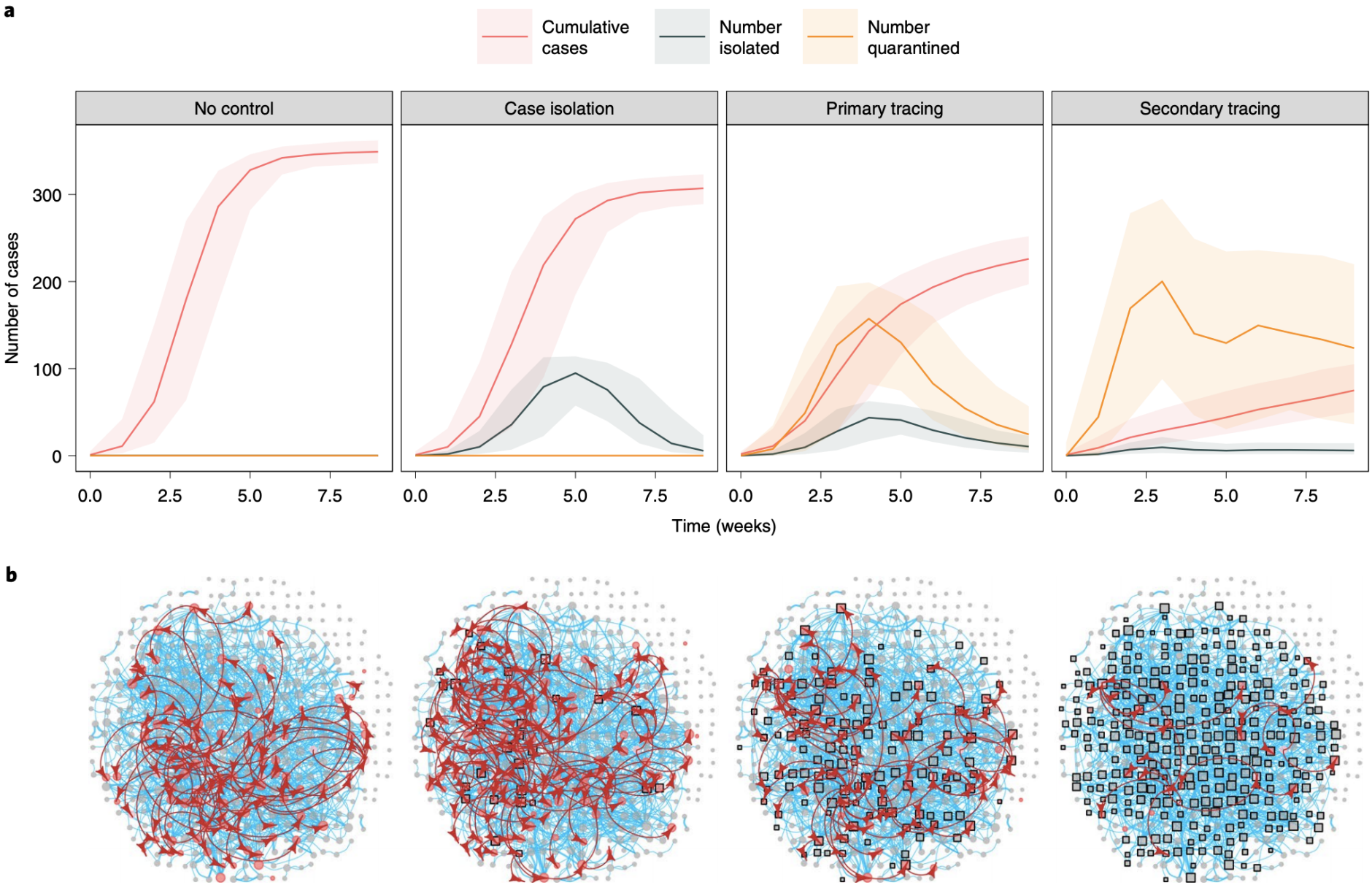
Source: The flight of refugees around the globe (The New York Times, June 20, 2015)

Why network analysis?



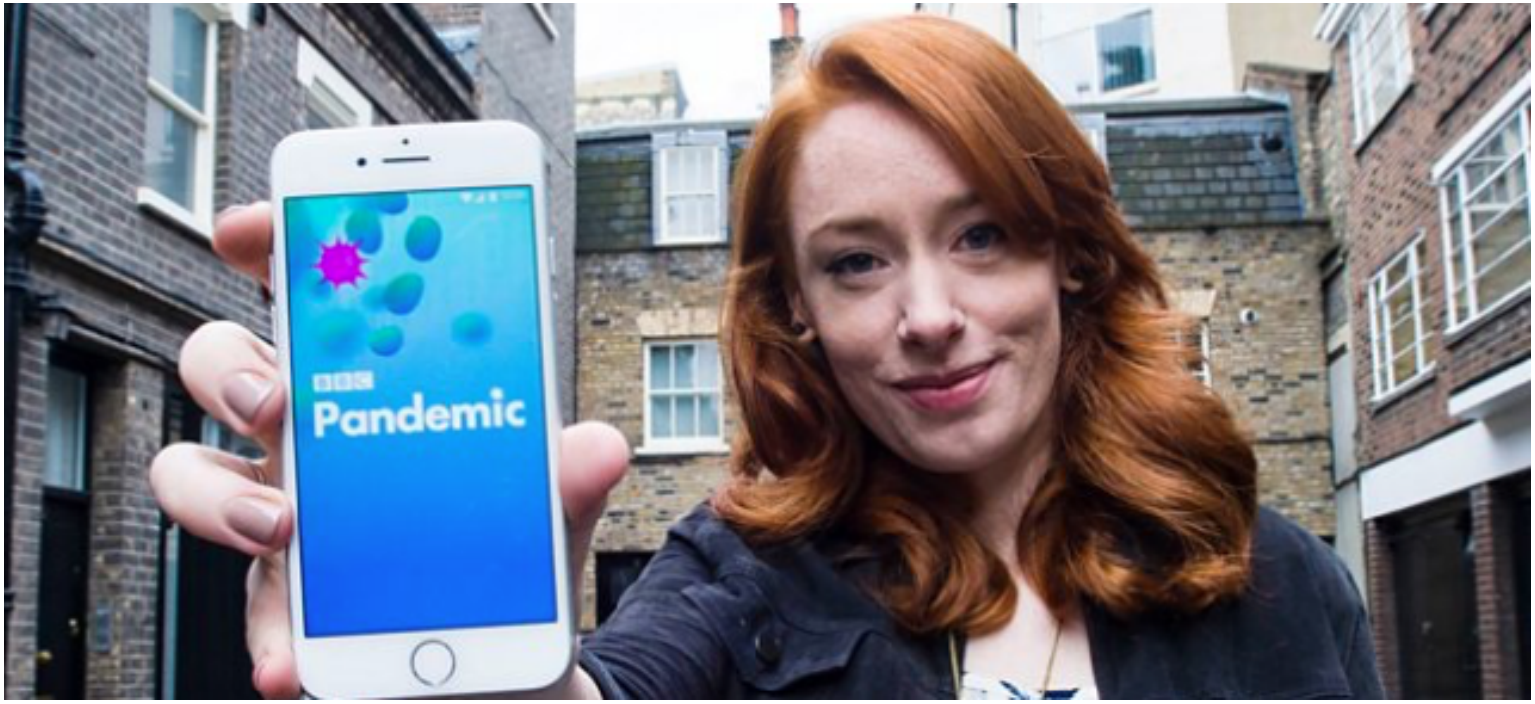
Source: Qualitative outbreak reconstruction (SARS, H1N1) [?]

Why network analysis?



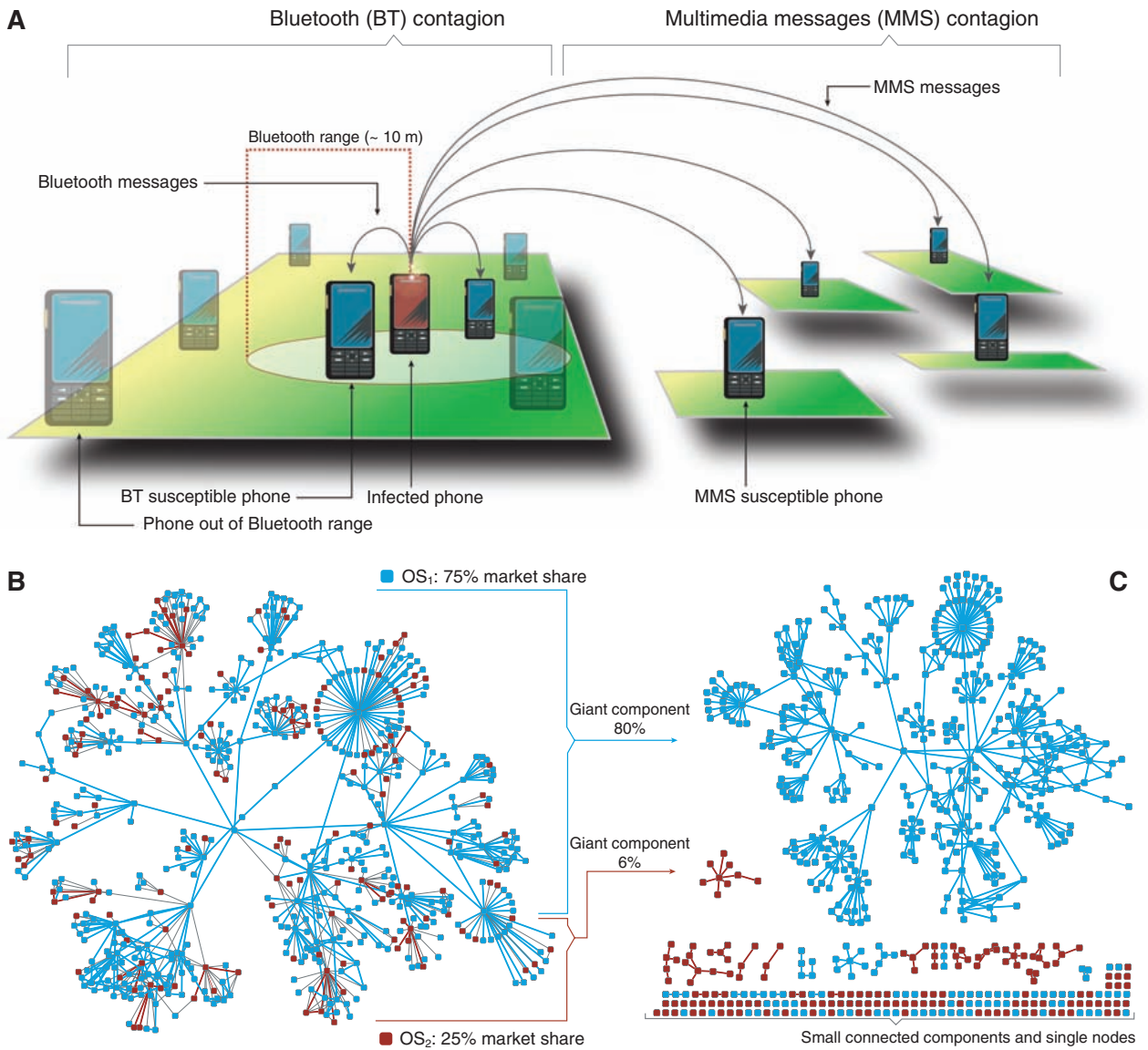
Source: COVID-19 epidemic model predictions under different non-pharmaceutical interventions (GPS data) [?]

Why network analysis?



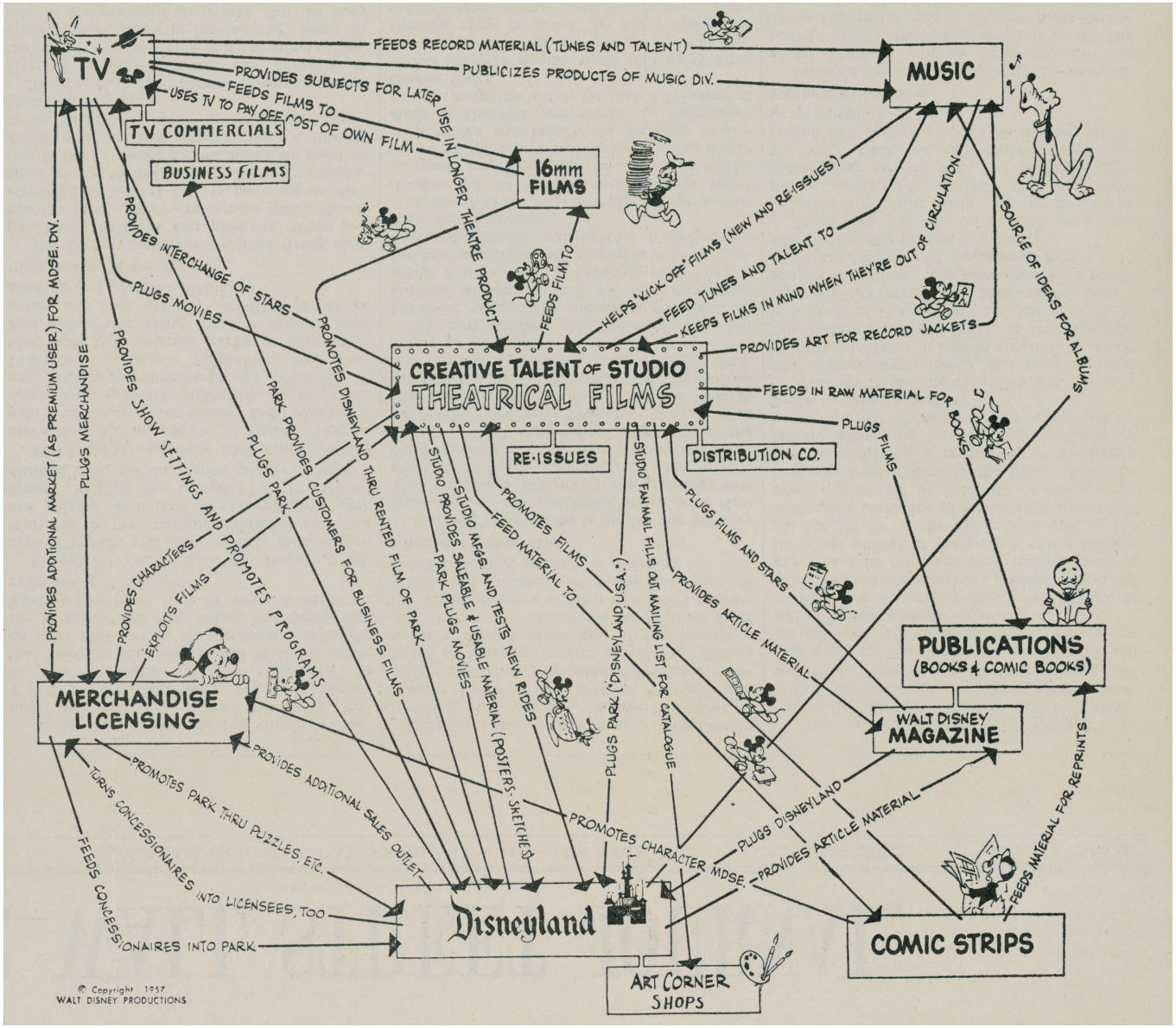
Source: Contagion: The BBC Four Pandemic (2018) - https://youtu.be/RmGiDUczhqQ

Why network analysis?



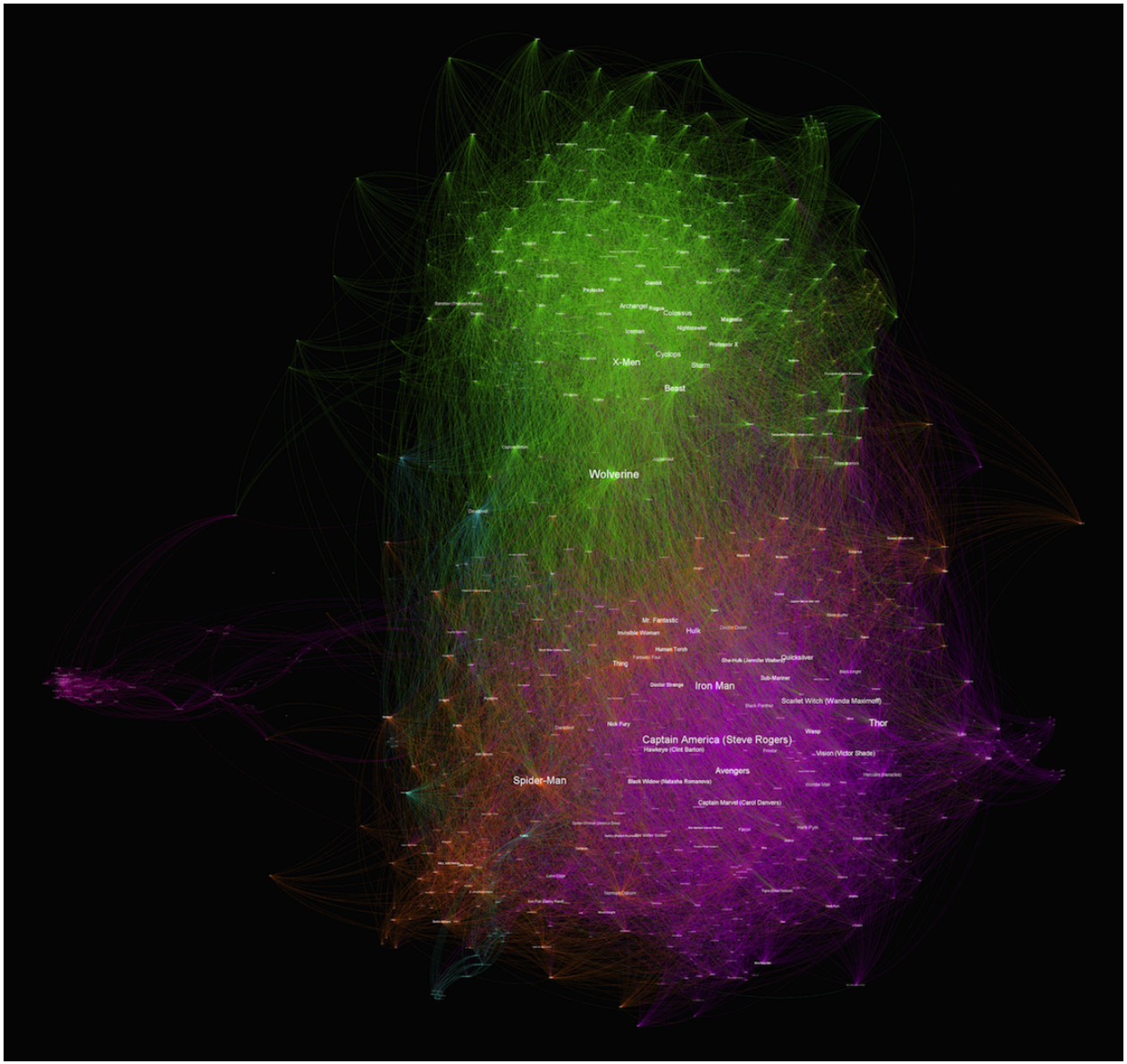
Source: Spreading patterns of mobile phone viruses [?]

Why network analysis?



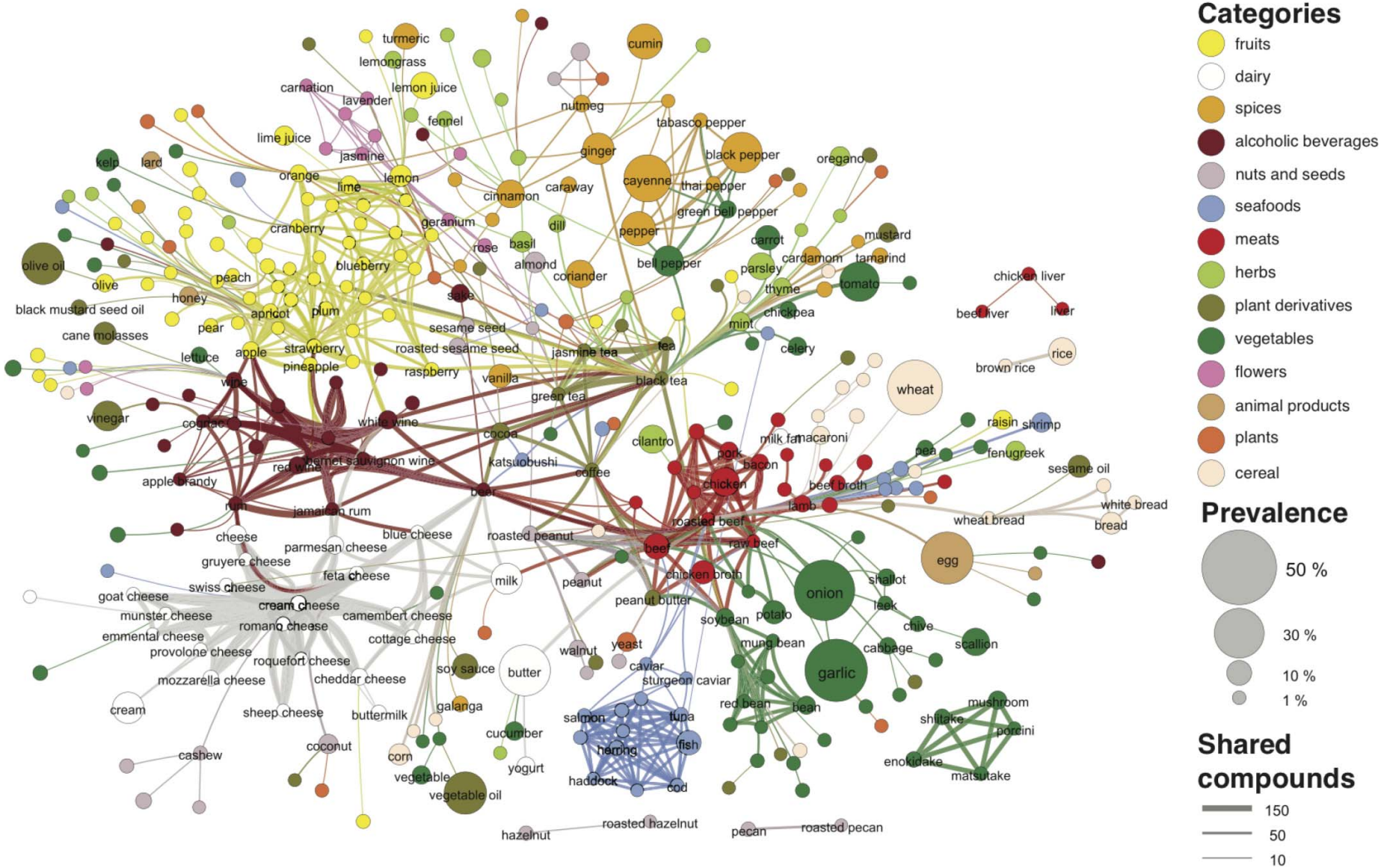
Source: Disney's business strategy in 1957 ('The Disney Recipe', Harvard Business Review, May 28, 2013)

Why network analysis?



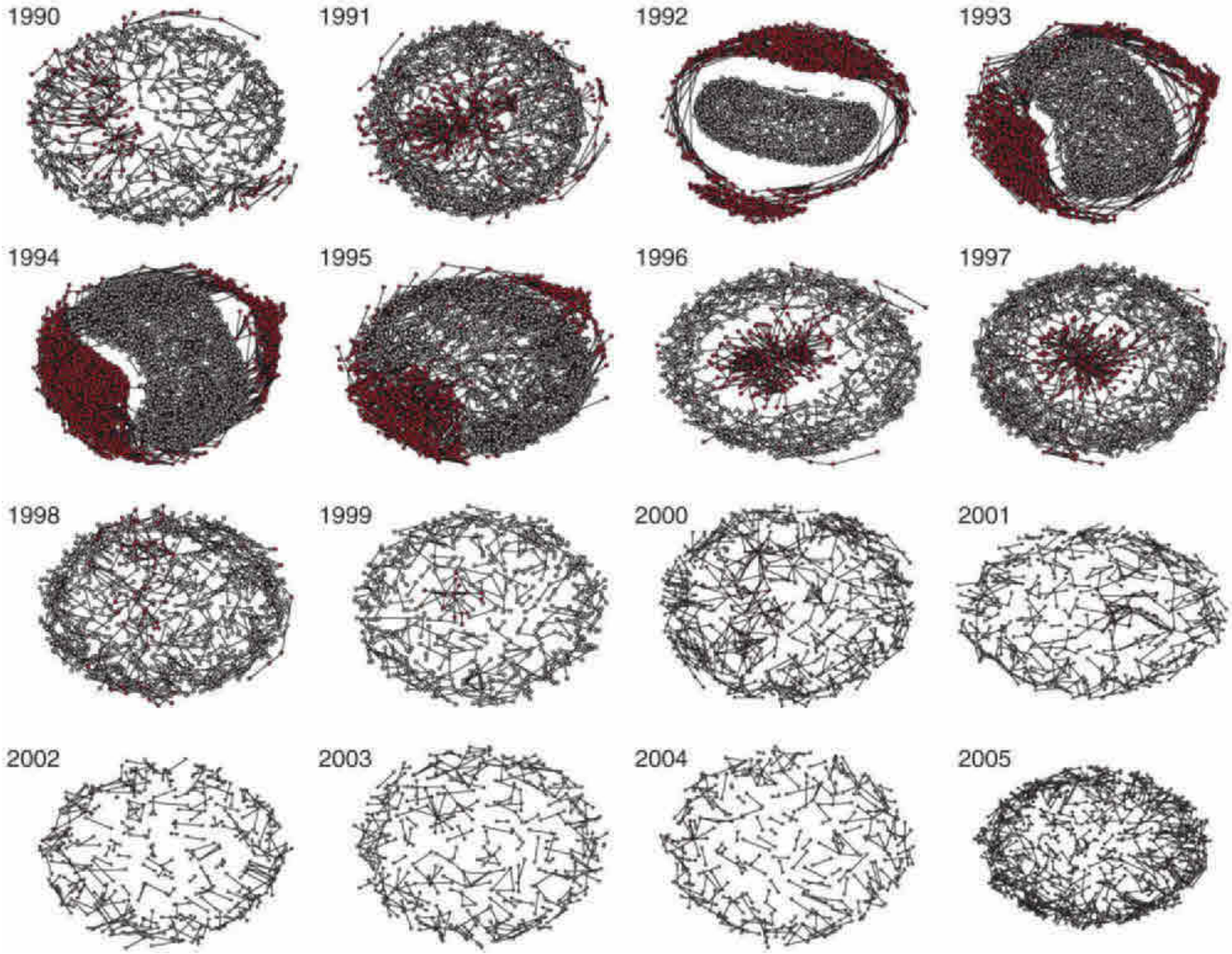
Source: Marvel universe of characters, 'uberframework' (`http://www.fastcompany.com`)

Why network analysis?



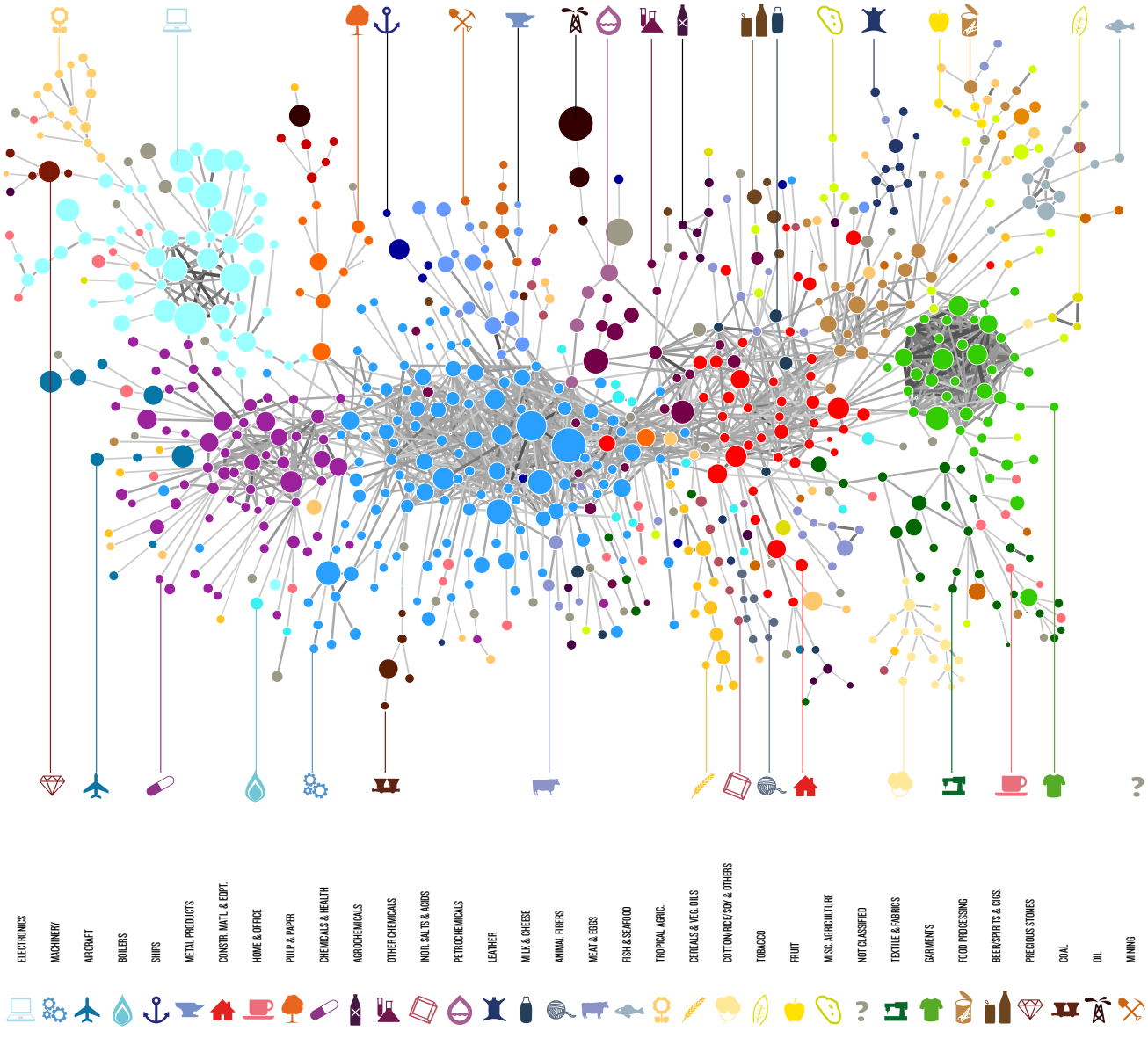
Source: Flavour network and the principles of food pairing [?]

Why network analysis?



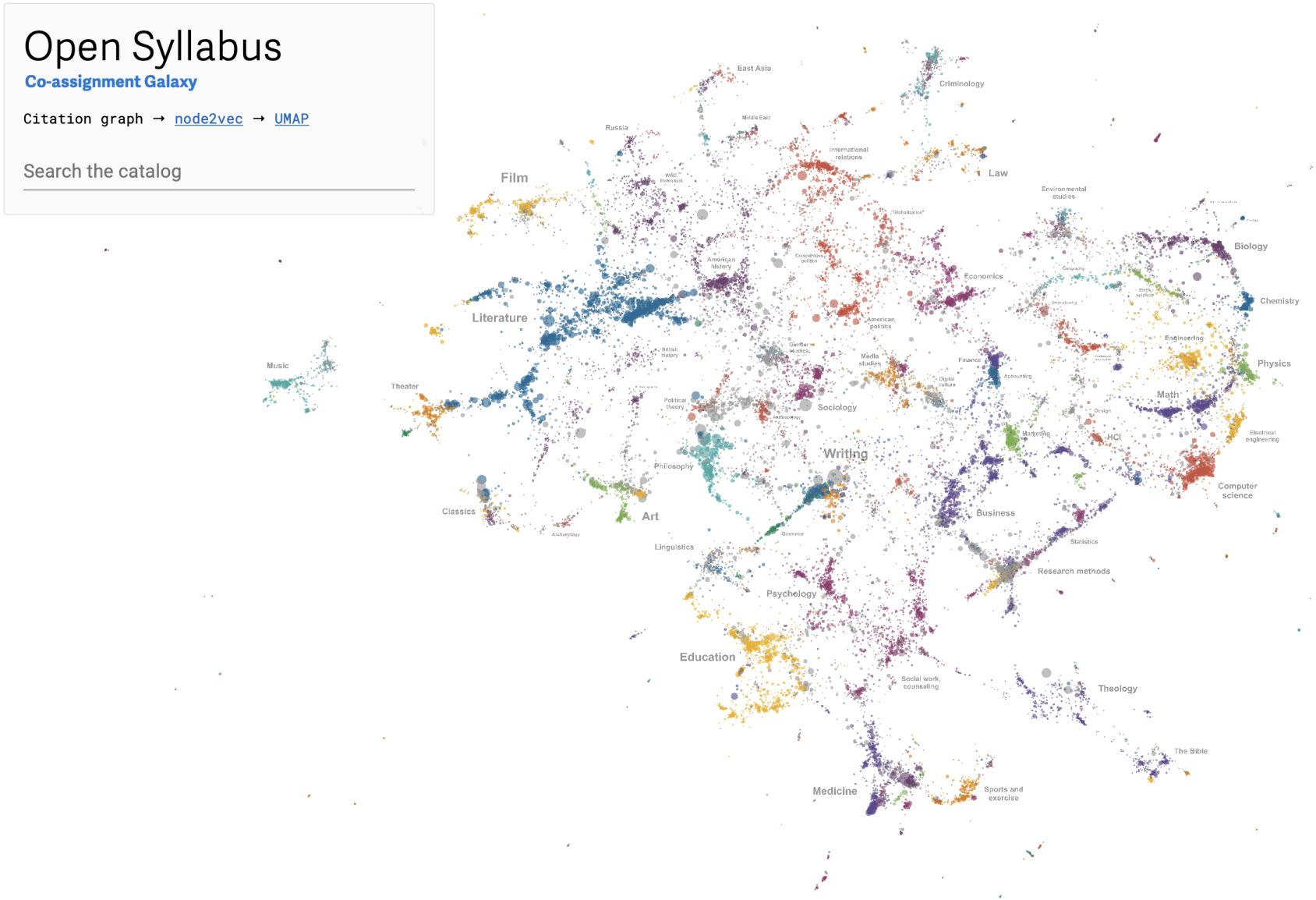
Source: Technology alliances [?]

Why network analysis?



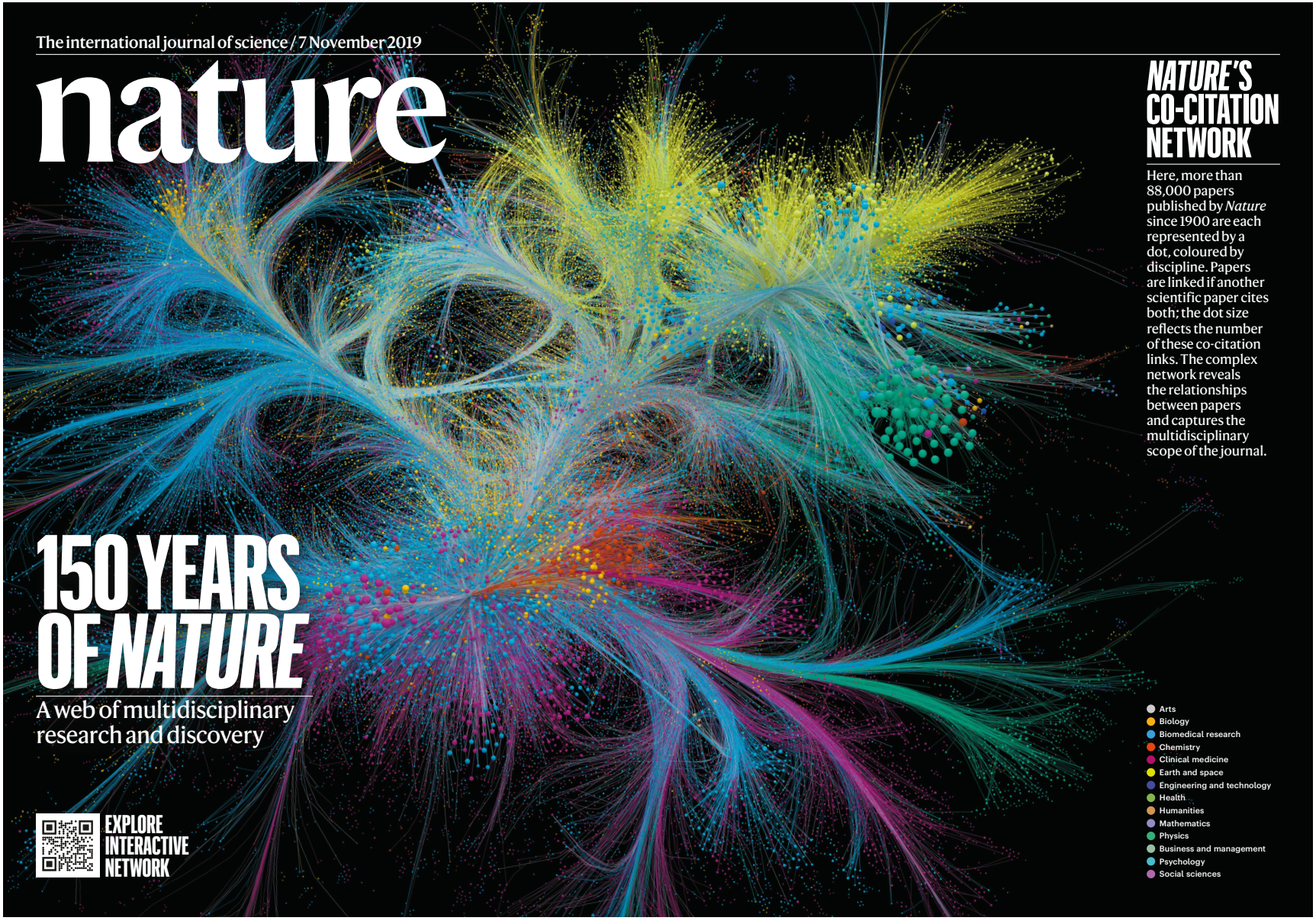
Source: Product space [?]

Why network analysis?



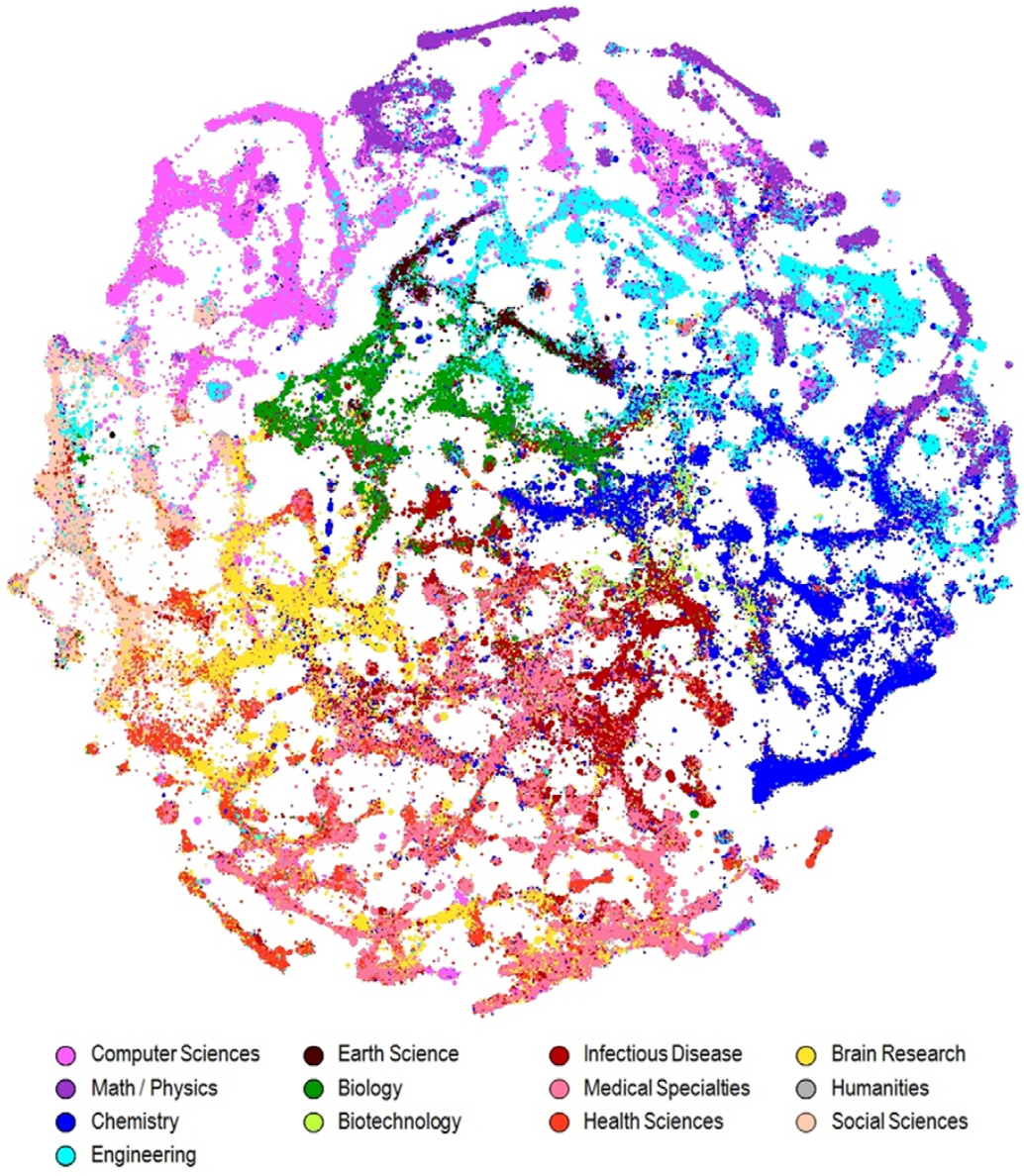
Source: Open Syllabus (`https://galaxy.opensyllabus.org`)

Why network analysis?



Source: Nature (Nov. 2019) – `https://youtu.be/GW4s58u8PZo`

Why network analysis?

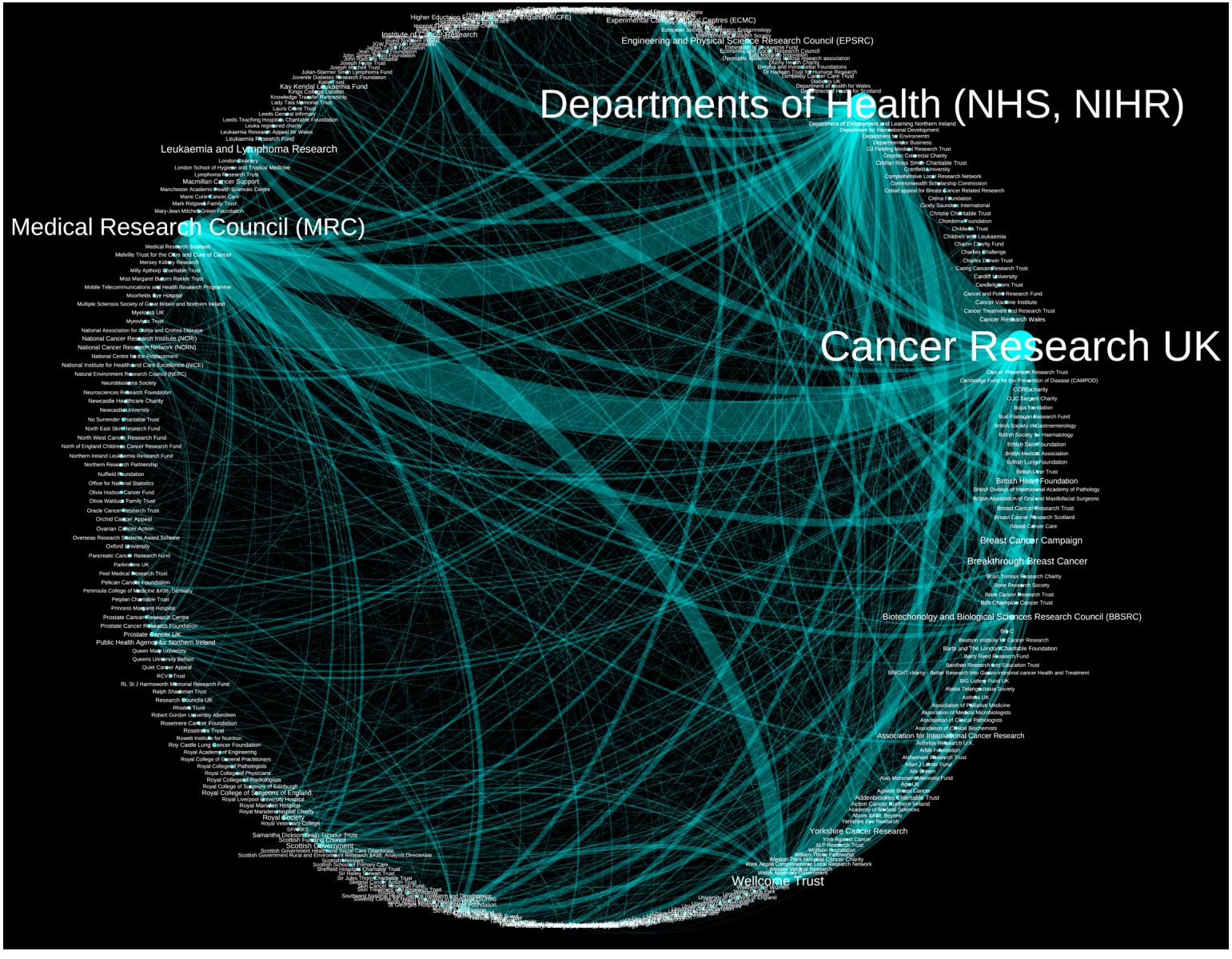


Source: Map of Science (+20M articles and +2M patents from 1996-2011)[?]

Why network analysis?

Source: Co-authorship at the city level (SCOPUS 2008-2012) [`http://olihb.com`]

Why network analysis?



Source: Co-funding in cancer research [**?**]

Why network analysis?

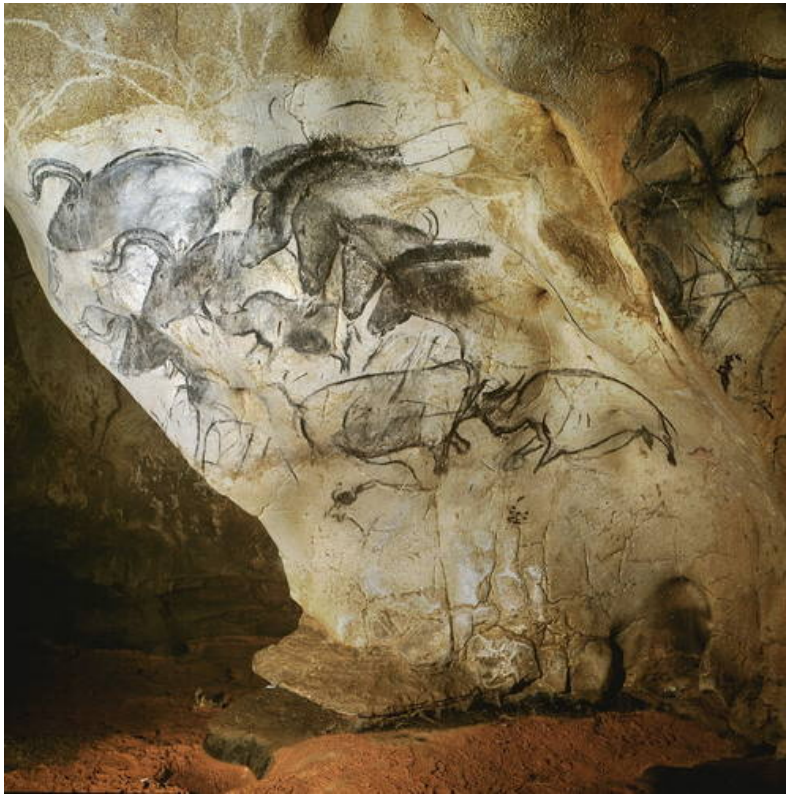
...

Why infographics?

Why infographics?

Our ability to process images

- We have been drawing pictures to comunicate with each other for thousands of years
- Half of our brain is dedicated to processing visual signals
- We can process images 60,000 times faster than text



Source: Figurative drawings of the Grotte Chauvet-Pont d'Arc, 30,000-32,000 BP (`http://whc.unesco.org/`)

Why infographics?

Table: Students in 2021/22

Student	Course
Student 1	SD
Student 2	STP
Student 3	SD
Student 4	SIM
Student 5	SD
Student 6	STP
Student 7	SD
Student 8	SD
Student 9	SIM
Student 10	SIM
Student 11	SD

Why infographics?

Table: Students in 2021/22

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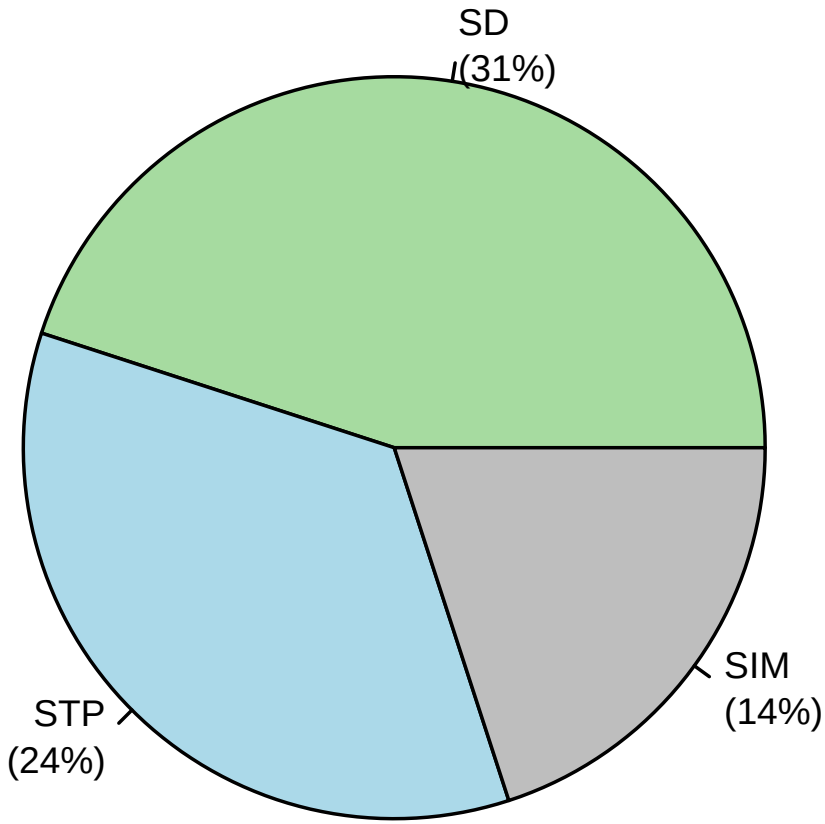
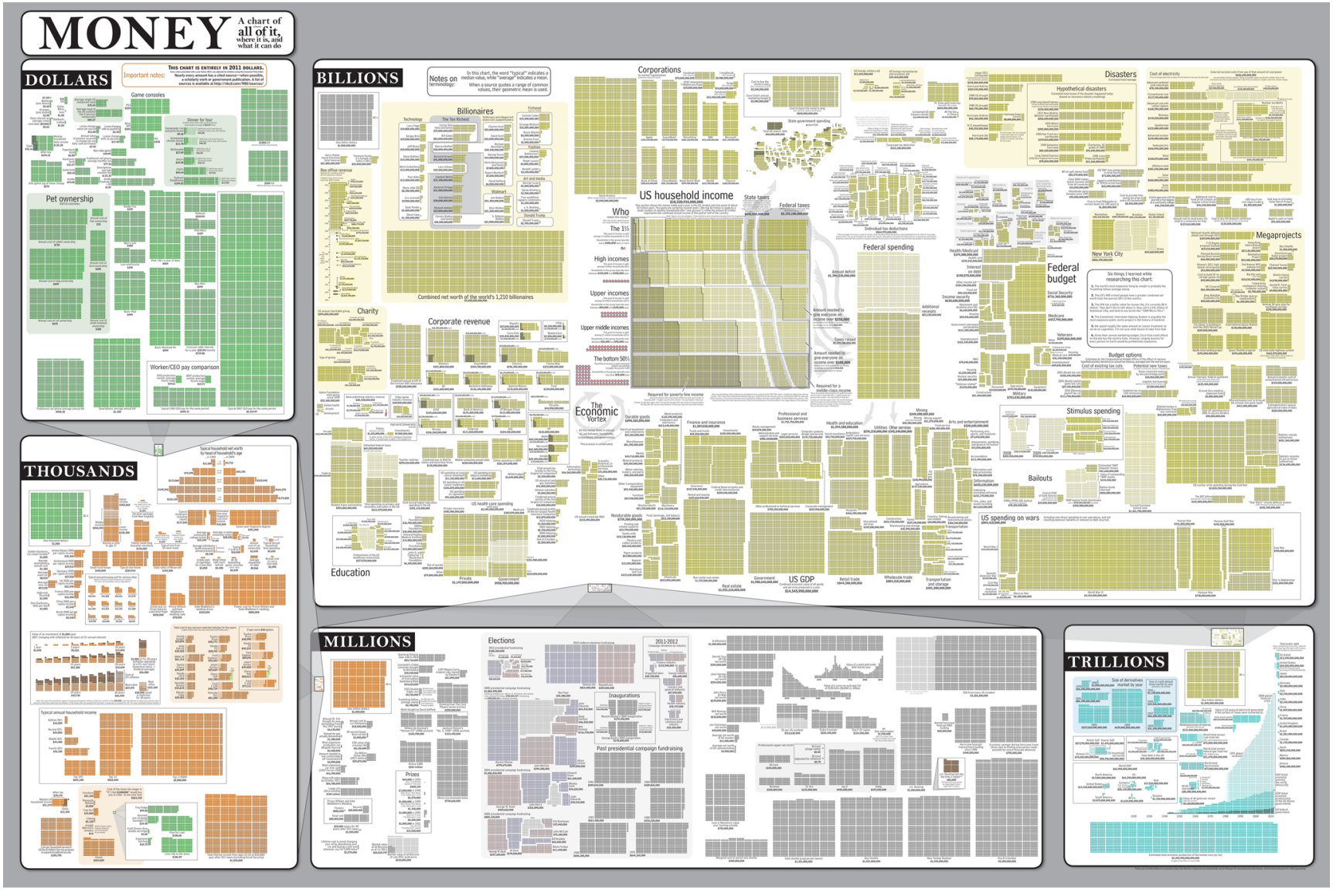
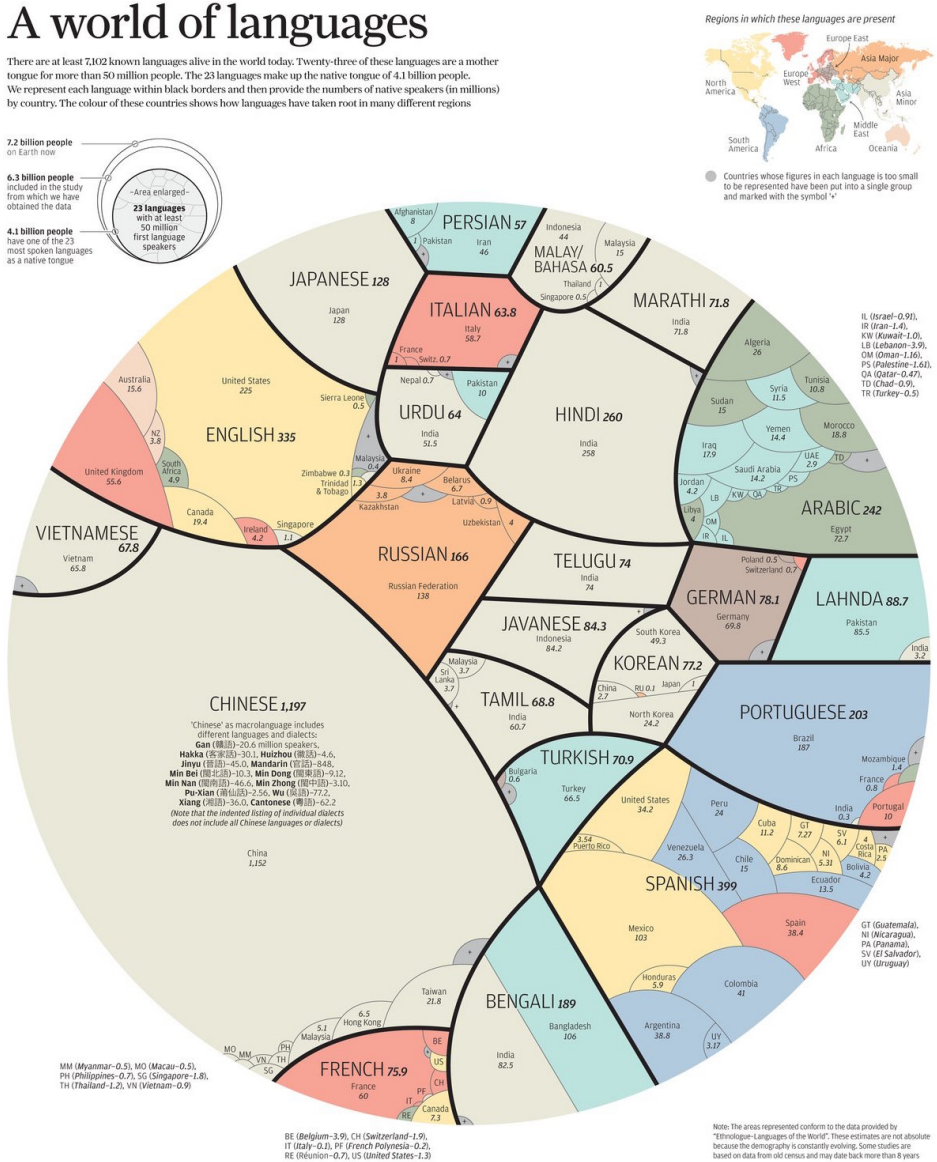


Why infographics?



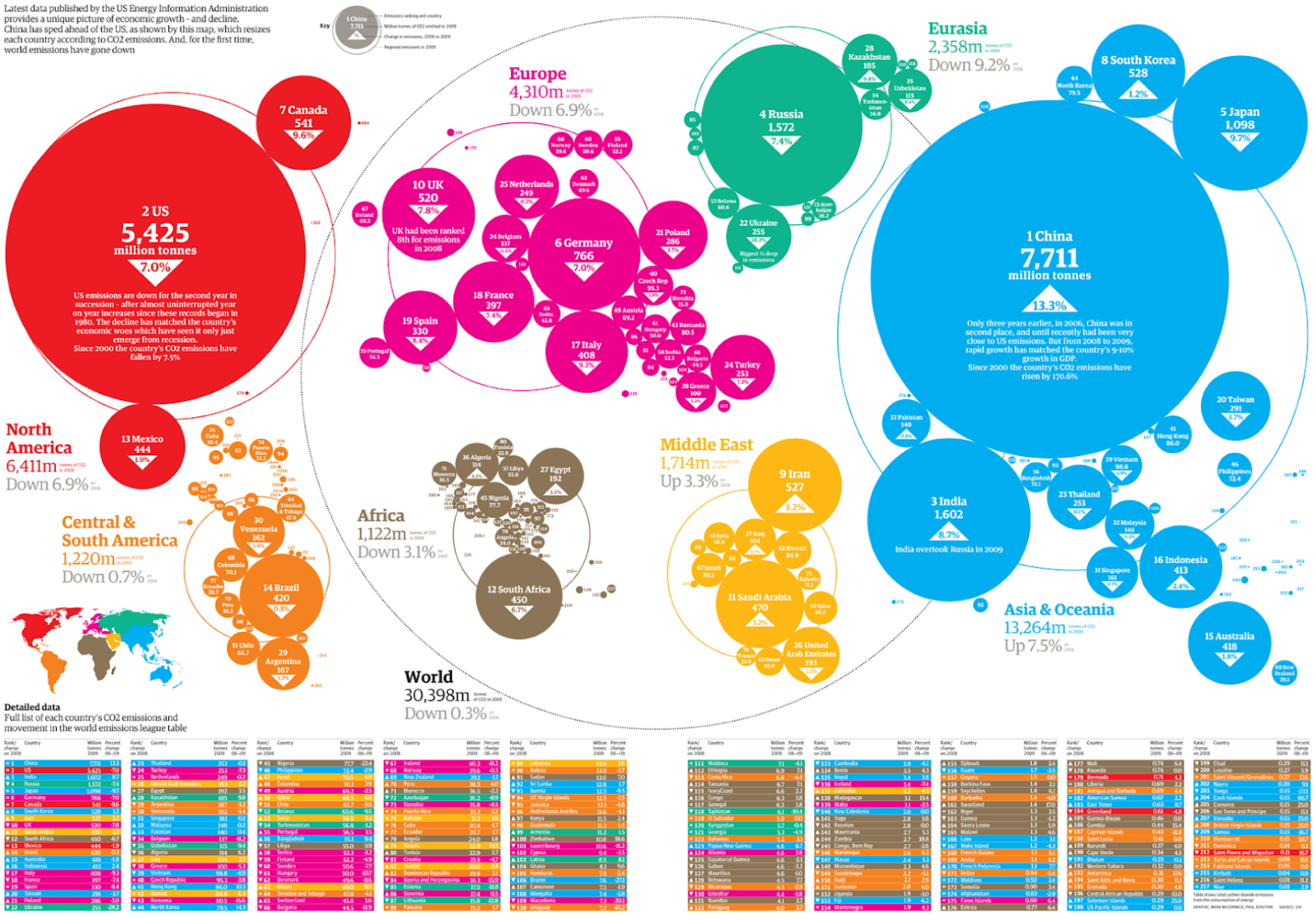
Source: "Money - A chart of all of it" (`https://xkcd.com/980/`)

Why infographics?



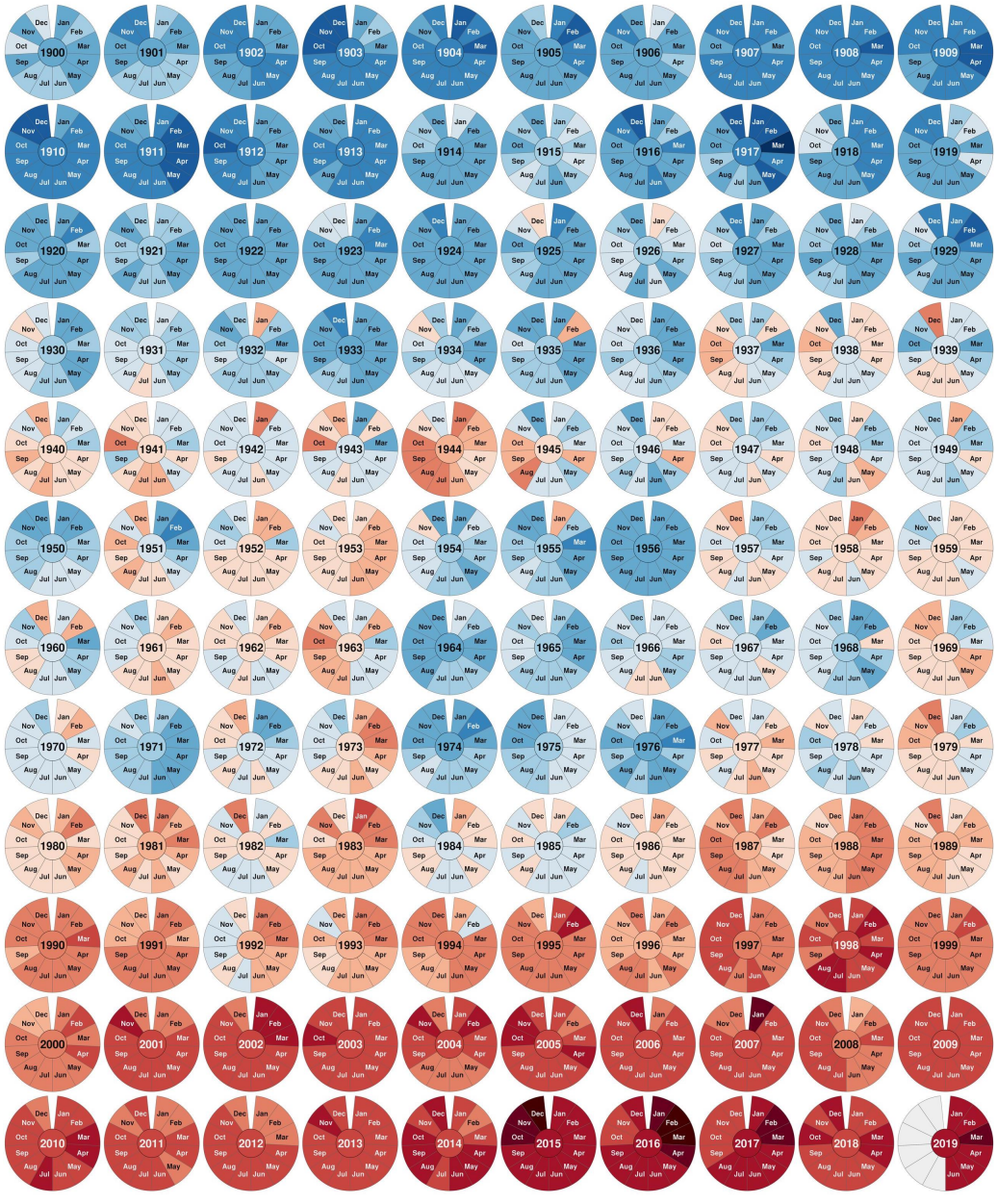
Source: "A world of languages" (`www.scmp.com/infographics/article/1810040/infographic-world-languages`)

Why infographics?



Source: "Atlas of pollution" (www.theguardian.com)

Why infographics?



Source: Monthly global mean temperature compared to average for 1961-1990, Neil Kaye @neilrkaye

Why infographics?

Source: The Economist (September 2019)

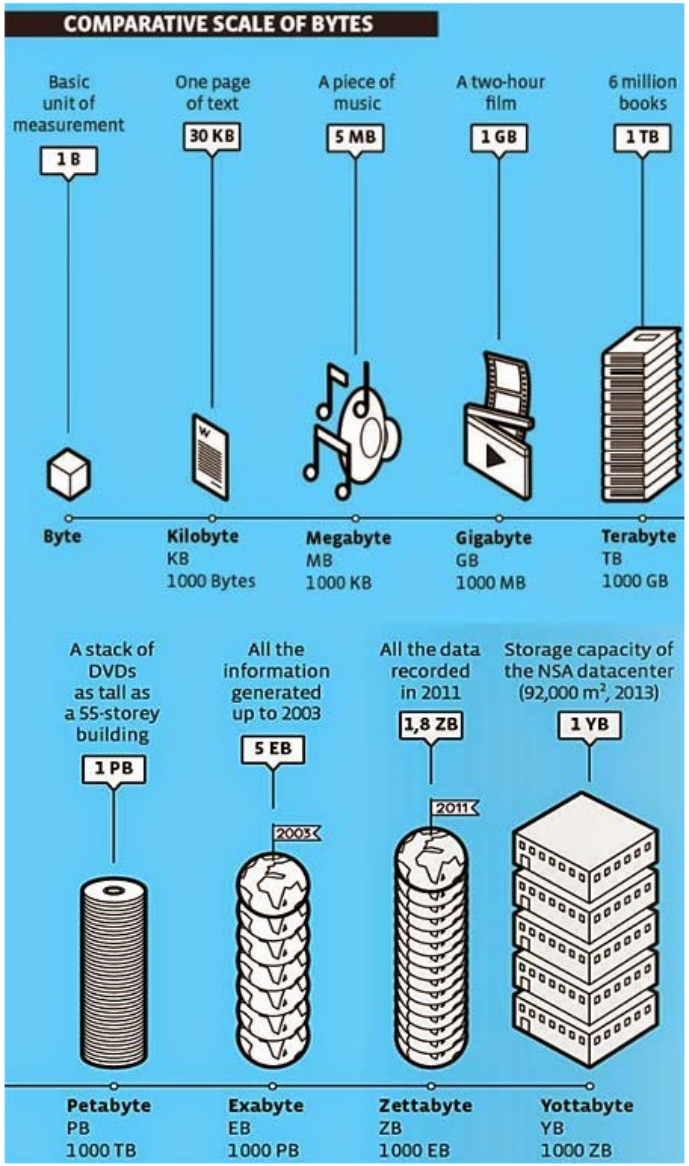
Why infographics?

Data, data, data, ...

Big Data, Data Science, ...

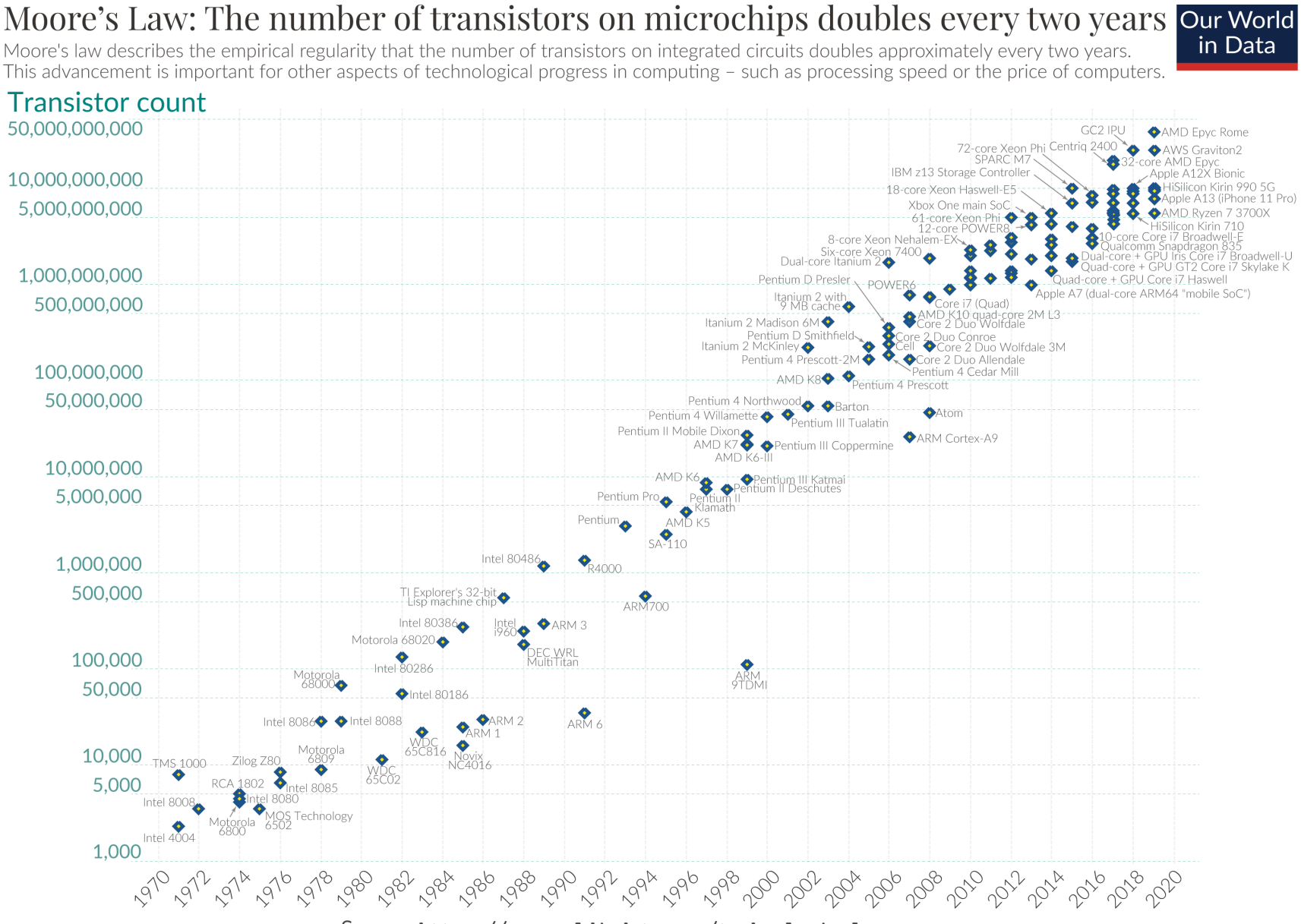
Why infographics?

- Technological advancements have considerably increased our capabilities to collect, store and analyse data
- Increasing access to data:
  - Government data
  - Open access
  - Open science
  - APIs
  - ...
- Risk of information overload



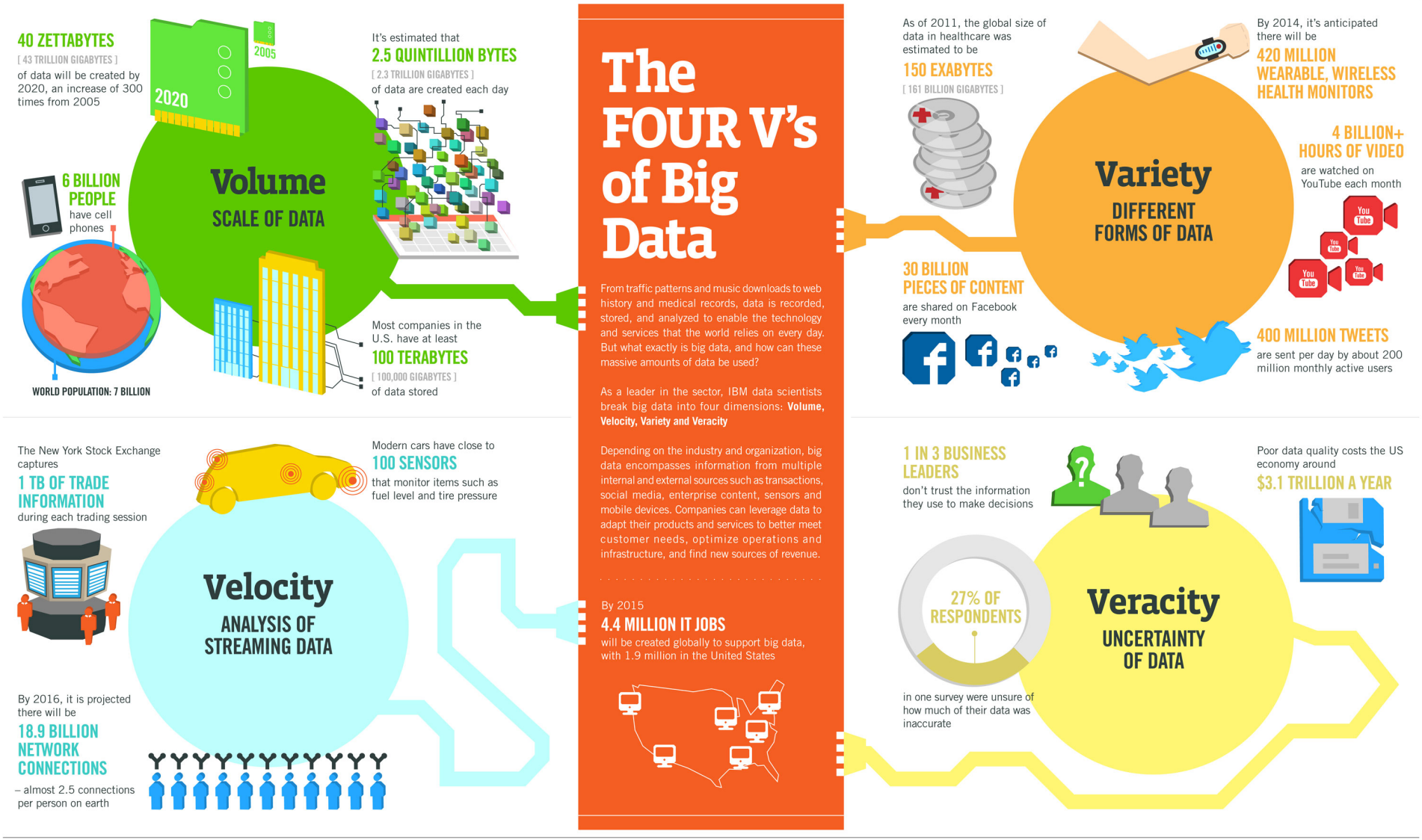
Source: CNRS (`http://www.cnrs.fr/`)

Why infographics?
Data



Source: `https://ourworldindata.org/technological-progress`

Why infographics?



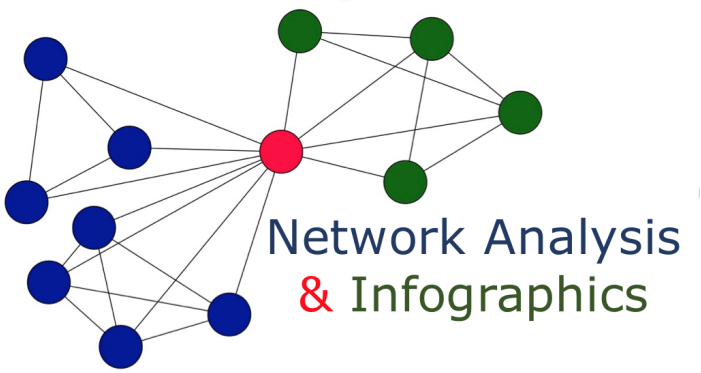
Source: IBM Big Data and Analytics Hub (`http://www.ibmbigdatahub.com`)

Why infographics?
Share your examples of infographics

1. Identify an example of infographic
2. Share your example at `https://uofsussex.padlet.org/d_rotolo/5ui28vq1183v3xg5`
3. Add your name
4. Time: 10 minutes

Overview of the module

Overview of the module



- 15-credit module
- An option module for all SPRU MSc courses:
  - Science and Technology Policy
  - Strategic Innovation Management
  - Sustainable Development
- The module introduces students to
  - qualitative, quantitative, and mixed methods to collect and analyse network data
  - principles for generating effective infographics

	Learning outcome	Assessment mode
1	Explain the concept of network and list the main network indicators	ESS
2	Describe and apply the major techniques for the collection of network data and their statistical analysis	ESS, GPN + GWS
3	Identify the main characteristics of networks by means of network measures	ESS, GPN + GWS
4	Employ network analysis techniques to produce network data-based infographics	GPN + GWS

Note: ESS: Essay; GPN: Group Presentation; GWS: Group Written Submission

This is what you will learn to do ...

Beyond R&D: Technological, Innovation and Entrepreneurship (TIE) funds to Chilean Universities during 2018

Overview

The problem

Universities play a key role in National Innovation Systems, not only in conducting research, but also in supporting industries' technical change (Nelson and Rosenberg, 1993).

Although there is vast literature regarding Chilean public programs supporting R&D within universities (Benavente et al., 2012; Boisier and Cevallos, 2019), **little attention has been paid to the role of universities as recipients of TIE funds from the Central Government**.

In this context, this work represents the first attempt to map the relation between the Chilean Central Government and universities in this field. We will try to answer how much, to whom, and from what institutions and programs these resources are allocated.

First findings

The Chilean Central Government's spending on Science, Technology and Innovation (STI) represented 1.43% of total spending for the year 2018, of which 0.12% corresponds to TIE programs transferred to universities (Figure 01), which is approximately £50,000,000.

Three main institutions build links with universities for these purposes: 8 programs from CORFO, the national development agency, which account for more than 70% of the funds; 13 regions through FIC-R (regional innovation funds, managed by the Ministry of Internal Affairs), and FIA (agricultural innovation).

The funds were directed to 39 universities and 6 spin-off university institutions. The distribution of funds among these institutions is: 40% to the top 5 universities; 13% to the rest of top 10 universities; 5% to university spin-offs; and the remaining to the rest of universities.

The data

Budget execution data come from the DIPRES website. STI data include 182 public programs from 14 different ministries.

CORFO data are based on the Transparency Law, specifically on the records of legal persons receiving public funds. FIC-R data are based on DIPRES budget execution data. FIA data were provided directly by the agency to the author.

The university rankings are based on QS World University Ranking for 2019.

The programs selected are designated as STI and TIE according to the methodology presented by DIPRES (2018).

Figure 01. Central Government spending in 2018

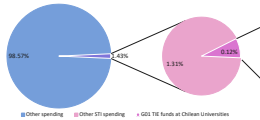


Figure 02. Proportion of funding for TIE programs allocated to Chilean universities during 2018, by program

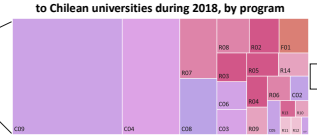
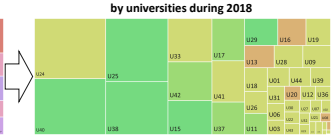
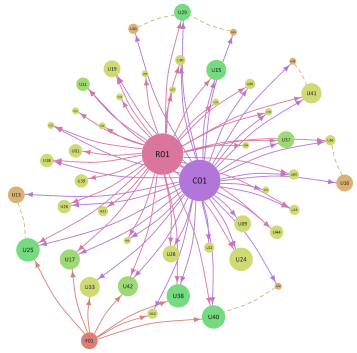


Figure 03. Proportion of public TIE resources received by universities during 2018



The relation between Central Government and universities on TIE programs

Figure 04. Transfer of funds from TIE programs to universities for 2018, by institution



Key features of the network

Every top 10 university within the network receives funds from at least CORFO and FIC-R (Figure 04). All university spin-offs in the network are related to their university hosts, which also receive funds from the same source, CORFO. These are the only closed triads in the network.

CORFO funds 29 universities and 6 spin-offs of them. This is executed through 8 different programs (which are managed by different departments within the institution), establishing 102 different connections (Figure 05).

The regional innovation fund, FIC-R finances 34 universities in 13 of the 15 regions of the country, through 75 different linkages (Figure 06).

Finally, FIA finances 7 different universities (Figure 04).

Box 01. Legends

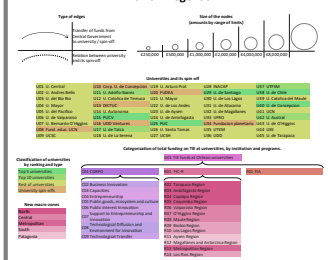


Figure 05. CORFO's TIE programs funds to universities in 2018, by region

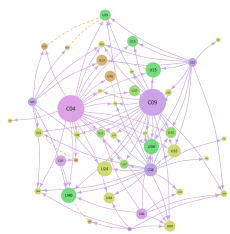
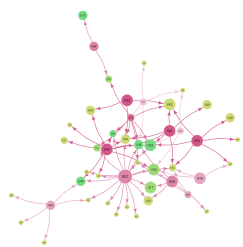


Figure 06. FIC-R funds to universities in 2018, by region



Box 02. Limitations and possible future research paths

- The information displayed did not consider the number of projects established between the program and the university nor more details about them. It could be relevant to address this due to the increasing demand for accountability for public programs (Vammalle and Ruiz, 2017) and the need for more coordination within the public STI system (DIPRES, 2018).

- Regional funds are more skewed than CORFO funds (figure 07 and 08). Future research could analyse the characteristics and nature of the former and, particularly, if at local-level universities there is competition for resources or if there is space for collaboration.

- The analysis presented is static and narrowed to 2018. Although budget spending tends to be "sticky" (Schick, 2009), this could be contrasted with a dynamic analysis.

- New legislation implies that regions will be merged into macro-zones (DIPRES, 2018). Figure 06 gives us clues to understand how the transition could be eased due to actors that already relate *de facto* with the macro-zones.

Figure 07. Lorenz curve for the distribution of CORFO and FIC-R resources on TIE programs to universities

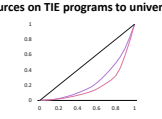
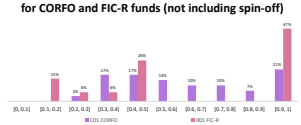


Figure 08. Frequency of universities' constraint level for CORFO and FIC-R funds (not including spin-off)



References

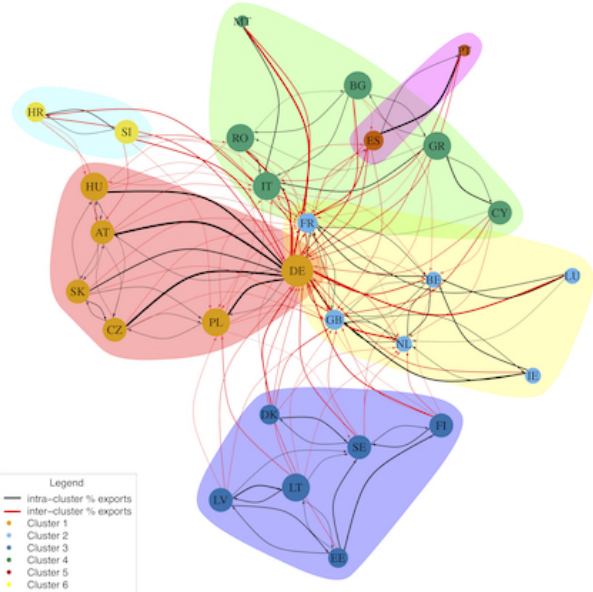
1. Benavente, J.M.; Crespi, G.; Figal, L. and Maffioli, A. (2012). The impact of national research funds: A regression discontinuity approach to the Chilean FONDECYT. *Research Policy*, 41, pp. 1461-1475.
2. Boisier, M.E. and Cevallos, R. (2019). Funding instruments to foster research in Chile: Recent history, current status and challenges. *Revista Medica Clinica Las Condes*, 30(1), pp. 19-28.
3. DIPRES (2018). Ciencia, Tecnología e Innovacion en Chile: un analisis presupuestario. *Serie de Estudios de las Finanzas Publicas*.
4. Nelson, R. and Rosenberg, N. (1993). Technical Innovation and National System. In: Nelson, R., ed. *National Innovation System: a comparative analysis*, 1st ed. New York: Oxford University Press, pp. 3-29.
5. Schick, A. (2009). Budgeting for fiscal space. *OECD Journal on Budgeting*. 2009/2, pp. 1-18.
6. Vammalle, C. and Ruiz, A.M. (2017). Budgeting in Chile. *OECD Journal on Budgeting*. 2016/3, pp. 9-70.

The Trade Between European Countries

Intra-EU Exports

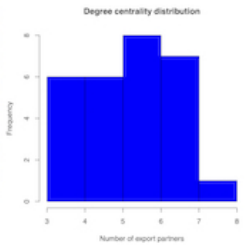
Intra-EU Imports

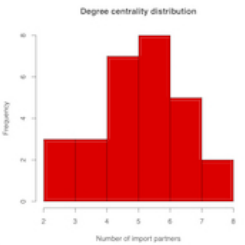
This poster depicts the trade of products between the 28 member states of the European Union. Although, each member state trades with all the other EU countries, the networks presented here only show up to a maximum of 75% of each country's intra-EU trade made in the year 2017 in terms of value (euros). This allows to observe in an instant each country's main European trade partners. For exports, the network is directed between the exporter and its partners. For imports, the network is directed between the partners and the importer. The edges are weighted to represent a percentage of the country's total intra-EU trade. Countries form clusters when their intra-trade is on average more significant than the trade made with the rest of the member states. The exports and imports networks' density, respectively 0.208 and 0.202, indicate that the large majority of the trade countries make only concerns a small number of all their partners.



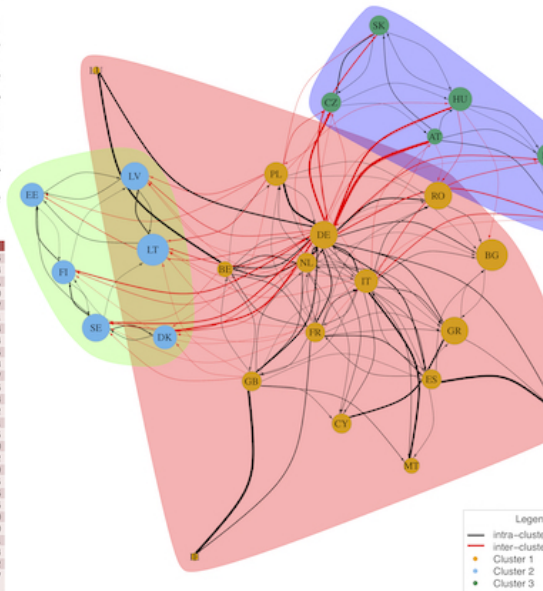
Exporter	Euros (millions)
Austria	105,814
Belgium	274,458
Bulgaria	17,483
Croatia	9,056
Cyprus	974
Czech Republic	133,412
Denmark	55,849
Estonia	9,189
Finland	35,550
France	278,256
Germany	749,450
Greece	15,483
Hungary	81,564
Ireland	61,418
Italy	248,531
Latvia	8,154
Lithuania	15,368
Luxembourg	11,663
Malta	1,113
Netherlands	432,251
Poland	162,789
Portugal	40,341
Romania	47,474
Slovakia	64,041
Slovenia	25,705
Spain	185,575
Sweden	79,672
United Kingdom	187,653

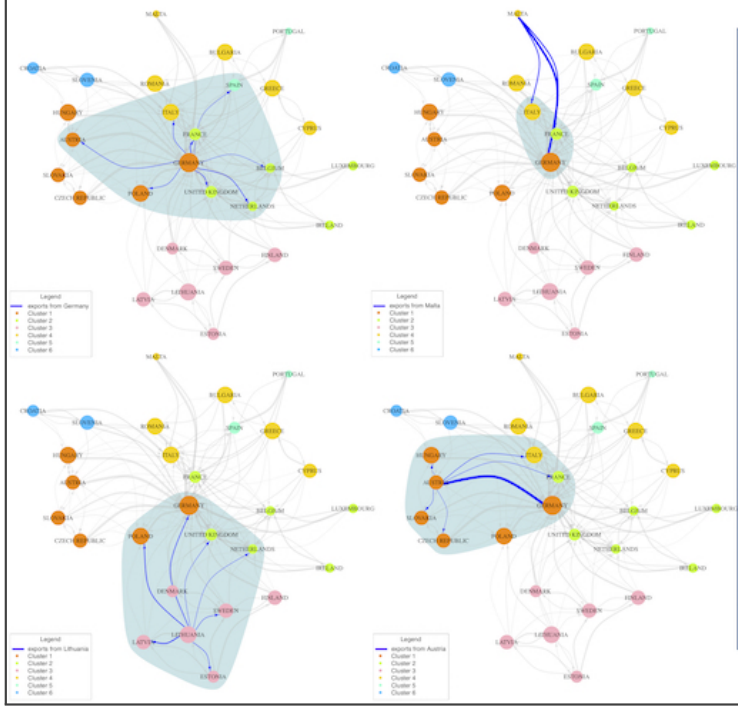
A country's degree centrality is shown by the size of its respective node. The smaller the node, the less partners the country has. Alternatively, the bigger the node, the more partners the country has. The degree centrality can affect a country's vulnerability within the network.





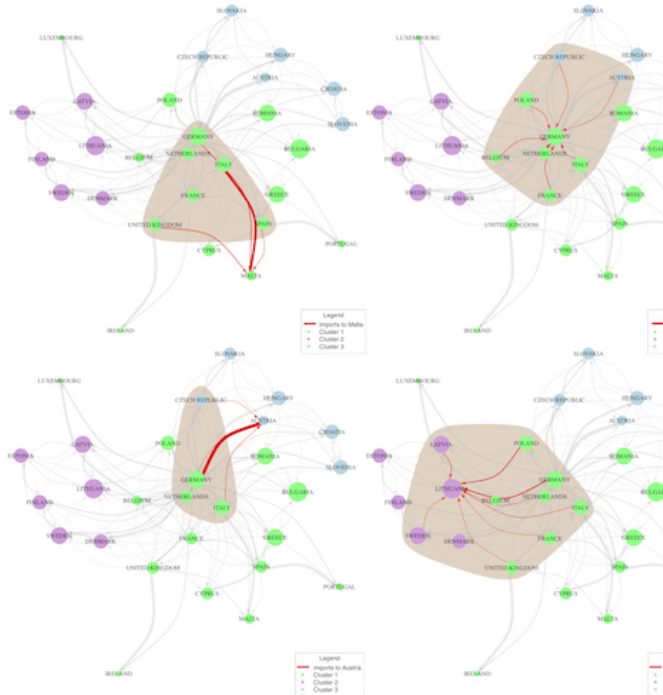
Importer	Euros (millions)
Austria	120,285
Belgium	231,544
Bulgaria	19,239,
Croatia	17,000
Cyprus	4,777
Czech Republic	110,341
Denmark	57,634
Estonia	11,934
Finland	44,515
France	385,563
Germany	682,237
Greece	26,146
Hungary	72,234
Ireland	50,312
Italy	240,601
Latvia	11,705
Lithuania	20,190
Luxembourg	16,582
Malta	3,199
Netherlands	235,045
Poland	145,366
Portugal	52,586
Romania	57,270
Slovakia	58,820
Slovenia	22,071
Spain	184,634
Sweden	96,752
United Kingdom	293,967





Four exporters (i.e. Germany, Malta, Lithuania and Austria) and their respective partners have been selected to allow a comparison across countries. The light blue cloud highlights the area of the network the country covers with its exports. This can be an additional indicator on how extensive a country's reach can be. It is also worth paying attention to which cluster each partner belongs to and its inter-cluster trade as this could provide a foundation for further research trying to analyse the interaction between each cluster. The width of a country's edges indicates the importance of each its partners in terms of value traded and consequently also provides information on how each country's exports are distributed.

The same four countries and their respective import partners have been chosen for further scrutiny. It is important to notice that the number of clusters has changed. The light red cloud highlights the area of the network the country covers with its imports. Accordingly, the same points of interests arise as in the exports section. Having the same countries as examples for both imports and exports graphs allows the reader to compare them and identify the differences. Such analysis can help understand how a country's partners change depending on the flow of trade or how it affects its trade in terms of value. Furthermore, the comparison of a country's position in the graph or in a cluster might also be of interest for further analysis.



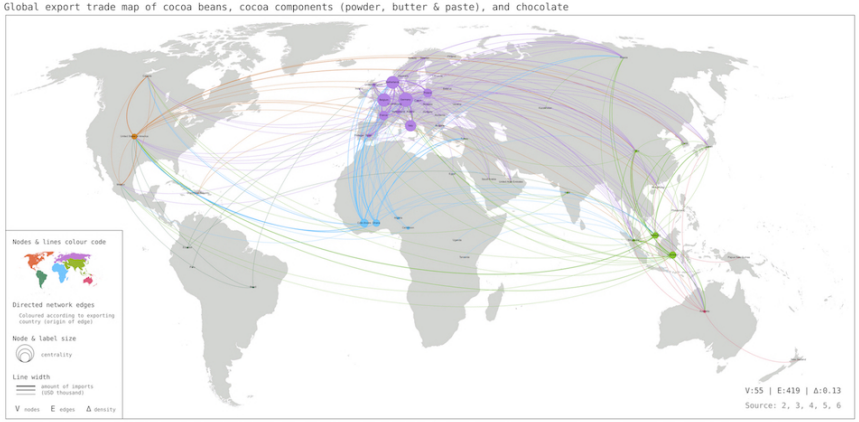
Poster presented for the module "Network Analysis and Infographics" at the University of Sussex, April 2018. Student n°178792

Source of data: European Commission, 2017. *Eurostat database*. [Online] Available at: http://ec.europa.eu/eurostat/en. [Data retrieved on April, 6th, 2018].

FROM BEANS TO CHOCOLATE

Following the trade of the treat we like the most

Global export trade map of cocoa beans, cocoa components (powder, butter & paste), and chocolate



Aim

To identify the countries involved in the exports of chocolate products, its components (cocoa butter, cocoa powder and cocoa paste), and cocoa beans to detect the key actors in each continent and to understand which countries are more central in the network.

Method

The main source used to collect the data was Trade Map, which uses the United Nations Comtrade database.

The criteria to select our information was the following:

Through FAO (Food and Agriculture Organization) we identified the tariff headings for cocoa beans, cocoa powder, cocoa butter, cocoa paste and chocolate[1]. Using these, we downloaded the total exports in USD thousand for each phase in 2016 from Trade Map[2,3,4,5,6].

We identified the countries that represented the 80% of the total exports in each phase and categorised them as top countries. Then we downloaded the databases of the countries that imported the 80% of the top countries exports' to build the set of ties.

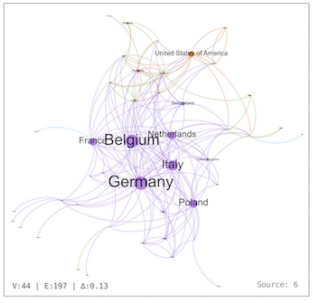
Tools

- R igraph package to create the networks, its attributes and measures.
- Gephi to improve the visualisation of the network through the layout algorithms ForceAtlas 2, Noverlap and Geo layout.

Cocoa beans network

Cocoa components network (powder, butter & paste)

Chocolate network



Findings & conclusions

The resulting networks are directed because exports go from one country to another. It is also a valued network because the relationships between countries are displayed in USD dollars.

For commodities value chains, such as cocoa, it is often the case that the trade of the commodity's derivatives is lower than the trade of the commodity itself. However, this network exhibits the opposite, which means that the chocolate market is larger than the cocoa beans'. Cocoa components have different industrial applications (e.g. cosmetics, health and other food products) in addition to the chocolate industry[7].

Overall, Europe has the most central countries in the network, which is related to the fact that this region consumes chocolate the most[7]. However, when looking at each phase, it is possible to conclude that:

- Cote d'Ivoire and Ghana are the most central in the cocoa beans network. This finding is consistent with the fact that these two countries produce over 60% of the cocoa beans in the world[7].
- The Netherlands is the most central country in the cocoa components network, followed by Germany. It seems like they are hubs for distribution in Europe. Also, Malaysia and Indonesia play similar roles for Asia. Cote d'Ivoire and Ghana have the highest degree centrality in the cocoa beans network, and they are also central in the components network. Therefore, we can conclude that these countries are adding value to the commodity they export.
- From the chocolate network, we can infer that Europe is the continent where chocolate is consumed the most. At this stage of the process the United States of America becomes more central for the exports of chocolate to Asia and the rest of North America.
- We expected the density measure for each network to increase while the process moved forward. However, as the number of nodes rises it is more difficult for all countries to create ties with every other country in the network. Nevertheless, our results are not consistent with this explanation either (see the density measure in each network Δ). This result could be analysed in future research in this field.

Sources

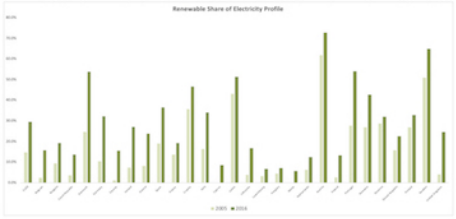
1. FAOSTAT *Definition and standards - Crops - Cocoa*. http://www.fao.org/fileadmin/templates/ess/documents/methodology/tcpi_definitions.htm#Cocoa. Accessed April 1, 2016.
2. Trade Map. *List of importers for 1801 cocoa beans in 2016*. www.trademap.org. Accessed April 4, 2016.
3. Trade Map. *List of importers for 1803 cocoa paste in 2016*. www.trademap.org. Accessed April 4, 2016.
4. Trade Map. *List of importers for 1804 cocoa butter in 2016*. www.trademap.org. Accessed April 4, 2016.
5. Trade Map. *List of importers for 1805 cocoa powder in 2016*. www.trademap.org. Accessed April 4, 2016.
6. Trade Map. *List of importers for 1806 chocolate in 2016*. www.trademap.org. Accessed April 4, 2016.
7. Atlas of economic complexity. *Who imported cocoa beans?* http://atlas.cid.harvard.edu/. Accessed April 15, 2016.

Dynamics of EU Renewable Electricity Profiles 2005 to 2016

Research Questions:

Based on the increasing share of renewable electricity across the European Union (EU), as seen in Renewable Share of Electricity Profile graph below, this project asks the following questions:

- To what extent have Member States of the EU developed their renewable electricity sectors in tandem with policy frameworks and outputs from the EU: Commission, Parliament and Council?
- To what extent are EU Member States converging or diverging in their total renewable electricity profile?
- To what extent are geographical and climate factors guiding specific technological uptake of renewable electricity production?
- How can renewable electricity patterns enable policy makers to understand drivers within EU electricity policy and how can new frameworks adapt to meet the 'green' aims of the EU and its member states?

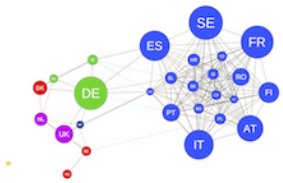


Data:

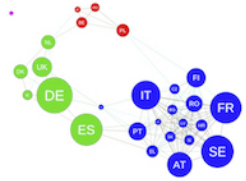
Data for the network visualization and complementary graphs presented was sourced from Eurostat **SHort Assessment of Renewable Energy Sources** (SHARES) 2016 Report. The objective of the SHARES tool is to facilitate calculation of the share of energy from renewable sources according to Directive 2009/28/EC. For this data series, hydro is normalised and excluding pumping, wind is normalised, solar includes solar photovoltaics and solar thermal generation, and all other renewables includes electricity generation from gaseous and liquid biofuels, renewable municipal waste, geothermal, and tidal, wave & ocean.

Data for the EU Renewable Electricity Policy Landscape below was sourced from IRENA and the EU's Renewable Energy Prospects for the EU 2018, Eurostat Energy Statistics, and Smart Cities Info-systems publications.

EU Renewable Electricity Profile Similarity 2005 - 2007



EU Renewable Electricity Profile Similarity 2008 - 2010

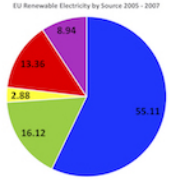


EU Renewable Electricity Profile Similarity 2011 - 2013

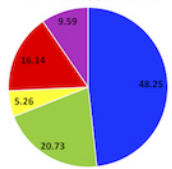
EU Renewable Electricity Profile Similarity 2014 - 2016

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

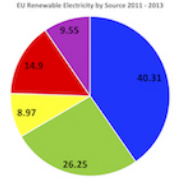
EU Renewable Electricity by Source 2005 - 2007



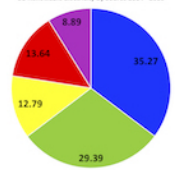
EU Renewable Electricity by Source 2008 - 2010

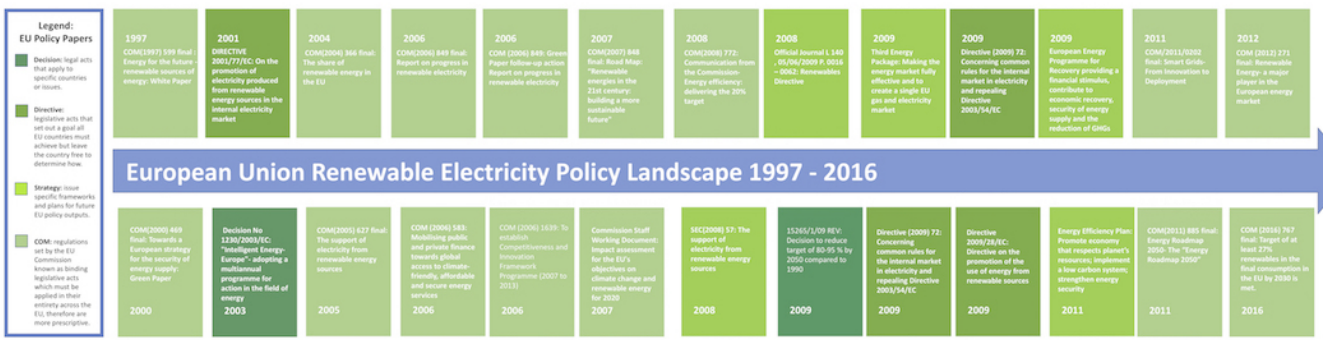


EU Renewable Electricity by Source 2011 - 2013



EU Renewable Electricity by Source 2014 - 2016





Findings and Further Research:

Over the eleven year period of this network analysis, there have been significant changes in cluster formation, strength of relationships between nodes, and predominance of renewable sources within electricity profiles. In terms of technology dominance (node colour), there was an overall shift towards wind, as seen in the case of the UK who was initially dominated by liquid biofuels and ocean based renewables. The most significant increases in renewable electricity output (node size) are seen in the cases of Germany and Italy with increases in wind and hydro power, respectively. In regard to strength of ties, there is a clear divergence of country profiles with increasing 'uniqueness' in electricity mix. Following the previous point, there are examples of clear shifts away from one cluster to another. For example, in 2005 – 2007 Poland was firmly linked within the hydro cluster then shifted to predominantly solid biofuels, and finally, in 2014 – 2016, due to significant growth in renewable electricity, became wind dominated. These findings suggest that each EU policy form has differing influence upon how policy is implemented by EU member states.

Further research could include investigating the level of investment by sector and technology across the EU and national level with particular reference to the European Investment Bank. In addition, understanding political and economic landscapes at the national level may help to explain divergences between national policies and the extent to which they relate directly or indirectly to EU policy outputs. Lastly, the absence of solar as a dominant renewable electricity source opens up a discussion regarding the extent to which geographical and climate factors effect technological adoption and diffusion.

'ZERO WASTE'

How is it used in publications?

1 Introduction

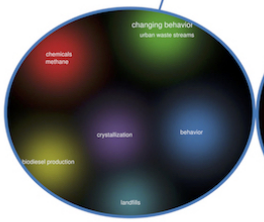
The term "zero waste" is colloquially used to pertain to the philosophy of retail sustainability (Flynn, 2018). This is also evident in Google engine searches where top results relate to *Zero Waste Shops*. This poster thus aim to see how the term "zero waste" is used in publications, how keywords from various research areas co-occur, and if the use of "zero waste" in publications agrees with the term's casual context.

Top 3 Google image search results for "zero waste" (accessed April 23, 2018)

2011 vs. 2017 Publications

Keywords from 2011 are characterized by closed networks, meaning they co-occur just within the same topic area, while most frequently used keywords from 2017 co-occur across different areas.

"Changing behavior" is the most prevalent co-occurring keyword in 2011, while it was "zero waste" and "waste management" in 2017.



Map 2. Keyword co-occurrence on documents published in 2011 with "zero waste" on title

Map 3. Keyword co-occurrence on documents published in 2017 with "zero waste" on title

2 Data Selection

- **Data Source:** Web of Science Core Collection
- **Data Collection:** Full-network method of documents search with "zero waste" OR "zero-waste" OR "zero wastes" OR "zero-wastes" in the title
- **Data Set:** 150 documents published from 1980 to present

Map 1. Keyword co-occurrence network of a total of 150 documents with "zero waste" on title (1980-present)

3 Bibliometric Analysis

KEYWORD CO-OCCURRENCE

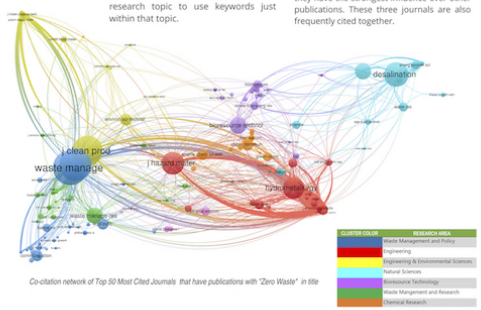
Total 150 Publications

- The clusters in Map 1 represent groups of publications within the same topic area. The nodes represent the keywords while the edges represent the documents.
- **"by-products"**, in its ego-network, acts as a liaison broker for three different clusters having keywords associated with *Biochemistry, Waste Management* , and *Chemical Engineering*, respectively (Gould and Fernandez, 1989).
- Remaining clusters are characterized by closed networks which signify the tendency of documents in a specific research topic to use keywords just within that topic.

CO-CITATION OF SOURCES

Top 50 Journals

- The top 50 most cited journals from the 150 publications were taken as a subset and analyzed using VOSviewer.
- This is to see which journals have the highest impact and which research area are the most active in publishing on "zero waste".
- Journal influence can be measured through Degree Centrality (CD) (Freeman, 1978). The higher the CD is, the more influential the journal is.
- ***The Waste Management, Resources, Conservation, and Recycling,*** and ***The Journal of Cleaner Productions*** are the journals with the highest CD, which means they have the strongest influence over other publications. These three journals are also frequently cited together.



Co-citation network of Top 50 Most Cited Journals that have publications with "Zero Waste" in title

4 Conclusion

- In publications, the term "zero waste" is used on a wide range of topics, and not only in reference to sustainability in retail.
- The term is most frequently used in publications on **Engineering** and **Environment**.
- Publications covering areas on *Waste Management, Policy, Engineering*, and *Environmental Sciences* are the most co-cited.

Sources:
Flynn, K. (2018). Is Zero Waste Attainable? <https://www.thegrunge.com/is-zero-waste-attainable-415948/>
Freeman, L. (1978). Centrality in social networks conceptual clarification. Social Networks, 1(3), 215-239.
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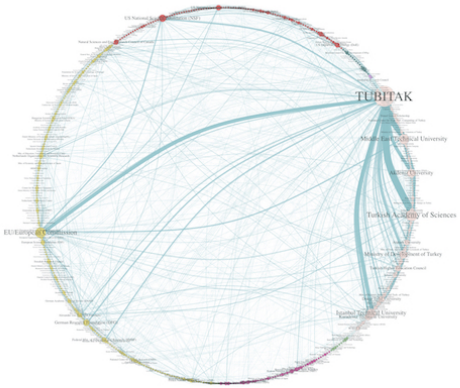
ZeroWaste. n.d. photograph. Accessed 23 Apr 2018. <https://openhausfurniture.org/2017/05/15/making-switch-zero-waste-lifestyle/

Co-Occurrence of R&D Funding in Turkey

Aim: To analyse the collaboration network of R&D funding institutions in Turkey & to explore differentiation among different funding institutions, universities and regions



Data:

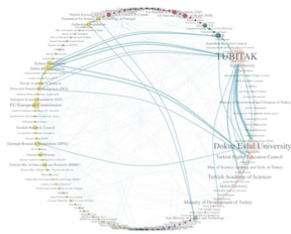
- Six universities are selected to represent the co-funding pattern in Turkey
- Most active universities in their regions in terms of international collaboration
- 4794 scientific publications are downloaded from Web of Science for the year 2013
- The acknowledgement part is analysed **one-by-one**
- 3828 different names converted into 778 unified funding institutions

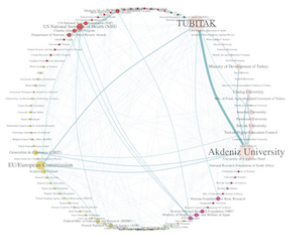
Overall Findings:

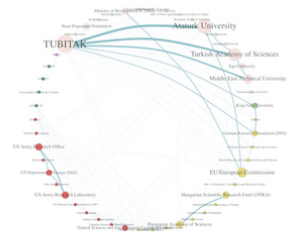
- 2109 publications out of 4794 (44%) take grant from at least one institution
- 980 publications (20%) have more than one funding institutions
- There are 474 different funding institutions in collaboration*
- 57% of funding comes from Turkish institutions
- 24% of funding comes from Europe whereas 11% and 5% are from North America and Asia, respectively
- Only 7.5% of funding institutions are industrial companies
- Only 2.5% of funding comes from industry
- The three most popular national R&D funding institutions are: TUBITAK (445), Turkish Academy of Sciences (118), Middle East Technical University (84)
- The three most popular international R&D funding institutions are: EU/European Commission (95), US National Science Foundation (NSF) (38), German Research Foundation (DFG) (27)

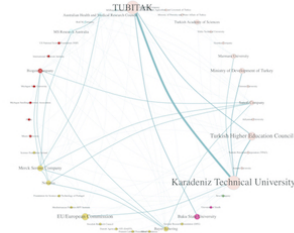
University-Specific Findings:

- Middle East Technical University (Top, Left)
  - n=154, density=0.0341
  - Most collaborative
  - International Orientation: Europe, North America and Asia
- Istanbul Technical University (Top, Right)
  - n=130, density=0.0343
  - International Orientation: Europe, North America and Asia
- Dokuz Eylul University (Middle, Left)
  - n=125, density=0.032
  - International Orientation: Mostly Europe, especially Spain (consistent with its geographical location)
- Akdeniz University (Middle, Right)
  - n=102, density=0.048
  - International Orientation: Europe, North America and Asia
- Ataturk University (Bottom, Left)
  - n=50, density=0.093
  - International Orientation: North America and Europe
  - No fund from Asia (inconsistent with its geographical location)
- Karadeniz Technical Univ. (Bottom, Right)
  - n=42, density=0.107
  - International Orientation: Europe and North America
  - Asian institutions are in top three (consistent with its geographical location)
  - A firm is in top three









Colour: Africa, Asia, Australia, Europe, Middle East, North America, South America, Turkey and Supranational

Notes:
* Funding institutions within CERN related publications are excluded
** Node size is proportional to the number of funded publications
*** Line thickness is proportional to the number of co-occurrence funding

959N1: NETWORK ANALYSIS AND INFOGRAPHICS

Group Project: Tracing Connections Between Research Funding and Policy Impact

UNIVERSITY OF SUSSEX

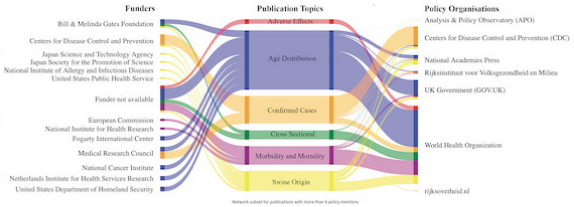
1. HOW TO MEASURE POLICY IMPACT OF RESEARCH FUNDING?

Measuring and understanding the impact of research funding on policy is becoming increasingly important in the context of academic evaluation systems based on societal demands (Ciarli & Rafols, 2019) . With the increasing availability of information on both funding and policy mentions of scientific publications, it becomes possible to analyse these links in more detail (Konkiel, 2016). We use data from Dimensions and Altmetric to create tripartite networks connecting research funders, publication topics and reports by policy organisations. To test our approach, we have selected three examples related to recent viral outbreaks: H1N1, Ebola and Covid-19. Publication topics in these examples were generated by applying LDA topic modelling on publication abstracts and subsequently using a naive topic labelling algorithm to assign topics to publications based on the highest probability.

Dimensions

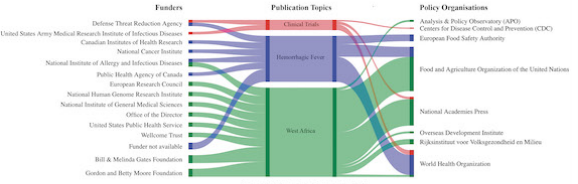
Altmetric

2. H1N1 (SWINE FLU)



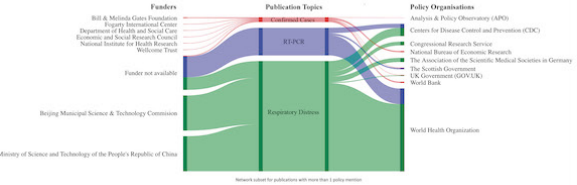
- Initial data were obtained from Scopus (TITLE-ABS-KEY ("H1N1" OR "swine flu" OR "A/California/7/2009") and PUBYEAR AFT 2009). There were 24,664 publications overall and 19,625 publications with abstracts, which were used for topic modelling. Out of these 19,625 only 744 publications were mentioned in policy reports 2,781 times, according to Altmetric.
- Topics were generated using LDA modelling (k = 20).
- The tripartite network on the left shows all available connections between funders, publication topics and policy organisations.
- The Sankey diagram above shows only data for publications with a minimum of 6 policy mentions (highly influential publications). The width of the vertical bars on the diagram represents the number of policy mentions.
- The Hive plot on the right shows all 24,664 publications from Scopus.

3. EBOLA VIRUS



- Initial data were obtained from Scopus (TITLE-ABS-KEY ("Ebola*" OR "EBOV") AND PUBYEAR AFT 2009). There were 10,994 publications overall and 7,706 publications with abstracts, which were used for topic modelling. Out of these 7,706 only 377 publications were mentioned in policy reports 918 times, according to Altmetric.
- Topics were generated using LDA modelling (k = 15).
- The tripartite network on the left shows all available connections between funders, publication topics and policy organisations.
- The Sankey diagram above shows only data for publications with a minimum of 6 policy mentions (highly influential publications). The width of the vertical bars on the diagram represents the number of policy mentions.
- The Hive plot on the right uses all 10,994 publications from Scopus.

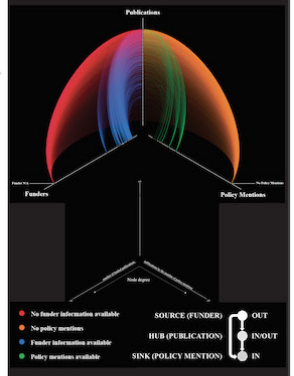
4. COVID-19

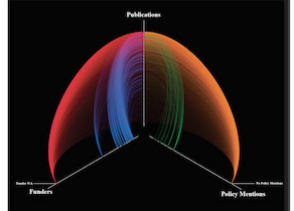


- Initial data were obtained from Scopus (TITLE-ABS-KEY("2019-nCoV" OR "COVID-19" OR "SARS-CoV-2" OR "HCoV-2019" OR "hcov" OR "NCOVID-19" OR "severe acute respiratory syndrome coronavirus 2" OR "severe acute respiratory syndrome corona virus 2" OR (("coronavirus" OR "corona virus") AND (Wuhan OR China OR novel)) AND PUBYEAR is 2020). There were 2,300 publications overall and 999 publications with abstracts, which were used for topic modelling. Out of these 999 only 53 publications were mentioned in policy reports 136 times, according to Altmetric.
- Topics were generated using LDA modelling (k = 10).
- The tripartite network on the left shows all available connections between funders, publication topics and policy organisations.
- The Sankey diagram above shows data for publications with at least 1 policy mention. The width of the vertical bars on the diagram represents the number of policy mentions.
- The Hive plot on the right uses all 999 publications from Scopus.

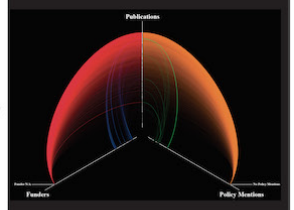
HOW MANY PUBLICATIONS MAKE IT TO POLICY REPORTS?

To visualise the proportion of publications that end up being mentioned in policy reports, we use the so-called hive plots developed by Martin Krzywinski et al. (2012). As opposed to conventional network visualisation, these plots make it possible to assign nodes to axes based on their properties. The most natural way of mapping nodes to axes for tripartite networks is based on the source-hub-sink classification. Here funders (source) are located on the left axis, publications (hub) in the middle and policy mentions (sink) on the right. The position of nodes on funder and policy axes is based on node degree. The higher the degree, the further the nodes are located from the centre of the plot.





The hive plots show how few publications eventually become cited in policy literature. They also illustrate the proportion of publications that have no available funding information. This highlights the limitations of analysing links between funding and policy mentions due to the relative inavailability of data.



The number of Covid-19 publications with policy attention is significantly lower than in other two examples, since this is an emerging research topic. However, this amount of policy mentions, in fact, seems to be quite significant for such a short period of time.

Hive plots were created using R and Jitlive.

References:

1) Martin Krzywinski, Inanc Birol, Steven JM Jones, Marco A Marra, Hive plots--rational approach to visualizing networks, Briefings in Bioinformatics, Volume 13, Issue 5, September 2012, Pages 627–644, https://doi.org/10.1093/bib/bbr069

2) Ciarli, T., & Rafols, I. (2019). The relation between research priorities and societal demands: The case of rice. Research Policy, 48(4), 949–967. https://doi.org/10.1016/j.respol.2018.10.027

3) Konkiel, S (2016). Altmetrics: diversifying the understanding of influential scholarship. Palgrave Commun 2, 16057. https://doi.org/10.1057/palcomms.2016.57

Ebola Virus Research: Mapping the Funding Landscape in Response to the 2014-6 West Africa Outbreak

West Africa's Funding Landscape and the Ebola Pandemic

Sub-Saharan Africa has notoriously weak health systems and is recorded to have double the disease burden per population than that of higher-income countries[1]. Under-investment in neglected tropical diseases by the pharmaceutical industry due to low commercial incentive further exacerbates the lack of adequate clinical research. State budgets in sub-Saharan Africa have begun to rise following the Abuja declaration, urging African governments to allocate 15% of their annual budget in improving the health sector[2]. However, this modest investment doesn't prepare a country for the social and economic disaster of a pandemic. In this setting, international grants can provide adequate funding for researching the treatment of the disease, and in a timely manner.

In response to the 2014-2015 Ebola Virus outbreak of over 28,000 cases and 11,000 deaths in West Africa[3], we show that funding for research into EVD by international organisations increased dramatically (Figure 3, Table 1). Our objective is to analyse trends in research grant allocation in response to the virus outbreak, focusing on the 4 largest international funders[1].

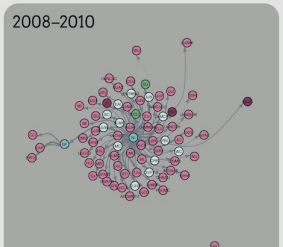


Figure 1: Merged Funding Networks from 2008-2010 . The NIH Awards the Majority of Grants.

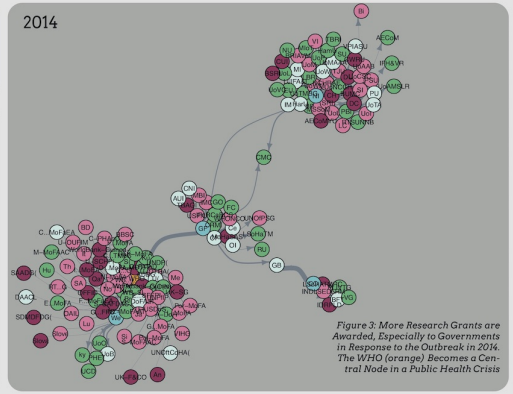


Figure 3: More Research Grants are Awarded, Especially to Governments in Response to the Outbreak in 2014. The WHO (orange) Becomes a Central Node in a Public Health Crisis

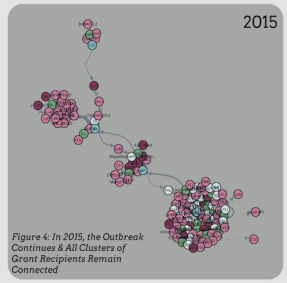


Figure 4: In 2015, the Outbreak Continues & All Clusters of Grant Recipients Remain Connected

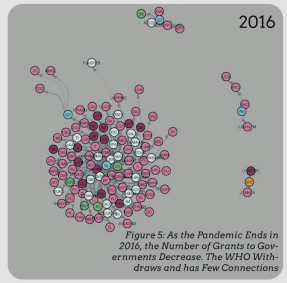


Figure 5: As the Pandemic Ends in 2016, the Number of Grants to Governments Decrease. The WHO Withdraws and has Few Connections

The Networks

Figures 1 and 2 show the funding landscape prior to the outbreak, with research into Ebola completed at a relatively low intensity. The majority of research in this period is funded by the NIH in the United States, with contributions from the Gates Foundation and the Wellcome Trust. The majority of recipients are universities and firms in the US and Europe (See: Geonetworks).

However, in response to the outbreak in 2014/5 (Graph 1), the 2014 network depicts the increase in research grants awarded. The number of institutions awarded grants tripled compared to 2008, from 52 to 158 (Table 1). Interestingly, in this timeframe, there was a relative increase in funding to firms (+13%), organisations (+8.5%), and governments (+3.5%) and a relative decrease in funding to universities (-22.9%). The locus of the majority of all grants over time remains in the global North (90.83%), but funding into West Africa directly is a distinct characteristic of the responsive funding regime (See: Geonetworks).

After the pandemic ended in 2016, the World Health Organisation (WHO) withdrew from the main component of the network to a small clique (Figure 5). 2017's funding regime still shows heightened funding, but a similar structure to before the outbreak. Then in 2018, the WHO returns to interact with the largest component in response to another resurgence of the virus in the DRC.

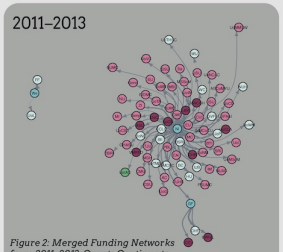
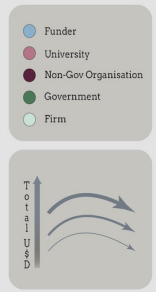


Figure 2: Merged Funding Networks from 2011–2013. Grants Continue to be Primarily Awarded to Universities and Firms



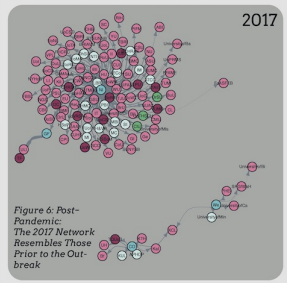


Figure 6: Post-Pandemic: The 2017 Network Resembles Those Prior to the Outbreak

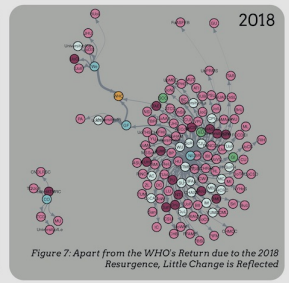
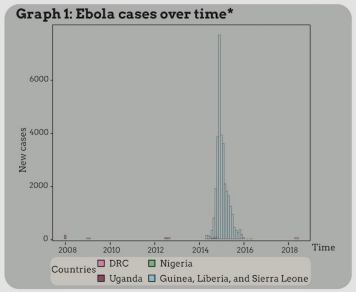


Figure 7: Apart from the WHO's Return due to the 2018 Resurgence, Little Change is Reflected

Graph 1: Ebola cases over time*

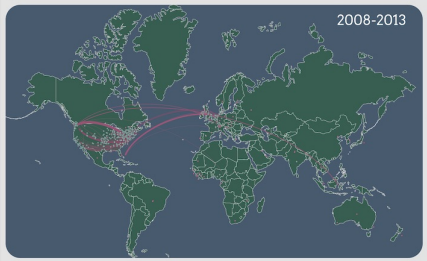


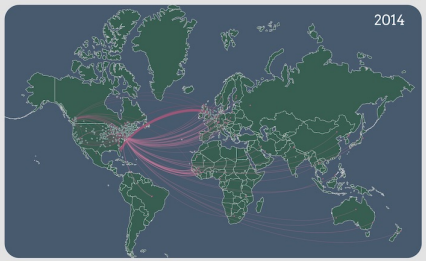
Our data

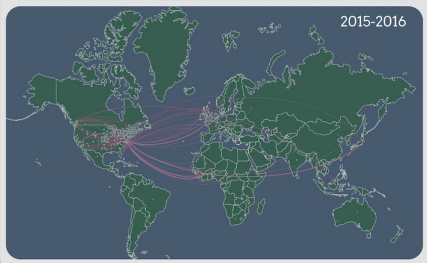
Our donors for this analysis consist of two public institutions: The National Institute of Health (NIH) and The European Union (CORDIS), and of two philanthropic funders: The Gates Foundation (GF) and the Wellcome Trust (We). The WHO receives its funding from these organisations and then distributes it to other projects.

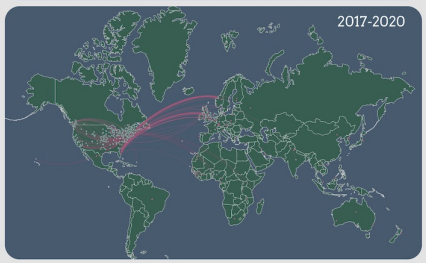
Our network data was collected from each institution's online websites or repositories for funding data. Research grants with the phrase 'ebola' in the title or description were collected over the 10 year period of 2008-2018.

Geonetworks of Ebola funding









Graph 2: Key Organisations' degree over time

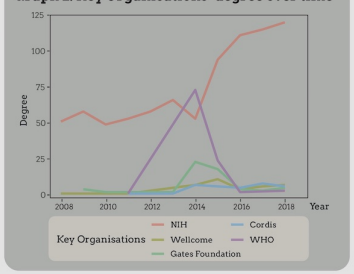


Table 1: Descriptive Analysis

Years	Edges	Nodes	Components	Diameters	Cliques
2008	52	54	2	6.196	52
2009	62	64	2	7.104	62
2010	50	51	1	7.269	50
2011	56	59	4	9.826	55
2012	60	62	3	8.152	59
2013	68	70	3	6.273	67
2014	158	156	1	18.857	154
2015	148	145	1	15.938	142
2016	124	127	4	13.198	123
2017	130	131	2	11.650	129
2018	136	136	2	14.662	133
ER50	50	50	8	9.000	56
ER150	150	150	25	18.000	167

Table 2: Node-level Measures

Year	Name	Degrees	Betweenness
2008	NI	51	2550
2008	We	1	0
2009	GF	4	354
2009	NI	58	3648
2009	We	1	0
2010	GF	2	98
2010	NI	49	2448
2011	WHO	1	0
2011	NI	53	2550
2011	GF	2	2
2011	CO	1	0
2011	We	1	0
2012	NI	58	3080
2012	CO	1	0
2012	GF	2	2
2013	NI	66	4032
2013	CO	1	0
2013	GF	2	2
2014	WHO	73	17520
2014	GF	23	15358
2014	CO	7	1818
2014	NI	53	13158
2014	We	7	1520
2015	WHO	24	5830
2015	GF	18	10814
2015	NI	94	17730
2015	We	11	8488
2015	CO	6	1410
2016	WHO	2	2
2016	NI	111	12420
2016	GF	4	660
2016	CO	5	20
2016	We	4	12
2017	NI	115	13104
2017	GF	3	454
2017	CO	8	140
2017	We	6	110
2018	WHO	3	1694
2018	GF	5	756
2018	NI	120	16124
2018	CO	6	30
2018	We	7	1494

Our findings

Network measures

The diameter in 2008-2013 remains similar, showing little co-funding by different organisations. Then the increase in diameter following the outbreak reflects the network becoming one giant component as clusters of funders join by co-funding certain institutions.

In 2014, the firm GlaxoSmithKline Biologicals (GB) joined CORDIS funding to the Gates Foundation. GB is, therefore, a bridge with the brokerage role of a 'liaison' joining two otherwise unconnected groups.

Once the outbreak has ended in 2016, the WHO, Cordis and Wellcome trust no longer co-fund with any other institutions. Whereas the NIH continues to fund the GF which in turn funds 3 American universities (Figure 5).

The most recent resurgence in 2018 shows the WHO returning, receiving funding from the NIH, Gates Foundation, and Wellcome Trust to bridge the giant component to this clique.

Graphs

The top bar graph shows new Ebola cases spiking in 2014-5[1]. The line graph below shows the node-level measure of degree for each funder, representing the number of grants they award per year. Of note is the large increase in funding received by the WHO in 2014, and the NIH frequently funding most Ebola research.

Further Research & Limitations:

From our study, we can not say to what extent Ebola research was neglected nor how much Ebola represents in the global aids flows. However, even with the increase in funding during the outbreak, the outcome has not avoided the second outbreak, which started in 2018 and still continues today.

It would also be beneficial to extend our study to measure the funding output, as the monetary inputs do not necessarily reflect the outcomes of tackling the disease.

An additional level of analysis would be to group projects by type, to see which research areas are prioritised and geographically distributed. However, this can be partially inferred from the institution type receiving the funding.

Bibliography

1) Confraria, H., & Wang, L. (2020). Medical research versus disease burden in Africa. Research Policy, 49(3), 103916. https://doi.org/10.1016/j.respol.2019.103916

2) Who.int. (2020). Ebola Virus Disease. [online] Available at: -https://www.who.int/en/news-room/fact-sheets/detail/ebola-virus-disease- [Accessed 24 April 2020].

3) Who.int. (2020). [online] Available at: -https://www.who.int/healthsystems/publications/abuja_report_aug_2011.pdf- [Accessed 24 April 2020].

** Data for Graph 1:*
https://doi.org/10.1371/journal.pntd.0007512
https://www.cdc.gov/vhf/ebola/history/2014-2016-outbreak/cumulative-cases-graphs.html

Week	Topic
1	Introduction
2	Network definition
3	Network data collection
4	Descriptive network analysis A
5	Descriptive network analysis B
6	Descriptive network analysis C
7	Principles of infographics
8	Network models
9	Innovation networks
10	Social network theories
11	Revisions

Essay (ESS) [50% weighting]

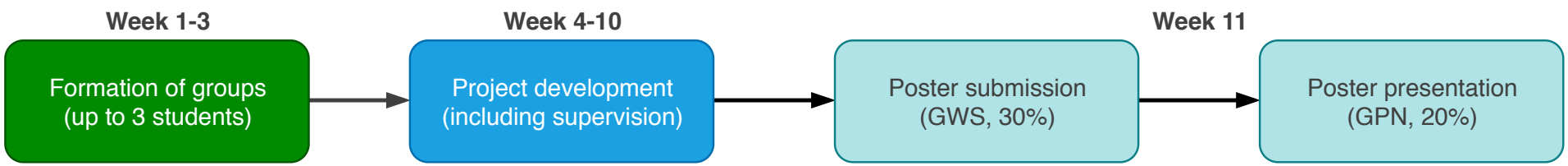
- 2,500-words essay to present a coherent analysis of the inter-organisational networks
- Data will be provided in Week 5
- See Canvas website for more details

Overview of the module

Assessment modes

Coursework

- Groups up to 3 students
- Report your group by Week 3:
  https://docs.google.com/spreadsheets/d/1p49sUUrOLK9y12-cSrxGEiHAP0BukdwDDGJSNuM
- Small-scale network analysis project using novel or existing network data
- Any topic!
- Assessment modes:
  - **Group Written Submission (GWS)** [30% weighting]
    Infographic poster (A1-size, PDF)
  - **Group Presentation (GPN)** [20% weighting]
    10-minute video recording presenting the infographic poster (GWS)
- Submission in Week 11 (see Canvas)
- Marking criteria (see Canvas)



Overview of the module

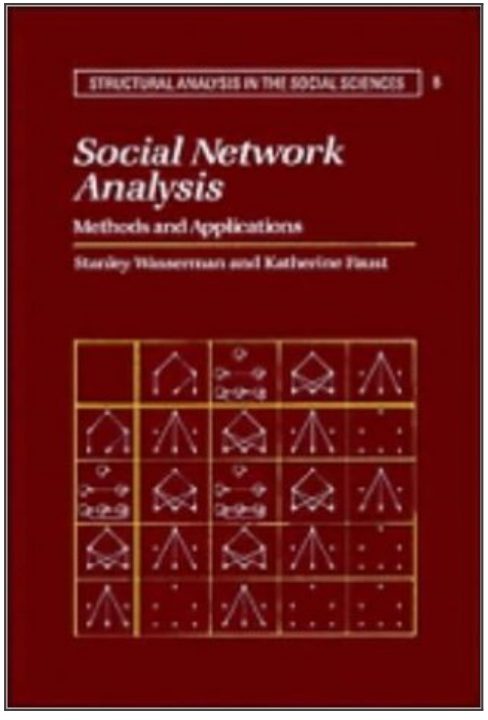
Assessment modes (RESIT)

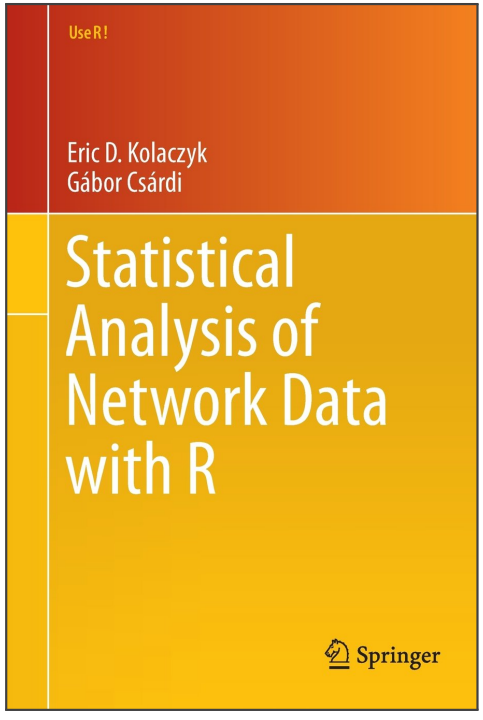
Exam	Resit	Weight
Essay (ESS, 2,500 words)	Essay (ESS, 2,500 words)	50%
Group Written Submission (GWS)	Report (REP, 1,500 words project summary)*	30%
Group Presentation (GPN)	Project (PRJ, A1-size poster)*	20%

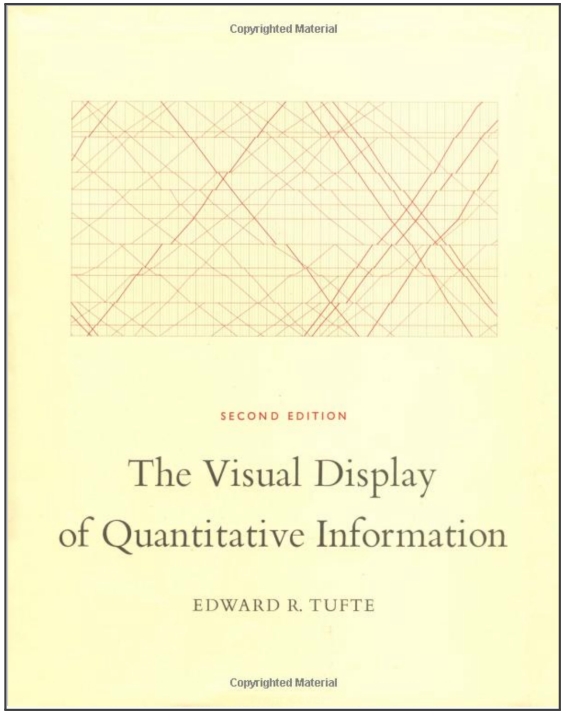
*Individual work

Overview of the module
Readings

- Essential and recommended readings as listed Canvas
- Selected chapters from the below books



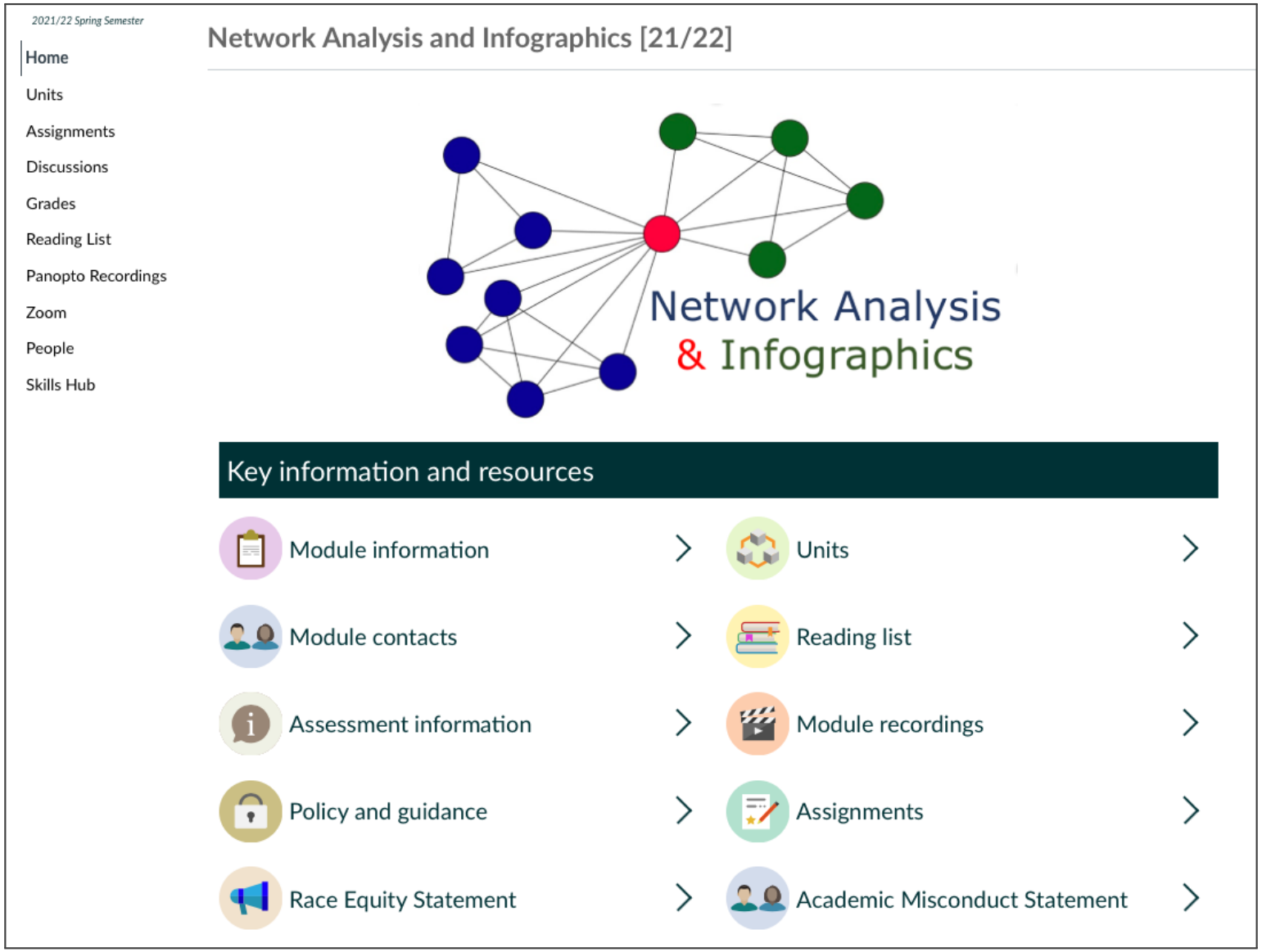




- R (`www.r-project.org`) and R-Studio (`www.rstudio.com`)
- igraph package for R (`http://igraph.org/r/`)
- Gephi (`https://gephi.org/`)
- VOSviewer (`www.vosviewer.com`)

Overview of the module

Canvas website



Next time ...

- **Seminar: Introduction**
  - Network visualisation exercise
  - Familiarising with the concept of network

- **Lecture: Network definition**
  - Definition of network and different types of networks
  - Overview of the historical and disciplinary origins of (social) network analysis
  - Network visualisation standards
  - Overview of R and the igraph package

Questions

References I