Visual exploration of scientific literature using VOSviewer and CitNetExplorer

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ICTeSSH 2020 Conference
July 1, 2020

Explosive growth of scientific literature

SARA GIRONI CARNEVALE

Scientists are drowning in COVID-19 papers. Can new tools keep them afloat?

By Jeffrey Brainard | May. 13, 2020 , 12:15 PM

***Science*'s COVID-19 reporting is supported by the Pulitzer Center.**

Timothy Sheahan, a virologist studying COVID-19, wishes he could keep pace with the growing torrent of new scientific papers about the disease and the novel coronavirus that causes it. But there are just too many—more than 4000 alone last week. "I'm not keeping up," says Sheahan, who works at the University of North Carolina, Chapel Hill. "It's impossible."

"A new scientific paper is published every 30 seconds and there are 10,000 updates to PubMed every day"

"It is impossible for humans alone to process all of the complex information potentially available to them for the advancement of scientific research"

James Chandler, November 2016, BenevolentAI

Bibliographic data sources

Scopus

Web of Science

Dimensions

PubMed

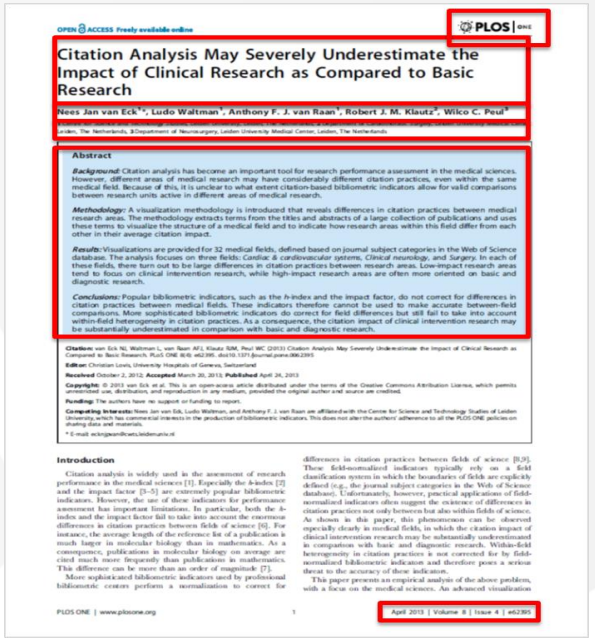
Crossref

Europe PMC

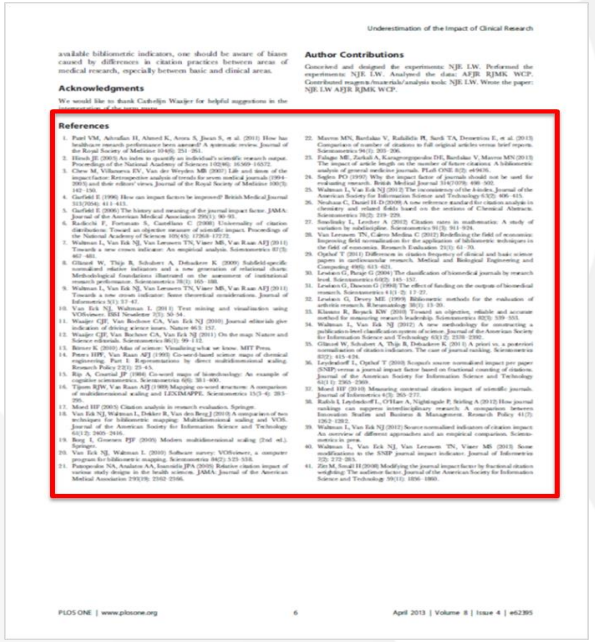
Semantic Scholar

Microsoft Academic

WIKIDATA



Citation Analysis May Severely Underestimate the Impact of Clinical Research as Compared to Basic Research



Bibliographic data sources

	Web of Science	Scopus	Dimensions
Journals	20,000	25,000	50,000
Publications	60 million	50 million	110 million
Citations	1.4 billion	1.5 billion	1.2 billion

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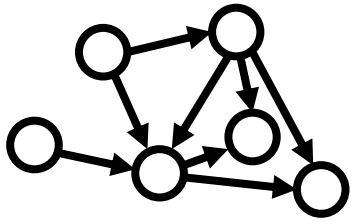
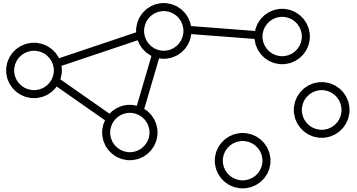
Bibliometric networks

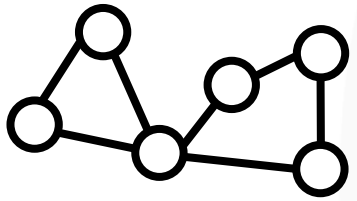
Bibliographic data source



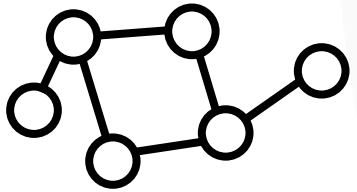
Citation network
of pubs / journals / authors / orgs / countries



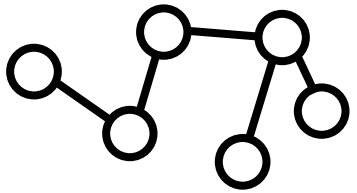
Co-authorship network
of authors / orgs / countries



Co-citation network
of pubs / journals / authors / orgs / countries



Bibliographic coupling network
of pubs / journals / authors



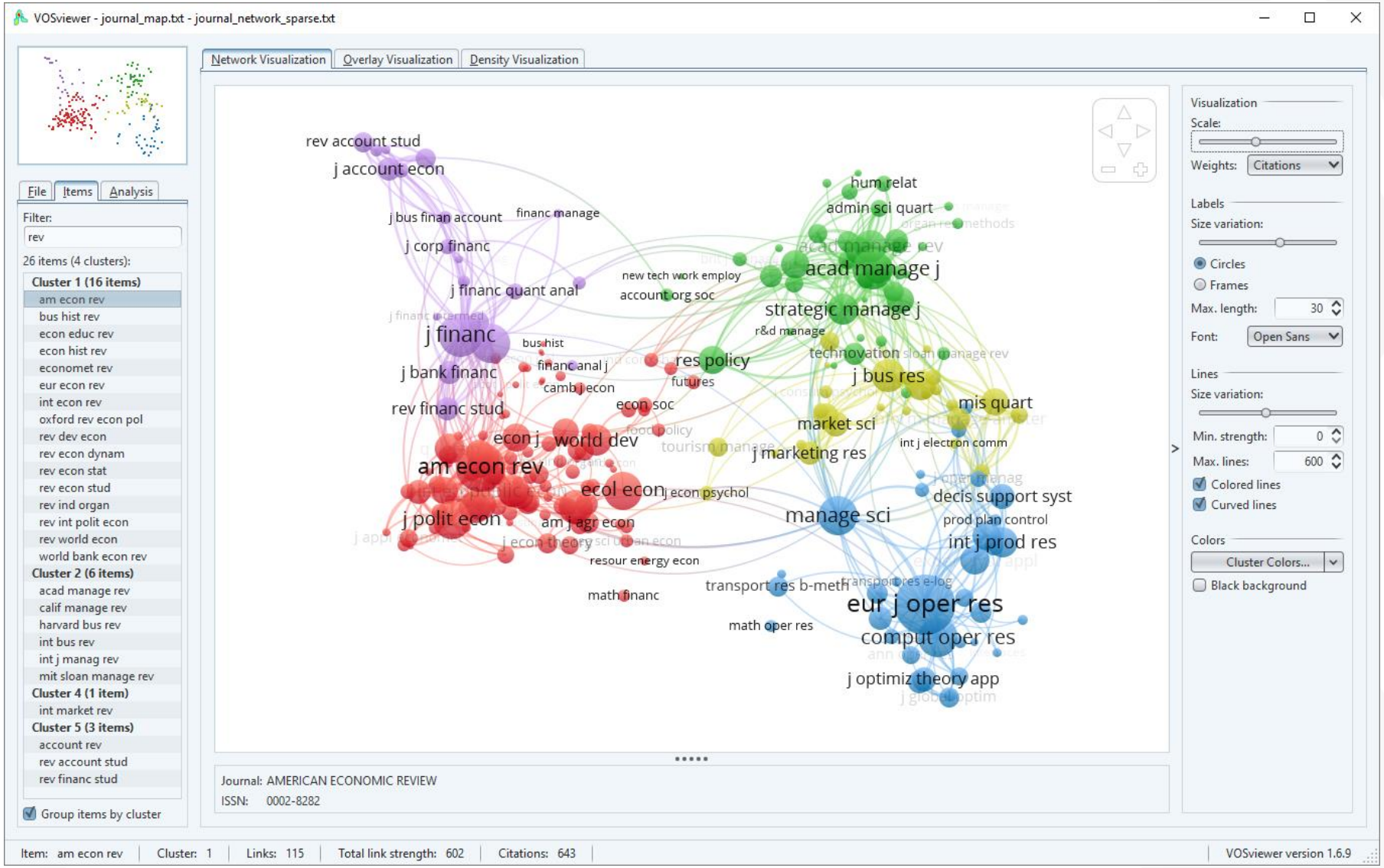
Co-occurrence network
of keywords / terms

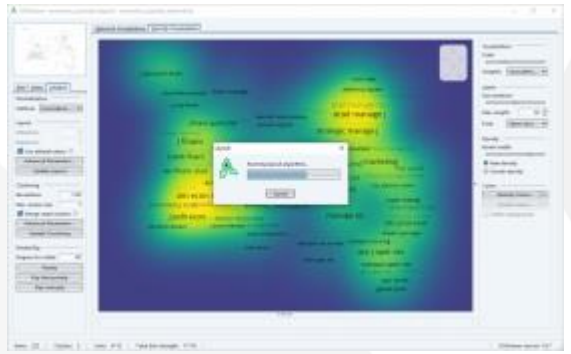
CWTS

Outline

- Software tools
  - VOSviewer
  - CitNetExplorer
- Network analysis techniques
- Algorithmically constructed classification system of science

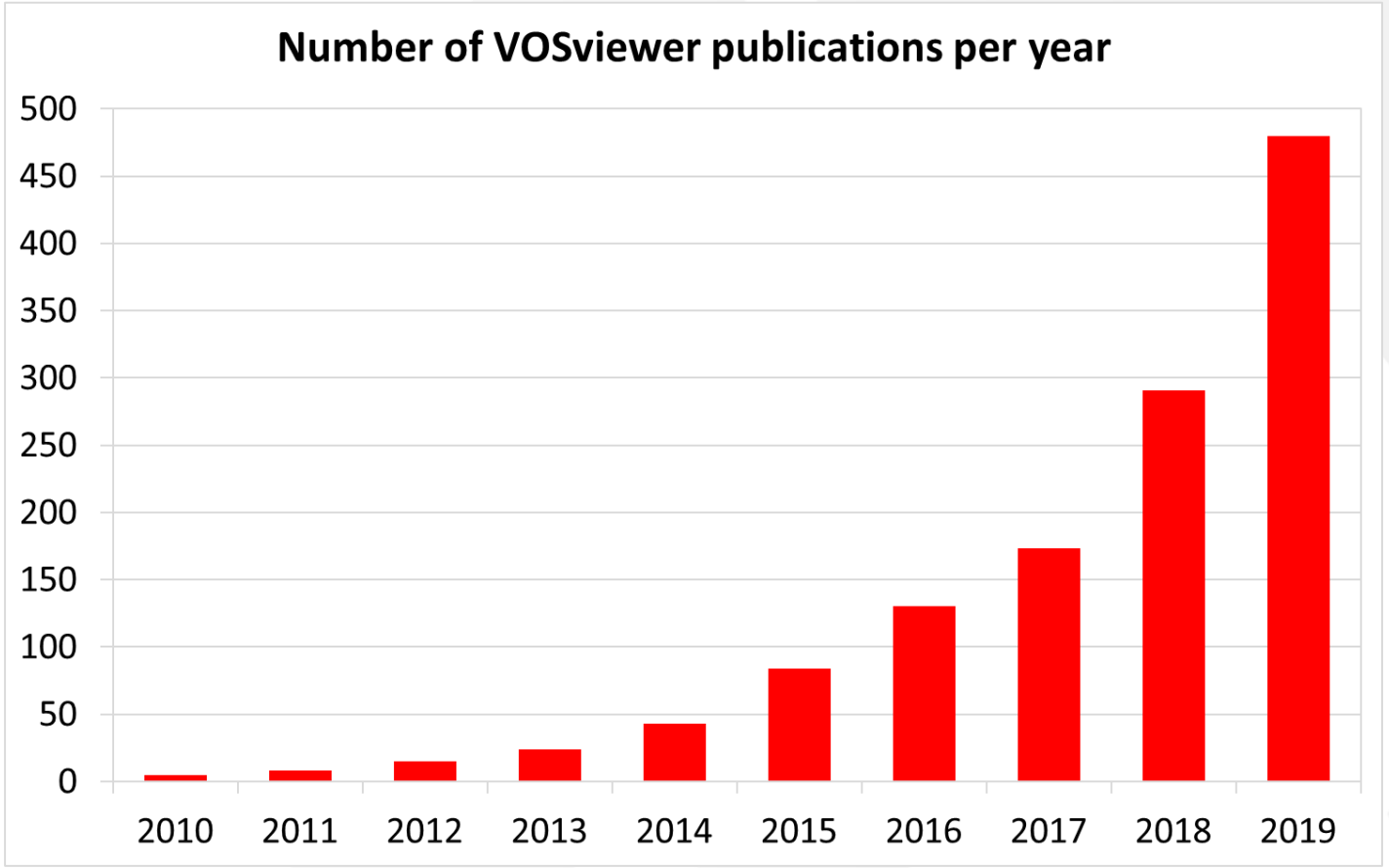
VOSviewer


VOSviewer - journal_map.txt - journal_network_sparse.txt
Network Visualization
Overlay Visualization
Density Visualization
File
Items
Analysis
Filter:
rev
26 items (4 clusters):
Cluster 1 (16 items)
am econ rev
bus hist rev
econ educ rev
econ hist rev
economet rev
eur econ rev
int econ rev
oxford rev econ pol
rev dev econ
rev econ dynam
rev econ stat
rev econ stud
rev ind organ
rev int polit econ
rev world econ
world bank econ rev
Cluster 2 (6 items)
acad manage rev
calif manage rev
harvard bus rev
int bus rev
int j manag rev
mit sloan manage rev
Cluster 4 (1 item)
int market rev
Cluster 5 (3 items)
account rev
rev account stud
rev financ stud
Group items by cluster
rev account stud
j account econ
j bus finan account
financ manage
j corp financ
j financ quant anal
new tech work employ
account org soc
j financ
bus hist
financ anal j
camb j econ
j bank financ
res policy
futures
econ soc
rev financ stud
econ j
world dev
am econ rev
ecol econ
j econ psychol
j polit econ
am j agr econ
j econ theory
resour energy econ
math financ
hum relat
admin sci quart
acad manage rev
acad manage j
strategic manage j
r&d manage
technovation
j bus res
mis quart
market sci
int j electron comm
j marketing res
manage sci
decis support syst
prod plan control
int j prod res
transport res b-meth
transport res e-log
eur j oper res
math oper res
comput oper res
j optimiz theory app
Journal: AMERICAN ECONOMIC REVIEW
ISSN: 0002-8282
Visualization
Scale:
Weights: Citations
Labels
Size variation:
Circles
Frames
Max. length: 30
Font: Open Sans
Lines
Size variation:
Min. strength: 0
Max. lines: 600
Colored lines
Curved lines
Colors
Cluster Colors...
Black background
Item: am econ rev
Cluster: 1
Links: 115
Total link strength: 602
Citations: 643
VOSviewer version 1.6.9

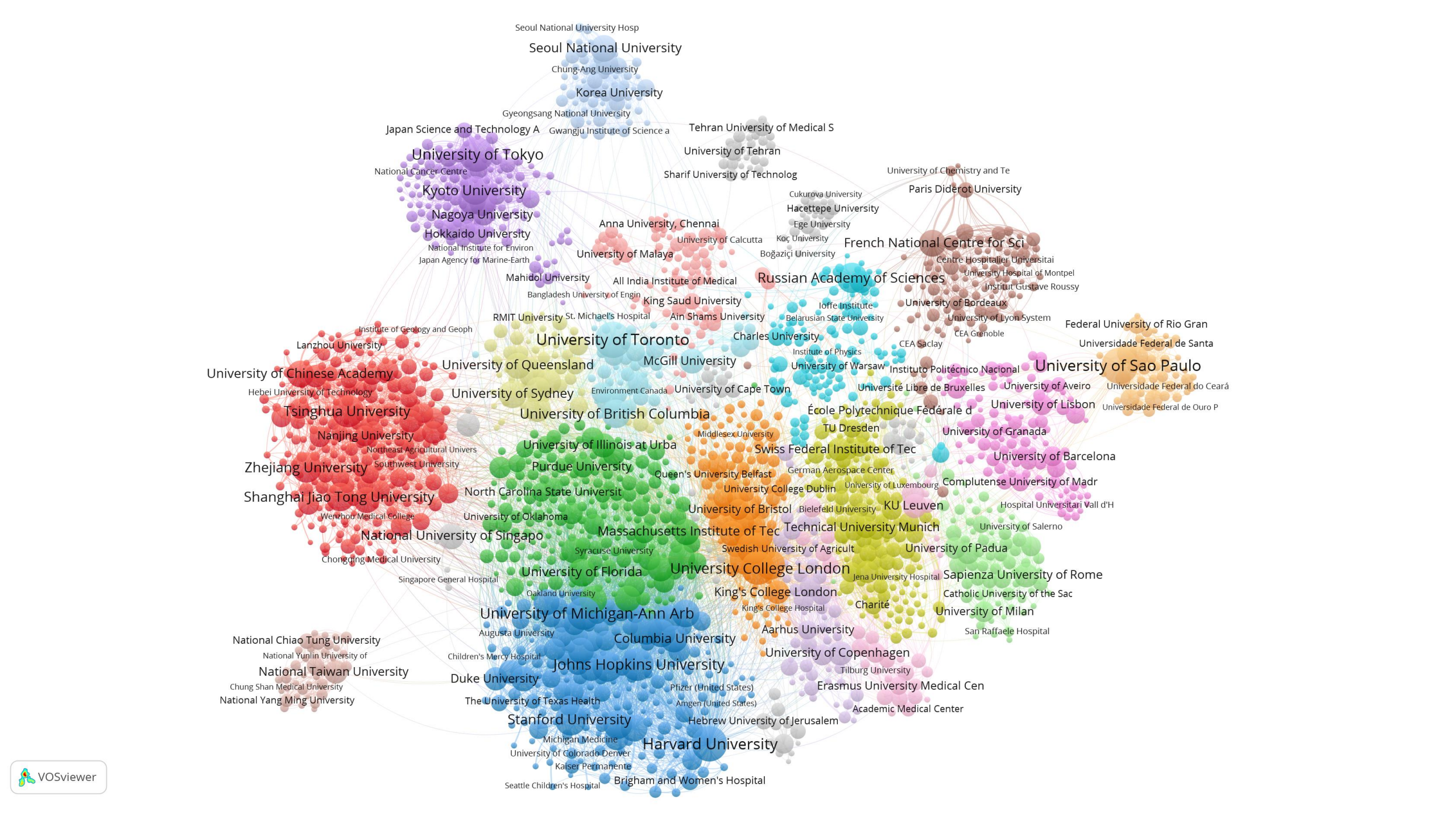


Users of VOSviewer

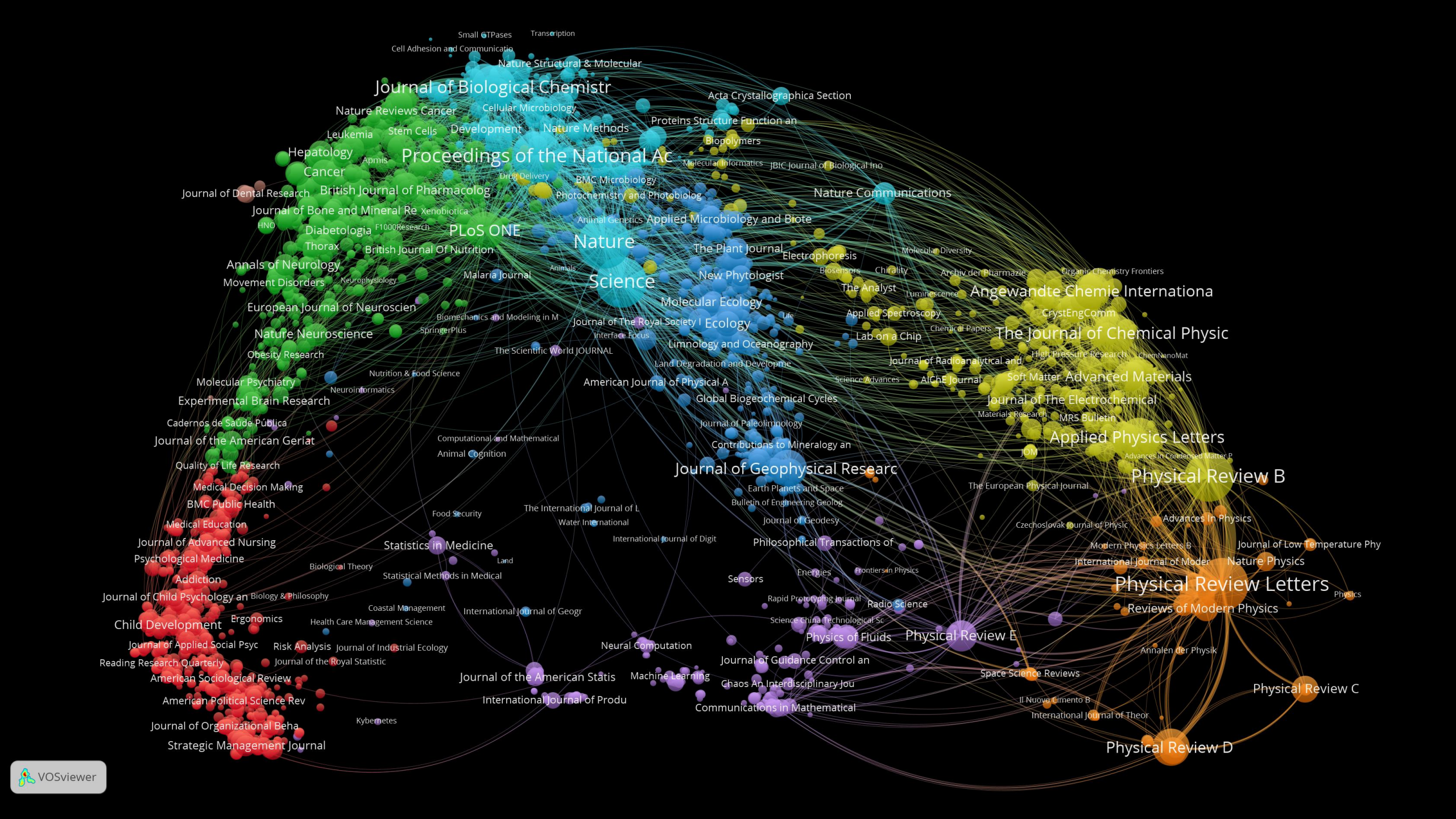
- Researchers
- Research institutions
- Research funders
- Scientific publishers
- Industry



CWTS

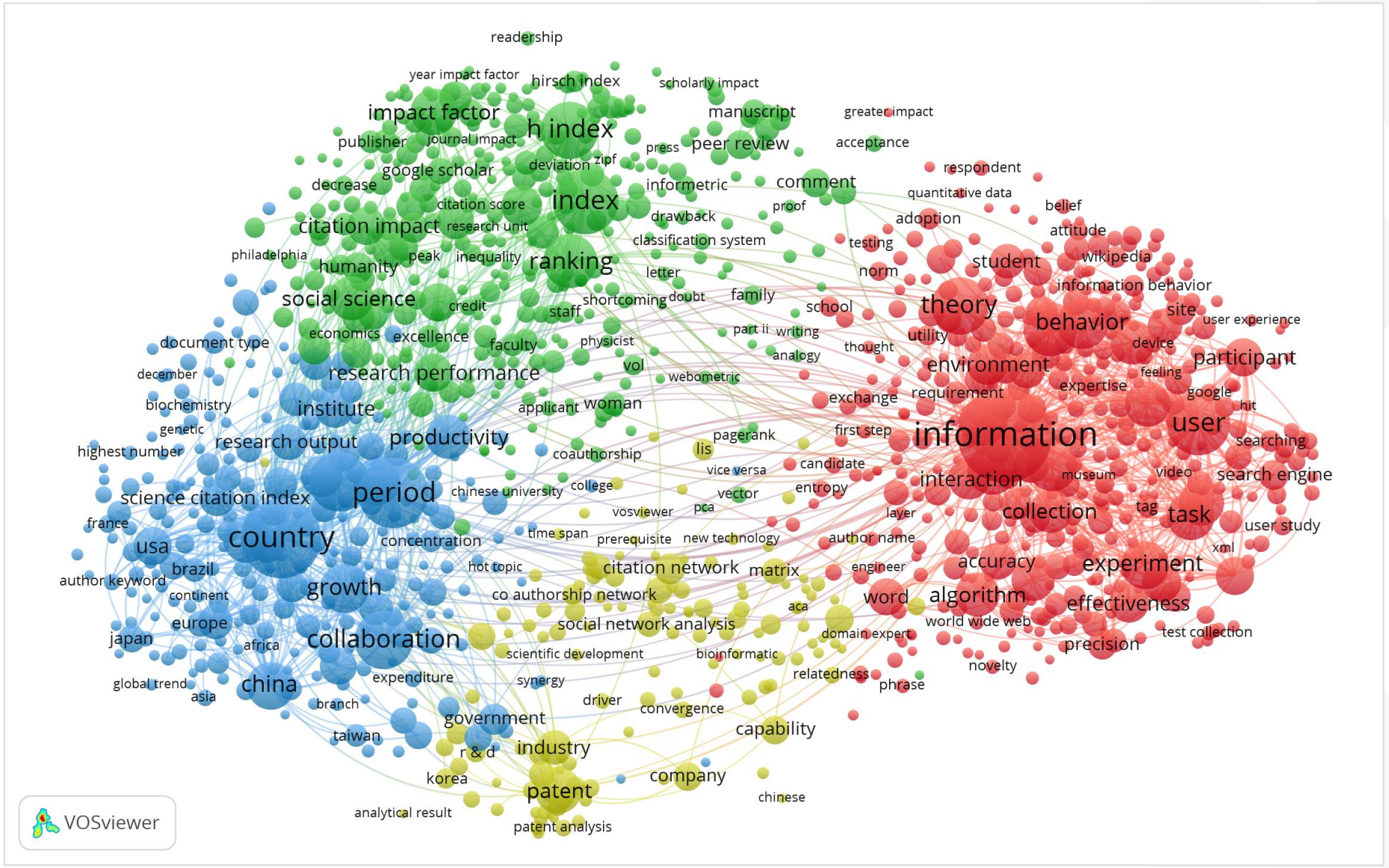

Seoul National University Hosp
Seoul National University
Chung-Ang University
Korea University
Gyeongsang National University
Japan Science and Technology A
Gwangju Institute of Science a
Tehran University of Medical S
University of Tehran
University of Tokyo
Sharif University of Technolog
National Cancer Centre
Kyoto University
Nagoya University
Hokkaido University
National Institute for Environ
Japan Agency for Marine-Earth
Anna University, Chennai
University of Calcutta
University of Malaya
Mahidol University
All India Institute of Medical
Bangladesh University of Engin
King Saud University
RMIT University
St. Michael's Hospital
Ain Shams University
University of Chemistry and Te
Paris Diderot University
Cukurova University
Hacettepe University
Ege University
Koç University
Boğaziçi University
French National Centre for Sci
Centre Hospitalier Universitai
University Hospital of Montpel
Russian Academy of Sciences
Institut Gustave Roussy
Ioffe Institute
Belarusian State University
University of Bordeaux
University of Lyon System
CEA Grenoble
CEA Saclay
Institute of Physics
University of Warsaw
Federal University of Rio Gran
Universidade Federal de Santa
Institute of Geology and Geoph
Lanzhou University
University of Toronto
Charles University
University of Queensland
McGill University
University of Chinese Academy
Hebei University of Technology
University of Sydney
Environment Canada
University of Cape Town
Instituto Politécnico Nacional
University of Sao Paulo
Université Libre de Bruxelles
University of Aveiro
Universidade Federal do Ceará
Tsinghua University
University of British Columbia
École Polytechnique Fédérale d
University of Lisbon
Universidade Federal de Ouro P
TU Dresden
Middlesex University
University of Granada
Nanjing University
University of Illinois at Urba
Swiss Federal Institute of Tec
Northeast Agricultural Univers
Purdue University
University of Barcelona
Zhejiang University
Southwest University
Queen's University Belfast
German Aerospace Center
University College Dublin
University of Luxembourg
Complutense University of Madr
North Carolina State Universit
Shanghai Jiao Tong University
University of Bristol
Bielefeld University
KU Leuven
Hospital Universitari Vall d'H
Wenzhou Medical College
University of Oklahoma
Technical University Munich
University of Salerno
National University of Singapo
Massachusetts Institute of Tec
Swedish University of Agricult
University of Padua
Syracuse University
Chongqing Medical University
University College London
Sapienza University of Rome
University of Florida
Jena University Hospital
Singapore General Hospital
King's College London
Catholic University of the Sac
Oakland University
Charité
King's College Hospital
University of Milan
University of Michigan-Ann Arb
Augusta University
Aarhus University
San Raffaele Hospital
National Chiao Tung University
Columbia University
National Yunlin University of
University of Copenhagen
Children's Mercy Hospital
Johns Hopkins University
Tilburg University
National Taiwan University
Duke University
Erasmus University Medical Cen
Chung Shan Medical University
Pfizer (United States)
National Yang Ming University
The University of Texas Health
Amgen (United States)
Academic Medical Center
Stanford University
Hebrew University of Jerusalem
Michigan Medicine
Harvard University
University of Colorado Denver
Kaiser Permanente
Brigham and Women's Hospital
Seattle Children's Hospital

VOSviewer


Small GTPases
Transcription
Cell Adhesion and Communicatio
Nature Structural & Molecular
Journal of Biological Chemistr
Acta Crystallographica Section
Nature Reviews Cancer
Cellular Microbiology
Proteins Structure Function an
Leukemia
Stem Cells
Development
Nature Methods
Biopolymers
Hepatology
Apmis
Proceedings of the National Ac
Molecular Informatics
JBIC Journal of Biological Ino
Cancer
Drug Delivery
BMC Microbiology
Journal of Dental Research
British Journal of Pharmacolog
Photochemistry and Photobiolog
Nature Communications
Journal of Bone and Mineral Re
Xenobiotica
Animal Genetics
Applied Microbiology and Biote
HNO
F1000Research
Diabetologia
PLoS ONE
Nature
Thorax
British Journal Of Nutrition
The Plant Journal
Electrophoresis
Molecular Diversity
Annals of Neurology
Animals
Biosensors
Chirality
Archiv der Pharmazie
Organic Chemistry Frontiers
Movement Disorders
Neurophysiology
Malaria Journal
Science
New Phytologist
The Analyst
Angewandte Chemie Internationa
Luminescence
European Journal of Neuroscien
Molecular Ecology
Applied Spectroscopy
CrystEngComm
Biomechanics and Modeling in M
Life
Journal of The Royal Society I
Ecology
Chemical Papers
SpringerPlus
Lab on a Chip
The Journal of Chemical Physic
Nature Neuroscience
Interface Focus
Limnology and Oceanography
High Pressure Research
ChemNanoMat
Obesity Research
The Scientific World JOURNAL
Land Degradation and Developme
Journal of Radioanalytical and
Nutrition & Food Science
Science Advances
AIChE Journal
Soft Matter
Advanced Materials
Molecular Psychiatry
American Journal of Physical A
Neuroinformatics
Global Biogeochemical Cycles
Journal of The Electrochemical
Experimental Brain Research
Materials Research
MRS Bulletin
Cadernos de Saúde Pública
Journal of Paleolimnology
Applied Physics Letters
Journal of the American Geriat
Computational and Mathematical
Contributions to Mineralogy an
JOM
Animal Cognition
Advances in Condensed Matter P
Quality of Life Research
Journal of Geophysical Researc
Physical Review B
Medical Decision Making
Earth Planets and Space
The European Physical Journal
BMC Public Health
Bulletin of Engineering Geolog
Food Security
The International Journal of L
Journal of Geodesy
Advances in Physics
Medical Education
Water International
Czechoslovak Journal of Physic
Journal of Advanced Nursing
International Journal of Digit
Philosophical Transactions of
Modern Physics Letters B
Journal of Low Temperature Phy
Psychological Medicine
Statistics in Medicine
International Journal of Moder
Nature Physics
Land
Biological Theory
Energies
Frontiers in Physics
Addiction
Statistical Methods in Medical
Sensors
Physical Review Letters
Journal of Child Psychology an
Biology & Philosophy
Rapid Prototyping Journal
Radio Science
Physics
Coastal Management
Reviews of Modern Physics
Child Development
Ergonomics
International Journal of Geogr
Health Care Management Science
Science China Technological Sc
Physics of Fluids
Physical Review E
Journal of Applied Social Psyc
Risk Analysis
Journal of Industrial Ecology
Neural Computation
Annalen der Physik
Reading Research Quarterly
Journal of the Royal Statistic
Journal of Guidance Control an
American Sociological Review
Journal of the American Statis
Machine Learning
Space Science Reviews
Chaos An Interdisciplinary Jou
Physical Review C
American Political Science Rev
International Journal of Produ
Il Nuovo Cimento B
Communications in Mathematical
International Journal of Theor
Kybernetes
Journal of Organizational Beha
Physical Review D
Strategic Management Journal

VOSviewer

Text mining


readership
year impact factor
hirsch index
scholarly impact
impact factor
h index
manuscript
greater impact
publisher
journal impact
press
peer review
acceptance
google scholar
deviation
zipf
respondent
decrease
index
informetric
comment
quantitative data
citation score
proof
belief
citation impact
research unit
drawback
adoption
attitude
classification system
testing
philadelphia
peak
inequality
ranking
student
wikipedia
humanity
letter
norm
information behavior
social science
credit
shortcoming
doubt
family
theory
site
staff
school
behavior
user experience
document type
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excellence
faculty
physicist
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expertise
google
biochemistry
institute
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woman
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requirement
hit
genetic
research output
productivity
pagerank
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information
user
highest number
coauthorship
lis
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vice versa
candidate
interaction
museum
video
search engine
science citation index
period
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college
vector
entropy
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layer
collection
user study
france
country
time span
prerequisite
new technology
author name
usa
concentration
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matrix
engineer
accuracy
experiment
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growth
continent
co authorship network
word
algorithm
effectiveness
aca
europe
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test collection
japan
africa
collaboration
domain expert
precision
scientific development
bioinformatic
novelty
global trend
expenditure
synergy
relatedness
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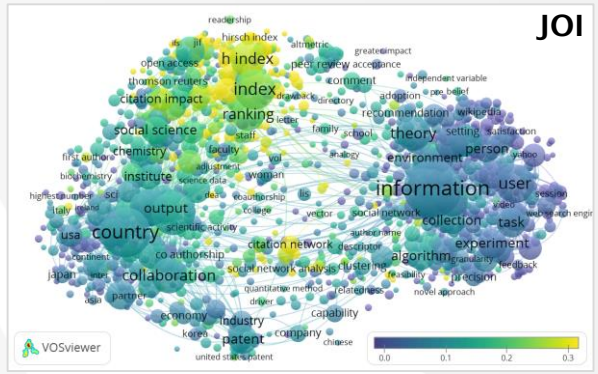
VOSviewer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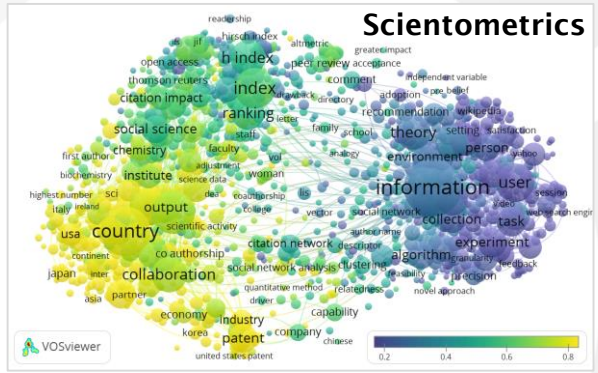
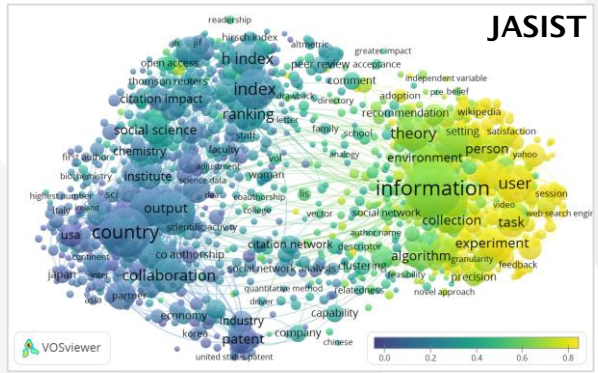
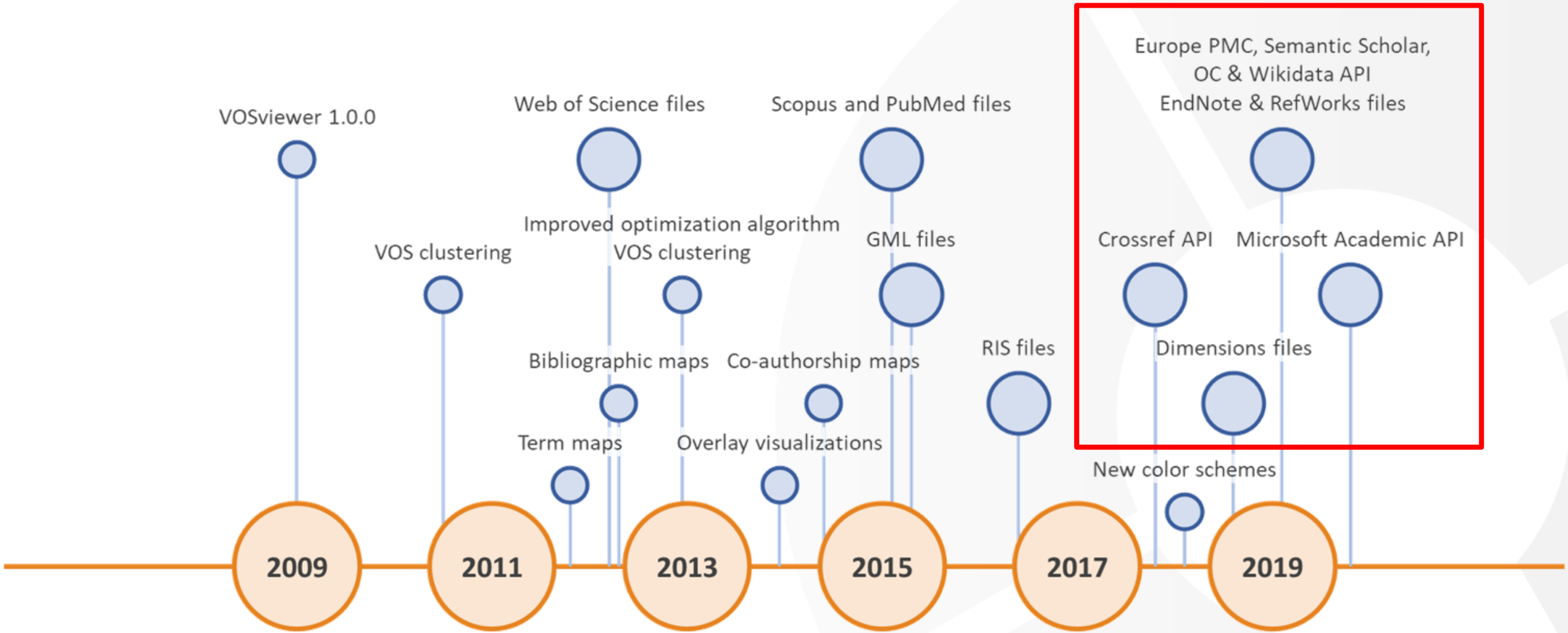
VOSviewer


Scientometrics
VOSviewer


JASIST
VOSviewer

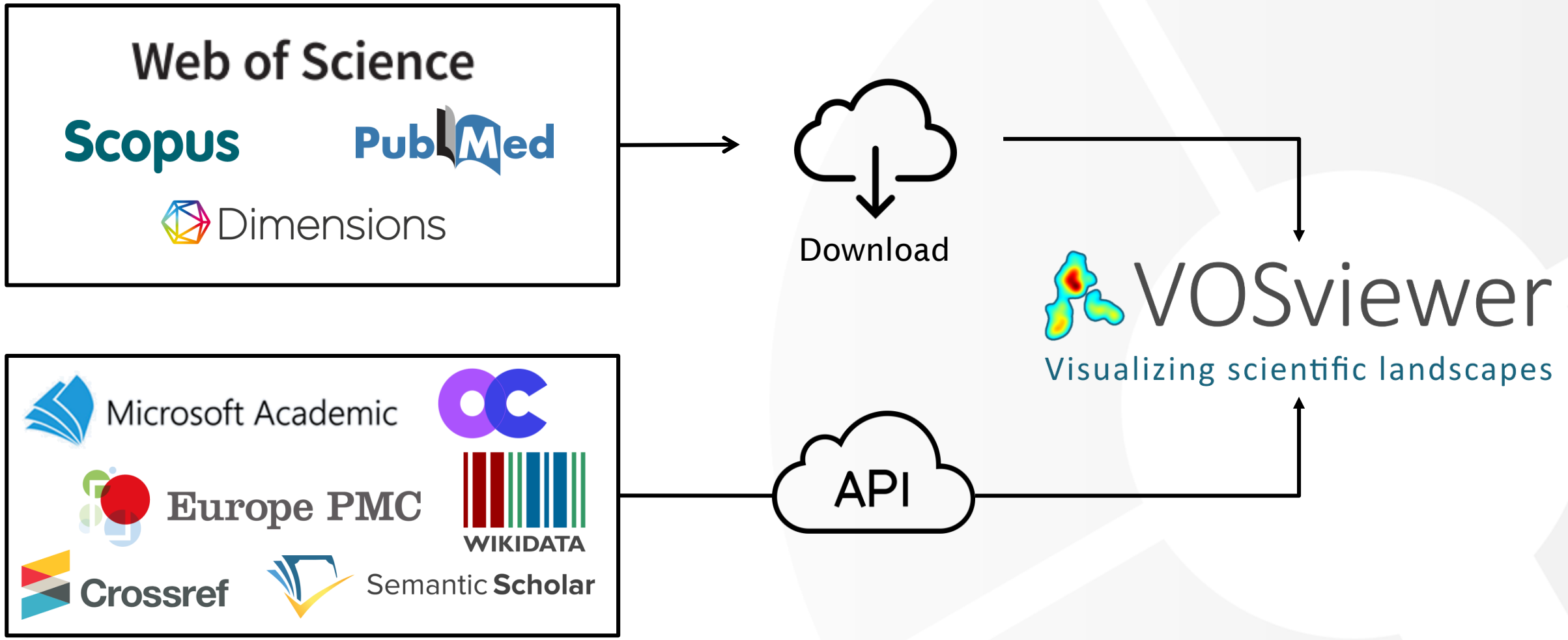
Development



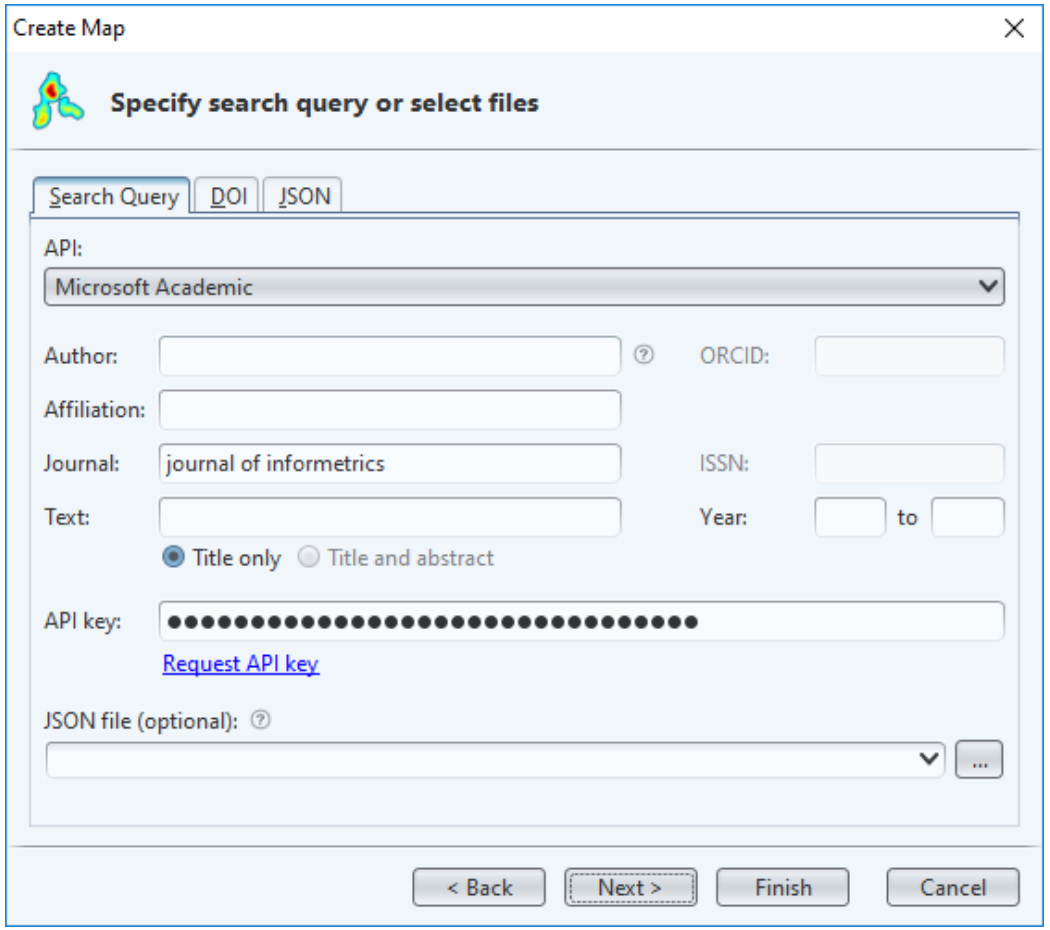
Types of networks supported by each data source

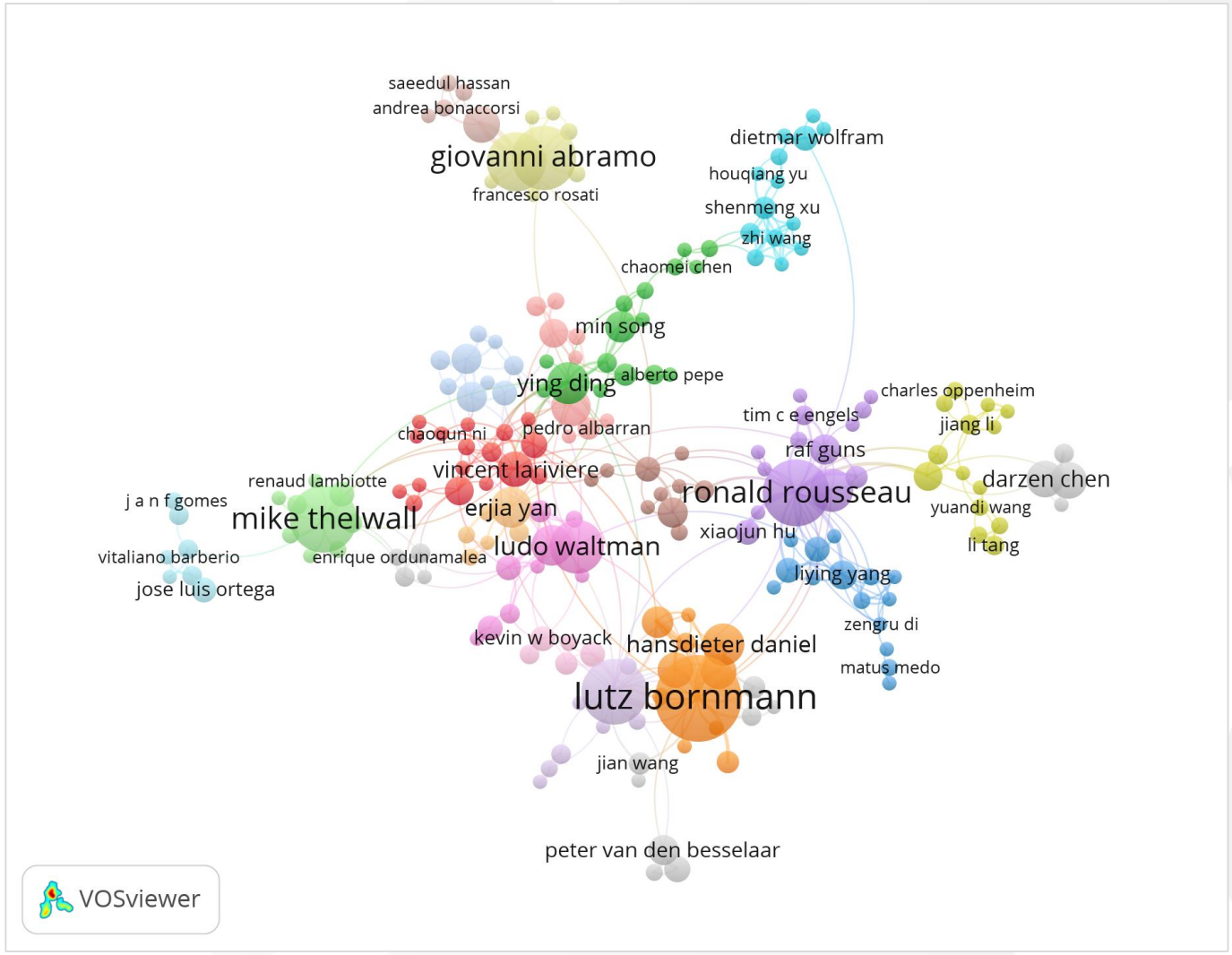
	Co-authorship	Co-occurrence	Citation	Bibliographic coupling	Co-citation
Web of Science	✓	✓	✓	✓	✓
Scopus	✓	✓	✓	✓	✓
Dimensions	✓	✓	✓	✓	✓
PubMed	✓	✓	✗	✗	✗
Crossref	✓	✓	✓	✓	✓
Europe PMC	✓	✓	✗	✗	✗
Microsoft Academic	✓	✓	✓	✓	✗
Semantic Scholar	✓	✓	✓	✓	✓
OCC / COCI	✓	✓	✓	✓	✗
Wikidata	✓	✓	✓	✓	✗

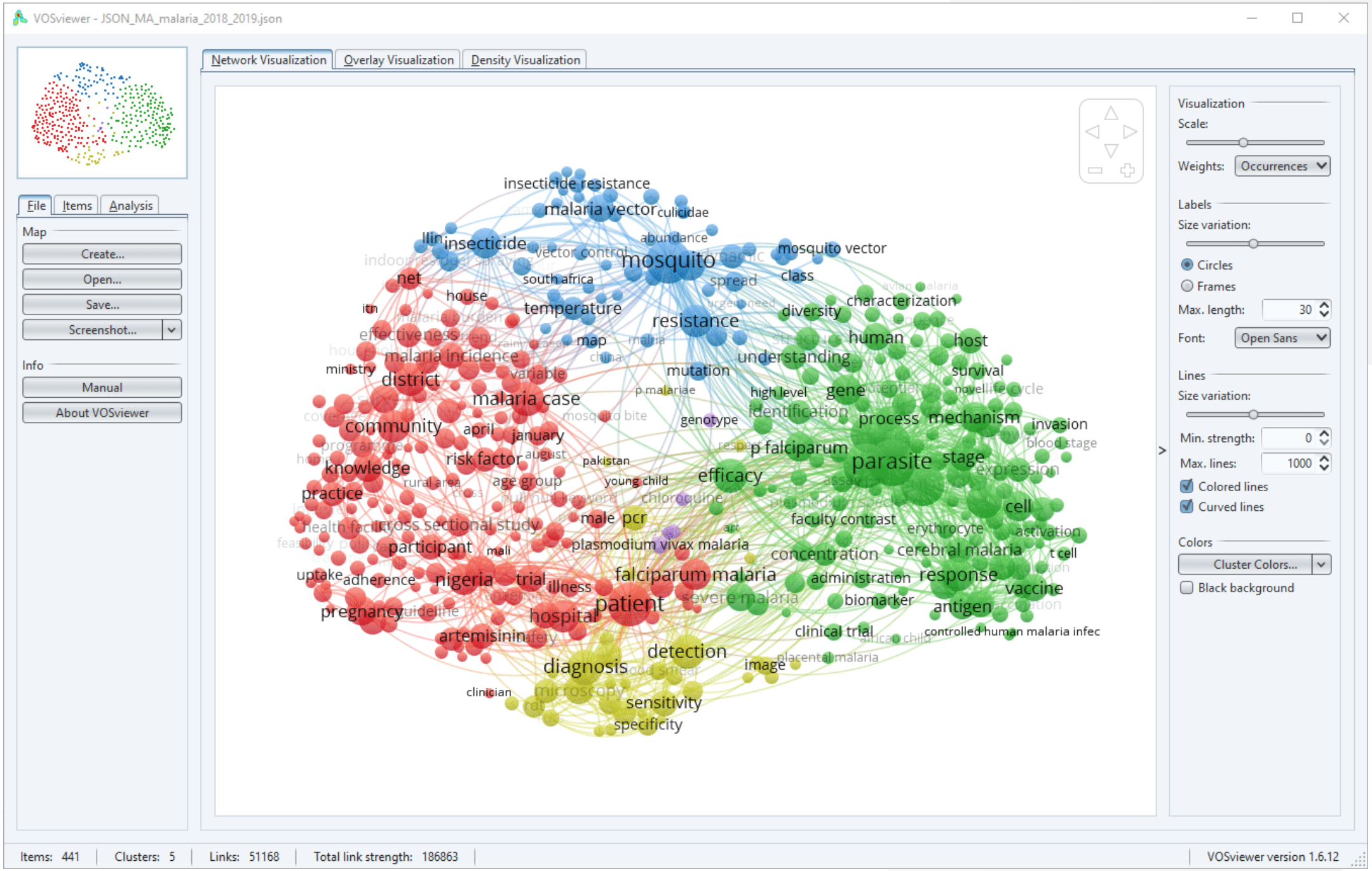
Data access


Web of Science
Scopus
PubMed
Dimensions
Download
VOSviewer
Visualizing scientific landscapes
Microsoft Academic
Europe PMC
WIKIDATA
Crossref
Semantic Scholar
API

Interactive querying






VOSviewer - JSON_MA_malaria_2018_2019.json
Network Visualization
Overlay Visualization
Density Visualization
File
Items
Analysis
Map
Create...
Open...
Save...
Screenshot...
Info
Manual
About VOSviewer
Visualization
Scale:
Weights: Occurrences
Labels
Size variation:
Circles
Frames
Max. length: 30
Font: Open Sans
Lines
Size variation:
Min. strength: 0
Max. lines: 1000
Colored lines
Curved lines
Colors
Cluster Colors...
Black background
insecticide resistance
malaria vector
culicidae
abundance
mosquito vector
insecticide
vector control
mosquito
class
spread
net
south africa
house
temperature
resistance
diversity
characterization
itn
effectiveness
map
human
host
malaria incidence
understanding
survival
ministry
district
variable
mutation
gene
malaria case
high level
identification
process
mechanism
invasion
community
april
january
genotype
p falciparum
parasite
stage
risk factor
august
pakistan
efficacy
knowledge
age group
young child
practice
chloroquine
cell
male
pcr
faculty contrast
erythrocyte
activation
cross sectional study
plasmodium vivax malaria
concentration
cerebral malaria
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mali
falciparum malaria
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response
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nigeria
trial
illness
severe malaria
biomarker
vaccine
patient
pregnancy
hospital
antigen
clinical trial
controlled human malaria infec
artemisinin
detection
diagnosis
image
clinician
microscopy
sensitivity
specificity
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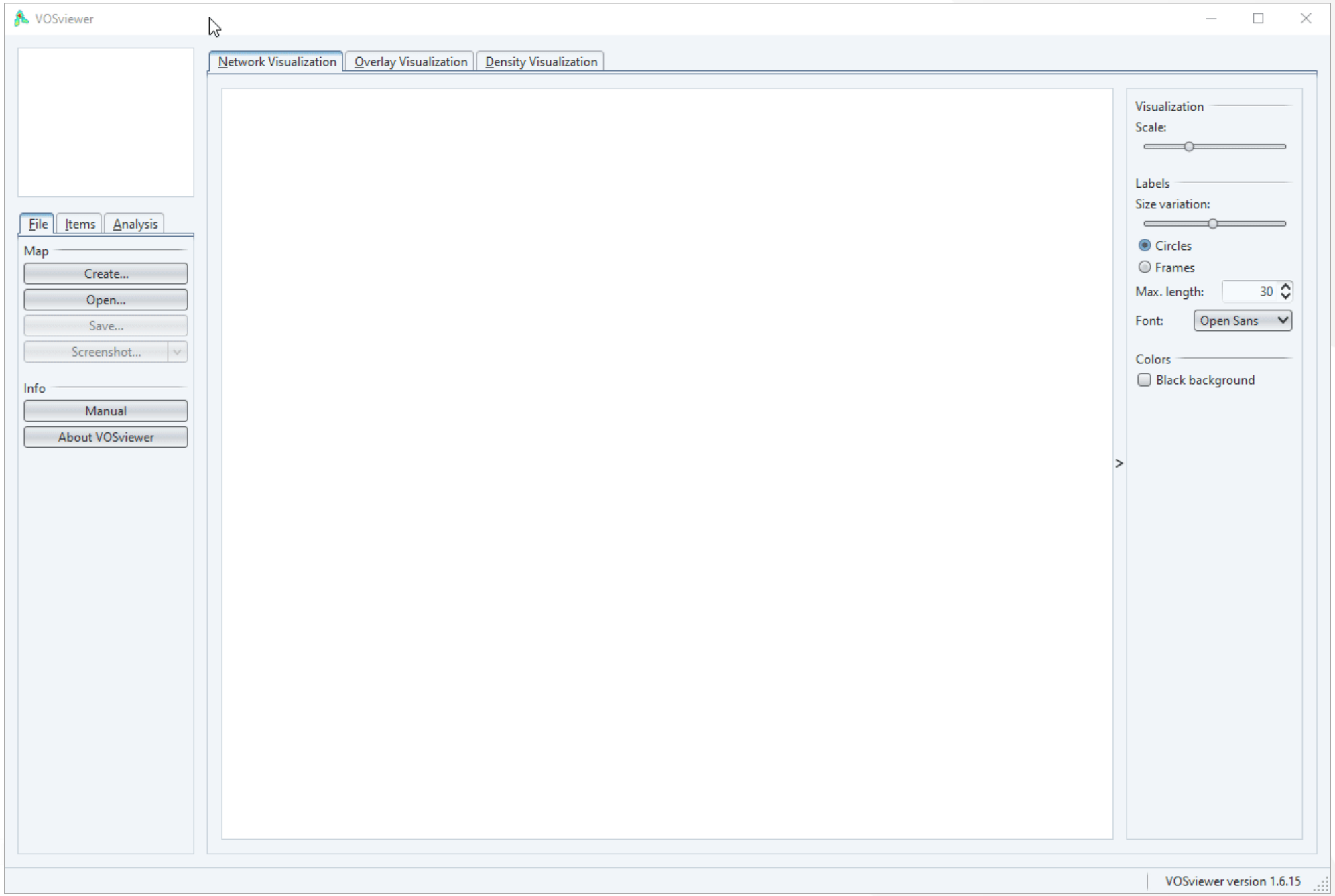
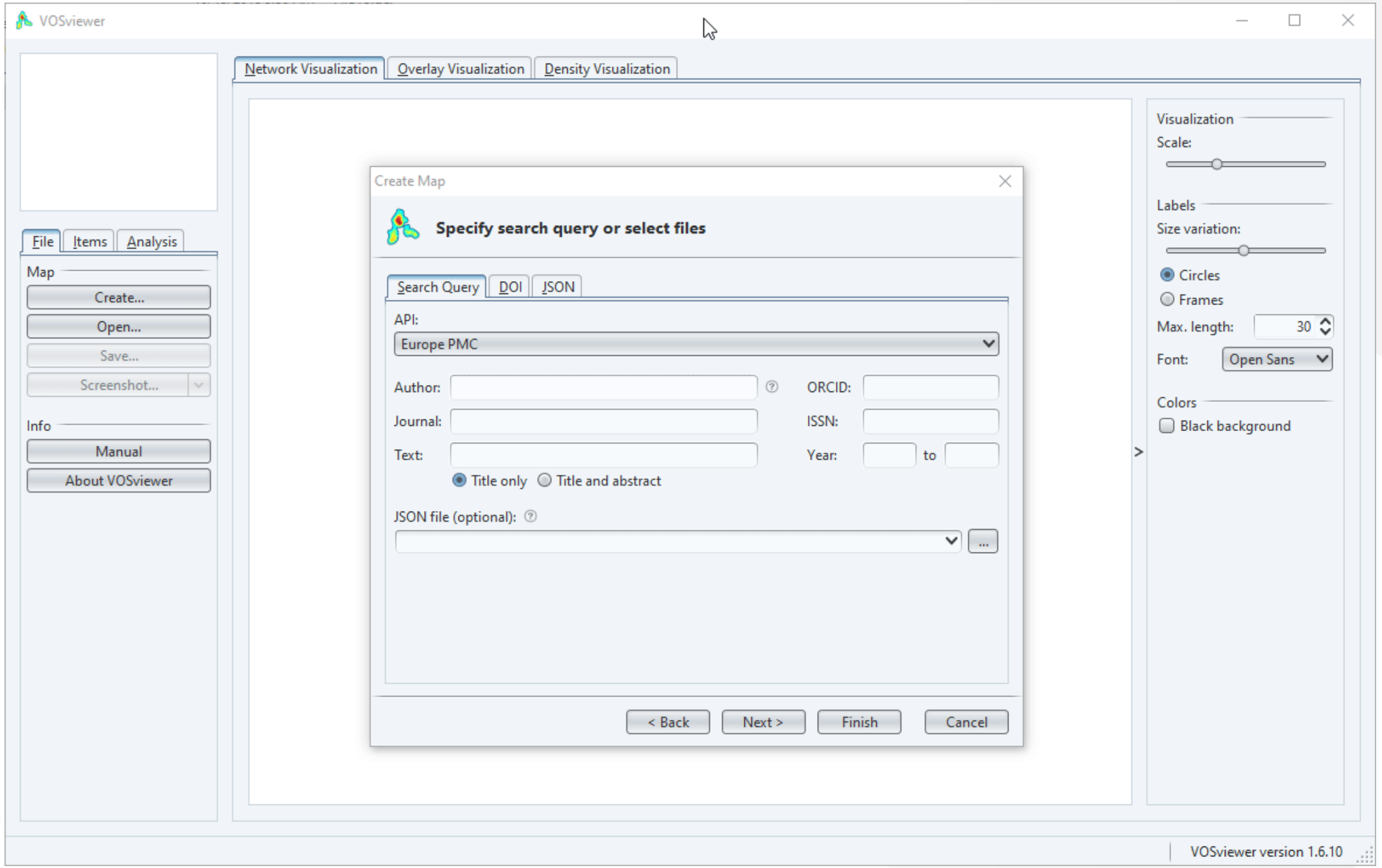
Clusters: 5
Links: 51168
Total link strength: 186863
VOSviewer version 1.6.12


VOSviewer
Network Visualization
Overlay Visualization
Density Visualization
File
Items
Analysis
Map
Create...
Open...
Save...
Screenshot...
Info
Manual
About VOSviewer
Visualization
Scale:
Labels
Size variation:
Circles
Frames
Max. length:
30
Font:
Open Sans
Colors
Black background
VOSviewer version 1.6.15


VOSviewer
Network Visualization
Overlay Visualization
Density Visualization
File
Items
Analysis
Map
Create...
Open...
Save...
Screenshot...
Info
Manual
About VOSviewer
Visualization
Scale:
Labels
Size variation:
Circles
Frames
Max. length:
30
Font:
Open Sans
Colors
Black background
Create Map
Specify search query or select files
Search Query
DOI
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Author:
ORCID:
Journal:
ISSN:
Text:
Year:
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Title and abstract
JSON file (optional):
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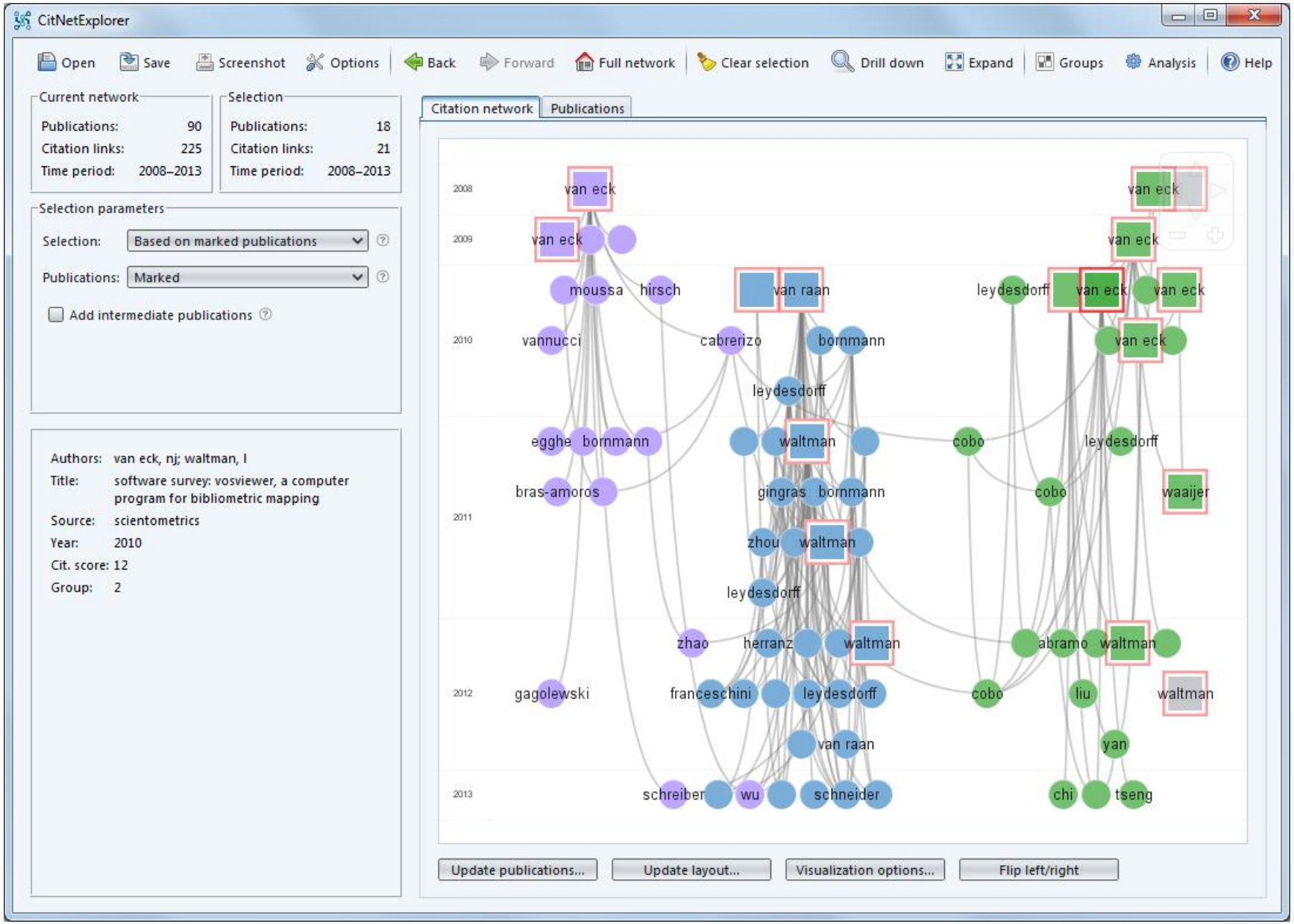
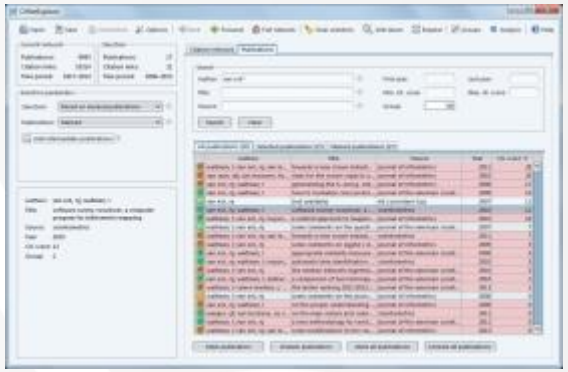
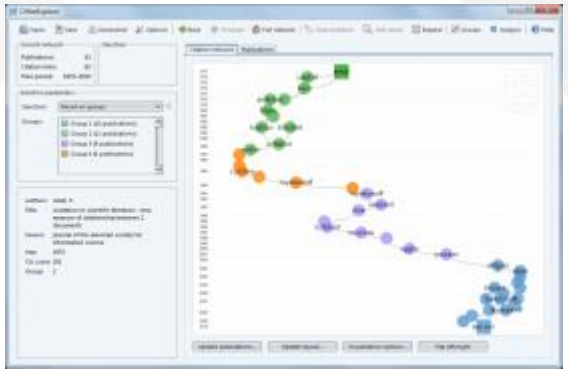
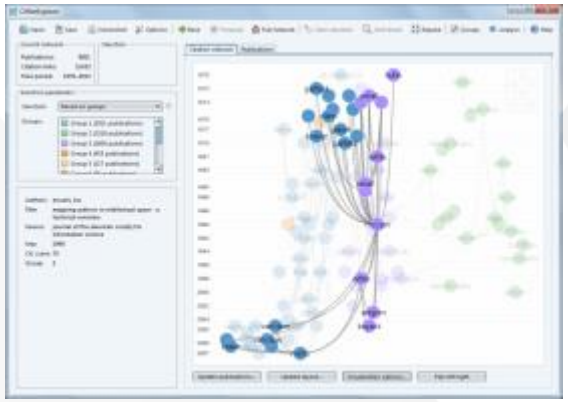
< Back
Next >
Finish
Cancel
VOSviewer version 1.6.10

CitNetExplorer



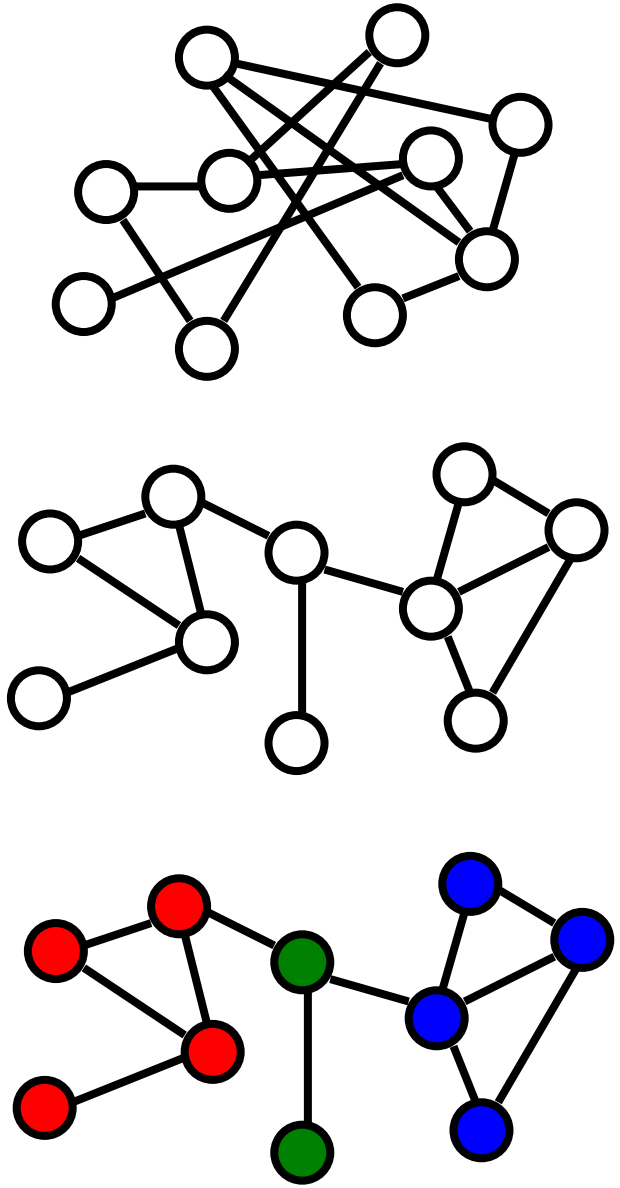






Network analysis techniques

Network analysis techniques



Layout:

- AKA mapping
- Visualization of similarities (VOS)

Clustering:

- AKA community detection
- Leiden algorithm

VOS

Journal of the American Society for Information Science and Technology / Volume 61, Issue 12

Research Article | Full Access

A comparison of two techniques for bibliometric mapping: Multidimensional scaling and VOS

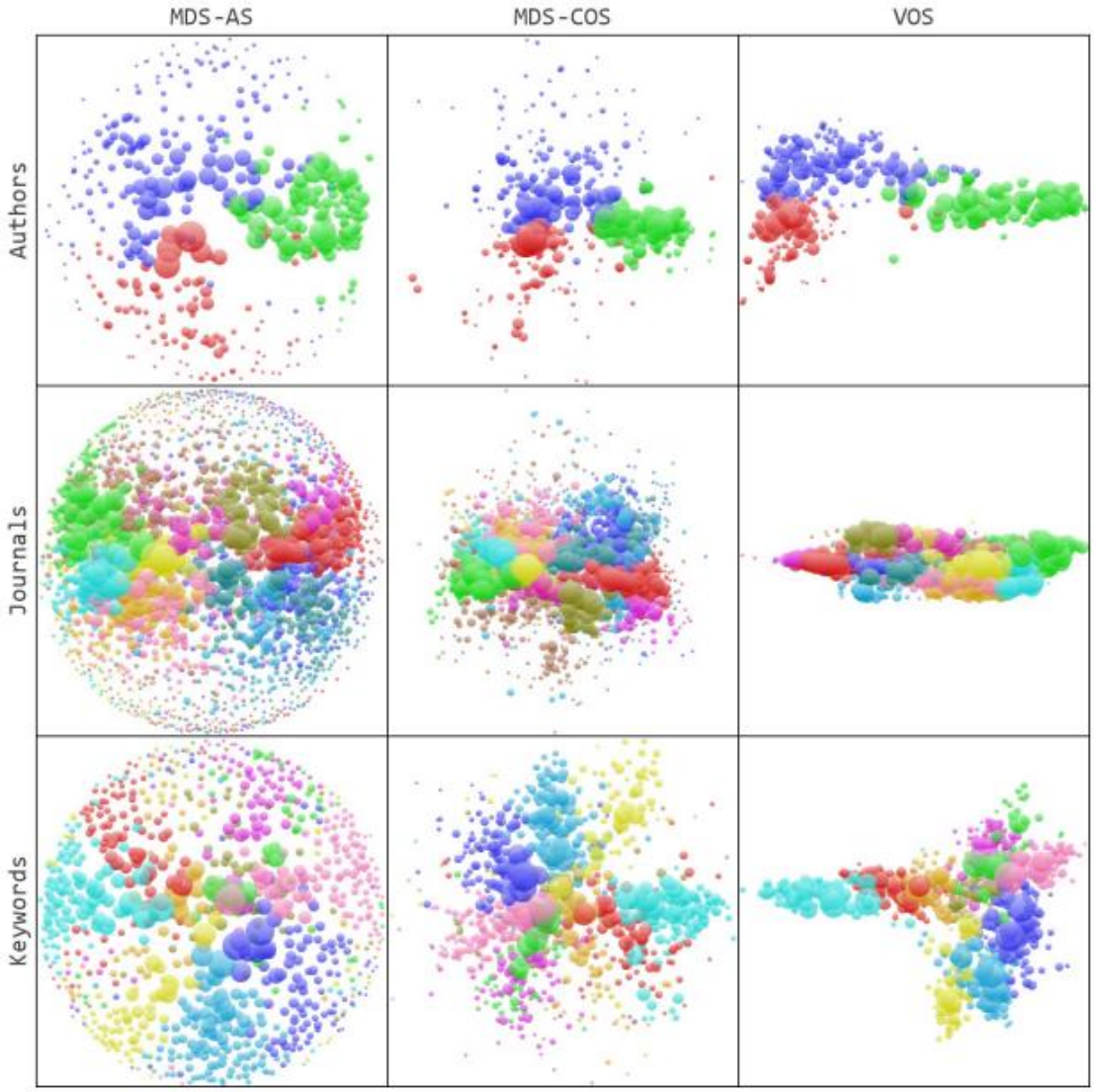
Nees Jan van Eck, Ludo Waltman, Rommert Dekker, Jan van den Berg

First published: 15 December 2010
https://doi.org/10.1002/asi.21421
Cited by: 88

GetIt@Leiden

Abstract

VOS is a new mapping technique that can serve as an alternative to the well-known technique of multidimensional scaling (MDS). We present an extensive comparison between the use of MDS and the use of VOS for constructing bibliometric maps. In our theoretical analysis, we show the mathematical relation between the two techniques. In our empirical analysis, we use the techniques for constructing maps of authors, journals, and keywords. Two commonly used approaches to bibliometric mapping, both based on MDS, turn out to produce maps that suffer from artifacts. Maps constructed using VOS turn out not to have this problem. We conclude that in general maps constructed using VOS provide a more satisfactory representation of a dataset than maps constructed using well-known MDS approaches.



Leiden algorithm

SCIENTIFIC REPORTS

Article | OPEN | Published: 26 March 2019

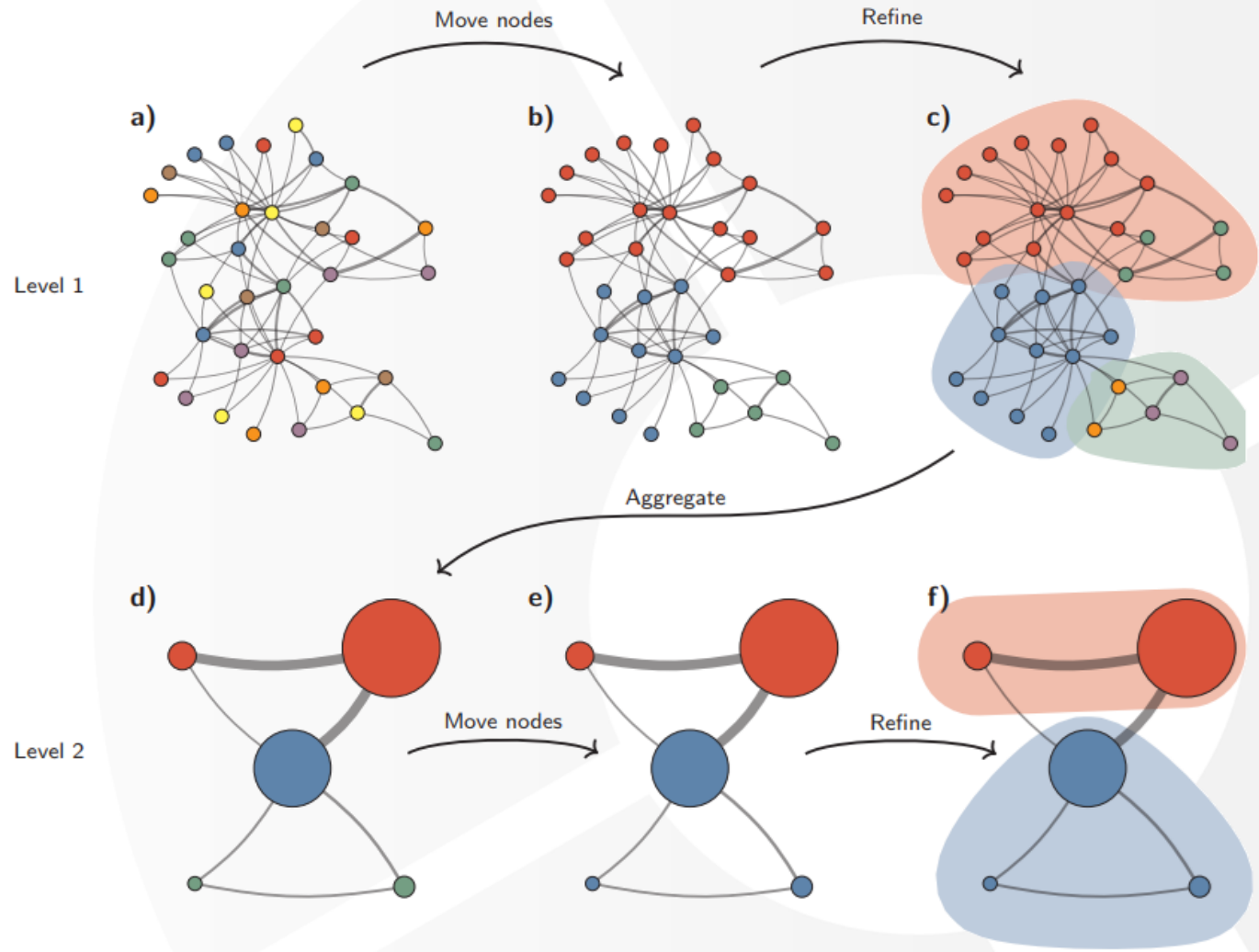
From Louvain to Leiden: guaranteeing well-connected communities

V. A. Traag, L. Waltman & N. J. van Eck

Scientific Reports **9**, Article number: 5233 (2019) | Download Citation

Abstract

Community detection is often used to understand the structure of large and complex networks. One of the most popular algorithms for uncovering community structure is the so-called Louvain algorithm. We show that this algorithm has a major defect that largely went unnoticed until now: the Louvain algorithm may yield arbitrarily badly connected communities. In the worst case, communities may even be



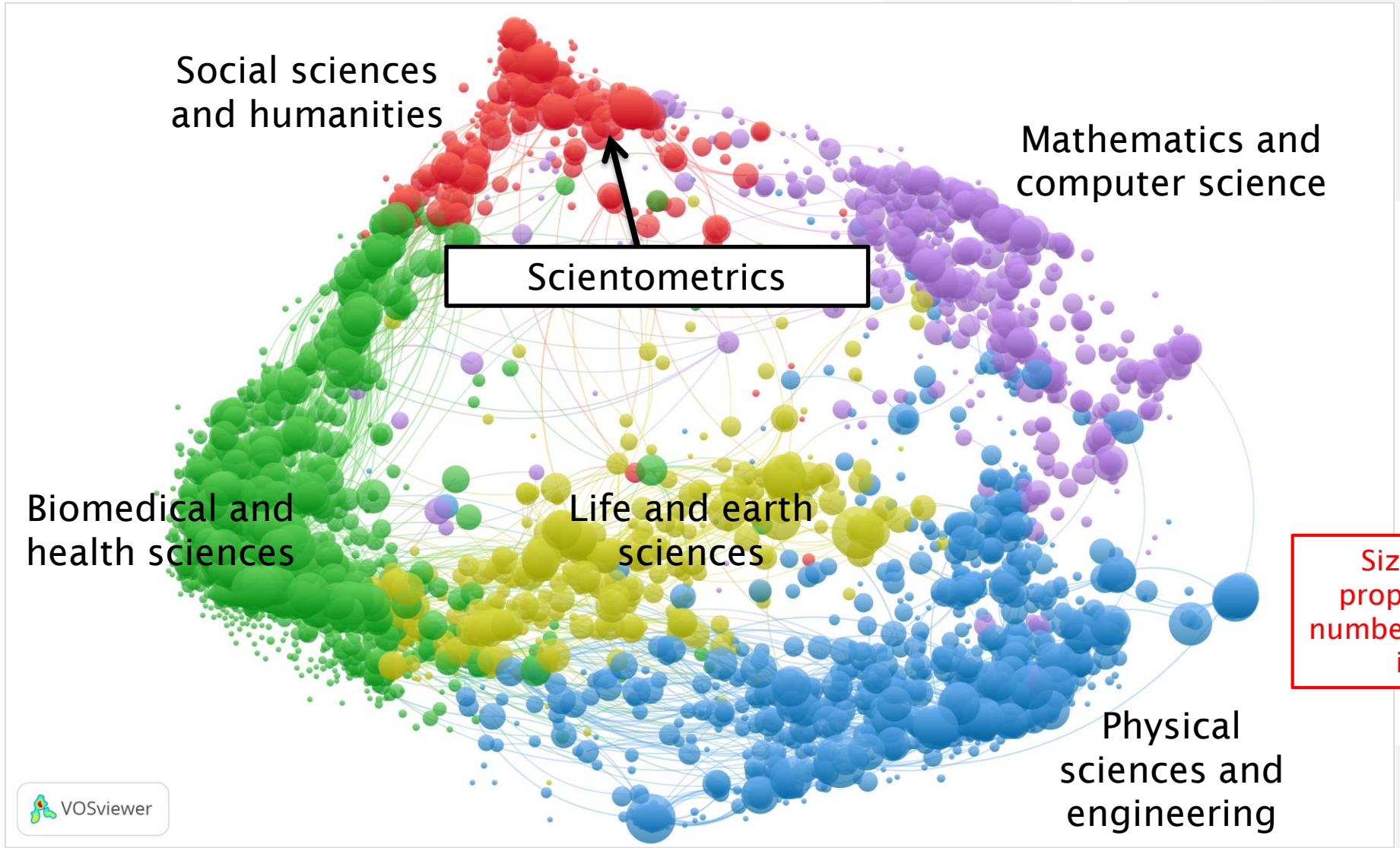
Algorithmic classification systems of science

CWTS publication-level classification system of science

- Based on all articles, reviews, and proceedings papers in Web of Science from the period 2000-2019
- 29.8 million publications
- 520.5 million citation links
- Classification system of 3 hierarchical levels:
  - 23 broad disciplines
  - 805 fields
  - 4,013 subfields
- Computational performance using the Leiden algorithm: less than 2hrs

CWTS

Breakdown of scientific literature into 4,013 subfields



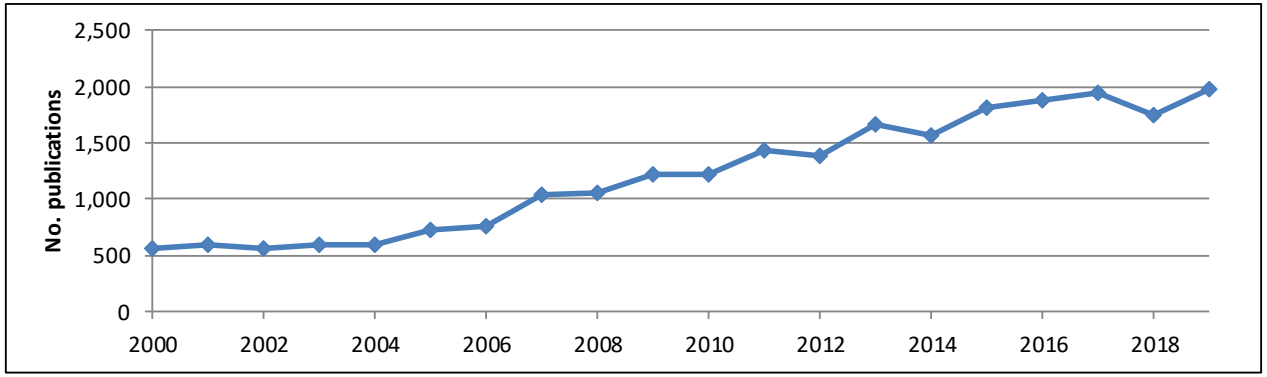
Size of a field is proportional to the number of publications in the field

Summary of scientometrics subfield

Cluster: 108

No. publications: 24,317

Top 5 terms	No. pubs
peer review	802
bibliometric analysis	1,563
h index	347
publication	2,255
impact factor	718



Top 5 publications	No. cits
hirsch, je (2005). an index to quantify an individual's scientific research output. proc nat acad sci usa, 102(46), 16569	3,690
wuchty, s; et al. (2007). the increasing dominance of teams in production of knowledge. science, 316(5827), 1036	995
van eck, nj; et al. (2010). software survey: vosviewer, a computer program for bibliometric mapping. scientometrics, 84(2), 523	988
chen, cm (2006). citespace ii: detecting and visualizing emerging trends and transient patterns in scientific literature. j am soc inf sci technol, 57(3), 359	801
moss-racusin, ca; et al. (2012). science faculty's subtle gender biases favor male students. proc nat acad sci usa, 109(41), 16474	789

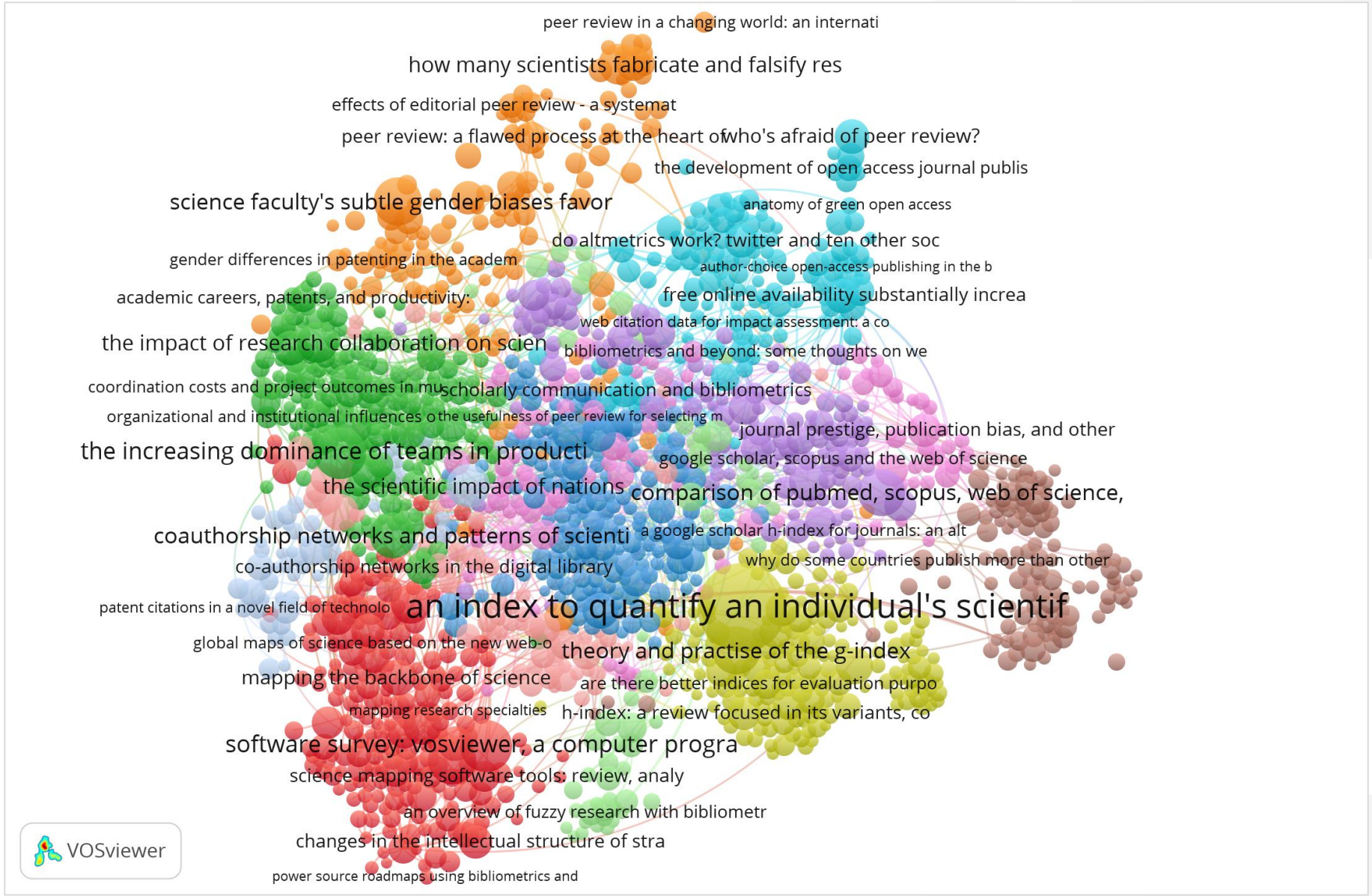
Top 5 authors	No. pubs
bornmann, l	281
leydesdorff, l	252
rousseau, r	199
thelwall, m	164
glanzel, w	154

Top 5 journals	No. pubs
scientometrics	3,285
proceedings of the international conference on scientometrics and informetrics	1,003
journal of informetrics	837
journal of the american society for information science and technology	576
plos one	424

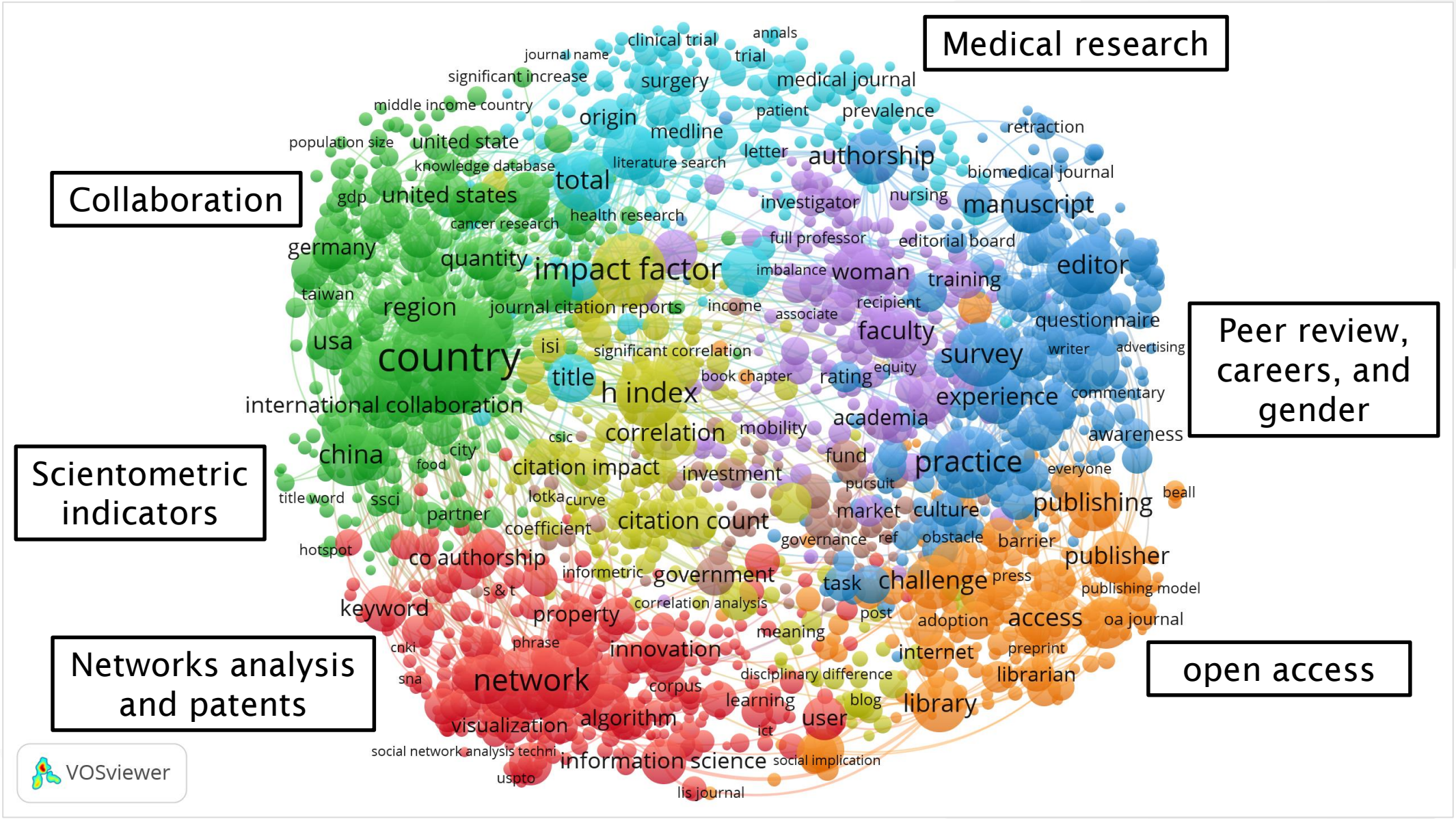
Top 5 institutes	No. pubs
leiden univ	382
indiana univ	370
katholieke univ leuven	354
univ granada	306
univ amsterdam	293

Top 5 departments	No. pubs
ctr sci & technol studies (leiden univ)	167
ctr sci & technol studies cwts (leiden univ)	149
amsterdam sch commun res ascor (univ amsterdam)	146
sch informat management (wuhan univ)	144
sch lib & informat sci (indiana univ)	141

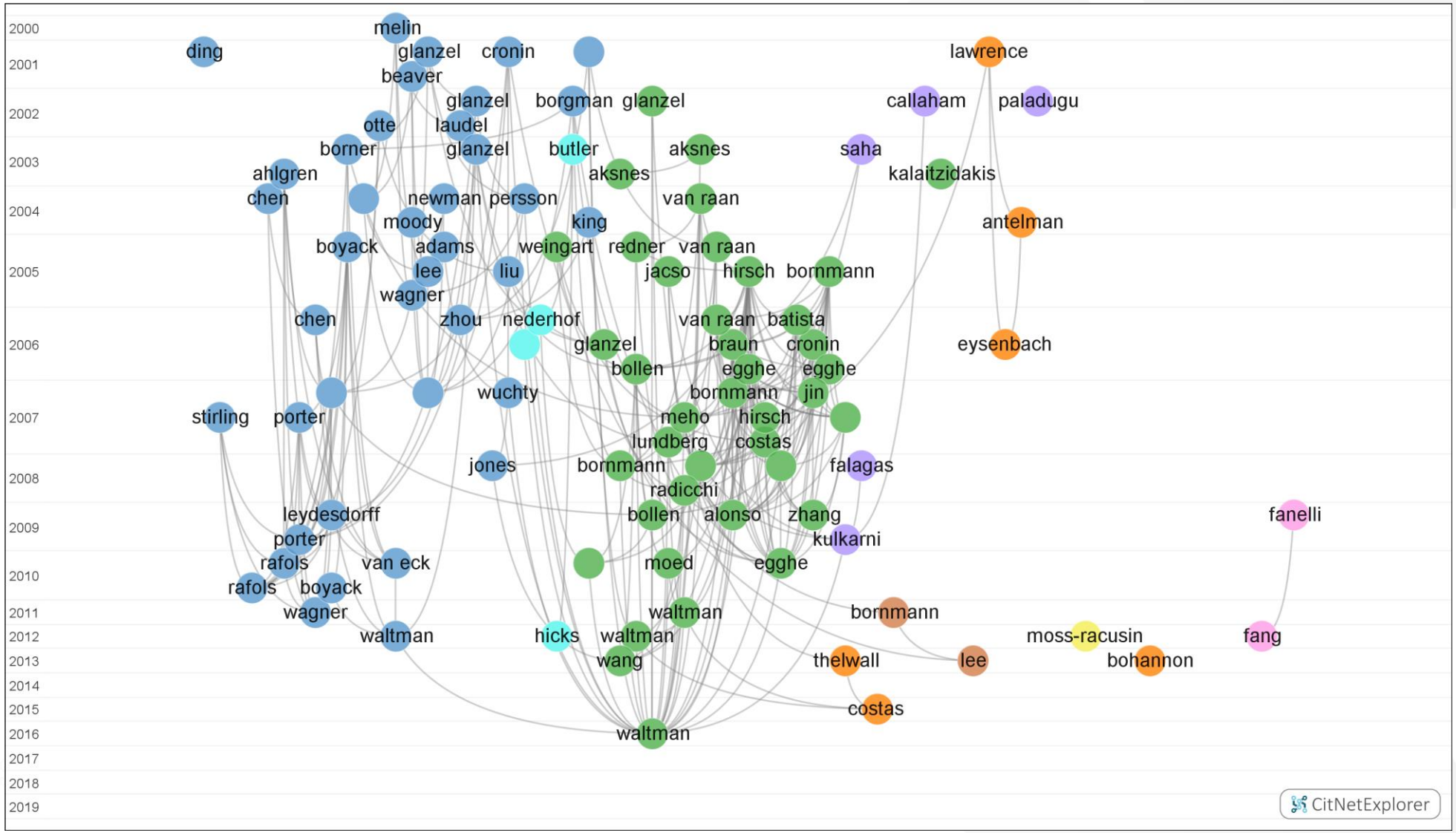
Publications in scientometrics subfield



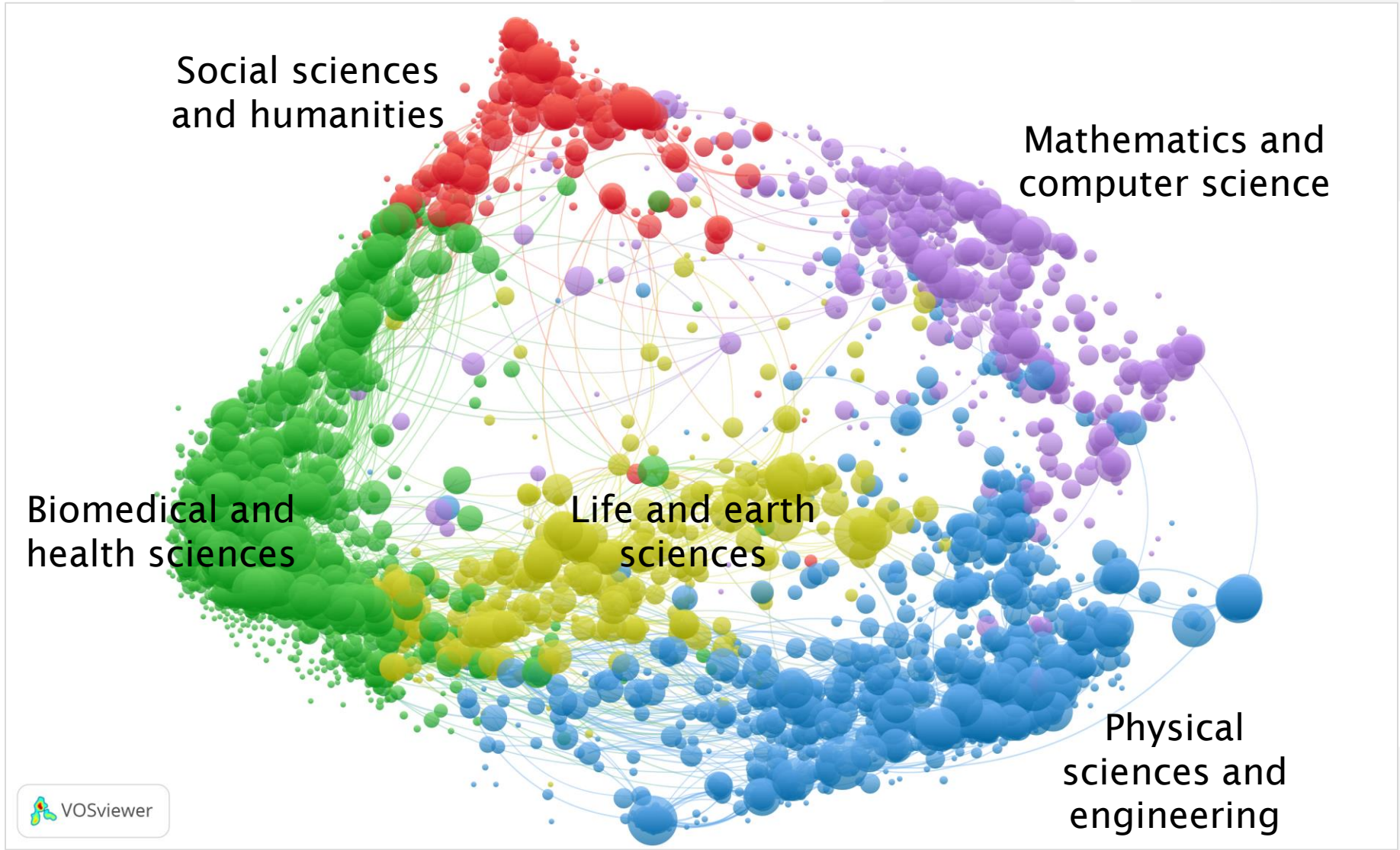
Term map of scientometrics field



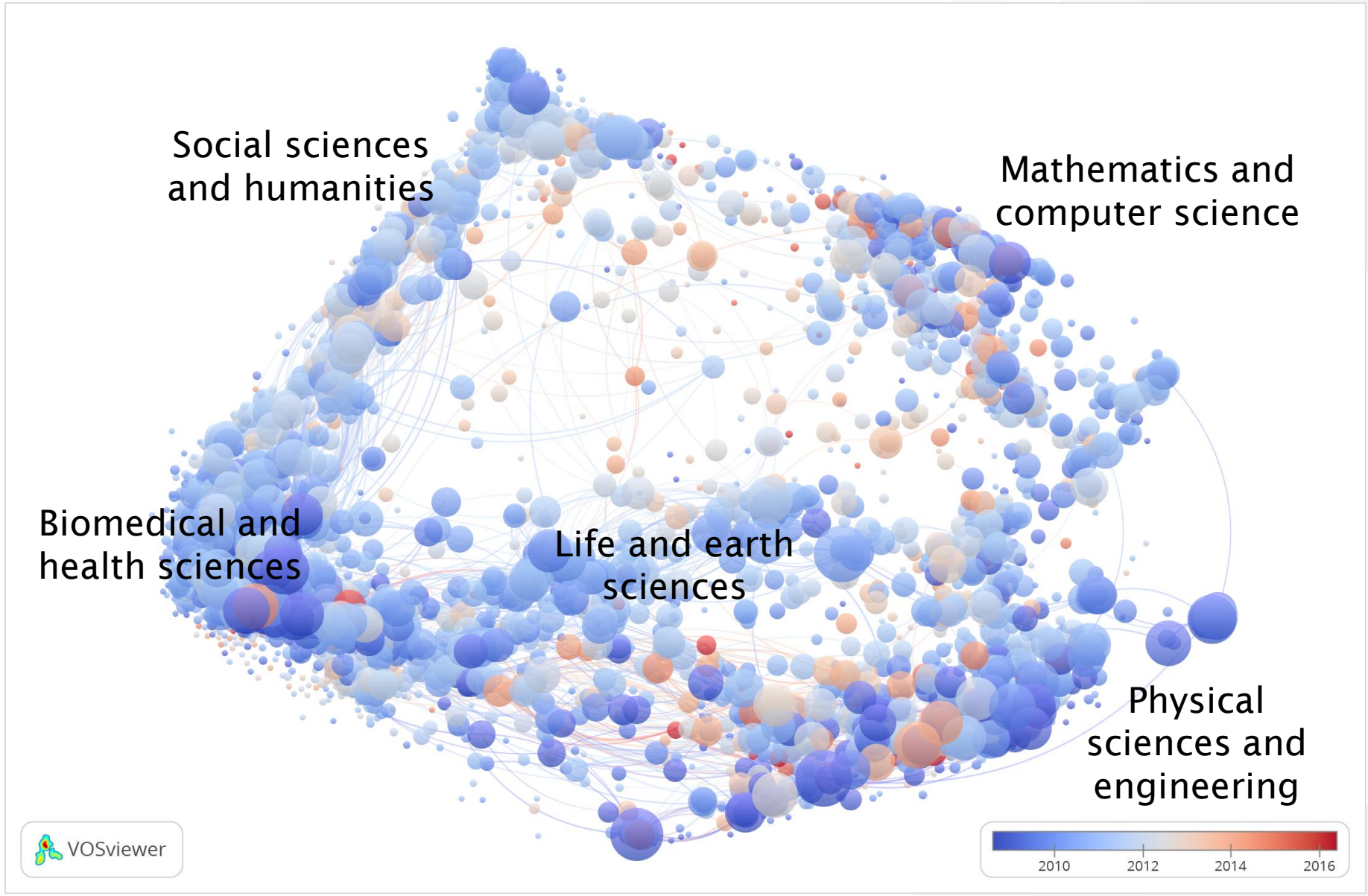
Time-line map of highly cited scientometrics publications



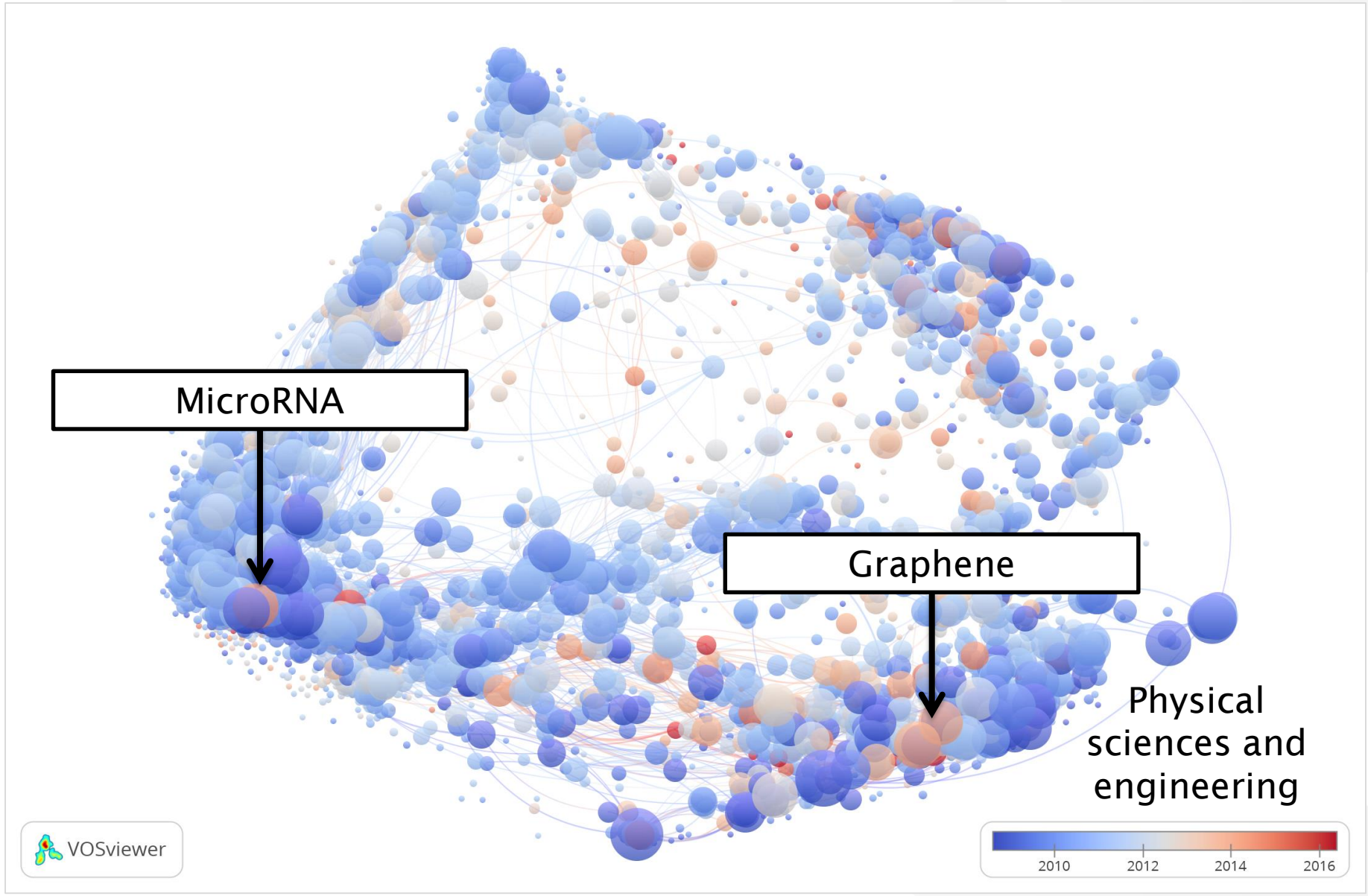
Overlay visualizations



Time trend


Social sciences and humanities
Mathematics and computer science
Biomedical and health sciences
Life and earth sciences
Physical sciences and engineering
VOSviewer
2010
2012
2014
2016

Time trend

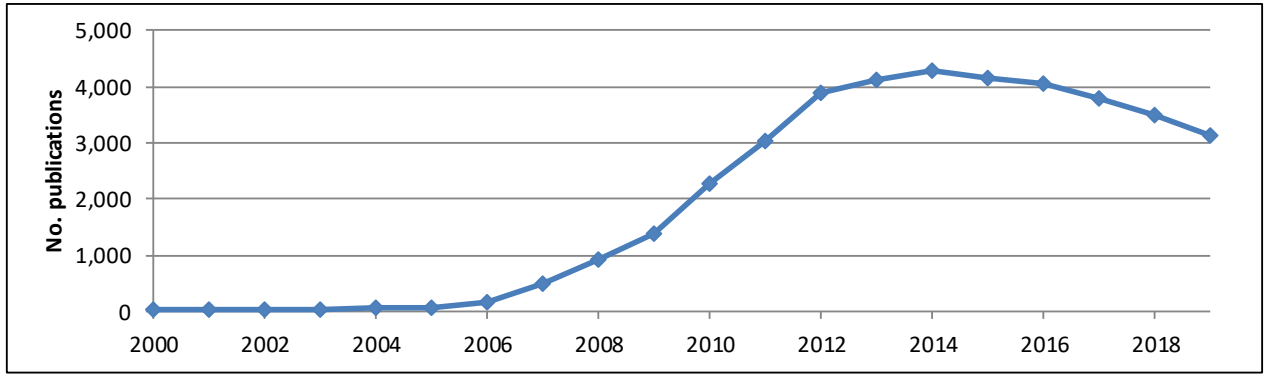

MicroRNA
Graphene
Physical sciences and engineering
VOSviewer
2010
2012
2014
2016

Summary of graphene subfield

Cluster: 14

No. publications: 39,564

Top 5 terms	No. pubs
graphene oxide	10,327
epitaxial graphene	596
bilayer graphene	1,046
graphene field effect transistor	309



Top 5 publications	No. cits
novoselov, ks; et al. (2004). electric field effect in atomically thin carbon films. science, 306(5696), 666	36,165
geim, ak; et al. (2007). the rise of graphene. nat mater, 6(3), 183	25,419
castro neto, ah; et al. (2009). the electronic properties of graphene. rev mod phys, 81(1), 109	14,462
novoselov, ks; et al. (2005). two-dimensional gas of massless dirac fermions in graphene. nature, 438(7065), 197	13,791
ferrari, ac; et al. (2006). raman spectrum of graphene and graphene layers. phys rev lett, 97(18)	11,432

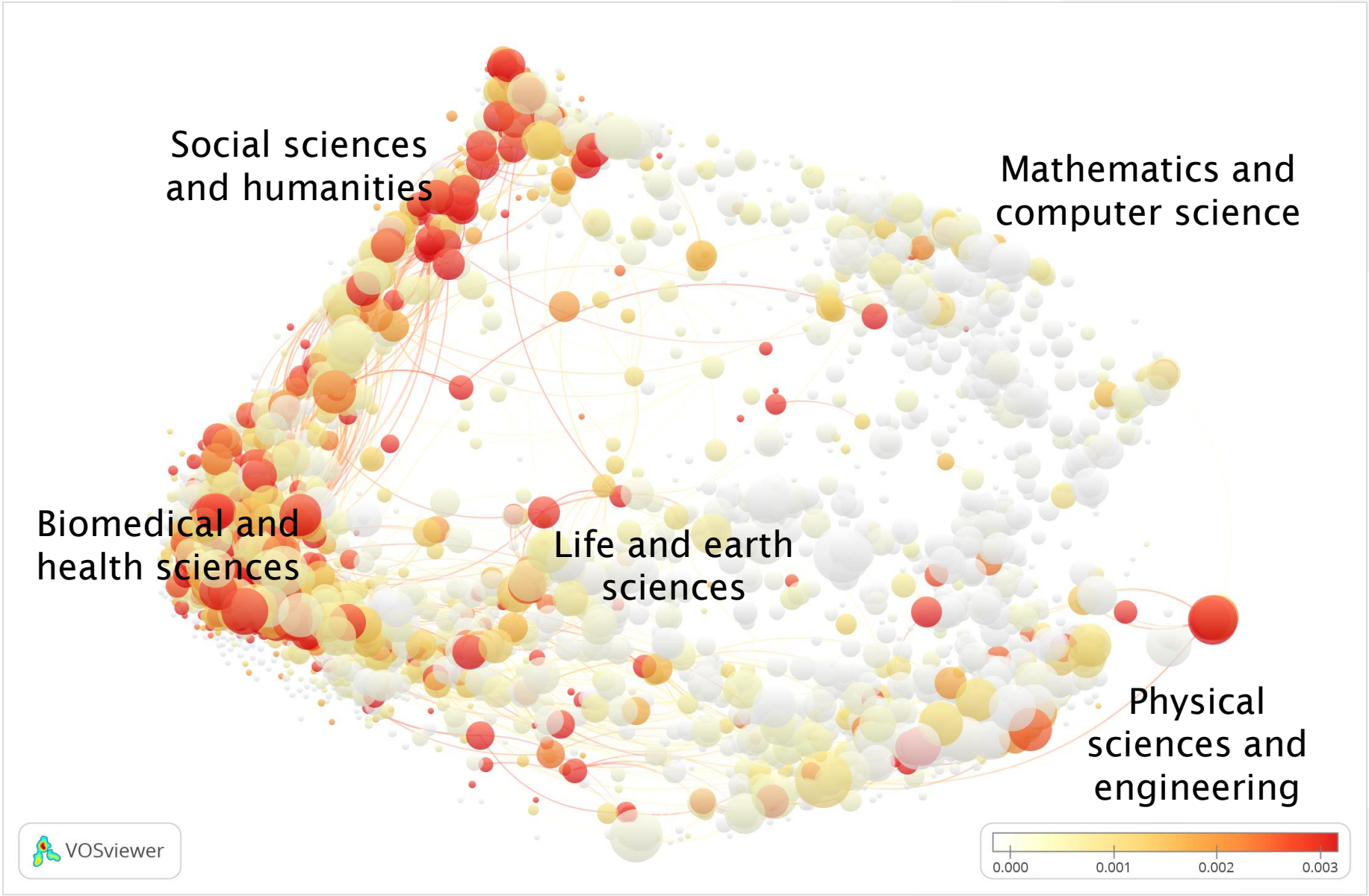
Top 5 authors	No. pubs
taniguchi, t	349
watanabe, k	346
wang, y	263
zhang, y	256
peeters, fm	219

Top 5 journals	No. pubs
physical review b	3,510
carbon	1,772
applied physics letters	1,676
rsc advances	921
nano letters	870

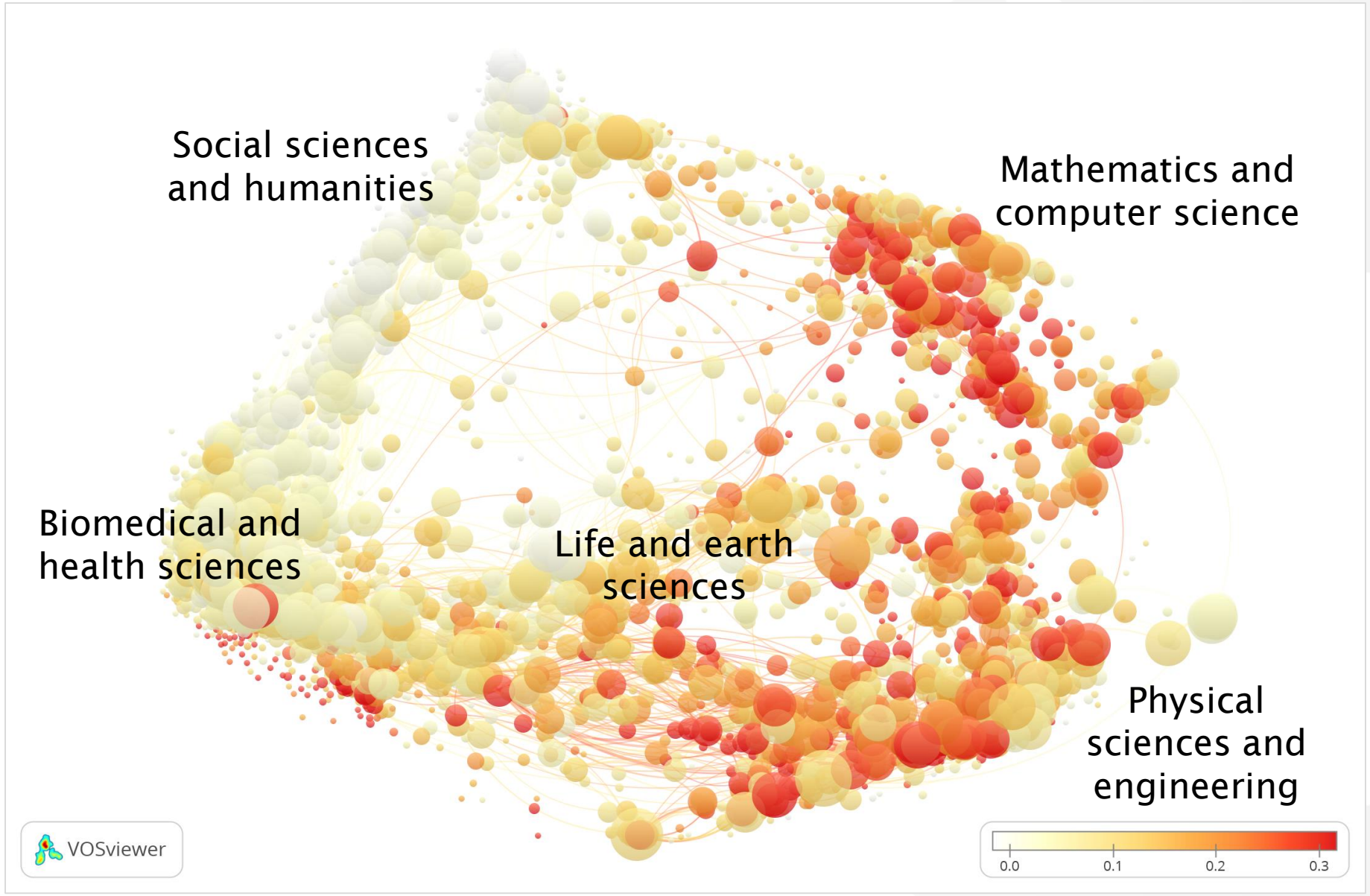
Top 5 institutes	No. pubs
chinese acad sci	2,023
russian acad sci	686
tsinghua univ	629
nanyang technol univ	628
peking univ	608

Top 5 departments	No. pubs
inst phys (chinese acad sci)	314
sch phys & math sci (nanyang technol univ)	307
dept phys (natl univ singapore)	287
sch phys & astron (univ manchester)	231
inst ciencia mat madrid (csic)	216

Leiden University



China


Social sciences and humanities
Mathematics and computer science
Biomedical and health sciences
Life and earth sciences
Physical sciences and engineering
VOSviewer
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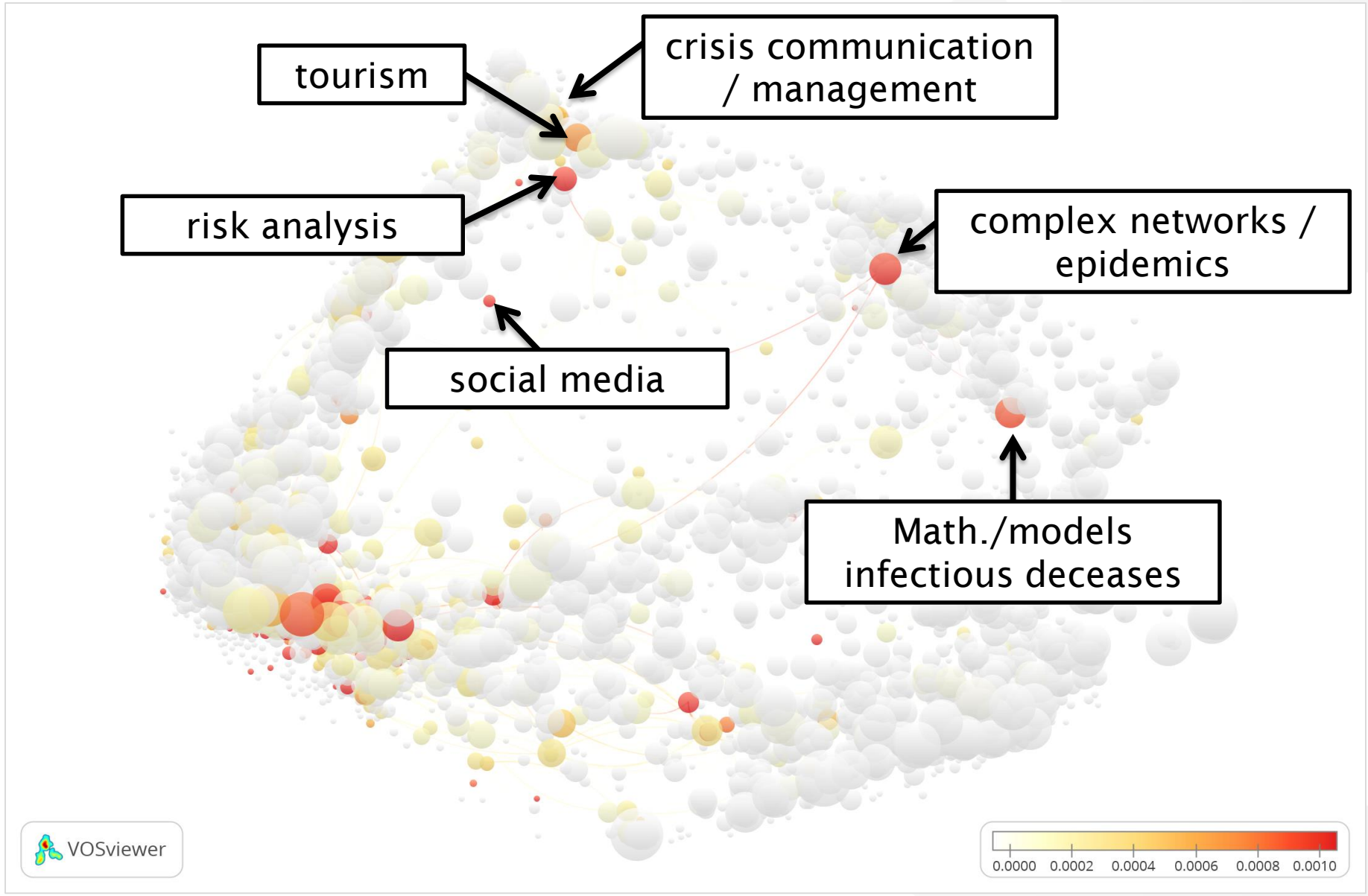
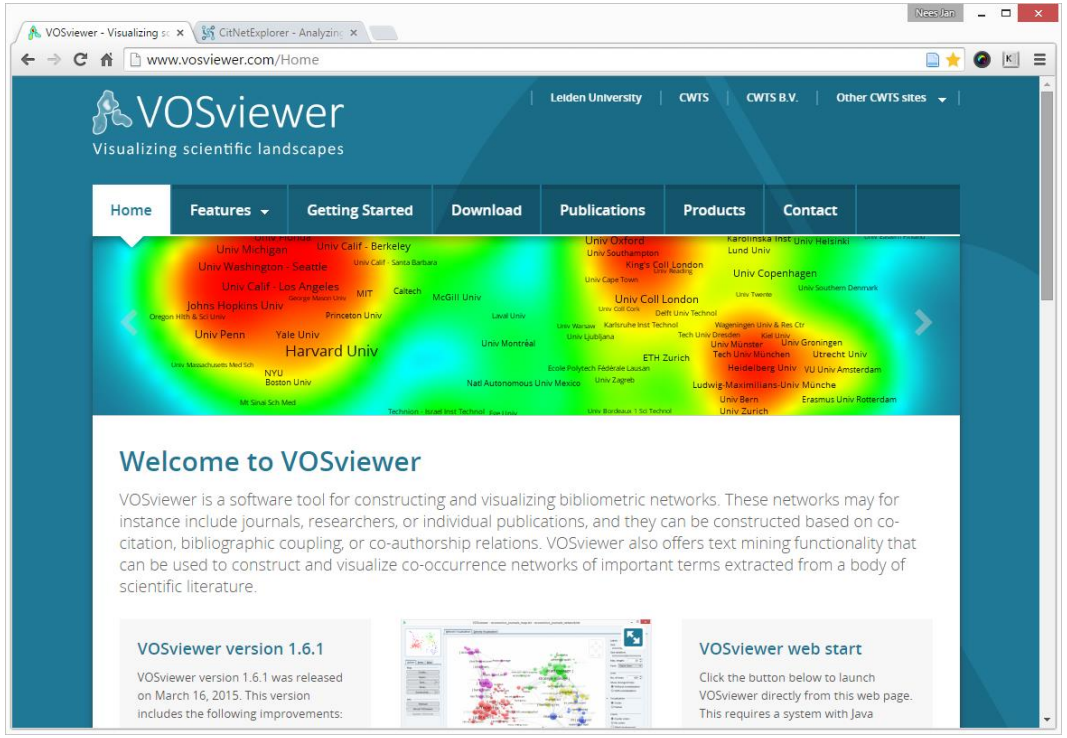
0.1
0.2
0.3

Coronavirus related research

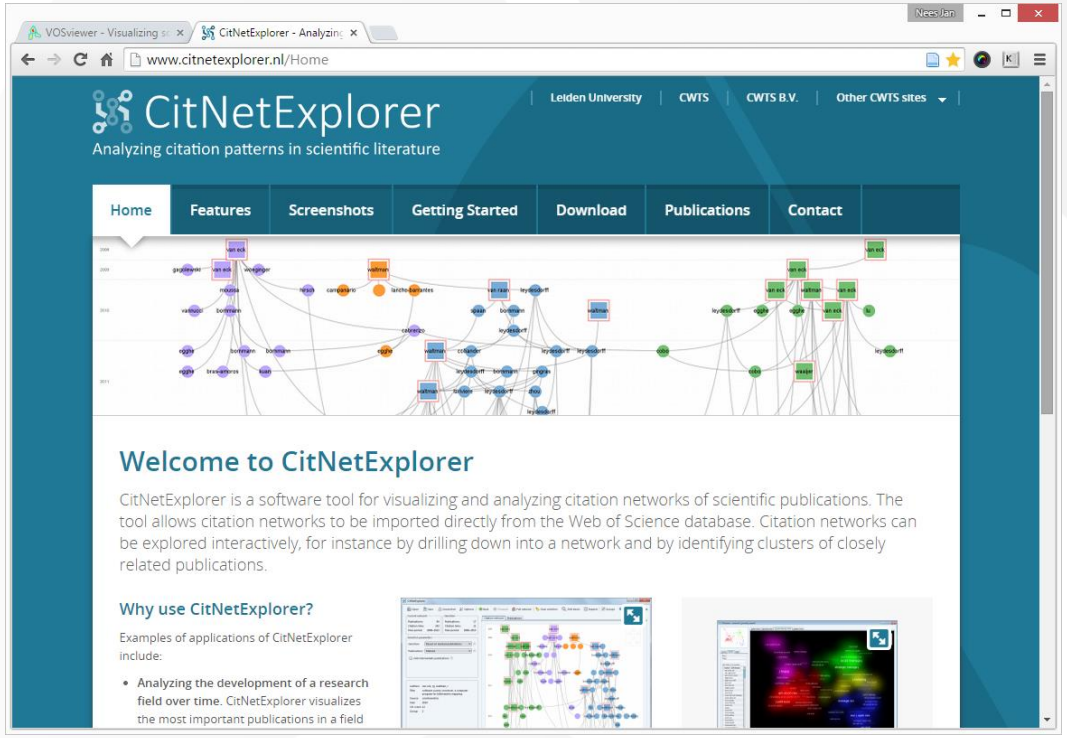


Do it yourself!

www.vosviewer.com



www.citnetexplorer.nl



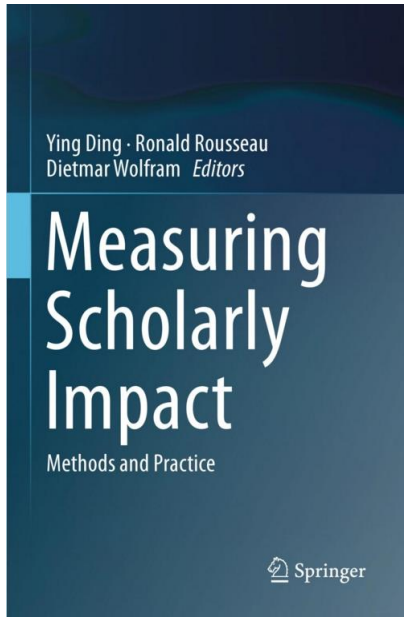
Course: Visualizing Science Using VOSviewer

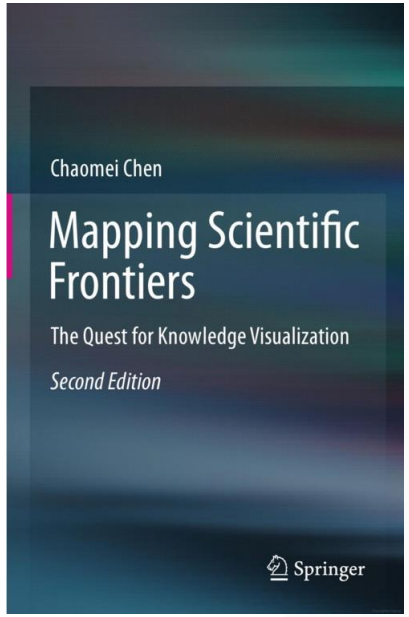
- January 26-29, 2021
- 4 half-day online sessions
- Participants are introduced into the main techniques for visualizing science
- Special attention is paid to applications in a research evaluation and research management context
- The course has an interactive format and the small group size allows participants to practice extensively with the VOSviewer software
- www.cwts.nl

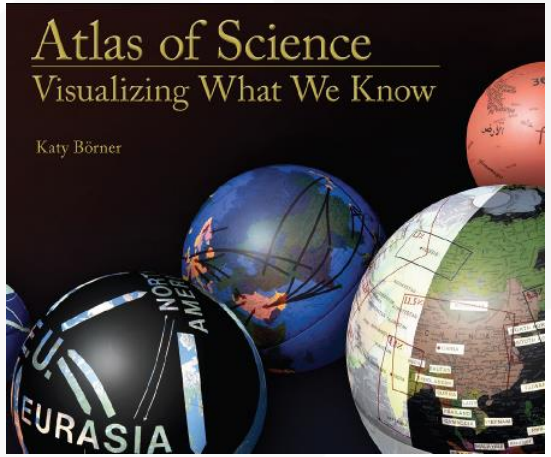
CWTS

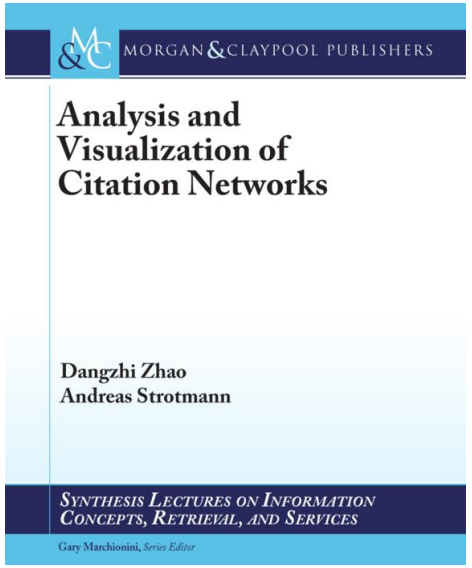
Thank you for your attention!

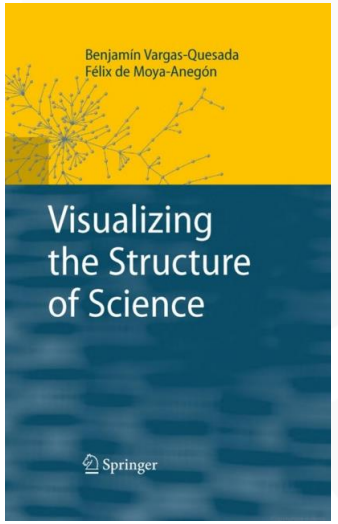
Further reading

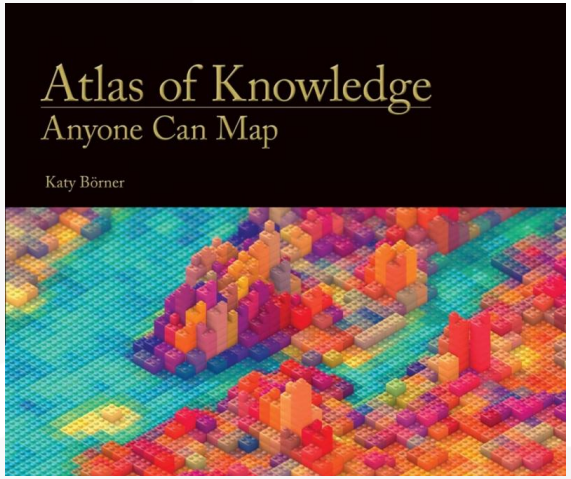
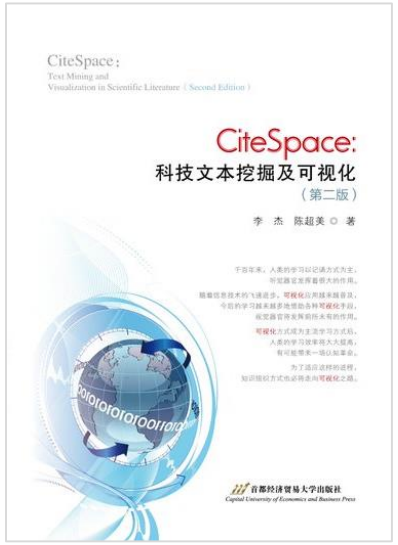
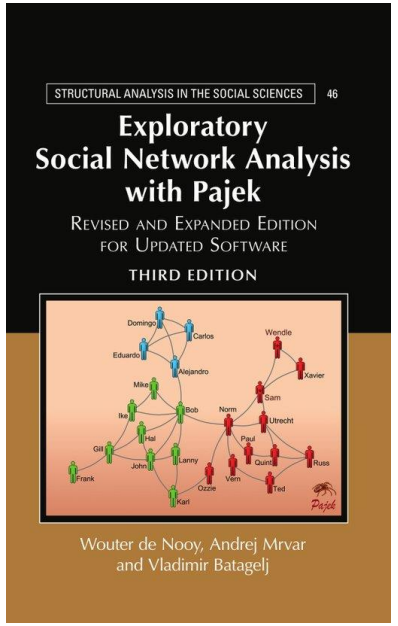
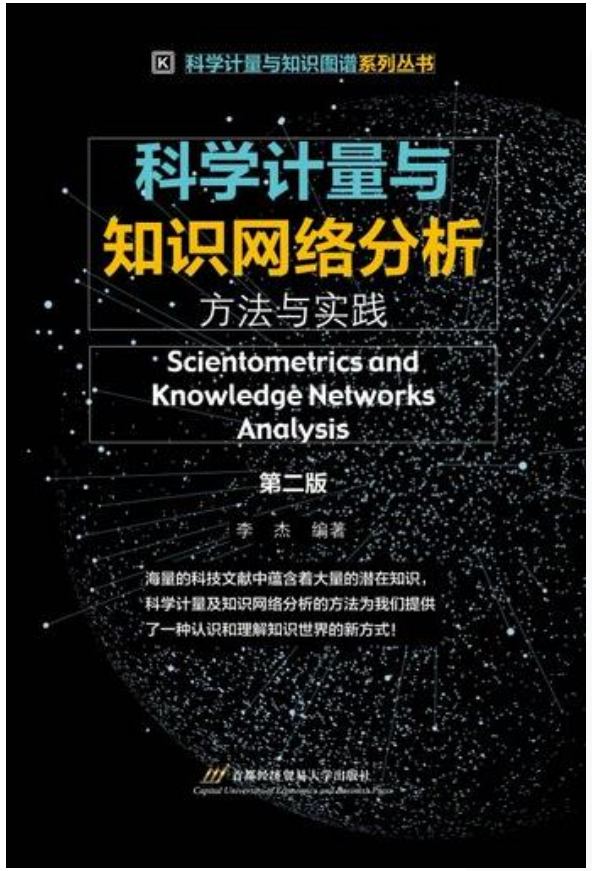
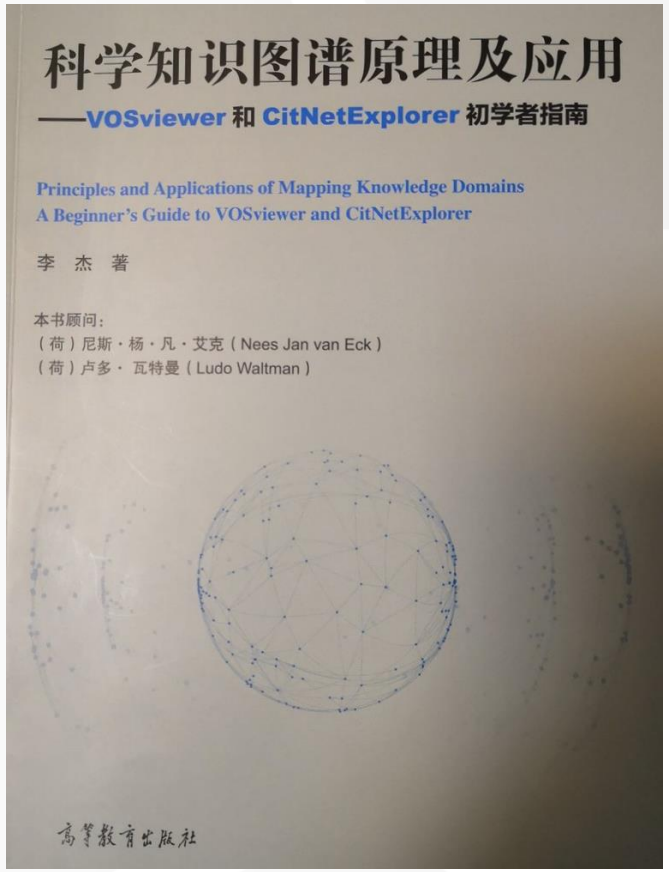












Further reading