S3 Peer-exchange workshop for EU Enlargement and Neighbourhood Regions

Quantitative Methods for Smart Specialisation: Identifying the Scientific Potential

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Contents

What kind of questions does S3 try to answer from the perspective of science / knowledge production?

Which questions can be answered through quantitative methods? How?

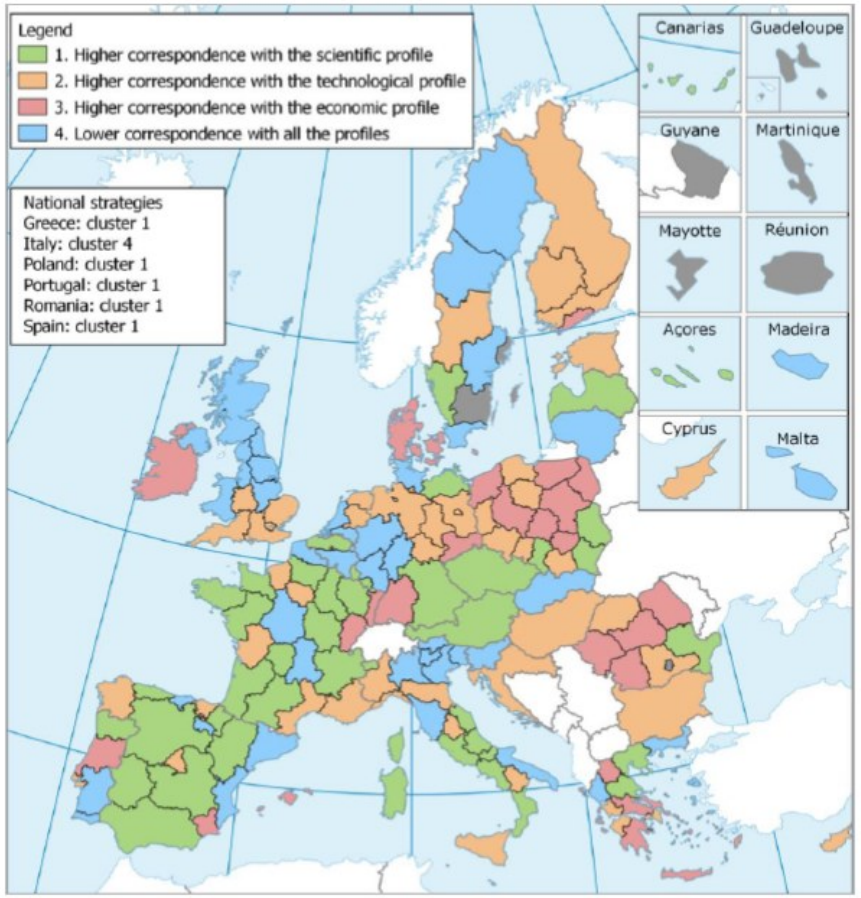
How do scientometrics inform the analysis of economic and innovative potential?

How do you do basic scientometrics?

What type of profile influenced S3 design in 2014-20 in Europe?

Source: Prognos/CSIL, *Study on prioritisation in Smart Specialisation Strategies in the EU*, Final Report, 2021

- 30% have a higher correspondence with the **technological profile**
  - → Highly diversified territories with a good innovation profile (classified as an innovation leader, strong or moderate innovator) and a high share of population employed in Science and Technology
- 25% exhibit a relatively **low correspondence with any profile**
  - → Ambitious strategies, aiming at unrelated diversification and relatively complex technologies
- 23% show a higher correspondence with the **scientific profile**
  - → Scientific competencies which are not effectively translated into technological competencies within firms, yet.
- 16% have a higher correspondence with the **economic profile**
  - → Transition regions and modest innovators, with a low degree of economic diversification



Source: Prognos / CSIL (2021). Note: The map shows the specific cluster to which the latest S3 strategies belong. Grey coloured regions are excluded from the analysis because of missing data.

Some **interesting** questions in profiling Science

Source: RIS3Key (https://era.gv.at/object/document/494)

1. Where does your country already excel or has the potential to put itself on the map as a recognized world-class place of competence?
2. Which are the specific scientific strengths and research specializations in your country?
3. Which emerging new scientific competences can be spotted in your country?
4. Who are the key actors? How are they linked with the national economy?
5. How fit is your national knowledge base to address conjointly the grand challenges of society?
6. How do lead institutions position themselves in global chains of knowledge?
7. How favorable are working conditions for researchers in your country? How much mobility between the public science and the private sector does exist? Do universities train scholars and graduates to become entrepreneurs?
8. Does current academic education fit to the needs of the national economy – do employers absorb graduates or are graduates forced to look elsewhere?
9. What about the internationalization of researchers and research collaborations?

Some interesting questions **that can be answered by quantitative methods for science profiling**

1. **Where does your country already excel or has the potential to put itself on the map as a recognized world-class place of competence?**
2. **Which are the specific scientific strengths and research specializations in your country?**
3. **Which emerging new scientific competences can be spotted in your country?**
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9. What about the **internationalization** of researchers and **research collaborations**?

What can you expect from quantitative methods?

Analysis of scientific production, specialization, and identification of key actors

- Who has done what? Who's good in what? Who collaborates with whom?
- Specialisation analysis at various levels

Analysis of knowledge trajectories and of the degree of participation in global knowledge chains

- Knowledge trajectories
- Access to global knowledge chains

Research evaluation

- Micro-, meso- and macro-levels

Research monitoring

- Who is researching what right now?

How can the results inform the analysis of economic potential?

The key question here is whether and which local research capacities can be productively combined with economic capacities

Economic Potential	***Scientific Capability***	
	Low	*High*
Low	Forget it (from the S3 perspective)!	Can the exploitation of research outputs create new economic opportunities?
High	Can relevance of research be improved through research policy?	Is knowledge exchange in place? Is it effective? How can it be reinforced?

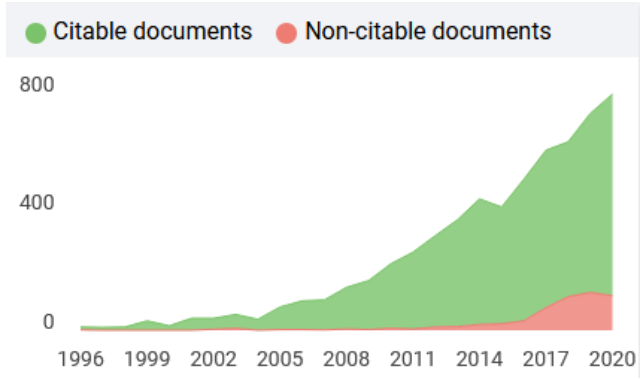
Part I

DESCRIPTIVE STATISTICS AND FIRST INSIGHTS

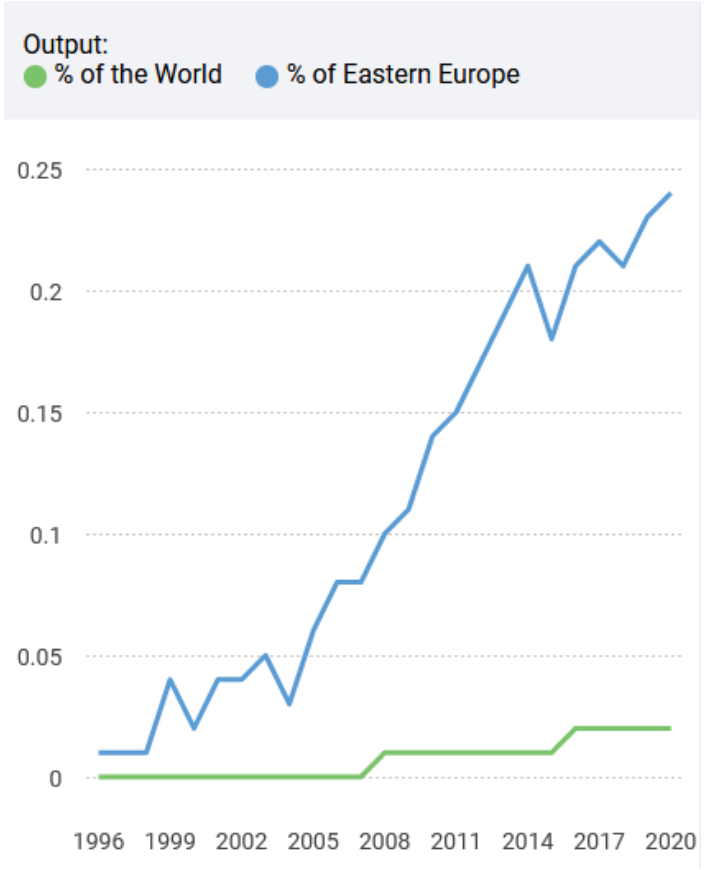
Scientific Production

Source: https://www.scimagojr.com/countrysearch.php?country=ME

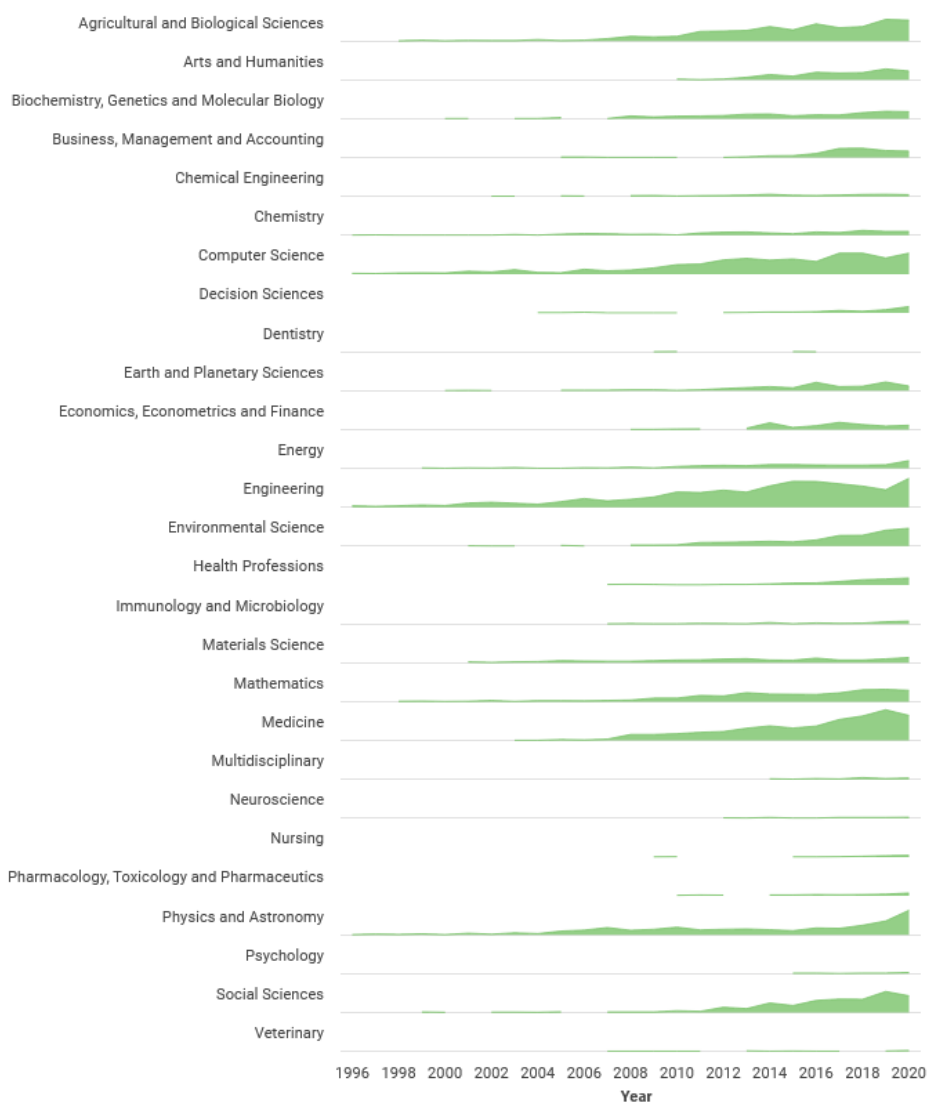
Publications per year



% international collaboration



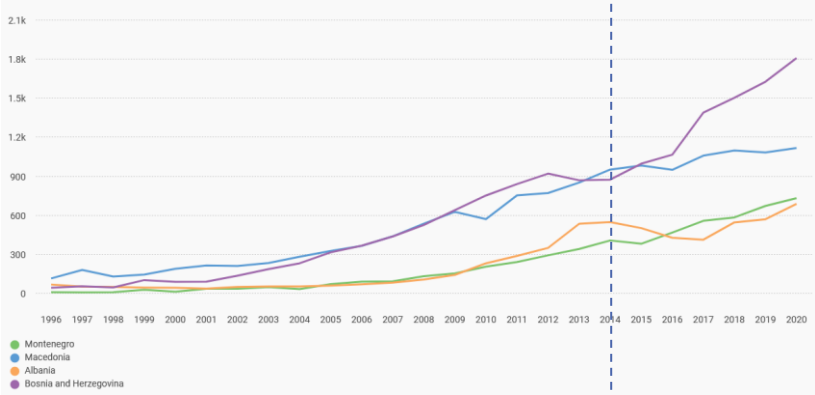
Publications per subject area



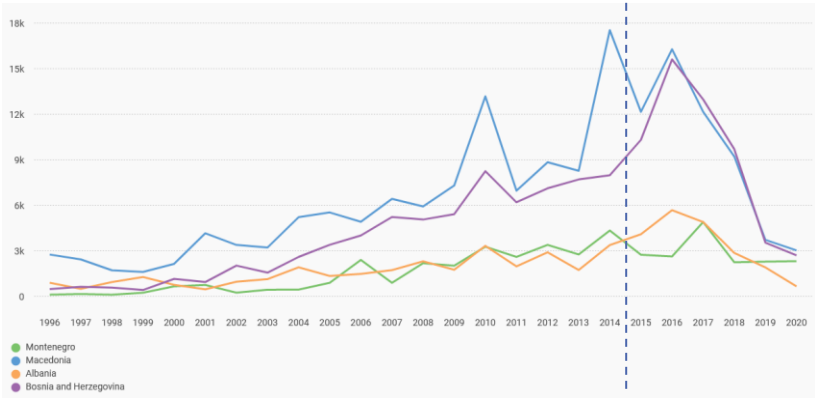
Simple benchmarking

Montenegro vs North Macedonia vs Albania vs Bosnia and Herzegovina

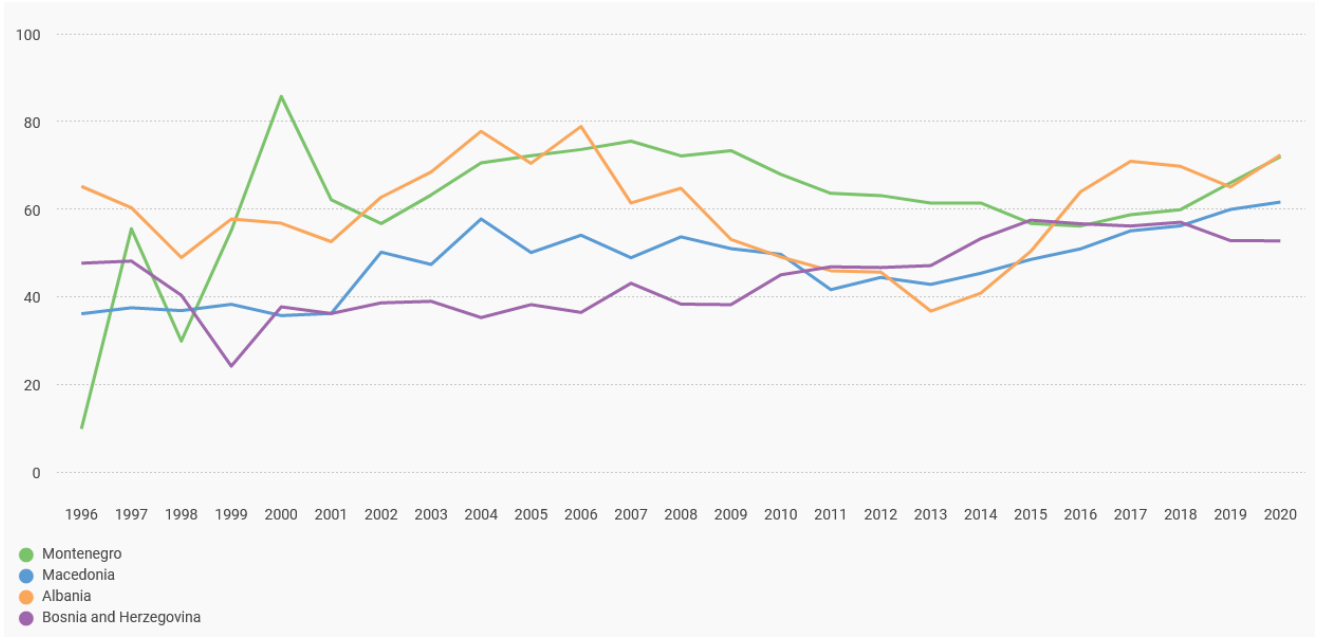
Publications



Citations



% international collaboration



Part II

SPECIALISATION ANALYSIS & IDENTIFICATION OF EMERGING COMPETENCES

Specialisation in Science: Key principles

1. Define the **baseline**, the geographic area that serves as the basis for the analysis (e.g., EU-27, a country)

2. Define the **reference**, a subset of the base line for which specialization is calculated (e.g., a EU member state, a region in a country)

3. Choose your preferred **bibliographic database** (Scopus vs Web of Science) and stick to that

4. Choose the metric: e.g., **Research Areas** vs **Research Subjects** when using Web of Science

5. Collect **aggregate data** for **two consecutive time windows** of minimum 4 years each (=1 PhD epoch), e.g., 2012-2015 and 2016-2019 (this can be relaxed, e.g., to suit programming periods).

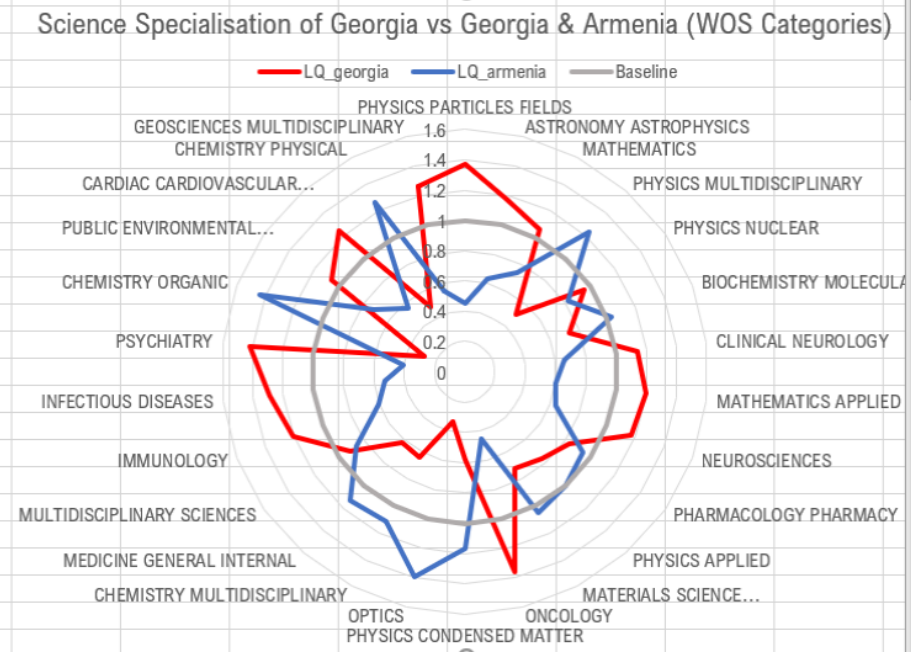
6. Calculate Location Quotients

7. Plot the results

Calculate and plot

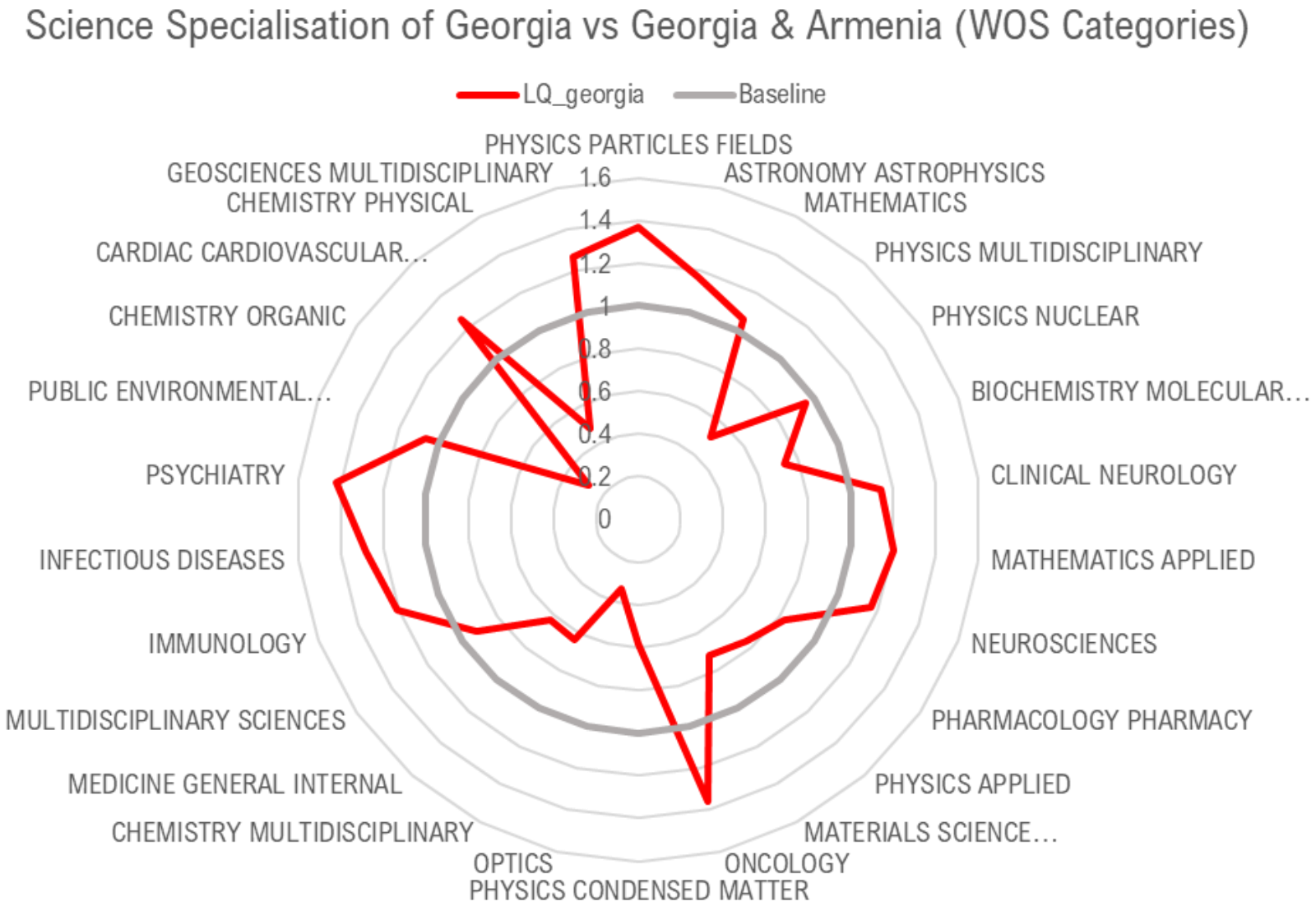
Standard practice for spider plots to sort the baseline data in decreasing order

	A	B	C	D	E	F	G
1		5229	5746	9756			
2	WOS Category	GEORG	Armenia	GEORG	LQ_geo	LQ_armeni	Baselir
3	PHYSICS PARTICLES FIELDS	1062	386	1448	1.3683875	0.4526108	1
4	ASTRONOMY ASTROPHYSICS	637	378	1015	1.1709182	0.6323127	1
5	MATHEMATICS	421	322	743	1.0571739	0.7358228	1
6	PHYSICS MULTIDISCIPLINARY	169	448	617	0.5110398	1.2328182	1
7	PHYSICS NUCLEAR	309	294	603	0.9560802	0.8278205	1
8	BIOCHEMISTRY MOLECULAR BIOLOGY	112	173	285	0.7332065	1.030641	1
9	CLINICAL NEUROLOGY	160	101	261	1.143754	0.6570328	1
10	MATHEMATICS APPLIED	165	91	256	1.2025333	0.6035421	1
11	NEUROSCIENCES	159	95	254	1.1679293	0.6350327	1
12	PHARMACOLOGY PHARMACY	101	126	227	0.8301349	0.9424338	1
13	PHYSICS APPLIED	92	133	225	0.7628839	1.0036338	1
14	MATERIALS SCIENCE MULTIDISCIPLINARY	86	138	224	0.7163142	1.0460134	1
15	ONCOLOGY	157	58	215	1.3624305	0.4580319	1
16	PHYSICS CONDENSED MATTER	67	148	215	0.5814194	1.168771	1
17	OPTICS	38	172	210	0.3376117	1.3906419	1
18	CHEMISTRY MULTIDISCIPLINARY	71	137	208	0.6368661	1.1183131	1
19	MEDICINE GENERAL INTERNAL	67	133	200	0.6250258	1.1290881	1
20	MULTIDISCIPLINARY SCIENCES	96	99	195	0.9185224	0.861999	1
21	IMMUNOLOGY	117	64	181	1.2060365	0.6003542	1
22	INFECTIOUS DISEASES	120	54	174	1.2867232	0.5269273	1
23	PSYCHIATRY	128	40	168	1.4215228	0.4042564	1
24	CHEMISTRY ORGANIC	24	134	158	0.2834049	1.4399714	1
25	PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH	90	68	158	1.0627683	0.7307318	1
26	CARDIAC CARDIOVASCULAR SYSTEMS	95	47	142	1.2482122	0.5619733	1
27	CHEMISTRY PHYSICAL	35	101	136	0.4801559	1.2609232	1
28	GEOSCIENCES MULTIDISCIPLINARY	90	43	133	1.2625367	0.5489376	1
29	ENVIRONMENTAL SCIENCES	89	43	132	1.2579669	0.5530962	1
30	PHYSICS MATHEMATICAL	38	94	132	0.5371095	1.2090941	1
31	PERIPHERAL VASCULAR DISEASE	85	43	128	1.2389738	0.5703805	1
32	INSTRUMENTS INSTRUMENTATION	67	59	126	0.9921045	0.7950375	1
33	PHILOSOPHY	13	99	112	0.2165601	1.5008018	1
34	MECHANICS	64	47	111	1.075747	0.7189208	1
35	GENETICS HEREDITY	46	64	110	0.7802222	0.9878556	1
36	MICROBIOLOGY	56	54	110	0.9498357	0.8335031	1
37	GASTROENTEROLOGY HEPATOLOGY	57	43	100	1.0634768	0.730087	1



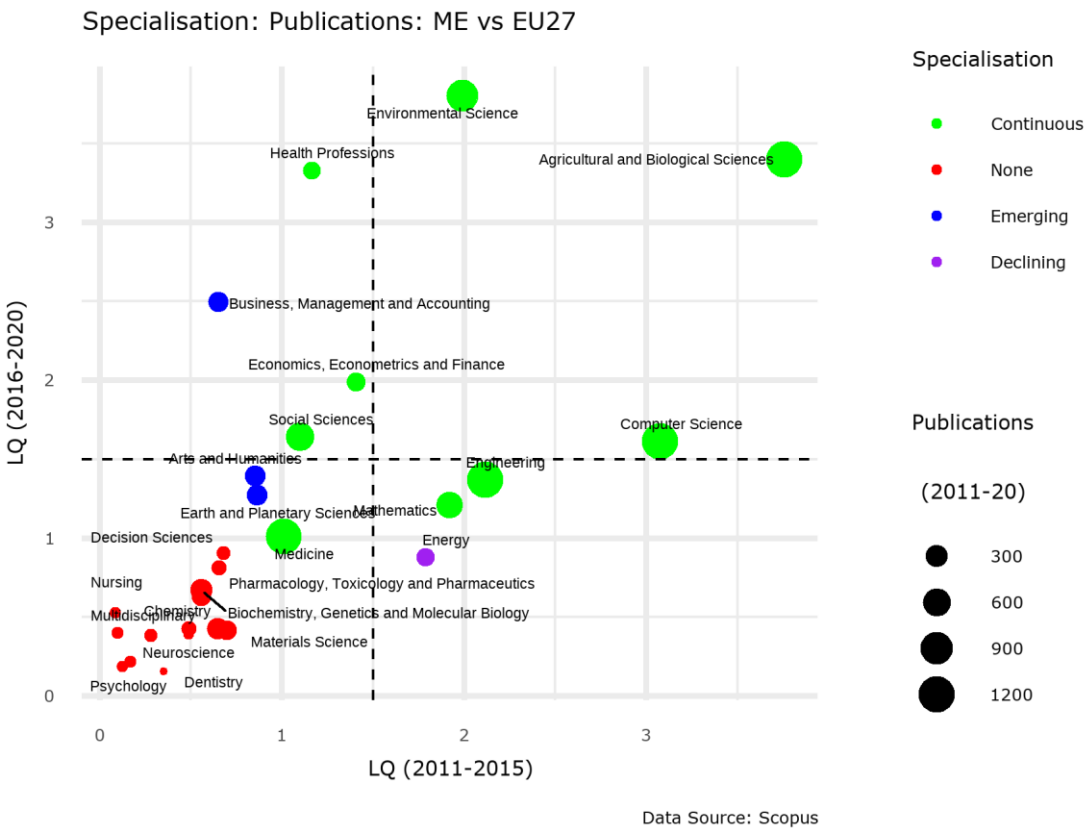
Georgia+Armenia | Georgia | pivot | LQ | All

Done!

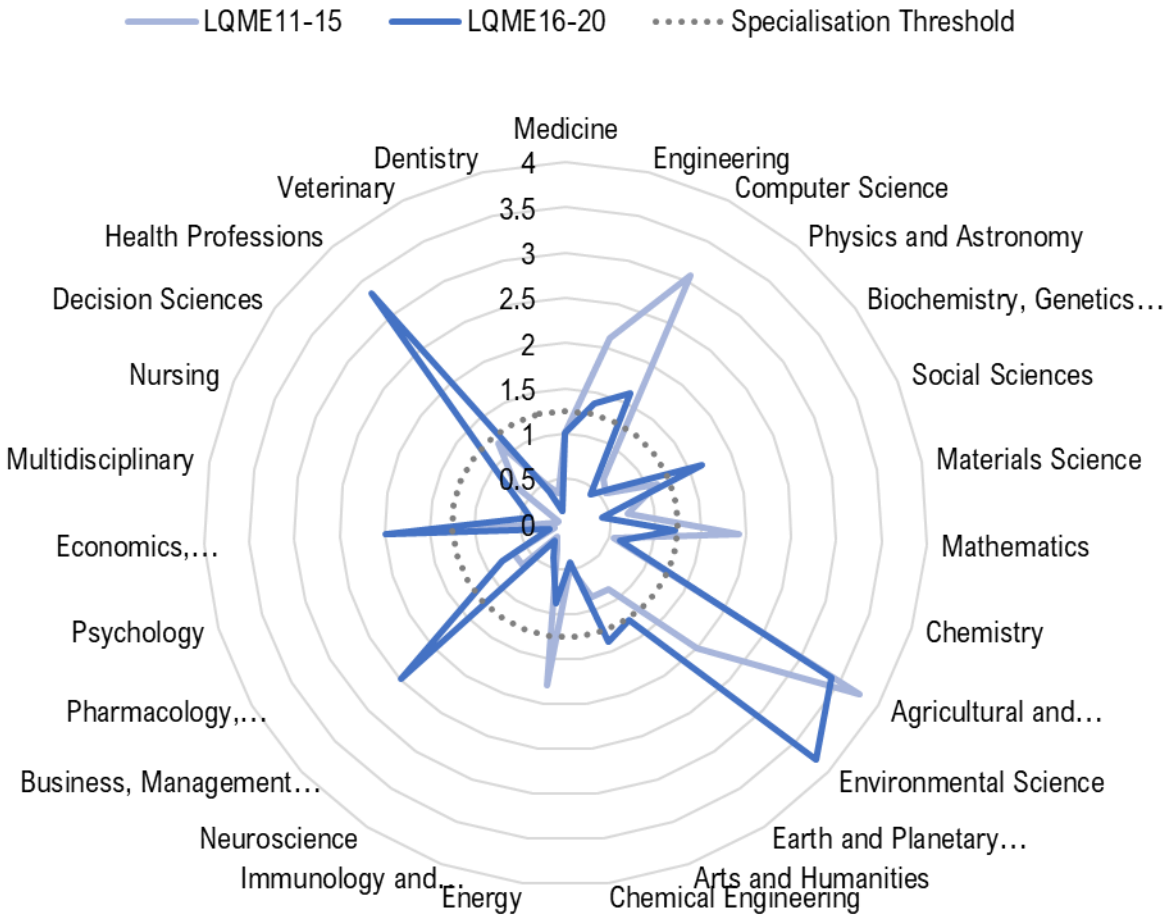


Examples of visualization of the same data

Montenegro vs EU27 (2011-2020) version 1



Montenegro vs EU27 (2011-2020) version 2



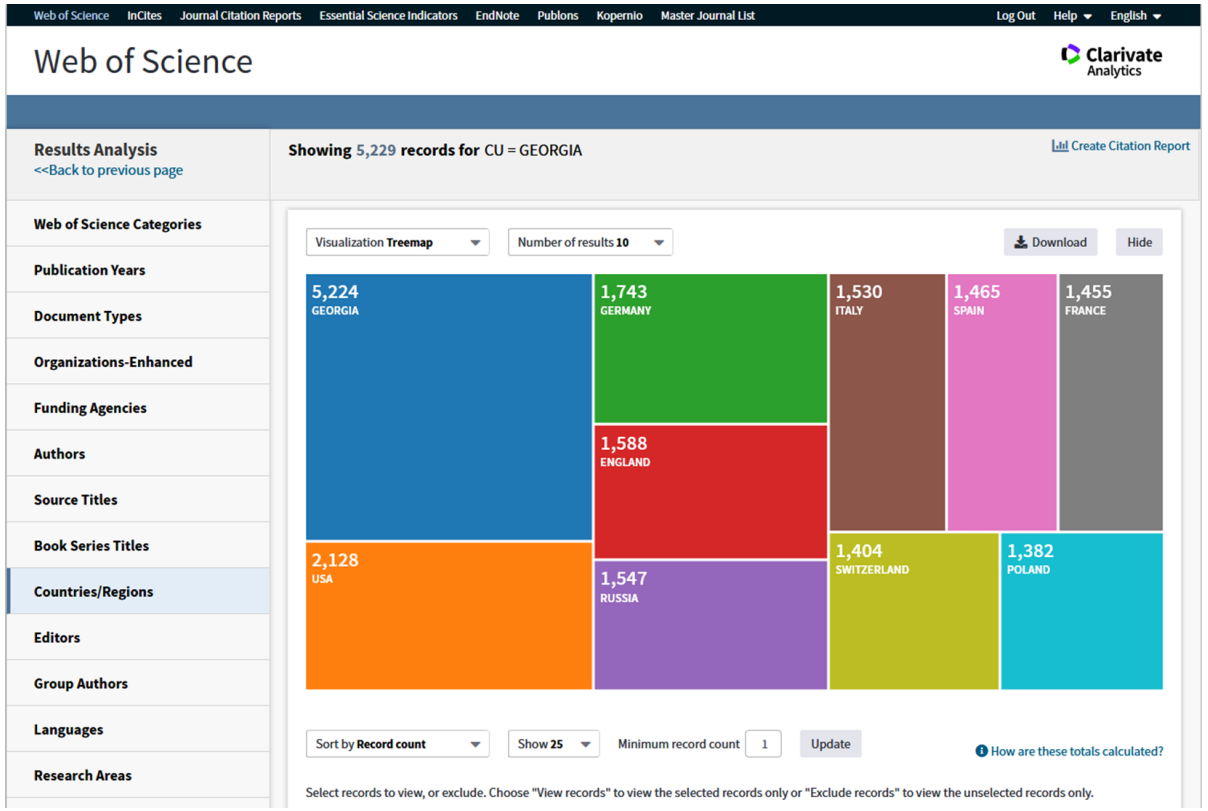
Part III

IDENTIFICATION OF KEY ACTORS & PRELIMINARY INTERNATIONALISATION ANALYSIS

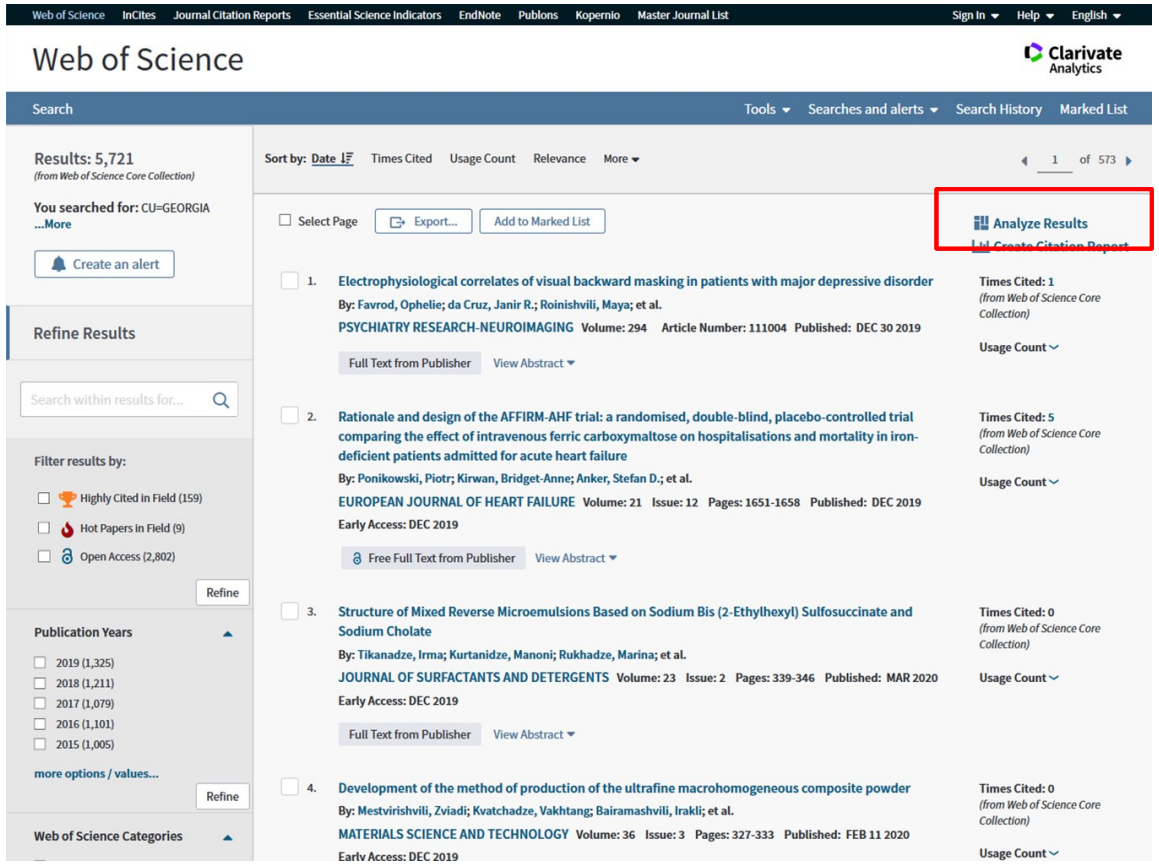
Institutions' contribution to scientific publications

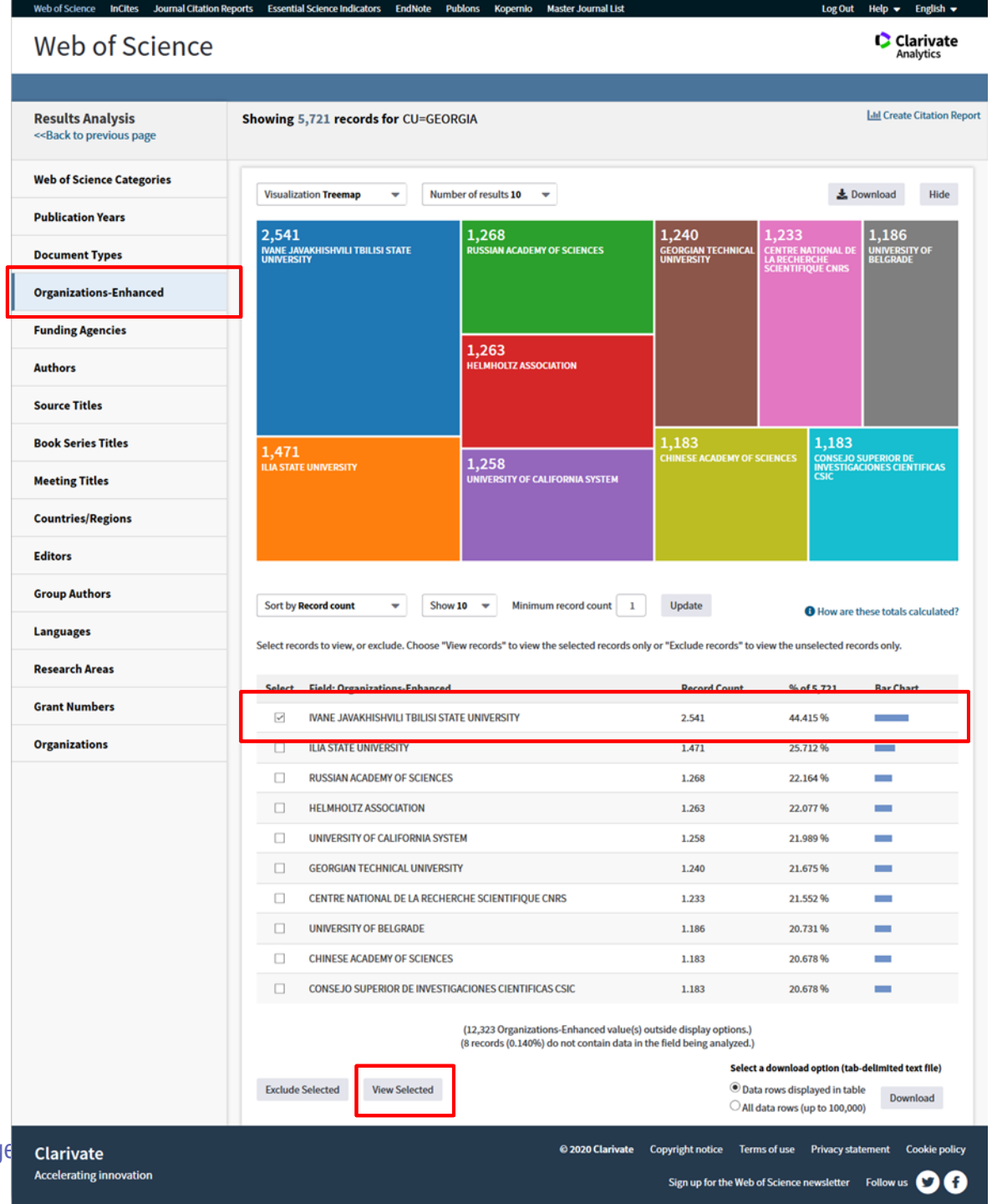
Organizations-Enhanced	records	% of 5229
IVANE JAVAKHISHVILI TBILISI STATE UNIVERSITY	2332	44.597
ILIA STATE UNIVERSITY	1421	27.175
RUSSIAN ACADEMY OF SCIENCES	1265	24.192
UNIVERSITY OF CALIFORNIA SYSTEM	1257	24.039
HELMHOLTZ ASSOCIATION	1252	23.943
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	1230	23.523
UNIVERSITY OF BELGRADE	1186	22.681
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS CSIC	1182	22.605
CHINESE ACADEMY OF SCIENCES	1181	22.586
ISTITUTO NAZIONALE DI FISICA NUCLEARE INFN	1181	22.586
CHARLES UNIVERSITY PRAGUE	1171	22.394
UNITED STATES DEPARTMENT OF ENERGY DOE	1171	22.394
UNIVERSITY OF BOLOGNA	1167	22.318
LOMONOSOV MOSCOW STATE UNIVERSITY	1164	22.26
BOSTON UNIVERSITY	1162	22.222
NATIONAL KAPODISTRIAN UNIVERSITY OF ATHENS	1160	22.184
NATIONAL RESEARCH CENTRE KURCHATOV INSTITUTE	1158	22.146
STATE UNIVERSITY OF NEW YORK SUNY SYSTEM	1158	22.146
OHIO STATE UNIVERSITY	1153	22.05
UNIVERSITE PARIS SACLAY	1152	22.031
UNIVERSITY OF CHICAGO	1146	21.916
JOINT INSTITUTE FOR NUCLEAR RESEARCH RUSSIA	1145	21.897
SAPIENZA UNIVERSITY ROME	1145	21.897
UNIVERSITY OF WISCONSIN MADISON	1145	21.897
UNIVERSITY OF WISCONSIN SYSTEM	1145	21.897
CNRS NATIONAL INSTITUTE OF NUCLEAR AND PARTICLE PHYSICS IN2P3	1142	21.84
UNIVERSITY OF ILLINOIS SYSTEM	1140	21.801
UNIVERSITY OF IOWA	1140	21.801
AUTONOMOUS UNIVERSITY OF MADRID	1133	21.668
UNIVERSITY OF PISA	1133	21.668
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH CERN	1131	21.629
HUNGARIAN ACADEMY OF SCIENCES	1130	21.61

Details on international collaborations

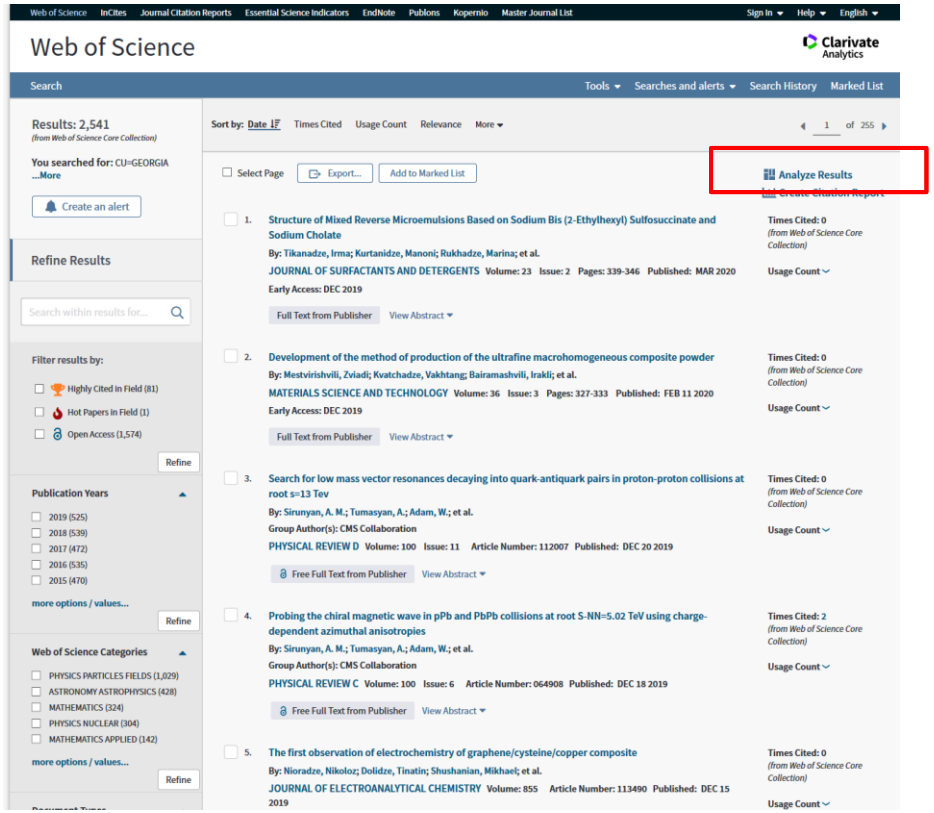


Search results
CU = GEORGIA





The subset of 2541 records for IVANE JAVAKHISHIVILI UNIVERSITY



The major research areas for IVANE JAVAKHISHIVILI UNIVERSITY

Part IV

MAPPING RELATIONSHIPS

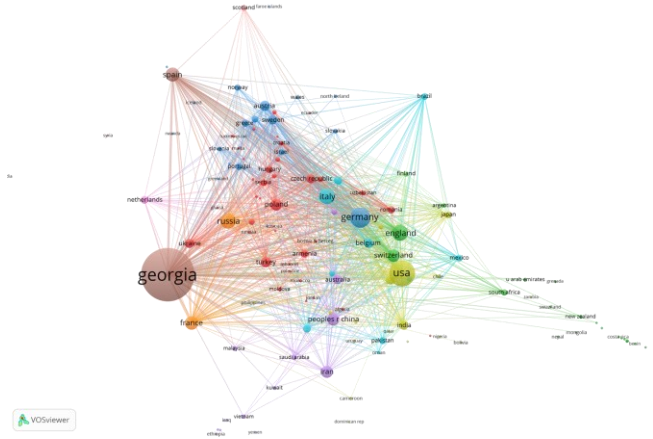
Fields of data and relationship analysis

A scientific publication	A patent	A project description
Author(s)	**Inventor(s)**	**Principal Investigator(s)**
Keywords / Title / Abstract	**Title / Abstract / Claims**	**Keywords / Title / Abstract**
Journal / Conference		
Author affiliation(s): • Department • **Institution** • **Country**	**Applicant(s)** • Department • **Institution / Organisation** • **Country**	**Participant(s):** • Department • **Institution / Organisation** • **Country**
Research area(s)	**IPC code**	Programme / Call / Priority Area
Funding source(s)	**Field of Technology (WIPO)**	Funding source(s)

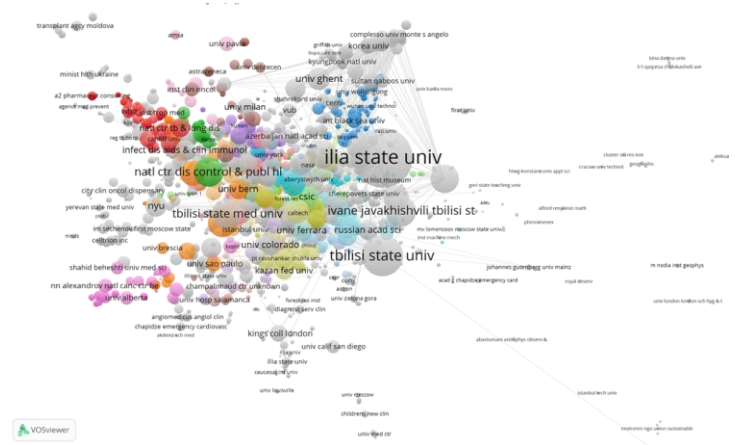
Examples of relationship mapping using open-source software

(Leiden University's VOSviewer, https://www.vosviewer.com/)

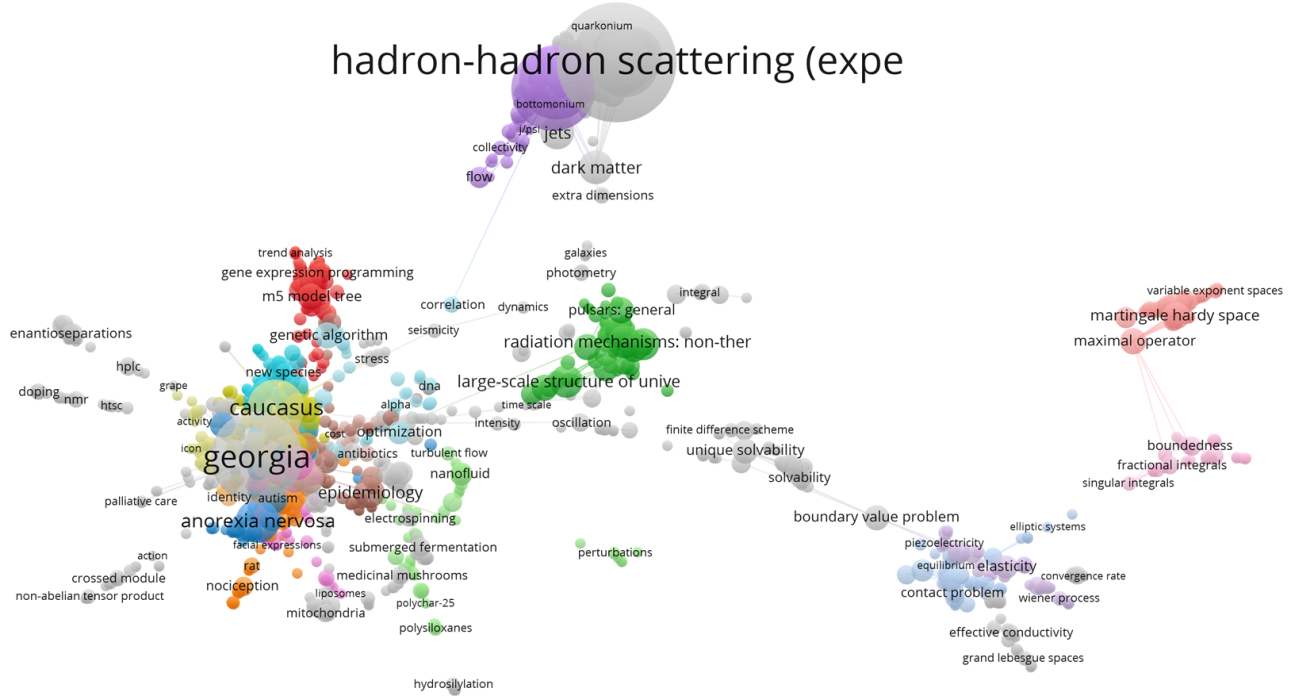
International Collaboration



Institutional Collaboration



Keyword Analysis



Advanced Scientometrics

Identifying and Mapping Emergent Science and Technology Domains through **Topic Modelling** → semantic characterization of a document corpus

Mapping STI Domains with a **Controlled Vocabulary** → identification of textual records related with some theme of interest

Mapping STI Domains from a **Seed Text Corpus** → Targeted analyses of STI within very specific domains

See Fuster, E., Massucci, F. A., and Matusiak, M. (2020). *Identifying specialisation domains beyond taxonomies: mapping scientific and technological domains of specialisation via semantic analyses*. In *Quantitative Methods for Place-Based Innovation Policy*, Cheltenham, UK: Edward Elgar Publishing. https://doi.org/10.4337/9781789905519.00014

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