



S3 Peer-exchange workshop for EU Enlargement and Neighbourhood Regions

# Quantitative Methods for Smart Specialisation: Identifying the Scientific Potential

29 March 2022

Dr-Ing Yannis Tolias

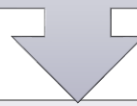
Managing Partner, innovatia systems

[tolias@innovatiasystems.eu](mailto:tolias@innovatiasystems.eu)

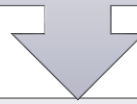


# Contents

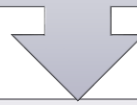
What kind of questions does S3 try to answer from the perspective of science / knowledge production?



Which questions can be answered through quantitative methods? How?



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

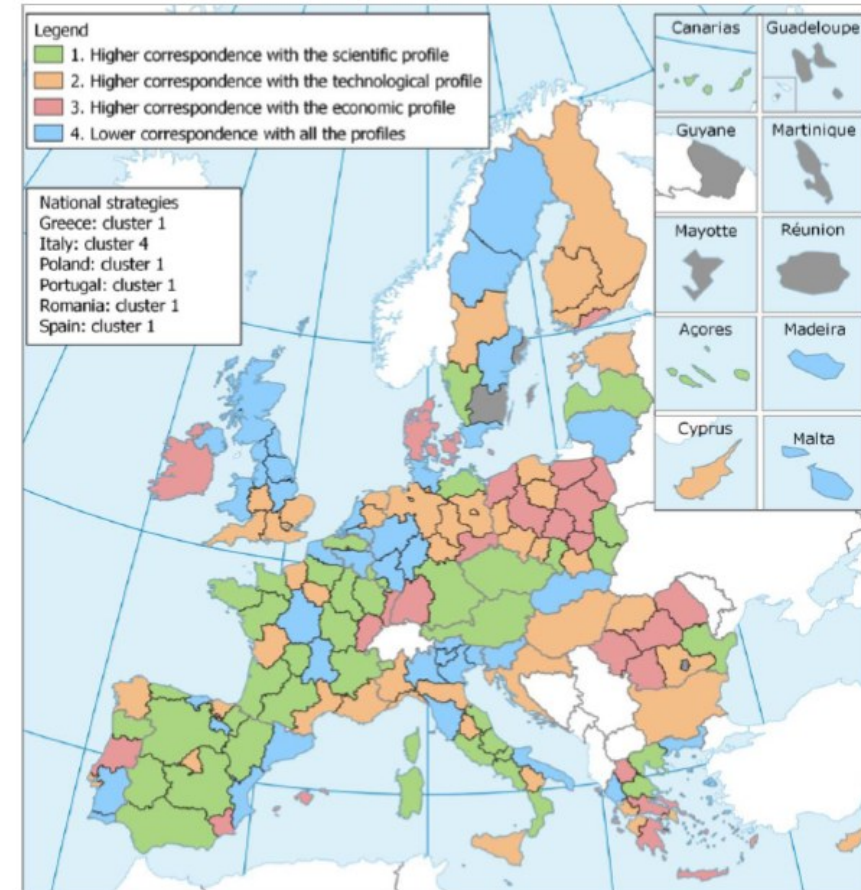


How do you do basic scientometrics?

# 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?
4. Who are the **key actors**? How are they linked with the national economy?
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6. How do lead institutions position themselves in global chains of knowledge?
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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**?

# 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

		<b><i>Scientific Capability</i></b>	
		<i>Low</i>	<i>High</i>
<b><i>Economic Potential</i></b>	<i>Low</i>	Forget it (from the S3 perspective)!	Can the exploitation of research outputs create new economic opportunities?
	<i>High</i>	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**

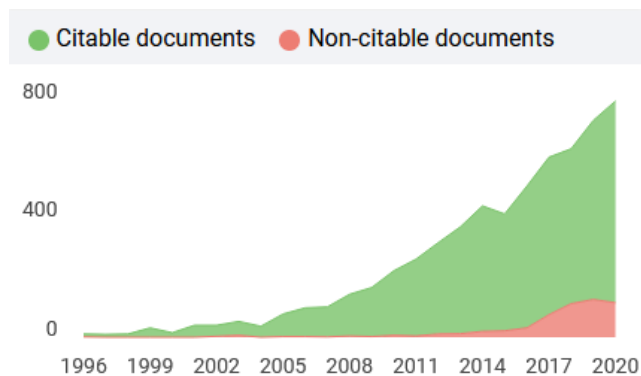




# Scientific Production

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

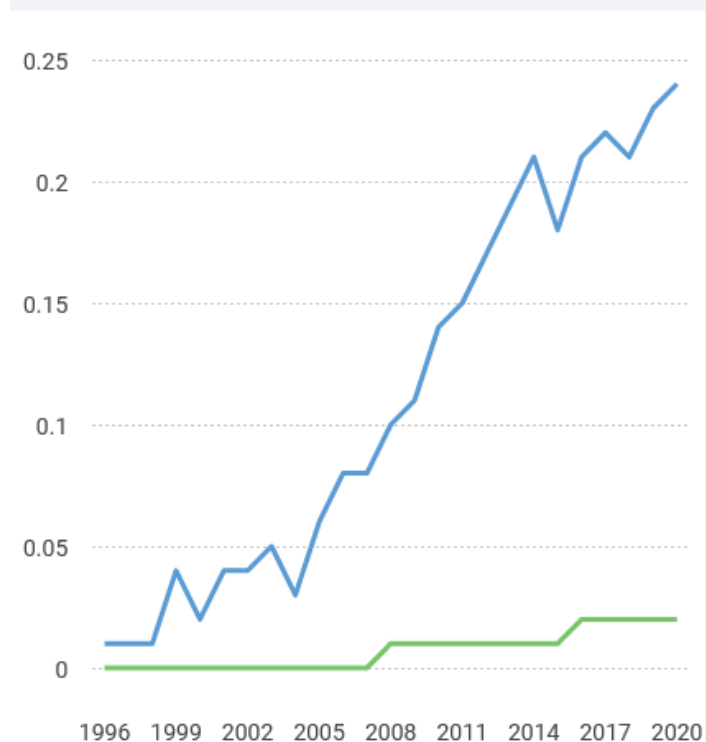
Publications per year



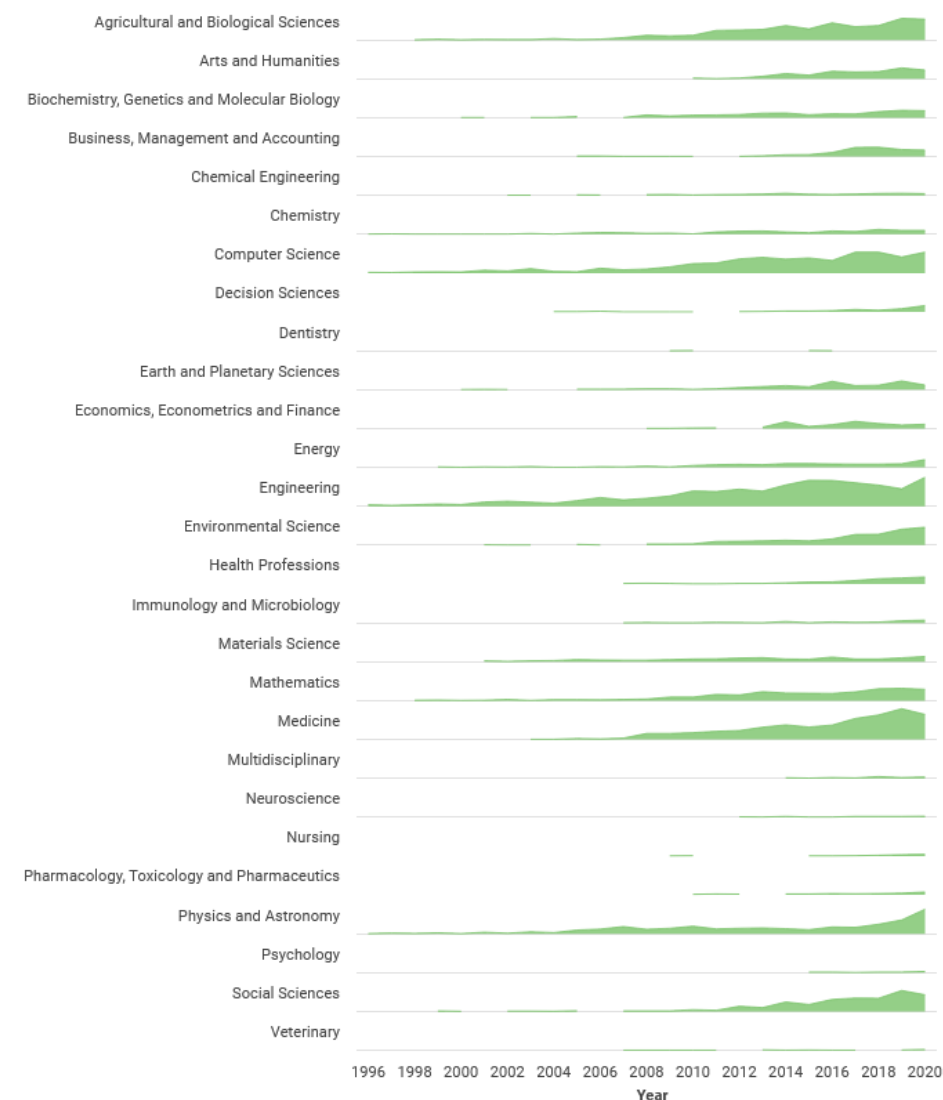
% international collaboration



Output:  
● % of the World ● % of Eastern Europe



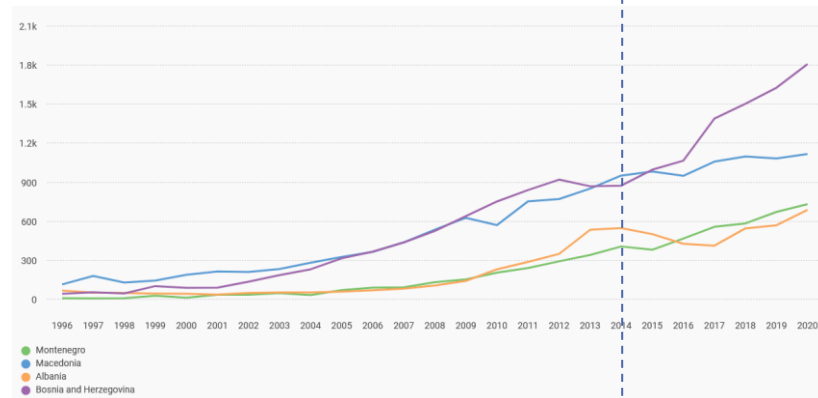
Publications per subject area



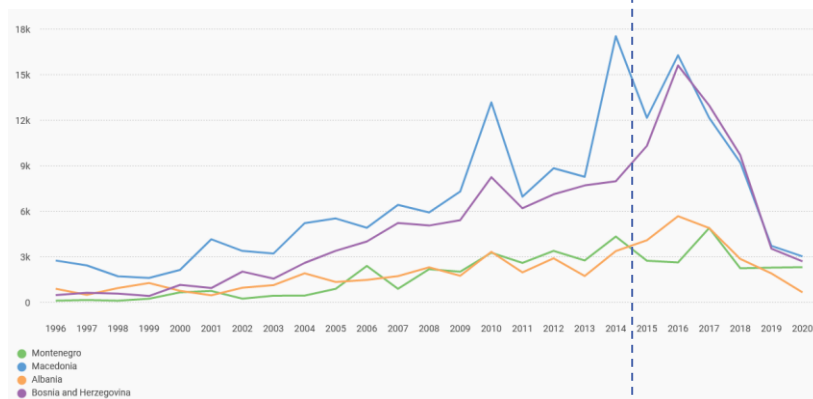
# Simple benchmarking

## Montenegro vs North Macedonia vs Albania vs Bosnia and Herzegovina

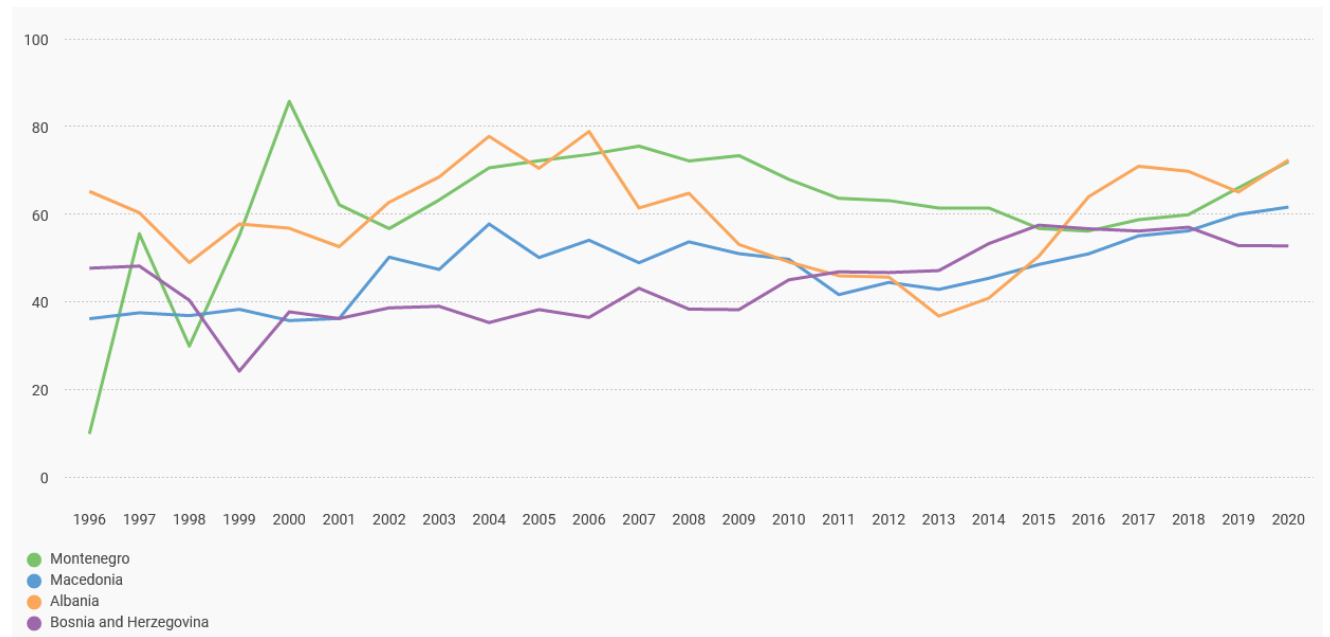
### Publications



### Citations



### % international collaboration



Part II

## **SPECIALISATION ANALYSIS & IDENTIFICATION OF EMERGING COMPETENCES**



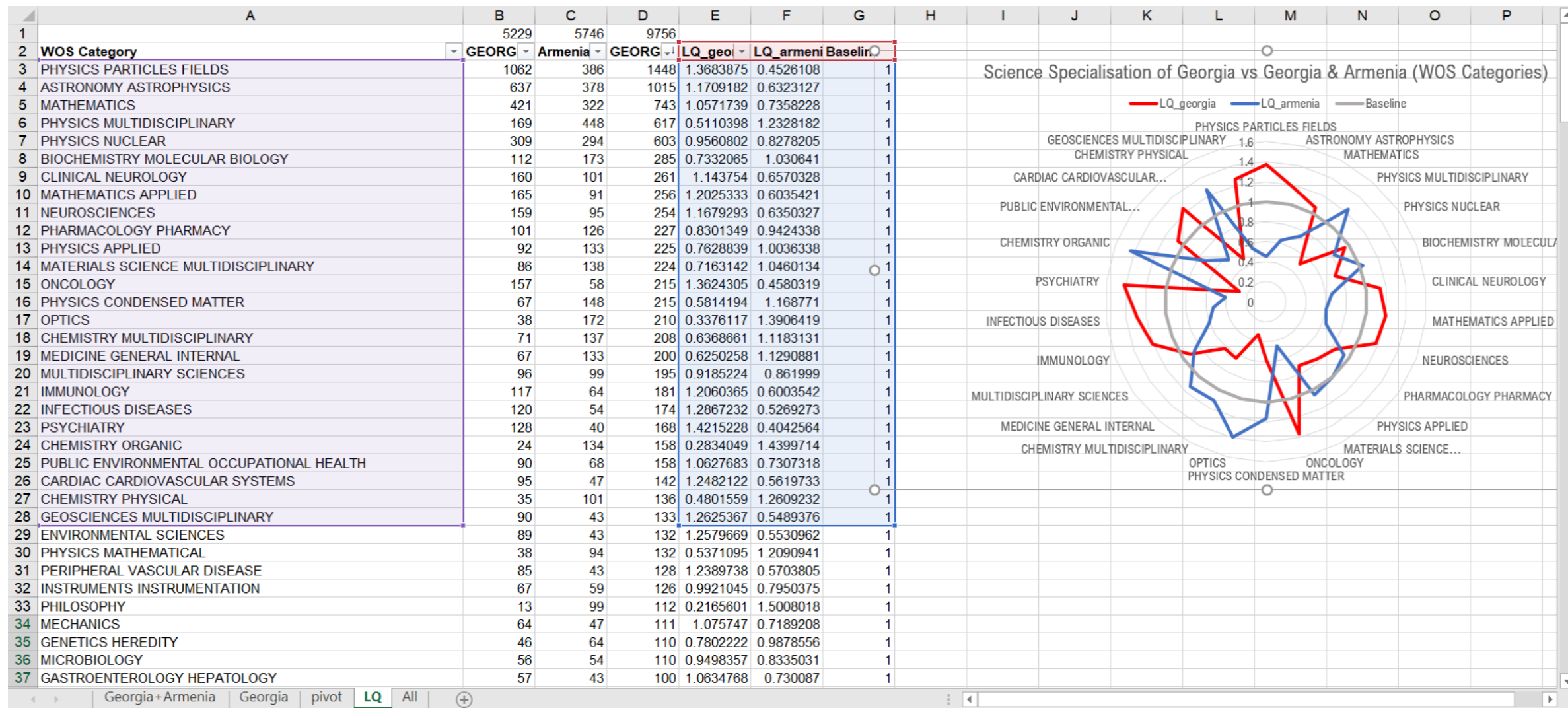
# Specialisation in Science: Key principles

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

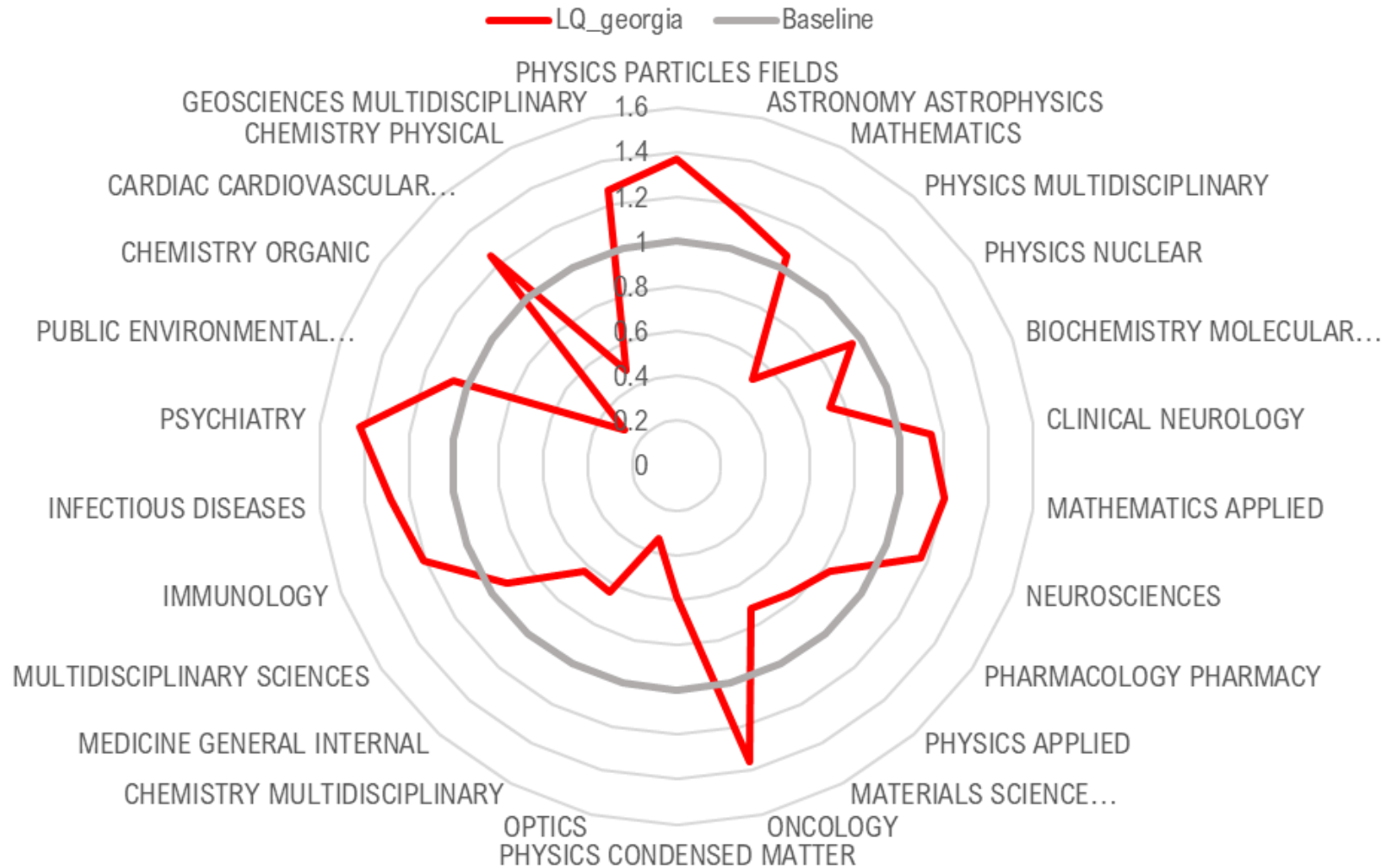


Standard practice for spider plots to sort the baseline data in decreasing order



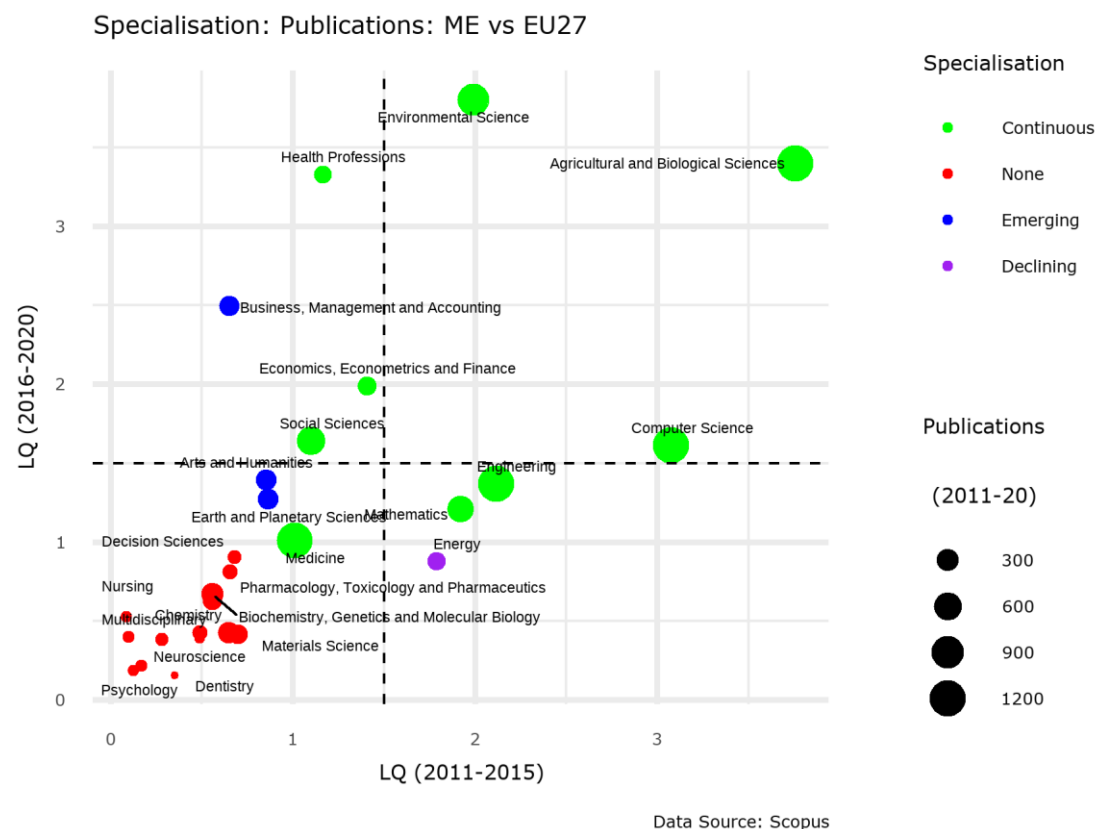
Done!

## Science Specialisation of Georgia vs Georgia & Armenia (WOS Categories)

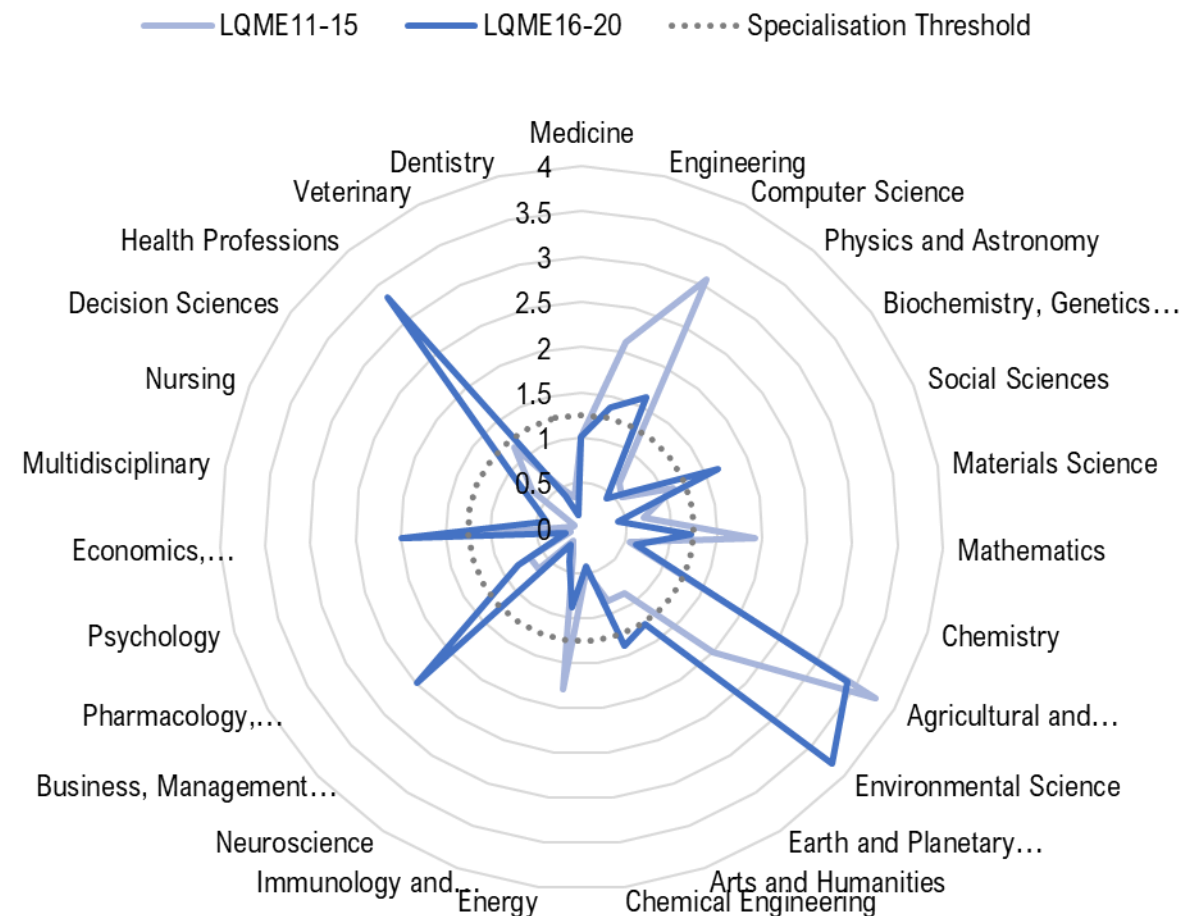


# Examples of visualization of the same data

Montenegro vs EU27 (2011-2020) version 1



Montenegro vs EU27 (2011-2020) version 2



Part III

## **IDENTIFICATION OF KEY ACTORS & PRELIMINARY INTERNATIONALISATION ANALYSIS**

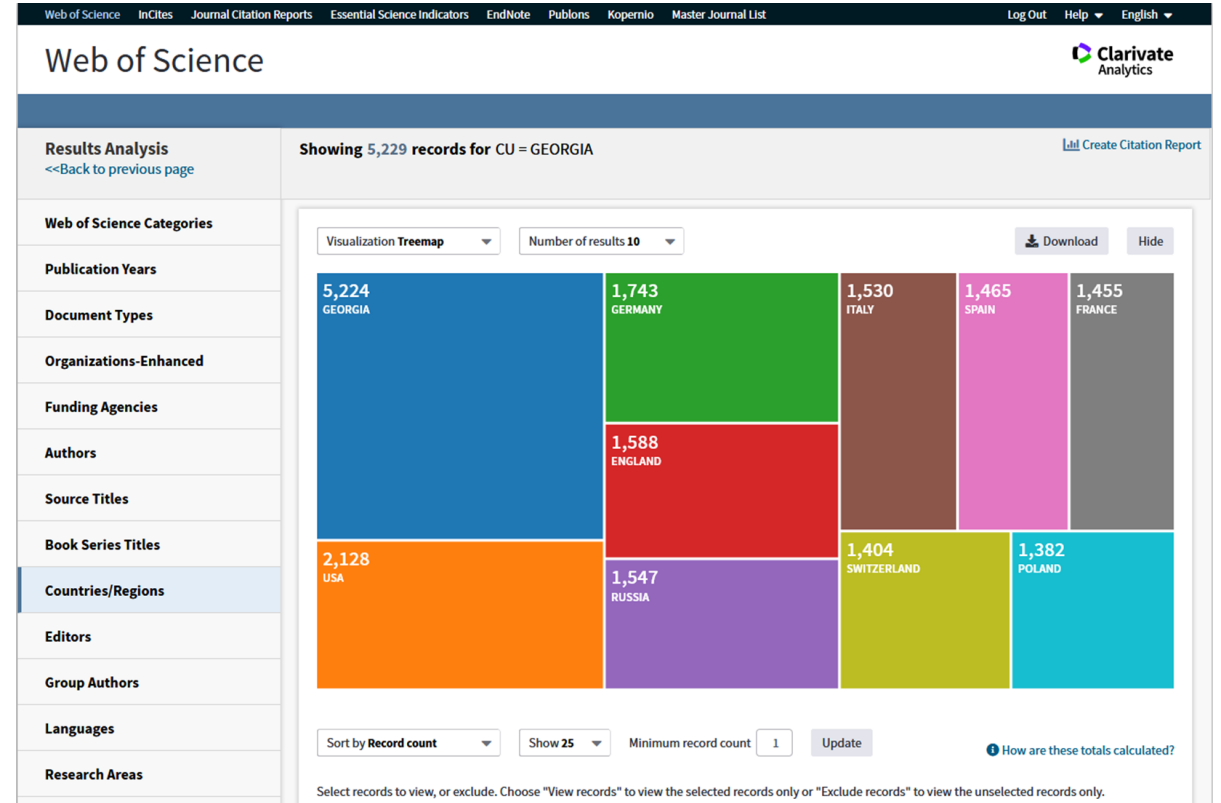




## Institutions' contribution to scientific publications

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

Web of Science InCites Journal Citation Reports Essential Science Indicators EndNote Publons Kopernio Master Journal List Sign In Help English

## Web of Science

Search Tools Searches and alerts Search History Marked List

Results: 5,721  
(from Web of Science Core Collection)

You searched for: CU=GEORGIA  
...More

Create an alert

### Refine Results

Search within results for...

Filter results by:

- ☐ Highly Cited in Field (159)
- ☐ Hot Papers in Field (9)
- ☐ Open Access (2,802)

Refine

Publication Years

- ☐ 2019 (1,325)
- ☐ 2018 (1,211)
- ☐ 2017 (1,079)
- ☐ 2016 (1,101)
- ☐ 2015 (1,005)

more options / values...

Refine

Web of Science Categories

Sort by: Date 1 Times Cited Usage Count Relevance More

1 of 573

Analyze Results  
Create Citation Report

1. Electrophysiological correlates of visual backward masking in patients with major depressive disorder  
By: Favrod, Ophelie; da Cruz, Janir R.; Roinishvili, Maya; et al.  
PSYCHIATRY RESEARCH-NEUROIMAGING Volume: 294 Article Number: 111004 Published: DEC 30 2019  
Full Text from Publisher View Abstract

2. Rationale and design of the AFFIRM-AHF trial: a randomised, double-blind, placebo-controlled trial comparing the effect of intravenous ferric carboxymaltose on hospitalisations and mortality in iron-deficient patients admitted for acute heart failure  
By: Ponikowski, Piotr; Kirwan, Bridget-Anne; Anker, Stefan D.; et al.  
EUROPEAN JOURNAL OF HEART FAILURE Volume: 21 Issue: 12 Pages: 1651-1658 Published: DEC 2019 Early Access: DEC 2019  
Free Full Text from Publisher View Abstract

3. Structure of Mixed Reverse Microemulsions Based on Sodium Bis (2-Ethylhexyl) Sulfosuccinate and Sodium Cholate  
By: Tikanadze, Irma; Kurtanidze, Manoni; Rukhadze, Marina; et al.  
JOURNAL OF SURFACTANTS AND DETERGENTS Volume: 23 Issue: 2 Pages: 339-346 Published: MAR 2020 Early Access: DEC 2019  
Full Text from Publisher View Abstract

4. Development of the method of production of the ultrafine macrohomogeneous composite powder  
By: Mestvirishvili, Zviadi; Kvatchadze, Vakhtang; Baimashvili, Irakli; et al.  
MATERIALS SCIENCE AND TECHNOLOGY Volume: 36 Issue: 3 Pages: 327-333 Published: FEB 11 2020 Early Access: DEC 2019  
Full Text from Publisher View Abstract

Web of Science InCites Journal Citation Reports Essential Science Indicators EndNote Publons Kopernio Master Journal List Log Out Help English

## Web of Science

Results Analysis <<Back to previous page

Showing 5,721 records for CU=GEORGIA Create Citation Report

Web of Science Categories

Publication Years

Document Types

Organizations-Enhanced

Funding Agencies

Authors

Source Titles

Book Series Titles

Meeting Titles

Countries/Regions

Editors

Group Authors

Languages

Research Areas

Grant Numbers

Organizations

Visualization Treemap Number of results 10 Download Hide

2,541 IVANE JAVAKHISHVILI TBILISI STATE UNIVERSITY

1,268 RUSSIAN ACADEMY OF SCIENCES

1,240 GEORGIAN TECHNICAL UNIVERSITY

1,233 CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS

1,186 UNIVERSITY OF BELGRADE

1,471 ILIA STATE UNIVERSITY

1,263 HELMHOLTZ ASSOCIATION

1,258 UNIVERSITY OF CALIFORNIA SYSTEM

1,183 CHINESE ACADEMY OF SCIENCES

1,183 CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS CSIC

Sort by Record count Show 10 Minimum record count 1 Update

Select records to view, or exclude. Choose "View records" to view the selected records only or "Exclude records" to view the unselected records only.

Select	Field: Organizations-Enhanced	Record Count	% of 5,721	Bar Chart
<input checked="" type="checkbox"/>	IVANE JAVAKHISHVILI TBILISI STATE UNIVERSITY	2,541	44.415 %	
<input type="checkbox"/>	ILIA STATE UNIVERSITY	1,471	25.712 %	
<input type="checkbox"/>	RUSSIAN ACADEMY OF SCIENCES	1,268	22.164 %	
<input type="checkbox"/>	HELMHOLTZ ASSOCIATION	1,263	22.077 %	
<input type="checkbox"/>	UNIVERSITY OF CALIFORNIA SYSTEM	1,258	21.989 %	
<input type="checkbox"/>	GEORGIAN TECHNICAL UNIVERSITY	1,240	21.675 %	
<input type="checkbox"/>	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	1,233	21.552 %	
<input type="checkbox"/>	UNIVERSITY OF BELGRADE	1,186	20.731 %	
<input type="checkbox"/>	CHINESE ACADEMY OF SCIENCES	1,183	20.678 %	
<input type="checkbox"/>	CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS CSIC	1,183	20.678 %	

(12,323 Organizations-Enhanced value(s) outside display options.)  
(8 records (0.140%) do not contain data in the field being analyzed.)

Exclude Selected View Selected

Select a download option (tab-delimited text file)

☒ Data rows displayed in table

☐ All data rows (up to 100,000)

Download



# The subset of 2541 records for IVANE JAVAKHISHVILI UNIVERSITY

Web of Science

Results: 2,541 (from Web of Science Core Collection)

You searched for: CU=GEORGIA

Create an alert

Refine Results

Search within results for...

Filter results by:

- ☐ Highly Cited in Field (81)
- ☐ Hot Papers in Field (1)
- ☐ Open Access (1,574)

Publication Years

- ☐ 2019 (525)
- ☐ 2018 (530)
- ☐ 2017 (472)
- ☐ 2016 (535)
- ☐ 2015 (470)

more options / values...

Web of Science Categories

- ☐ PHYSICS PARTICLES FIELDS (1,029)
- ☐ ASTRONOMY ASTROPHYSICS (428)
- ☐ MATHEMATICS (324)
- ☐ PHYSICS NUCLEAR (304)
- ☐ MATHEMATICS APPLIED (142)

more options / values...

1. Structure of Mixed Reverse Microemulsions Based on Sodium Bis (2-Ethylhexyl) Sulfosuccinate and Sodium Cholate

By: Tikanadze, Irma; Kurtanidze, Manoni; Bakhadze, Marina; et al.

JOURNAL OF SURFACTANTS AND DETERGENTS Volume: 23 Issue: 2 Pages: 339-346 Published: MAR 2020

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Full Text from Publisher View Abstract

2. Development of the method of production of the ultrafine macrohomogeneous composite powder

By: Mestvirishvili, Zviadi; Kvachadze, Vakhtang; Bainamashvili, Irakli; et al.

MATERIALS SCIENCE AND TECHNOLOGY Volume: 36 Issue: 3 Pages: 327-333 Published: FEB 11 2020

Early Access: DEC 2019

Full Text from Publisher View Abstract

3. Search for low mass vector resonances decaying into quark-antiquark pairs in proton-proton collisions at root s=13 TeV

By: Sirunyan, A. M.; Tumanyan, A.; Adam, W.; et al.

Group Author(s): CMS Collaboration

PHYSICAL REVIEW D Volume: 100 Issue: 11 Article Number: 112007 Published: DEC 20 2019

Free Full Text from Publisher View Abstract

4. Probing the chiral magnetic wave in pPb and PbPb collisions at root s-NN=5.02 TeV using charge-dependent azimuthal anisotropies

By: Sirunyan, A. M.; Tumanyan, A.; Adam, W.; et al.

Group Author(s): CMS Collaboration

PHYSICAL REVIEW C Volume: 100 Issue: 6 Article Number: 064908 Published: DEC 18 2019

Free Full Text from Publisher View Abstract

5. The first observation of electrochemistry of graphene/cysteine/copper composite

By: Nioradze, Nikoloz; Dolidze, Tinatin; Shushanian, Mikhael; et al.

JOURNAL OF ELECTROANALYTICAL CHEMISTRY Volume: 855 Article Number: 113490 Published: DEC 15 2019

# The major research areas for IVANE JAVAKHISHVILI UNIVERSITY

Web of Science

Results Analysis

Showing 2,541 records for CU=GEORGIA

Web of Science Categories

Publication Years

Document Types

Organizations-Enhanced

Funding Agencies

Authors

Source Titles

Book Series Titles

Meeting Titles

Countries/Regions

Editors

Group Authors

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Visualization Treemap

Number of results 10

Download Hide

1,029 PHYSICS PARTICLES FIELDS

324 MATHEMATICS

142 MATHEMATICS APPLIED

133 PHYSICS MULTIDISCIPLINARY

428 ASTRONOMY ASTROPHYSICS

304 PHYSICS NUCLEAR

78 ENGINEERING ELECTRICAL ELECTRONIC

46 PHYSICS CONDENSED MATTER

69 PHYSICS APPLIED

42 MATERIALS SCIENCE MULTIDISCIPLINARY

Sort by Record count

Show 10

Minimum record count 1

Update

How are these totals calculated?

Select records to view, or exclude. Choose "View records" to view the selected records only or "Exclude records" to view the unselected records only.

Select	Field: Web of Science Categories	Record Count	% of 2,541	Bar Chart
<input type="checkbox"/>	PHYSICS PARTICLES FIELDS	1,029	40.496 %	
<input type="checkbox"/>	ASTRONOMY ASTROPHYSICS	428	16.844 %	
<input type="checkbox"/>	MATHEMATICS	324	12.751 %	
<input type="checkbox"/>	PHYSICS NUCLEAR	304	11.964 %	
<input type="checkbox"/>	MATHEMATICS APPLIED	142	5.588 %	
<input type="checkbox"/>	PHYSICS MULTIDISCIPLINARY	133	5.234 %	
<input type="checkbox"/>	ENGINEERING ELECTRICAL ELECTRONIC	78	3.070 %	
<input type="checkbox"/>	PHYSICS APPLIED	69	2.715 %	
<input type="checkbox"/>	PHYSICS CONDENSED MATTER	46	1.810 %	
<input type="checkbox"/>	MATERIALS SCIENCE MULTIDISCIPLINARY	42	1.653 %	

(159 Web of Science Categories value(s) outside display options.)  
(1 records (0.039%) do not contain data in the field being analyzed.)

Select a download option (tab-delimited text file)

☐ Data rows displayed in table

☐ All data rows (up to 100,000)

Download

Exclude Selected View Selected



Part IV

## **MAPPING RELATIONSHIPS**



# Fields of data and relationship analysis

A scientific publication

**Author(s)**

**Keywords / Title / Abstract**

Journal / Conference

**Author affiliation(s):**

- Department
- **Institution**
- **Country**

Research area(s)

Funding source(s)

A patent

**Inventor(s)**

**Title / Abstract / Claims**

**Applicant(s)**

- Department
- **Institution / Organisation**
- **Country**

**IPC code**

**Field of Technology (WIPO)**

A project description

**Principal Investigator(s)**

**Keywords / Title / Abstract**

**Participant(s):**

- Department
- **Institution / Organisation**
- **Country**

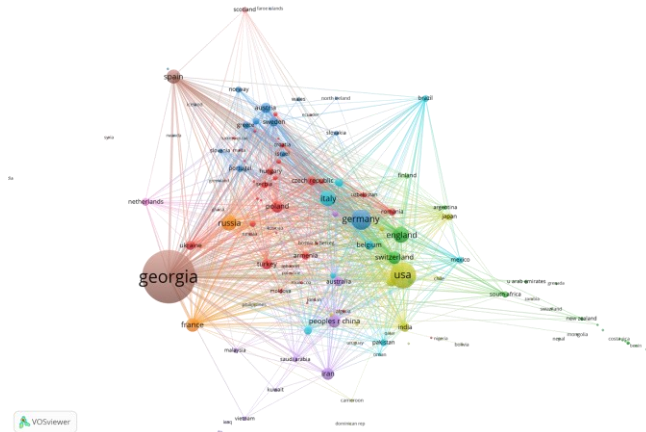
Programme / Call / Priority Area

Funding source(s)

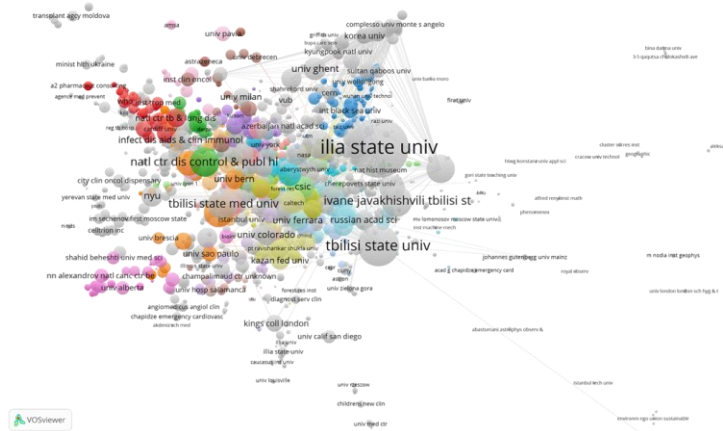
# Examples of relationship mapping using open-source software

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

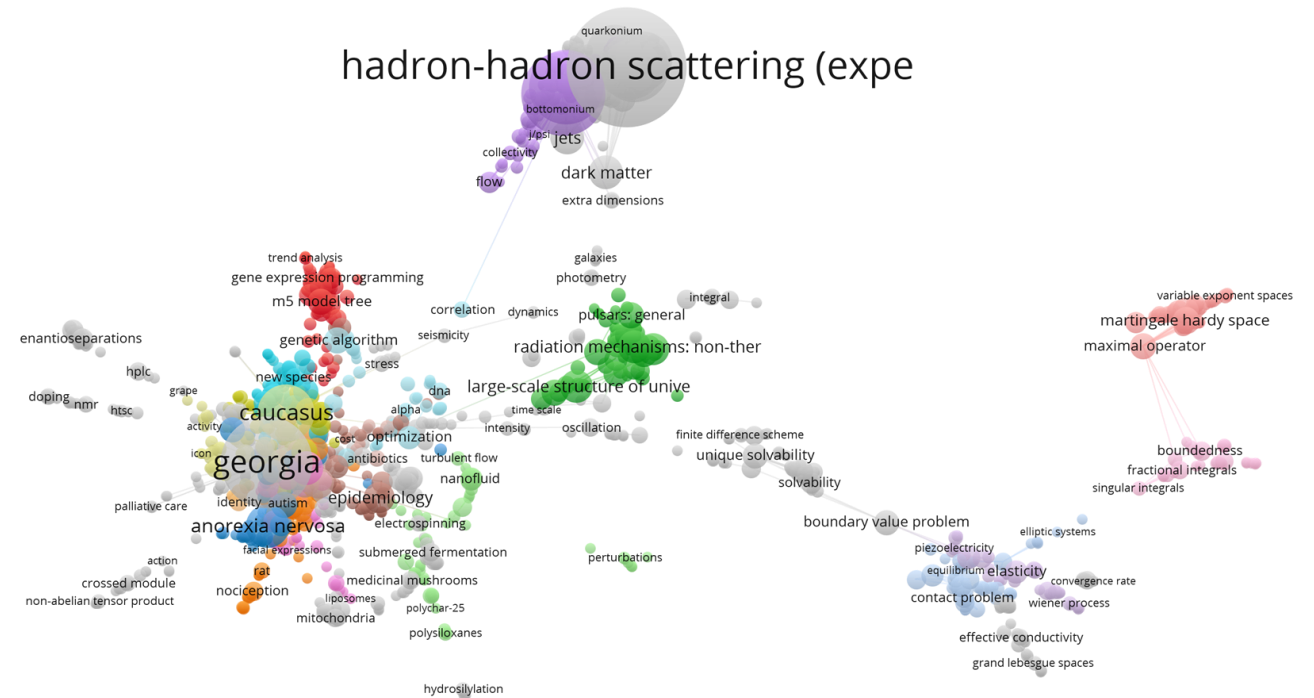
## International Collaboration



## 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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