

Network science meets Digital humanities: MANY challenges and ONE success story

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UNIVERSITAT DE
BARCELONA



Acknowledgments

Javier
Borge Holthoefer



Diana
Roig Sanz



Albert
Solé Ribalta



Elisabet
Carbó Catalan



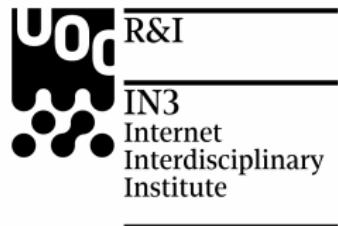
Ainamar
Clariana Rodagut



Rubén
Rodríguez Casañ



Ventsislav
Ikoff







I
to be best in
point of view.

Translation

another language;
language foreign to
written communica
ight

What are Digital Humanities?

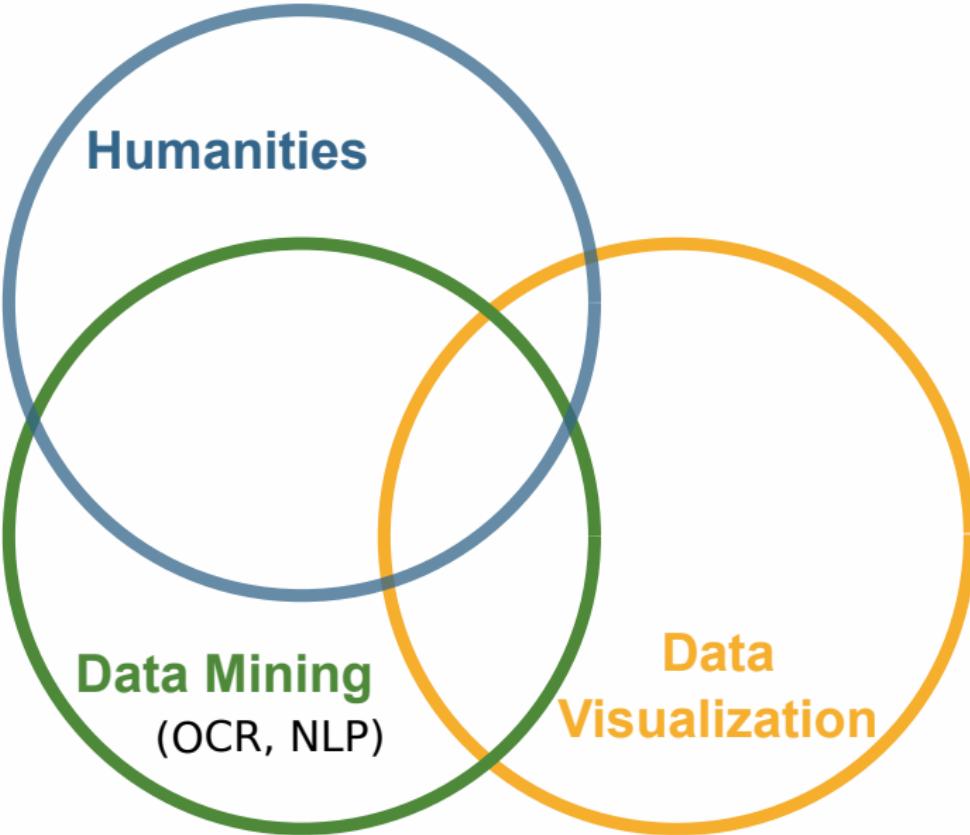


Humanities

A Venn diagram consisting of two overlapping circles. The left circle is blue and labeled "Humanities". The right circle is green and labeled "Data Mining (OCR, NLP)". The two circles overlap in the center.

Humanities

Data Mining
(OCR, NLP)

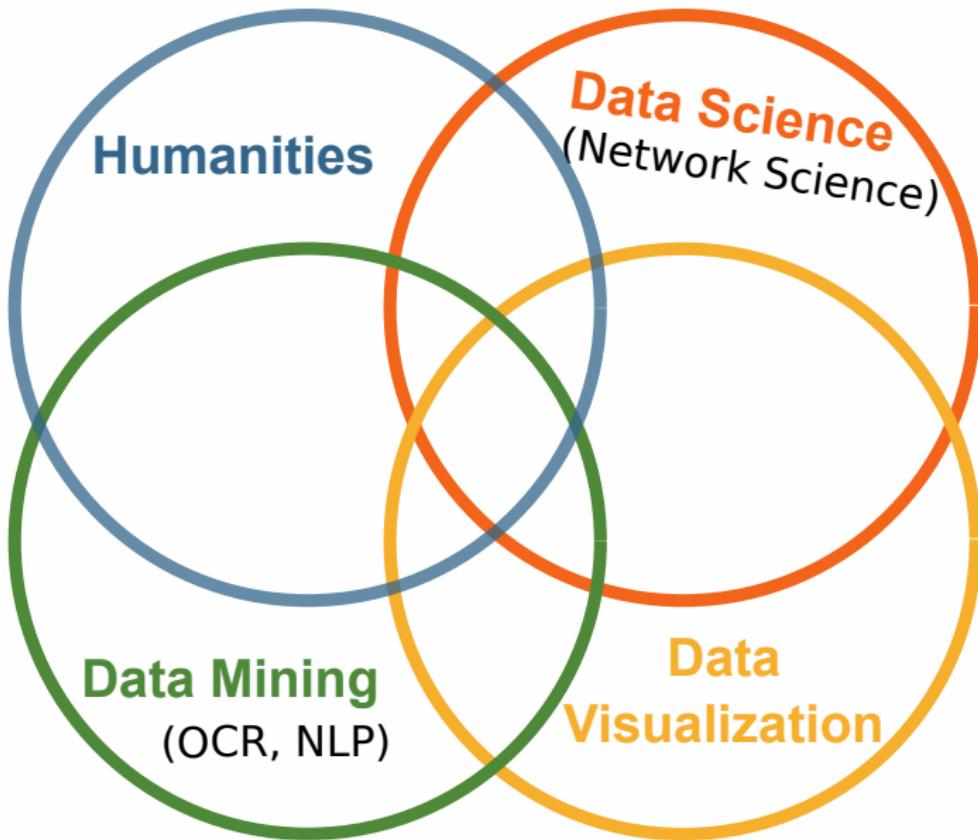


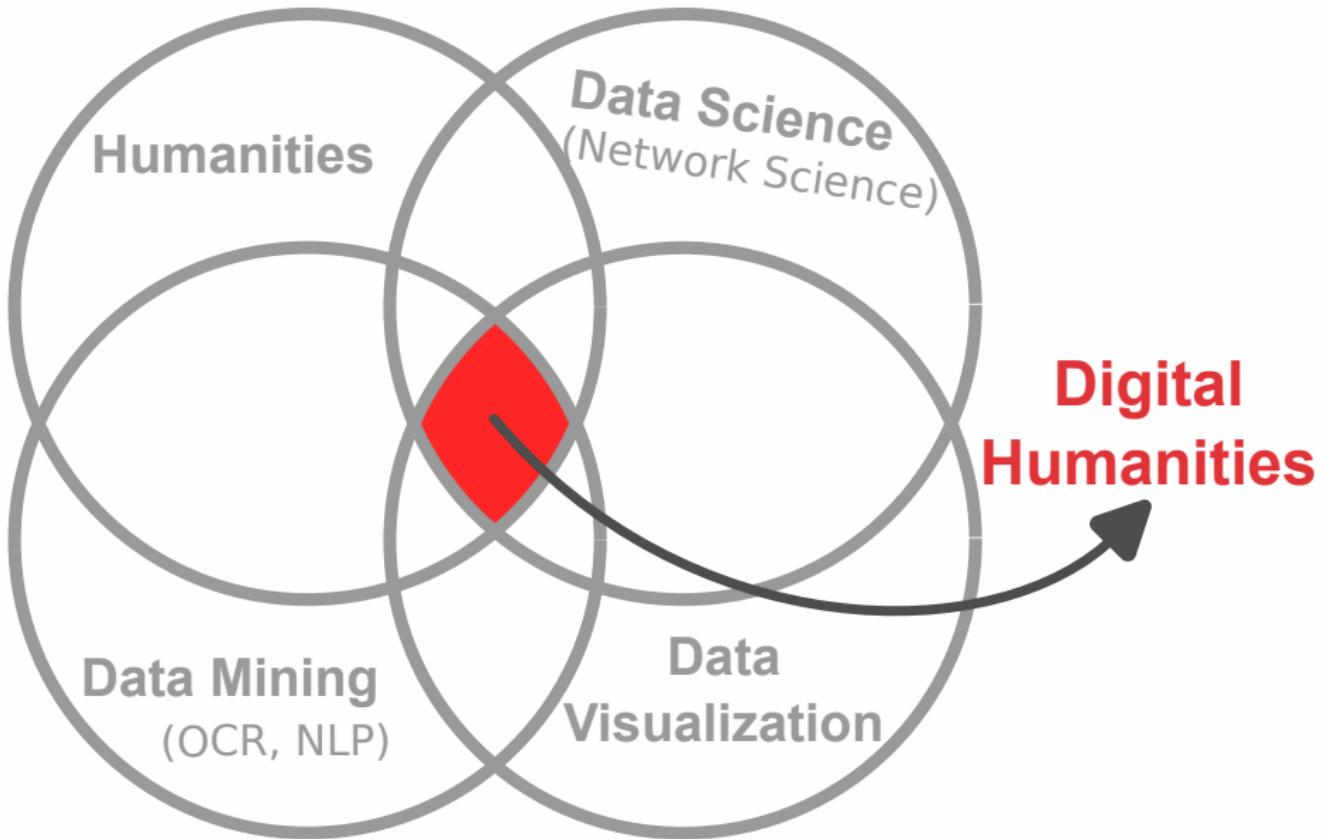
A Venn diagram consisting of three overlapping circles. The top circle is blue and labeled "Humanities". The bottom-left circle is green and labeled "Data Mining (OCR, NLP)". The bottom-right circle is orange and labeled "Data Visualization". All three circles overlap.

Humanities

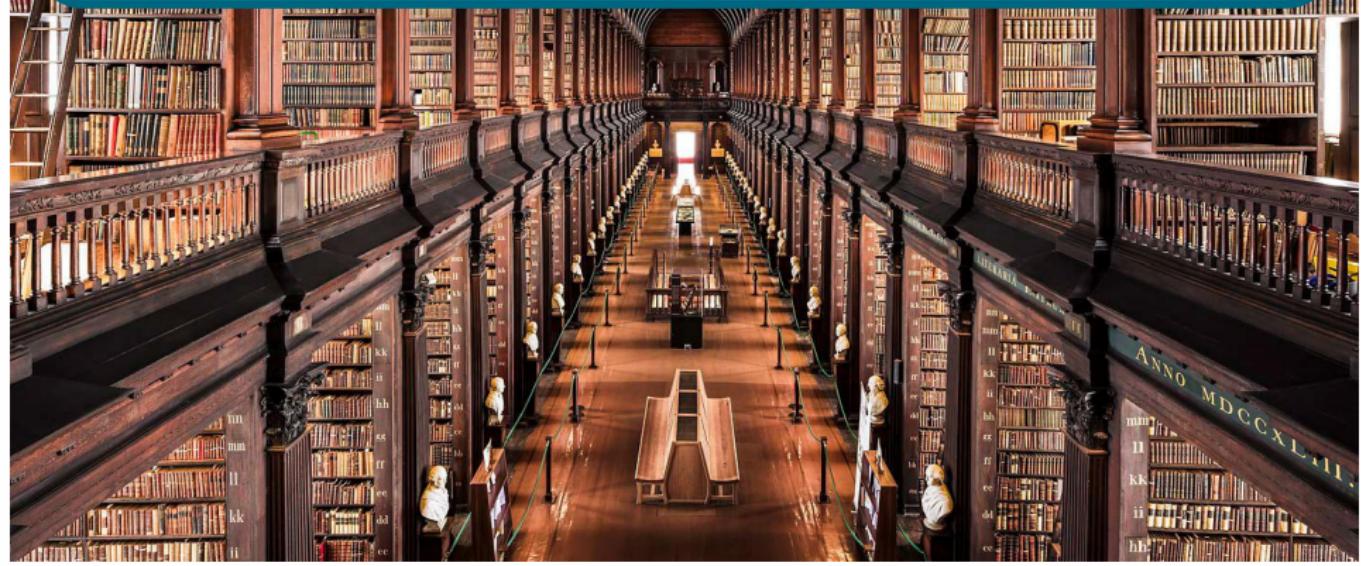
Data Mining
(OCR, NLP)

**Data
Visualization**

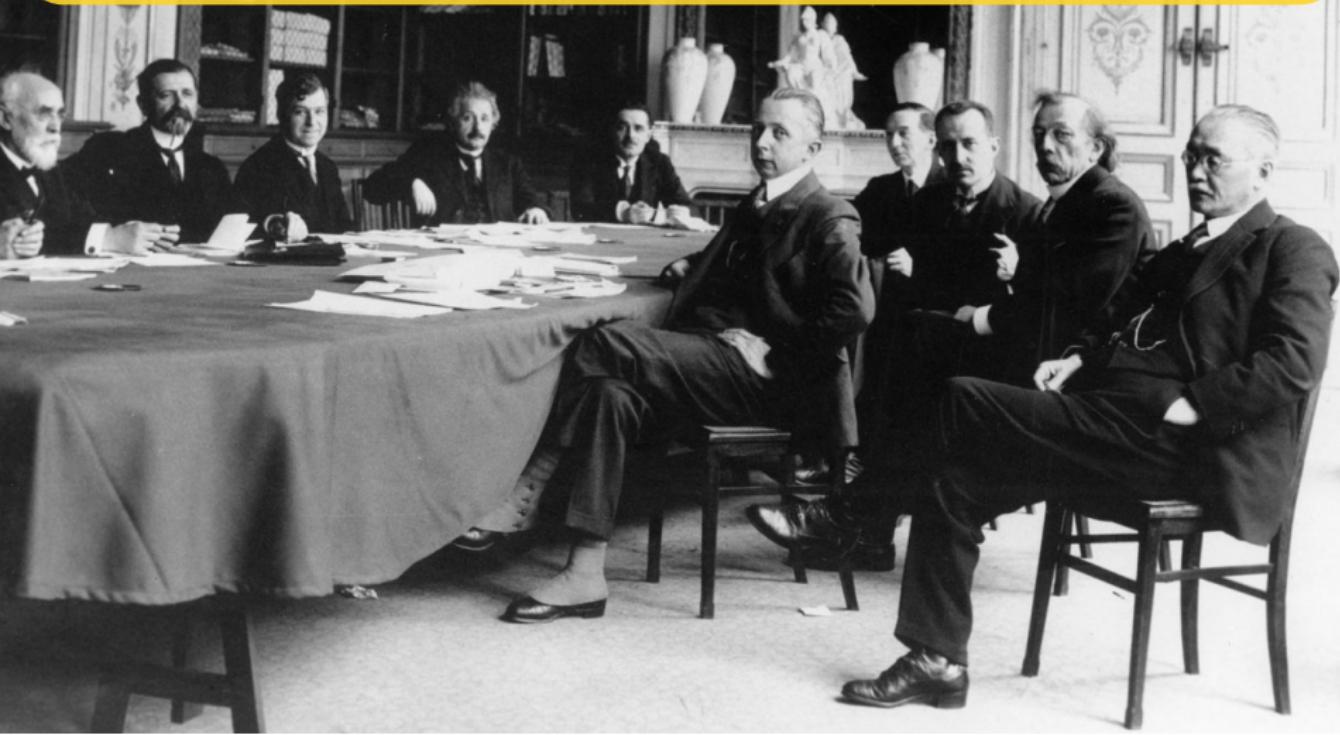




How complexity science can help us in addressing research questions *relevant for scholars working in art and humanities?*



Geopolitics of intellectual cooperation during the interwar period







*Directed by LEWIS MILESTONE • a CARL LAEMMLE Jr. Production • Story
Adaptation and Dialogue by MAXWELL ANDERSON and GE*

A UNIVERSAL PICTURE

THE NEW YORK TIMES, WEDNESDAY, DECEMBER 25, 1918.



Victory Democracy Peace

Make them secure by a

LEAGUE OF NATIONS

PEACE this year dawned on a world groping from war toward peace. The world hopes and prays that peace may be established on justice and safeguarded against future wars. ¶ The army of occupation that sleeps till the judgement Day in the hearts of men will have fought and died in vain unless such a PEACE is framed. ¶ Our Soldiers and Sailors, returning from VICTORY, will have fought and suffered in vain if that VICTORY is not made secure. ¶ All the peoples of the free nations will have given in vain billions of their wealth and millions of their own flesh and blood if DEMOCRACY is not established forever.

These things which the whole world loves for can be mixed with the greater, states in the

These things which the world would have had to pass by the creation, right at the Peace Table, of a LEAGUE OF NATIONS. President Wilson has declared for such a League and is in France for the express purpose of guiding its formation. Ex-President Taft believes in it, heart and soul, and is making his recommendations thereto.

is a dead letter. Yet the leaders of the world Peace treaty at Paris face difficulties a hundredfold greater than those which confronted the fathers of our Republic. It will be impossible to apply the provisions of the Peace treaty without an international court to interpret them. How shall this court be appointed? How shall its decision be enforced? There is but one answer—**By a LEAGUE OF NATIONS.**

This is a movement in which every man and woman in the United States can share. You believe in the principles; here are tools. You want to make the world safe against the menace of future wars. You think that the progress of Civilization depends upon world cooperation. All these factors will help you to win the War. You will be contributing to the victory of the Allies.

The League to Enforce Peace offers you an opportunity to DO SOMETHING ABOUT IT.

League to Enforce Peace

Fifth Floor, 265 Madison Avenue, New York
TELEGRAMS: PEACEFIVE

Chairman of the Ad Hoc Committee to Study the Future of the Library
W. E. BROWN, Secretary **HAROLD E. HODGSON, President**

The term *anti-monopoly* was first coined by John Gutfreund, chairman of Salomon Brothers Inc., in 1986.

The photographs attempt to reflect the variety of people who have come from West Africa and made a new life in a land where such people have traditionally been few.

This advertising campaign will be coordinated and presented to the public by the local news media. With more than 100 local stations and publications

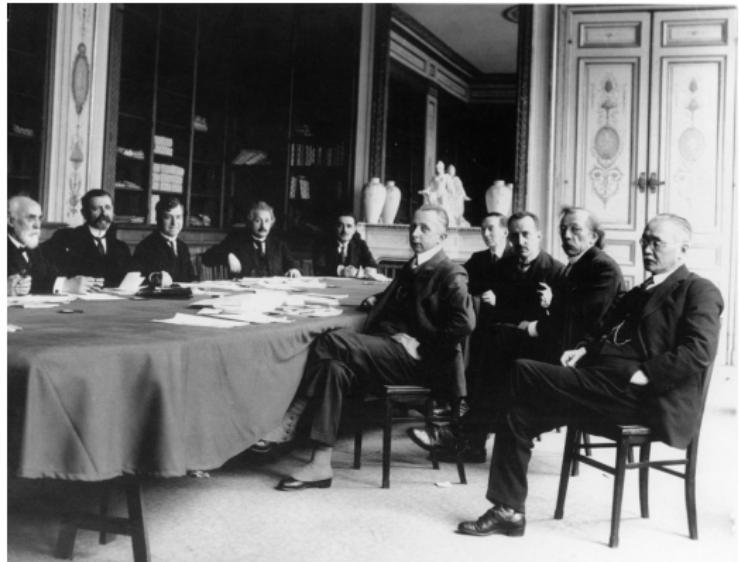
Age must be honored at the time of the decision, or the insurance may be less favorable.

Call for a consultation or your free quote.

New Books Month in Webster & Stevens' Library

International Committee on Intellectual Cooperation (ICIC)

- Founded in 1922.
- Based in Geneva.
- Advisory organization of the League of Nations.



• <https://unesco.libguides.com/IICI>

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International Institute of Intellectual Cooperation (IIIC)

- Founded in 1926.
- Based in Paris.
- Created to support the work ICIC as an **executive branch**.
- Ancestor of UNESCO.

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• <https://unesco.libguides.com/IICI>





**What was the *role* played by
countries in the web of
global intellectual cooperation?**

The data: UNESCO's archives

- 1 Scanned documents of one folder
(folder A: *internal affairs*)
of the IIIC's archive.

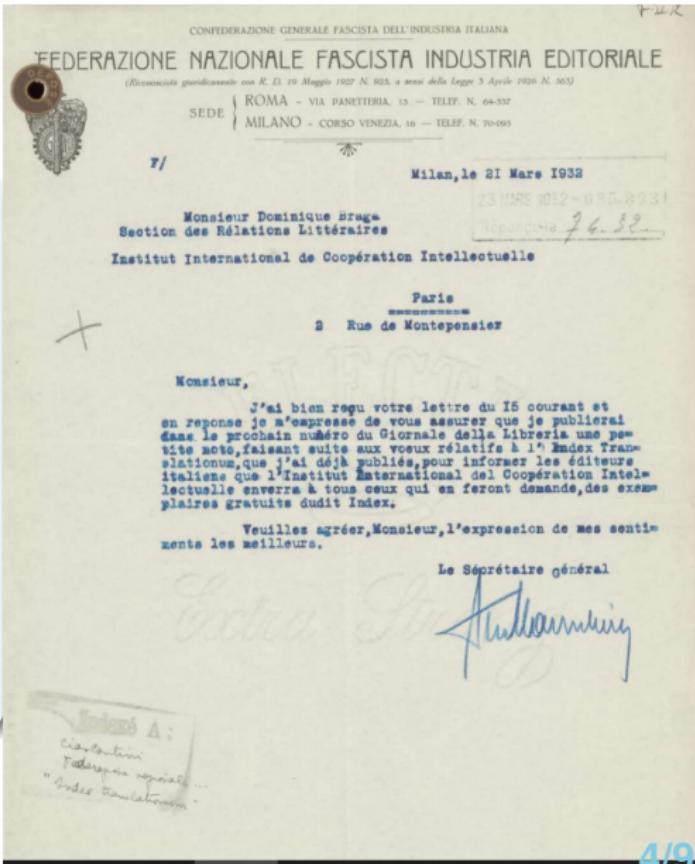
The screenshot shows the UNESCO Archives AtoM Catalogue interface. At the top, there is a logo for the United Nations Educational, Scientific and Cultural Organization (UNESCO) and a search bar labeled "Search UNESCO Archives". Below the search bar, the title "UNESCO Archives AtoM Catalogue" is displayed, along with the tagline "Building peace in the minds of men and women". On the right side of the header, there are icons for user account and login. The main content area is titled "Archive Group AG 1 - International Institute of Intellectual Co-operation". Under this title, there is a list of items:

- [Archive Group] AG 1 - International Institute of Intellectual Co-operation, 1921-1954
 - [Fonds] ICI - International Institute of Intellectual Co-operation fonds, 1921-1954
 - [Subseries] A - Correspondance relative aux Commissions nationales, Délégués d'Etats et Affaires générales de la DI...
 - [Subseries] B - Correspondance relative aux relations diverses entre pays, 1925-1946
 - [Subseries] C - Correspondance relative aux questions des relations universitaires, début de la Conférence permanente...
 - [Subseries] D - Correspondance relative aux questions scientifiques, Bibliothèques et Congrès bibliothécaires, Bibliog...
 - [Subseries] DD - Correspondance de la Section des Sciences historiques et sociales, 1924-1940

<https://atom.archives.unesco.org/iiic>

The data: UNESCO's archives

- ① Scanned documents of one folder (folder A: *internal affairs*) of the IIIC's archive.
- ② Over the 59,820 documents available in folder A, we extract 4,265 typewritten letters with an **origin** and **destination** locations.

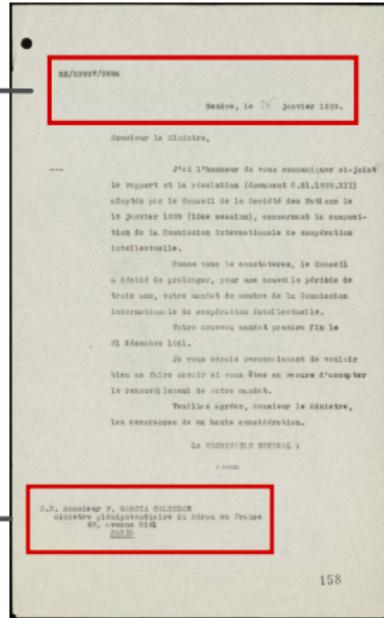


The data: UNESCO's archives

- 1 Scanned documents of one folder (folder A: *internal affairs*) of the IIIC's archive.
- 2 Over the 59,820 documents available in folder A, we extract 4,265 typewritten letters with an **origin** and **destination** locations.

Origin
Country
(Switzerland)

Destination
Country
(France)



158

The data: UNESCO's archives

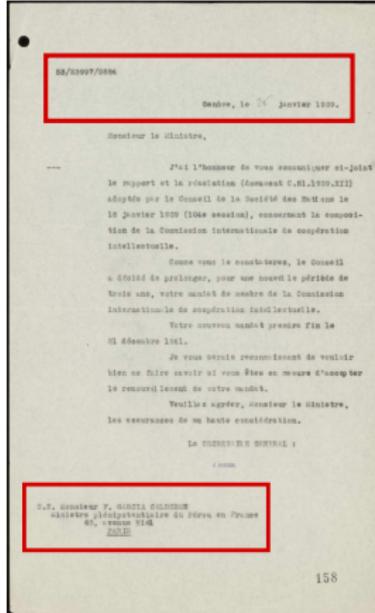
- ① Scanned documents of one folder (folder A: *internal affairs*) of the IIIC's archive.
- ② Over the 59,820 documents available in folder A, we extract 4,265 typewritten letters with an **origin** and **destination** locations.
- ③ We use this information to build a weighted **network of *information exchange*** between countries.

Switzerland



$$w_{ij} = 1$$

France



158

Method: Network cartography in a nutshell

Method: Network cartography in a nutshell

- A technique to **assign roles to nodes** by studying their connectivity pattern.

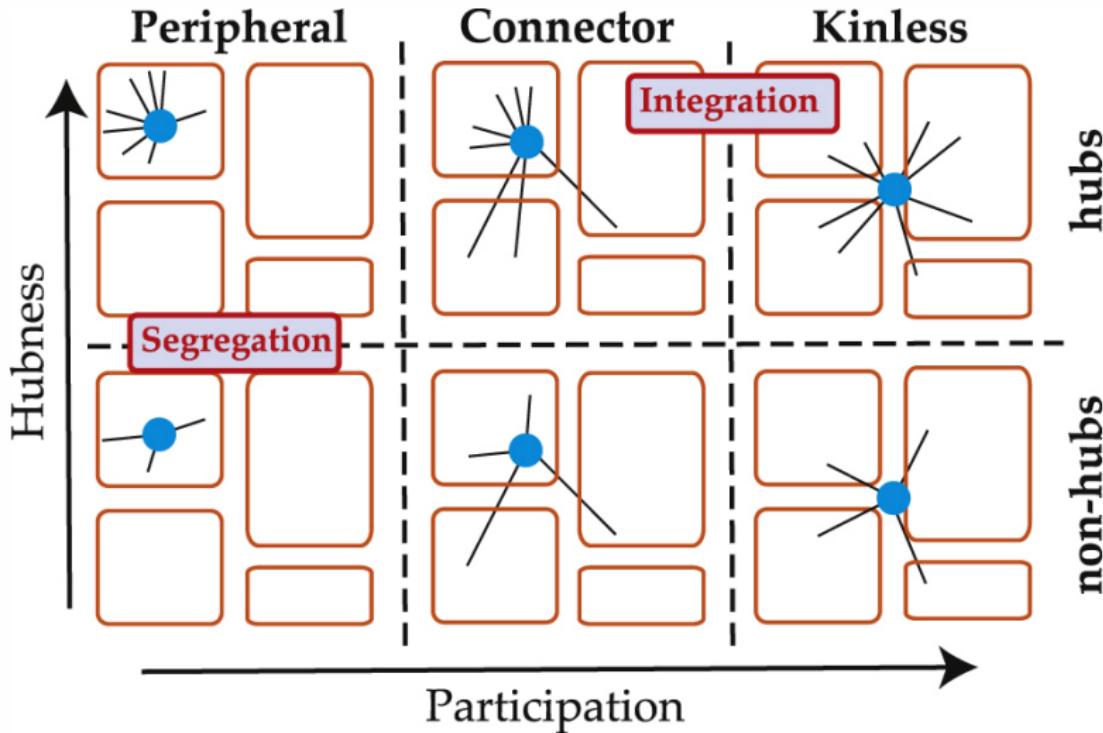
- R. Guimerá, and L. A. N. Amaral, “*Functional cartography of complex metabolic networks*”. Nature, **433**, 895, (2005). DOI: [10.1038/nature03288](https://doi.org/10.1038/nature03288)

Method: Network cartography in a nutshell

- A technique to **assign roles to nodes** by studying their connectivity pattern.
- **It requires a partition of the network into groups** (i.e., the results *depend* on the partitioning criterion).

- R. Guimerá, and L. A. N. Amaral, “*Functional cartography of complex metabolic networks*”. Nature, **433**, 895, (2005). DOI: [10.1038/nature03288](https://doi.org/10.1038/nature03288)

Method: Network cartography in a nutshell



- F. Klimm, et al. “Individual node’s contribution to the mesoscale of complex networks”. New Journal of Physics, **16**, 125006, (2014). DOI: [10.1088/1367-2630/16/12/125006](https://doi.org/10.1088/1367-2630/16/12/125006)

Method: Network cartography in a nutshell



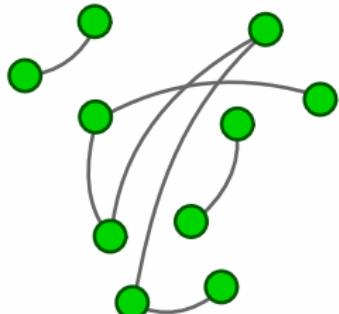
Results

Results

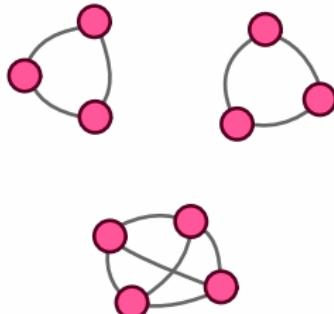
Modularity

$$Q = \frac{1}{2E} \sum_{i,j=1}^N \left[a_{i,j} - \frac{k_i k_j}{2E} \right] \delta(g(i), g(j))$$

$$Q \approx 0$$



$$Q \simeq 1$$



- M. E. J. Newman, Proc. Natl. Acad. Sci. USA, **103**, 8577, (2006). DOI: [10.1073/pnas.0601602103](https://doi.org/10.1073/pnas.0601602103)

Results

Results

N_{comms}	15
Q	0.242

- V. A. Traag, et al. “From Louvain to Leiden: guaranteeing well-connected communities”. Sci. Rep., **9**, 5233, (2019). DOI: [10.1038/s41598-019-41695-z](https://doi.org/10.1038/s41598-019-41695-z)

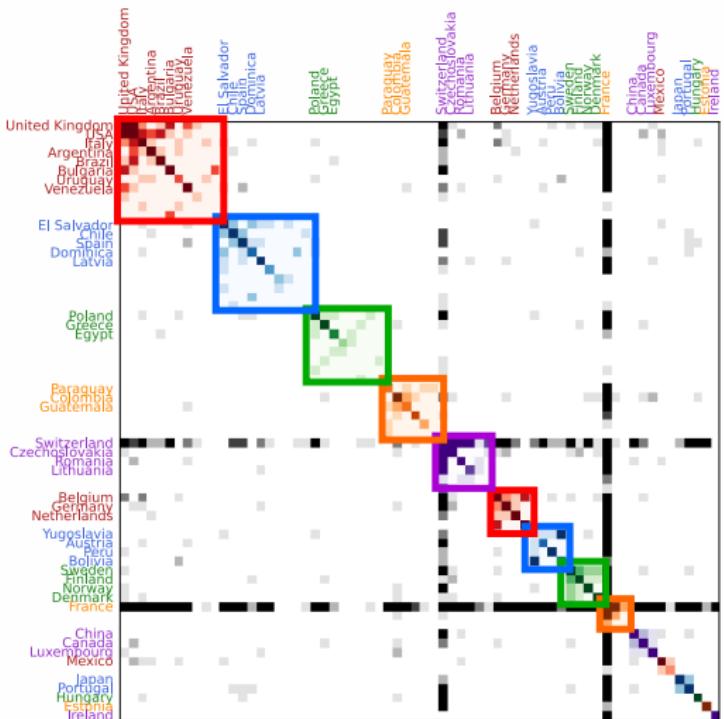
Results

N_{comms}

15

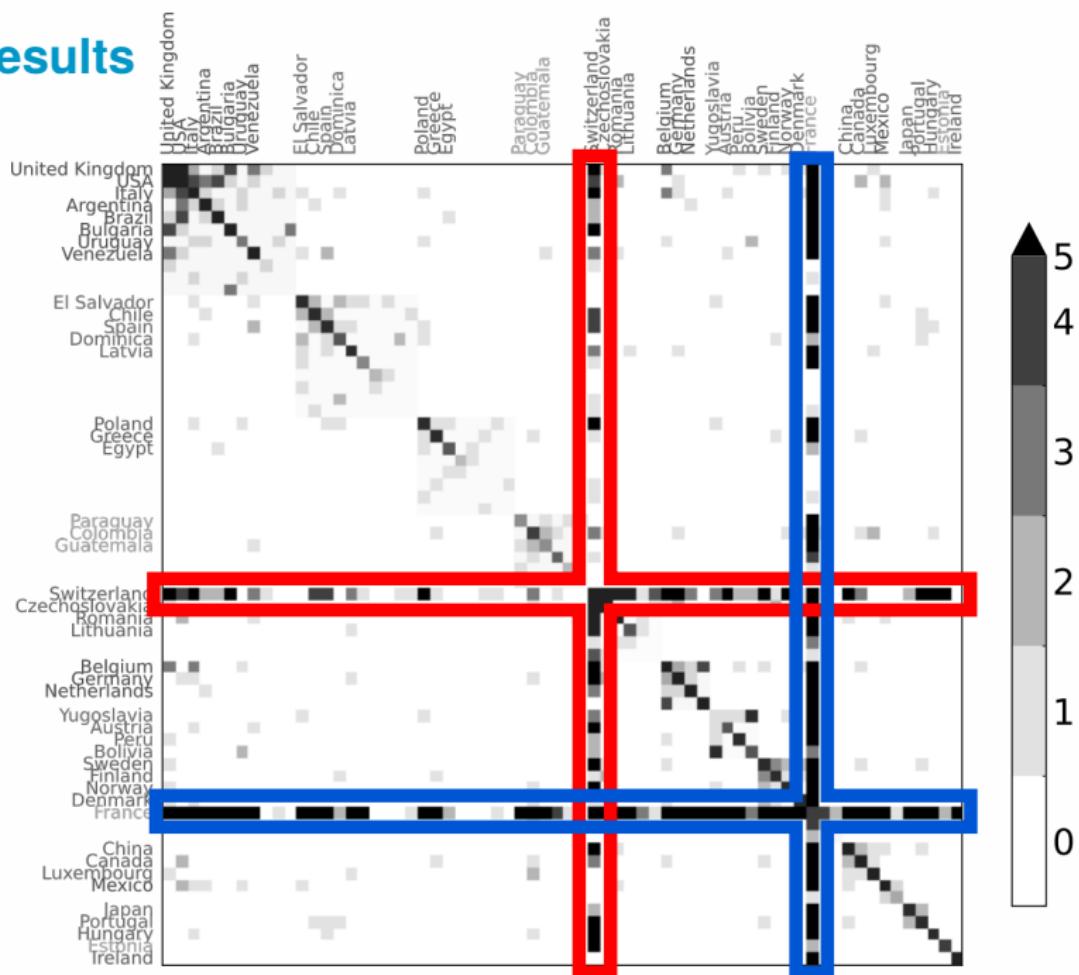
15

0.242

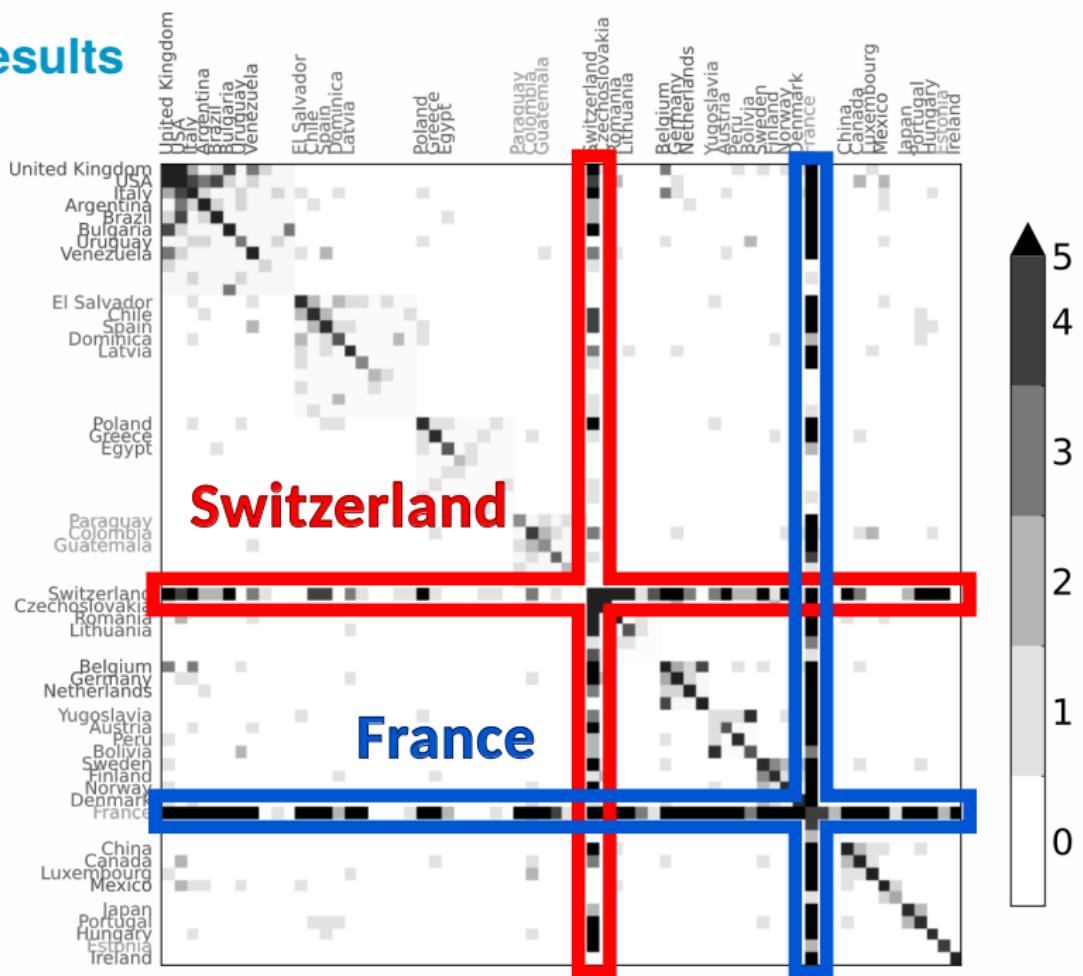


- V. A. Traag, et al. "From Louvain to Leiden: guaranteeing well-connected communities". Sci. Rep., **9**, 5233, (2019). DOI: [10.1038/s41598-019-41695-z](https://doi.org/10.1038/s41598-019-41695-z)

Results



Results



Results

Was there intellectual cooperation
beyond that *with* (and *between*)
France and Switzerland?

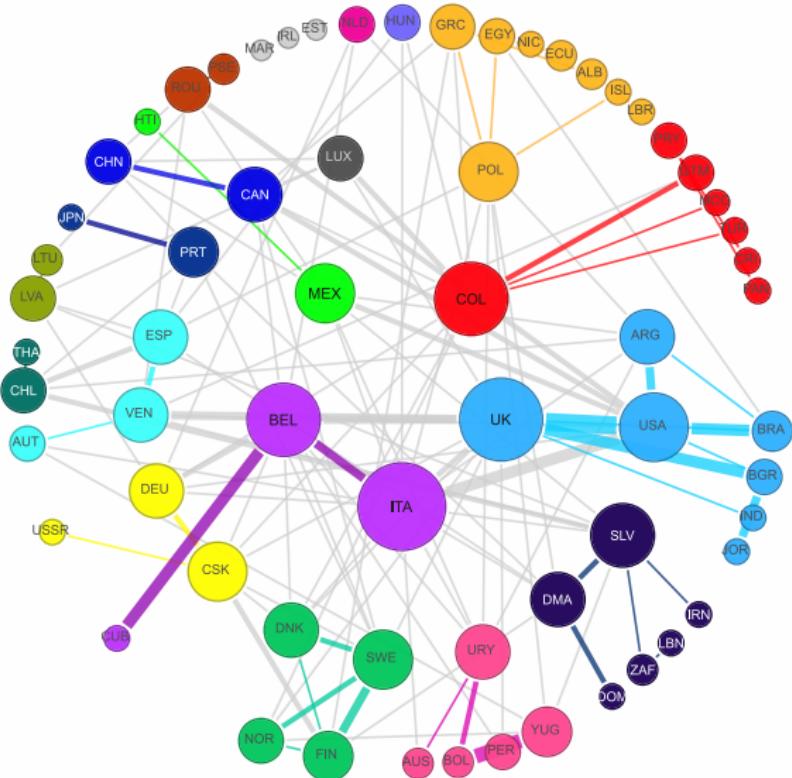
Results

N_{comms}

21

Q

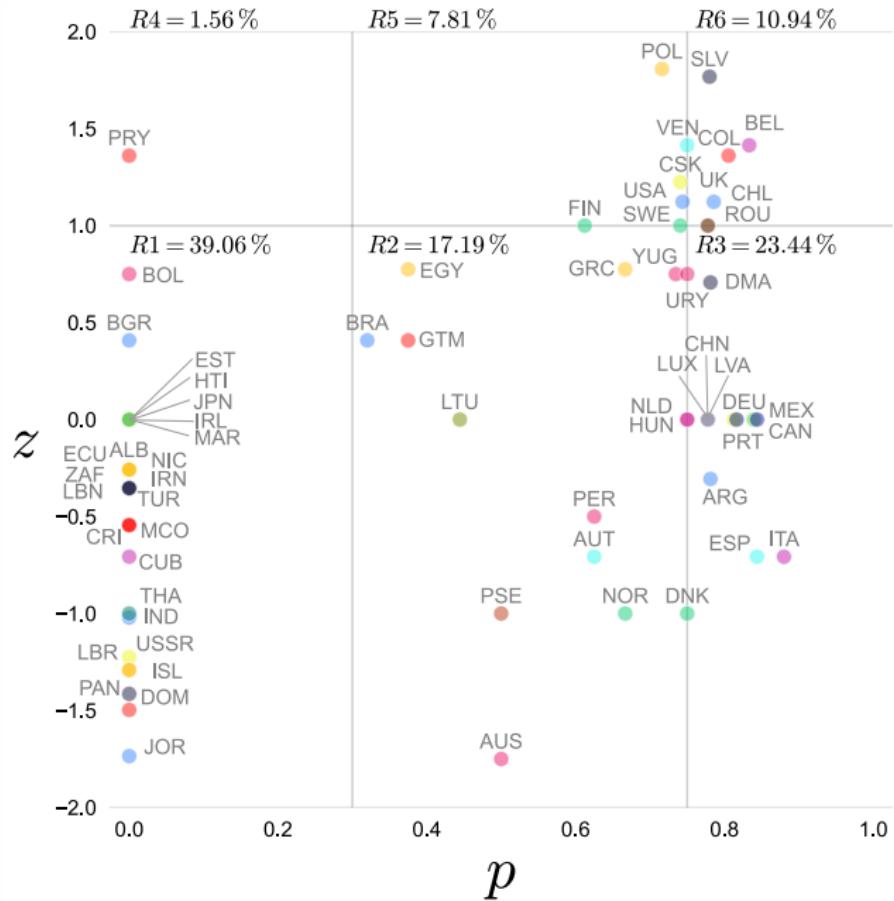
0.787



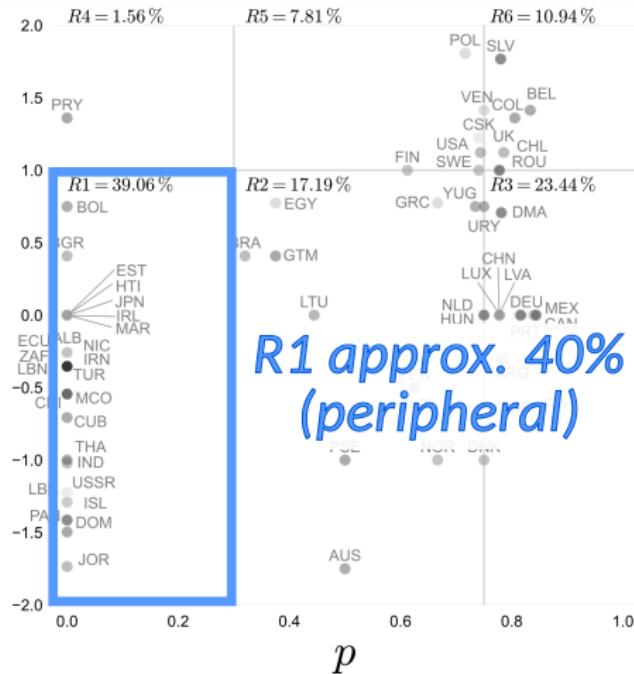
- R. Rodríguez-Casañ *et al.*, Hum. Soc. Sci. Commun. **11**, 1408 (2024).

DOI: 10.1057/s41599-024-03829-1

Results



Results

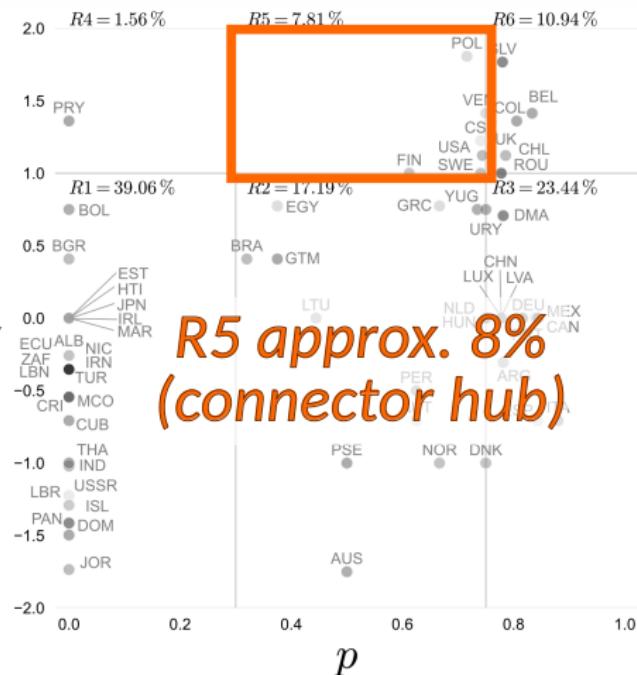


Estonia, Iceland, Monaco, **USSR**, Ireland, Bulgaria, Albania, Turkey, Morocco, Nicaragua, Cuba, Panama, Costa Rica, Haiti, Ecuador, Bolivia, Dominican Republic, Iran, Jordan, Lebanon, South Africa, Liberia, **India**, **Japan**, Thailand.

- R. Rodríguez-Casañ *et al.*, Hum. Soc. Sci. Commun. **11**, 1408 (2024).

DOI: [10.1057/s41599-024-03829-1](https://doi.org/10.1057/s41599-024-03829-1)

Results



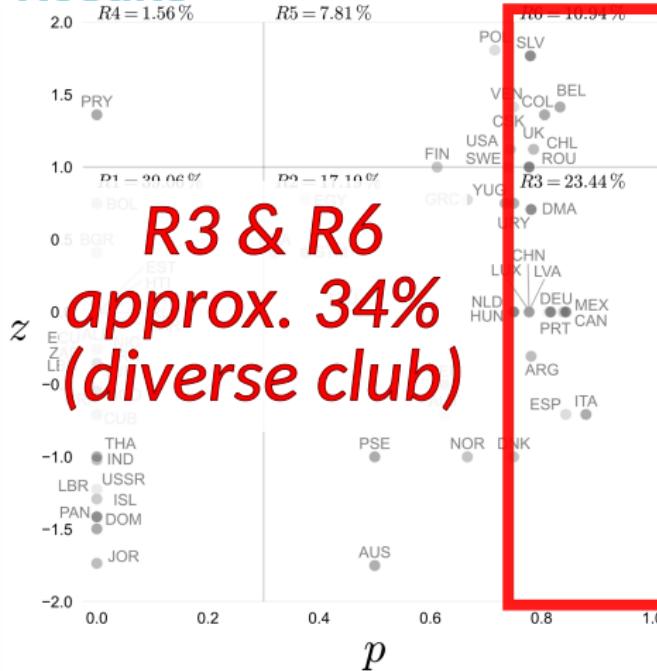
R5

**United States of America,
Sweden, Finland, Czechoslovakia,
Poland.**

- R. Rodríguez-Casañ *et al.*, Hum. Soc. Sci. Commun. **11**, 1408 (2024).

DOI: [10.1057/s41599-024-03829-1](https://doi.org/10.1057/s41599-024-03829-1)

Results



**Belgium, United Kingdom,
Romania, Chile, Colombia,
El Salvador, Venezuela.**

R6

**Italy, Spain, Portugal, Germany,
Hungary, Netherlands,
Luxembourg, Denmark, Latvia,
China, Canada, Mexico,
Argentina, Uruguay, Dominica.**

R3

- R. Rodríguez-Casañ *et al.*, Hum. Soc. Sci. Commun. **11**, 1408 (2024).

DOI: [10.1057/s41599-024-03829-1](https://doi.org/10.1057/s41599-024-03829-1)

- M. A. Bertolero, *et al.* “The diverse club.” Nat. Comms. **8**, 1277, (2017).

DOI: [10.1038/s41467-017-01189-w](https://doi.org/10.1038/s41467-017-01189-w)

Conclusions

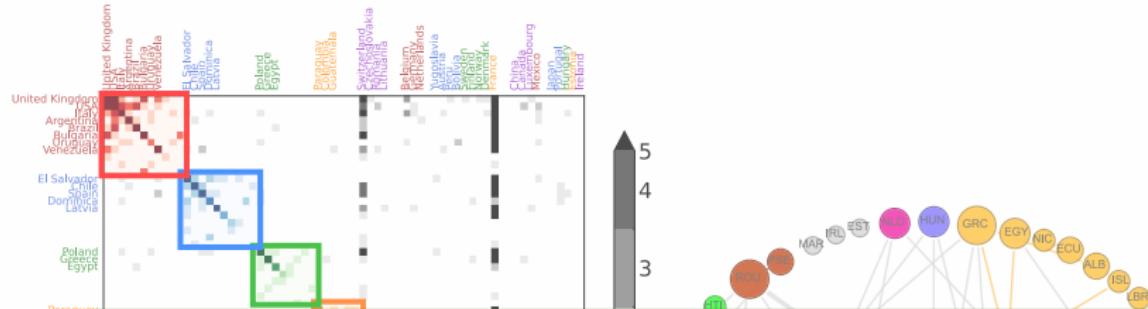
Take Home Messages



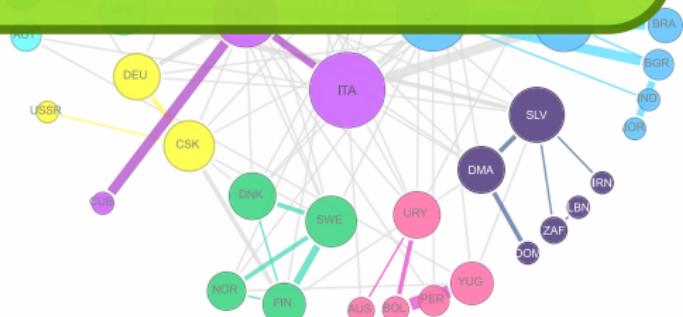
Digital humanities **ARE an opportunity** for Complexity science



Take Home Messages



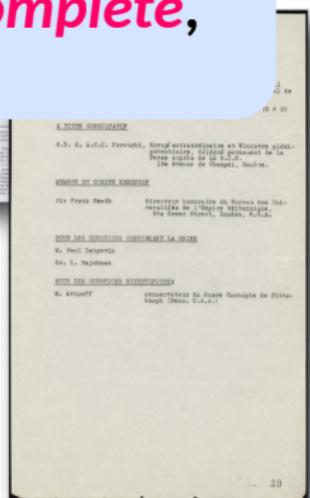
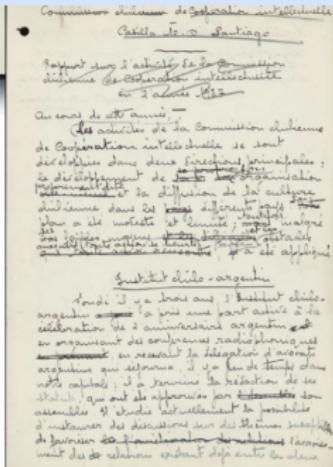
The use of quantitative methods allows for the discovery of *non orthogonal* but *non trivial* features



Take Home Messages



All that glitters is not gold: we have to deal with *biased*, *unstructured*, *incomplete*, and *noisy* data.



Acknowledgments II

The screenshot shows a web page with a torn paper effect. At the top, it says "Humanities & Social Sciences Communications". Below that are navigation links: "Explore content ▾", "About the journal ▾", and "Publish with us ▾". A horizontal line separates this from the main content. Underneath, there's a breadcrumb trail: "nature > humanities and social sciences communications > articles > article". The main title of the article is "Analysing inter-state communication dynamics and roles in the networks of the International Institute of Intellectual Cooperation". Below the title, the authors listed are Rubén Rodríguez-Casañ, Elisabet Carbó-Catalan, Albert Solé-Ribalta, Diana Roig-Sanz, Javier Borge-Holthoefer, and Alessio Cardillo. The text is in a serif font, and the overall layout is clean and professional.

DOI: 10.1057/s41599-024-03829-1

Open Dataset

DOI: 10.34810/data985

Acknowledgments II



European Research Council
Established by the European Commission

ERC-2018-STG
ID: 803860



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<https://cardillo.web.bifi.es/>



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The shameless plug



May 4-8 Zaragoza (Spain)

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- Jesús Gómez-Gardeñes
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- David Soriano-Paños
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Program Chairs:

- Carmen Cabrera
University of Liverpool, UK
- Alessio Cardillo
Universitat de Barcelona, Spain



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Zaragoza

Extra content

Cartography

within module degree κ

$$\kappa_i = \sum_j a_{ij} \delta_{c_i, c_j}$$

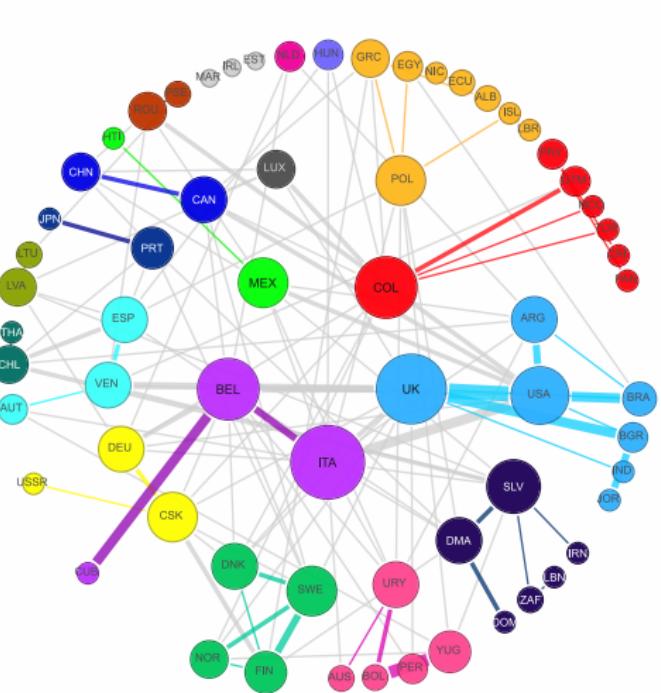
hubness z

$$z_i = \frac{\kappa_i - \bar{\kappa}_{c_i}}{\sigma_{\kappa_{c_i}}}$$

Participation coefficient p

$$p_i = 1 - \sum_j^{N_c} \left(\frac{\kappa_i(c_j)}{k_i} \right)^2$$

III C – partition into groups



C1 Poland, Greece, Albania, Nicaragua, Ecuador, Iceland, Egypt, and Liberia.

C2 United Kingdom, United States of America, Argentina, Brazil, Bulgaria, India, and Jordan.

C3 Colombia, Paraguay, Guatemala, Monaco, Turkey, Costa Rica, and Panama.

C6 Sweden, Denmark, Norway, and Finland.

C7 Spain, Austria, and Venezuela.

C8 Germany, Czechoslovakia, and USSR.

C9 Belgium, Italy, and Cuba.

Others All other countries.

IIIC – Historical grouping

Group's name	Countries
EU western and USA	France, United Kingdom, Switzerland, Germany, Italy, Belgium, The Netherlands, Spain, and United States of America
EU central countries	Austria, Czechoslovakia, Hungary, and Poland
EU eastern countries	Albania, Bulgaria, Greece, Yugoslavia, and Romania
Baltic countries	Estonia, Latvia, and Lithuania
Nordic countries	Denmark, Finland, Norway, Iceland, and Sweden
Latin countries	Portugal, Argentina, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Chile, Dominican Republic, Ecuador, Dominica, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Paraguay, El Salvador, Uruguay, and Venezuela
UK's Dominions	Australia, Canada, India, South Africa, and Ireland
Colonies	Egypt, Benin, French Guiana, Haiti, Turkey, Lebanon, Jordan, Morocco, and Palestine
Eastern countries	China, Japan, Cambodia, and Thailand
Middle East	Iran
Other countries	Luxembourg, Monaco, Liberia, and USSR

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“Configuring random graph models with fixed degree sequences.” SIAM Review, **60** 315–355, (2018). DOI: [10.1137/16M1087175](https://doi.org/10.1137/16M1087175)
-  J.-J. Renollet, *L’UNESCO oubliée. La Société des Nations et la coopération intellectuelle (1919–1946)*. (Publications de la Sorbonne, Paris, 1999).
-  R. Guimerá, and L. A. N. Amaral, “Functional cartography of complex metabolic networks”. Nature, **433**, 895–900, (2005).
DOI:[10.1038/nature03288](https://doi.org/10.1038/nature03288)
-  F. Klimm, J. Borge-Holthoefer, N. Wessel, J. Kurths, and G. Gorka Zamora-López. “Individual node’s contribution to the mesoscale of complex networks”. New Journal of Physics, **16**, 125006, (2014).
DOI:[10.1088/1367-2630/16/12/125006](https://doi.org/10.1088/1367-2630/16/12/125006)
-  V. A. Traag, L. Waltman, and N. J. van Eck, “From Louvain to Leiden: guaranteeing well-connected communities”. Sci. Rep., **9**, 5233, (2019).
DOI:[10.1038/s41598-019-41695-z](https://doi.org/10.1038/s41598-019-41695-z)



M. Girvan, and M. E. J. Newman, “*Community structure in social and biological networks.*” Proc. Nat. Acad. Sci. USA, **99**, 7821, (2002). DOI:[10.1073/pnas.122653799](https://doi.org/10.1073/pnas.122653799)



A. Barrat, M. Barthélemy, R. Pastor-Satorras, and A. Vespignani, “*The architecture of complex weighted networks.*” Proc. Nat. Acad. Sci. USA, **101**, 3747, (2004). DOI: [10.1073/pnas.0400087101](https://doi.org/10.1073/pnas.0400087101)



S. Fortunato, and M. E. J. Newman, “*20 years of network community detection.*” Nat. Phys., **18**, 848, (2022). DOI:[10.1038/s41567-022-01716-7](https://doi.org/10.1038/s41567-022-01716-7)



S. Fortunato, & D. Hric, “*Community detection in networks: A user guide.*” Phys. Rep., **659**, 1–44, (2016). DOI:[10.1016/j.physrep.2016.09.002](https://doi.org/10.1016/j.physrep.2016.09.002)



R. Rodríguez-Casañ, E. Carbó-Catalan, A. Solé-Ribalta, D. Roig-Sanz, J. Borge-Holthoefer, and A. Cardillo, “*Analysing inter-state communication dynamics and roles in the networks of the International Institute of Intellectual Cooperation.*” Hum. Soc. Sci. Comms. **11**, 1408 (2024). DOI: [10.1057/s41599-024-03829-1](https://doi.org/10.1057/s41599-024-03829-1)