Strengthening
University-Industry
Partnerships

Modeling the Front End of the Innovation Cycle using Machine Learning and Data Analytics: An Emergency Approach

UIDPVirtual 2020

Daniel Calto, Elsevier

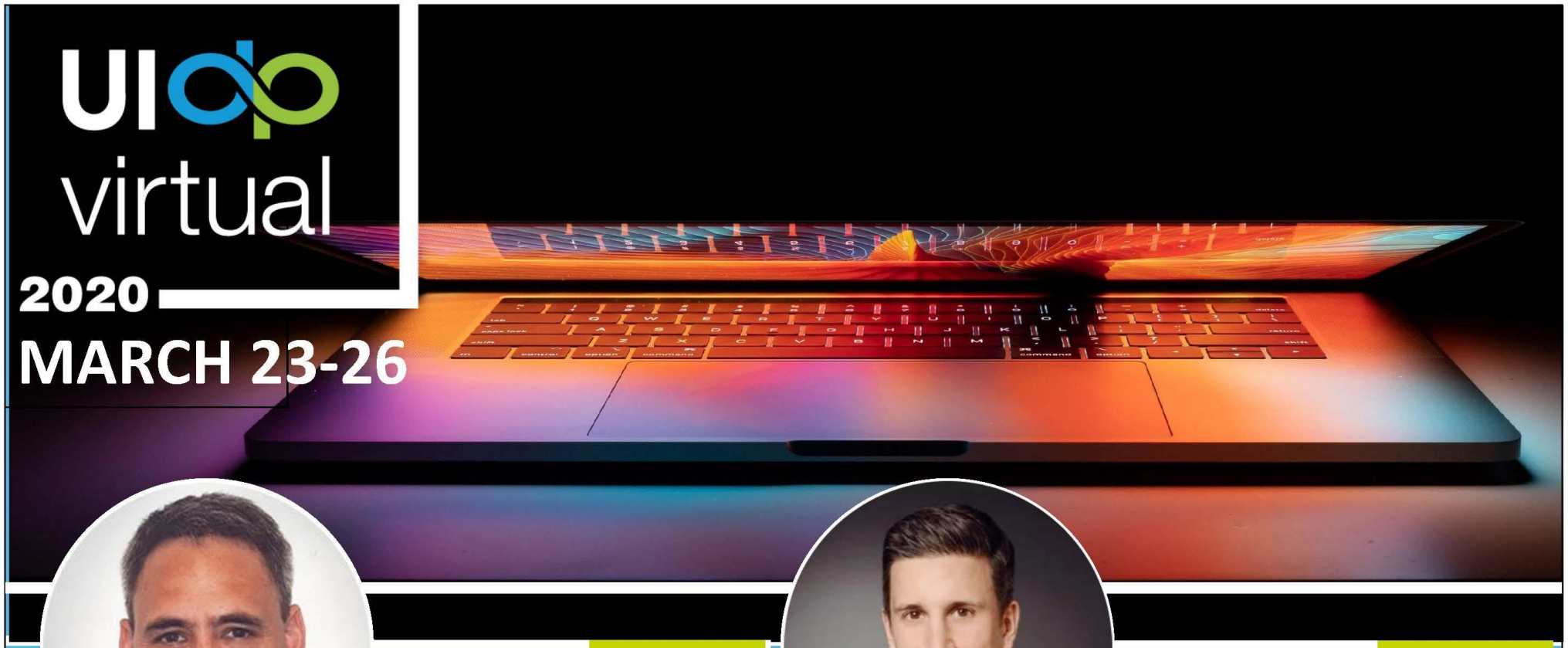
Sven Rueddigkeit, PatentSight/LexisNexis

March 24, 2020

UIDP virtual

2020

MARCH 23-26



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Elsevier

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PatentSight/LexisNexis

Modeling the Front End of the Innovation Cycle Using Machine Learning and Data Analytics

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ELSEVIER

Research Intelligence

Modeling the Front End of the Innovation Cycle using Machine Learning and Data Analytics: An Emergent Approach

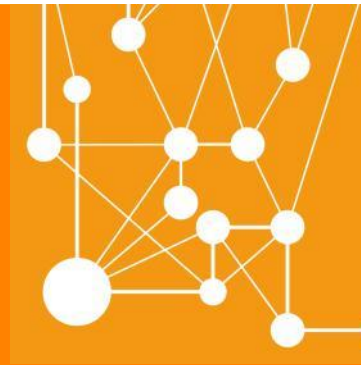
Daniel Calto
Director of Solution Services
Research Intelligence, Elsevier

Sven Ruddigkeit
Director of Business Development
PatentSight GMBH

UIDP Annual Conference
College Station, TX
23 March 2020

Empowering Knowledge

Data Sources, Tools, and Technologies



Scopus Coverage Summary (Feb. 2020)

World's largest Abstract and Citations Database

77.9M records from **24.0K** serials, **119K+** conferences and **217K** books from more than **5000** publishers and **105** countries

- Updated daily—approximately **10,000** articles per day indexed
- **9.19M** open access documents
- "Articles in Press" from **>8,075** titles
- **40** different languages covered
- **5,527** active Gold Open Access journals indexed

Number of Journals by subject area*

- **Physical Sciences** 7,441
- **Health Sciences** 7,133
- **Social Sciences** 8,698
- **Life Sciences** 4,601

JOURNALS

24,039** active peer-reviewed journals
294 trade journals
5,527 Gold OA Journals (DOAJ/ROAD)

- Full metadata, abstracts and cited references (refs post-1970 only)
- Funding data from acknowledgements
- Citations back to 1970

CONFERENCES

119K+ conference events
9.87M conference papers

Mainly Engineering and Computer Sciences

BOOKS

852 book series
218K stand-alone books
1.81M items

Focus on Social Sciences and A&H

PATENTS*

44.0M patents

From 5 major patent offices
- WIPO
- EPO
- USPTO
- JPO
- UK IPO

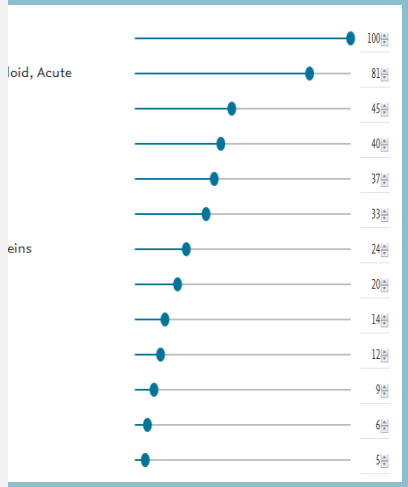
*Journals may be classified in multiple subject areas: this count includes current actively indexed titles only
**Total number of Scopus journals in database including inactive titles is 39,743

Natural Language Processing Applied to Text

From Natural Language to Structured Semantic Machine-Readable Text

Source Text → **Text processing pipeline** → **Semantic by Thesauri** → **Concepts Extraction** → **Fingerprint**

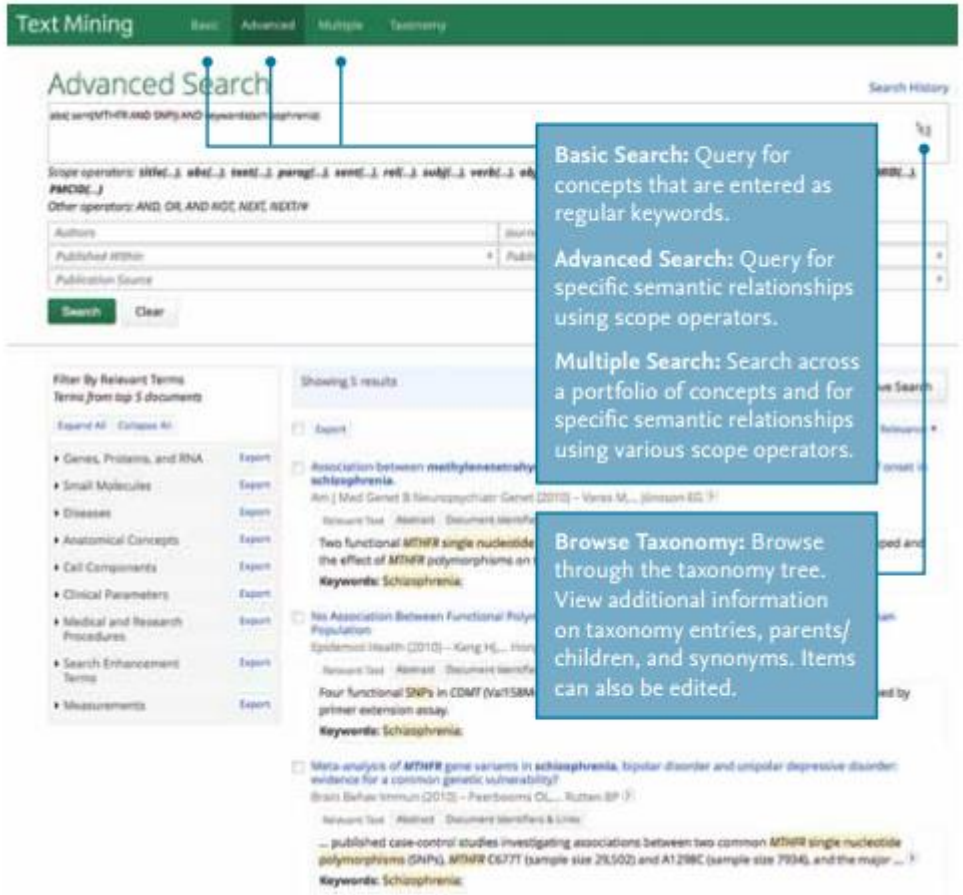
Domain	Thesaurus/Vocabulary
Life Sciences	MeSH thesaurus
Physics	NASA thesaurus
Agriculture	NAL thesaurus
Economics	STW thesaurus, Eco Humanities vocabulary
Social Sciences	Gesis thesaurus
Mathematics	Cambridge Math thesaurus, Math vocabulary
Geosciences	Geobase thesaurus
Engineering	Compendex thesaurus
Humanities	Humanities vocabulary
Compounds (Chemistry)	Compendex thesaurus, MeSH thesaurus



- Any text can be
  applications to
- Fingerprints are generated from the title and abstract
- Natural Language Processing techniques are applied

xt. Each concept is
s suitable for the
scientific area of the text.
- Concepts are weighted to create a precise summary of the text's meaning.

Text mining capabilities



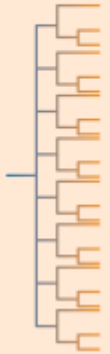
Input

Content (ca. 7 million items)

New content added weekly from public and commercial sources

- Abstracts
- Full-text articles
- Conference proceedings
- Grants
- Clinical Trials
- Patents
- Internal Data

Taxonomy



Keywords and data are extracted from the content, including

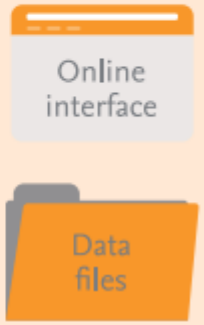
- Drug names
- Measurements
- Disease names
- Research methods
- Treatment methods

NLP Engine

Natural language queries find semantic relationships like:

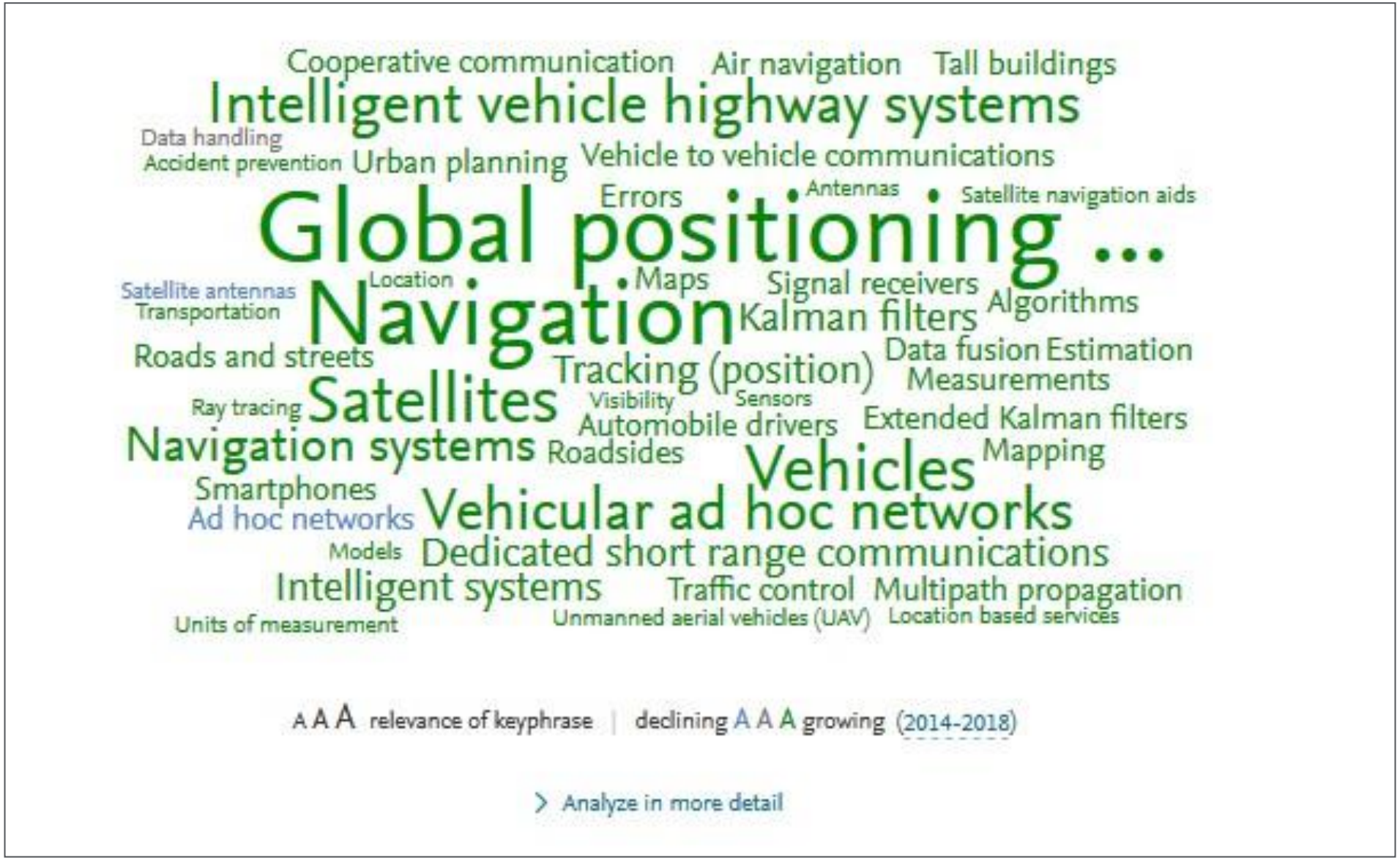
- "Drugs that reduce blood pressure"
- "Synthesis of Thalidomide"
- "Pathogenesis of cancer"
- "Resistance to linezolid"

Output



Output formats suit various user work flows

FPE in Action: SciVal



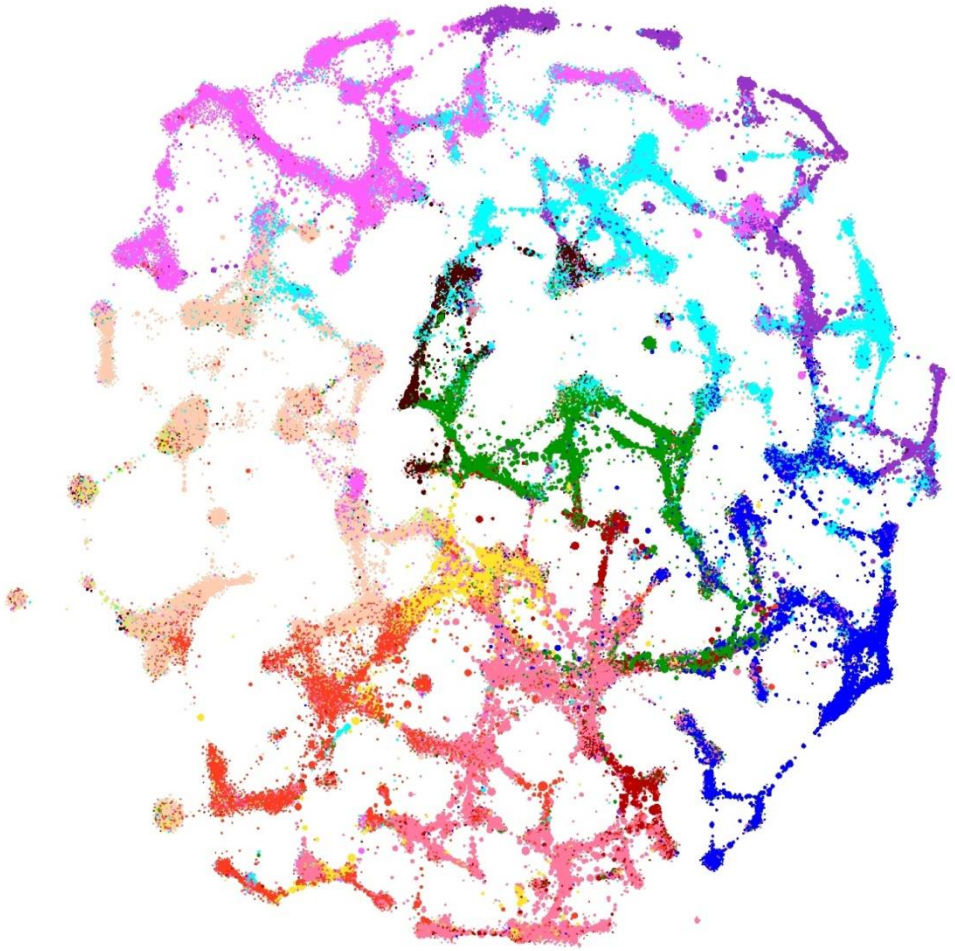
Topic Modelling and Analysis

History of Topic Modelling Using Abstracts/Citation Databases

- **Research Fronts (1985)** 2% coverage 10,000 clusters
- **Research Communities** 4% coverage 35,000 clusters
- **Distinctive Competencies** 15% coverage 200,000 clusters
- **Topics** 95% coverage 100,000 clusters
- **Topic Prominence (2017)** Predicts funding
  - Full coverage and accurately models supply of and demand for science

Example model and map

- Using 2013-10 datacut (source data 1996-2012)
- 582 million citing-cited pairs, 24.6 million source EID, 23.8 million cited non-indexed EID
- Calculated relatedness for 582 million pairs
- Ran SLM using resolution of 3×10^{-5}
- A few clusters with <50 items were merged with larger clusters
- Result – 97,726 clusters (topics)



Klavans, R. and K.W. Boyack, Research portfolio analysis and topic prominence. Journal of Informetrics, 2017 (under review).

Single topic characterization for 97,000 Topics

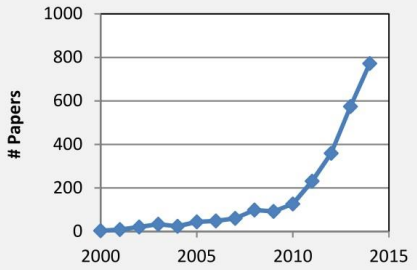
DC5 7909

FOM: 2.9852 (98.07%); CPP: 21.069

ENGNG; DC4:20; DC3:269; DC2:23; REG:105

TOP PHRASES (2011-2015)	score
1 anode material	20
2 anode materials	20
3 batteries LIBs	20
4 capacity retention	20
5 cycling stability	20
6 discharge capacity	20
7 electrochemical performances	20
8 electrode materials	20
9 electron microscopy	20
10 graphene oxide	20

IDIOSYNCRATIC PHRASES (2011-2015)	score
1 mA g⁻¹	60.97
2 batteries LIBs	40.07
3 superior electrochemical	30.01
4 lithium storage	22.27
5 anode materials	16.07
6 anode material	15.77
7 mAh g⁻¹	15.65
8 reversible capacity	15.13
9 metal oxides	13.96
10 conversion reaction	12.85



TOP CATEGORIES (2011-2015)	score
1 Nanoscience & Nanotechnology	0.98
2 Energy	0.78
3 Materials	0.27
4 General Chemistry	0.05
5 Unclassified	0.04
6 Physical Chemistry	0.03
7 Inorganic & Nuclear Chemistry	0.03
8 Organic Chemistry	0.01
9 Chemical Physics	0.01
10 Applied Physics	0.01

TOP SOURCES (2011-2015)	score
1 electrochim acta	2.96
2 j mater chem a	2.85
3 j power sources	1.78
4 nano energy	1.13
5 acs appl mater interfaces	0.78
6 rsc adv	0.59
7 nanoscale	0.45
8 j mater chem	0.43
9 mater lett	0.41
10 j alloys compd	0.26

TOP INSTITUTIONS (2011-2015)	count
1 Nanyang Technological University	130
2 University of Science and Technology of	108
3 Shandong University	115
4 XiangTan University	37
5 CAS - Changchun Institute of Applied Ch	40
6 China Three Gorges University	30
7 University of Wollongong	49
8 Anhui University of Technology	24
9 Zhejiang Normal University	26
10 CAS - Shanghai Institute of Ceramics	24

TOP AUTHORS (2011-2015)	score
1 Ni S. (China Three Gorges University)	29
2 Qian Y. (University of Science and Techn	44
3 Yang X. (China Three Gorges University)	29
4 Ma J. (China Three Gorges University)	14
5 Lv X. (China Three Gorges University)	14
6 Pereira N. (Rutgers University)	14
7 Amatucci G.G. (Rutgers University)	19
8 Xiong Q.Q. ()	16
9 Zhang J. (China Three Gorges University	10
10 Xiong S. (Shandong University)	19

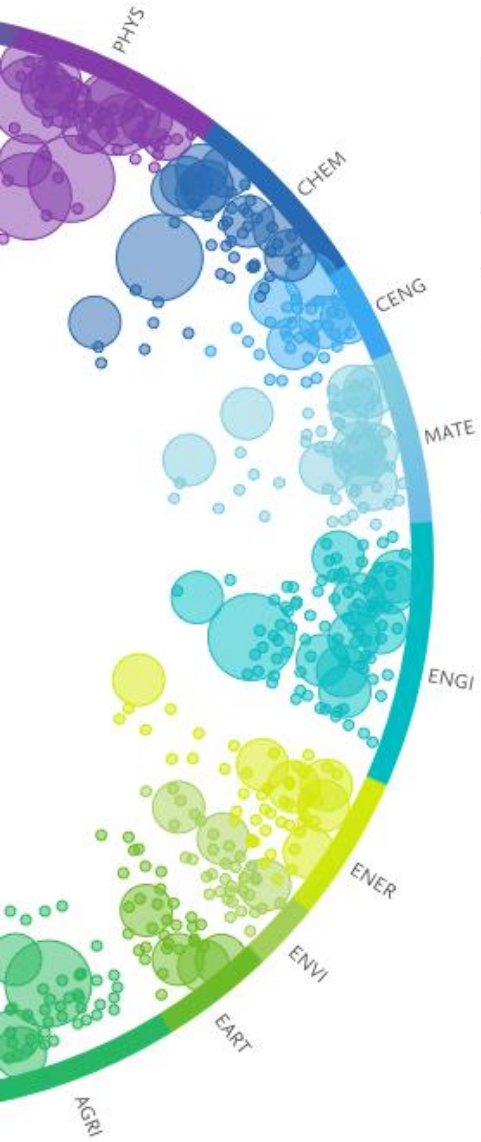
REPRESENTATIVE PAPERS (2011-2014)	ncited
1 Reddy M.V. (2013) Metal oxides and oxysalts as anode materials for Li ion batteries. Chemical Reviews	530
2 Zhu X. (2011) Nanostructured reduced graphene oxide/Fe2O3 composite as a high-performance anode mater	514
3 Ji L. (2011) Recent developments in nanostructured anode materials for rechargeable lithium-ion batteries. En	576
4 Wang Z. (2012) Assembling carbon-coated Î±-Fe2O3 hollow nanohorns on the CNT backbone for superior lith	270
5 Wang J.-Z. (2011) Graphene-encapsulated fe3O4 nanoparticles with 3d laminated structure as superior anode	230
6 Wang B. (2011) Quasiemulsion-templated formation of Î±-Fe2O3 hollow spheres with enhanced lithium storag	350
7 Sun B. (2011) MnO/C core-shell nanorods as high capacity anode materials for lithium-ion batteries. Journal o	118
8 Deng Y. (2011) One-pot synthesis of ZnFe2O4/C hollow spheres as superior anode materials for lithium ion ba	106
9 Jin S. (2011) Facile synthesis of hierarchically structured Fe3O4/carbon micro-flowers and their application to	127
10 Wu H.B. (2012) Nanostructured metal oxide-based materials as advanced anodes for lithium-ion batteries. Na	324

Summary

- We have created an accurate model with nearly 100,000 topics that is suitable for portfolio analysis
    - The methodology can be easily reproduced, but requires a full database
- We have created a topic-level indicator – Prominence – that is strongly correlated with future funding
- Funding per author increases with increasing topic prominence
- Topics and their prominence enable stakeholders in the science system to have the knowledge necessary to make portfolio decisions

Topics of Prominence—Country-Level and Links to Manufacturing Capabilities

United States—Country Output



United States ☆

2014 to 2019 | no subject area filter selected | ASJC

Summary | Topics & Topic Clusters | Published | Viewed | Cited | Authors | Institutions | Economic Impact | Awarded Grants

Overall research performance

4,062,401 ▲
Scholarly Output

2,949,350 ▲
Authors

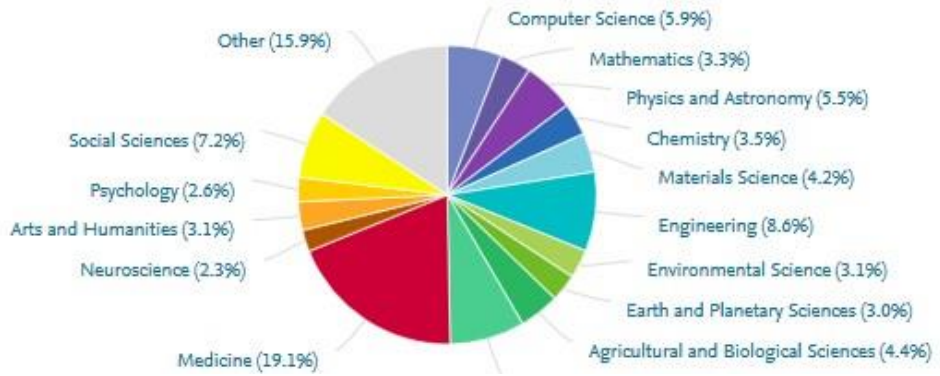
1.43
Field-Weighted Citation Impact

View list of publications

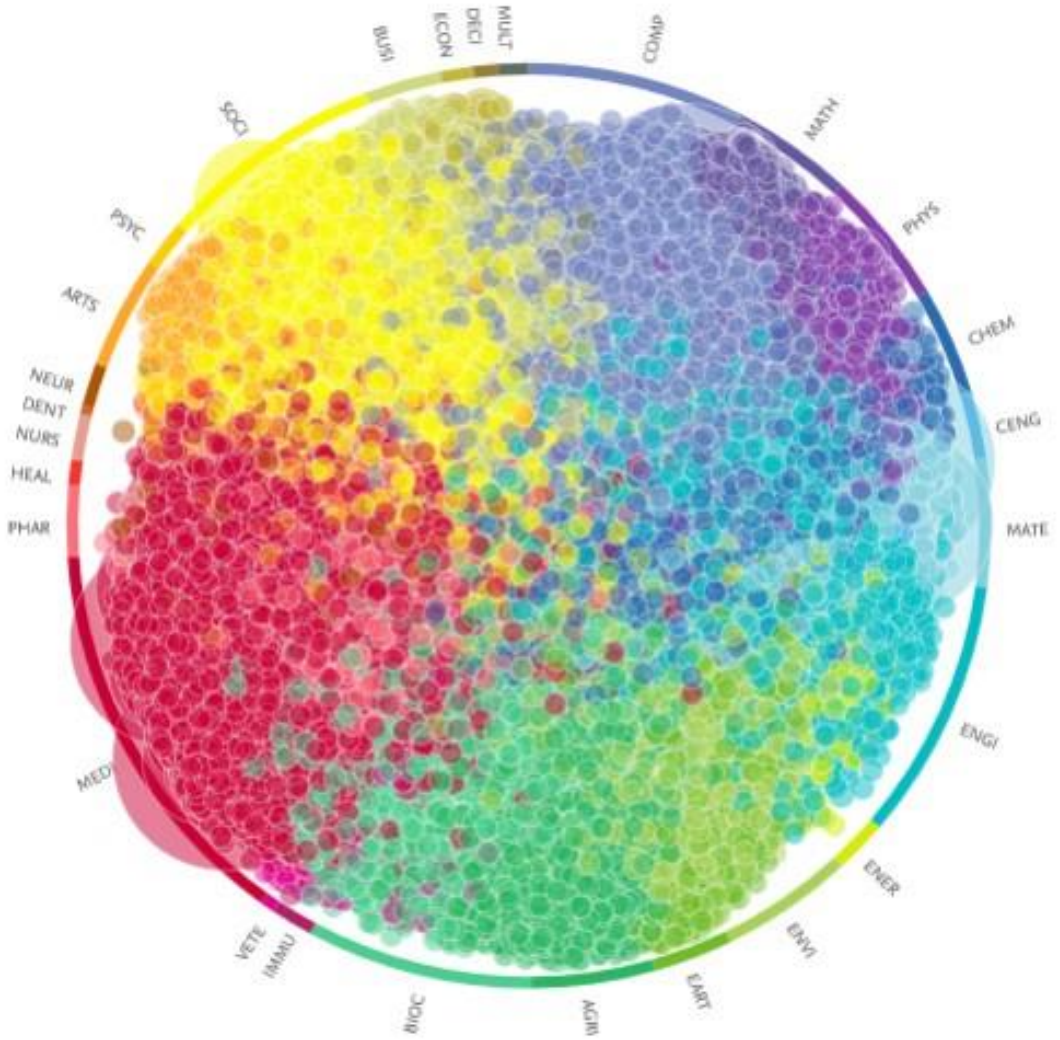
38,647,031
Citation Count

9.5
Citations per Publication

Pie Chart

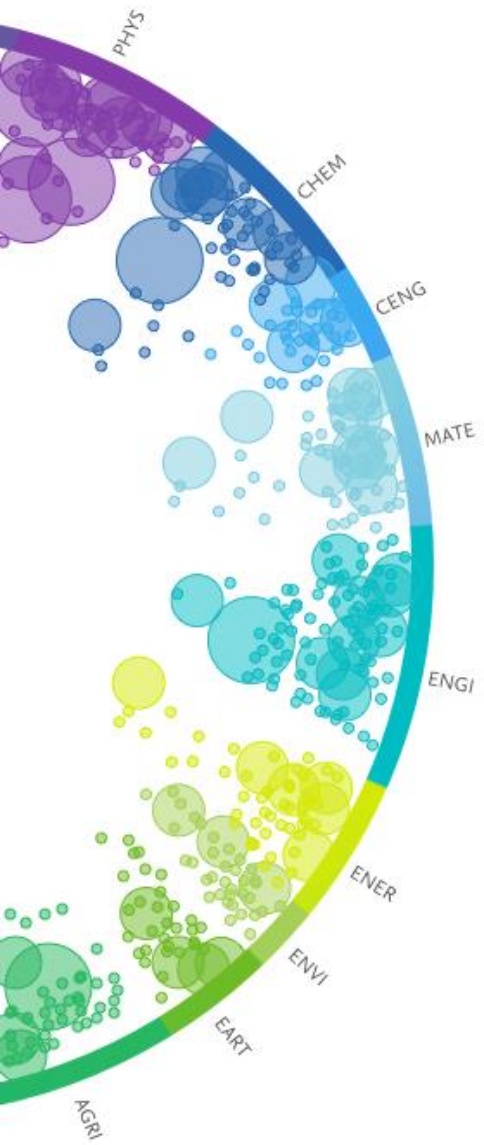


United States—Topics of Prominence (88,923 total)



COMP	Computer Science
MATH	Mathematics
PHYS	Physics and Astronomy
CHEM	Chemistry
CENG	Chemical Engineering
MATE	Materials Science
ENGI	Engineering
ENER	Energy
ENVI	Environmental Science
EART	Earth and Planetary Sciences
AGRI	Agricultural and Biological Sciences
BIOC	Biochemistry, Genetics and Molecular Biology
IMMU	Immunology and Microbiology
VETE	Veterinary
MEDI	Medicine
PHAR	Pharmacology, Toxicology and Pharmaceutics
HEAL	Health Professions
NURS	Nursing
DENT	Dentistry
NEUR	Neuroscience
ARTS	Arts and Humanities
PSYC	Psychology
SOCI	Social Sciences
BUSI	Business, Management and Accounting
ECON	Economics, Econometrics and Finance
DECI	Decision Sciences
MULT	Multidisciplinary

United States—Topics of Prominence



United States

2012 to 2017 | no filter selected | ASJC | Data s

Summary | Topics | Awarded Grants | Published | Viewed | Cited | Economic Impact | Authors | Institutions

Browse Topics

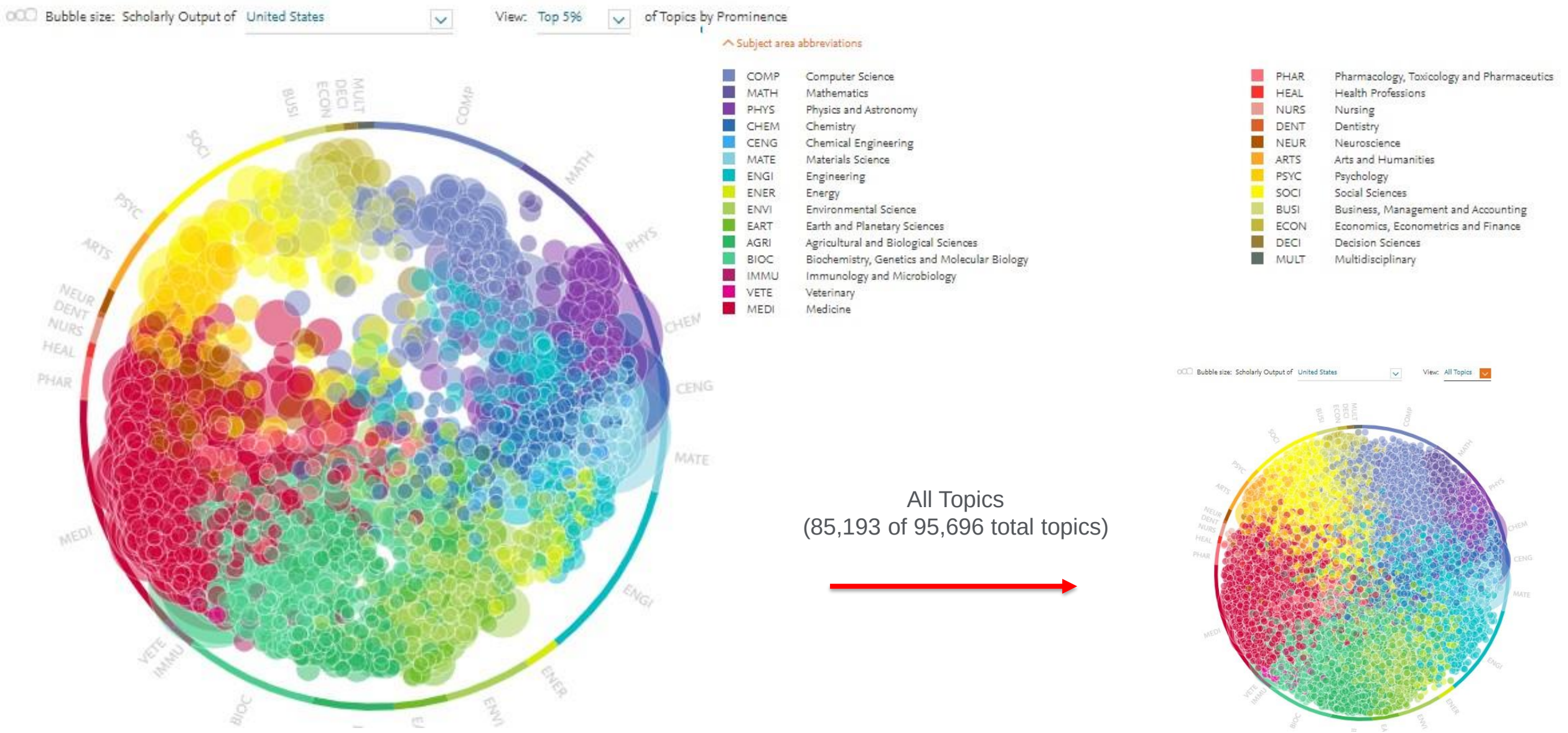
Researchers in the United States have contributed to 90,988 topics between 2012 to 2017

Table | Wheel

Search this Country's Topics

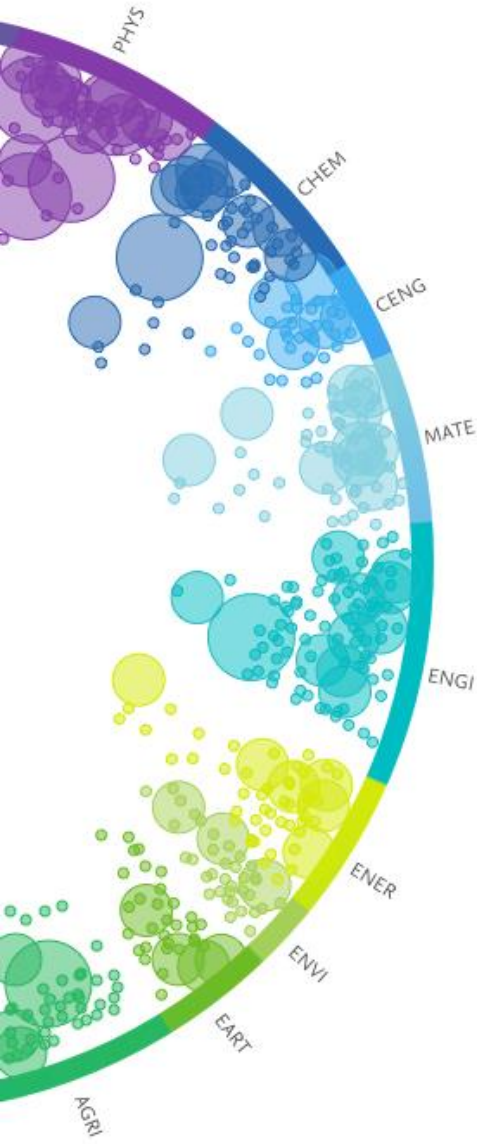
Topic	In this Country: Scholarly Output	In this Country: Publication Share	In this Country: Field-Weighted Citation Impact	Worldwide: Prominence percentile
Molybdenum compounds; Monolayers; dichalcogenides TMDs ... T.63	2,013	35.51% ▼	5.42	99.999
Analgesics, Opioid; Prescriptions; opioid prescriptions ... T.248	1,989	69.59% ▲	2.53	99.762
Genome; RNA, Guide; effector nucleases ... T.456	1,829	45.49% ▼	5.94	99.998
Immunotherapy; Melanoma; immune-related adverse ... T.403	1,765	44.81% ▼	9.96	99.991
Brain; Magnetic Resonance Imaging; network DMN ... T.219	1,689	47.19% ▼	2.97	99.940
Hepacivirus; Hepatitis C; direct acting ... T.608	1,606	47.54% ▼	4.65	99.955
Sports; Athletes; sport-related concussion ... T.952	1,560	71.33% ▲	2.29	99.725
Heart-Assist Devices; Heart Failure; pump thrombosis ... T.121	1,555	60.93% ▼	1.69	99.229
planet; planets; planet candidates ... T.131	1,545	62.15% ▲	2.18	99.740
Hemorrhagic Fever, Ebola; Ebolavirus; ebola virus ... T.182	1,518	46.06% ▼	3.35	99.968

United States—Topics of Prominence—Top 5%



All Topics
(85,193 of 95,696 total topics)

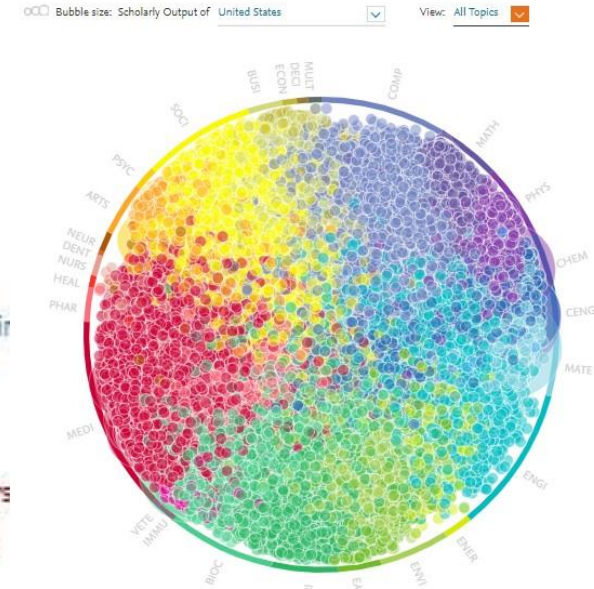
Semantic Word Cloud by Topic



Virtual reality
Electrodes
Applications
Signal processing
Biomedical engineering
Patient rehabilitation
Control
Classifiers
Decoding
Wheelchairs
Feature extraction
Personnel trair
Image retrieval
Interfaces (computer)
Electrophysiology
Experiments
Robots
Motors
Brain
Support vector machines
Robotics
Communication
Brain computer interface
Neurophys
Computers
Discriminant analysis
Electroencephalography
Research
Interfaces (materials)
Data processing
Algorithms
Classification (of information)
Neural networks
Synchronization
Frequency bands
Power spectral density
Independent component analysis
Handicapped persons

A A A relevance of keyphrase | declining growing (2012-2016)

> Analyze in more detail



Leading Institutions in High-Throughput Genetic Sequencing

Genome; High-Throughput Nucleotide S

2012 to 2016 | no subject area filter selected | ASJC

Summary | Institutions | Countries | Authors | Scopus Sources | Keyphras

Top Institutions

Worldwide | All sectors | ← Filter for more (regional) detail

Map | Table | Chart

Top 100 Institutions in this Topic, by Scholarly Output

Size: Scholarly Output | total value | Color: Views Cour

Organic light emitting diodes (OLED); Phosphorescence; Light emission T.158

2012 to 2016 | no subject area filter selected | ASJC

Summary | Institutions | Countries | Authors | Scopus Sources | Keyphrases

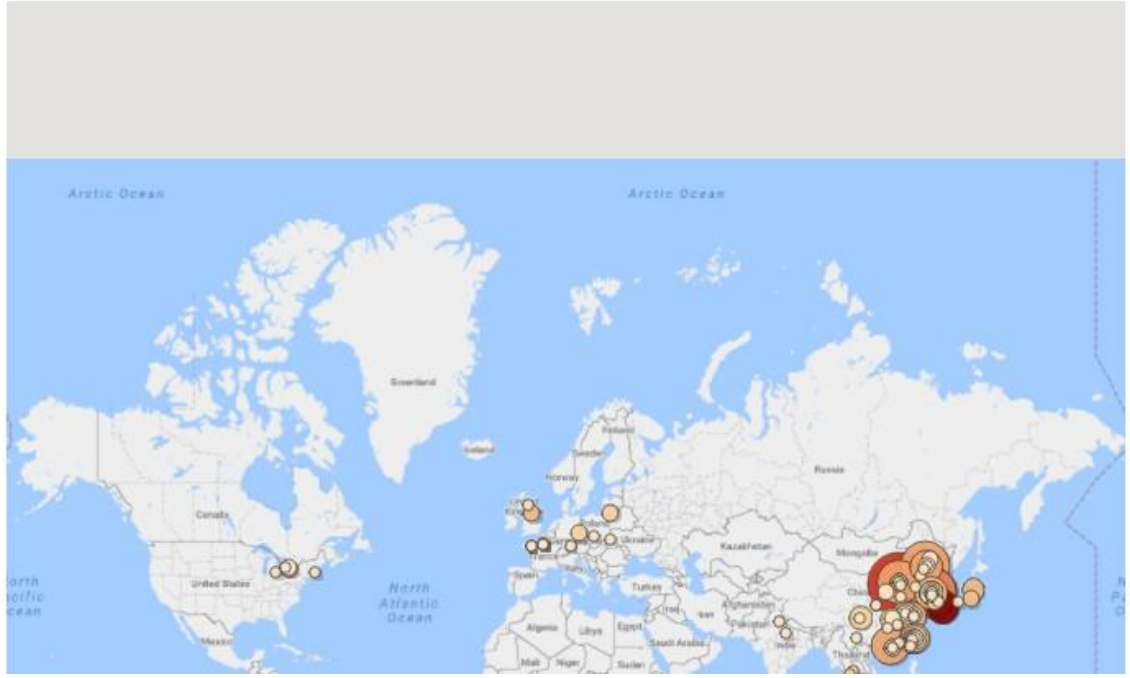
Top Institutions

Worldwide | All sectors | ← Filter for more (regional) detail

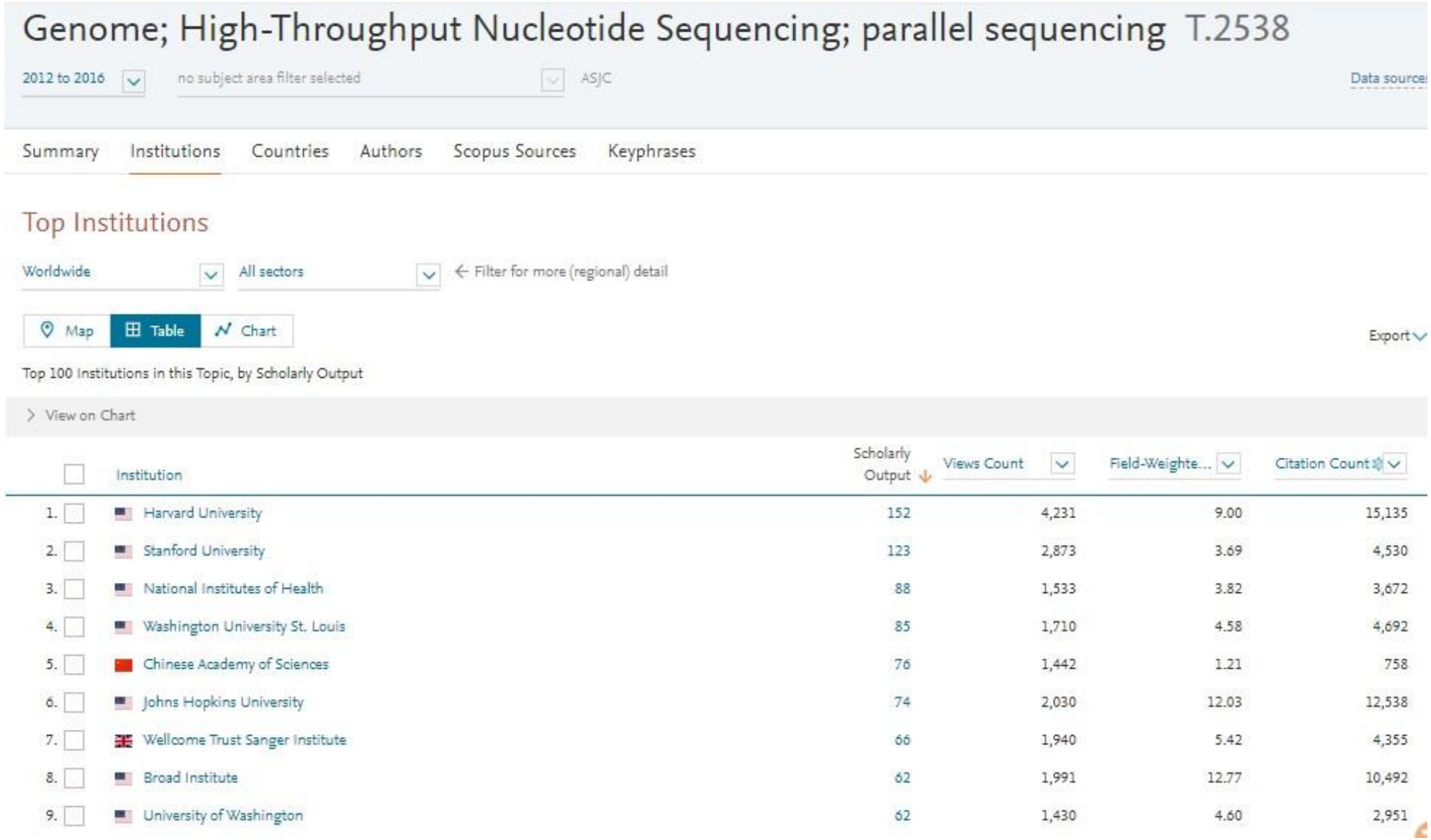
Map | Table | Chart

Top 100 Institutions in this Topic, by Scholarly Output

Size: Scholarly Output | total value | Color: Views Count | total value



Leading Institutions in High-Throughput Genetic Sequencing



Genome; High-Throughput Nucleotide Sequencing; parallel sequencing T.2538

2012 to 2016 | no subject area filter selected | ASJC | Data source

Summary | Institutions | Countries | Authors | Scopus Sources | Keyphrases

Top Institutions

Worldwide | All sectors | ← Filter for more (regional) detail

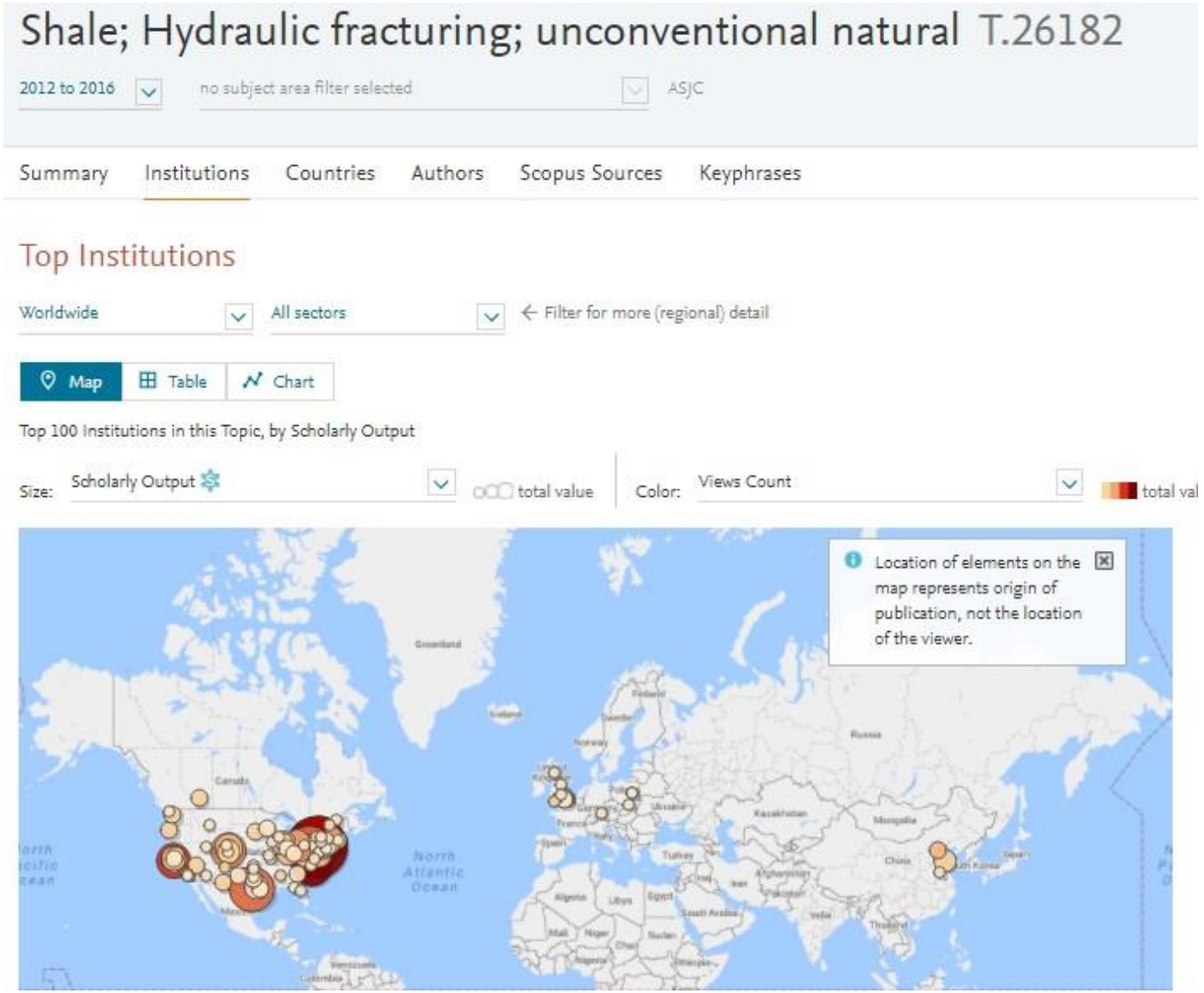
Map | Table | Chart | Export

Top 100 Institutions in this Topic, by Scholarly Output

> View on Chart

	Institution	Scholarly Output	Views Count	Field-Weighte...	Citation Count
1.	Harvard University	152	4,231	9.00	15,135
2.	Stanford University	123	2,873	3.69	4,530
3.	National Institutes of Health	88	1,533	3.82	3,672
4.	Washington University St. Louis	85	1,710	4.58	4,692
5.	Chinese Academy of Sciences	76	1,442	1.21	758
6.	Johns Hopkins University	74	2,030	12.03	12,538
7.	Wellcome Trust Sanger Institute	66	1,940	5.42	4,355
8.	Broad Institute	62	1,991	12.77	10,492
9.	University of Washington	62	1,430	4.60	2,951

US Topics of Prominence—Shale, Hydraulic Fracturing



US Topics of Prominence—Hydraulic Fracturing

Topic T.1009 | part of Topic Cluster TC.164 - Reservoirs (Water); Oil Well Flooding; Hydraulic Fracturing

Hydraulic fracturing; Fracture; Fracture geometry ☆

Report from

2014 to 2019

Dat

Summary | Institutions | Countries & Regions | Authors | Scopus Sources | Keyphrases | Related Topics

Top Institutions

Worldwide | All sectors

Table | Visualization

+ Add to Reporting | Expor

Top 100 Institutions in this Topic, by Scholarly Output

View on Chart

	Institution	Scholarly Output	Views Count	Field-Weighted Citation Impact	Citation Count
75.	Apache Corporation	12	29	9.19	100
68.	ConocoPhillips	14	36	7.88	164
4.	University of Texas at Austin	206	1,647	7.73	3,247
7.	Texas A and M University	146	833	7.47	1,714
74.	Missouri University of Science and Technology	13	41	6.28	69
15.	University of Houston	65	346	5.09	551
39.	Louisiana State University	23	160	4.92	309
63.	Curtin University of Technology	15	143	4.61	208

Quantum Technologies and Autonomous Driving: Two Views of the US and Global Commercialization Landscape

Quantum Computing: Worldwide

2012 to 2017 | no subject area filter selected | ASJC | Data sources

Summary | Institutions | Countries | Authors | Scopus Sources | Keyphrases

Top Institutions

Worldwide | All sectors

Map | Table | Chart | Export

Top 100 Institutions in this Research Area, by Scholarly Output

View on Chart

	Institution	Scholarly Output	Views Count	Field-Weighte...	Citation Count
1.	Chinese Academy of Sciences	176	1,701	1.22	1,283
2.	University of Waterloo	166	1,680	1.65	1,826
3.	CNRS	152	2,026	2.09	2,143
4.	Massachusetts Institute of Technology	137	1,521	2.22	2,235
5.	National University of Singapore	132	1,258	1.27	1,342
6.	University of Science and Technology of China	124	1,550	1.94	2,003
7.	University of Oxford	122	1,622	2.23	2,296
8.	Tsinghua University	98	1,186	2.41	1,149
9.	University of Tokyo	98	1,367	1.46	1,025
10.	University of Maryland	94	867	2.03	1,286
11.	University of New South Wales	86	2,094	2.38	1,934
12.	Harvard University	83	1,404	3.12	2,122
13.	Microsoft USA	83	862	2.95	888
14.	University of California at Santa Barbara	73	1,198	3.77	2,407
15.	University of Southern California	71	746	1.88	891
16.	Ministry of Education China	69	796	1.42	556
17.	ETH Zurich	66	1,112	2.33	1,069
18.	CNR	65	1,117	2.02	833

Quantum Computing: Worldwide

2012 to 2017 | no subject area filter selected | ASJC | Data sources

Summary | Institutions | Countries | Authors | Scopus Sources | Keyphrases

Top Institutions

Worldwide | All sectors

Map | Table | Chart | Export

Top 100 Institutions in this Research Area, by Scholarly Output

View on Chart

	Institution	Scholarly Output	Views Count	Field-Weighte...	Citation Count
89.	University of Copenhagen	29	466	6.63	662
19.	Delft University of Technology	65	1,408	5.20	1,476
59.	Max-Planck-Institut fur Quantenoptik	36	718	5.05	2,290
55.	RIKEN	37	658	4.16	995
14.	University of California at Santa Barbara	73	1,198	3.77	2,407
30.	University of Melbourne	55	1,656	3.70	2,804
53.	IBM	37	520	3.43	613
82.	Google Inc.	30	530	3.28	531
33.	Stanford University	52	809	3.17	1,024
77.	University of British Columbia	32	344	3.13	582
12.	Harvard University	83	1,404	3.12	2,122
87.	INRIA Institut National de Recherche en Informatique et en Automatique	29	338	3.12	591
39.	University of Queensland	47	720	3.09	1,572
72.	Deutsches Forschungszentrum fur Kunstliche Intelligenz (DFKI GmbH)	32	190	2.98	187
13.	Microsoft USA	83	862	2.95	888
66.	Keio University	33	504	2.90	926

Quantum Computing Research: Highest FWCI Non-US

Quantum Computing: Non-U.S.

2012 to 2017 | no subject area filter selected | ASJC | Data source

Summary | Institutions | Countries | Authors | Scopus Sources | Keyphrases

Top Institutions

Worldwide | All sectors

Map | Table | Chart | Export

Top 100 Institutions in this Research Area, by Scholarly Output

View on Chart

	Institution	Scholarly Output	Views Count	Field-Weighte...	Citation Count
21.	Delft University of Technology	42	861	4.80	650
88.	Ruhr-Universitat Bochum	21	318	3.98	176
63.	Max-Planck-Institut fur Quantenoptik	26	397	3.39	1,015
49.	Deutsches Forschungszentrum fur Kunstliche Intelligenz (DFKI GmbH)	29	165	3.08	175
55.	University of Vienna	28	434	2.89	955
29.	Austrian Academy of Sciences	36	600	2.66	1,154
75.	Ecole Normale Superieure	23	244	2.44	404
26.	University of Bremen	39	265	2.41	244
56.	CSIC	27	792	2.35	730
91.	University of Rome La Sapienza	21	283	2.31	436
23.	Universite Pierre et Marie Curie	42	666	2.28	543
41.	PSL Research University	31	379	2.28	496
17.	Universite Paris Saclay	46	712	2.23	588
39.	University of Melbourne	32	783	2.17	1,006
2.	CNRS	130	1,781	2.15	1,870

Quantum Computing Research: Highest FWCI US

Quantum Computing: U.S.

2012 to 2017 | no subject area filter selected | ASJC | Data source

Summary | Institutions | Countries | Authors | Scopus Sources | Keyphrases

Top Institutions

North America | United States | All sectors | reset filter

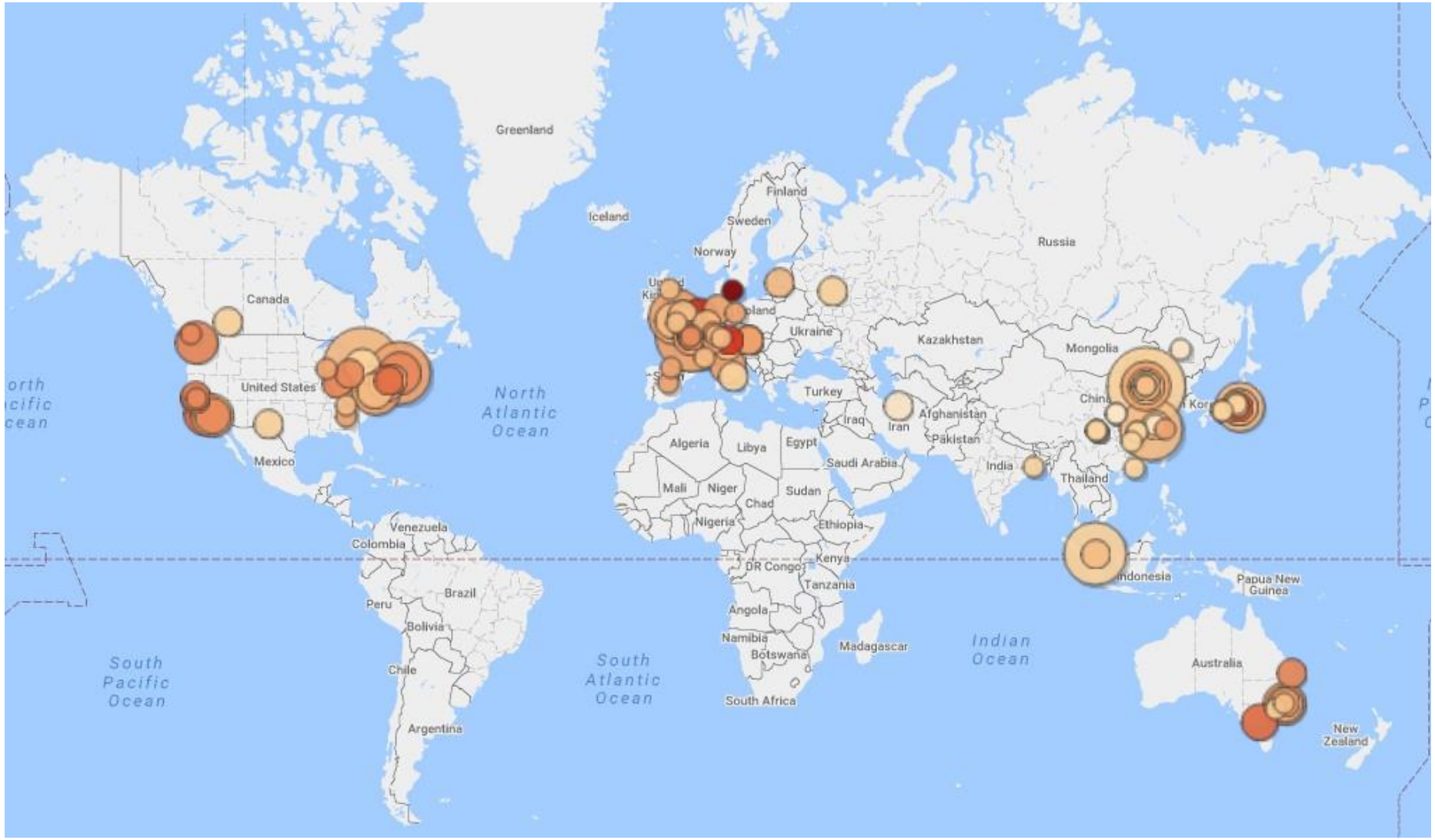
Map | Table | Chart | Export

Top 100 Institutions in this Research Area, by Scholarly Output

View on Chart

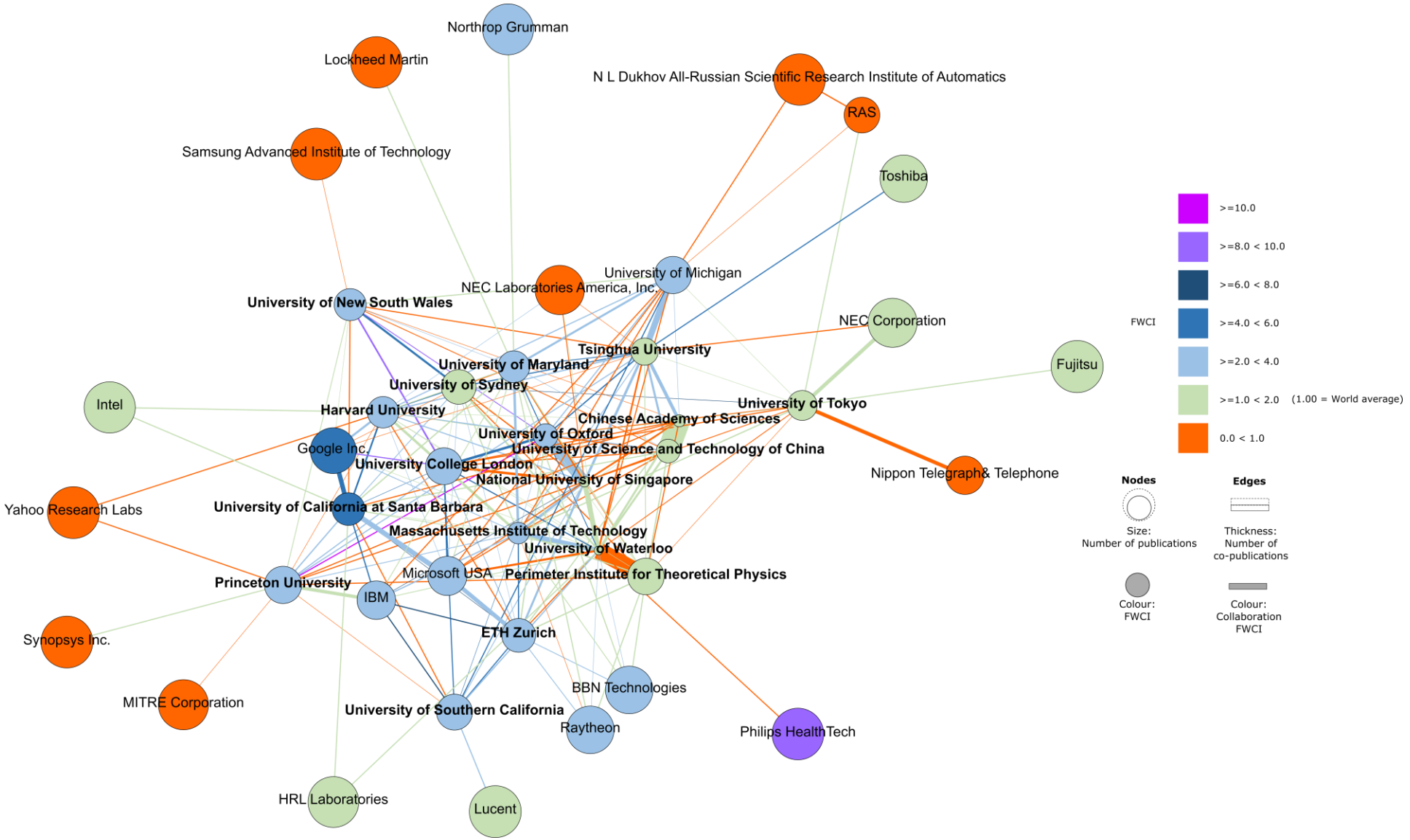
	Institution	Scholarly Output	Views Count	Field-Weighte...	Citation Count
84.	University of California at Irvine	7	199	9.39	1,047
62.	Intel	10	111	7.62	40
69.	National Science Foundation	9	53	5.00	119
49.	University of California at Riverside	13	201	4.54	672
5.	University of California at Santa Barbara	73	1,198	3.77	2,407
93.	Virginia Polytechnic Institute and State University	6	89	3.67	22
45.	Florida State University	15	199	3.61	166
16.	IBM	37	520	3.43	613
72.	University of Utah	9	139	3.41	211
19.	Google Inc.	30	530	3.28	531
64.	New York University	10	119	3.23	118
10.	Stanford University	52	809	3.17	1,024
3.	Harvard University	83	1,404	3.12	2,122
22.	Duke University	25	495	3.05	812
31.	Lawrence Berkeley National Laboratory	18	378	3.05	510

Quantum Computing Research Worldwide--FWCI



Quantum Computing Research Worldwide--Academic-Corporate Collaboration

Academic-Corporate Collaboration—Network Map of Top 20 universities in Quantum Computing



Autonomous Vehicle Networks – Top Institutions

Topic T.23482 | part of Topic Cluster TC.712 - Global Positioning System; Satellites; Navigation

Global positioning system; Navigation; Urban canyons ☆

2014 to 2019

Summary | Institutions | Countries & Regions | Authors | Scopus Sources | Keyphrases | Related Topics

Top Institutions

Worldwide | All sectors

Table | Visualization

Top 100 Institutions in this Topic, by Scholarly Output

View on Chart

	Institution	Scholarly Output	Views Count	Field-Weighted Citation Impact
1.	University of Tokyo	29	369	1.68
2.	University College London	23	166	3.22
3.	Hong Kong Polytechnic University	21	237	2.07
4.	University of Calgary	15	137	2.98
5.	Chemnitz University of Technology	11	118	2.18
6.	Beihang University	10	62	0.52
7.	Beijing Jiaotong University	10	70	0.58
8.	CEA	10	121	3.20

Autonomous Vehicle Networks – Top Corporates

Top Institutions

Worldwide | Corporate | reset filter

Table | Visualization

Top 100 Institutions in this Topic, by Scholarly Output

View on Chart

	Institution	Scholarly Output	Views Count	Field-Weighted Citation Impact
1.	Daimler AG	4	54	1.09
2.	Robert Bosch GmbH	3	24	10.45
3.	Sigtem Technology, Inc	3	13	0.68
8.	Spirent Communications plc	2	68	1.00
5.	Honda Motor Co., Ltd.	2	36	2.47
7.	MITRE Corporation	2	23	2.78
6.	Microsoft USA	2	22	0.79
4.	ÅF Industry	2	12	0.00
9.	Zenuity AB	2	12	0.00
11.	Digital Catapult	1	103	5.67
17.	Jaguar Land Rover	1	103	5.67
15.	Hyundai Mobis	1	34	1.63
31.	Volvo	1	18	1.91

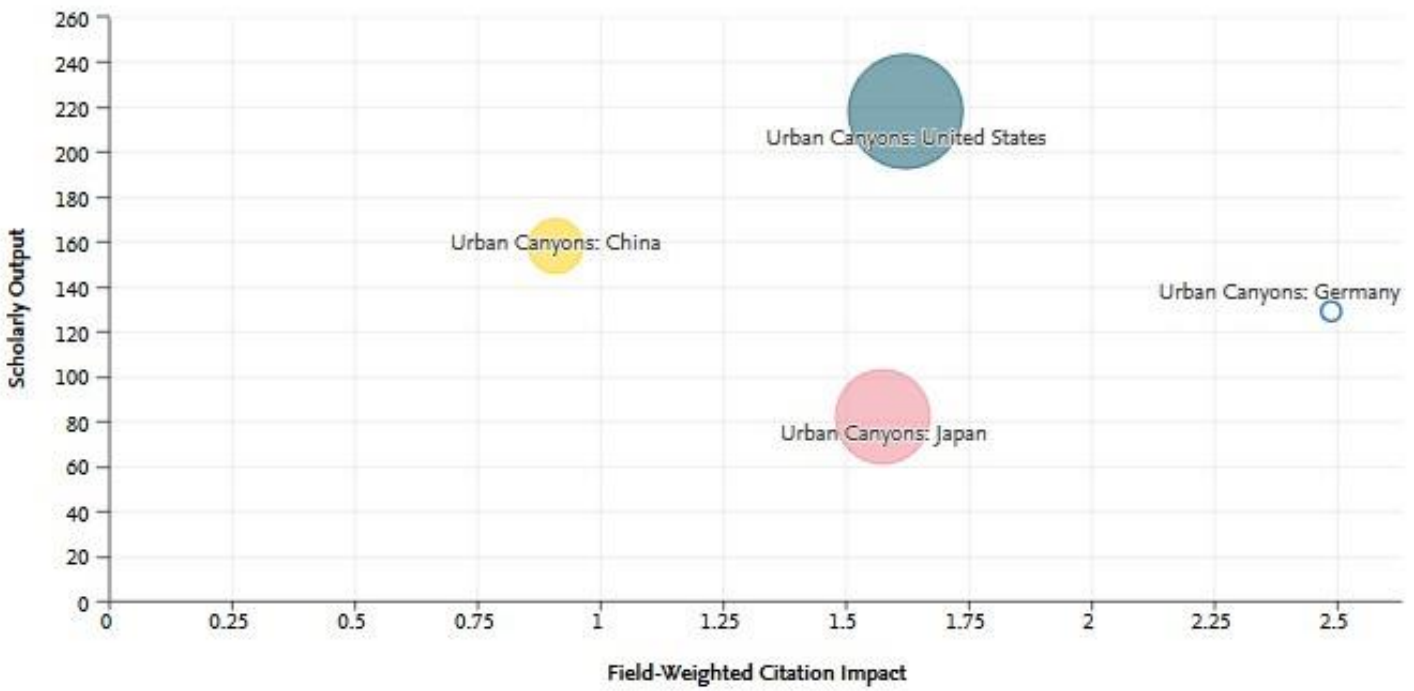
Autonomous Vehicle Networks: Patent Citations per Scholarly Output, US vs. Peers

y-axis
Scholarly Output

x-axis
Field-Weighted Citation Impact

Bubble size
Patent-Citations per Scholarly Output

View timeline motion chart



Urban Canyons: United States
Urban Canyons: China
Urban Canyons: Germany
Urban Canyons: Japan

Hide all chart labels

View list of Scopus Sources for the selected Researchers and Gr

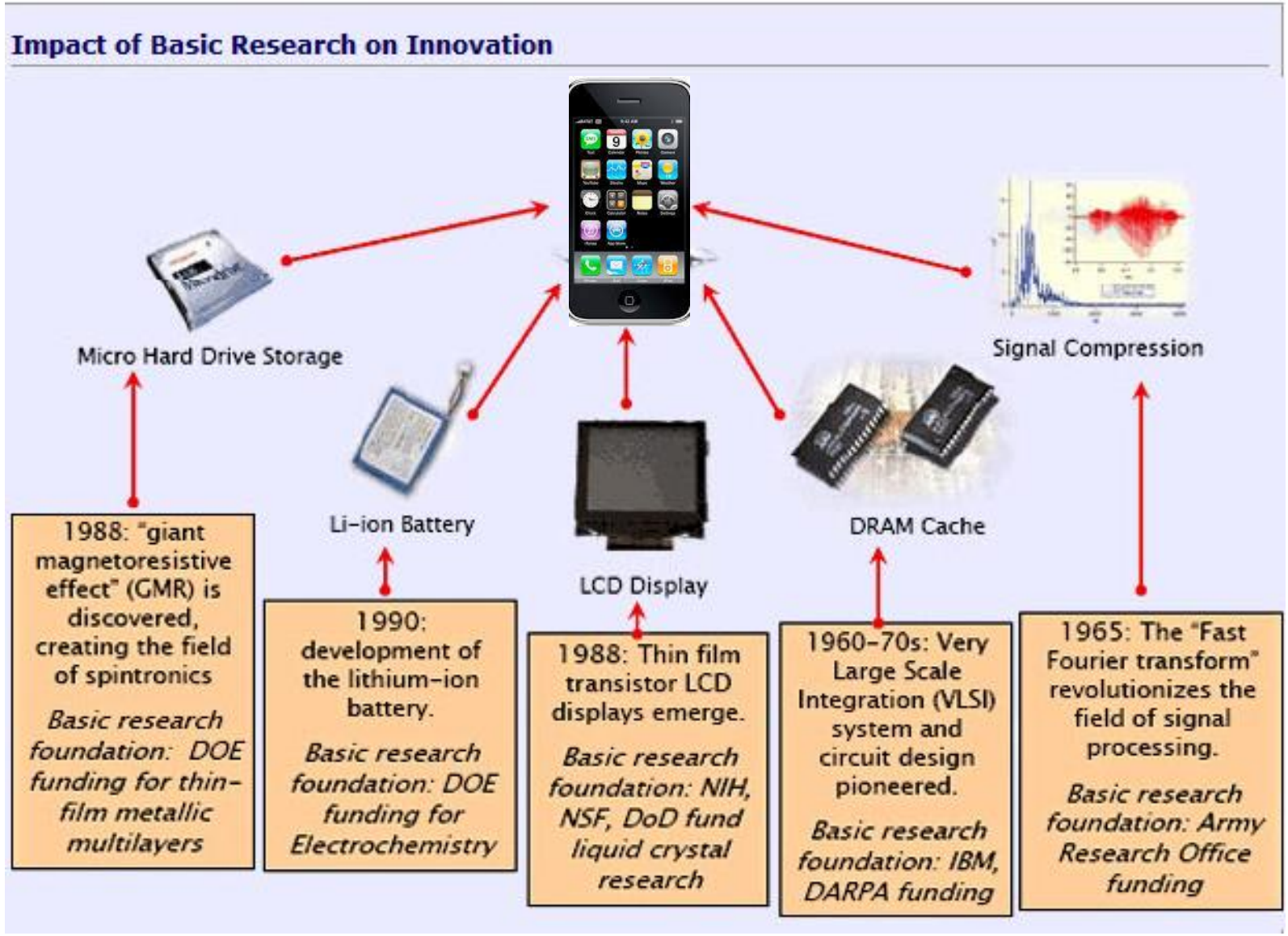
Patent-Citations per Scholarly Output

Metrics details

y-axis: **Scholarly Output**
Types of publications included: all.

Autonomous Vehicle Networks and Urban Canyons: Academic-Corporate Collaboration and Patent Citations per Scholarly Output, US vs. Peers

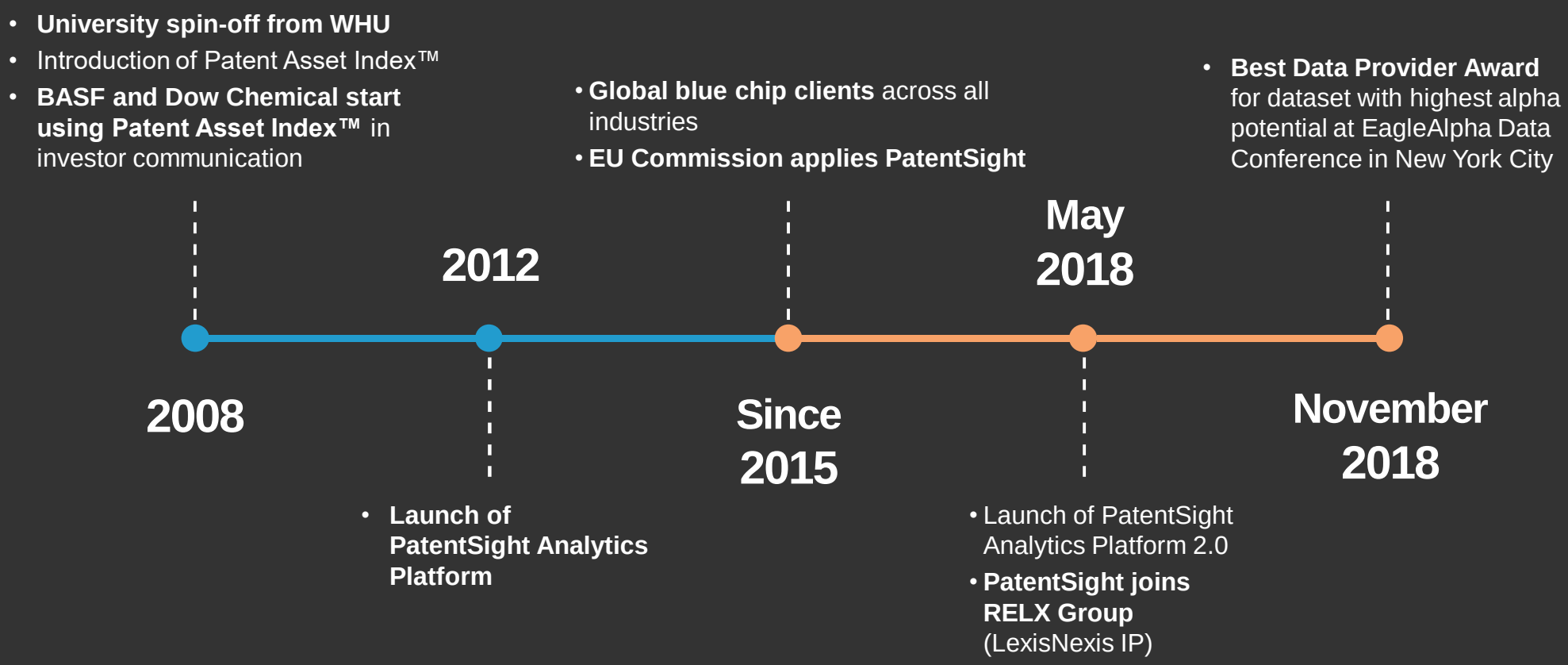
Impact of Basic Research on Innovation--Smartphones



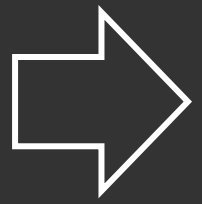
PatentSight Analysis

How to Apply Big Data Innovation Analytics for Technology Trend Scouting

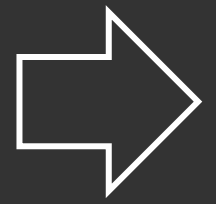
Sven Rueddigkeit
Director Business Development
PatentSight GmbH


• University spin-off from WHU
• Introduction of Patent Asset Index™
• BASF and Dow Chemical start using Patent Asset Index™ in investor communication
2008
• Launch of PatentSight Analytics Platform
2012
• Global blue chip clients across all industries
• EU Commission applies PatentSight
Since 2015
• Launch of PatentSight Analytics Platform 2.0
• PatentSight joins RELX Group (LexisNexis IP)
May 2018
• Best Data Provider Award for dataset with highest alpha potential at EagleAlpha Data Conference in New York City
November 2018

Key patent on relevant technology



Commercially successful product



High revenues and impact on stock price

Challenge #1: Data Quality

Patent data is publicly available

Incomplete ownership information

Ambiguous legal status information

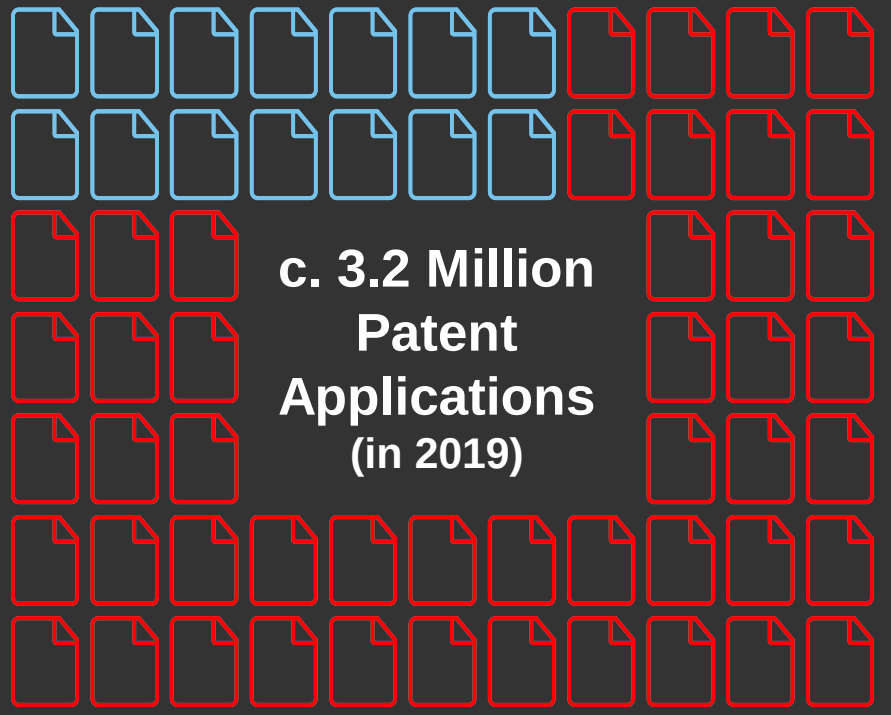
Errors: Wrong translations and misspellings

Challenge #2: Data Masses

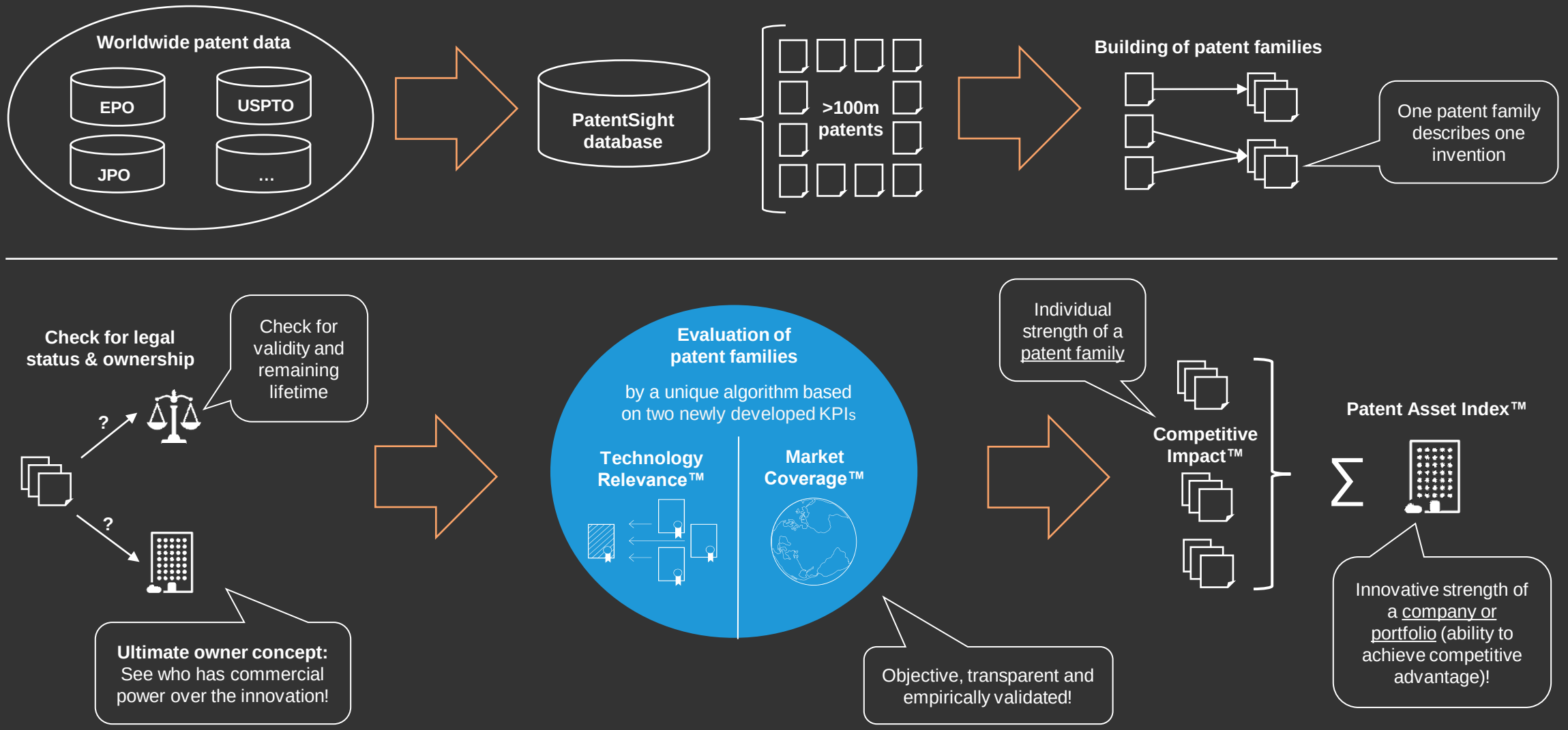
Global R&D Expenditures 2019

c. 2.5 Trillion USD

About 80% of all patents have **no commercial value**



Our Approach

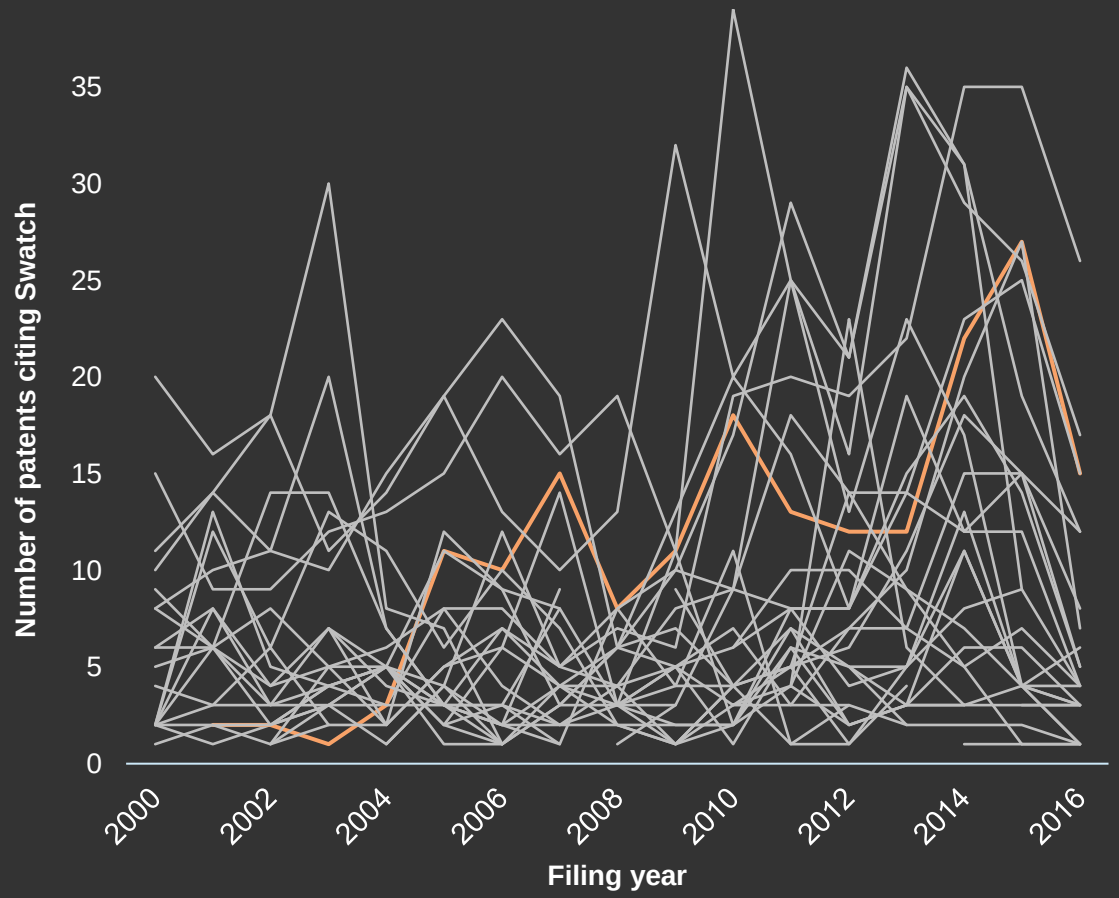


Use Cases

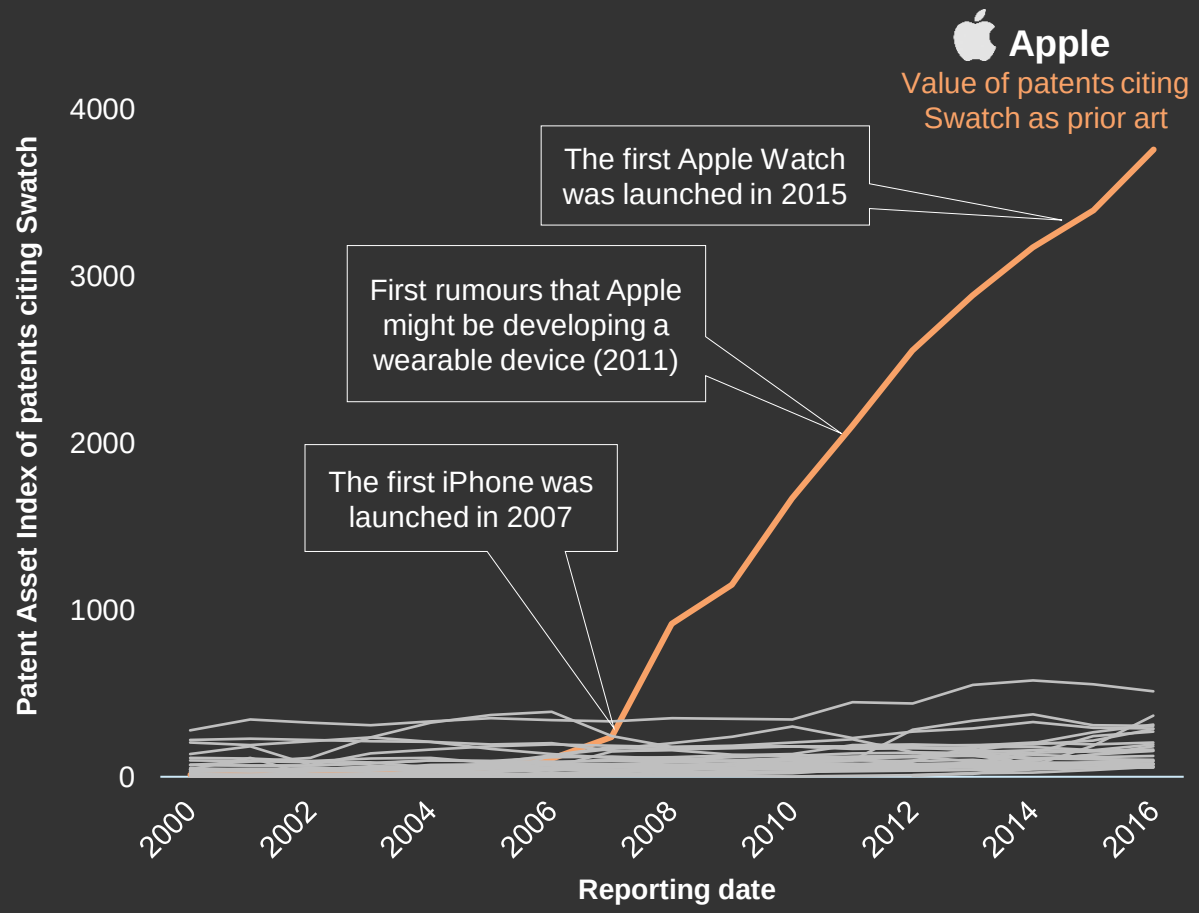
Trend Scouting

swatch

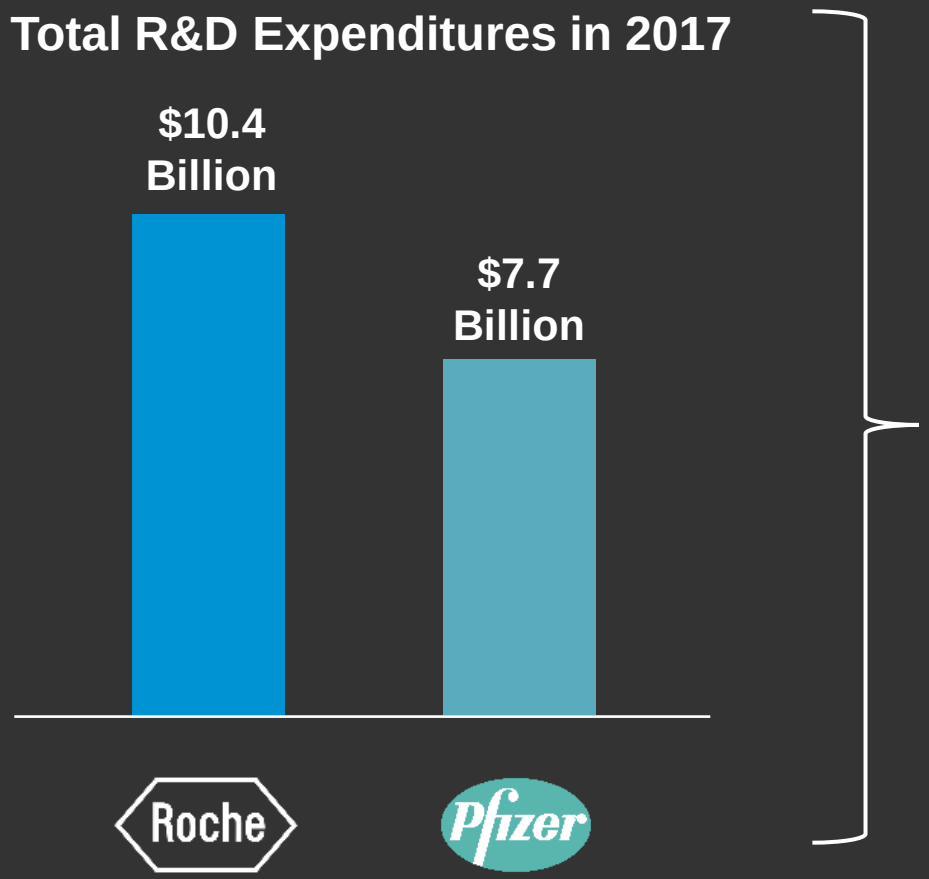
Analysis with conventional patent data



Analysis with Patent Asset Index™ concept applied

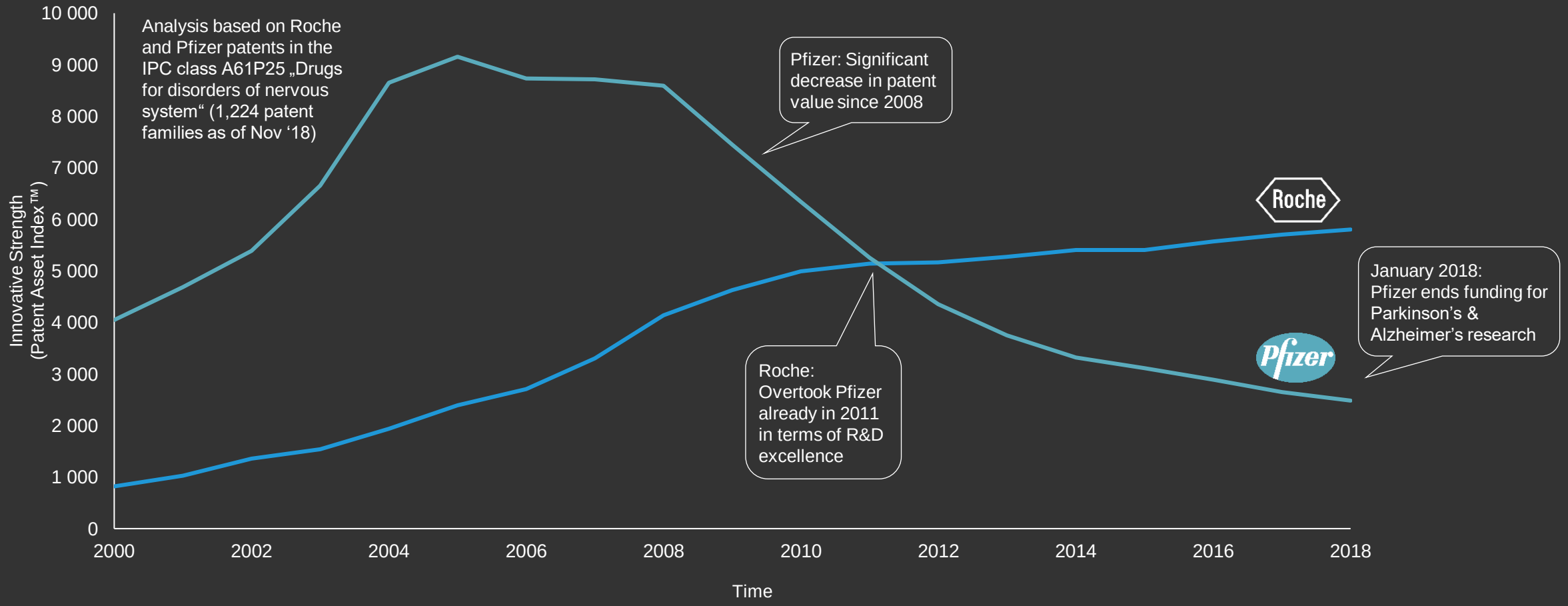


R&D Benchmarking



One of the major research areas today:
Parkinson & Alzheimer

- **5.5 million Americans suffer from Alzheimer's disease** (13.8 million by 2050)
- **50,000 Americans** are diagnosed **with Parkinson's** disease **each year**
- The United States spent **$259 billion on health care expenses for Alzheimer's disease in 2017 alone**


Analysis based on Roche and Pfizer patents in the IPC class A61P25 „Drugs for disorders of nervous system“ (1,224 patent families as of Nov ‘18)
Pfizer: Significant decrease in patent value since 2008
Roche: Overtook Pfizer already in 2011 in terms of R&D excellence
January 2018: Pfizer ends funding for Parkinson’s & Alzheimer’s research
Roche
Pfizer
Innovative Strength (Patent Asset Index™)
10 000
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Time

Target Search

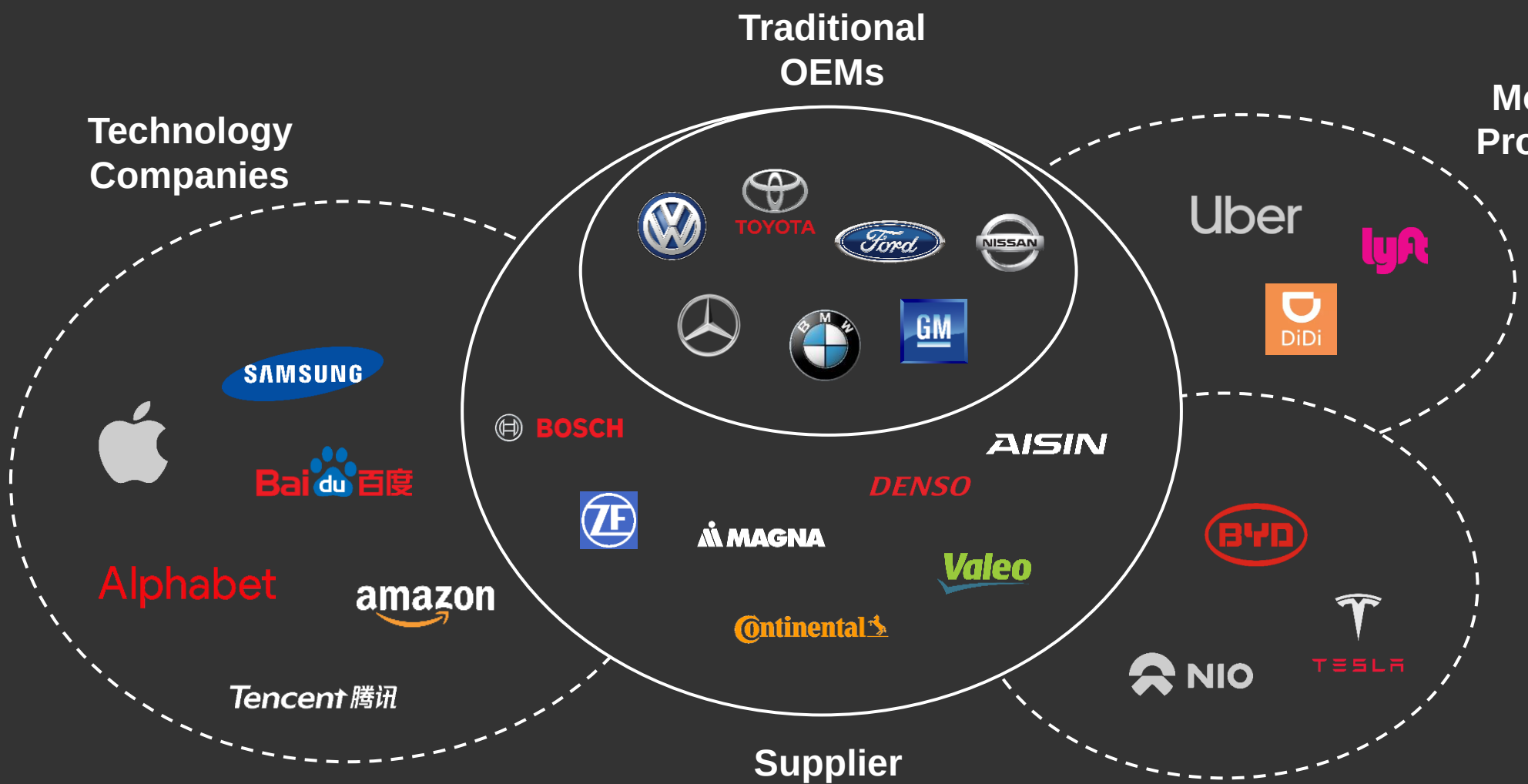
Yesterday

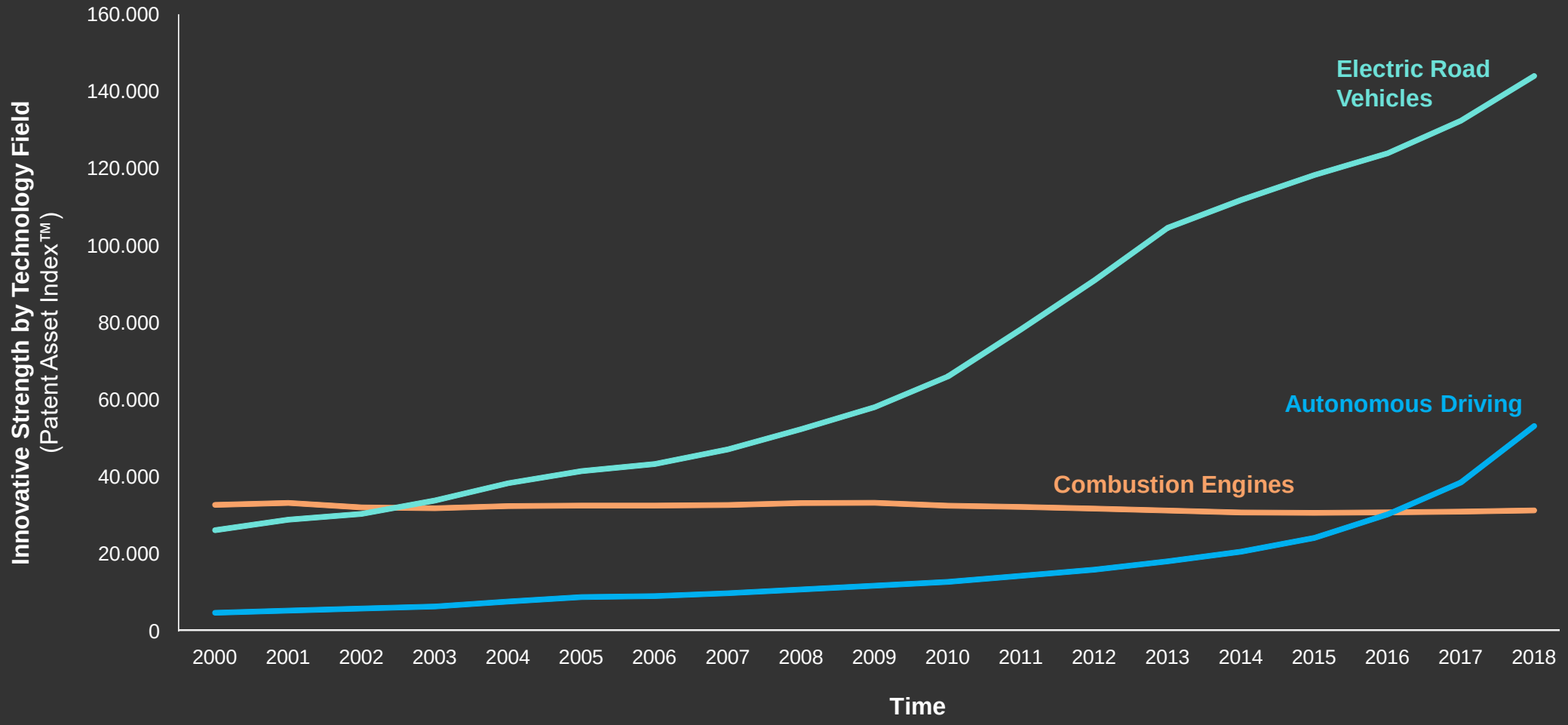
Traditional industries with established value chains

Digitalization

Today

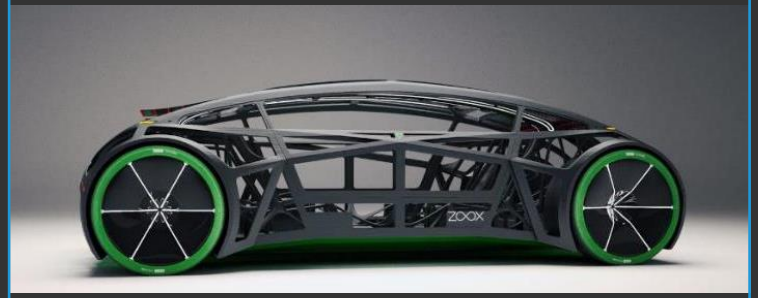
New globally interconnected ecosystem


Traditional OEMs
Technology Companies
Mobility Providers
TOYOTA
NISSAN
Ford
GM
Uber
lyft
DiDi
SAMSUNG
BOSCH
AISIN
DENSO
Baidu 百度
ZF
MAGNA
Valeo
Alphabet
amazon
Continental
BYD
TESLA
NIO
Tencent 腾讯
Supplier
New OEMs


Innovative Strength by Technology Field
(Patent Asset Index™)
160.000
140.000
120.000
100.000
80.000
60.000
40.000
20.000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Time
Electric Road Vehicles
Autonomous Driving
Combustion Engines

Company	Business Area	Revenue (2018)	Number of Patents in Selected Technology	Average Innovative Strength of Patents
ASI	Autonomous Driving: Vehicle Automation	$ 29m	49	2.1
Faraday Future	Electric Vehicles: Motor Technology	$ 120m	324	1.2
Lucid Motors	Electric Vehicles: Battery Tech & Luxury Cars	$ 28m	157	2.6
PROTERRA	Electric Vehicles: E-Busses	$ 10m	43	3.5
ZOOX	Autonomous Driving: Zero-Emission Vehicles	$ 20m	57	5.3

ZOOX



Autonomous Vehicles, Robotics; Zero-Emission Vehicles

Jesse Levinson, Carl Bass, Aicha Evans

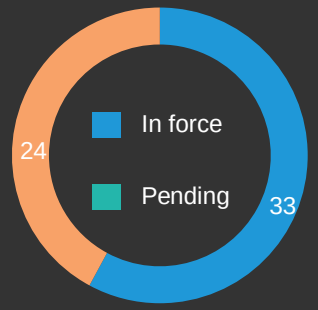
Silicon Valley, 2014

420

Revenue: $ 20 m (2018)

Private Company; $ 790 m total funding

Patent Portfolio

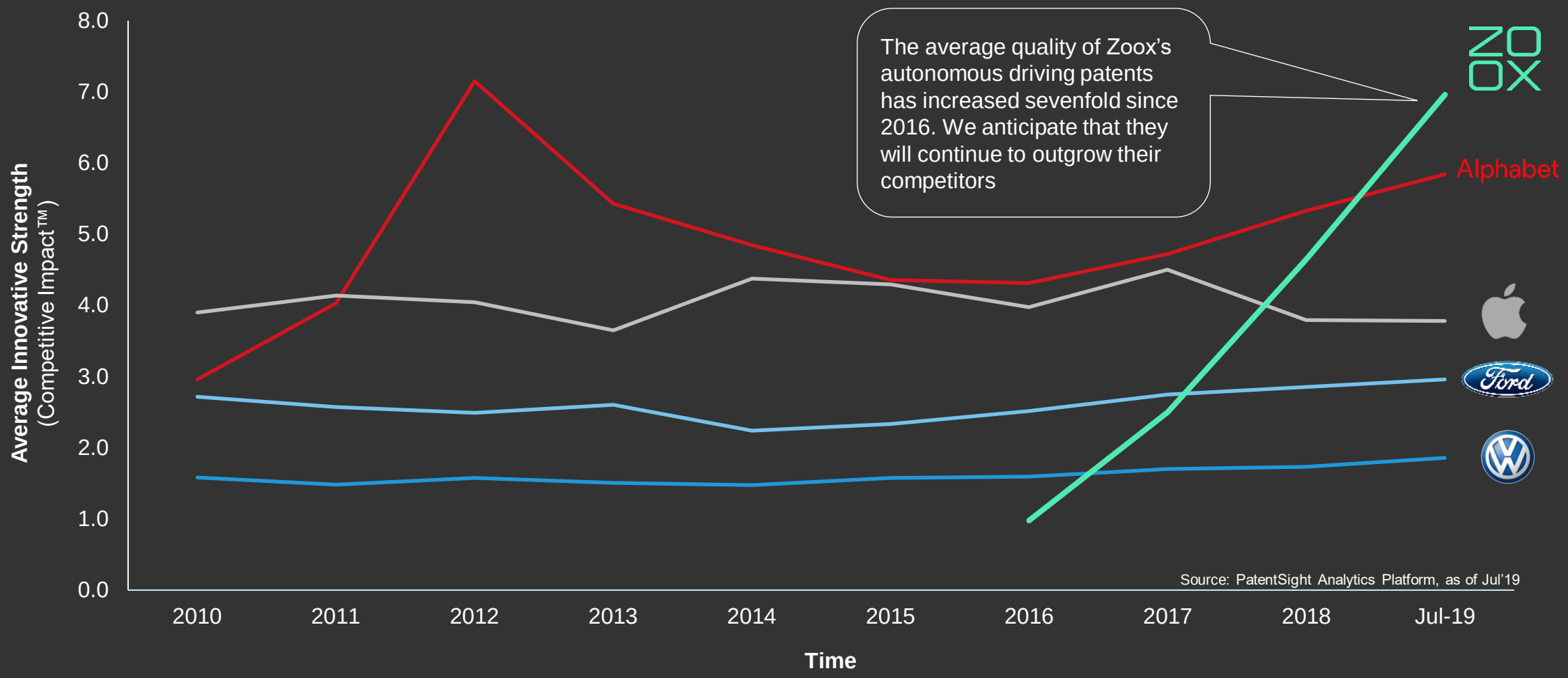


Innovation Peer Group

nauto
Ford
intel
GM
ZOOX
OneTrust
SAMSUNG
Alphabet
Uber

Recent News

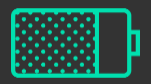
July 2019	**Zoox Plans to Have Autonomous Cars on the Road by 2020** (Innovation&tech today)
March 2019	**Zoox can cruise San Francisco without drivers, but now it needs cash** (Automotive News)
July 2019	**Zoox's self-driving car will provide a smooth ride via independent active suspension** (TC)
December 2018	**California lets self-driving startup Zoox offer autonomous rides** (Reuters)


8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Average Innovative Strength
(Competitive Impact™)
2010
2011
2012
2013
2014
2015
2016
2017
2018
Jul-19
Time
The average quality of Zoox's autonomous driving patents has increased sevenfold since 2016. We anticipate that they will continue to outgrow their competitors
ZOOX
Alphabet
Ford
Source: PatentSight Analytics Platform, as of Jul'19

ESG Investing

Renewable Energy

- Silicon Photovoltaics
- Organic Dye & Perovskite PV
- Photovoltaic AC/DC Conversion
- Photovoltaics (Others)
- Solar Thermal Energy
- Maritime Hydropower
- Wind Energy
- Geothermal Energy



Energy Efficiency

- Lithium Batteries
- Capacitors
- Solid State Battery
- Battery Technology (Others)
- Fuel Cell
- Power Saving
- Smart Grid
- Smart Home

Climate Change Mitigation

- Electric Road Vehicles
- Hybrid Vehicles
- Railroad & Tram
- E-Motors & Winding Machines
- Biomass & Biofuel
- Carbon Capture
- Precision Agriculture

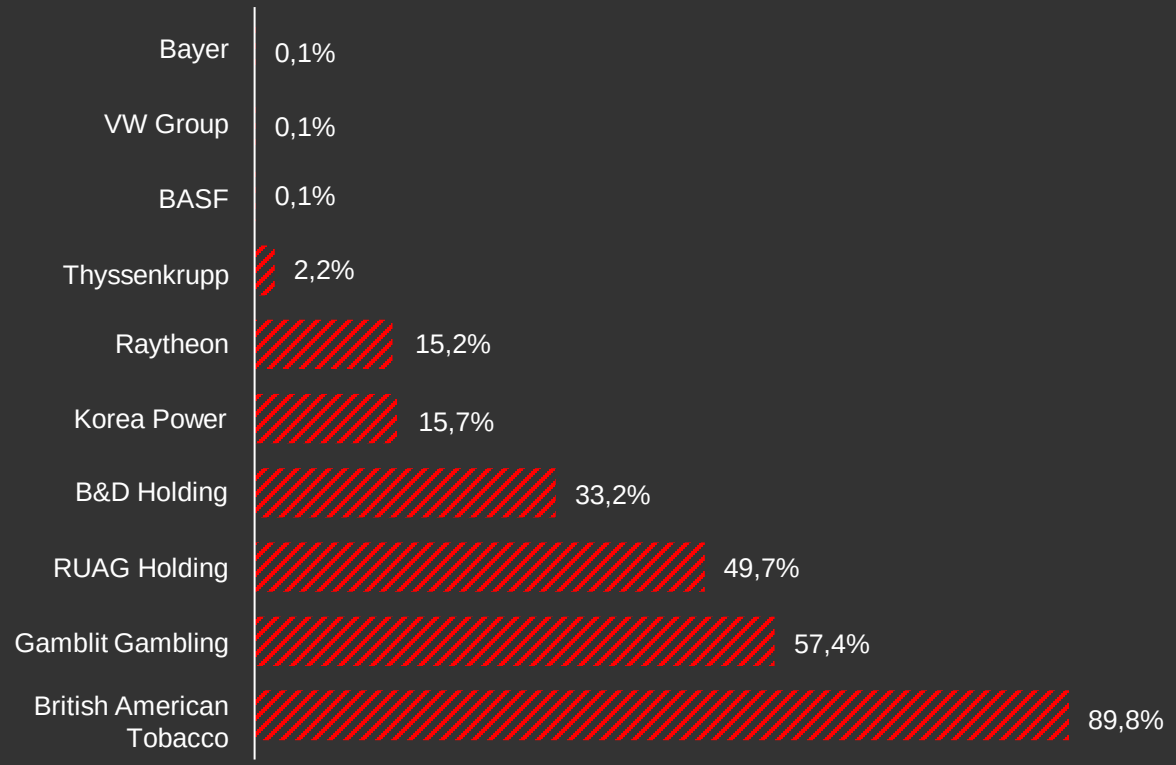
Sustainable Consumption

- Biopolymers
- Recycling
- Sustainable Packaging
- Waste Management
- Water Treatment

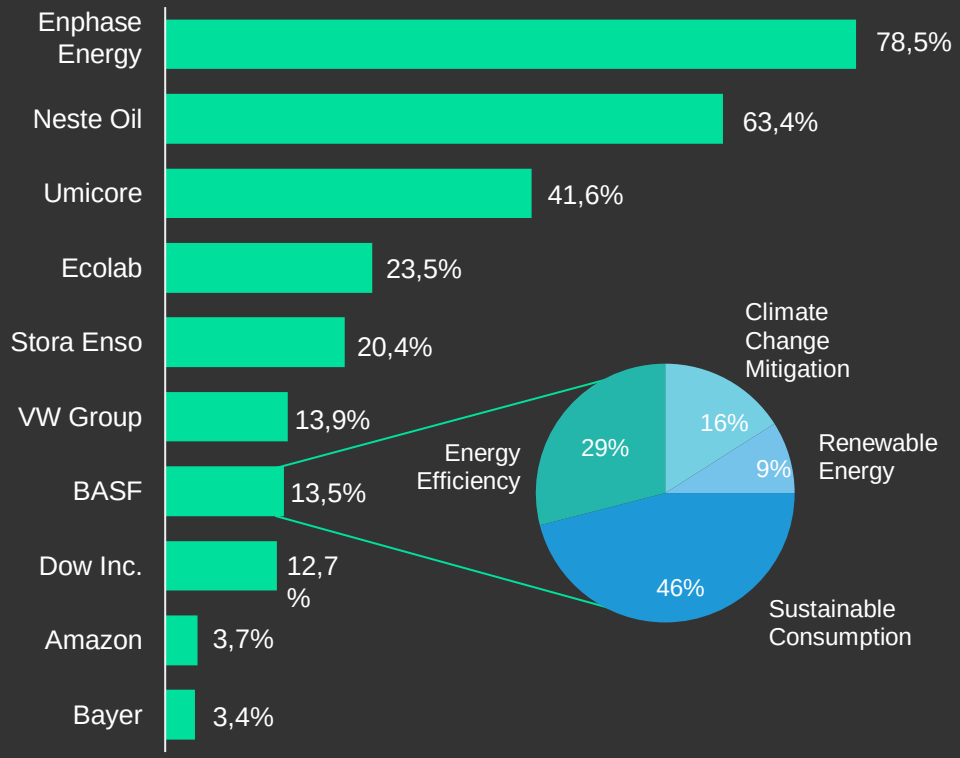
Toxic Technologies

- Casino, Gambling, Betting
- Nuclear Power
- Tobacco & Cigarettes
- Weapons & Military

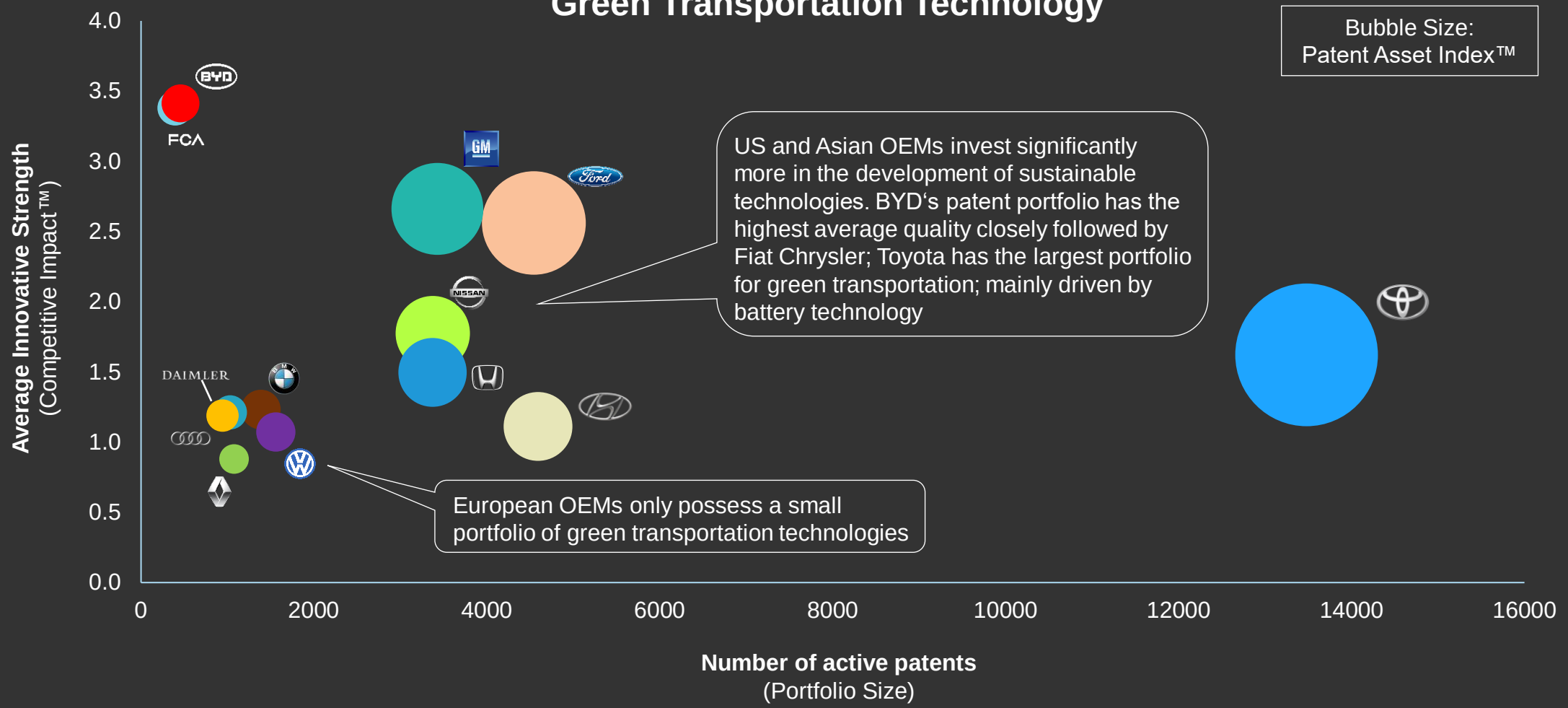
Share of Innovative Strength in Toxic Technologies (Selected Companies)



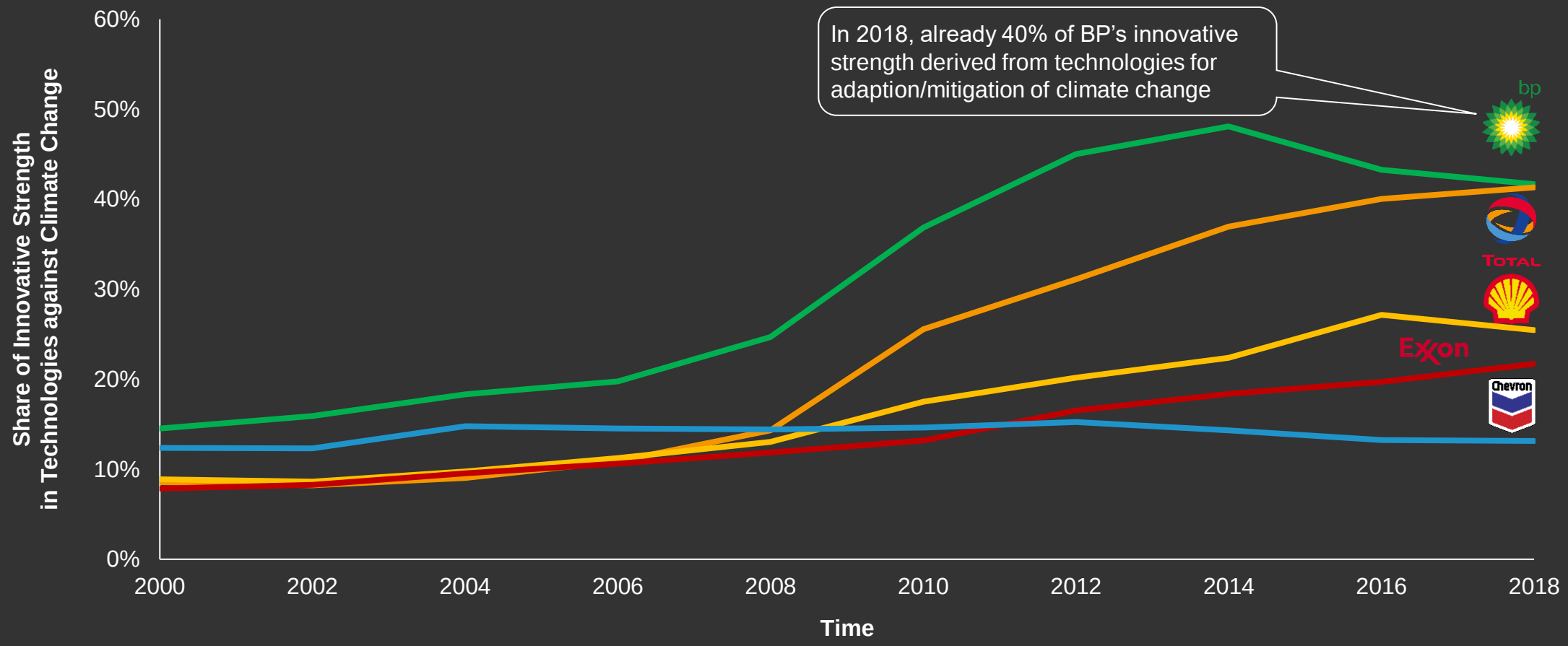
Share of Innovative Strength in Climate-friendly Technologies (Selected Companies)



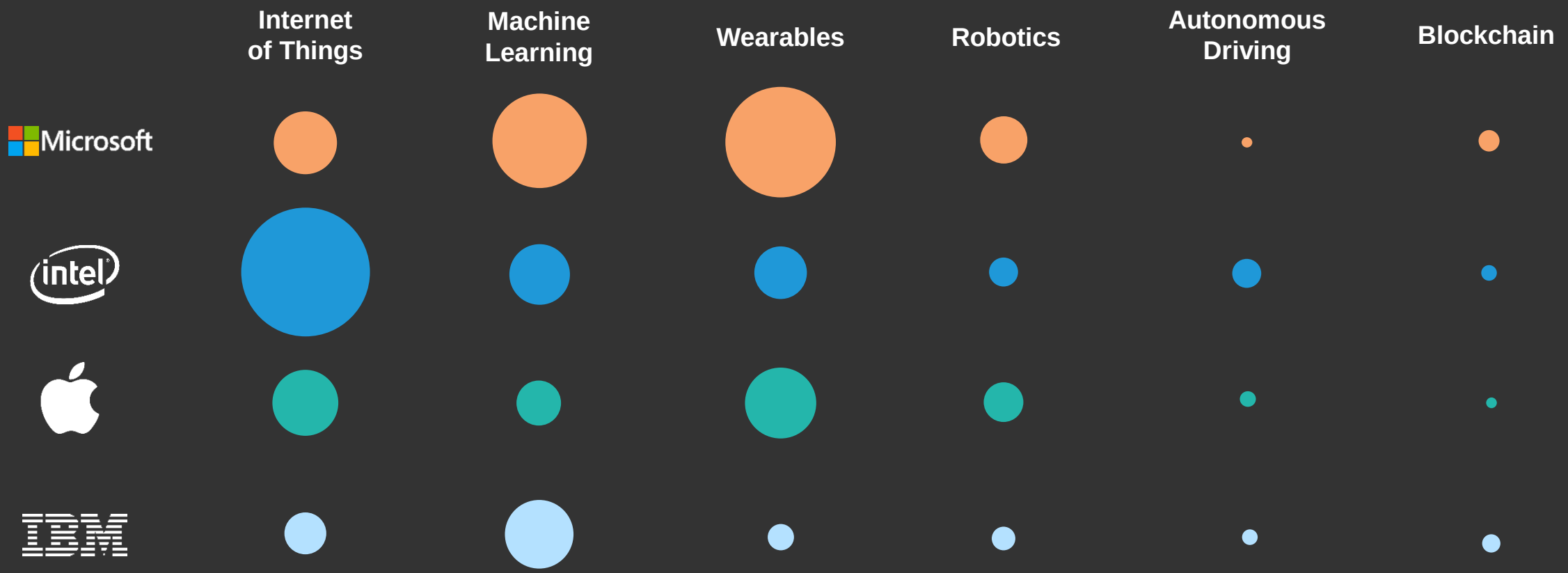
Green Transportation Technology



Share of Innovative Strength in Technologies Against Climate Change



Technology Field Analysis



Bubble Area: Innovative Strength (Patent Asset Index™)

Our Product Range

Product	PatentSight Analytics Platform	PatentSight Datasets	PatentSight Expert Analyses
Features	Leading innovation analytics platform (software-as-a-service); Powerful data analysis and visualization capabilities	Global patent datasets with unique innovation KPIs; mapped to financial IDs for direct inclusion into data feed	Comprehensive IP analyses conducted by our inhouse patent expert team with longstanding experience
Target Customers	Discretionary investors	Quantitative investors	Private Equity investors and M&A advisors
Use Cases	Fundamental company analysis; Competitive intelligence; Trend scouting	Stock picking; Creation of trading signals	Pre-investment: Target search and Due Diligence Post-investment: Business optimization
Pricing	Per License	Per Dataset	Per Project

PatentSight Dataset Features

Data Sources	Patent data is derived from patent office databases, such as European Patent Office, US Patent Office or Japan Patent Office	**Frequency**	Weekly updates of database (lag of 2 working days). Data can be delivered in weekly, monthly, quarterly or annually frequency
Panel Size	Over 100 million patent documents worldwide	**Mapping to Financial Identifiers**	Stock-listed companies are mapped to ISIN identifiers
Coverage	Private and stock-listed companies with patent portfolios from the US, Europe and Asia	**Delivery Methods**	API, FTP, or any other format requested by client
History	Data can be tracked over time from the year 2010 (includes patent information from early 1990s until today)	**Variations**	Data can be delivered on patent-level or aggregated on company-level
Point-in-time	Patent data and company ownership information are point-in-time for full database history	**Pricing**	Enterprise license with annual payments

Research Intelligence

Q&A/Discussion Session

Thank You!

Daniel Calto
Global Director of Solution Services
Research Intelligence
Elsevier
d.calto@Elsevier.com
+1-917-455-4788

Sven Rueddigkeit
Director of Business Development
PatentSight GMBH
srueddgkeit@patentsight.com
+49 228 763711-33

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Sign up for information about UIDP news, webinars, projects, and more at https://uidp.org/listserv-signup/.

Member Webinar

WEDNESDAY, APRIL 8, 2020

12 to 1 p.m. EDT

Jim Bray
Northwestern University
Moderator

UIDP Strengthening University-Industry Partnerships

How Companies Approach Academic Research Engagement in these Disruptive Times

Join us to learn how our industry members, in diverse sectors, are evaluating and reframing their current approaches to academic collaborations.

Panelists

Gaylene Anderson
Boehringer Ingelheim Pharmaceuticals, Inc

Kent Foster
Microsoft

Austin Kozman
PepsiCo