



Delft University of Technology

Research positioning & trend identification a data-analytics toolbox

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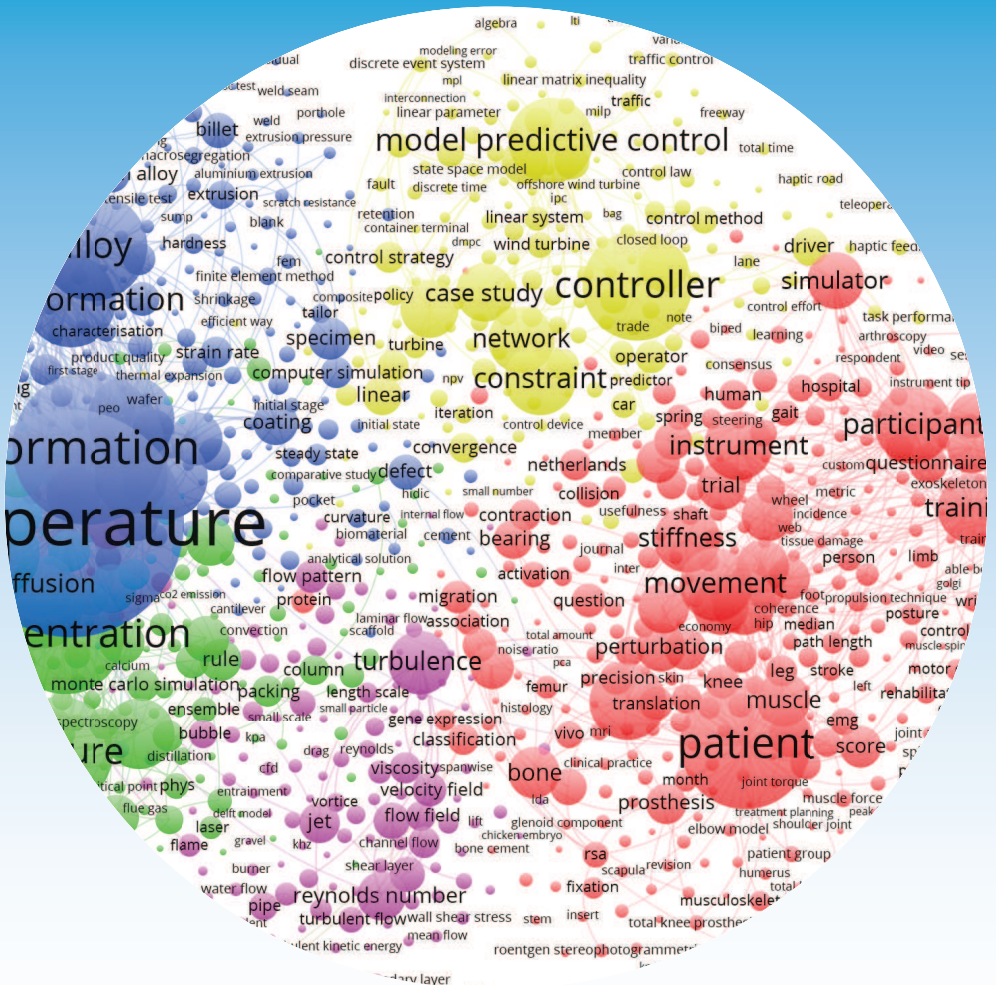
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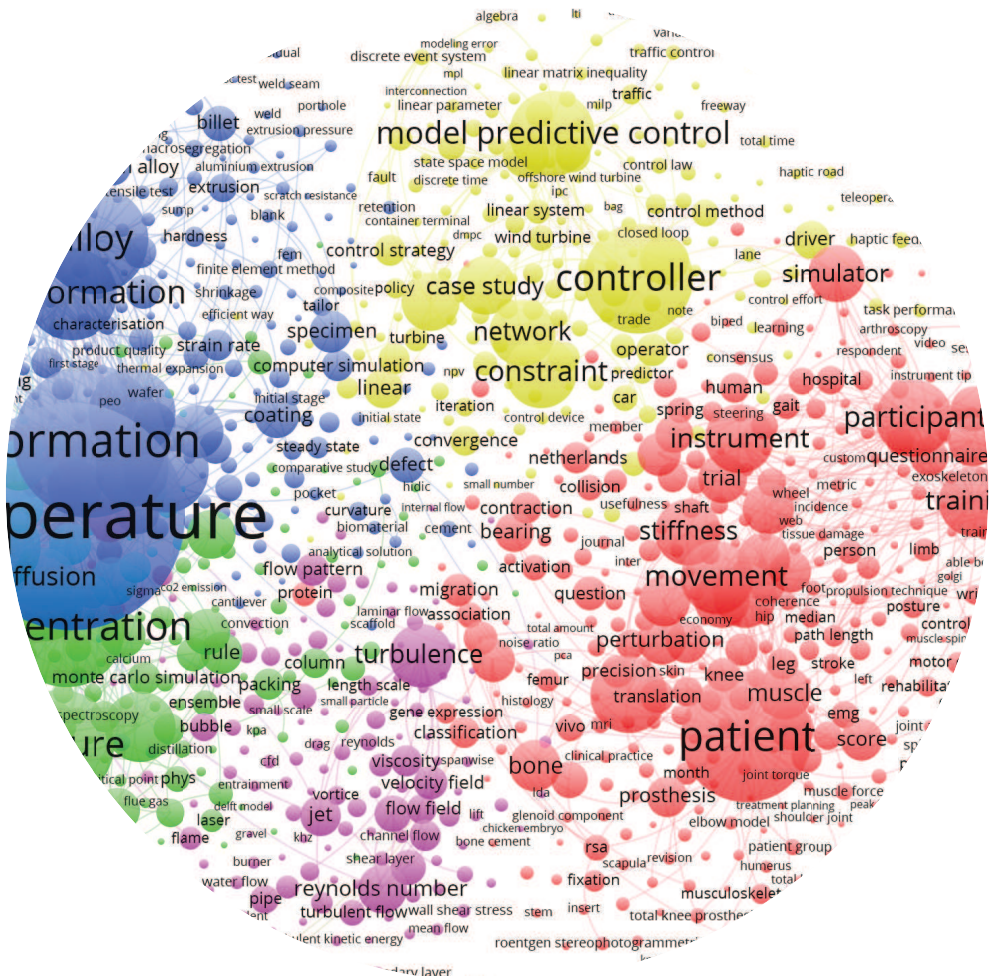
Trend Identification

- a data-analytics toolbox



Trend Identification

- a data-analytics toolbox



B. Ranjbar-Sahraei & R.R. Negenborn

This booklet was produced within the AIDA project.



AIDA was an initiative of TU Delft scientific staff in cooperation with TU Delft Library and Leiden University's Centre for Science and Technology Studies (CWTS). The aim of the AIDA project was to provide TU Delft researchers and faculties with easy-to-use tools for research positioning and trend identification.

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In order to improve the content, format, and design, this reprint might be updated in the near future. The reader is therefore recommended to use the following link to check whether updated material is available. Recommendations for corrections and possible improvements should be sent to the authors.

An electronic version of this booklet is available at <http://aida.tudelft.nl/toolbox/aida-booklet>.

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The information and visualizations provided in this booklet are for informational purposes only. Although all reasonable efforts have been made to ensure that the information and visualizations are correct, such is not guaranteed. Any concerns about the concepts, topics or information provided in this booklet should be addressed to the project leads.

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How to use this booklet

This booklet introduces a toolbox that will help a wide range of end-users – such as [PhD candidates](#), [researchers](#), [group leaders](#), and university [policymakers](#) – to position their research and identify important patterns and trends within their domains of interest. The information provided and the case studies presented were developed based on the questions received from end-users at TU Delft. In compiling this information, extensive use was made of the experience of Leiden University's Centre for Science and Technology Studies (CWTS) and the Research Support of TU Delft library. The presentation style is meant to be visual and easy to use, and to provide practical benefits.

In this booklet, we first introduce the [researcher's toolbox](#), which consists of [data collection](#), [analysis](#), and [communication tools](#). We then provide a list of frequent questions that we have received from our end-users and for each question we indicate the pages in which relevant case studies can be found. Each case study shows some of the methods that can be used to position research and identify trends. We provide a sample illustration and its description for each case study. We explain [WHAT](#) the case study is about, [WHY](#) it is important, [WHO](#) can benefit from it, and [HOW](#) you can replicate it or make similar ones based on the data at hand.

For the sake of brevity and simplicity, the HOW section of each case study is abstract and only sketches the approach that you need to follow to replicate the work. A more detailed description of the HOW for each case study is provided online at aida.tudelft.nl. The online material of each case study provides more information including the original data (whenever possible) and the illustrations in digital format.

We encourage you to replicate some of the presented case studies such that you can get similar results as illustrated in this booklet. This will allow you to familiarize yourself with the technicalities of each method.

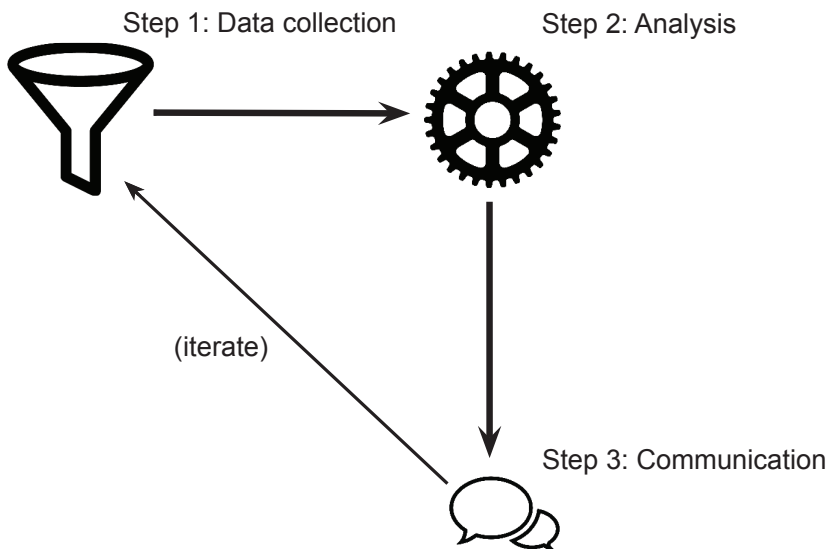
Last but not least, the information provided in this booklet is meant to be used as a source of inspiration and only as a [complementary solution](#) for research positioning and trend identification.

The researcher's toolbox

The researcher's toolbox will help you position your research and identify the patterns/trends within your research area. The toolbox should be used in three steps. Step 1 is the **data collection** step, which will enable you to collect large amounts of data from the relevant databases. The second step is the **analysis** step, which will enable you to objectively analyze the data using easy-to-use bibliometric analysis tools. Finally, the **communication** step will help you communicate your findings to the outside world via standard visualization and reporting methods.



It is important to consider each round of using these three steps as only one iteration of the whole process. Depending on the outputs of the analysis and the feedback received after communication, you should iterate through the same steps to make the required improvements.



Step 1: Data collection



About 200 academic databases and search systems are accessible within the network of TU Delft. Although only some academic databases allow the downloading of large batches of data, the most famous ones – including Scopus and Web of Science – do allow it. Below are some of the popular platforms that can be used to collect the research data that you might need.



[Scopus](#) provides a subscription-based search tool for research output in the fields of science, technology, medicine, social sciences, and arts and humanities. Scopus features different tools to track, analyze, and visualize research.



WEB OF SCIENCE

[Web of Science](#) is an online subscription-based scientific citation indexing service maintained by Clarivate Analytics. It gives access to multiple databases that reference cross-disciplinary research.

Many important journals are indexed by both [Scopus](#) and [Web of Science](#). Still, depending on your discipline, you may find one more useful.



[IEEEExplore](#) provides access to Institute of Electrical and Electronics Engineers (IEEE) journals, transactions, letters, magazines, and conference proceedings.



[ProQuest](#) provides documents from various sources such as newspapers, dissertations and theses, scholarly journals, and television and radio broadcasts.



[Mendeley](#) is a reference manager that can help you to manage your research. The collection of publications available in Mendeley provides a dataset that is useful for analysis purposes.

Step 2: Analysis



The analysis of bibliometric data is now easier than ever before thanks to the availability of online analysis tools and standalone software tools. Such tools can answer questions ranging from “Who is the most frequent author in a set of articles?” and “What are the most frequently used keywords in a set of articles?” to more complex questions such as “What is the state of the art in a research domain?”. Some practical analysis tools are introduced below.

online tools



The [Scopus](#) platform provides an online analysis tool. This tool enables the exploration of data regarding publication year, source of publication, authorship and various other attributes. The interface also provides visualization in the form of distribution graphs, and bar and pie charts.



WEB OF SCIENCE®

The [Web of Science](#) platform provides an online analysis tool similar to Scopus. This tool provides aggregated statistics on authorship, publication source and year, as well as the funding source and many other attributes of publications.

standalone tools



[VOSviewer](#) is a software tool for constructing and visualizing bibliometric networks. This tool also offers a text mining functionality that can be used to construct and visualize co-occurrence networks.




[CitNetExplorer](#) is a software tool for visualizing and analyzing the citation networks of scientific publications. The networks can be explored interactively.

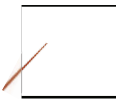
general purpose tools



Various general purpose software tools – such as [Excel](#) as a spreadsheet program, [Python](#), [R](#), [MATLAB](#), and [Java](#) as programming languages, and [Gephi](#) as a network analysis and visualization tool – can also be used for to analyze data.

Step 3: Communication

 You can use various approaches to communicate the results of your analysis to your audience. Before communication, however, you should be aware of the caveats and limitations of your analysis. Try to transparently share the methodology of data collection and analysis with your audience, and provide a convenient channel through which they can provide feedback. Below are some suggestions regarding communication.



Add your visualizations to your [presentation](#) slides. Such visualizations allow you to convey your message more easily.



Use your visualizations and the statistics that you've extracted from your analysis in your [research articles](#). This makes your research outcome more understandable and easier to digest. For examples, check the link below.

<http://aida.tudelft.nl/toolbox/m3-communication#papers>



Your [internal project reports](#) provide a perfect medium to store the analysis results. Each single analysis can be summarized with a set of visualizations and statistical information to be documented in your reports. Check the link below for some examples.

<http://aida.tudelft.nl/toolbox/m3-communication#reports>



Presenting analysis results online in the form of [interactive web-based visualizations](#) is an effective way to communicate the findings to a large audience. AIDA provides a web-based visualization tool: <http://aida.tudelft.nl/WIVOS>



A great benefit of translating your message into visualizations is that it broadens its general audience. You can use various [social channels](#) to spread your ideas and increase your visibility. Visualizations make your message more appealing and memorable.

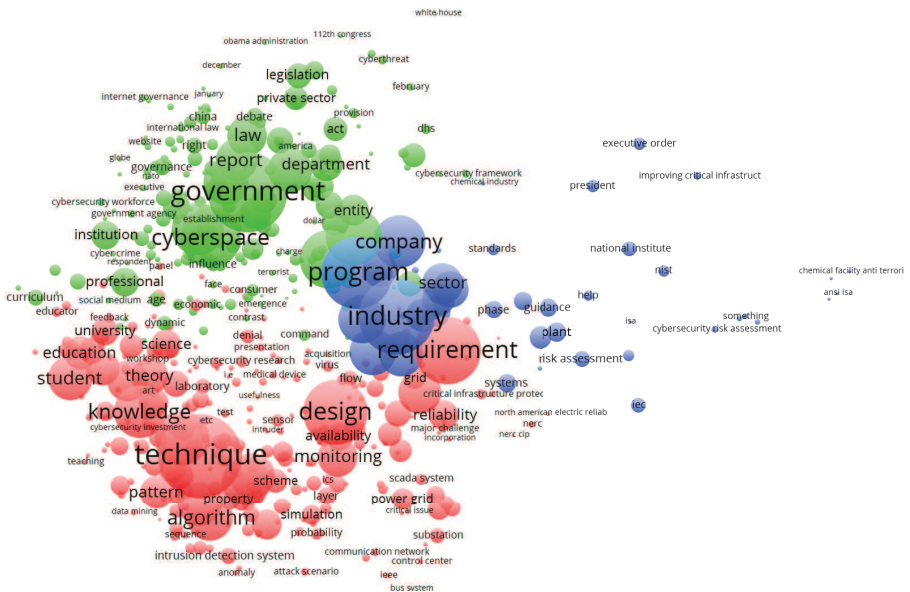
End-user questions

This booklet is meant to answer some of the most frequent questions that end-users – including PhD candidates, researchers, group leaders, and policymakers – have asked. For each question, the pages that provide some insights are listed.

				Page numbers
PhD Candidates	Researchers	Group Leaders	Policymakers	
x	x	x	x	Q1. What is the state of the art in my research area? 1,2,3
x	x	x	x	Q2. What is the position of my work in relation to the existing work? 1,4,5,11
x	x	x	x	Q3. How can I extract emerging trends in a research area? 2,11
x	x	x	x	Q4. How to get a quick overview of what is happening in my field? 1,2,3
x	x	x	x	Q5. Which researchers are my potential collaborators? 1,4,14,20
x	x	x		Q6. Who are the co-authors of a researcher whom I know? 4,15
x	x	x		Q7. What are the frequently investigated topics by an arbitrary group of authors? 1
x	x			Q8. What are the scientific origins of my research field? 1,2,11,12
x				Q9. What keywords are relevant to my research? 1,6
x				Q10. Which papers should I read to learn a specific topic?.....11,12,13
x	x	x		Q11. Which journals are suitable for my research to be published in? 13,15,18
x	x	x	x	Q12. How can I study non-bibliometric datasets such as news and policy documents?16,17
	x	x	x	Q13. Who are the top authors in my research field?4,5,11,14
	x	x		Q14. What is the position of my group in relation to the competitors? 4,5,20,21
	x	x		Q15. How can I get an overview of the expertise of another research group? 1,4,9,19
	x	x		Q16. Can I have an assistive tool for brainstorming session? 1,2,3,4,5,11
	x	x		Q17. Which journals do the researchers of my group usually publish in? 13,15
	x	x		Q18. What are the dominant research areas that my group should be aware of? 1,6,11,16,19
	x	x		Q19. How can I showcase the set of articles submitted to a conference or a journal? 7,18
	x	x		Q20. How can I study a consortium assembly and explore the expertise of each member? 8
	x	x		Q21. How strong is the collaboration between my group and other research groups?... 4,9,10,20
	x			Q22. How can I recommend potential reviewers for a paper/proposal? 1,4,8
	x			Q23. Is the structure of my organization aligned with the research landscape? 1,10,19
	x			Q24. What projects can be optimally supervised by a selected group of researchers? 8,9

CASE 1:

State of the art overview



This term map shows the state of the art of the cybersecurity field according to the Scopus search for the term cybersecurity. Studies on techniques, applications, and policies are represented by red, blue, and green clusters, respectively.

WHAT

Shows the state of the art in a research field

WHY

To get an overview of a research field, find how different subfields are interconnected, and find the potential opportunities for bridging the gaps between subfields

WHO

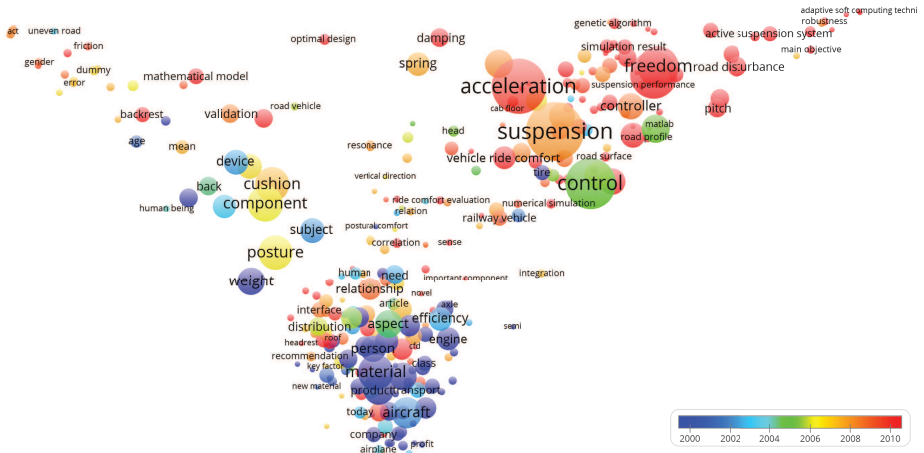
PhD candidates, researchers, group leaders, and policymakers

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the term map based on [text data](#)
4. Use the VOSviewer screenshot to export your map

CASE 2:

Evolution of research



WHAT

Illustrates the evolution of a research area over time

WHY

To understand the trend of research from the past to present

WHO

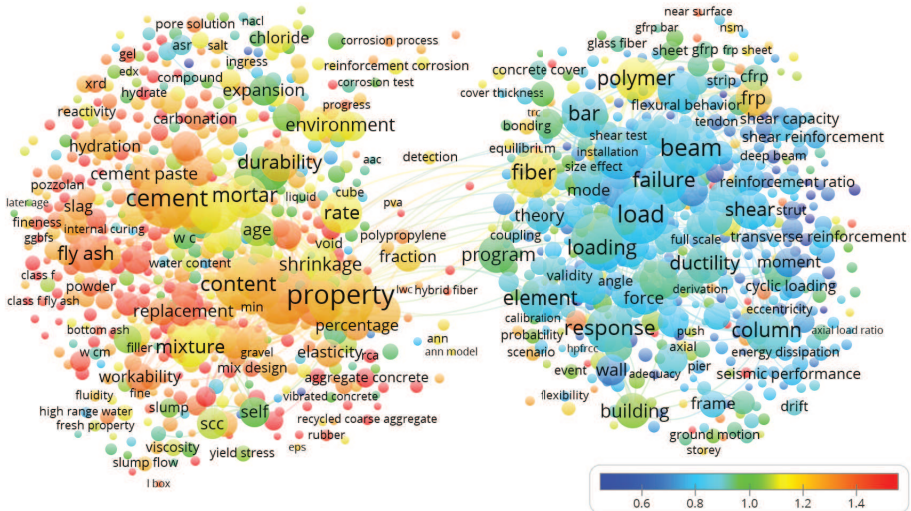
PhD candidates, researchers, group leaders, and policymakers

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the term map based on [text data](#)
4. Use the [overlay visualization](#) feature to color the circles with the average publication year corresponding to the terms
5. Use the VOSviewer screenshot to export your map

CASE 3:

Citation impact



This term map shows the state of the art in research on concrete. The overlay color of each circle corresponds to the average citation impact of all the papers that include the corresponding term. In this map, the terms with cold colors (on the right) represent the research activities with lower number of citations compared to the terms with hot colors (on the left).

WHAT

Distinguishes the terms that have made a higher citation impact than the other terms

WHY

To understand the subareas with higher citation impact

WHO

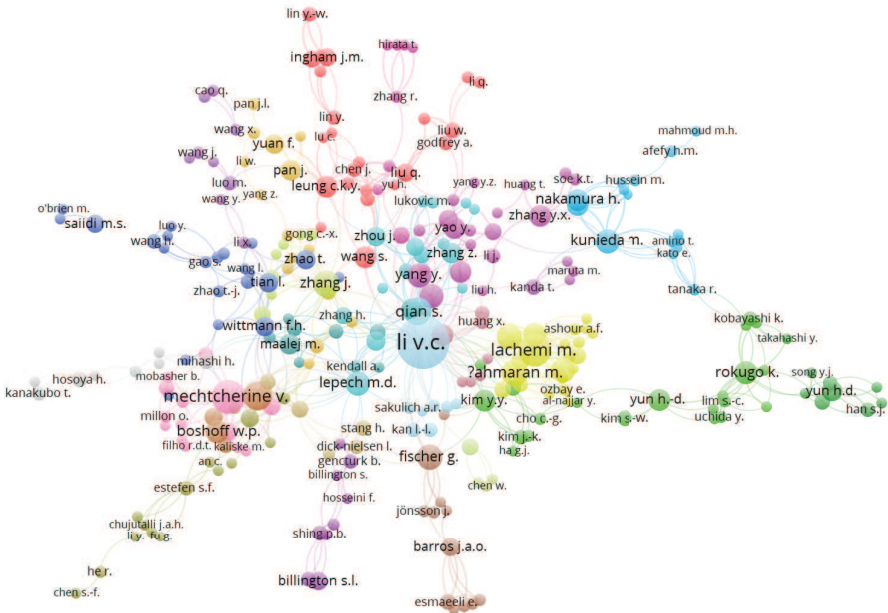
PhD candidates, researchers, group leaders, and policymakers

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the term map based on [text data](#)
4. Use the [overlay visualization](#) feature to color the circles with the citation impact corresponding to the terms
5. Use the VOSviewer screenshot to export your map

CASE 4:

Collaboration profile



This co-authorship map shows the names of authors who are publishing papers in a specific domain. The size of the circles corresponds to the number of papers each author in the publication list has published, and the links between the circles show co-authorships of papers.

WHAT

Reveals co-authorship patterns

WHY

To determine the role of researchers within their research team and identify active research teams

WHO

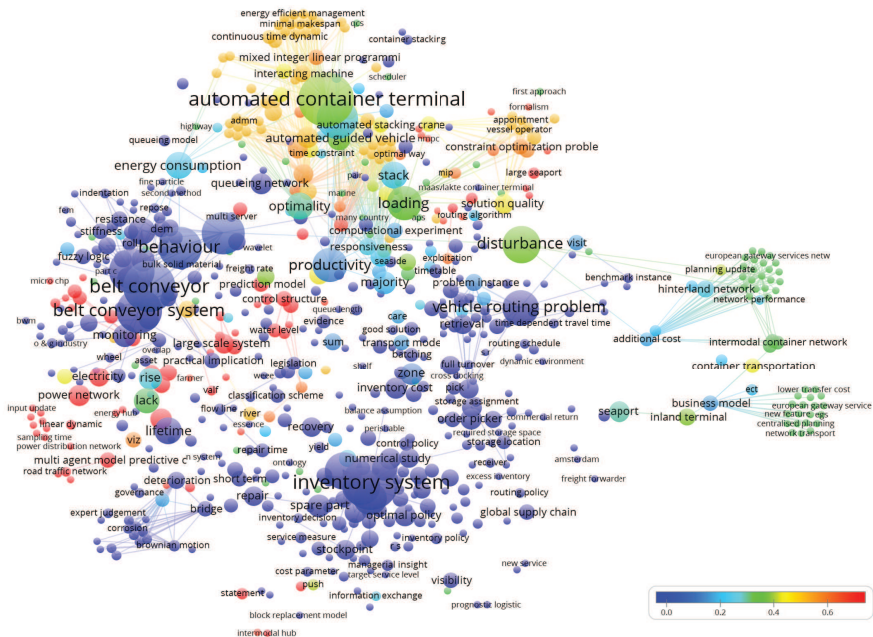
PhD candidates, researchers, group leaders, and policymakers

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the **co-authorship** map based on **bibliographic data**
4. Use the VOSviewer screenshot to export your map

CASE 5:

Research positioning



This term map visualizes the topics that are being covered by the publications of a group of researchers active in the logistic research area. The circles with hot colors (e.g., yellow and red) represent the expertise area of a specific researcher.

WHAT Indicates what terms the research outcome of a researcher is focused on

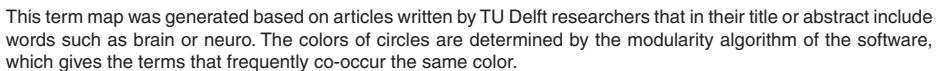
WHY To understand the focus area of a researcher and to find the focal area for potential collaboration

WHO PhD candidates, researchers, group leaders, and policymakers

HOW

1. Collect your data from an appropriate data source
2. Generate a **corpus** and a **score** file such that in the score file you indicate whether or not each of the corpus file documents belongs to the author in question
3. Generate the term map based on **text data** (i.e., corpus and score files)
4. Use the **overlay visualization** feature to color the terms such that the color indicates how often the term is mentioned in the author's publications
5. Use the VOSviewer screenshot to export your map

Research showcasing



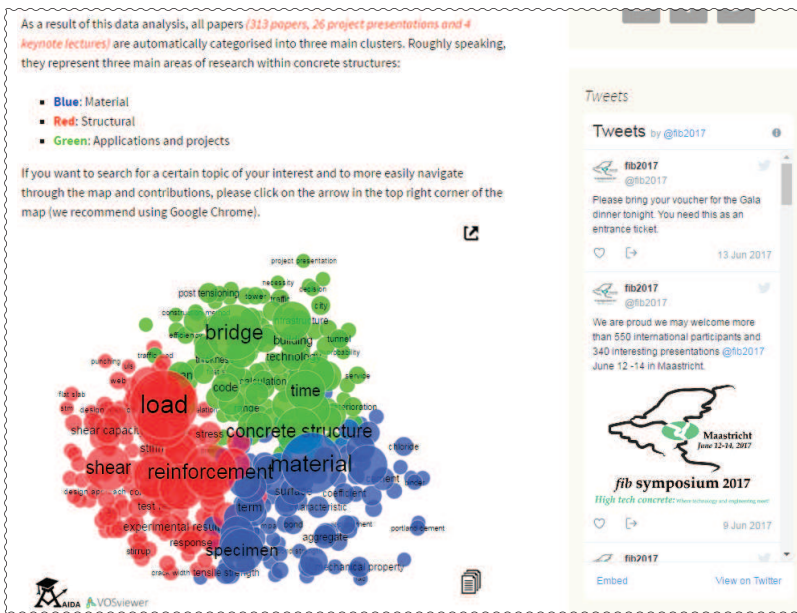
WHAT	Visualizes all or a subset of an organization's research outcome
------	--

WHO Researchers, group leaders, and policymakers

6

CASE 7:

Conference submission profile



This term map visualizes the terms that appear in the titles and abstracts of articles submitted to a conference. The large circles indicate which terms are mentioned more frequently. The terms that are closer to each other and have the same color (which is automatically determined by the software), are terms that co-occur very frequently.

Data for this case study is provided by Dr. Mladena Lukovic.

WHAT

Provides an overview of the articles (or abstracts) submitted to a conference or journal

WHY

To enable conference participants to navigate through the terms mentioned in the submitted papers, and to trace the terms back to the submitted articles

WHO

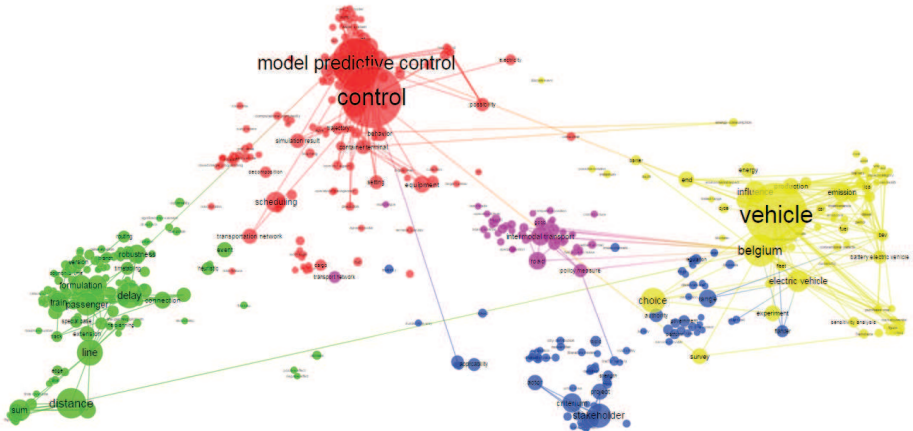
Group leaders and policymakers

HOW

1. Collect the data (authors, titles, and abstracts) of articles submitted to the conference
2. Import the data into VOSviewer
3. Generate the term map based on [text data](#)
4. Use the VOSviewer [save](#) button to export the map file in txt format
5. You can use the [AIDA web interface](#) to show the results on your website

CASE 8:

Consortium assembly profile



This term map visualizes the topics that are being covered by the publications of members of a consortium. As can be seen, in this case the expertise areas are relatively diverse and the term clusters are not tightly connected to each other.

WHAT

Illustrates the expertise areas of the members of a consortium

WHY

To determine the expertise area of consortium members and identify their common interests

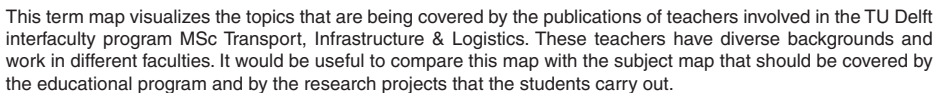
WHO

Group leaders and policymakers

HOW

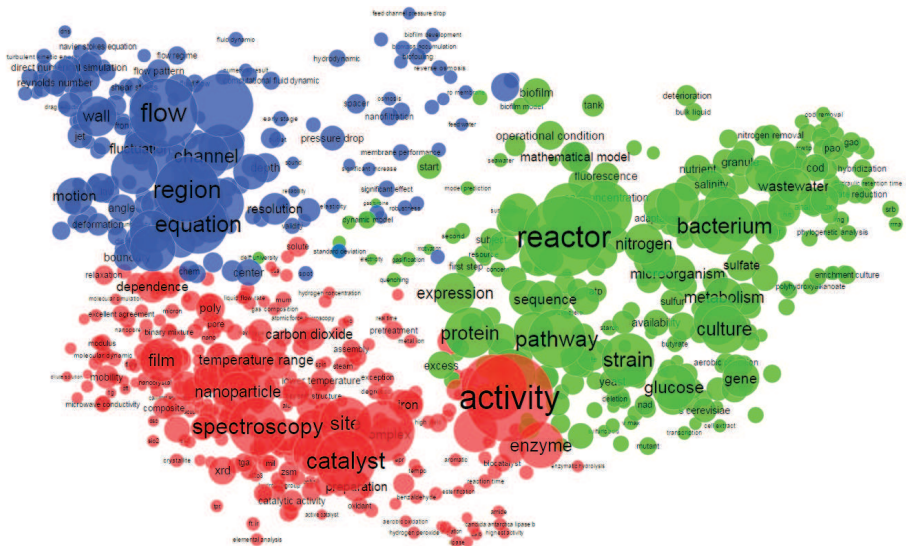
1. Collect the data of articles published by members of the consortium
2. Generate a [corpus](#) and a [score](#) file such that in the score file you indicate which author(s) wrote each of the articles
3. Generate the term map based on [text data](#) (i.e., corpus and score files)
4. Use the [overlay visualization](#) feature to color the terms such that the color indicates how often the term is mentioned in the publications of an arbitrary author
5. Use the VOSviewer screenshot to export your map

Educational program profile

9

CASE 10:

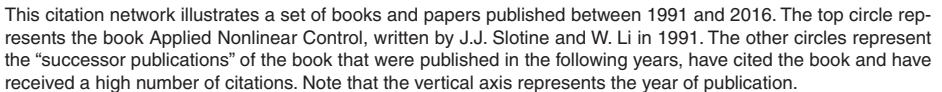
Organization overview



This term map was generated based on the research articles written by researchers in an organization that is composed of various departments. Three clusters shown in blue, red and green show the terms that frequently co-occur. This map provides an overview of the organization's research area and positions the work of each department within the organization.

WHAT	Illustrates the research areas covered by an organization
WHY	To identify the expertise and potential collaborations within an organization
WHO	Group leaders and policymakers
HOW	<ol style="list-style-type: none">1. Collect the data of articles published by researchers of an institute2. Import the data into VOSviewer3. Generate the term map based on text data4. Use the VOSviewer screenshot to export your map5. You can use the AIDA web interface to show the results on your website

Citation networks (1)



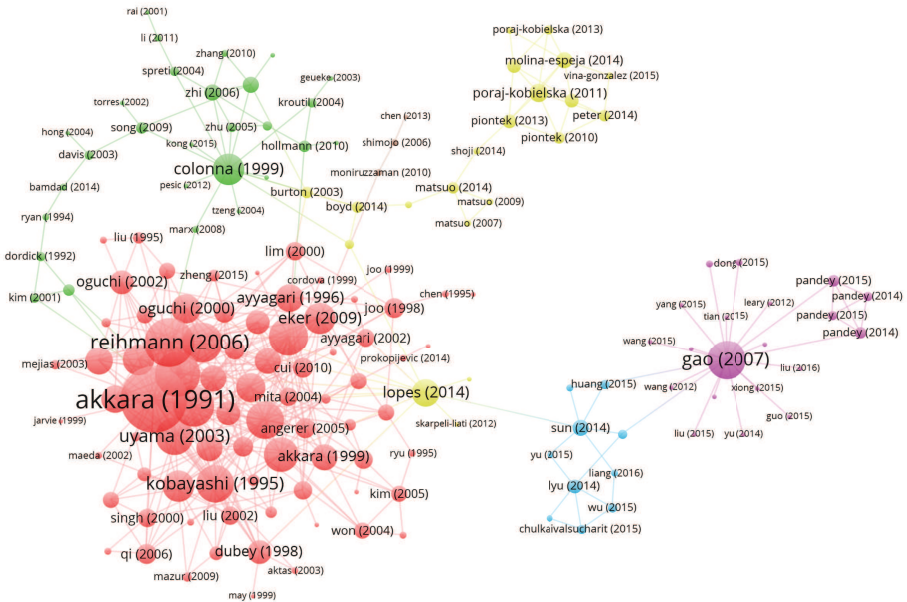
Depicts the citation network of a set of articles

To identify the literature on a research topic or explore the publication oeuvre of a researcher

PhD candidates and researchers

1. Collect your data from the [Web of Science](#) platform
2. Import the data into CitNetExplorer software tool
3. Use the [drill down, expand](#) and [analysis](#) features to study the network
4. Use the CitNetExplorer screenshot to export your map

Citation networks (2)



In this citation map, each circle corresponds to an important paper represented by the last name of first author and year of publication. The size of circles corresponds to the number of times the paper has been cited. As can be seen, the colors of the map, which are assigned automatically, show clusters of papers which have cited each other frequently.

WHAT	HOW
Depicts the citation network of a set of articles	<ul style="list-style-type: none"> Nodes: articles Edges: citations

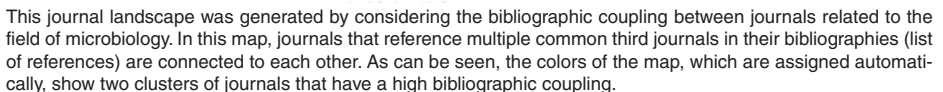
WHY To identify the key publications that are cited frequently with other articles, as well as articles that act as a bridge between different topics

WHO PhD candidates, researchers, and group leaders

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the **citation** map based on **bibliographic data**
4. Use the VOSviewer screenshot to export your map

Journal landscape



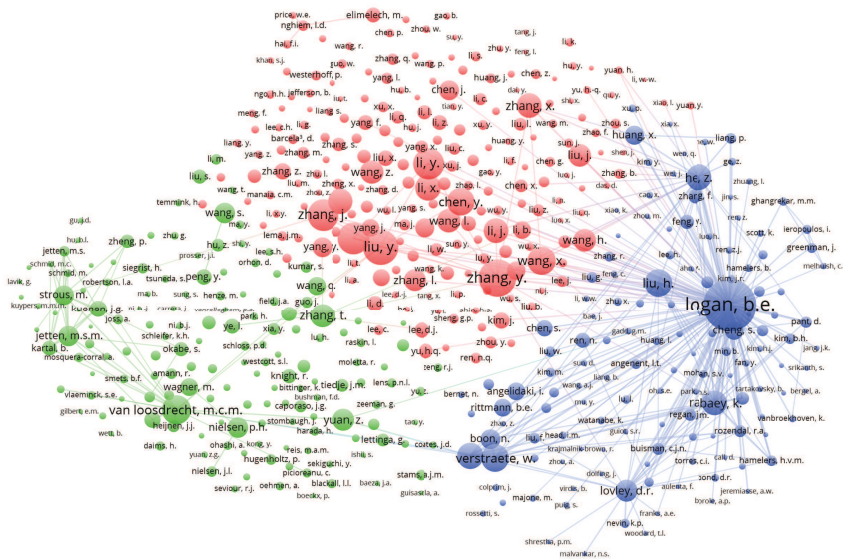
WHY To gain a better understanding of the similarity of journals

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the **bibliographic coupling** map in **journal level** based on **bibliographic data**
4. Use the VOSviewer screenshot to export your map

CASE 14:

Author landscape



This author landscape was generated by considering the co-citation of different papers published in the field of microbiology. In this map, the authors who are mentioned in the bibliographies (list of references) of the papers are shown, and every pair of authors who frequently co-occur in the bibliographies of the same papers are connected to each other. The authors connected to each other or positioned in close vicinity of each other do not necessarily work together, but are active in the same type of research.

WHAT

Shows how frequently the articles of different researchers are co-cited by the same articles

WHY

To gain a better understanding of the author landscape in a field from an intellectual point of view

WHO

PhD candidates, researchers, group leaders, and policymakers

HOW

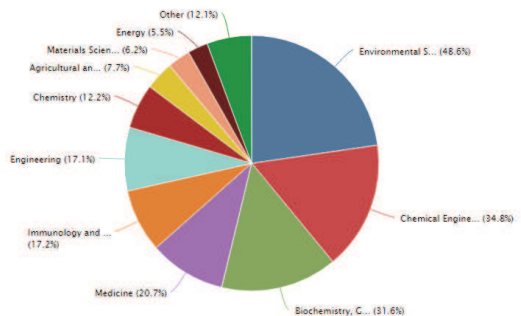
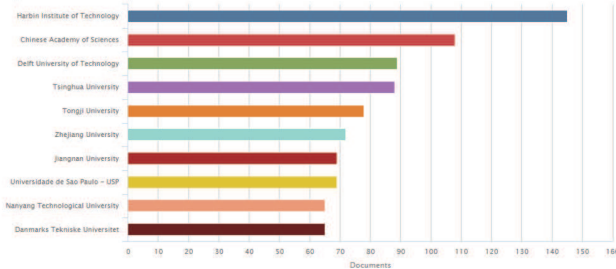
1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the **co-citation** map in **author** level based on **bibliographic data**
4. Use the VOSviewer screenshot to export your map

CASE 15:

Ranking

Documents by affiliation

Compare the document counts for up to 15 affiliations



The above graphs were extracted from the online analysis tool of Scopus. The search was performed on the term bioreactor and the publication year was limited to 2015 and 2016. These graphs are easy to make and provide quantitative information about affiliations, authors, and types and subjects of articles.

WHAT

Indicates the aggregated information of a set of publications

WHY

To visualize the ranking of universities, important subjects and other properties of scientific articles in a quantitative manner

WHO

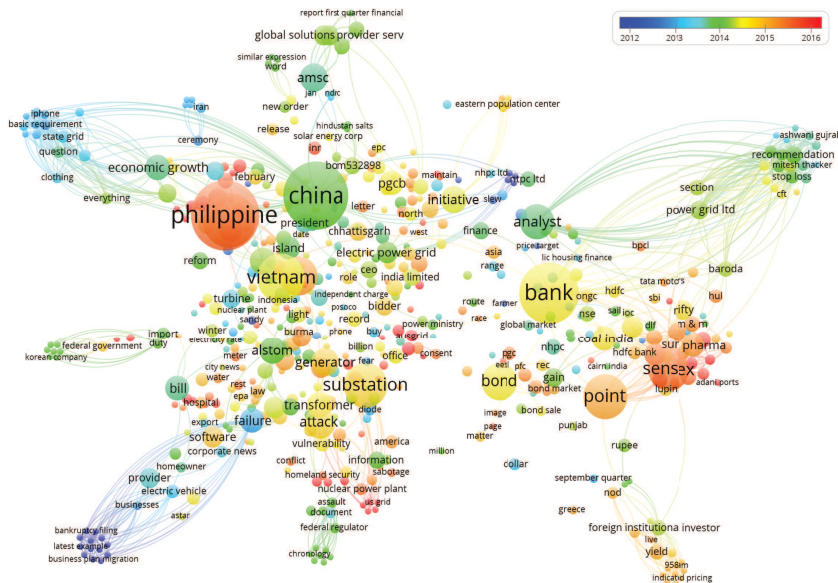
PhD candidates, researchers, group leaders, and policymakers

HOW

1. Run your query in the [Scopus](#) or [Web of Science](#) platform
2. Use the [analysis \[search\] results](#) link
3. Select the appropriate attribute to see the results
4. Export the graphs or raw data for further analysis

CASE 16:

News overview



This map visualizes the terms that appeared in news articles on the topic power grid. The color indicates the average year of publication of articles that included each term.

WHAT

Provides an overview of the terms occurred in news articles on a certain topic

WHY

To identify the important topics discussed in news articles and identify links between these topics

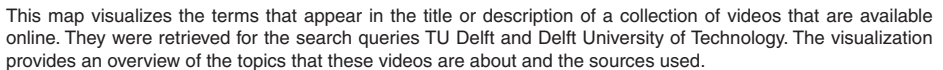
WHO

PhD candidates, researchers, group leaders, and policymakers

HOW

1. Go to search.proquest.com and run your query
2. Export your results in [RIS format](#)
3. Import the data into VOSviewer
4. Generate the term map based on [text data](#)
5. Use the [overlay visualization](#) feature to color the circles with the average publication year corresponding to the terms
6. Use the VOSviewer screenshot to export your map

Web media content



WHAT	Provides an overview of the videos that are available online on a topic or institute
------	--

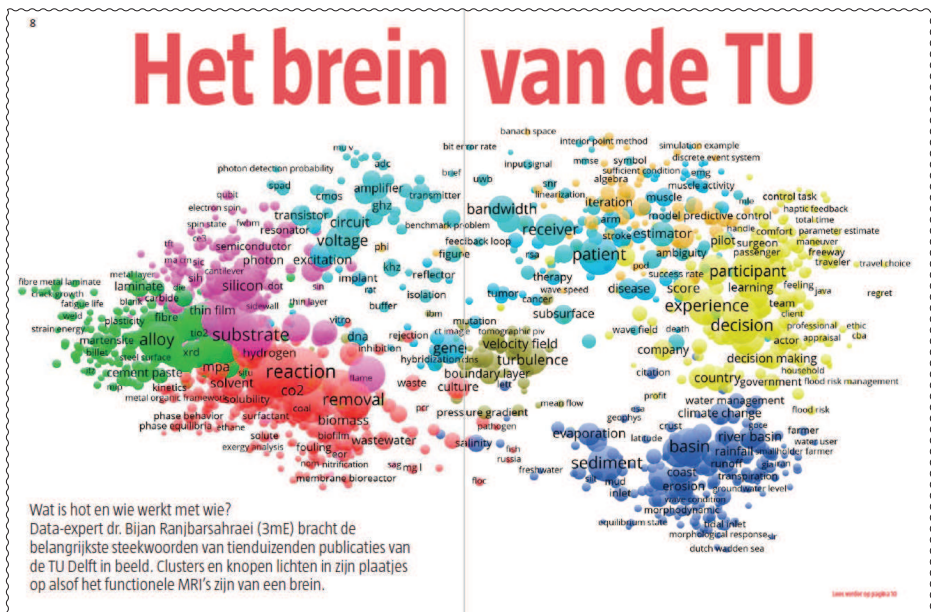
WHO Policymakers

17

Open-access zone

CASE 19:

TU Delft research profile



This term map was generated based on research articles written by researchers at TU Delft. The terms were extracted from the title and abstract of articles. The clusters are automatically detected using the built-in modularity detection algorithm of the VOSviewer software.

This visualization was first published in Delta magazine (No. 7, 6 March 2017).

WHAT Illustrates the research topics covered by TU Delft researchers

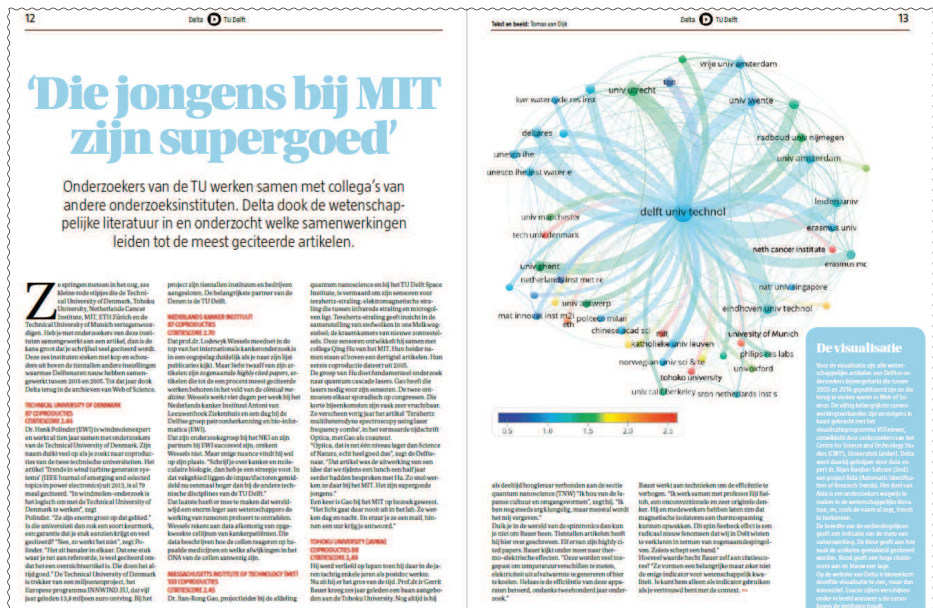
WHY To provide a better overview of the disciplines that TU Delft researchers work on and the relation between these disciplines

WHO PhD candidates, researchers, group leaders and policymakers

HOW

1. Collect the data of articles published by researchers
2. Import the data into VOSviewer
3. Generate the term map based on [text data](#)
4. Use the VOSviewer screenshot to export your map

TU Delft collaborators (1)



This collaboration network was generated based on articles written by TU Delft researchers. The institutes with the highest number of collaborations were chosen, and the colors were used to indicate the citation impact of each collaboration link.

This case study was carried out by Tomas van Dijk and was first published in Delta magazine (No. 9, 24 April 2017).

WHAT

Shows TU Delft's top collaborators and the citation impact of each collaboration

WHY

To identify TU Delft's collaborators and the disciplines that each collaboration is built upon, and to evaluate these collaborations

WHC

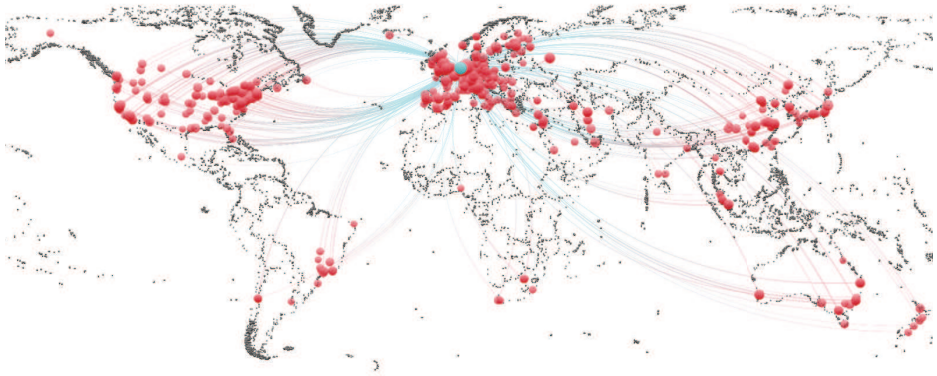
PhD candidates, researchers, group leaders, and policymakers

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer
3. Generate the **co-authorship** map based on **bibliographic data** in **organization level**
4. Use the **overlay visualization** feature to color the terms based on the citation impact
5. Use the VOSviewer screenshot to export your map

CASE 21:

TU Delft collaborators (2)



This collaboration map was generated based on research articles written by researchers at TU Delft from 2012 to 2018. Each red circle indicates an institution that has published articles together with the researchers of TU Delft (the blue circle) in the mentioned time period.

This visualization is made in collaboration with the CWTS researchers.

WHAT

Shows TU Delft's collaborators on a geographic map

WHY

To identify TU Delft's collaborators with a focus on the geographic locations

WHO

PhD candidates, researchers, group leaders, and policymakers

HOW

1. Collect your data from an appropriate data source
2. Import the data into VOSviewer and generate the [co-authorship](#) map based on [bibliographic data](#) in [organization level](#)
3. Save the map file, and change the values in x and y columns of the map file to the [longitude](#) and [latitude](#) of the corresponding institutions
4. Add extra nodes that represent the country borders [see the online material for more information], and open the updated map file in VOSviewer
5. Use the VOSviewer screenshot to export your map

Useful links

		Data Collection	Analysis	Communication	General
Online material http://aida.tudelft.nl	Provides the online material of this booklet with data to download, visualizations and description				x
Scopus http://www.scopus.com	Scholarly search engine and online analysis tool	x	x		
Web of Science http://www.webofknowledge.com	Scholarly search engine and online analysis tool	x	x		
IEEEExplore http://ieeexplore.ieee.org	Scholarly search engine	x	x		
ProQuest http://search.proquest.com	Scholarly and media search engine	x	x		
VOSviewer http://www.vosviewer.com	Analysis and visualization tool		x		
CitNetExplorer http://www.citnetexplorer.nl	Analysis and visualization tool		x		
AIDA web interface http://aida.tudelft.nl/WIVOS	Interactive web interface for the online visualization of maps generated by VOSviewer			x	
AIDA project http://aida.tudelft.nl	TU Delft project focused on automatic trend identification				x
TU Delft Research Support http://researchsupport.tudelft.nl	Portal where researchers can find solutions to their research-related support questions				x
oaDOI http://oadoi.org	Provides the full text of scholarly articles, as well as an API to extract the open access status of articles based on DOI	x			
Pure https://pure.tudelft.nl	Portal to access TU Delft research outcome	x			
Scholarly resource APIs http://libguides.mit.edu/apis	Provides a list of some scholarly resources that make their APIs available for use	x			x
Mendeley https://www.mendeley.com	Reference manager and academic social network	x			

AIDA highlights

The AIDA project was carried out by TU Delft and Leiden University's CWTS in 2016-2017. AIDA used [state of the art tools](#) for collection, processing, visualization and interpretation of bibliometric data.

AIDA organized [interactive workshops](#) in which researchers from different disciplines worked together to overcome the existing limitations in research positioning and trend identification. Together with the researchers, AIDA created a [toolbox](#) consisting of easy-to-use and yet effective software tools for analysis of large bodies of literature.

In order to guarantee a [long-term impact](#), AIDA engaged in dialogues and collaboration with TU Delft researchers and support staff. The [informed community](#) allowed AIDA to disseminate the project outcomes to the TU Delft life.

AIDA will be followed-up by various activities including, but not limited to, the following.

- The [skills](#) and [knowledge](#) developed during the AIDA project will be transferred to the Research Support Center of TU Delft Library for supporting researchers and faculties of TU Delft.
- The [pilot software tools](#) produced during the project and the [experience](#) of interaction with end-users will be transferred to Leiden University's CWTS, AIDA partner, for further improvement and developments.
- The research positioning [workshops](#) will be organized at the level of the Leiden-Delft-Erasmus partnership.

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Community

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