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Weak signals in Science and Technologies

Weak signals in 2020

Technologies at a very early stage of development that could impact the future

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Weak signals in Science and Technologies

Weak signals in 2020

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Contents

Abstract

This report presents a list of 75 individual weak signals in science and technology development in 2020. In addition, 4 clusters of weak signals have also been detected and are reported. These early signs of emerging technologies or products were detected using text mining, clustering techniques and scientometrics indicators applied on a corpus of peer-reviewed scientific publications.

A dashboard is at the disposal of the reader to further explore the weak signals:

https://www.timanalytics.eu/TimTechPublic/dashboard/index.jsp#/space/s_1597?ds=126842

Acknowledgements

The authors would like to thank Philip Hines and Ralf Herold from the Horizon Scanning, Regulatory Science and Innovation Task Force at the European Medicines Agency for their contribution to this report.

1 Introduction

Foresight at JRC

Acting at the interface between science and policy, one of the role of JRC is to inform policy makers working in policy fields with a technological component about new scientific developments. The early identification of emerging technologies is indeed key for the design of new policies, which need to take into account their potential to create new market opportunities or technological disruptions. In a time of accelerating technological change and hyperconnectivity, early awareness of potentially disrupting technologies or scientific development allows for more time to design well-fitted policies that secure both a stable business environment for industrial actors and a safe society for citizens to live in.

Through its foresight activities, the JRC brings together relevant experts and stakeholders to develop anticipatory knowledge and collect insights on possible alternative futures. As many policy fields have a technological component, these scenarios for the future are used to support policy-makers with long-term implications and opportunities on technological development. This report, which is the outcome of the second exercise ran by JRC to detect weak signal in science and technology development using text mining and clustering algorithms on a large collection of scientific publications[1][2], contributes to this foresight process by 1) flagging new emerging topics or challenges that should be explored by means of qualitative processes or by 2) validating/reinforcing the results of a qualitative exercise.

Weak signals

The list of weak signals presented in this report is the result of a detection process ran by the JRC during the first trimester 2021 on a corpus of peer-reviewed scientific publications using TIM Trends[3]. This software combines text mining techniques with computational and data visualisation means and has been specifically designed by JRC to detect weak signals of emerging technologies or new scientific topics.

75 weak signals and 4 clusters of weak signals were detected using the Scopus collection of scientific publications (from 1996 to 2020), following a methodology combining text mining, scientometrics and domain knowledge (read more about the methodology in section 3). Domain knowledge for the weak signals related to Biotechnologies and Health was provided by the European Medicine Agency. The list of weak signals is by no means exhaustive and may contain technologies that will never lead to new innovations.

Dashboard

A dedicated dashboard is available for the readers that would like to go a step further in understanding the weak signals. It displays peer-reviewed scientific publications, patents and research projects (funded by the EU framework programmes) and offers many

1 Eulaerts O., Joanny G., Giraldi J., Fragkiskos S., Perani S., *Weak signals in Science and Technologies - 2019 Report*, EUR 29900 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-12386-6, doi:10.2760/858426, JRC118147.

2 Eulaerts O., Joanny G., Perani S., *Weak signals in Science and Technologies 2019 - Analysis and recommendations*, EUR 30061 EN, Publications Office of the European Union, Luxembourg ISBN 978-92-76-15133-3, doi:10.2760/319103, JRC. 119395

3 TIM Trends is a tool of the TIM analytics suite developed by JRC. Link to TIM analytics website: https://knowledge4policy.ec.europa.eu/text-mining/topic/tim_analytics_en

features to quickly grasp the main characteristics of each signal (what it is about, which organisations are active in the field, what countries are involved, what is the dynamics and the trajectory of the research, etc.). It is accessible here:

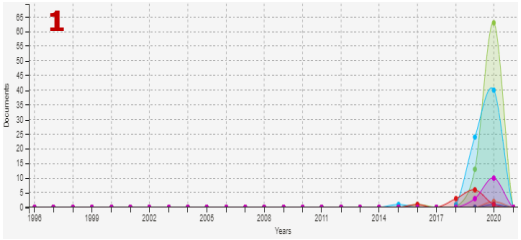
https://www.timanalytics.eu/TimTechPublic/dashboard/index.jsp#/space/s_1597?ds=126842

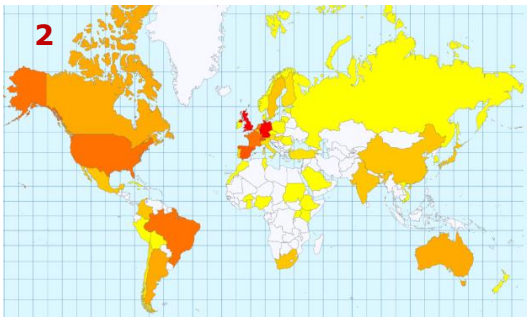
This dashboard is a projection of a dedicated space that has been set up in the TIM Technology system[4].

Visualisations

The four visualisations below are systematically used in the report to give the reader a quick overview of the characteristics for each weak signal.

Figure 1: Visualisations for weak signal





Each visualisations corresponds respectively to:

1

Distribution of documents

It shows the distribution of documents retrieved for the weak signal. The sharper and higher the peak, the most intense the weak signal is.

2

Origin of the documents

The origin of the documents related to each weak signal are aggregated at country level and projected on a world heatmap. This graphic allows the reader to understand in the blink of an eye where research is concentrated.

3

List of main organisations

This list provide an indication of the most active organisations for each weak signal. Organisations with at least 1 document are considered, with a maximum of 20 organisations per list.

4

Wordcloud of relevant keywords

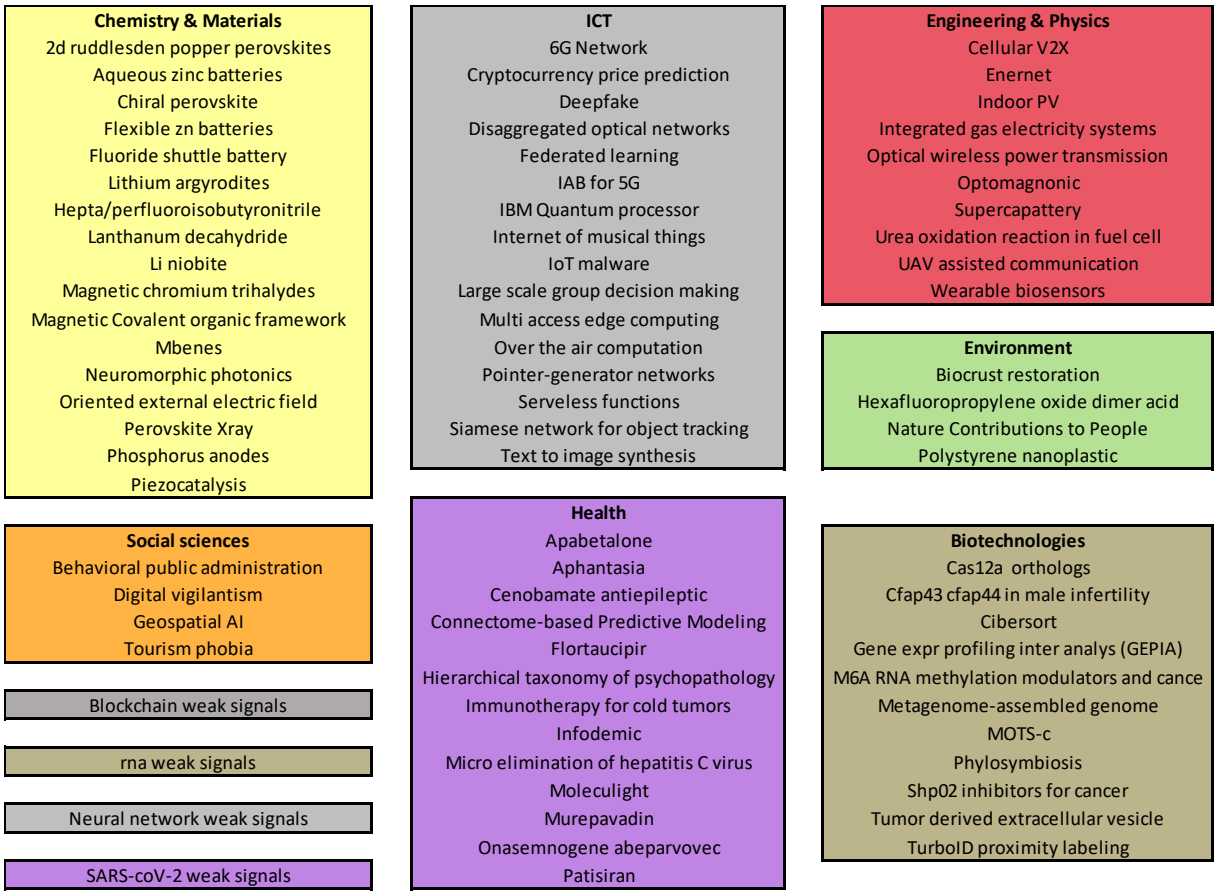
These keywords are generated by TIM's language processing algorithms to represent the dataset as a whole. The size of the keywords in the cloud measures the "relevance" of the term in the dataset.

[4] https://www.timanalytics.eu/TimTechPublic/main.jsp?dataset=s_1507
TIM tools are free of access to all Commission staff and under certain conditions to any outsiders. Feel free to check our website or to contact the authors of this report for more information.

2 Weak signals

The weak signals in 2020 are grouped by sector in the table below. There are 75 individual signals categorised in Chemistry & Materials, ICT, Engineering & Physics, Environment, Biotechnologies, Health, and Social Sciences. In addition, numerous weak signals have been detected in these 4 technology areas: blockchain, RNA, neural networks, and SARS-coV-2. They have been aggregated into four "mega weak signals" to clarify the reporting.

Figure 2: List of the weak signals by sector



The following section contains a small description and the four summary visualisations for each weak signal retrieved in each of the categories.

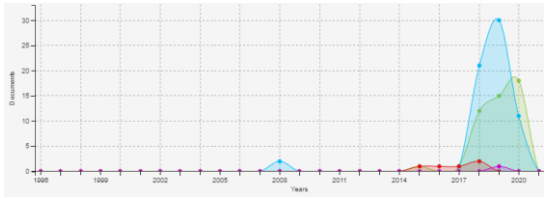
For the clusters of weak signals, we also looked into the pervasion of the technology in other domains, represented by journal categories. An increase in the diversity of journal categories in which publications for a certain technology are published suggests that the number of applications of that technology in different domains is increasing. It can be interpreted as an indication of a technology becoming more mature.

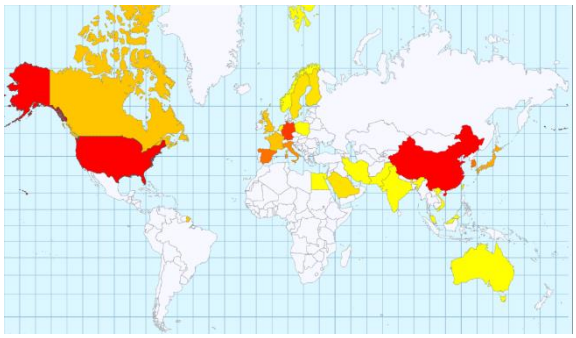
2.1 Engineering & Physics

Cellular V2X

There is intense R&D ongoing on connected and autonomous vehicles, promising an improved safety, a decrease in traffic congestion, and lower environmental impacts. Vehicle-to-everything communication (V2X) is a key enabler technology that will allow vehicles to communicate with other vehicles, pedestrians, road-side equipment and the vast amount of information available on Internet. Cellular V2X is a standard launched in 2018 under the umbrella of the 3GPP consortium.

Figure 3: Visualisations for Cellular V2X





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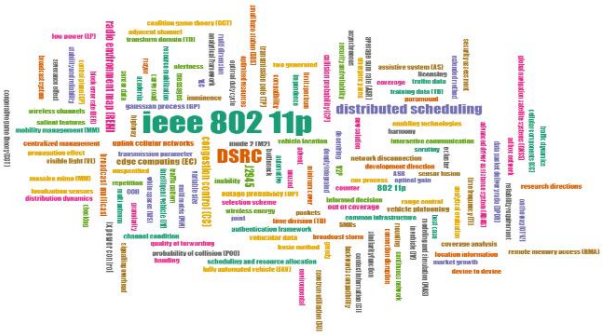
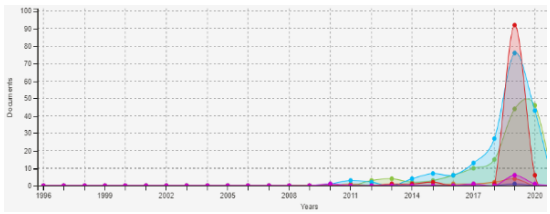
Southwest Jiaotong University	6.0
QUALCOMM INC	5.0
Peking University	5.0
Virginia Tech	4.0
Korea University	4.0
Ericsson Research	4.0
Beijing University of Posts and Telecommunications	4.0
Université Paris-Saclay	3.0
Università Mediterranea	3.0
University of Central Florida	3.0
Universitat Politècnica de Catalunya UPC	3.0
Paderborn University	3.0
NTT DoCoMo Inc	3.0
Nagoya University	3.0

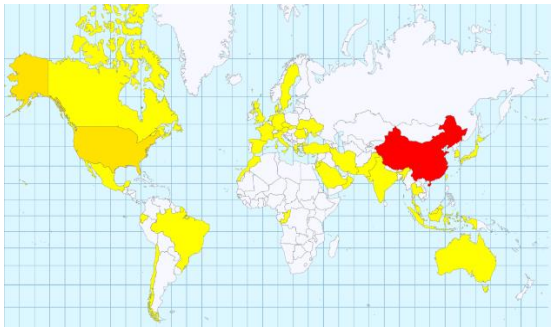


Enernet

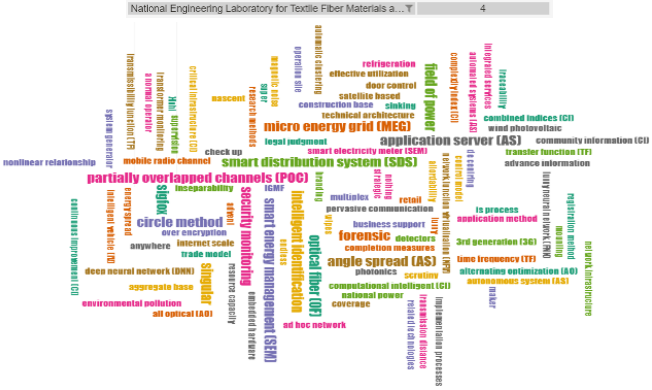
is a term combining Internet and Energy that describes what many consider an unavoidable convergence of electricity smart grids with the internet of things. This emerging network of distributed and interactive energy generation, storage and delivery is expected to become the largest Internet of things with billions of "things" to be monitored and managed (smart nodes on the grid, smart thermostats and appliances, electric vehicles, home energy storage, etc.).

Figure 4: Visualisations for Enernet





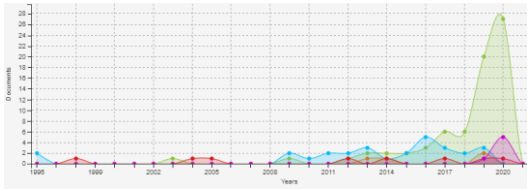
STATE GRID	63
STATE GRID CORPORATION OF CHINA	25
North China Electric Power University	16
Jiangsu Electric Power Company	14
South China University of Technology	10
NARI Group Corporation	10
CHINA ELECTRIC POWER RESEARCH INSTITUTE	10
Wuhan University	9
Shanghai Jiao Tong University	8
State Grid Shandong Electric Power Research Institute	7
NARI Technology Co. Ltd.	7
Electric Power Research Institute	7
XI'AN JIAOTONG UNIVERSITY	6
Chinese Academy Of Sciences	6
STATE GRID SHANDONG ELECTRIC POWER COMPANY	5
Shanghai Municipal Electric Power Company	5
Semiconductor Manufacturing International Corporation	5
Hohai University	5
XJ Group Corporation	4
Tsinghua University	4
Tianjin University	4
STATE GRID HEBEI ELECTRIC POWER COMPANY	4
Shanghai University of Electric Power	4
Shandong University	4
National Engineering Laboratory for Textile Fiber Materials a...	4

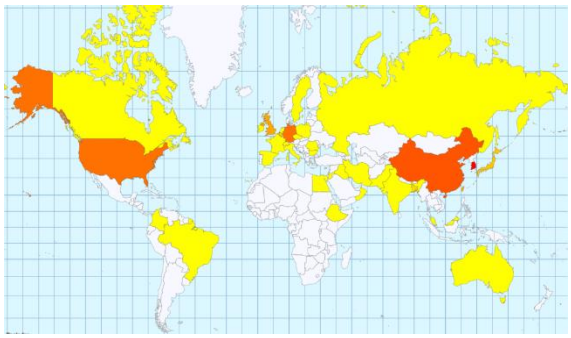


Indoor photovoltaics

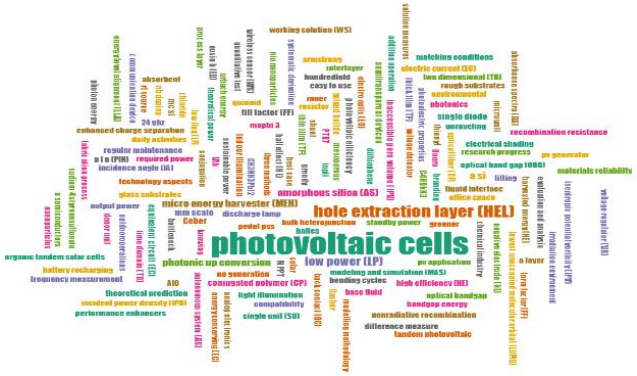
is one of the most promising technologies to power connected devices (IoT) in indoor environments. Indoor spectral and working conditions differ significantly from outdoor applications (e.g. artificial light sources) and specific research and engineering is needed before indoor photovoltaics start to equip indoor devices.

Figure 5: Visualisations for Indoor PV





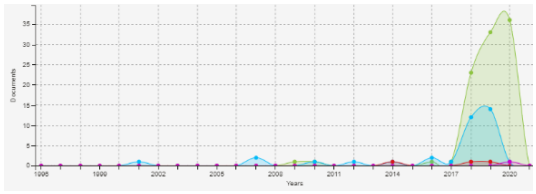
IND ACADEMIC COOP FOUND YONSEI UNIV	10
Korea University	9
University of Michigan	5
Kyungpook National University	5
University of Seoul	4
University of Freiburg	4
TU Dortmund University	4
National Taiwan University	4
Kyung Hee University	4
Hong Kong Baptist University	4
Fraunhofer Institute for Solar Energy Systems ISE	4
Chinese Academy Of Sciences	4
Academia Sinica	4
Soochow University	3
Nanyang Technological University	3
Mingchi University of Technology	3
Imperial College London	3
ELECT&TELECOMUNICATIONS RES INST	3
Bangladesh University of Engineering and Technology	3

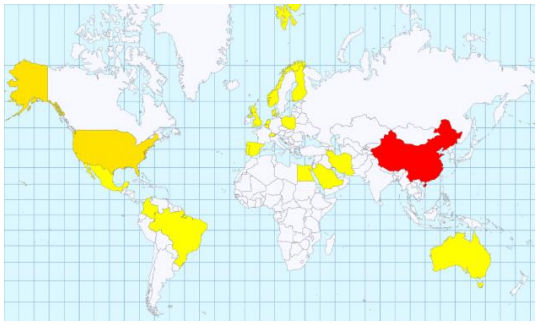


Integrated gas electricity systems

The future power system will be an interconnection of different energy vectors e.g. gas network, wind power, solar power. Integrated electricity gas network poses various challenges of coordination, reliability, and optimisation.

Figure 6: Visualisations for Integrated gas electricity systems





Chinese Academy of Sciences	27
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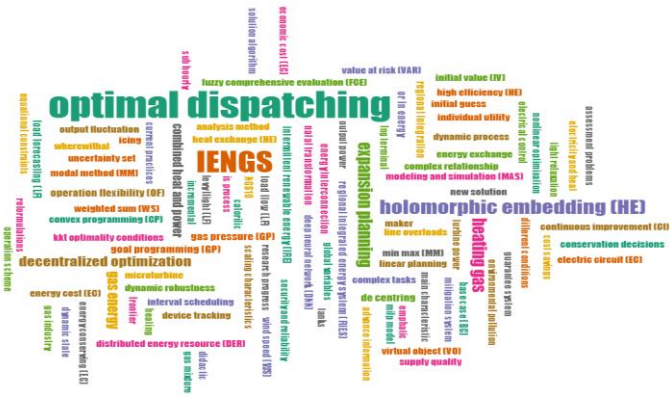
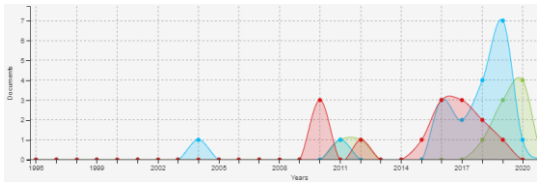
Sichuan University	10
South China University of Technology	9
Tianjin University	8
STATE GRID	6
Shandong University	6
Tsinghua University	5
NORTHEAST ELECT POWER UNIVERSITY	5
North China Electric Power University	5
Illinois Institute of Technology	5
Electric Power Research Institute	5
University of Bath	4
Stevens Institute of Technology	4
STATE GRID CORPORATION OF CHINA	4
Shiraz University of Technology	4
Economic Research	4
Aalborg University	4
Wuhan University	3
Nanyang Technological University	3

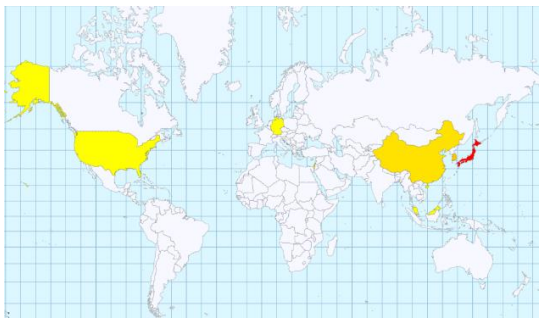


Optical wireless power transmission

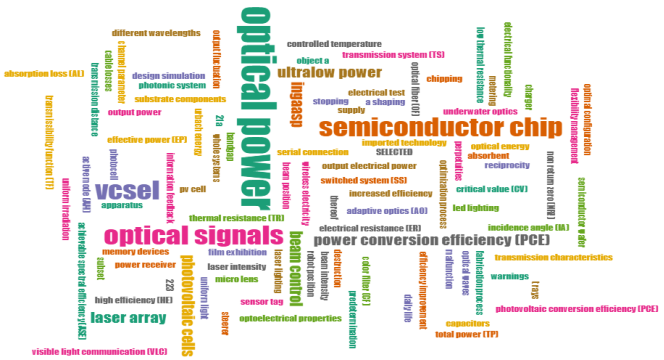
is a technology that has a high potential to change our daily lives and has many applications such as the charging of implanted medical devices, the powering of underwater vehicles and aerial drones, or the wireless transfer of power over long distance.

Figure 7: Visualisations for optical wireless power transmission





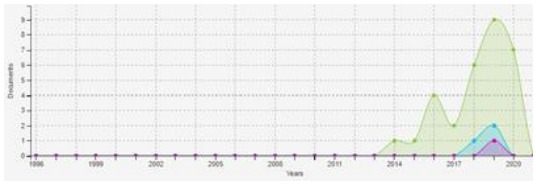
Tokyo Institute of Technology	17
WI CHARGE LTD	5
STS SC & TELECOMM CO LTD	3
SEKISUI CHEM CO LTD	2
Kyungsung University	2
Kanazawa University	2

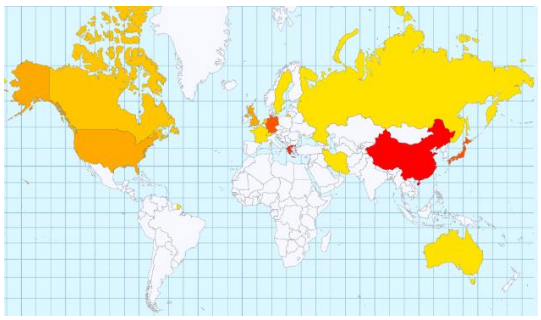


Optomagnonic

is an emerging field dealing with the photon-spin coupling in solid state systems, in particular using optical and microwave cavities, and related to the fast development of quantum technologies. New class of quantum systems and new physics are being explored mixing photonics, electronics, and spintronics.

Figure 8: Visualisations for Optomagnonic





National and Kapodistrian University of Athens	5.0
Chinese Academy of Sciences	5.0
University of Tokyo	4.0
Max Planck Institute for the Science of Light	4.0
Institute of Nanoscience and Nanotechnology	4.0
Beijing Normal University	4.0
Yale University	3.0
University of Erlangen-Nürnberg	3.0
Tohoku University	3.0
National Technical University of Athens	3.0
Institute of Physical and Chemical Research (RIKEN)	3.0
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University of Cambridge	2.0
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Hitachi Ltd	2.0
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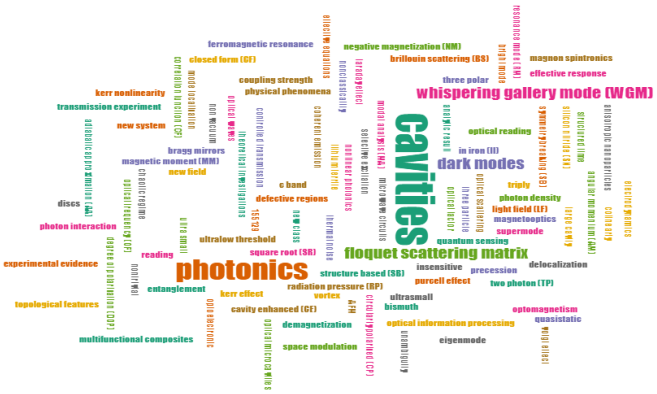
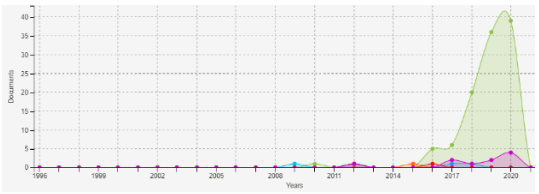
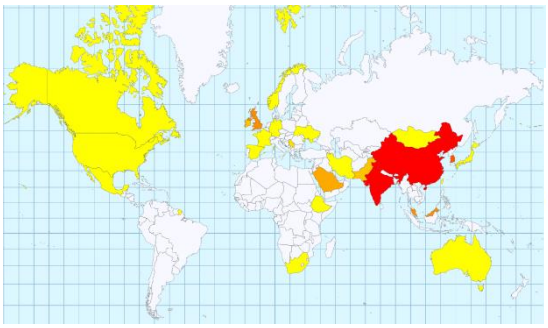


Supercapattery

is a term that has been invented in 2008 to designate hybrid electrochemical energy storage devices that combines the merits of rechargeable battery (high energy density) and of supercapacitor (long life cycle and high power density). Supercapattery devices gained a lot of attention over the recent years has they have the potential to meet a shortcoming of today's batteries i.e. combining a high energy density with little to no constrain on power density.

Figure 9: Visualisations for Supercapattery





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University of Malaya	14
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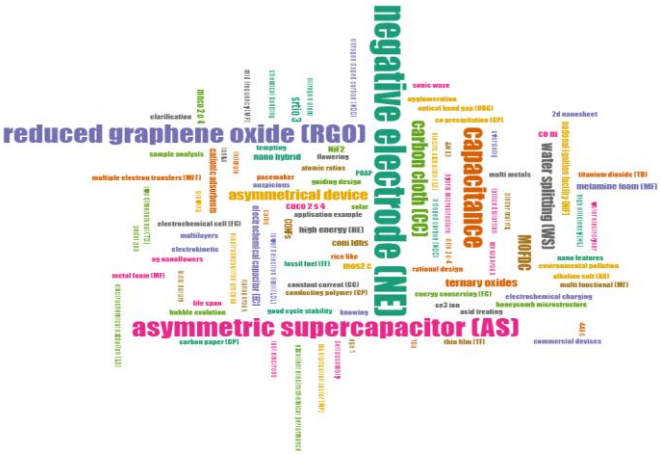
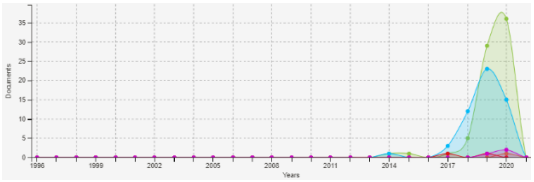
GIK Institute of Engineering Sciences and Technology	9
Bharathiar University	9
University College Cork	8
Sunway University	8
King Abdulaziz University	7
Pusan National University	5
Kyung Hee University	5
Kwangwoon University	5
University of Belgrade	4
Pondicherry University	4
Majmaah University	4
Yonsei University	3
Sunchon National University	3
Lviv Polytechnic National University	3
Kalasalingam Academy of Research and Education	3
IND FOUND OF CHONNAM NATIONAL UNIV	3

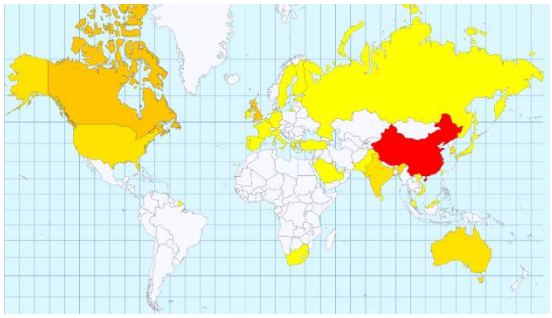


UAV assisted communication

This weak signal relates to the potential of Unmanned Aerial Vehicles (UAVs) to revolutionise various sectors like automotive, energy, or healthcare, by working as wireless relays to improve the connectivity with and between networks of connected devices on the ground.

Figure 10: Visualisations for UAV assisted communication





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Chinese Academy of Sciences	7
Carleton University	6
National Institute of Technology	5
King's College London	5
University of New South Wales	4
National Research Tomsk Polytechnic University	4
Chinese Academy Of Sciences	4
China University of Mining and Technology	4
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University of Victoria	3
School of Information and Electronics	3
Qatar University	3
North Carolina State University	3
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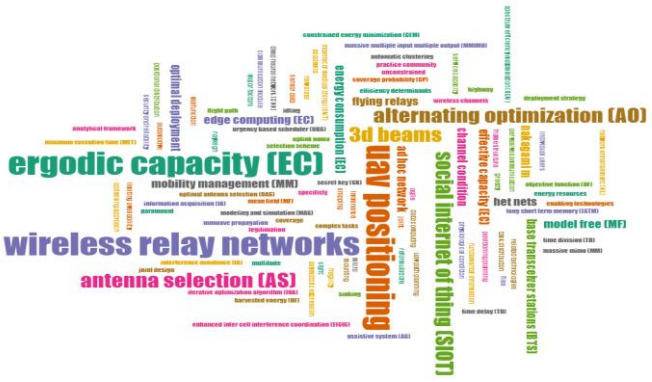
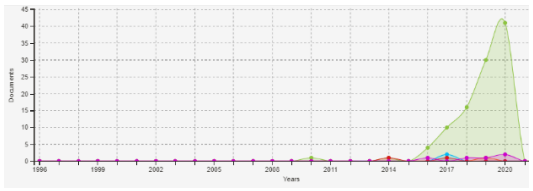
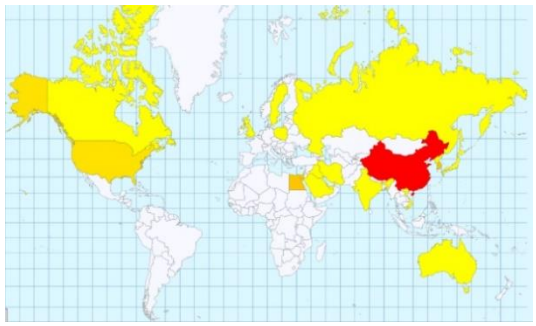


Urea oxidation reaction in fuel cell

The global drive for greener energy production processes induces intense R&D activities toward innovative electrochemical energy devices with an optimized ratio energy density/emissions. Fuel cells base on the oxidation of urea are attracting interest: abundance of urea in waste waters, high energy density, good ratio output (discharging)/input (charging) capacity, and low-cost catalysts.

Figure 11: Visualisations for Urea oxidation reaction in fuel cell





Chinese Academy Of Sciences	12
Harbin Engineering University	10
Minia University	8
Gachon University	8
Qingdao University of Science and Technology	6
Chonbuk National University	6
Zhejiang University	5
University of Texas at Austin	4
Sichuan University	4
Qatar University	4
Yangzhou University	3
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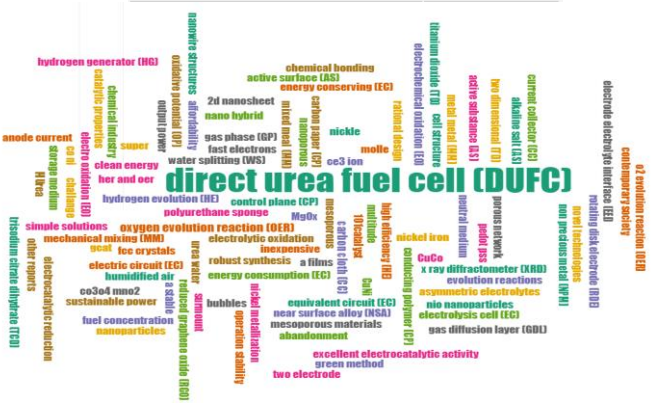
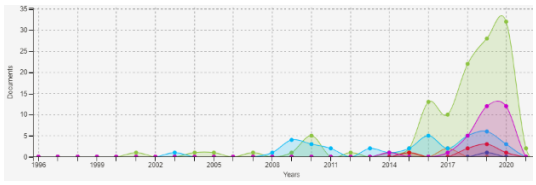
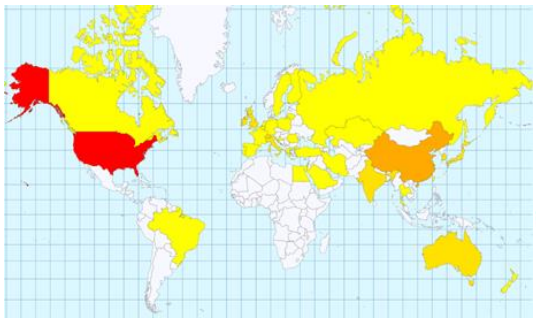


Wearable biosensors

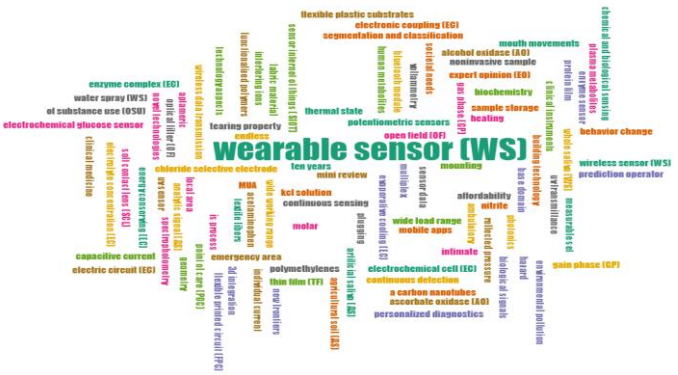
will soon become essential tools for remote monitoring of human health by on-the-skin detection. These sensors will detect human metabolites and/or biomarkers for disease. Human sweat, tears or saliva are rich in molecules and biomarkers and can be monitored in a non-invasive manner.

Figure 12: Visualisations for wearable biosensors





University of California	26
Dublin City University	13
Tokyo Medical and Dental University	8
Lawrence Berkeley National Laboratory	6
Stanford University	5
University of Wollongong	4
University of Science and Technology	4
Universitat Rovira I Virgili	4
Northwestern University	4
Monash University	4
Melbourne Centre for Nanofabrication	4
Chinese Academy Of Sciences	4
California Institute of Technology	4
University of Texas at Dallas	3
University of São Paulo	3
University of Pisa	3
University of Cincinnati	3
Universidad de Alcalá	3
Stanford School of Medicine	3
Southeast University	3
San Diego State University	3
Johns Hopkins University	3
Ecole Polytechnique Fédérale de Lausanne	3

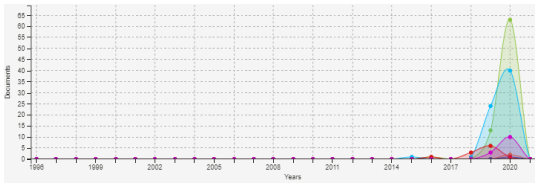


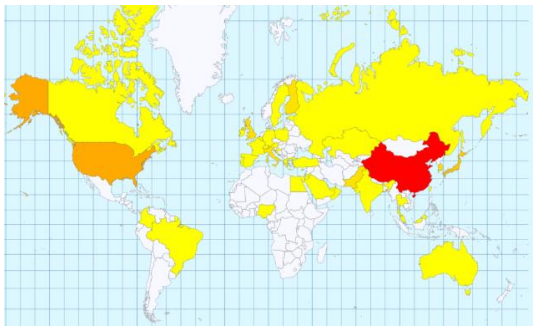
2.2 Information & Communication technologies

6G Network

will extend the performance of 5G applications and allow the development of innovative applications in wireless connectivity, cognition, sensing and imaging. 6G will use higher frequencies and will enable much faster sampling rates and higher data rates. Edge computing should also be an in-built feature of 6G.

Figure 13: Visualisations for 6G networks





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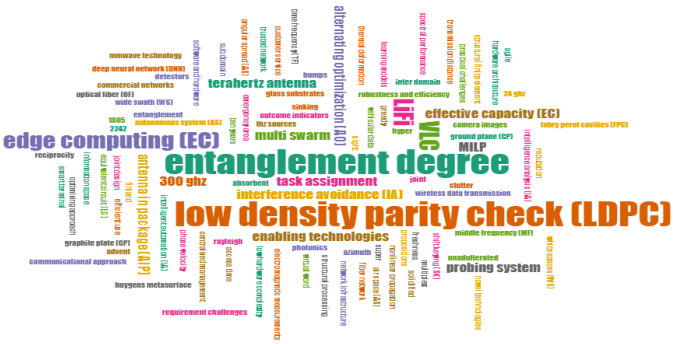
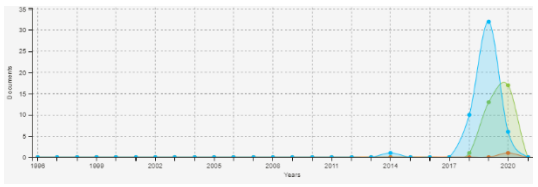
Chinese Academy of Sciences	7.0
University of Oulu	5.0
University of Electronic Science and Technology of China	4.0
Southeast University	4.0
Shanghai Jiao Tong University	4.0
National Institute of Telecommunications	4.0
Nanjing University of Posts and Telecommunications	4.0
King Saud University	4.0
University of Engineering and Technology	3.0
University of Central Oklahoma	3.0
Tohoku University	3.0
NORTHWESTERN POLYTECHNICAL UNIVERSITY	3.0
Nanyang Technological University	3.0
Georgia Institute of Technology	3.0
Asia University	3.0
Aalto University	3.0
ZTE CORP	2.0
XIDIAN UNIVERSITY	2.0
Waseda University	2.0

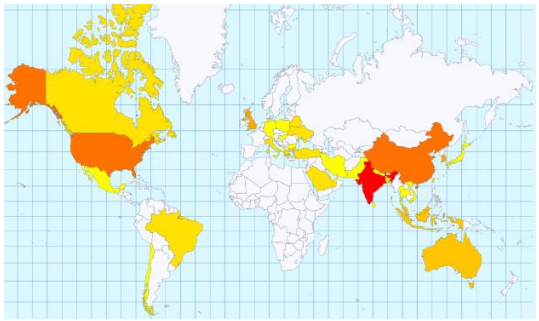


Cryptocurrency price prediction

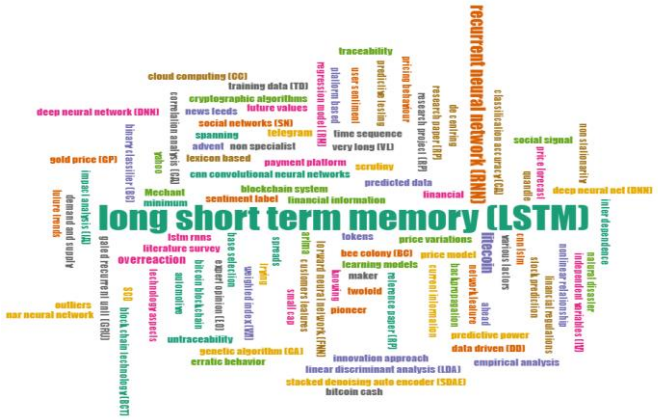
Cryptocurrencies are subject to price volatility and accurate price predictions can assist investors towards making the right decisions as well as supporting policy makers and researchers in studying the behaviour of cryptocurrency markets.

Figure 14: Visualisations for Cryptocurrency price prediction





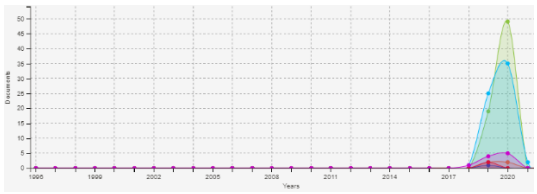
Jaypee Institute of Information Technology	3.0
University of Pavia	2.0
University of Patras	2.0
University of Liverpool	2.0
Universiti Tun Hussein Onn Malaysia	2.0
Sungkyunkwan University	2.0
Nirma University	2.0
King Abdulaziz University	2.0
Firat Universitesi	2.0
Dartmouth College	2.0
Chinese Academy Of Sciences	2.0
Belarusian-Russian University	2.0
Asia University	2.0

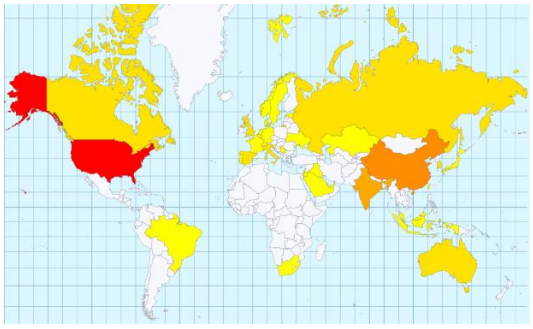


Deepfake

in itself is not a new technology but its rapid dissemination and its potential impact on society makes it an emerging research area. Deepfake encompasses various face-swapping technologies that enable the making of realistic fake videos or images. The weak signal also includes developing techniques to detect deepfakes. These technologies are creating ethical, social, technical and legal challenges, but also opportunities.

Figure 15: Visualisations for Deepfake





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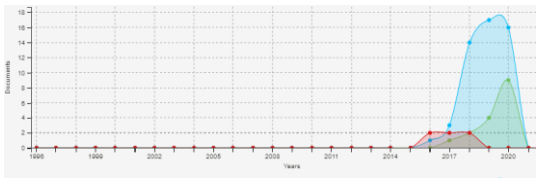
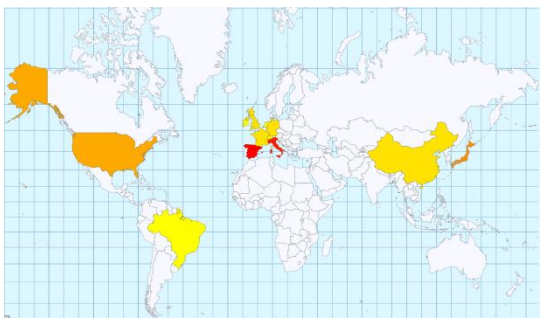
University of California	4.0
Chinese Academy Of Sciences	4.0
University of Central Florida	3.0
Sungkyunkwan University	3.0
State University of New York	3.0
ALIBABA GROUP HOLDING LTD	3.0
Wuhan University	2.0
Veermata Jijabai Technological Institute	2.0
University of South Carolina	2.0
University of Maryland	2.0
University Federico II of Naples	2.0
Universidad Autónoma de Madrid	2.0
UNED	2.0
St. Petersburg State University	2.0
Shandong University of Political Science and Law	2.0
Rochester Institute of Technology	2.0
Queensland University of Technology	2.0
Purdue University	2.0
Pennsylvania State University	2.0
National Research Nuclear University MEPhI	2.0
National Inter-University Consortium for Telecommunications	2.0
Harvard University	2.0
Bank of Canada	2.0

Disaggregated optical networks

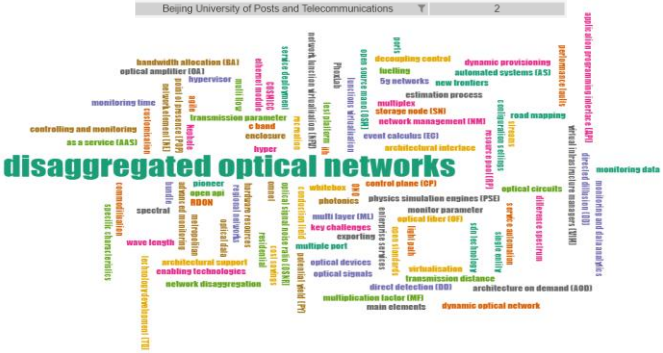
Is a technology that could enable network slicing, a key aspect of 5G networks that enables the multiplexing of virtualized and independent logical networks on the same physical network infrastructure. The link between network slicing and the underlying (optical) network virtualization is a growing research topic.

Figure 16: Disaggregated optical networks





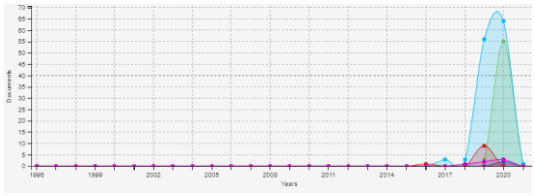
Centre Tecnològic de Telecomunicacions de Catalunya	28
CNIT	15
Scuola Superiore Sant'Anna	14
NOKIA CORP	8
KDDI CORP	7
Universitat Politècnica de Catalunya	5
CTO	4
University of Bristol	3
Universitat Politècnica de Catalunya UPC	3
Universidad Autónoma de Madrid	3
Telefonica	3
Politecnico di Torino	3
Fujitsu Corp	3
Eindhoven University of Technology	3
ADVA Optical Networking	3
University of Dublin	2
Universidad Carlos III de Madrid	2
Telecom Italia	2
NTT COMMUNICATIONS KK	2
CIENA CORP	2
Beijing University of Posts and Telecommunications	2

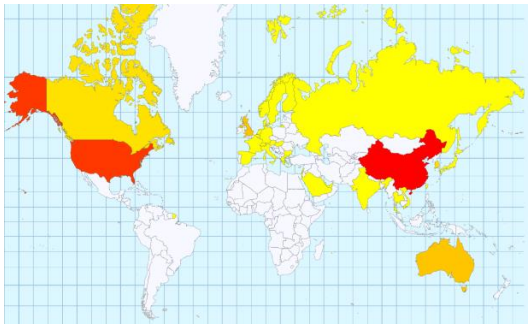


Federated learning

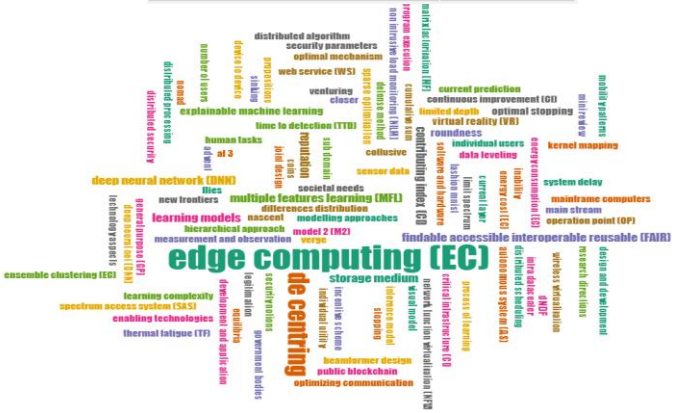
is an emerging machine learning technique for training computing models with data collected by devices at the edge (e.g. mobile devices). As data collected is not transmitted to a central place, this technique provides privacy for mobile owners while simultaneously ensuring high learning performance.

Figure 17: Visualisations for federated learning





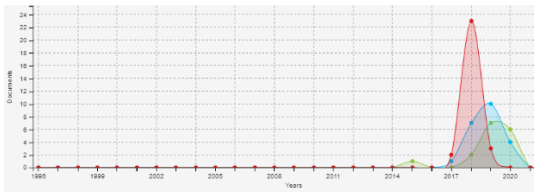
Nanyang Technological University	15
IBM Corp	12
Princeton University	8
Hong Kong University of Science and Technology	8
University of Electronic Science and Technology of China	7
Kyung Hee University	7
Beijing University of Posts and Telecommunications	7
University of Technology Sydney	6
University of Houston	6
Hong Kong Polytechnic University	6
University of Sydney	5
University of Oulu	5
TENCENT TECHNOLOGY CO., LTD.	5
Singapore University of Technology and Design	5
Zhejiang University	4
XIDIAN UNIVERSITY	4
King's College London	4
GOOGLE INC	4
Georgia Institute of Technology	4
University of Science and Technology	3
University of Hong Kong	3
University of Colorado at Colorado Springs	3
Tsinghua University	3
Sungkyunkwan University	3
National Engineering Laboratory for Textile Fiber Materials a...	3
Imperial College London	3
Fraunhofer Heinrich Hertz Institute	3

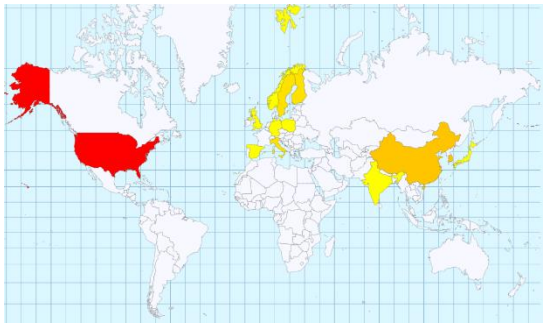


IAB for 5G

or Integrated Access and Backhaul, is one of the main novelties of 5G. With this type of networks, the operator can use part of the available radio resources for wireless backhauling. This would provide backhaul and cellular services in the same node, creating more flexibility and reducing the implementation cost.

Figure 18: Visualisations for IAB for 5G





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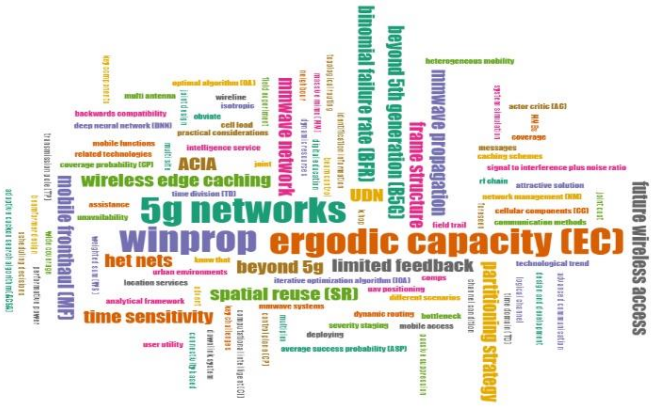
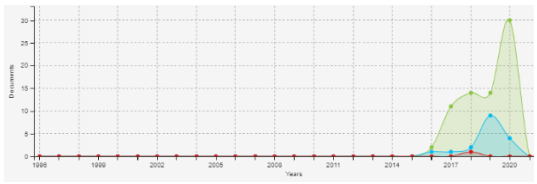
IBM Corp	6
KT CORP	5
Virginia Tech	4
University of Padova	4
Inter Digital Communications, Inc.	3
Florida International University	3
Ericsson Research	3
University of California	2
Samsung Corp	2
NORTHWESTERN POLYTECHNICAL UNIVERSITY	2
NOKIA TECH LTD	2
NOKIA CORP	2
HUAWEI TECH CO LTD	2

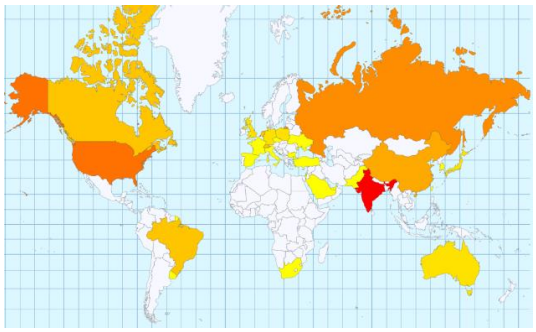


IBM Quantum processor

is a weak signal related to experiments performed by researchers on the online platform "IBM Quantum Experience" that gives public users access to a set of prototype quantum processors. Over 20 devices are part of the experience (number from early 2021), six of which are freely accessible. These quantum processors are made up of superconducting transmon qubits, located in a dilution refrigerator at IBM Research headquarters.

Figure 19: Visualisations for IBM quantum processor





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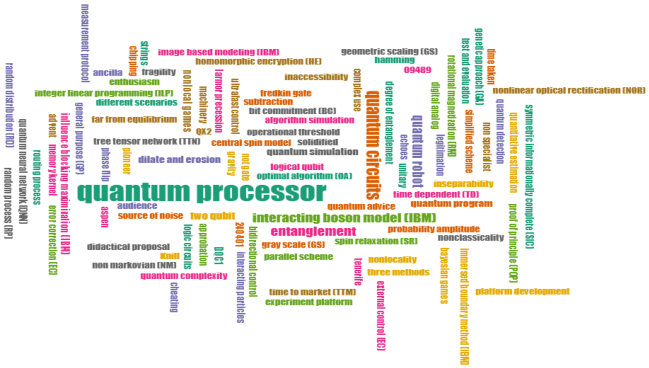
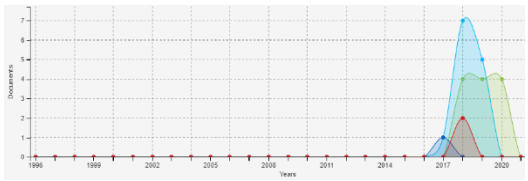
Russian Academy of Sciences	10
QUANTUM CORP	10
National Research Nuclear University MEPhI	8
Russian Quantum Center	5
University of Science and Technology of China	4
National Research University of Electronic Technology MIET	4
Jaypee Institute of Information Technology	4
Institute of Automatics	4
University of Science and Technology	3
Moscow Institute of Physics and Technology	3
IBM Corp	3
Delft University of Technology	3
Università di Parma	2
University of Waterloo	2
University of Technology Sydney	2
University of New Brunswick	2
University of Guelph	2
University of Groningen	2
Universidade Federal Fluminense	2

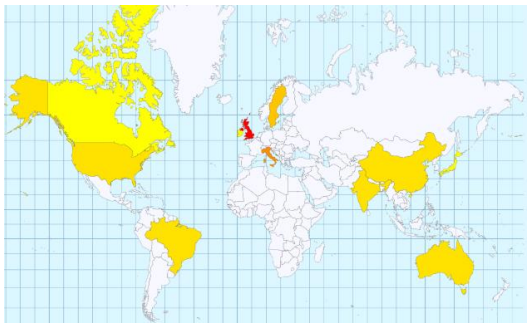


Internet of musical things

is the extension of the Internet of Things to the musical world and refers more specifically to the network of physical musical objects dedicated to the production of musical content. Musical things, such as smart musical instruments or wearables, are connected through an infrastructure that enables multidirectional communication.

Figure 20: Visualisations for internet of musical things





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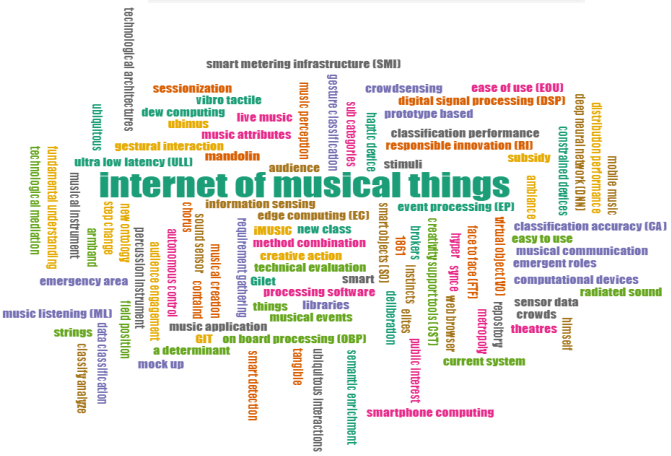
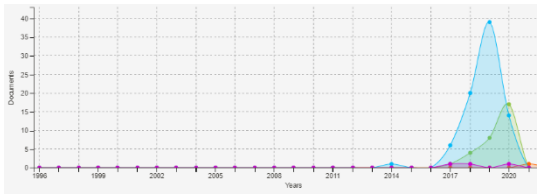
University of Western Australia	3
University of Bologna	3
KTH Royal Institute of Technology	3
West Bengal University of Technology	2
McGill University	2

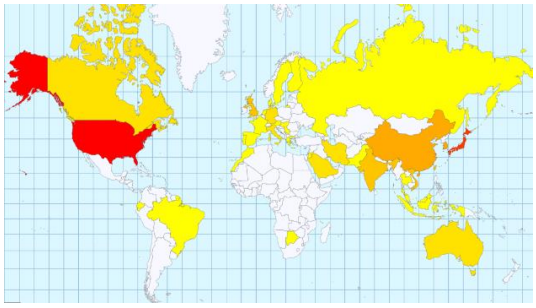


IoT malware

are malicious software targeting the Internet of Things. This area of research has become one of the focus of the security research community over the last years as threats are multiplying.

Figure 21: Visualisations for IoT malware





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National Institute of Information and Communications Technology	7.0
Yokohama National University	6.0
Inha University	6.0
Yamaguchi University	5.0
VNU University of Engineering and Technology	3.0
University of Texas at San Antonio	3.0
University of Science and Technology	3.0
Shiraz University of Technology	3.0
Shiraz University	3.0
Posts and Telecommunications Institute of Technology	3.0
Japan Advanced Institute of Science and Technology	3.0
George Mason University	3.0
Orebro University	2.0
University of Guelph	2.0
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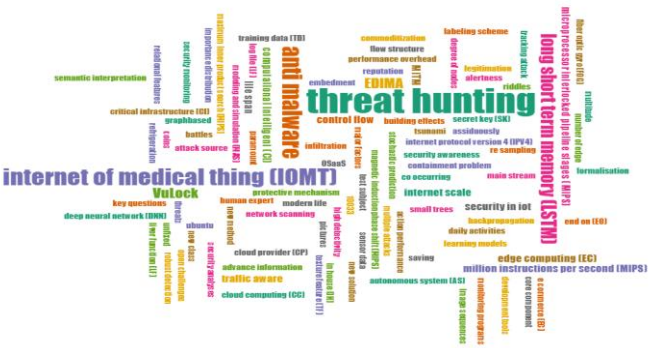
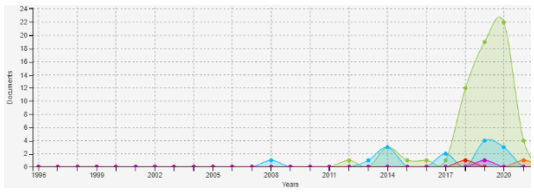
Technical University of Denmark	2.0
Symantec Research Labs	2.0
Sichuan University	2.0
Rajalakshmi Engineering College	2.0

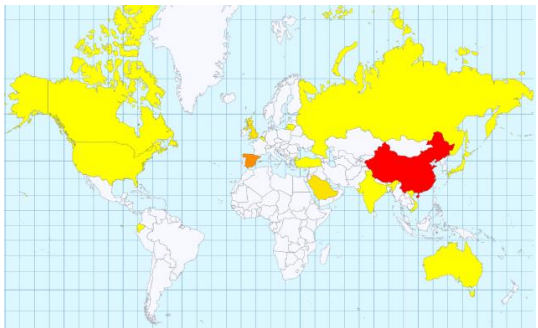


Large scale group decision making

The increasing complexity of our society makes decision-making tasks more and more difficult to manage and take. In the recent years, new technologies and communication means are being investigated to improve large-scale group decision-making processes.

Figure 22: Visualisations for large scale group decision making





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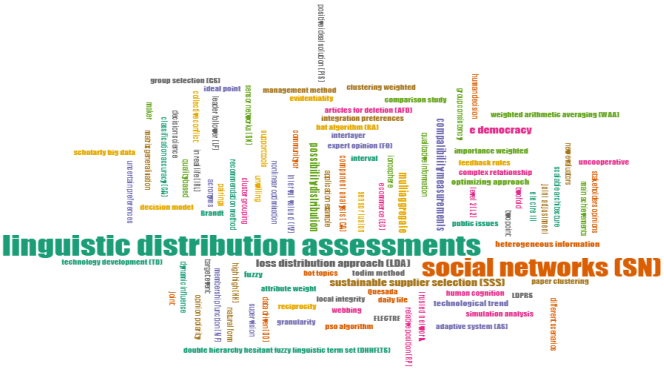
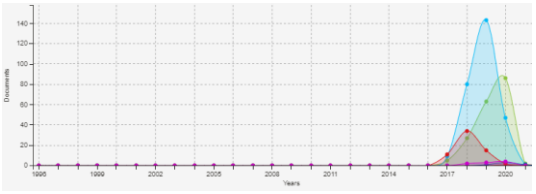
Sichuan University	17
Universidad de Jaén	14
King Abdulaziz University	12
Central South University	8
Hohai University	7
Southeast University	6
University of Electronic Science and Technology of China	4
Nanjing University of Information Science and Technology (NUST)	4
Nanjing University of Aeronautics and Astronautics	4
University of Bristol	3
Tianjin University	3
Sun Yat-Sen University	3
Shenzhen University	3
Guangxi University	3

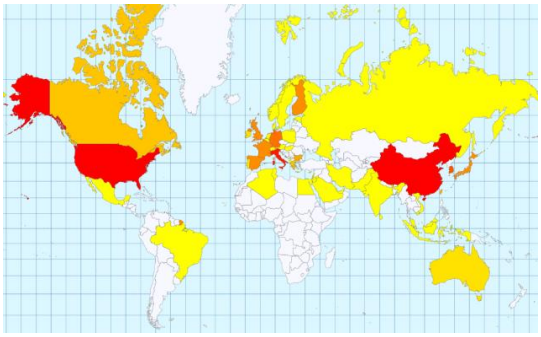


Multi access edge computing

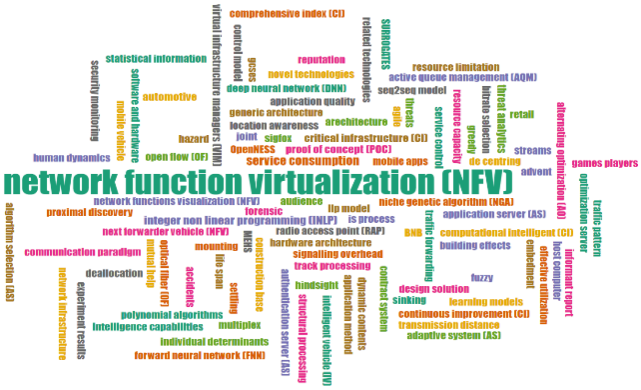
is an important enabling technology for 5G architecture aiming at the reduction of network latency and traffic. It will offer cloud-computing capabilities and a full IT environment at the edge of the network.

Figure 23: Visualisations for multi access edge computing





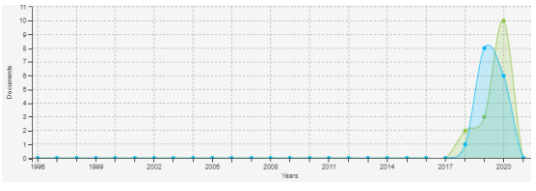
Technical University of Sofia	33
Kyung Hee University	22
Beijing University of Posts and Telecommunications	19
IBM Corp	18
Aalto University	16
University of Oulu	15
NOKIA CORP	15
EURECOM	14
INTEL DEUTSCHLAND GMBH	13
University of Bologna	11
Sejong University	10
NEC Corp	10
VERIZON PATENT&LICENSING INC	9
University of Pisa	9
Sapienza University of Rome	8
University of Murcia	7
University of Houston	7
National Taiwan University	7
National Chiao Tung University	7
Industrial Technology Research Institute	7

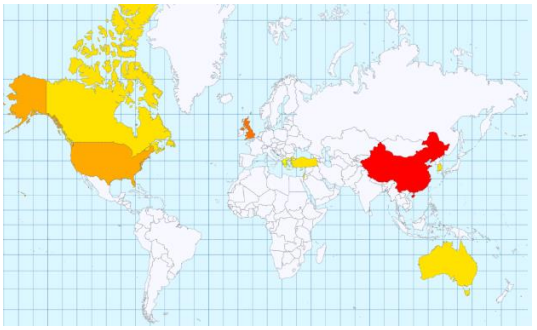


Over the air computation

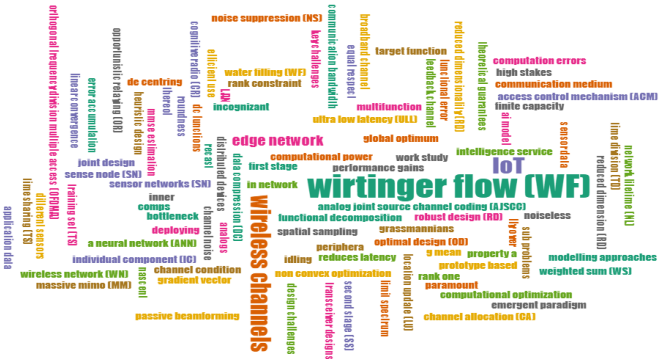
will enable the data collection and computation from concurrent sensors by combining communication and computation efficiently, utilizing the superposition property of wireless channels. This is an important technology for the future of the IoT where the collection and interpretation of data from numerous smart sensors is challenging.

Figure 24: Visualisations for over the air computation





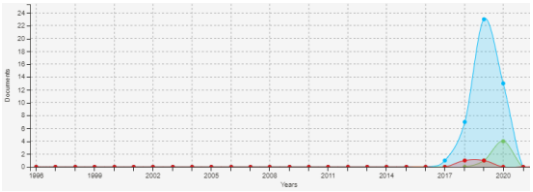
University of Hong Kong	9.0
ShanghaiTech University	6.0
University of Science and Technology of China	3.0
University of California	3.0
King's College London	3.0
Carleton University	3.0
University of Warwick	2.0
University of Sydney	2.0
University of Science and Technology	2.0
Southeast University	2.0
Princeton University	2.0
Imperial College London	2.0
Dalian University of Technology	2.0
Chinese Academy Of Sciences	2.0



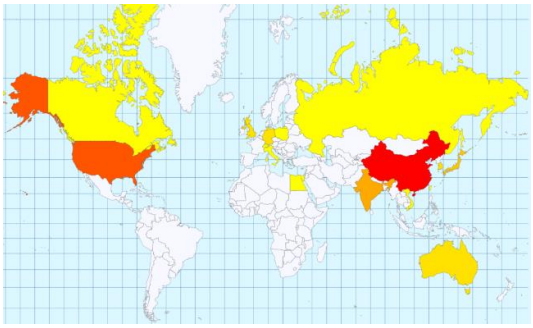
Pointer-generator networks

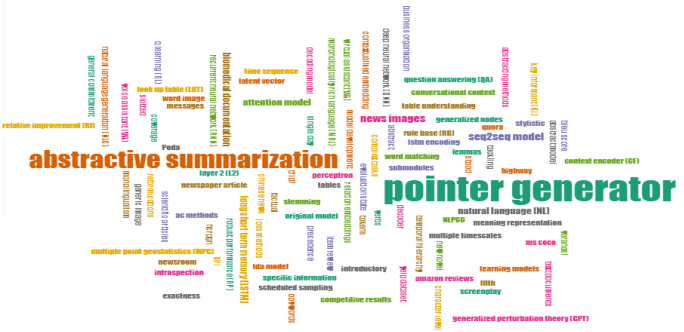
are used in natural language processing to improve automated text summarization, a tricky process in which many algorithms fail to detect the essential parts of long documents.

Figure 25: Visualisations for pointer-generator networks



GOOGLE INC	3.0
Amazon	3.0
Tsinghua University	2.0
Singapore Management University	2.0
Samsung Corp	2.0
PricewaterhouseCoopers	2.0
Chinese Academy Of Sciences	2.0

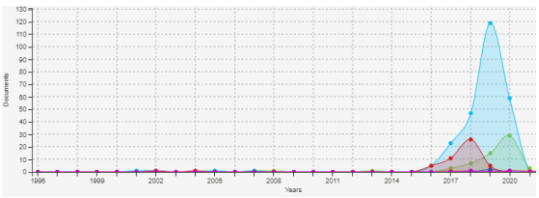




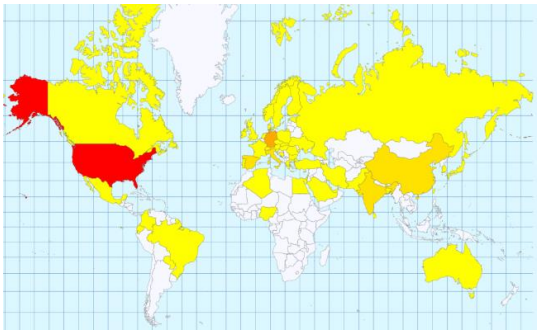
Serverless computing

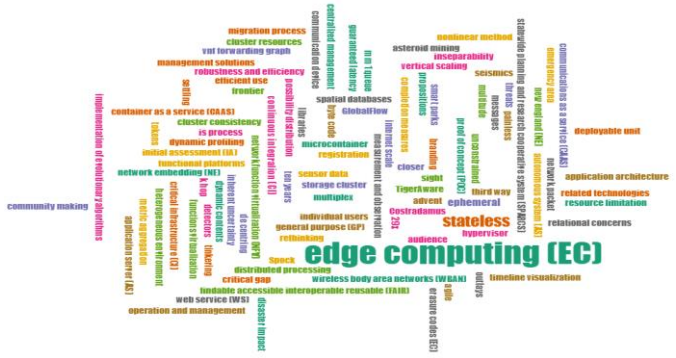
is emerging as an evolution of cloud computing for the deployment of applications and services. Serverless architecture brings the advantage of offloading the management and server configuration from the user to the provider.

Figure 26: Visualisations for serverless computing



IBM Corp	26
University of California	7
Universitat Rovira i Virgili	7
University of Washington	6
University of Tartu	6
University of Bamberg	6
UC Berkeley	6
Stanford University	6
Imperial College London	6
Escuela Superior Politécnica del Litoral	6
Zurich University of Applied Sciences	5
Universidad Politécnica de Valencia	5
TU Berlin	5
HUAWEI TECH CO LTD	5
CISCO TECH INC	5
Vrije Universiteit Amsterdam	4
VMWARE INC	4
University of Würzburg	4
University of Wisconsin-Madison	4
University of Stuttgart	4

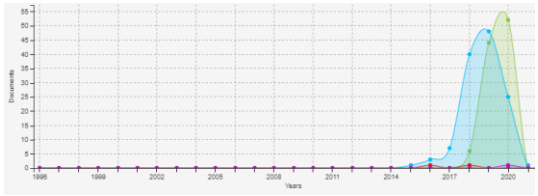


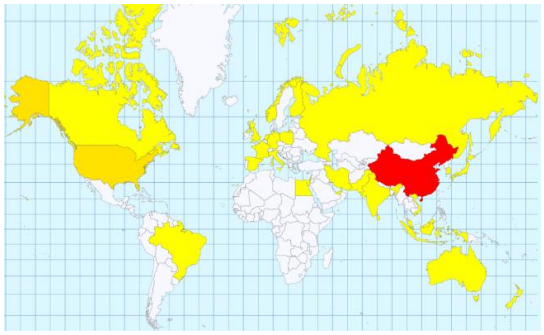


Siamese network for object tracking

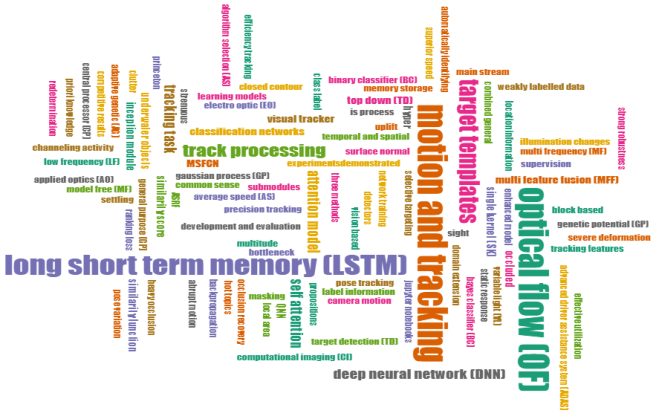
This type of neural networks have achieved remarkable results in application such as (multiple) tracking of objects, a very intense area of research with applications in robotics, video surveillance, unmanned vehicles or activity tracking and recognition.

Figure 27: Visualisations for Siamese network for object tracking





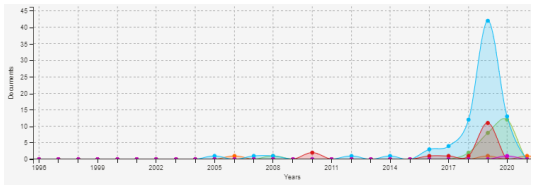
Chinese Academy of Sciences	34
Beijing University of Posts and Telecommunications	9
Nanjing University of Posts and Telecommunications	7
Nanjing University of Information Science and Technology (NUST)	7
XI'AN JIAOTONG UNIVERSITY	6
Shanghai Jiao Tong University	6
National University of Defense Technology	6
Tongji University	5
Harbin Institute of Technology	5
Beijing Jiaotong University	5
Beihang University	5
Air Force Engineering University	5
University of Science and Technology of China	4
University of Electronic Science and Technology of China	4
School of Computer Science and Technology	4
School of Computer Science	4
Kyungpook National University	4
Dalian University of Technology	4
XIDIAN UNIVERSITY	3
Xiamen University	3
University of California	3

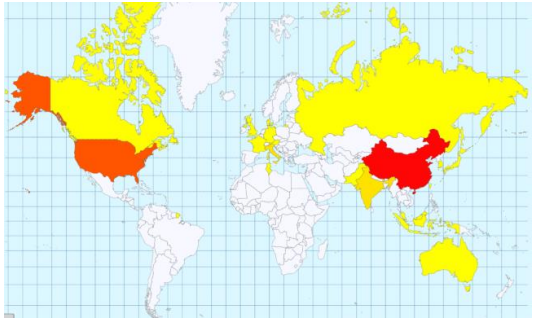


Text to image synthesis

Neural networks, and in particular generative adversarial networks, are emerging as efficient tools to generate images or videos from a text description.

Figure 28: Visualisations for text to image synthesis





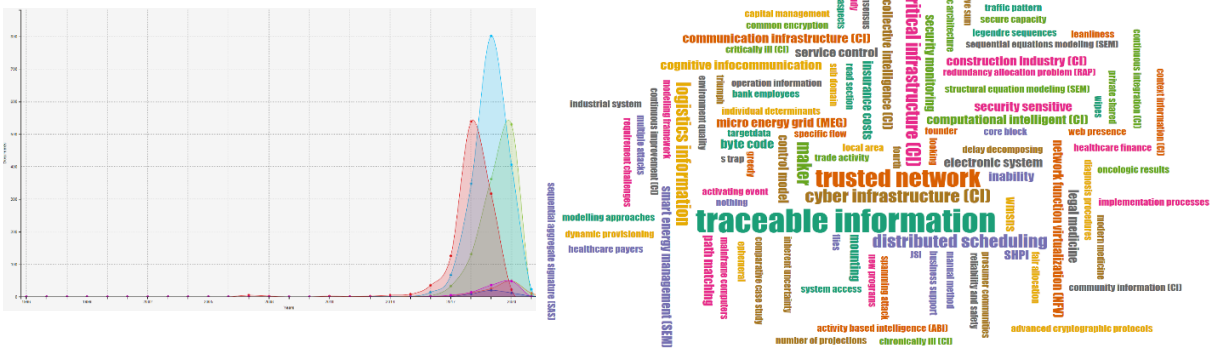
Semiconductor Manufacturing International Corporation	7.0
Zhejiang University	5.0
Peking University	5.0
Chinese Academy Of Sciences	5.0
Tsinghua University	4.0
XIDIAN UNIVERSITY	3.0
University of Trento	3.0
University of Michigan	3.0
Southwest University of Science and Technology	3.0
Microsoft Corp	3.0
Imperial College London	3.0
Guangdong University of Technology	3.0
GOOGLE INC	3.0
Fudan University	3.0
Chinese University of Hong Kong	3.0
Washington State University	2.0
University of Science and Technology of China	2.0
University of North Carolina at Charlotte	2.0
University of Electronic Science and Technology of China	2.0
University of China	2.0

Weak signals related to blockchain

The blockchain technology appeared in 2008 and is being applied in an ever growing number of applications. This open distributed ledger can record data transactions between two parties and is by design resistant to data alteration. Weak signals of emerging applications of blockchain have been detected in sectors as diverse as healthcare or disinformation.

Figure 29: Visualisations for blockchain related weak signals.
(distribution of documents and wordcloud for all WS on blockchain)

blockchain - inter planetary file system	topic:("inter planetary file system" OR (IPFS AND blockchain))
blockchain as a service	topic:("blockchain as a service"~2)
blockchain disinfo	topic:(blockchain AND ("fake news" OR disinformation))
blockchain for anti-counterfeiting	topic:(blockchain AND "anti counterfeiting")
blockchain for democracy	topic:(blockchain AND (democracy OR "e voting" OR "electronic vote"))
blockchain for vehicular networks	topic:(blockchain AND ("vehicular network" OR vehicle))
blockchain in health	topic:(blockchain AND (health OR (medical AND record)))
blockchain in maritime sector	topic:(blockchain AND (maritime OR shipping))
blockchain security	topic:("blockchain security"~1)
mobile blockchain	topic:("mobile blockchain" OR (blockchain AND "edge computing"))
permissioned blockchain	topic:("permissioned blockchain"~2)



Journal categories recently pervaded by blockchain technologies
(Score is activeness 2019-2020 i.e. the % of articles published in 2019-2020 for this journal category)

Tourism, Leisure and Hospitality Management	100
Radiology Nuclear Medicine and imaging	100
Pollution	100
Physics and Astronomy	100
Pharmacology, Toxicology and Pharmaceutics	100
Mechanics of Materials	100
Health, Toxicology and Mutagenesis	100
Economics, Econometrics and Finance (miscellaneous)	100
Earth and Planetary Sciences	100
Bioengineering	100
Biochemistry, Genetics and Molecular Biology	100
Economics and Econometrics	96
Applied Mathematics	95
Social Sciences (miscellaneous)	95
Analytical Chemistry	95
Accounting	93
Development	93
Political Science and International Relations(RT)	92
Computational Mathematics	92
Atomic and Molecular Physics, and Optics	92
Management, Monitoring, Policy and Law	90
Computational Theory and Mathematics	90
Biochemistry	89
Geography, Planning and Development	89
Management Information Systems	88
Ocean Engineering	87
Transportation	86
Management of Technology and Innovation	86
Energy (miscellaneous)	85
Condensed Matter Physics	85

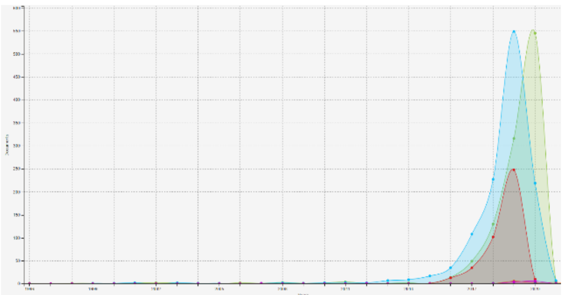
Aerospace Engineering	85
Engineering	85
Materials Science	85
Safety Research	85
Process Chemistry and Technology	85
Engineering (miscellaneous)	85
Environmental Science	84
Electrical and Electronic Engineering	84
Mathematics	84
Urban Studies(RT)	83
Marketing	83
Fluid Flow and Transfer Processes	83
Computer Vision and Pattern Recognition	82
Business and International Management	82
Signal Processing	81
Control and Optimization	81
Strategy and Management	81
Information Systems	81
Decision Sciences (miscellaneous)	81
Media Technology (NEW)	80
Automotive Engineering	80
Instrumentation	80
Food Science	80
Energy Engineering and Power Technology	80
Information Systems and Management	79
Energy	78
Software	78
Environmental Engineering	78
Control and Systems Engineering	78
Civil and Structural Engineering	78

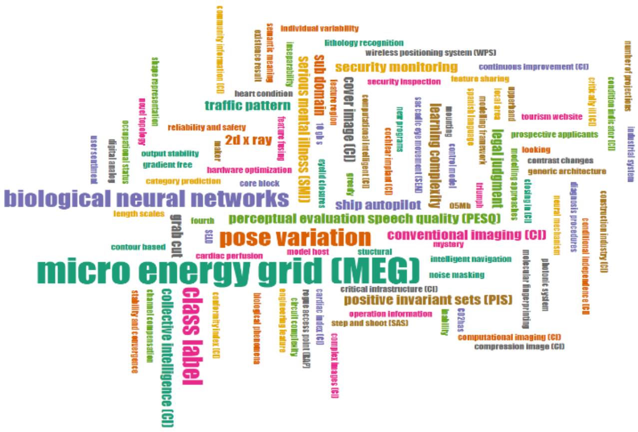
Weak signals related to Neural Networks

Neural networks are an effective means of performing machine learning. Numerous weak signals related to neural networks have been detected, of which the most relevant are listed below. Similarly to blockchain technologies, neural networks permeate all fields of science and technologies, as shown by the list of most recently pervaded journal categories.

Figure 30: Visualisations for Neural networks related weak signals (distribution of documents and wordcloud for all WS on neural networks)

1d convolutional neural network	topic:("1d convolutional neural network"~2)
attentional neural network	topic:("attentional neural network")
convolutional recurrent neural network	topic:("convolutional recurrent neural network")
graph convolutional neural network	topic:("graph convolutional neural network"~2)
hybrid convolutional neural networks	topic:("hybrid convolutional neural networks"~2)
hybrid deep neural network	topic:("hybrid deep neural network")
lightweight neural network	topic:("lightweight neural network"~2)
photonic neural network	topic:("photonic neural network"~2)
quaternion valued neural networks	topic:("quaternion valued neural networks"~2)
shallow convolutional neural network	topic:("shallow convolutional neural network")
temporal convolution neural network	topic:("temporal convolution neural network"~2)
Zeroing neural network	topic:("Zeroing neural network"~2)





Journal categories recently pervaded by neural networks
(Score is activeness 2019-2020 i.e. the % of articles published in 2019-2020 for this journal category)

Strategy and Management	100
Statistics, Probability and Uncertainty	100
Fuel Technology	100
Environmental Engineering	100
Chemistry (miscellaneous)	100
Biotechnology	100
Transportation	95
Neuroscience	94
Fluid Flow and Transfer Processes	92
Mathematics	91
Process Chemistry and Technology	91
Materials Science	91
Radiological and Ultrasound Technology	90
Decision Sciences (miscellaneous)	90
Computers in Earth Sciences	90
Spectroscopy	88
Structural Biology	87
Physics and Astronomy (miscellaneous)	87
Management, Monitoring, Policy and Law	87
Management Information Systems	87
Health Information Management	87
Civil and Structural Engineering	87
Building and Construction (NEW)	87
Engineering	87
Chemical Engineering	86

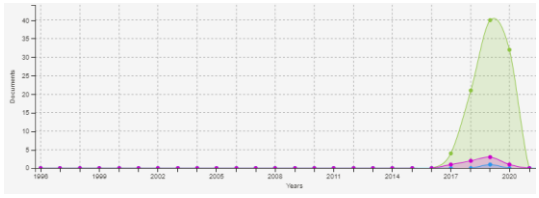
Industrial and Manufacturing Engineering	86
Analytical Chemistry	86
Nuclear Energy and Engineering	85
Forestry	85
Energy	85
Earth and Planetary Sciences (miscellaneous)	85
Computer Science (miscellaneous)	85
Algebra and Number Theory	85
Library and Information Sciences	84
Renewable Energy, Sustainability and the Environment	83
Engineering (miscellaneous)	83
Instrumentation	83
Automotive Engineering	81
Public Health, Environmental and Occupational Health	80
Physical and Theoretical Chemistry	80
Molecular Medicine	80
Horticulture	80
Geometry and Topology	80
Discrete Mathematics and Combinatorics	80
Biomaterials	80
Bioengineering	80
Atmospheric Science	80
Agronomy and Crop Science	80
Safety, Risk, Reliability and Quality	79
Biochemistry	79

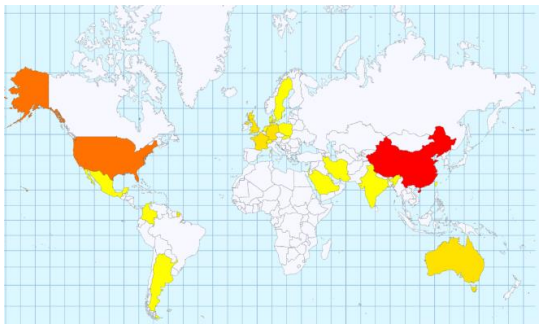
2.3 Chemistry and Materials

2D ruddlesden popper perovskites

This type of perovskite materials have attracted a lot of attention due to their excellent optoelectronic properties. They are promising materials for a number of applications in solar cells and as photodetectors.

Figure 31: Visualisations for 2D ruddlesden popper perovskites



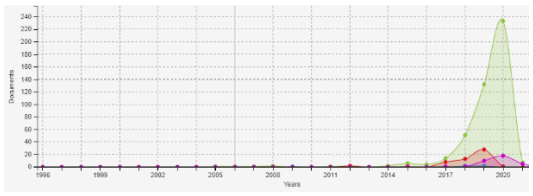


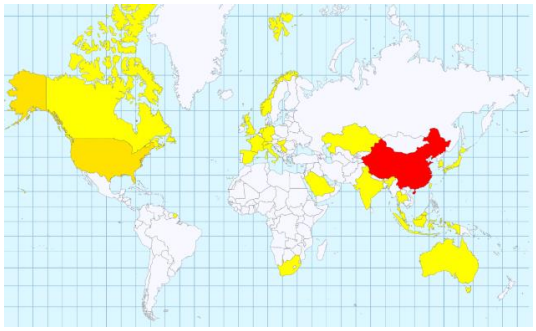
Chinese Academy of Sciences	23
Northwestern University	9
Fudan University	8
Rice University	6
Nankai University	5
Los Alamos National Laboratory	5
Huazhong University of Science and Technology	5
CNRS	5
New Mexico State University	4
National University of Singapore	4
Lund University	4
King Abdullah University of Science and Technology	4
Hunan University	4
University of Southern California	3
University of Electronic Science and Technology of China	3
Technical University of Denmark	3
Swinburne University of Technology	3
Soochow University	3
Shenzhen University	3
Shanghai Jiao Tong University	3

Aqueous zinc batteries

are promising energy storage systems due to the combination of low cost, high safety and higher capacity compared to lithium ion batteries. There are still some challenges to be solved, mainly related to the development of optimised materials for the cathodes and anodes.

Figure 32: Visualisations for aqueous Zinc batteries



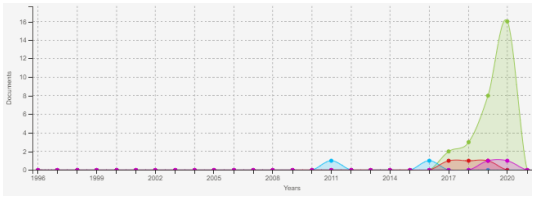


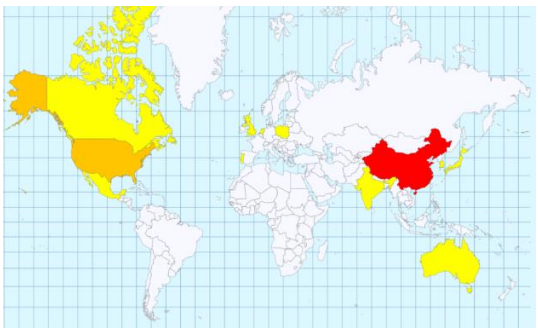
Chinese Academy of Sciences	136
Central South University	67
Nankai University	27
City University of Hong Kong	19
Fudan University	18
University of Science and Technology of China	17
Zhengzhou University	16
Nanyang Technological University	14
University of Washington	13
Nanjing Forestry University	13
Sun Yat-Sen University	12
Tsinghua University	11
IND FOUND OF CHONNAM NATIONAL UNIV	11
Dalian Maritime University	11
National University of Singapore	10
Shenyang University of Technology	9
Peking University	8
Jishou University	8
Huazhong University of Science and Technology	8
Yantai University	7

Chiral perovskite

are emerging as promising new materials for applications in ferroelectrics, spintronics and chiroptoelectronics.

Figure 33: Visualisations for chiral perovskites



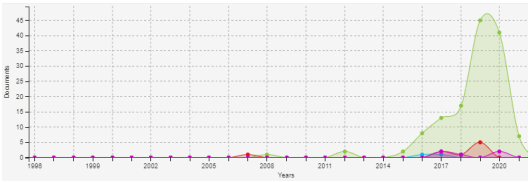


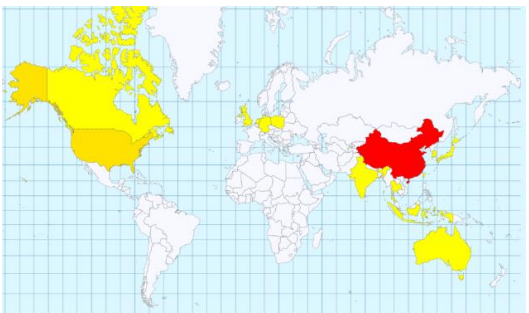
Tianjin University	7.0
Chinese Academy Of Sciences	5.0
Nankai University	4.0
Huazhong University of Science and Technology	4.0
Shenzhen University	3.0
Yonsei University	2.0
University of Utah	2.0
University of Sydney	2.0
University of Science and Technology	2.0
University of Pittsburgh	2.0
University of Cambridge	2.0
National Center for Nanoscience and Technology	2.0
Nanyang Technological University	2.0
Nanchang University	2.0

Flexible Zinc-air batteries

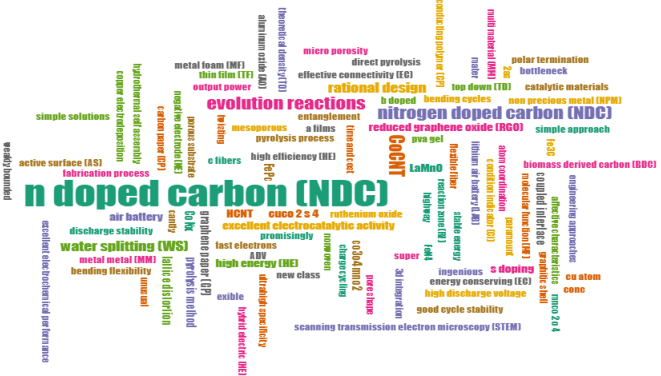
have seen a remarkable increase in research papers over the two last years, justifying to be in the list of weak signals. Due to its high safety, energy density, and relatively low cost of production, this type of battery is a promising candidate for the next generation of batteries that will fuel the internet of things and the myriad of flexible electronic devices that will invade our daily life.

Figure 34: Visualisations for flexible Zinc-air batteries





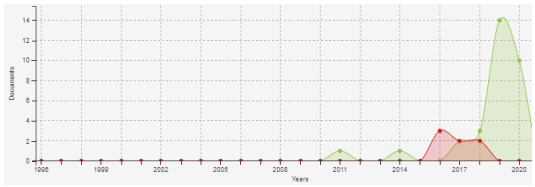
Chinese Academy of Sciences	44
Tianjin University	12
National University of Singapore	10
University of Science and Technology of China	8
Tsinghua University	8
University of Waterloo	7
Ningbo University	6
Nanyang Technological University	6
Zhengzhou University	5
Sun Yat-Sen University	5
Semiconductor Manufacturing International Corporation	5
Nankai University	5
Chulalongkorn University	5
Soochow University	4
Shanghai University	4
School of Materials Science and Engineering	4
NORTHWESTERN POLYTECHNICAL UNIVERSITY	4
Nanjing University of Aeronautics and Astronautics	4
Huazhong University of Science and Technology	4
Collaborative Innovation Center of Chemical Science and Engineering	4



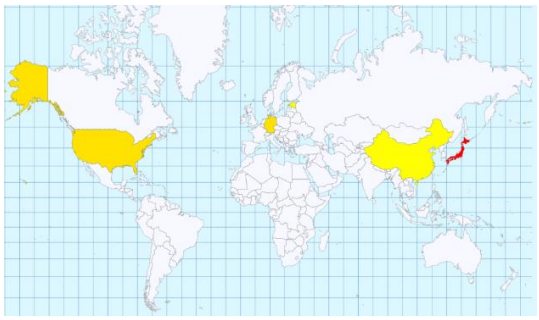
Fluoride shuttle batteries

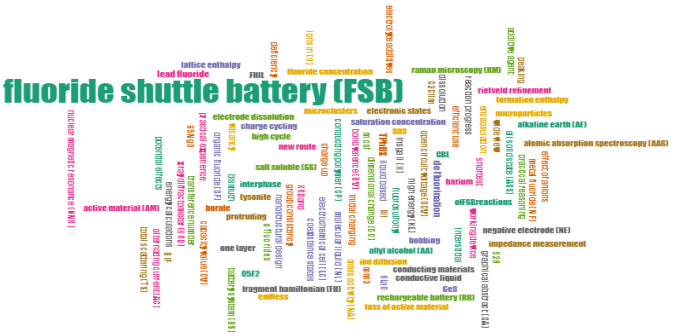
can theoretically provide high energy densities and are considered as potential candidate to replace traditional Li-ion batteries. R&D efforts are needed to improve their current performance.

Figure 35: Visualisations for blockchain-related weak signals



Kyoto University	26
HONDA MOTOR CO LTD	5
Hitachi Ltd	5
California Institute of Technology	4
Tohoku University	3
Tallinn University of Technology	3
Karlsruhe Institute of Technology KIT	3
University of Ulm	2
Toyota Motor Corp	2
PANASONIC CORP	2
Institute of Materials Structure Science	2

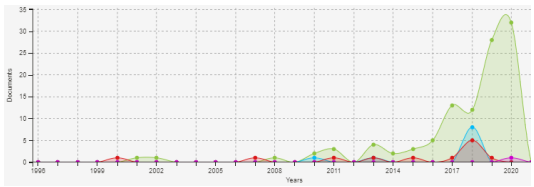




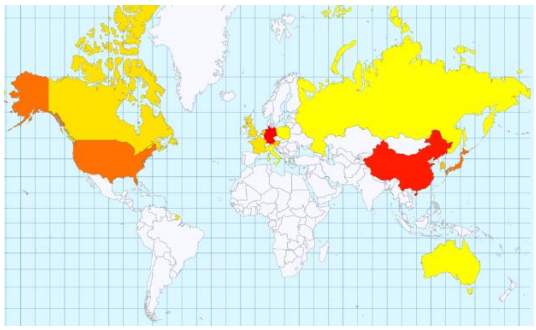
Lithium argyrodites

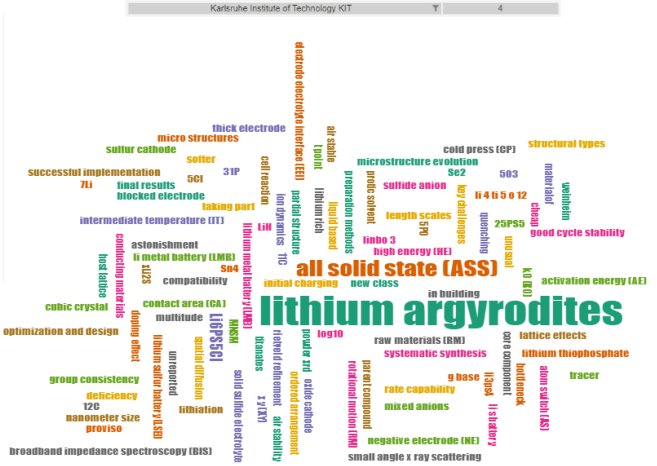
are materials that are being considered as electrolytes for all-solid-state batteries. This type of battery works in the same way as the traditional Li-ion batteries but are safer, have a longer duration and a higher energy density.

Figure 36: Visualisations for Lithium argyrodites



Justus-Liebig-University Giessen	14
Mitsui Corp	9
Delft University of Technology	9
National University of Singapore	8
Yanshan University	6
Osaka Prefecture University	6
Hanyang University	6
Bosch Corp	6
University of Western Ontario	5
Technische Universitat München	5
Karlsruhe Institute of Technology	5
Hokkaido University	5
Graz University of Technology	5
Zhengzhou University	4
Zhejiang University of Technology	4
Université de Picardie Jules Verne	4
University of Siegen	4
University of California	4
Karlsruhe Institute of Technology KIT	4

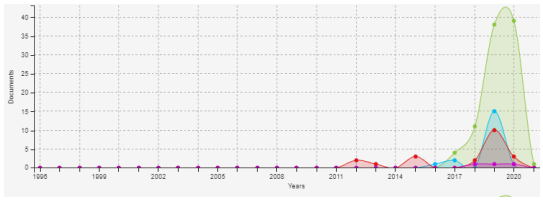


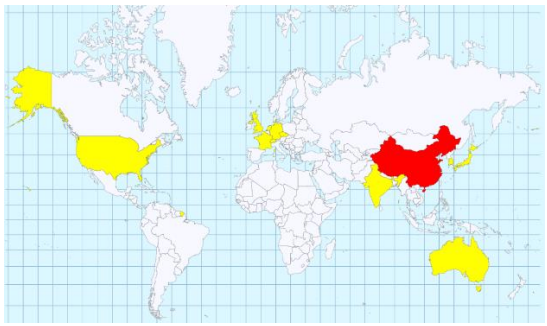


Hepta/perfluoroisobutyronitrile

Heptafluoroisobutyronitrile and perfluoroisobutyronitrile gases are promising candidates to replace the greenhouse gas SF6 that is widely used in electrical insulators and suppressant devices for electric arcs.

Figure 37: Visualisations for Hepta/perfluoroisobutyronitrile





Wuhan University	49
XI'AN JIAOTONG UNIVERSITY	32
ANHUI ELECTRIC POWER RESEARCH INSTITUTE	17
CHINA ELECTRIC POWER RESEARCH INSTITUTE	16
Electric Power Research Institute	8
PINGGAO GROUP CO., LTD.	6
North China Electric Power University	6
Hubei University of Technology	6
CHINA ACADEMY OF SPACE TECHNOLOGY	6
General Electric Co	5
Chongqing University	5
YUNNAN POWER GRID CO., LTD.	4
STATE GRID CORPORATION OF CHINA	4
ETH Zurich	4
XI'AN UNIVERSITY OF TECHNOLOGY	3
State Grid Zhejiang Electric Power Research Institute	3
STATE GRID	3
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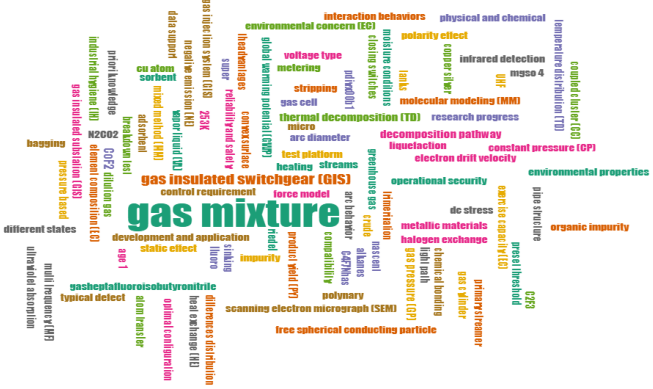
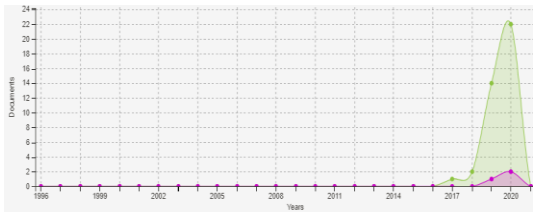
Shanghai Jiao Tong University	3
CSIRO Manufacturing	3

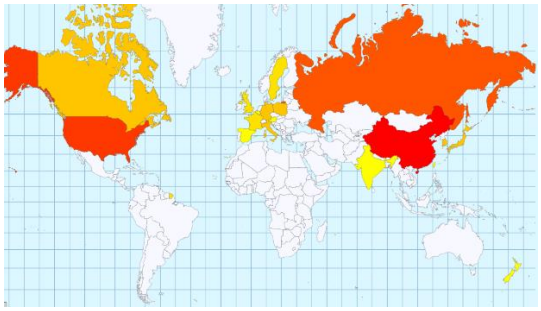


Lanthanum decahydride

is one of two materials (with H3S) that has recently provided the first glimpse to room temperature superconductivity, the holy grail of condensed matter physics.

Figure 38: Visualisations for Lanthanum decahydride





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Skolkovo Innovation Center	5.0
NORTHWESTERN POLYTECHNICAL UNIVERSITY	5.0
Jilin University	5.0
Chinese Academy of Sciences	5.0
Ural Federal University	4.0
Ningbo University	4.0
Jiangsu Normal University	4.0
Hanyang University	4.0
Carnegie Institution of Washington	4.0
University of Chicago	3.0
Moscow Institute of Physics and Technology	3.0
George Washington University	3.0
Czestochowa University of Technology	3.0
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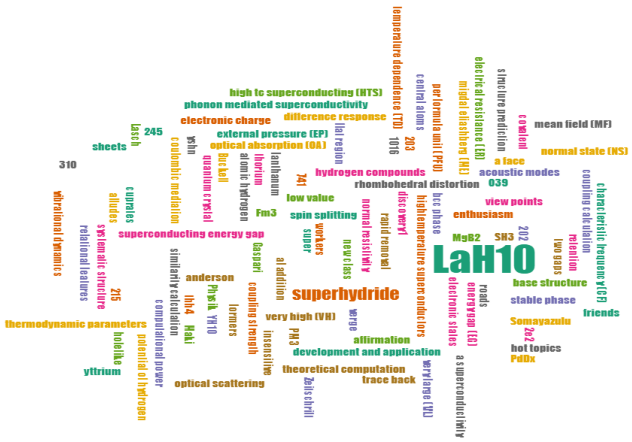
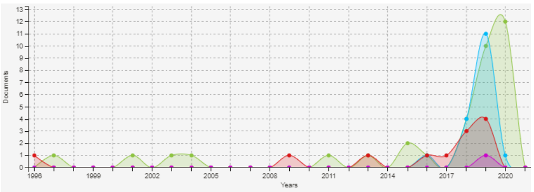
University of Tokyo	2.0
University of Saskatchewan	2.0
University of Guelph	2.0
University of Cambridge	2.0
Tohoku University	2.0



Lithium niobite

is a material with interesting electro-optic, acousto-optic, elasto-optic, piezoelectric and nonlinear characteristics. It holds great promises in numerous potential applications e.g. batteries, memristors, neuromorphic circuitry or optoelectronics.

Figure 39: Visualisations for lithium niobite



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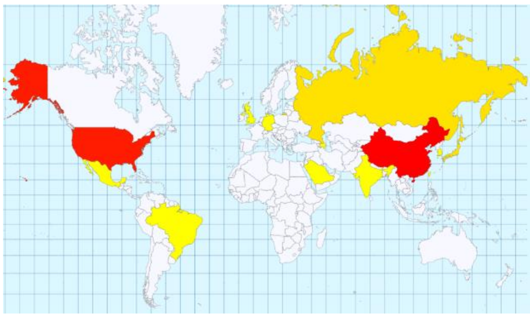
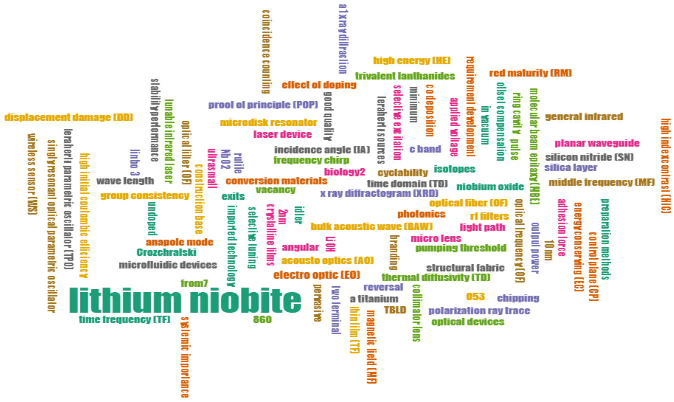
Georgia Institute of Technology	Y	4.0
University of Electronic Science and Technology of China	Y	3.0
School of Electrical and Computer Engineering	Y	3.0
Vanderbilt University	Y	2.0
Ural Federal University	Y	2.0
University of Science and Technology of China	Y	2.0
Tsinghua University	Y	2.0
Space Engineering S.p.A.	Y	2.0
Southwest Institute of Technical Physics	Y	2.0
Shanxi University	Y	2.0
Shandong University	Y	2.0
School of Electrical Engineering	Y	2.0
Raytheon BBN Technologies	Y	2.0
Howard University	Y	2.0
City University of Hong Kong	Y	2.0

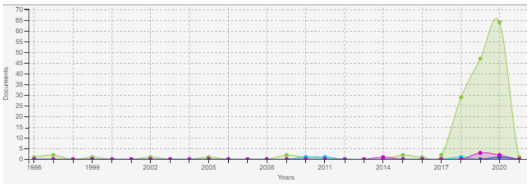




Magnetic chromium trihalide

is a novel two-dimensional material with unique magnetic properties with potential applications in electronics and spintronics.

Figure 40: Visualisations for magnetic chromium trihalide



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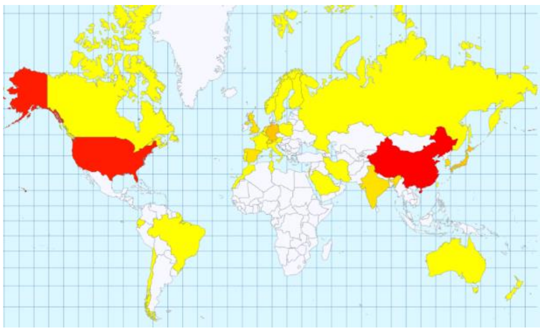
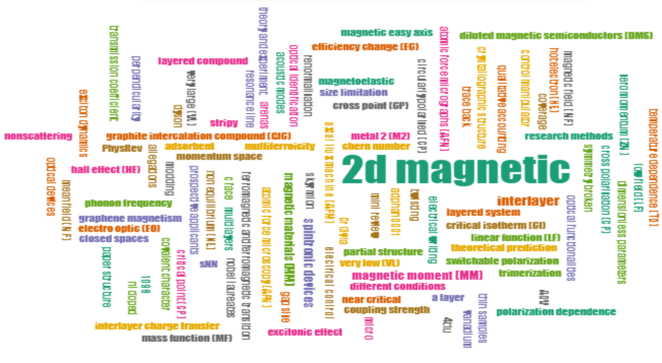
University of Washington	Y	11
Oak Ridge National Laboratory	Y	10
Radboud University	Y	7
Nanjing University	Y	7
University of California	Y	6
Renmin University of China	Y	5
International Iberian Nanotechnology Laboratory	Y	5
Cornell University	Y	5
Carnegie Mellon University	Y	5
University of Hong Kong	Y	4
University of Geneva	Y	4
SHAANXI NORMAL UNIVERSITY	Y	4
Jilin University	Y	4
Collaborative Innovation Center of Advanced Microstructures	Y	4
University of Waterloo	Y	3
University of Science and Technology of China	Y	3
University of Michigan	Y	3
University of Manchester	Y	3

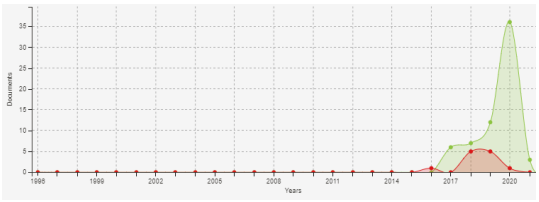


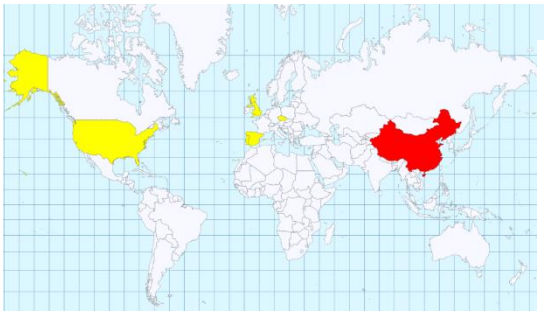


Magnetic covalent organic frameworks

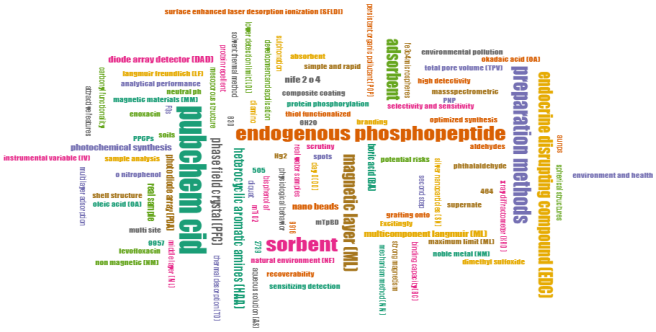
are investigated recently for their use in the remediation of wastewaters. They have a high adsorbing capacity for environmental pollutants like perfluorinated compounds, endocrine disruptors, insecticides or even mercury.

Figure 41: Visualisations for magnetic covalent organic frameworks





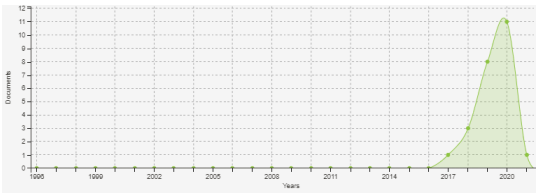
SHAANXI UNIVERSITY OF SCIENCE&TECHNOLOGY	11
Fuzhou University	11
China National Center for Food Safety Risk Assessment	9
Tsinghua University	8
Qufu Normal University	6
Chinese Academy Of Sciences	6
Zhejiang University of Technology	5
Hong Kong Baptist University	5
Nankai University	4
Beijing Technology and Business University	4
Qilu University of Technology	3
Northwest University	3
National Engineering Laboratory for Textile Fiber Materials and Processing T...	3
Medical University	3
Chongqing University	3
China University of Geosciences	3
Zhejiang University	2
Zhejiang Academy of Agricultural Sciences	2
University of Vigo	2
University of Aveiro	2

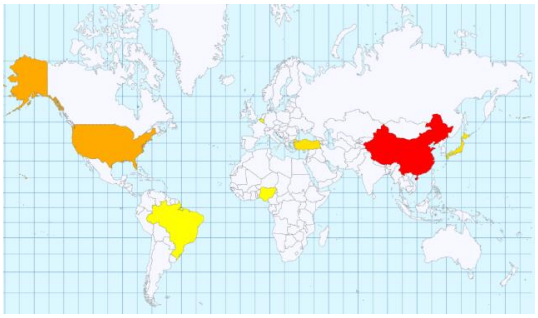


Mbenes

are an emerging class of two-dimensional transition metal borides. They are promising materials for applications in electronics and catalysis, or as 2D ferromagnets or as material for energy conversion/energy storage.

Figure 42: Visualisations for Mbenes





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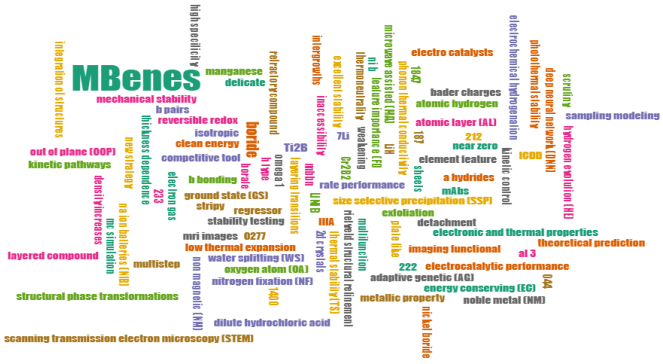
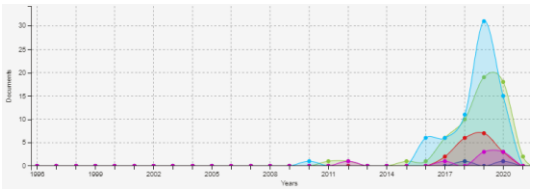
Hebei University of Technology	2.0
Dokuz Eylul University	2.0
Dalian University of Technology	2.0
Chinese Academy Of Sciences	2.0
Beijing Jiaotong University	2.0
Beihang University	2.0
AEROSPACE RESEARCH INSTITUTE OF MATERIALS&PROCESSING TE...	2.0
Adnan Menderes University	2.0
Zhengzhou University	1.0
Zhejiang University of Technology	1.0
Wuhan University of Technology	1.0
University of Virginia	1.0
University of Tokyo	1.0
University of Science and Technology of China	1.0
University of North Dakota	1.0
University of California	1.0
University of Antwerp	1.0

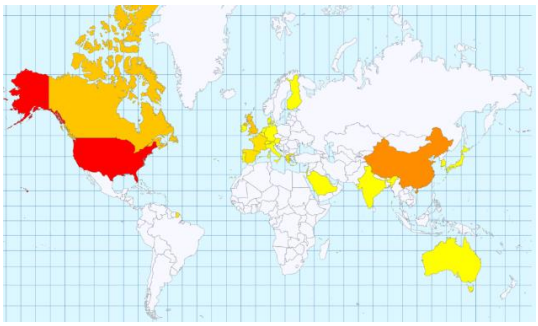


Neuromorphic photonics

Photonic neural networks are physical/hardware networks (as opposed to algorithmic neural networks) inspired by the structure of the human brain. They are under investigation for their potential advantages (speed, energy consumption) in computational tasks (e.g. image recognition, speech processing, machine learning).

Figure 43: Visualisations for neuromorphic photonics





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George Washington University	14
Queen's University	13
University of Strathclyde	11
National Institute of Standards and Technology	9
Massachusetts Institute of Technology	9
XIDIAN UNIVERSITY	8
China University of Mining and Technology	8
Université de Bourgogne Franche-Comté	7
Universitat de les Illes Balears	6
Stanford University	5
Shanghai Jiao Tong University	5
Purdue University	5
Aristotle University of Thessaloniki	5
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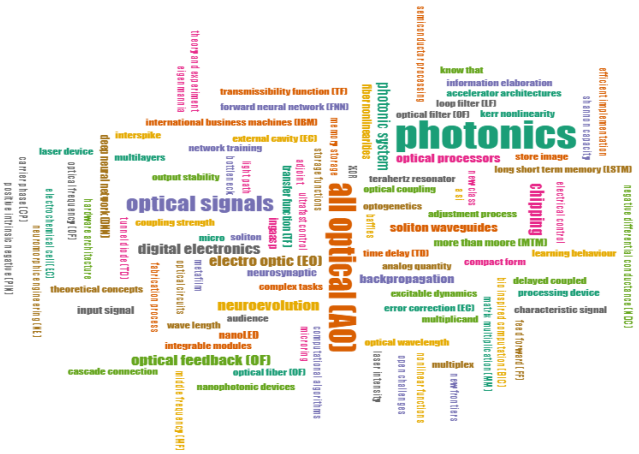
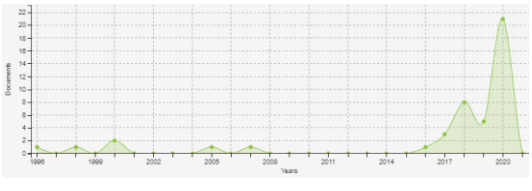
Johns Hopkins University	4
Université Libre de Bruxelles	3
Semiconductor Manufacturing International Corporation	3
Eindhoven University of Technology	3
Beijing University of Posts and Telecommunications	3

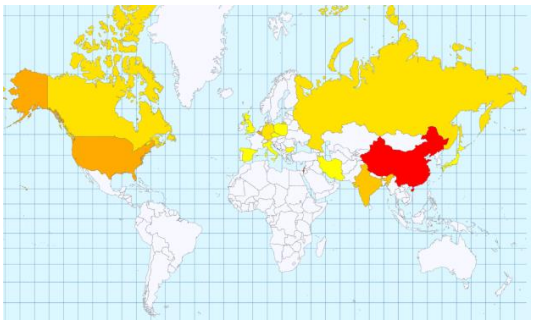


Oriented external electric fields

have been shown to provide unprecedented control over chemical reactions, catalysis and kinetics of reactions, as well as selectivity, allowing to synthetize improved materials for a wide variety of applications.

Figure 44: Visualisations for oriented external electric field





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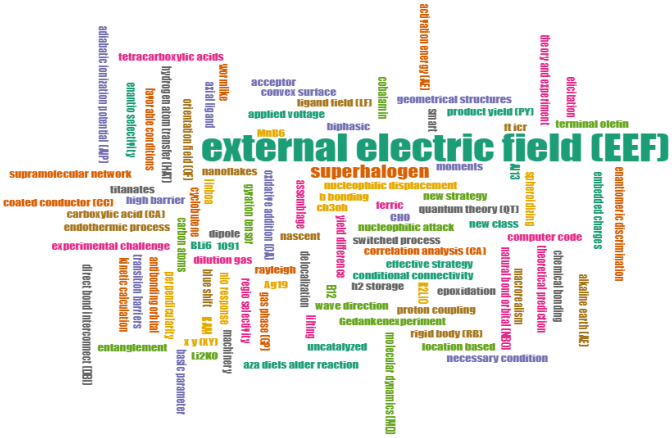
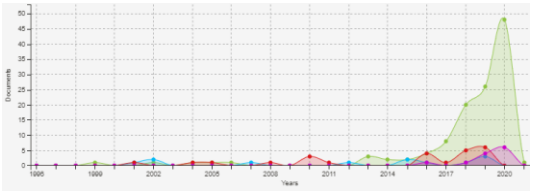
Shandong University	6
Jilin University	4
Chongqing University of Technology	4
University of Louisville	3
Technische Universitat Berlin	3
Hebrew University	3
XI'AN JIAOTONG UNIVERSITY	2
School of Chemistry and Biochemistry	2
Presidency University	2
Fujian Medical University	2

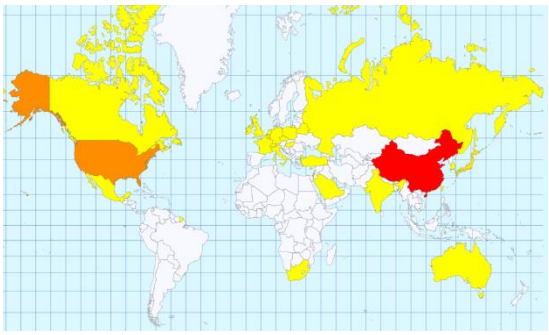


Perovskite X-ray

is yet another promising application of perovskite materials. Halide perovskites, in particular, have been reported recently as promising materials to detect X-rays, owing to their strong X-ray stopping capacity, high sensitivity, and low cost manufacturing.

Figure 45: Visualisations for perovskite X-ray





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Chinese Academy Of Sciences	14
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Tsinghua University	8
Northwest Institute of Nuclear Technology	7
Nanjing University of Aeronautics and Astronautics	7
Iwate Medical University	5
Argonne National Laboratory	5
Zhejiang University	4
Wuhan University	4
Tongji University	4
Toho University Ohashi Medical Center	4
Southeast University	4
North Carolina State University	4
Jilin University	4
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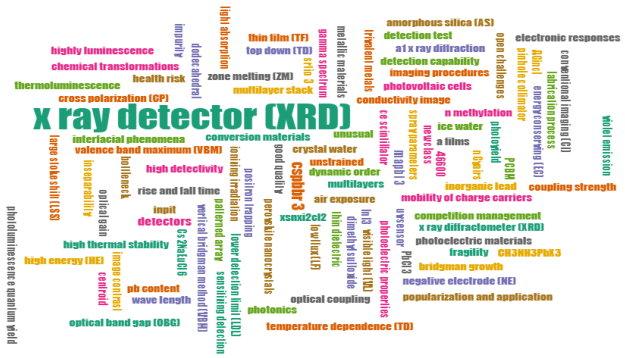
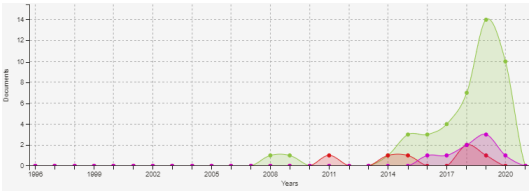
XIJING UNIVERSITY	3
University of Tennessee-Knoxville	3
Soochow University	3
SHAANXI NORMAL UNIVERSITY	3

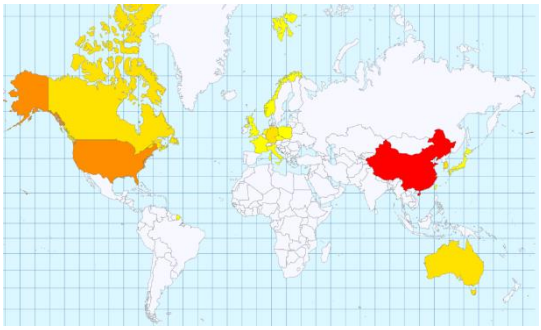


Phosphorus anodes

show great potential as negative electrodes for alkaline metal ion batteries due to their characteristics, natural abundance, and environmental friendliness. Alkaline metal ion batteries (e.g. lithium ion batteries) are increasingly used in many applications in consumer electronics or for electric vehicles and energy storage because of their high energy and power density and their long life cycle.

Figure 46: Visualisations for lithium niobite





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Tsinghua University	5.0
University of Wollongong	4.0
School of Materials Science and Engineering	4.0
Chinese Academy Of Sciences	4.0
Stanford University	3.0
Shenzhen University	3.0
Argonne National Laboratory	3.0
XI'AN UNIVERSITY OF TECHNOLOGY	2.0
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University of Wisconsin-Milwaukee	2.0
University of Windsor	2.0
University of Western Ontario	2.0
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University of Science and Technology of China	2.0
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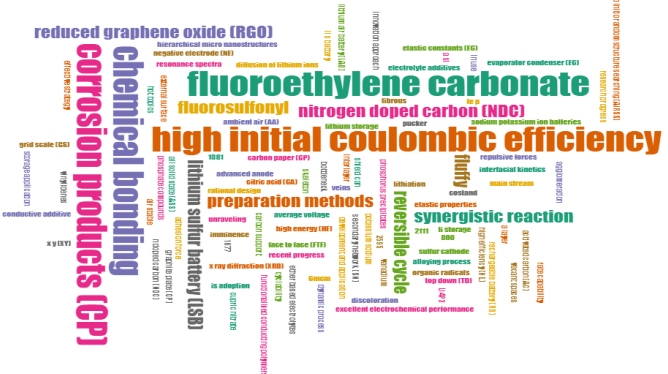
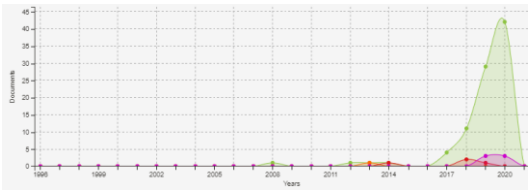
Tianjin Polytechnic University	2.0
Technical University of Munich	2.0
Stanford Institute for Materials and Energy Sciences	2.0
Soochow University	2.0

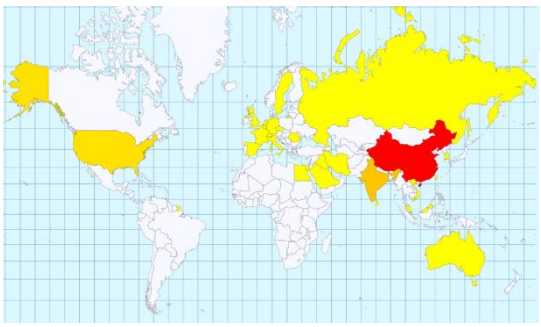


Piezocatalysis

consists in converting mechanical vibration into energy that can be used to catalyse chemical reactions. It has recently emerged as a promising technique for example in water-splitting (production of H2) or for disinfection applications.

Figure 47: Visualisations for piezocatalysis





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Chinese Academy Of Sciences	11
School of Engineering	9
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University of Wisconsin-Madison	5
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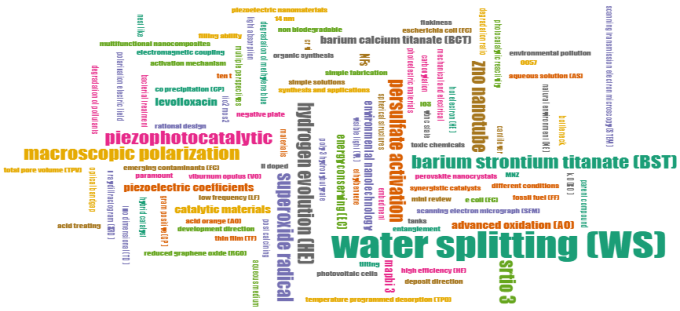
Hong Kong Polytechnic University	5
Zhejiang Normal University	4
Xi'an University of Posts and Telecommunications	4
XI'AN POLYTECHNIC UNIVERSITY	4
Qingdao University	4
Hangzhou Dianzi University	4
Wuhan University of Technology	3
University of Science and Technology	3
University of Newcastle	3
University of Bath	3
South China Normal University	3
Shanghai Jiao Tong University	3
National Tsinghua University	3
Nanjing University of Information Science and Technology (NUST)	3

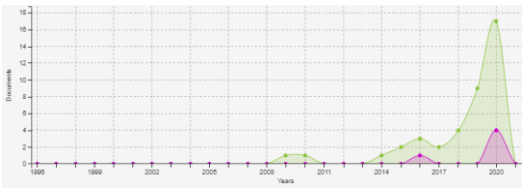


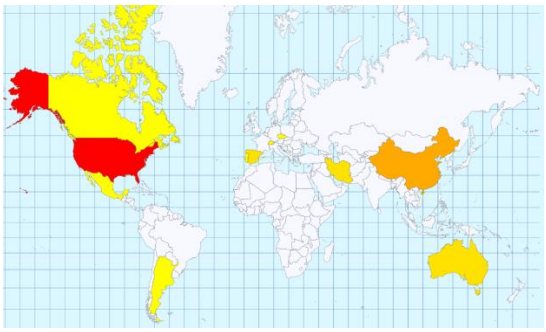
2.4 Environment

Biocrust restoration

Biocrusts are multifunctional communities of cyanobacteria, algae, lichens and other organisms that are increasingly being used to restore degraded or damaged ecosystems. In particular, they are used to restore drylands ecosystems (40% of earth surface) that are facing increasing degradation due to human activity.

Figure 48: Visualisations for biocrust restoration





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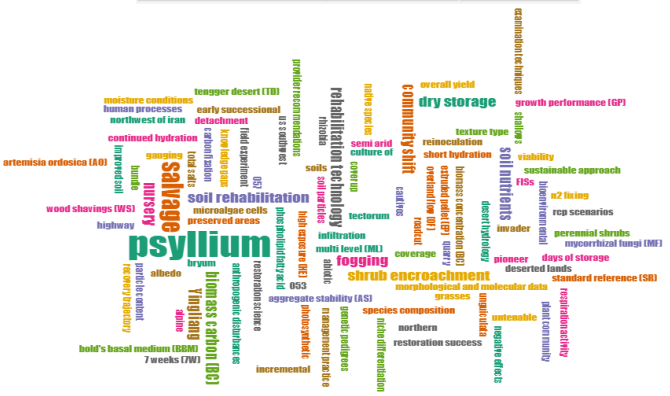
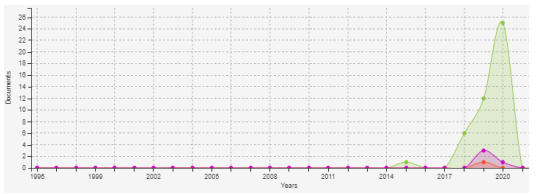
Chinese Academy Of Sciences	7
University of Colorado	6
Southwest Biological Science Center	6
Universidad de Almería	4
New Mexico State University	3
Universidad de Buenos Aires	2
Universidad Autónoma de Madrid	2
NORTHWEST A&F UNIVERSITY	2
National Institute of Genetic Engineering and Biotechnology	2
MPG	2
Lanzhou University	2
Forest and Rangeland Ecosystem Science Center	2
DePaul University	2

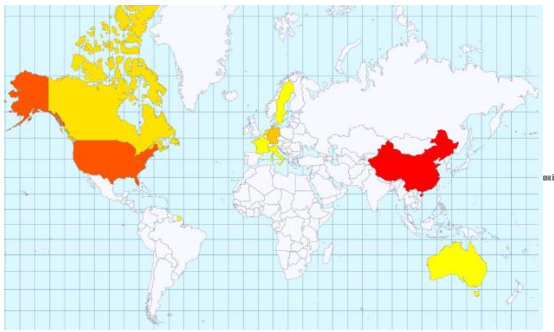


Hexafluoropropylene oxide dimer acid

Perfluoroalkyl and polyfluoroalkyl substances are emerging persistent organic pollutants. Widely used, their persistence in the environment, their bioaccumulation and toxicity calls for their replacement by new compounds.

Figure 49: Visualisations for Hexafluoropropylene oxides contamination





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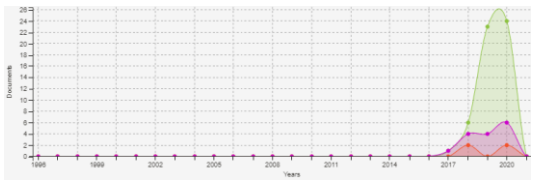
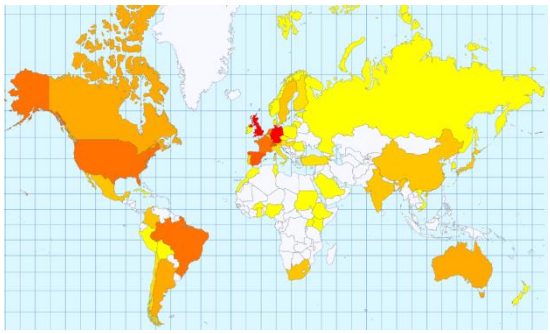
Nankai University	6.0
Universität Hamburg	3.0
University of North Carolina at Chapel Hill	3.0
U.S. Environmental Protection Agency	3.0
Tsinghua University	3.0
North Carolina State University	3.0
Institute for Coastal Research	3.0
Örebro University	2.0
University of North Carolina at Charlotte	2.0
U.S. EPA	2.0
Shanghai Ocean University	2.0
Oak Ridge Institute for Science and Education	2.0
National Institutes of Health	2.0
East Carolina University	2.0
Centre for Materials and Coastal Research	2.0

Nature's Contribution to People

is a new trend in policy making that aims at including the valuation of nature's contribution to people and society when designing new policies.

Figure 50: Visualisations for Natures's contribution to people



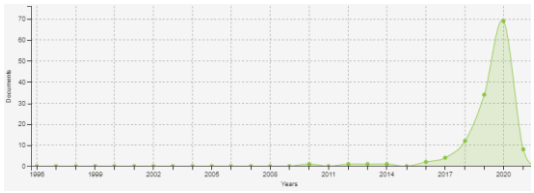


University of Bern	7.0
Leuphana University Lüneburg	6.0
Helmholtz Centre for Environmental Research-UFZ	6.0
University of São Paulo	5.0
CNRS	5.0
Basque Foundation for Science	5.0
University of the Basque Country	4.0
University of Leeds	4.0
International Institute for Applied Systems Analysis	4.0
Wageningen University and Research	3.0
Wageningen University	3.0
University of Paris	3.0
Universitat Autònoma de Barcelona	3.0
Universidad Nacional Autónoma de México	3.0
Potsdam Institute for Climate Impact Research	3.0
Lund University	3.0
Laboratoire d'Excellence CORAIL	3.0
International Institute for Sustainability	3.0
Instituto Tecnológico Vale	3.0
German Centre for Integrative Biodiversity Research	3.0

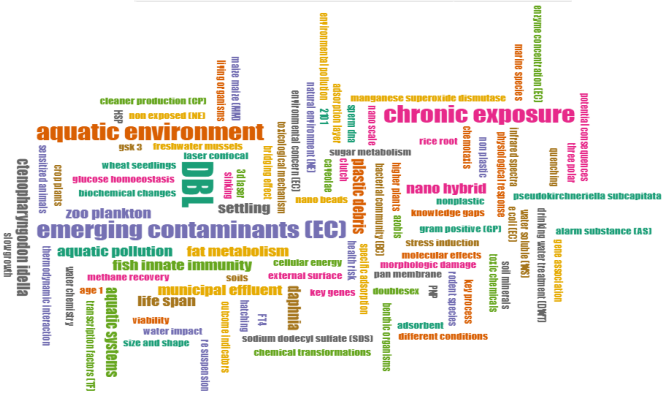
Polystyrene nanoplastic

It is not surprising to find a signal related to nanoplastics among the list of weak signals. There is no doubt that micro- and nanoplastics are accumulating in the environment and research has been performed recently on their detection/identification in the environment and toxicity mechanisms.

Figure 51: Visualisations for polystyrene nanoplastics



Southeast University	28
Jinan University	11
East China Normal University	8
TENCENT TECHNOLOGY CO., LTD.	6
University of Geneva	5
University of Aveiro	5
Shandong University	5
Nanjing University	5
Nankai University	4
Nanjing Agricultural University	4
Chinese Academy Of Sciences	4
University of Tennessee	3
University of Siena	3
University of Murcia	3
Universitat Autònoma de Barcelona	3
Universidad de Cádiz	3
South China Agricultural University	3
Shahid Beheshti University of Medical Sciences	3
National Research Council	3
Islamic Azad University	3

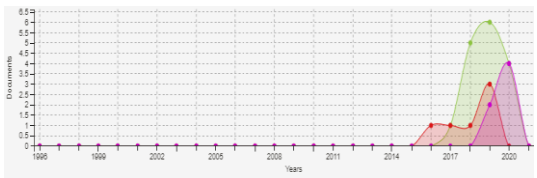


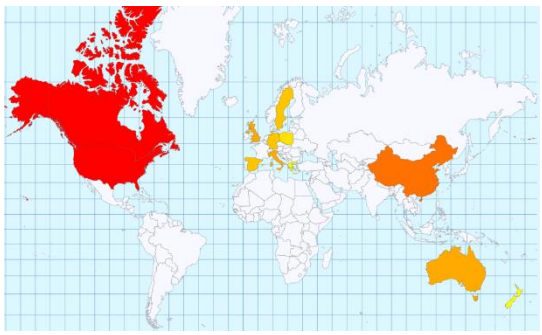
2.5 Health

Apabetalone

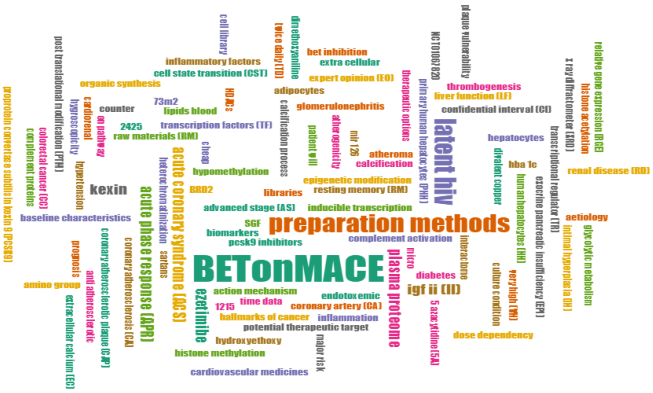
is a small molecule inhibitor targeting epigenetic readers termed BET proteins that contribute to gene dysregulation in various human disorders. This weak signal is linked to the field of epigenetics where new innovative treatments are expected despite the underpinning science being still thin.

Figure 52: Visualisations for Apabetalone





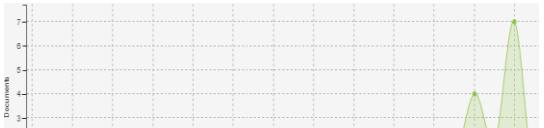
University of California	5.0
University of Colorado School of Medicine	4.0
Veterans Affairs Medical Center	3.0
University of Calgary	3.0
UCLA Fielding School of Public Health	3.0
Karolinska University Hospital	3.0
Imperial College London	3.0
Veterans Affairs Salt Lake City Healthcare System	2.0
University of California Irvine Medical Center	2.0
University of Adelaide	2.0
University Hospital	2.0
Polish Mother's Memorial Hospital-Research Institute	2.0
Monash University	2.0
Johns Hopkins University School of Medicine	2.0
IRCCS SDN	2.0
Columbia University	2.0
Collaborative Innovation Center of Chemical Science and Engineering	2.0

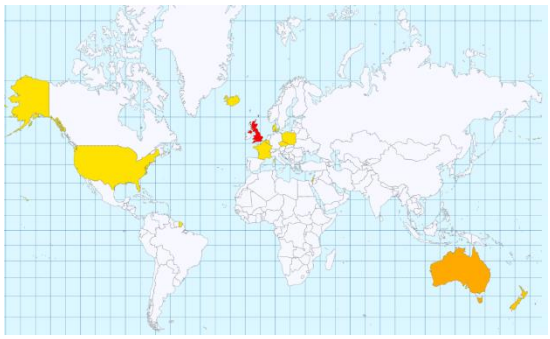


Aphantasia

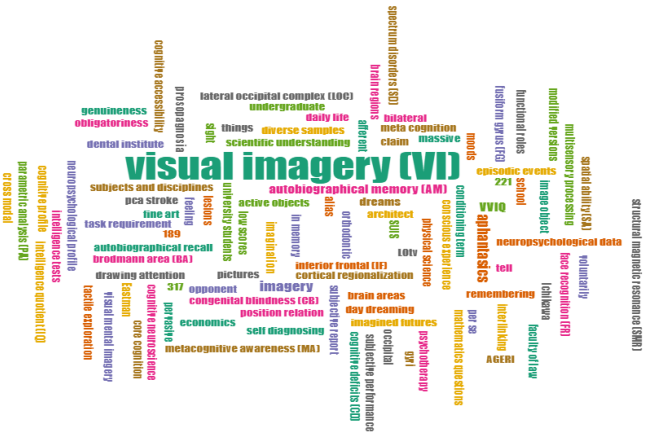
a spectrum disorder characterized by a total lack of ability to generate visual forms of mental imagery, and in some cases any form of sensory representation. It is now estimated that 2–3% of the population may have this disorder. Study of aphantasia may lead to a better understanding of mental imagery in other cognitive processes.

Figure 53: Visualisations for aphantasia





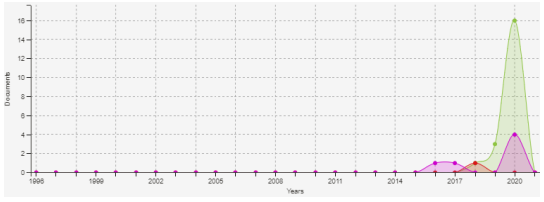
University of New South Wales	3.0
University of Exeter Medical School	2.0
University of Exeter	2.0
University College London	2.0
Weizmann Institute of Science	1.0
Université Catholique de Louvain	1.0
University of Westminster	1.0
University of Warwick	1.0
University of South Bohemia	1.0
University of Oxford	1.0
University of Otago	1.0
University of Manchester	1.0
University of Iceland	1.0
University of Edinburgh	1.0
University of Copenhagen	1.0
University of Cambridge	1.0
University of California	1.0
University of Auckland	1.0
UCL Eastman Dental Institute	1.0
Pedagogical University of Cracow	1.0

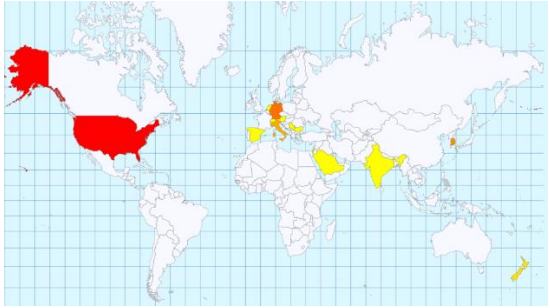


Cenobamate antiepileptic

Cenobamate is a new antiseizure drug that has showed high efficacy in clinical trials, promising new perspective for the treatment of drug-resistant epilepsies.

Figure 54: Visualisations for Cenobamate antiepileptic



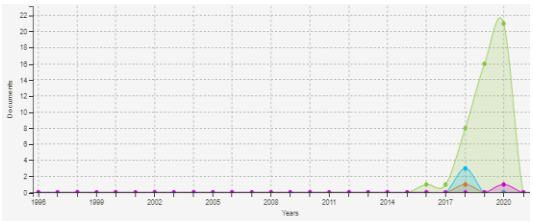


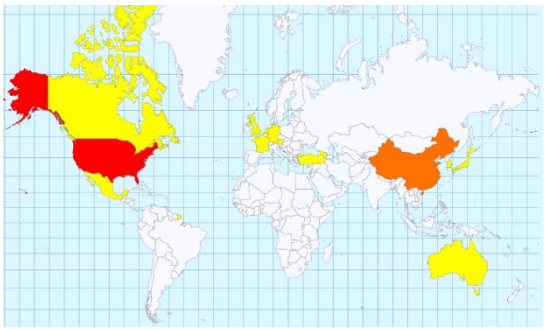
SK Life Science Inc	8.0
Springer	2.0
Kyungpook National University	2.0
Johns Hopkins University School of Medicine	2.0
Geological Survey of Canada	2.0
Florence Health Authority	2.0
Epilepsy Research Group	2.0
Comprehensive Epilepsy Center	2.0
Chungnam National University	2.0

Connectome-based Predictive Modelling

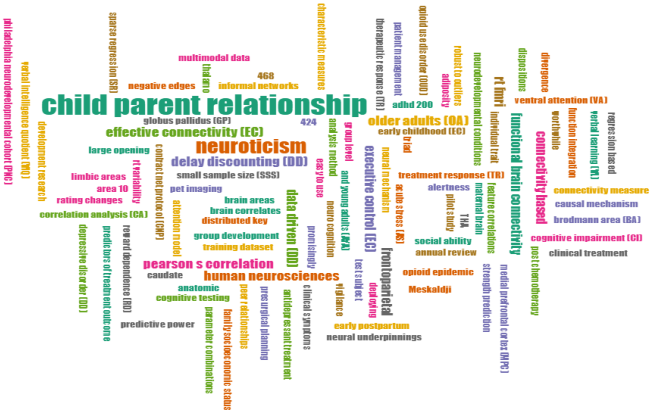
was recently developed to predict individual differences in traits and behaviours of people on the basis of their unique functional brain connectivity, measured with functional magnetic resonance imaging.

Figure 55: Visualisations for connectome-based predictive modelling





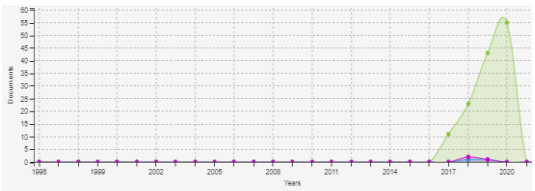
Yale University	20
Yale School of Medicine	16
Chinese Academy of Sciences	8
University of Chicago	7
Yale University School of Medicine	4
University of New Mexico	4
National University of Singapore	4
Institute of Neuroscience	3
Georgia Institute of Technology	3
Duke-NUS Medical School	3
University of Electronic Science and Technology of China	2
Southern Medical University	2
South China Normal University	2
Shenzhen University	2
Shanghai University	2
National Institute of Mental Health	2
Harvard University	2
GENERAL HOSPITAL CORP	2
First Affiliated Hospital of Anhui Medical University	2
Connecticut Mental Health Center	2

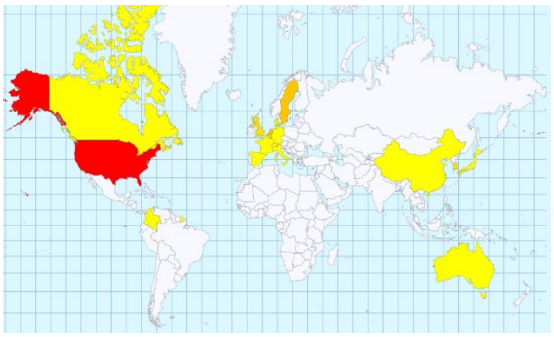


Flortaucipir

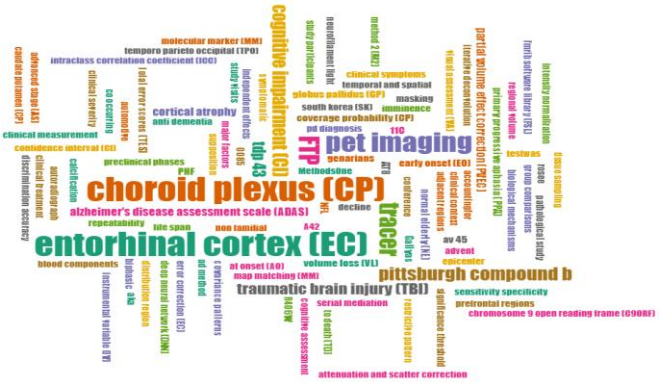
is a tracer used in targeted positron emission tomography that makes it possible to investigate the development of tau and amyloid-b in and the related development of cognitive impairment due to Alzheimer's disease.

Figure 56: Visualisations for Flortaucipir





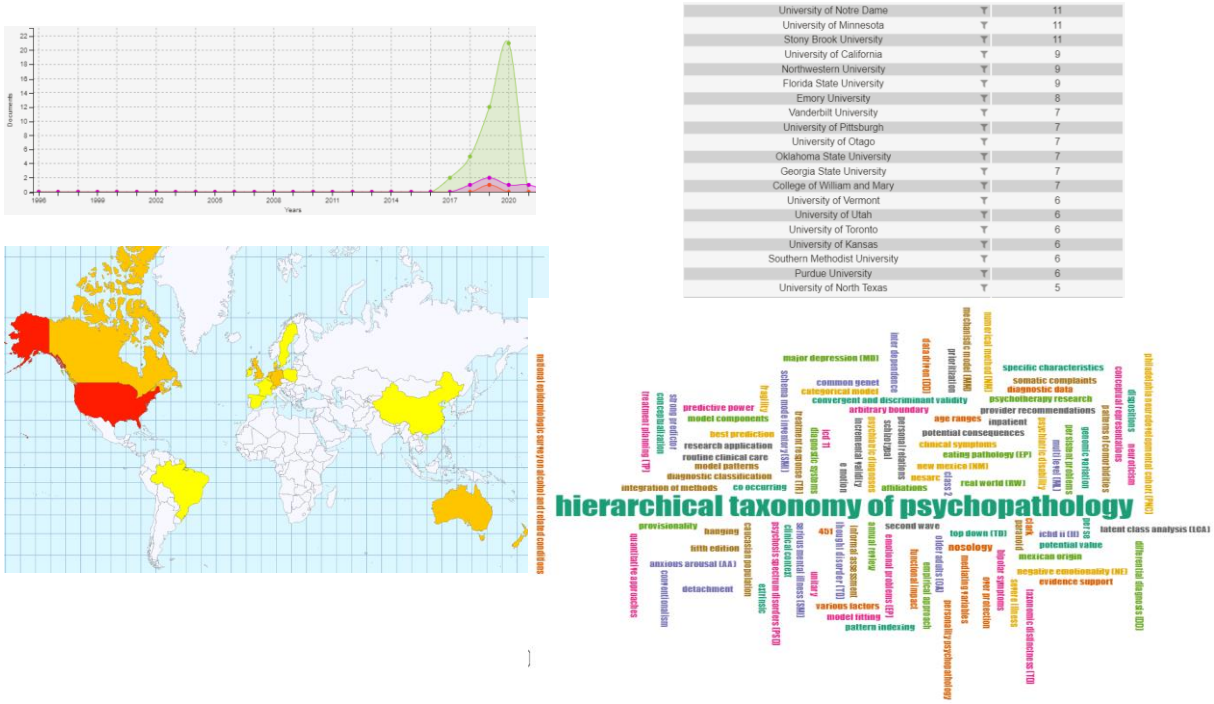
Harvard University	24
University of California	23
Lund University	21
Mayo Clinic	15
Avid Radiopharmaceuticals	13
Skåne University Hospital	12
Lawrence Berkeley National Laboratory	11
University of Pennsylvania	10
Yonsei University College of Medicine	9
University of Melbourne	8
Tabriz University	8
Indiana University School of Medicine	8
VU University Medical Center	7
Université Catholique de Louvain	7
Maastricht University	7
Karolinska Institutet	7
Indiana University	7
University College London	6
German Center for Neurodegenerative Diseases	6
Banner Alzheimer's Institute	6



Hierarchical taxonomy of psychopathology

is a new classification of mental illness resulting from research efforts by a consortium of 70 investigators. It aims at addressing several shortcomings of traditional taxonomies and provide a better framework of reference for both clinical and research activities.

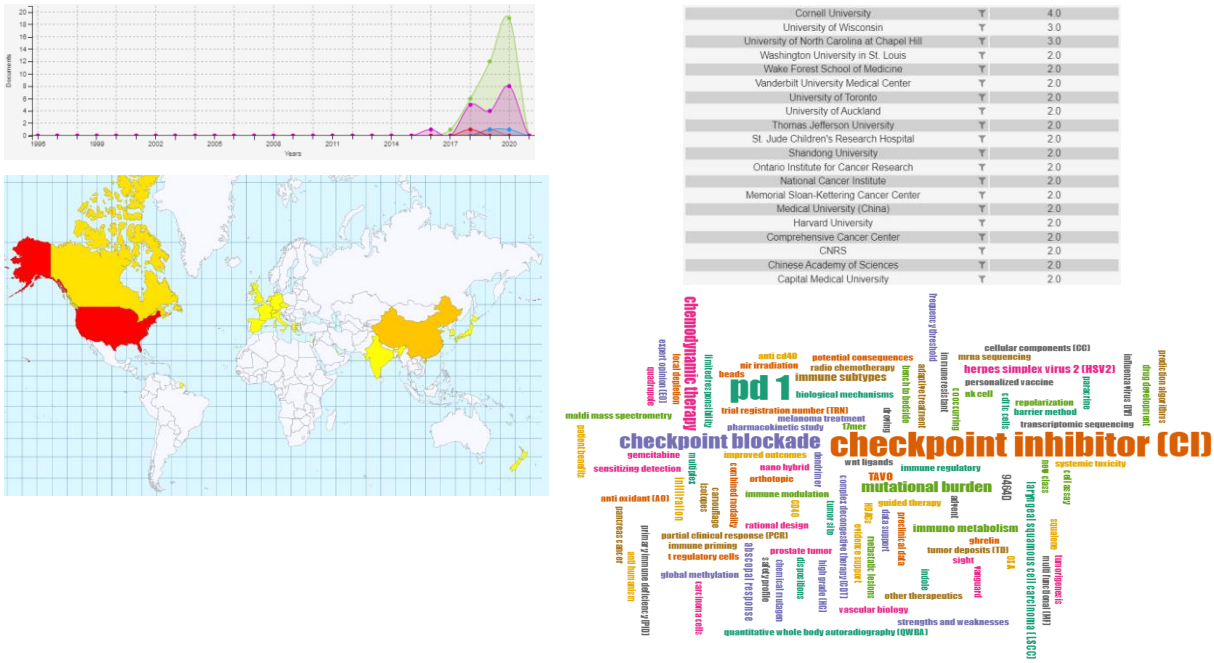
Figure 57: Visualisations for hierarchical taxonomy of psychopathology



Immunotherapy for cold tumors

Cold tumors are cancer tumors that exhibit very low to no immunological response to immunotherapy. A key challenge for treating certain type of cancers is to transform these cold tumors into “hot” ones that will respond to immunotherapy.

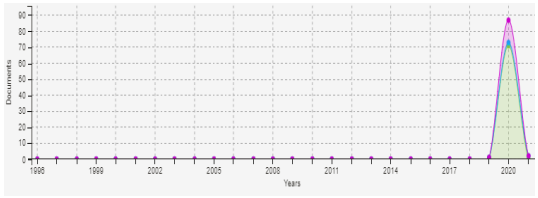
Figure 58: Visualisations for immunotherapy for cold tumors



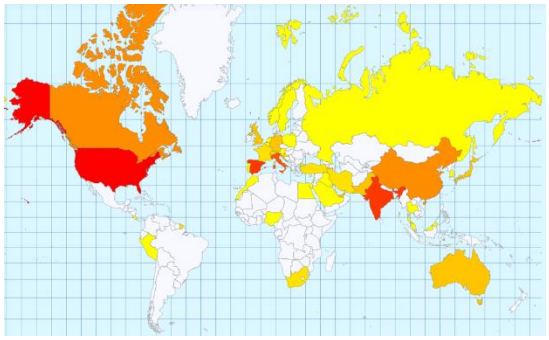
Infodemic

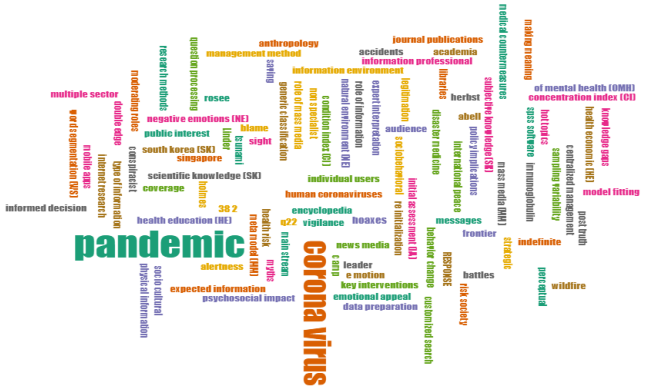
With the dissemination of fake news, hoaxes, misleading content or conspiracy theories, it is safe to say that the COVID-19 pandemic was also a disinformation pandemic. This unprecedented infodemic is triggering research in various fields e.g. machine learning, educational sciences or public health policy.

Figure 59: Visualisations for infodemic



University of Oxford	4.0
United Arab Emirates University	3.0
University of Victoria	2.0
University of California	2.0
National University of Singapore	2.0
Keio University	2.0
Islamia University of Bahawalpur	2.0
Fudan University	2.0
Boston University	2.0
All India Institute of Medical Sciences	2.0
Yale-NUS College	1.0
Yale School of Medicine	1.0
World Health Organization	1.0
Washington University School of Medicine	1.0

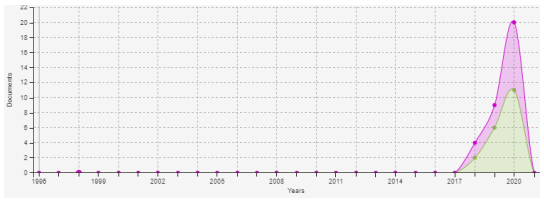




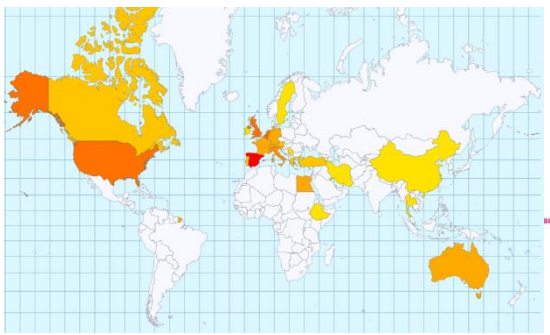
Micro elimination of hepatitis C virus

This weak signal is directly related to the decision by the WHO target to eliminate hepatitis C virus by 2030. A micro-elimination approach where discrete populations are targeted seems to be promising to reach this ambitious goal.

Figure 60: Visualisations for micro elimination of hepatitis C virus



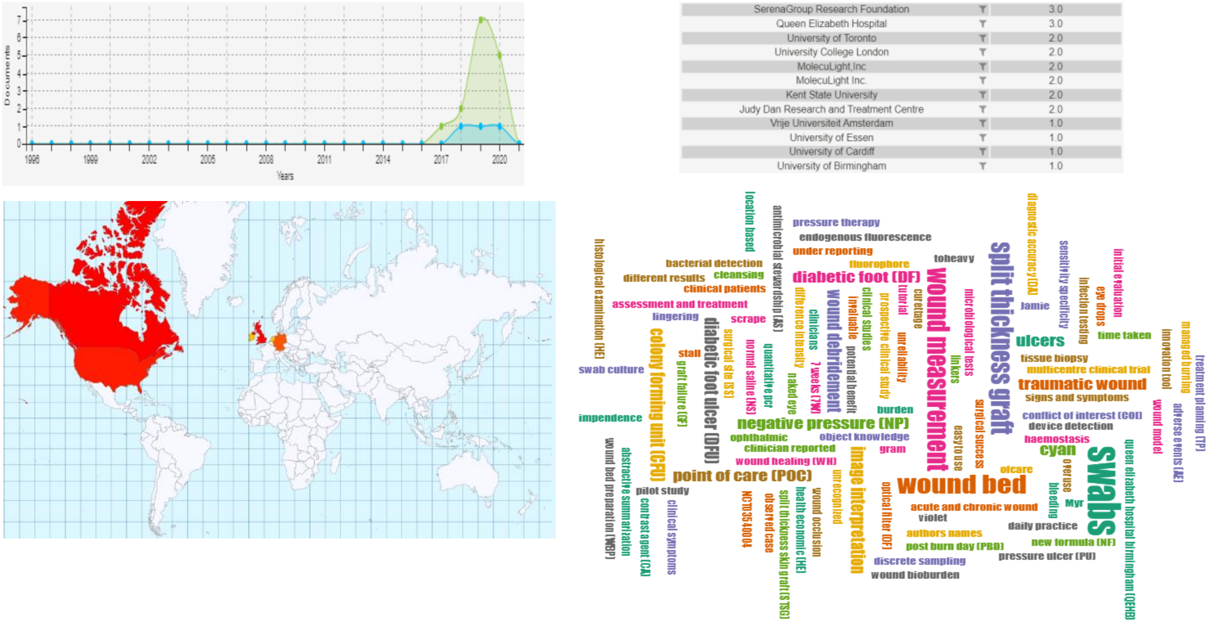
Universitat de Barcelona	7.0
University of Ljubljana	3.0
Center for Disease Analysis	3.0
Utrecht University	2.0
Université Catholique de Louvain	2.0
University School of Medicine	2.0
University of New South Wales (UNSW)	2.0
University Medical Centre Ljubljana	2.0
University Hospitals	2.0
McGill University	2.0
Imperial College	2.0
Humanitas Hospital	2.0
Hospital Universitario Virgen del Rocío	2.0
Hospital Universitario San Cecilio	2.0
Hospital Universitario Marqués de Valdecilla	2.0
Hospital Universitario Fundación Alcorcón	2.0
Hospital Universitario	2.0
Diakonessen Hospital	2.0
CNRS	2.0



Moleculight

is a weak signal related to the testing of an innovative device used to visualise the bacterial load in a wound, potentially reducing infection risks.

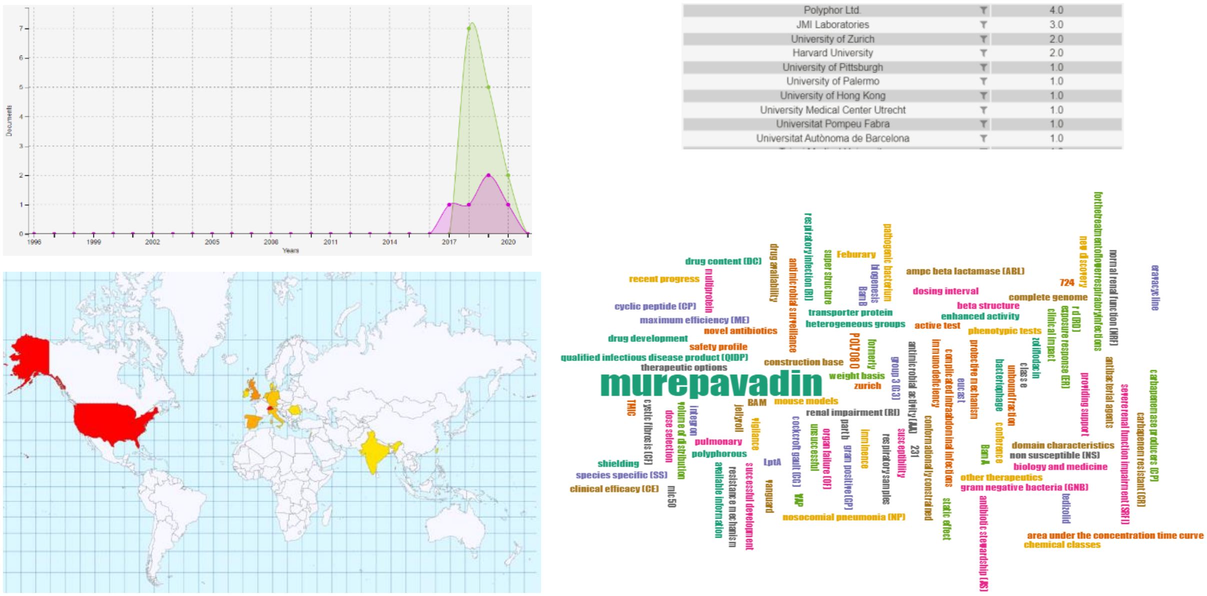
Figure 61: Visualisations for Moleculight



Murepavadin

is a novel antibiotic under development for the treatment of infectious diseases related to Gram-negative bacteria.

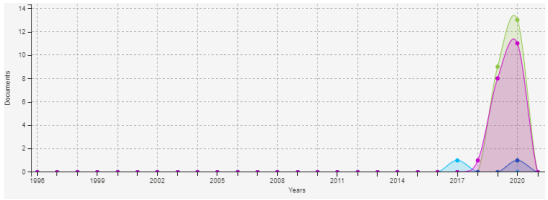
Figure 62: Visualisations for Murepavadin



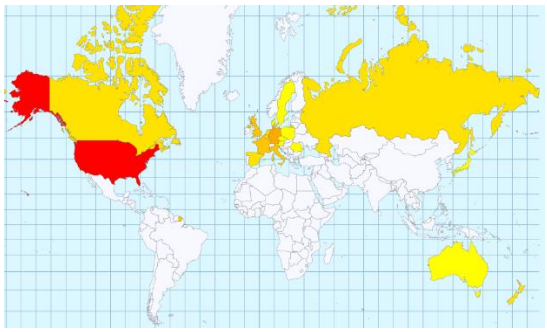
Onasemnogene abeparvovec

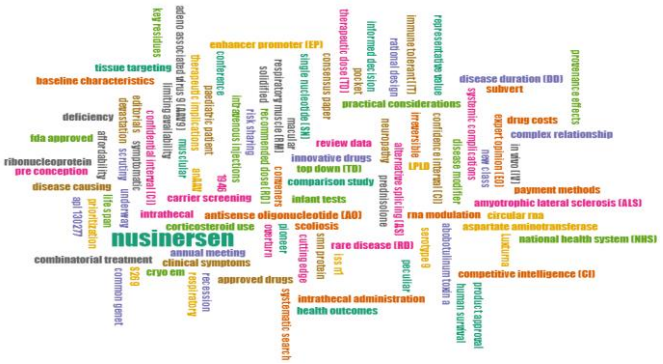
are novel gene-based therapies to treat the orphan disease Spinal Muscular Atrophy.

Figure 63: Visualisations for Hexafluoropropylene oxides contamination



Nationwide Children's Hospital	7.0
Ohio State University Wexner Medical Center	4.0
Ohio State University	4.0
AveXis, Inc.	3.0
Universitätsklinikum Heidelberg	2.0
University of Oxford	2.0
University of Massachusetts Medical School	2.0
Sorbonne University	2.0

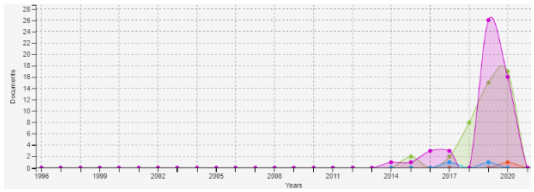




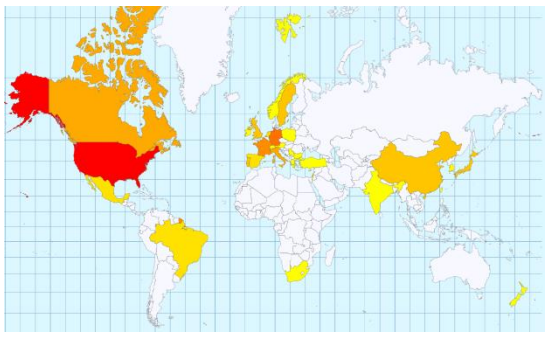
Patisiran

is a new RNAi therapeutic for the treatment of polyneuropathy caused by the hereditary rare disease transthyretin-mediated amyloidosis.

Figure 64: Visualisations for Patirisan



ALNYLAM PHARMACEUTICALS INC	14
Mayo Clinic	10
University of British Columbia	6
Universitätsklinikum Münster	5
University of Heidelberg	5
University College London	5
Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán	5
University Medical Center Utrecht	4
Universidade de Lisboa	4
Umeå University	4
School of Life Science	4
Hospital Universitário Clementino Fraga Filho	4
Harvard University	4
Columbia University	4
CNRS	4
Chinese Academy of Sciences	4
Centro Hospitalar do Porto	4
Boston Medical Center	4
University of Pavia	3
University Hospital Münster	3



Weak signals related to SARS-coV-2

A significant number of weak signals related to SARS-coV-2 was expected. 106 signals have been found, each containing at least 50% of articles directly mentioning SARS-coV-2 and all with an activeness (2019-2020) above 70%. These weak signals account together for more than 35k scientific publications and are listed here below. They were not analysed further and are not included in the online dashboard.

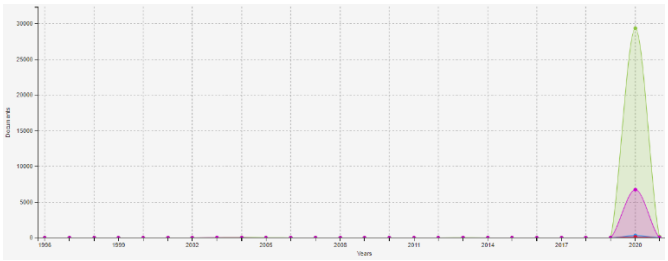
Figure 65: Visualisations for weak signals related to SARS-coV-2

2019 novel corona virus	cytokine storm syndrome (CSS)	lianhua qingwen	post covid 19
3cl hydrolase	D614G	LitCovid	post viral olfactory dysfunction
6LU7	diamond princess	lock down	protective personal equipment (PPE)
ace2 receptor	digital contact tracing	lockdown measures	proximity traces
biorxiv	EarlyR	major public health emergencies	qingfei paidu decoction (QPD)
BLINDING	emergency remote teaching (ERT)	MASKING	RaTG13
chilblain like lesions	enhanced community quarantine (ECQ)	medRxiv	remdesivir
columbia university irving medical center (CUIMC)	epidemic prevention and control	mild covid 19	Sarbecovirus
community quarantine	fangcang shelter hospital	MoHFW	SARSr
corona pandemic	fear of covid 19	movement control order (MCO)	seiar model
coronaphobia	flatten the curve	multisystem inflammatory syndrome	seird model
coronavirus 2	galidesivir	national health commission (NHC)	SIRD model
coronavirus crisis	GC376	national lockdown	self quarantine
coronavirus disease	george floyd	navirus	sentinel 5p
coronavirus epidemics	GISAID	neurocovid	SEORL
coronavirus outbreak	gs 441524	non covid	severe covid 19
coronavirus pandemic	gs 5734	non placement work integrated learning	SFJDC
coronavirus pneumonia	Guanggu	openwho	social lockdown
coronavirus sars cov 2	home quarantine	ORF1ab	state of alarm
CoV2	homemade mask	Orthocoronavirinae	TriNetX
covid	Huoshenshan	pandemic containment	umifenovir
covid 2019	id now	pandemic crisis	videoconferencing psychotherapy
covid19 pandemic	infection fatality rate (IFR)	pandemic times	wastewater surveillance
covid toes	infodemics	panther fusion	Worldometer
CR3022	Jinyintan	par agerfalk	wuhan coronavirus
crises sanitaires	kieran conboy	pediatric covid 19	wuhan pneumonia
cytokine release storm (CRS)	Leishenshan		

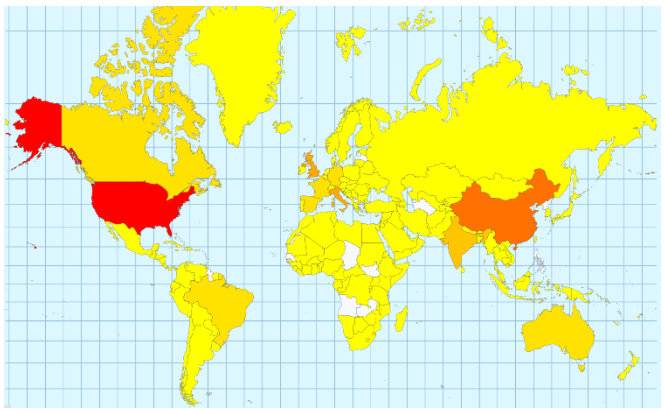
List of weak signals related to SARS-coV-2 (with at least 50% of articles mentioning covid19 and with activeness2019-2020>70%)

Huazhong University of Science and Technology	398
Harvard University	311
University of California	258
CNRS	230
University Hospital	209
University of Hong Kong	187
Chinese Academy Of Sciences	187
People's Hospital	168
University of Oxford	157
University of Toronto	149
All India Institute of Medical Sciences	149
Fudan University	140
Tehran University of Medical Sciences	136
Capital Medical University	134
Zhongnan Hospital of Wuhan University	115
Wuhan University	115
University College London	113
Cornell University	113
GENERAL HOSPITAL CORP	108
Columbia University	104
University of Washington	103
China University of Geosciences	103
University of Michigan	101
National University of Singapore	101
Imperial College London	100
Icahn School of Medicine at Mount Sinai	99
Chinese University of Hong Kong	99
University of Paris	98
Medical Center	98
Central South University	98
Sichuan University	97
University of Pennsylvania	95
Renmin Hospital of Wuhan University	95
School of Medicine	94
University of São Paulo	93
Sapienza University of Rome	92
King's College London	90
National Institutes of Health	88
University of Melbourne	84
Zhejiang University	83
University of Rome II Tor Vergata	83
University of British Columbia	83
Sun Yat-Sen University	80
Monash University	80
Mayo Clinic	79
Shahid Beheshti University of Medical Sciences	78
King Saud University	77
Iran University of Medical Sciences	63
Shiraz University of Medical Sciences	60

Top 50 organisations



Document distribution



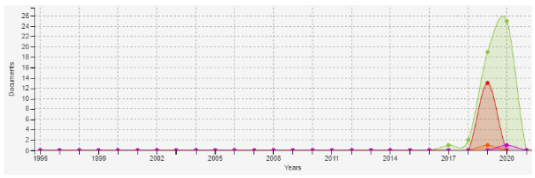
Country of origin of organisations publishing on SARS-coV-2

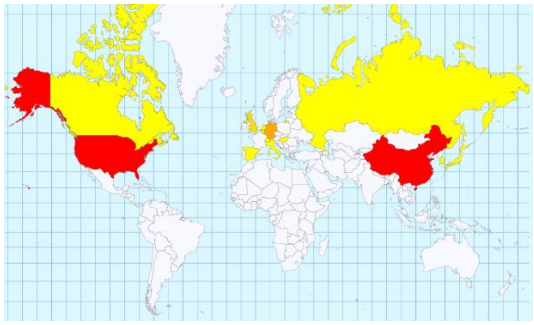
2.6 Biotechnologies

Cas12a orthologs

The Cas12a endonuclease (previously Cpf1) offers several advantages over Cas9, the other endonuclease used in the CRISPR-Cas technique. This makes Cas12a promising for many genome engineering applications. New Cas12a orthologs are being tested to further expand the possibilities of the Cas12a genome editing toolbox.

Figure 66: Visualisations for Cas12a orthologs



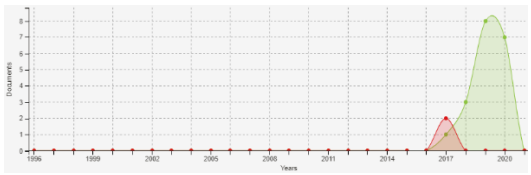


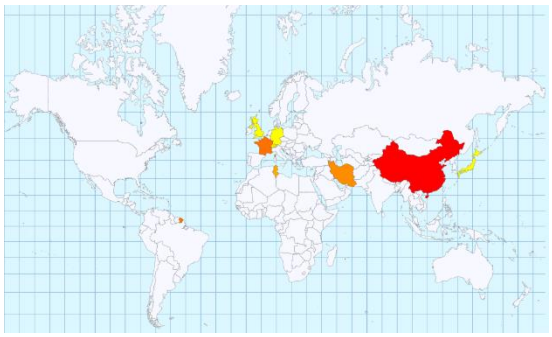
National Engineering Laboratory for Textile Fiber Materials and Processing T...	12
Chinese Academy of Sciences	8
Harvard University	6
Massachusetts General Hospital	4
Karlsruhe Institute of Technology	4
Iowa State University	4
University of Florida	3
University of California	3
MIT-Harvard	3
Huazhong Agricultural University	3
University of Science and Technology of China	2
University of Science and Technology	2
University of Massachusetts Medical School	2
University of Maryland	2
University of Iowa	2
Ohio State University	2
Massachusetts Institute of Technology	2
Lawrence Berkeley National Laboratory	2
Korea University	2
Integrated DNA Technologies, Inc.	2

Cfap43 cfap44 in male infertility

Genetic mutations on Cfap43 and Cfap44 genes have been found to be responsible for many cases of male infertility. The pathogenic mechanisms remain unclear and are being investigated.

Figure 67: Visualisations for cfap43 and cfap44 in male infertility



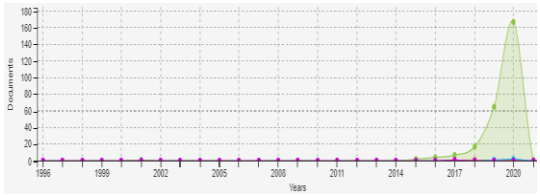


Université Paris Descartes	6.0
CNRS	6.0
Institut Cochin	5.0
Yantai Yuhuangding Hospital	4.0
University of Malaya	3.0
Royan Institute for Reproductive Biomedicine	3.0
Neuroscience Institute	3.0
Fudan University	3.0
First Affiliated Hospital of Anhui Medical University	3.0
Chinese Academy of Sciences	3.0
Centre Urbain Nord	3.0
University of Geneva Medical School	2.0
University of Bordeaux	2.0
Technology Research Center	2.0
Shanxi Agricultural University	2.0
Shanghai Jiao Tong University School of Medicine	2.0
Shanghai Jiao Tong University	2.0
Medical College of Shandong University	2.0
INSTITUT POLYTECHNIQUE DE BORDEAUX	2.0
Centre Hospitalier Universitaire de Grenoble	2.0

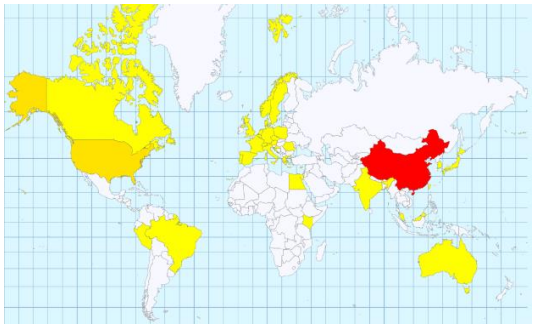
Cibersort

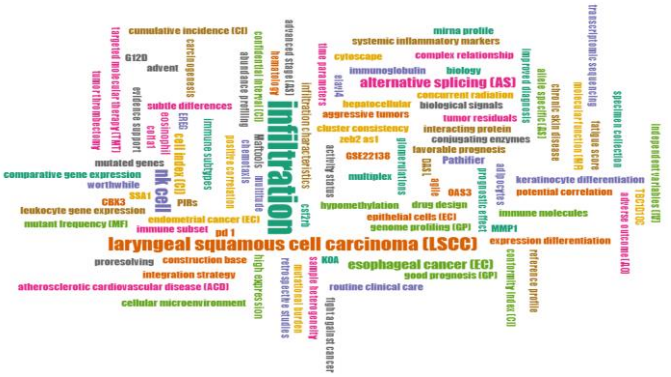
combines genetic with computational methods to characterize with a high precision the cell composition of complex tissues from their gene expression profile. It is more and more used to determine the composition of tumors to adapt therapies and predict therapeutic effects.

Figure 68: Visualisations for cibersort



Chinese Academy of Sciences	14
Fudan University	11
China Medical University	10
Shanghai Jiao Tong University School of Medicine	9
Sun Yat-Sen University	8
Shanghai Jiao Tong University	8
Comprehensive Cancer Center	8
Zhejiang University	7
Yokohama City University	7
Tokyo Medical University	7
Niigata University Graduate School of Medical and Dental Sciences	7
First Affiliated Hospital of Zhengzhou University	7
Central South University	7
Huazhong University of Science and Technology	6
Fudan University Shanghai Cancer Center	6
First Affiliated Hospital of Nanjing Medical University	6
Zhongnan Hospital of Wuhan University	5
Wenzhou Medical University	5
Tongji University School of Medicine	5
Stanford University	5

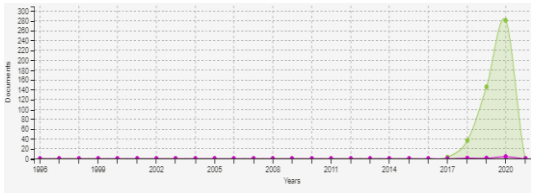




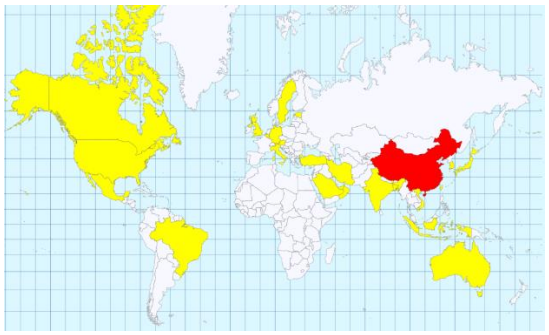
GEPIA

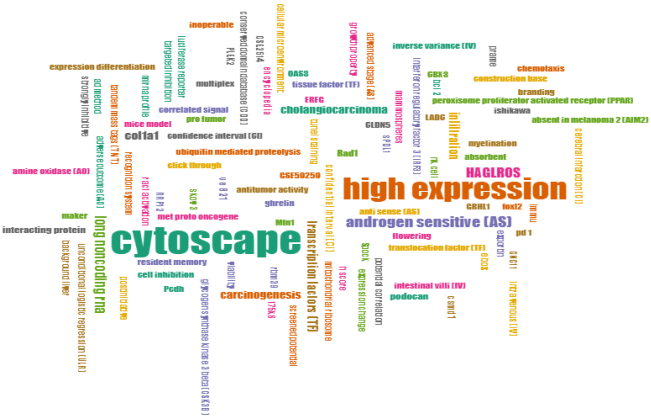
Stands for Gene Expression Profiling Inter Analysis, an interactive online tool for cancer prognosis analysis based on gene expression. Prognostic biomarkers help to predict the chance of survival of patients with cancer, are used to adjust the treatments, to elucidate tumorigenesis mechanisms, and to identify therapy targets.

Figure 69: Visualisations for GEPIA



Chinese Academy of Sciences	24
People's Hospital	23
Central South University	20
Huazhong University of Science and Technology	19
Zhongnan Hospital of Wuhan University	14
Zhejiang University	13
First Affiliated Hospital	13
Fudan University	11
Zhengzhou University	9
Nanjing University of Chinese Medicine	9
First People's Hospital	9
First Affiliated Hospital of Xi'an Jiaotong University	9
First Affiliated Hospital of Guangxi Medical University	9
Central Hospital (China)	9
Capital Medical University	9
Sun Yat-Sen University	8
Hospital of Nanjing Medical University	8
Renmin Hospital of Wuhan University	7
Nanjing Medical University	7
First Affiliated Hospital of Soochow University	7

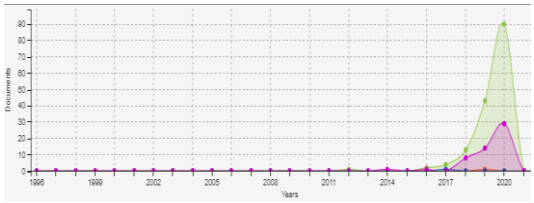


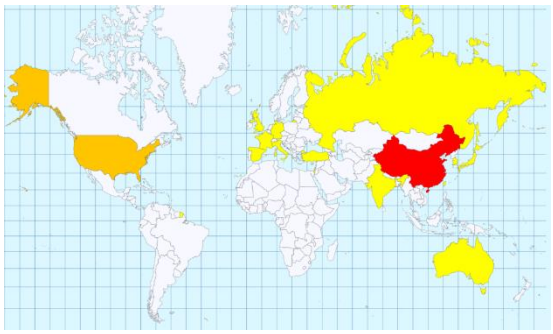


M6A RNA methylation modulators and cancer

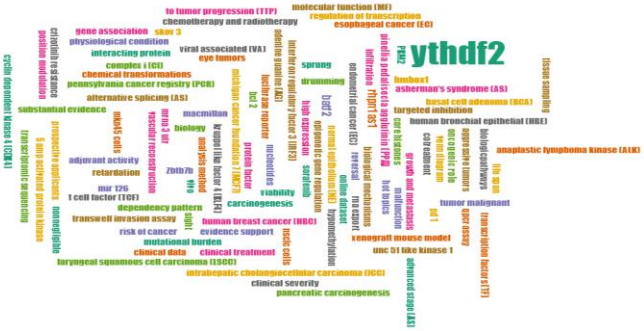
Modifications of the RNA N6-methyladenosine (m6A) have recently been discovered to have a crucial role in the progression of cancer. Aberrant modifications contribute to tumorigenesis and metastasis. It has also been reported to have an impact on the resistance of malignant tumors to chemotherapy and radiotherapy.

Figure 70: Visualisations for M6A RNA methylation modulators and cancer





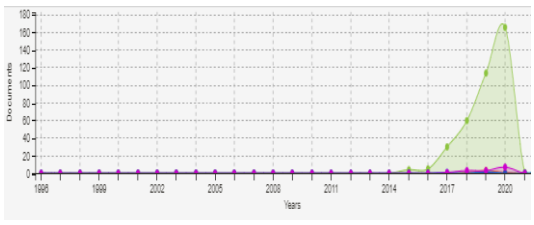
Chinese Academy of Sciences	31
Sun Yat-Sen University	17
Zhejiang University	14
Nanjing Medical University	12
Shanghai Jiao Tong University	10
First Affiliated Hospital of Zhengzhou University	9
Central South University	9
People's Hospital	8
First Affiliated Hospital of Nanjing Medical University	8
Shanghai Jiao Tong University School of Medicine	7
Harvard University	7
Hospital of Nanjing Medical University	6
First Affiliated Hospital of Sun Yat-Sen University	6
University of Chicago	5
Guangzhou Medical University	5
Beckman Research Institute of the City of Hope	5
Tianjin Medical University	4
Southern Medical University	4
Shandong University	4
Nankai University	4

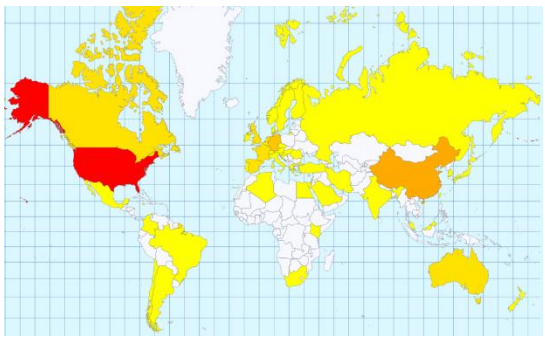


Metagenome-Assembled Genome

is an approach that facilitates the sequencing of whole genomes from environmental samples (instead of using pure cultures); several genomes from a sample are assembled to generate the metagenome-assembled genome. This method is mainly used on phylogenetic analysis of microbial populations. However, recent research investigates its potential use in public-health microbiology for surveillance of virulence factor and antimicrobial resistance genes.

Figure 71: Visualisations for metagenome-assembled genome



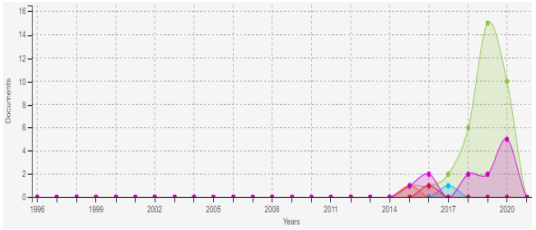


University of California	52
Chinese Academy of Sciences	34
Lawrence Berkeley National Laboratory	19
University of Queensland	18
Max Planck Institute for Marine Microbiology	17
CNRS	17
University of Southern California	15
University of Vienna	14
University of Hong Kong	13
Georgia Institute of Technology	13
Universidad Miguel Hernández	12
Uppsala University	11
University of Wisconsin-Madison	11
University of Tennessee	11
Shenzhen University	11
Ohio State University	10
DOE Joint Genome Institute	10
University of Calgary	9
University of British Columbia	9
Harvard University	9

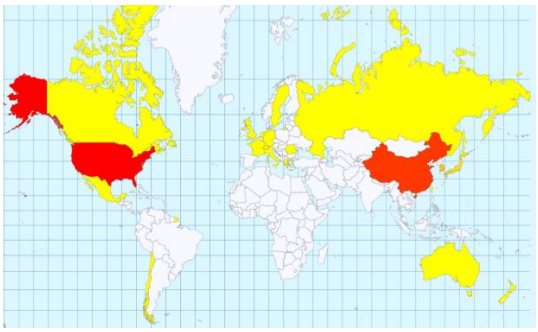
MOTS-c

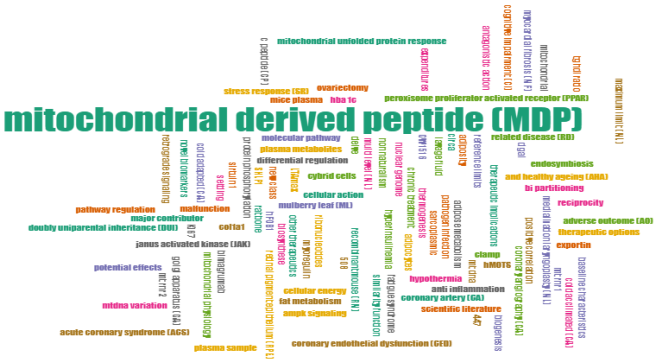
Mitochondrial-derived peptides are a novel class of bioactive microproteins that modify cell metabolism. Among them, MOTS-C is being studied for its potential use in Alzheimer's disease, prostate cancer, macular degeneration, cardiovascular disease, diabetes, obesity, and others.

Figure 72: Visualisations for metagenome-assembled genome



University of Southern California	13
Fourth Military Medical University	5
Ajou University	5
USC/Norris Comprehensive Cancer Center	4
Juntendo University	4
Chinese Academy of Sciences	4
Xi'an Medical University	3
University of Auckland	2
Shaanxi Provincial People's Hospital	2
North Sichuan Medical College	2
Japan Society for the Promotion of Science	2
German Sport University Cologne	2
European Monitoring Center for Emerging Doping Agents	2
China Pharmaceutical University	2

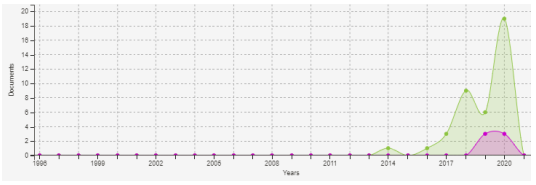




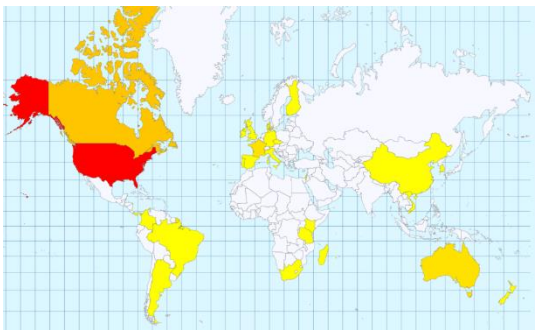
Phylosymbiosis

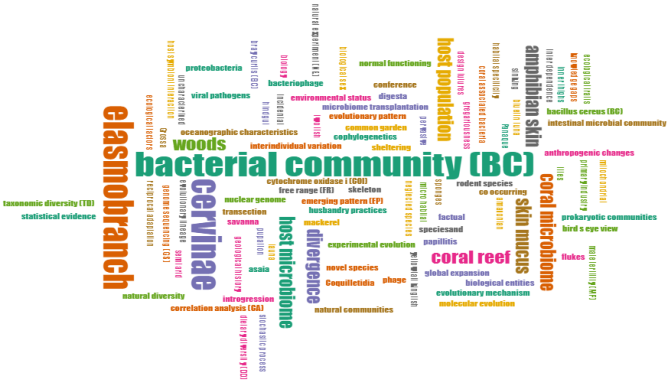
Microbiome of plants and animals often show a degree of correlation with the phylogeny of the host, an eco-evolutionary pattern known as phylosymbiosis. Given that phylosymbiosis has been shown to relate to functional components of host fitness, researching the processes that contribute to these patterns will be important for better understanding the ecology and evolution of host-microbe interactions.

Figure 73: Visualisations for phylosymbiosis



Vanderbilt University	7.0
University of California	7.0
Harvard University	5.0
University of Copenhagen	4.0
University of British Columbia	4.0
University of Queensland	3.0
University of Pittsburgh	3.0
University of Montpellier	3.0
University of Colorado at Boulder	3.0
Smithsonian Institution	3.0
James Cook University	3.0
Chinese Academy of Sciences	3.0
Australian Institute of Marine Science	3.0
Vanderbilt University Medical Center	2.0
University of Waterloo	2.0
University of Utah	2.0
University of Texas at Austin	2.0
University of Minnesota	2.0
University of Guelph	2.0
University of Georgia	2.0

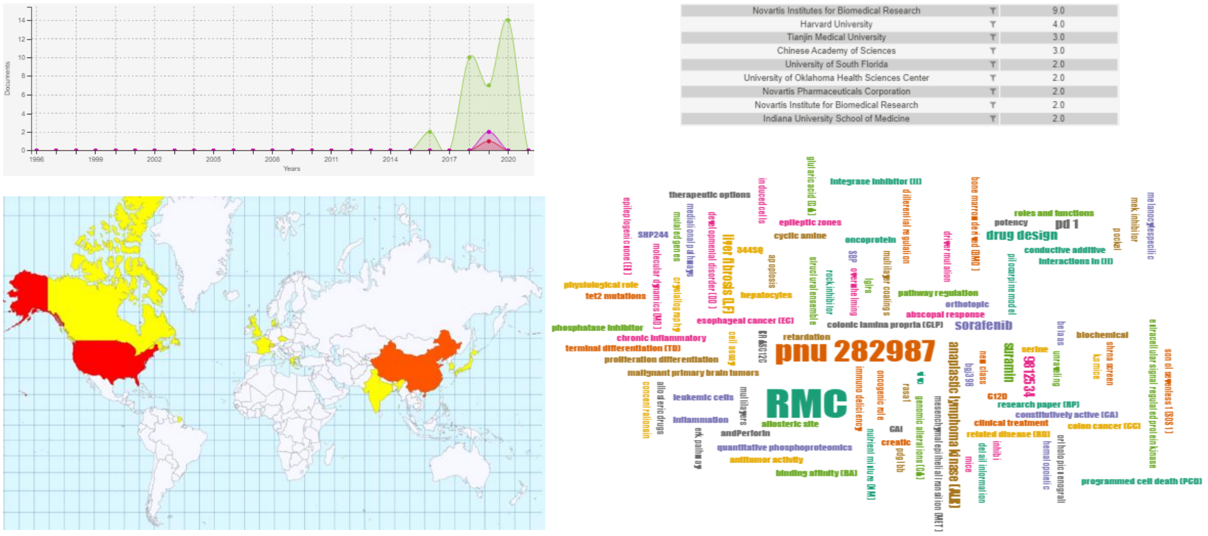




Shp2 inhibitors for cancer

Src homology 2 domain-containing phosphatase 2 (SHP2), and its inhibitor SHP099, are being investigated for their potential as therapeutic target for human cancers and other human diseases.

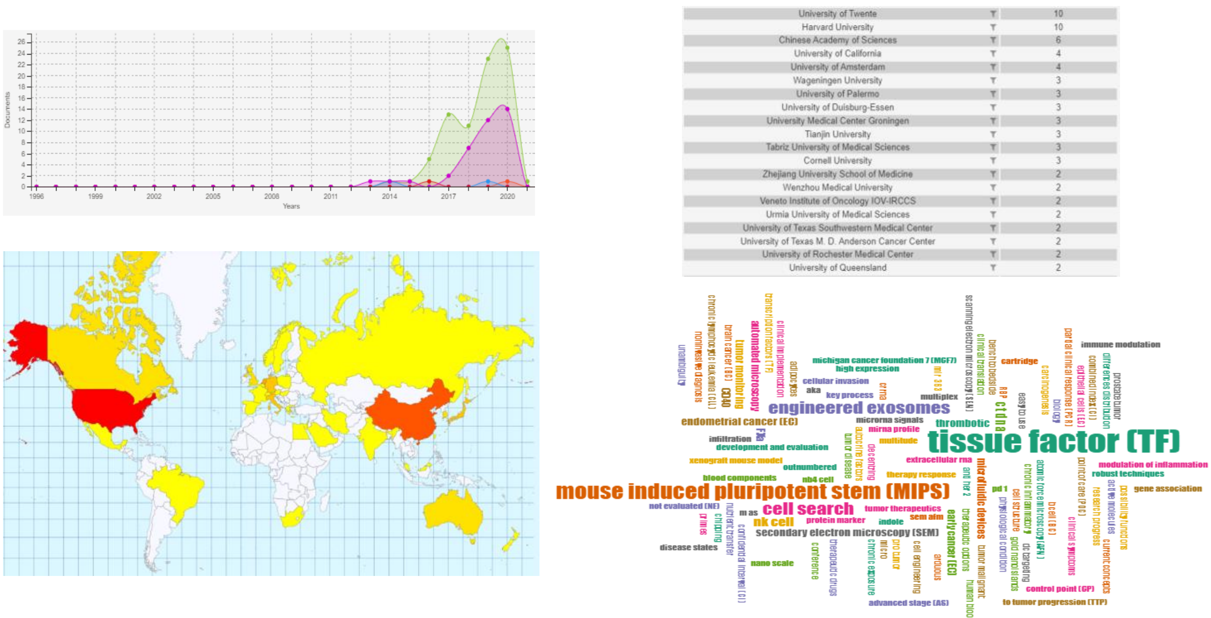
Figure 74: Visualisations for Shp2 inhibitors for cancer



Tumour-derived extracellular vesicle

are important signals in tumor-host cell communication and have a role in preparing tumor-free organs to become hosts for new tumors by transferring biologically active molecules that facilitate the malignant growth, metastatic process, and resistance to chemotherapy.

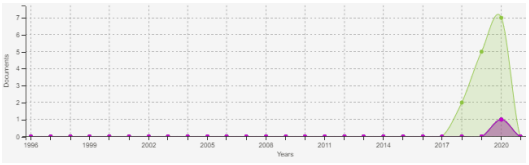
Figure 75: Visualisations for tumor-derived extracellular vesicle



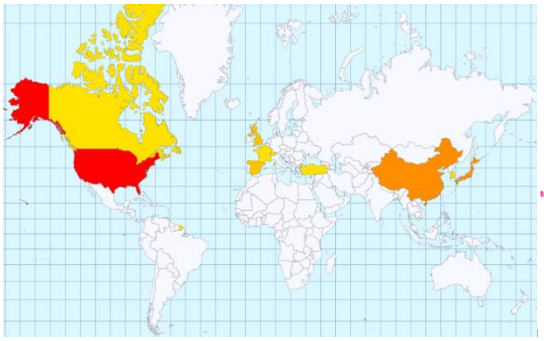
TurboID proximity labeling

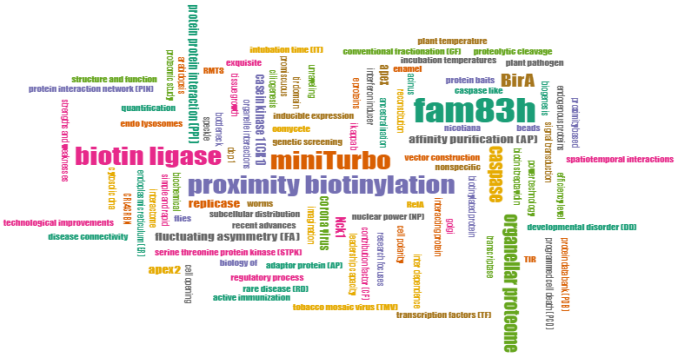
Proximity labelling techniques are used to define specific protein interactions and to identify spatially or temporally restricted local proteomes, which helps to better grasp cellular processes. Two recently developed highly active biotin ligase variants (TurboID and miniTurbo) allow to overcome some limitations of traditional labelling techniques like cell toxicity, long incubation time and high incubation temperature.

Figure 76: Visualisations for metagenome-assembled genome



Stanford University	T	5.0
Massachusetts Institute of Technology	T	5.0
Chan Zuckerberg Biohub	T	5.0
University of California	T	2.0
Tokushima University	T	2.0
MIT-Harvard	T	2.0
Howard Hughes Medical Institute	T	2.0
Chinese Academy of Sciences	T	2.0



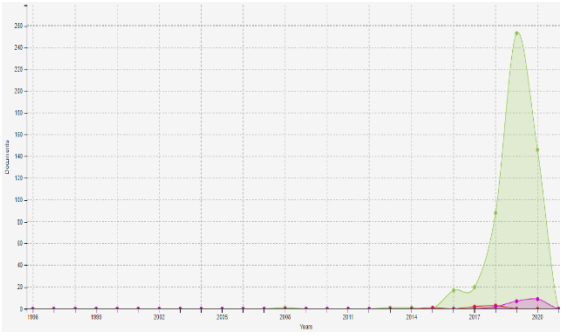


Weak signals related to RNA

Circular RNA and long non coding RNA are subject to intense research in the recent years for their possible role in ageing, cancers and other diseases. Investigations on circRNA and lncRNA are blooming in many medical fields, as can be seen in the list of the most recently pervaded journal categories.

Figure 76: Visualisations for weak signals related to RNA
(distribution of documents and wordcloud for all WS on RNA)

awpph	topic:awpph
cdr1as	topic:(cdr1as AND ("circular RNA" OR circRNA))
circRNA back splicing	topic:(circRNA AND "back splicing")
circrna mirna mrna network	topic:("circRNA miRNA mRNA network"~2)
foxd2 as1	topic:"foxd2 as1"
haglros	topic:haglros
hand2 as1	topic:"hand2 as1"
linc00460	topic:linc00460
Magi2 as3	topic:("Magi2 as3" AND (cancer OR tumor))
pcat6	topic:pcat6
sbf2 as1	topic:"sbf2 as1"
snhg14	topic:snhg14
snhg16	topic:snhg16
snhg5	topic:snhg5
snhg7	topic:snhg7



Rheumatology	100
Pharmacology, Toxicology and Pharmaceutics	100
Hepatology	100
Clinical Neurology	100
Biochemistry, medical	100
Clinical Biochemistry	98
Pathology and Forensic Medicine	95
Biomedical Engineering	90
Pulmonary and Respiratory Medicine	90
Pharmaceutical Science	90
Medicine (miscellaneous)	90
Endocrinology, Diabetes and Metabolism	88
Genetics(clinical)	88
Molecular Medicine	87
Ageing	87
Physiology (medical)	85
Neuroscience	84
Structural Biology	83
Obstetrics and Gynaecology	83
Histology	83
Drug Discovery	83
Applied Mathematics	83
Immunology and Microbiology	81
Modelling and Simulation	80
Epidemiology	80

Endocrinology	80
Pharmacology (medical)	79
Biotechnology	78
Cell Biology	78
Gastroenterology	77
Cardiology and Cardiovascular Medicine	77
Computational Mathematics	76
Pharmacology	76
Medicine	76
Genetics	75
Cancer Research	75
Statistics and Probability	75
Developmental Biology	75
Physiology	73
Biochemistry	73
Oncology	73
Hematology	72
Organic Chemistry	72
Agricultural and Biological Sciences	72
Radiology Nuclear Medicine and imaging	71
Physical and Theoretical Chemistry	70
Computer Science Applications	69
Spectroscopy	68
Inorganic Chemistry	68
Catalysis	68

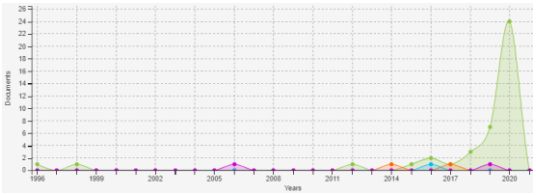
Journal categories recently pervaded by lncRNA and circRNA
(Score is activeness 2019-2020 i.e. the % of articles published in 2019-2020 for this journal category)

2.7 Social sciences

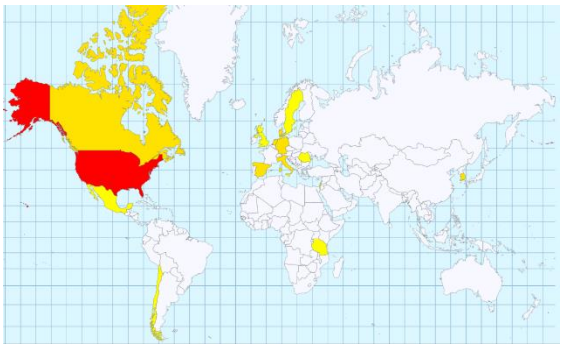
Behavioral public administration

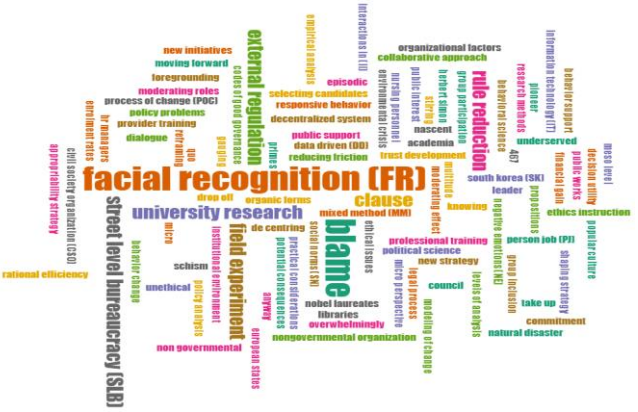
is a new concept that combines behavioral science with theories of public administration. Proponents of the behavioral public administration call for using theories from psychology and experimental research designs to improve the rigor of public administration research.

Figure 77: Visualisations for behavioral public administration



Bocconi University	4.0
University of Copenhagen	3.0
Arizona State University	3.0
École Nationale d'Administration Publique	2.0
University of Wisconsin-Madison	2.0
University of New Hampshire	2.0
University of Mannheim	2.0
University of Hamburg	2.0
University of California	2.0
Sungkyunkwan University	2.0
Scuola Superiore Sant'Anna	2.0
Sant'Anna School of Advanced Studies	2.0
Rutgers University-Newark	2.0
Aarhus University	2.0

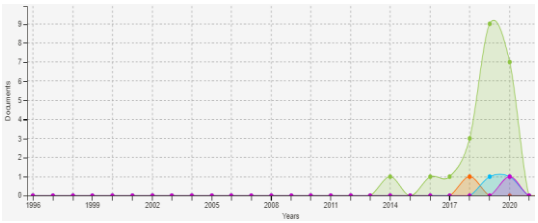




Digital vigilantism

is an emerging practice where citizens are using modern IT technologies for societal vigilantism i.e. a parallel criminal justice with no moral or legal legitimacy.

Figure 78: Visualisations for digital vigilantism

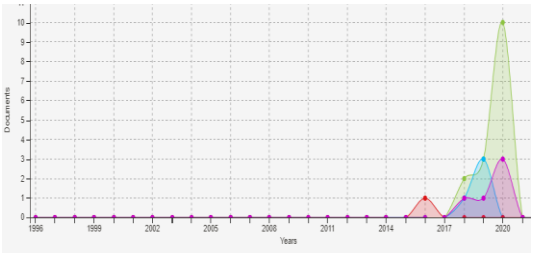


Erasmus University	9.0
CNRS	2.0
Vilnius University	1.0
Université Laval	1.0
Université de Montréal	1.0
University of Wisconsin	1.0
University of Waterloo	1.0
University of Toyama	1.0
University of Toulouse	1.0
University of Tasmania	1.0
University of Michigan	1.0
University of Kentucky	1.0
University of Colorado	1.0
Temple University	1.0
Telecom Paris	1.0

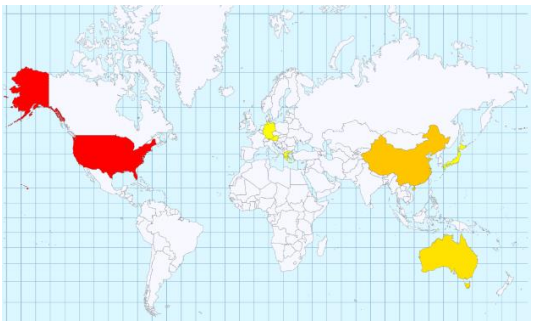
Geospatial AI

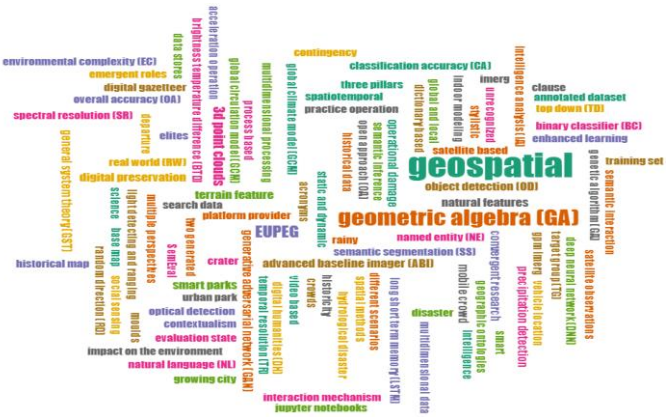
is what happens when geospatial computing and analysis meets big data and artificial intelligence. New AI techniques are being developed for geospatial data management, processing, analysis, modeling, and visualization.

Figure 79: Visualisations for geospatial AI



George Mason University	5.0
Arizona State University	5.0
Pennsylvania State University	3.0
Harvard University	3.0
University of Wisconsin-Madison	2.0
University of Southern California	2.0
University of South Carolina	2.0
NASA Center for Climate Simulation	2.0
Nanjing Normal University	2.0

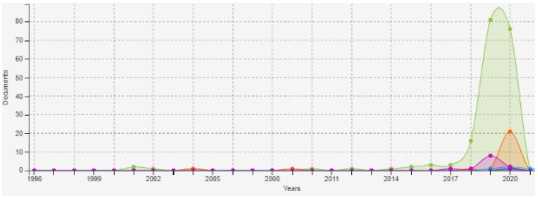


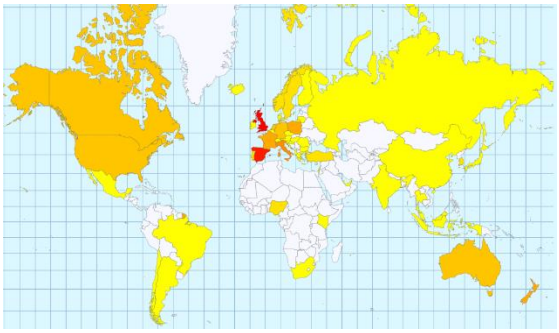


Tourism phobia

Touristic pressure on local populations has received much attention recently in the media as tensions related to social, economic or environmental change have grown in many destinations. In reaction, anti-tourism movements are now more organised, vocal, and active at a political level.

Figure 80: Visualisations for tourism phobia





University of Winchester	14
University of Canterbury	6
University of Applied Sciences	6
Universidad de Alicante	6
Universidad de Alcalá	5
Lund University	5
University of Physical Education	4
University of Johannesburg	4
University of Aveiro	4
University of Africa	4
Universidad Complutense de Madrid	4
Silesian University of Technology	4
Western Norway Research Institute	3
University School of Physical Education	3
University of Wollongong	3
University of Waterloo	3
University of Strathclyde	3
University of Naples Parthenope	3
University of Lleida	3
University of Iceland	3

3 Methodology

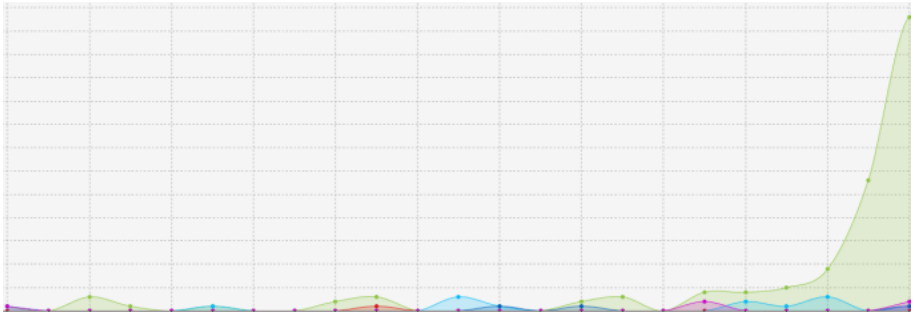
3.1 Building datasets

A dictionary of multi-word concepts is generated from a corpus of documents using text mining techniques. To capture the recent vocabulary used in scientific publications, documents from the last five years (2016-2020) of the Scopus database are used as corpus (~2.5 million scientific publications). Single words, multi-word terms and acronyms are extracted from the title, abstract or author keywords of the publications. The TF*IDF[5] method is then used to select the most relevant keywords, and stemming is applied to group words with similar basic meaning. The resulting dictionary is composed of more than four million relevant concepts, each of them subsequently used in an automated query process that builds an equivalent number of datasets. These contain the documents retrieved by the search from scientific publications dating from 1996 to 2020[6].

3.2 Detection of raw weak signals

A custom-built indicator called "activeness" is used to sort the datasets obtained by the text mining process. This indicator is defined as the ratio between the number of documents retrieved for a certain period and the total number of documents retrieved for the period 1996-2020. For example, activeness[2018-2020] corresponds to the ratio [#documents published during the period 2018-2020] / [#documents published during the period 1996-2020]. A high activeness score means that a higher percentage of documents have been published during the selected period. Several activeness indicators for different periods have been used to detect the weak signals in the Scopus database.

Figure 81: Typical shape of a weak signal on a graph #documents (Y-axis) Vs years (X-axis).



[5] Term frequency–inverse document frequency (TF-IDF) is a numerical statistic method that calculates how important a word is to a document in a collection or in a corpus.
[6] Detecting weak signals implies looking into the past to verify novelty.

3.3 Selection of relevant weak signals

Various filters are used to refine the list of raw weak signals, which inevitably also contains false positives. First, a simple filter is applied to reject datasets that do not reach a certain minimum number of documents. Then, a more elaborate filter relying on "semantic compactness"[7] is used to reject weak signals containing documents that are not similar from a semantic perspective. Weak signals pertaining to different conceptual areas but with one or two semantic concepts in common are not considered (e.g. documents related to a conference where the only common term between the documents is the name of said conference). Manual filtering is also used to reject datasets resulting from errors in the original corpus (e.g. spelling mistakes). Finally, custom-made indicators are used to further refine the list of weak signals. To complete the selection, the remaining weak signals are reconstructed in the TIM Technology system, which, in addition to scientific publications, also contains patents and EU R&D grants. The search queries are optimised to increase the recall of documents and to further validate the list of weak signals.

[7] The semantic compactness indicator allows evaluating the semantic proximity of a collection of documents. It relies on the cosine similarity matrix, calculated for the collection of documents. To build the matrix, a vector of relevant semantic concepts is built for each document; these vectors are then used to calculate the cosine similarity of each document to the others. The indicator then displays the compactness of the set of documents from a semantic perspective.

List of figures and tables

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