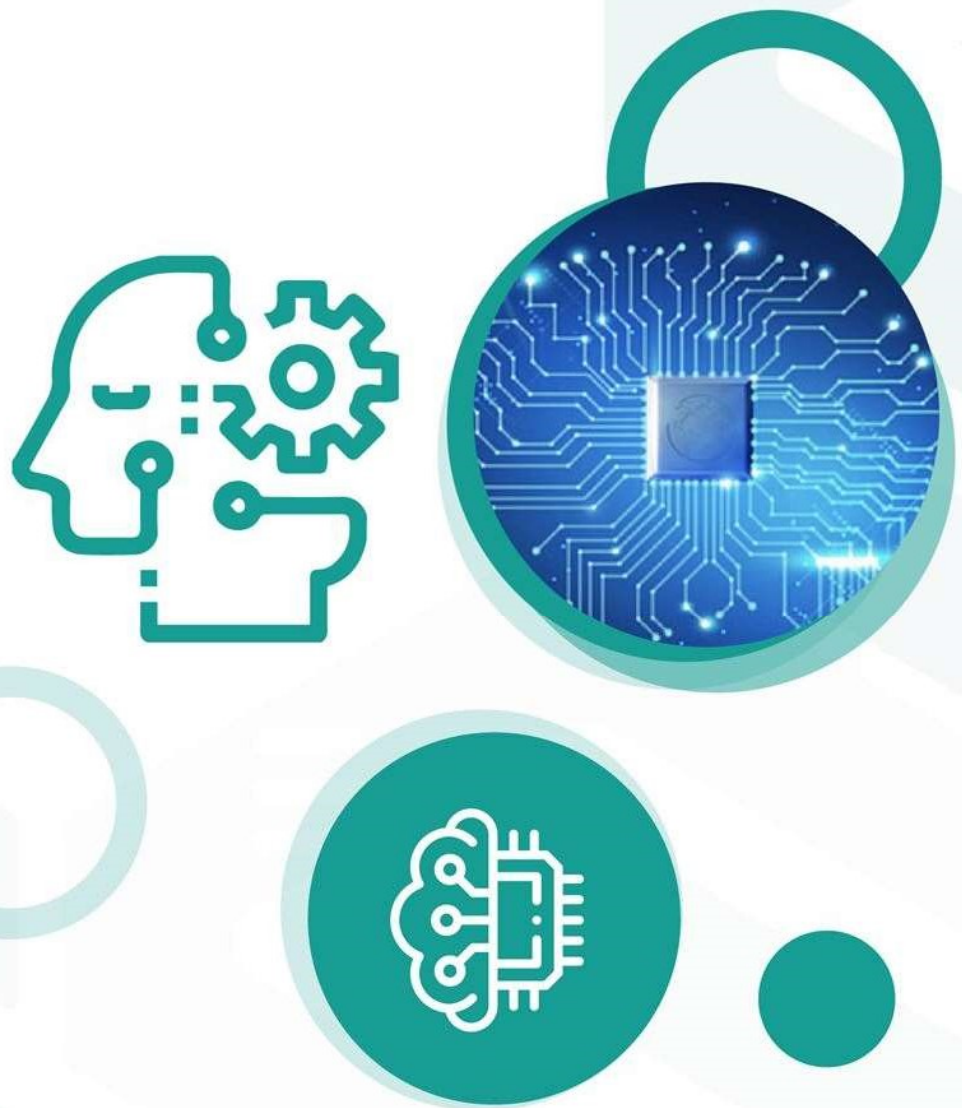


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## **AI Research Index:**

# **What is the Best AI University in the World?**

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The contents of this report may differ from the official opinion of the Ministry of Science and ICT. They are personal opinions of the researchers.

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## Summary

As artificial intelligence (“AI”) has been attracting attention as an innovative growth engine that will drive future industries and societies, strengthening the research capacity for AI is becoming a bottom-line issue. Research capacity is the most crucial intangible activity for technological innovation. It is key to achieving the best performance in the upcoming technology market. Therefore, we, in this article, sought to develop an AI Research Index that could measure the research capacity for AI for universities around the world and draw implications.

We defined AI Research Index as the indexed value of AI research performance from 2016 to 2019. We leveraged Scholarly Output, Citation per Publication (“CPP”), and the Field-Weighted Citation Impact (“FWCI”) to measure research capacity for AI. We then reflected weights for variables. We first selected the world's top 500 universities based on the Scholarly Output for AI research and measured the AI Research Index for 500 universities in consideration of the quantity, quality, and weight of variables. After that, we selected the world's top 100 AI universities and analyzed the proportion by country.

The world's top 500 universities were first selected based on their Scholarly Output for AI research. They were found to conduct an average of 404 research studies each over a four-year period (from 2016 to 2019). Nationalities of these top 500 universities are: 101 (20.2%) in China, 61 (12.2%) in the US, 45 (9.0%) in India, 29 (5.8%) in the UK, 25 (5.0%) in Japan, and 21 (4.2%) in France. In consideration of the quantity and quality of performance indices, we measured the AI Research Index and found that the average index was 46.01 for the top 500 universities. The average index of AI Research Index of the top 100 universities was 67.26, different from that of 500 universities. Among the top 100 universities, ratios of universities in China, the US, and the UK were high. Among these top 10 universities with the highest AI research indices, the US had the highest proportion at 40%.

The implication of this research was that there was a difference in AI research capacity between universities. The distribution of AI research capacity was not a normal one, but a form of power law. This result was similar to results of previous research studies on the distribution of human resources. The top universities with high AI research indices are located mainly in the US and China. It is expected that universities in China, the UK, and Australia are more likely to enter the top ten in the future. In response, we need to pay attention to universities arising in the AI field, seek various universities to cooperate with, continuously develop measurement models for AI research indices, and build monitoring systems.

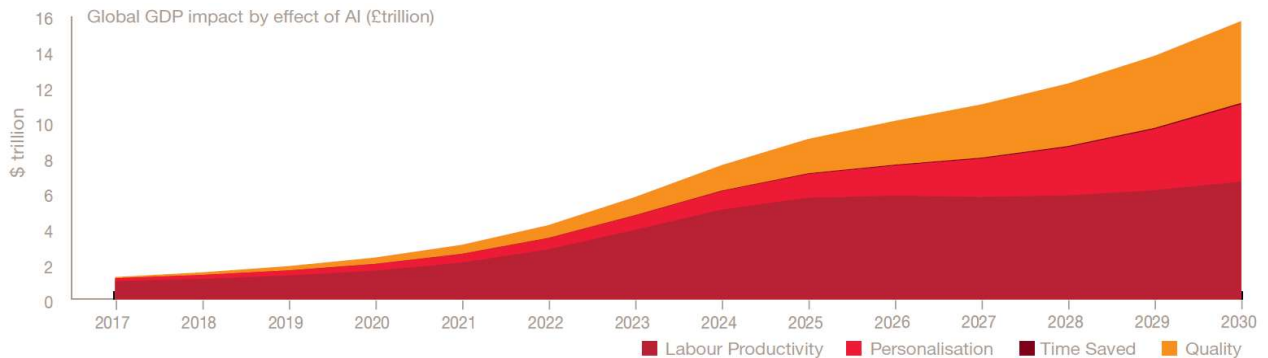
# Table of Contents

<b>I. Research Background and Methods</b> .....	5
<b>II. AI Research Index Measurement</b> .....	8
<b>III. Implications</b> .....	13
<b>Appendices</b> .....	19
<b>References</b> .....	22

## I. Research Background and Methods

- **As AI has been attracting attention as an innovative growth engine that will drive future industries and societies, strengthening the research capacity for AI is becoming a bottom-line issue.**
  - AI is expected to generate an economic effect of \$15.7 trillion in 2030 after increasing productivity and personalization.<sup>1</sup>

**Figure 1. The ripple effect of AI.**



Source: [www.pwc.com/AI](http://www.pwc.com/AI), Sizing the prize: What's the real value of AI for your business and how can you capitalize?

- Research capacity is the most crucial intangible activity for technological innovation. It is the key to achieving the best performance in the upcoming technology market.<sup>2</sup>
- The government, universities, and companies are making efforts to strengthen their research capacities on AI.
  - Eric Schmidt, the former CEO of Google, has announced plans to set up a "Digital Service Academy" to strengthen the research capacity on AI and nurture human resources.<sup>3</sup>
    - \* The National Security Commission on AI (NSCAI)<sup>4</sup> supports the establishment of the Academy, unanimously approving the report submitted by Eric Schmidt on July 20, 2020.
  - MIT has invested approximately one trillion KRW to establish and operate the M.I.T. Stephen A. Schwarzman College of Computing, a college specializing in AI, since 2019.

<sup>1</sup> [www.pwc.com/AI](http://www.pwc.com/AI), Sizing the prize: What's the real value of AI for your business and how can you capitalize?

<sup>2</sup> 26, 521-536.; Dutta, S., O, Narasimhan and S. Rajiv (1999), "Success in High-Technology Markets: Is Marketing Capability Critical?" *Marketing Science*, 18(4), 547-568.

<sup>3</sup> *Business Insider* (Jul 21, 2020), Ex-Google CEO Eric Schmidt is working on launching a university that would rival Stanford and MIT and funnel tech workers into government work.

<sup>4</sup> NSCAI (National Security Commission on AI): an NSC-affiliated committee established by the US congress in 2018 to counter to the pursuit of AI technologies by China and Russia.

- **There is a lack of objective indices that can measure and compare research capacities on AI.**
  - Although there are AI-related indices, objective indices that specialize in research capacity are lacking due to proportions biased toward qualitative indices.
  - There is no index that can compare AI with other institutions in the form of a single index in consideration of both quantity and quality of performance indices.

**Table 1. AI-related key indices.**

Indices	What can they do (or cannot do)?
AI Index	<ul style="list-style-type: none"> <li>- It was announced by the Stanford Institute for Human-Centered AI. It presents various statistics on the cost and accuracy of training AI.</li> <li>- Although there are some data related to the amount of research, there are limited comparable data to compare data in the form of a final index by reflecting qualitative indices.</li> </ul>
Government AI Readiness Index	<ul style="list-style-type: none"> <li>- It was announced by the Oxford Insight in 2019. South Korea is ranked 26th. It includes qualitative indicators such as national AI strategy and the existence of data legislation.</li> </ul>
AI Research	<ul style="list-style-type: none"> <li>- It was released on OECD.AI by leveraging MS Academic Graph data.</li> <li>- Although the Scholarly Output for AI research and collaborative research indices by institution are being presented, they are not presented in the form of a final index or ranking in consideration of both the quantity and quality.</li> </ul>
AI Brain Index	<ul style="list-style-type: none"> <li>- SPRi (2019) measured and compared capacities of 100 the most outstanding core human resources in 25 countries in consideration of both the quantity and quality of AI research.</li> </ul>

Source: Stanford HAI (2019) “AI Index”, Oxford Insight (2019) “Government AI Readiness Index”, OECD.AI, SPRi (2019), SPRi Analysis Based on "Artificial Intelligence Brain Index: Analysis and Meaning of Core Human Resources".

- **We, in this article, have developed an AI Research Index that can measure the research capacity on AI and derive implications.**
  - An index has been prepared to compare results of AI research by the world's top universities.
    - Universities are incubators of knowledge and human resource as core national resources.<sup>5</sup> They are highly accessible with large ripple effects because they produce knowledge that is relatively open compared to industrial organizations.<sup>6</sup>
  - Results of artificial intelligence research from 2016, when the Google Deepmind Challenge Match (AlphaGo versus Lee Sedol) was held, to 2019 were compared in consideration of both quantity and quality.

<sup>5</sup> Samsung Economic Research Institute (2006), "University Innovation and Competitiveness"

<sup>6</sup> Krätke, S. (2010), “Regional Knowledge Networks: A Network Analysis Approach to the Interlinking of Knowledge Resources”, European Urban and Regional Studies, 17(1): 83-97.

- **Measurement and analysis of AI Research Index by dividing it into four stages.**
  - The AI Research Index is a value indexed by AI research performance between 2016 and 2019.
    - \* This research measured the index based on research performance from the match with AlphaGo in 2016, which emphasized the importance of AI, to 2019.
    - \* Objects to be measured by the AI Research Index can be classified into universities, government agencies, companies, and so on. However, this research was conducted on universities.
  - By leveraging the Scholarly Output, the CPP, and the FWCI,<sup>7</sup> we measured the quantity and quality of AI Research Index and reflected weights of variables.<sup>8</sup>

$$AI\ Research\ Index = W_{Scholarly\ Output} * V_{Scholarly\ Output} + W_{Citation/Publication} * V_{Citation/Publication} + W_{FWCI} * V_{FWCI}$$

- \*  $W_i$  = weight of variable  $i$ ,  $V_i$  = measured value of variable  $i$
- Based on the Scholarly Output for AI research, the world's top 500 universities were first selected and indices were measured in consideration of quantity, quality, and weight of variables (data from domestic universities were not reflected).<sup>9</sup>
- We selected the world's top 100 AI universities and analyzed the proportion of universities by country.

**Table 2. Measurement stages of AI Research Index.**

<b>1</b>	Overview of AI Research Index	<ul style="list-style-type: none"> <li>• Concept of AI Research Index: Indexed values of research performance for AI from 2016 to 2019 based on 100 points</li> <li>• Research performance variables: Scholarly Output, CPP, and FWCI</li> </ul>
<b>2</b>	Selecting the top 500 universities	<ul style="list-style-type: none"> <li>• Selecting top 500 universities based on the Scholarly Output</li> </ul>
<b>3</b>	Measuring AI research indices	<ul style="list-style-type: none"> <li>• Weighting three variables</li> <li>• Analyzing AI research indices of the top 500 universities</li> </ul>
<b>4</b>	Analyzing the AI Research Indices	<ul style="list-style-type: none"> <li>• Analyzing AI Research Indices for the world's top 500 AI universities.</li> </ul>

<sup>7</sup> The Field Weighted Citation Impact (FWCI) is a citation rate compared to the world average. For example, if the FWCI is 1.23, it can be interpreted that the paper has been cited 23% more than the world average.

<sup>8</sup> We collected data from 2016 to 2019 based on Elsevier DB's Artificial Intelligence classification, included various research types such as 224 journals, 4,102 conferences, and book chapters, and measured weights via interviews with AI experts.

<sup>9</sup> Data from domestic universities will be collected separately and reflected in the future.

## II. Measurement of the AI Research Index

### II-A. Analysis of Top 500 Universities

- **The world's top 500 universities were first selected based on their Scholarly Output for AI research. They were found to conduct an average of 404 studies each over a four-year period (2016-2019).**
  - During that period, 500 universities were selected from 6,138 universities in 173 countries that could be measured in the DB.
  - Between 2016 and 2019, the top 500 universities based on the Scholarly Output conducted an average of 404.4 studies, with an average of CPP of 4.81.
  - The average FWCI of 500 universities between 2016 and 2019 was 1.26, which was more than 23% of the world average.

**Table 3. Statistics of AI research performance variables (2016-2019).**

	Scholarly Output	Citations per Publication	Field Weight Citation Impact
Number of observations	500	500	500
Mean	404.40	4.812	1.26
Variance	292.72	2.87	0.53

Source: SPRi Analysis.

- **There was a difference in research capacity between universities based on the Scholarly Output for AI research.**
  - There were great differences in Max and Min values of research results and performances within 500 institutions.
    - \* The number of universities that did the most research in four years was 2,067, which was much larger than the minimum of 181.
    - \* The FWCI also showed a very large gap, with a Max of 3.75 and a Min of 0.34.

**Table 4. Max and Min values of AI research performance variables (2016-2019).**

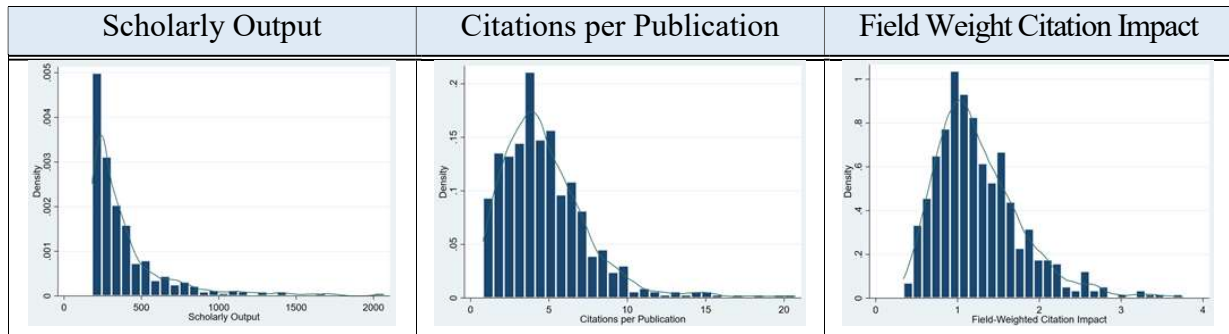
	Scholarly Output	Citations per Publication	Field Weight Citation Impact
Max	2067	20.7	3.75
Min	181	0.8	0.34

Source: SPRi Analysis.



- Data for the three performance indices of research capacity were concentrated on the left side of the distribution with long tails on the right side (Positive Skewness).

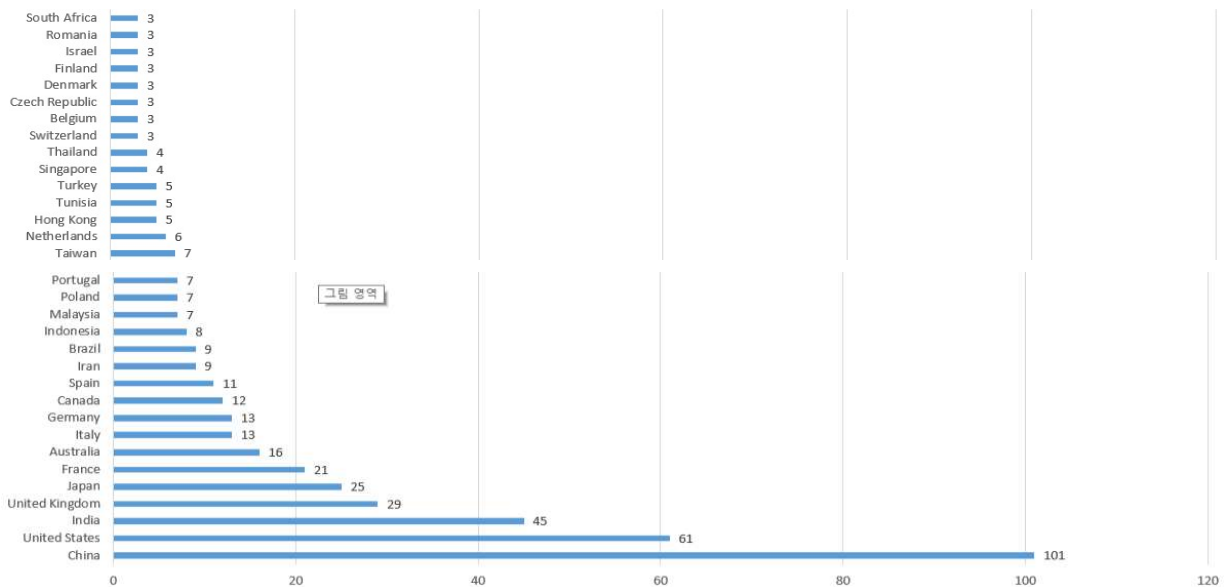
**Figure 2. Distribution of AI research performance variables.**



Source: SPRi Analysis

- **Among the top 500 universities based on the Scholarly Output, China and the US accounted had high proportions.**
  - Among the 500 universities, the top five countries accounted for 52.2%.
  - 101 (20.2%) in China, 61 (12.2%) in the US, 45 (9.0%) in India, 29 (5.8%) in the UK, 25 (5.0%) in Japan, and 21 (4.2%) in France.

**Figure 3. Nationality distribution of the top 500 universities based on the Scholarly Output.**



Source: SPRi Analysis.

## II-B. Measurement of AI Research Index

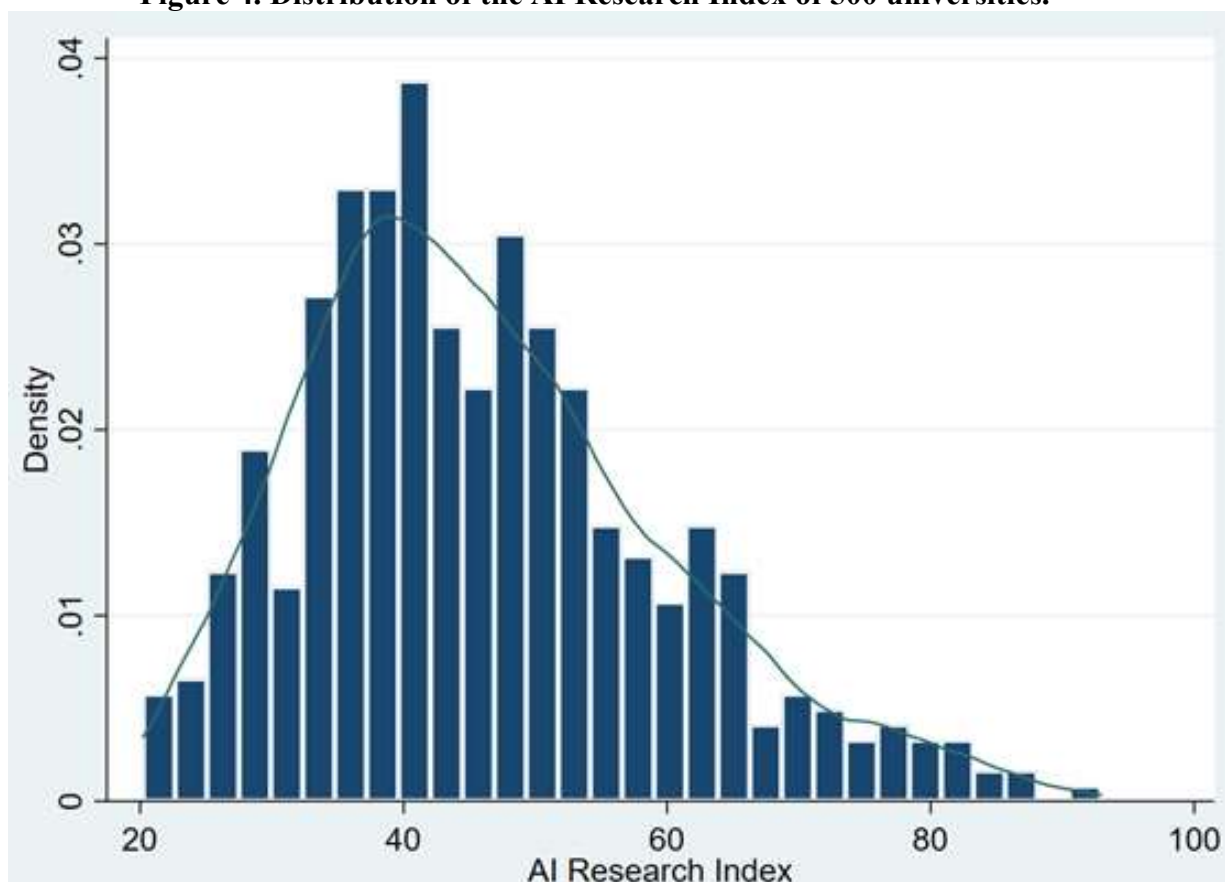
- **Research indices of artificial intelligence of the 500 universities were measured in consideration of both the quantity and quality of performance indices. The average of AI research index was 46.01.**
  - 100 points were given to the top 0.5% or more of the performance variables and 50 points were given to the average. These weights were measured via interviews with AI experts.<sup>10</sup>
  - The average AI research index for 500 universities was 46.01, with the highest one at 92.9.

**Table 5. Statistics for the AI Research Index of 500 universities.**

	Mean	Variance	Max	Min
AI Research Index	46.01	13.65	92.9	20.2

Source: SPRi Analysis.

**Figure 4. Distribution of the AI Research Index of 500 universities.**



Source: SPRi Analysis.

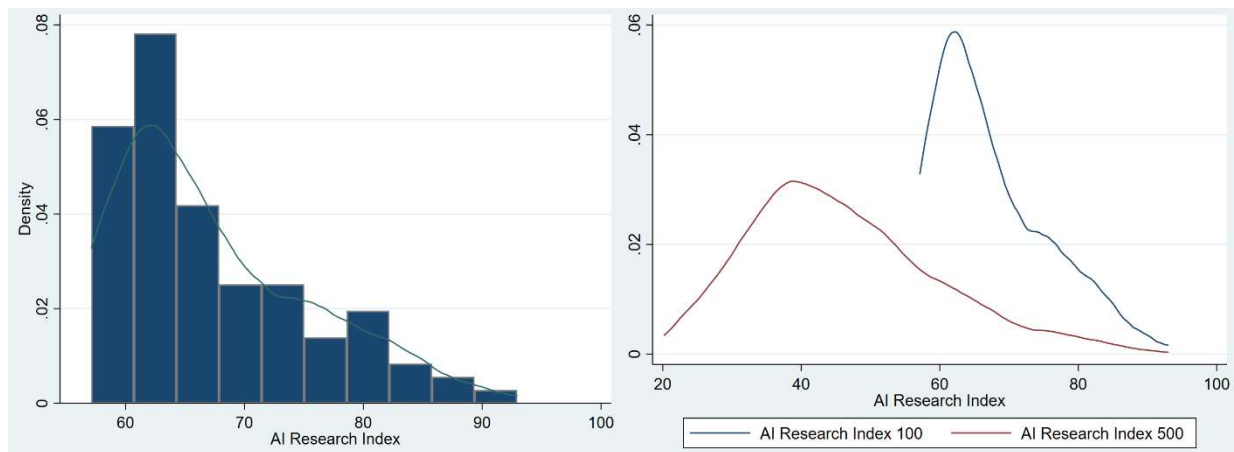
<sup>10</sup> Weights: Scholarly Output 0.32, CPP 0.15, and FWCI 0.53

- **The average of top 100 universities based on the AI Research Index was 67.26, which was higher than that for the top 500 universities. Among these 100 universities, China, the US, and the UK had high proportions.**
- The average AI Research Index for the top 100 universities was 67.26. It was 46.01 for the top 500 universities.

**Table 6. T-test statistics of AI Research Index for the top 100 universities and top 500 universities.**

	Mean	Variance	95% Confidence Interval	
			lower	upper
AI Research Index 100	67.26	8.22	65.63	68.90
AI Research Index 500	46.01	13.65	44.81	47.21
Combined	49.55	15.14	48.34	50.77
t value	15.02			

Source: SPRi Analysis.



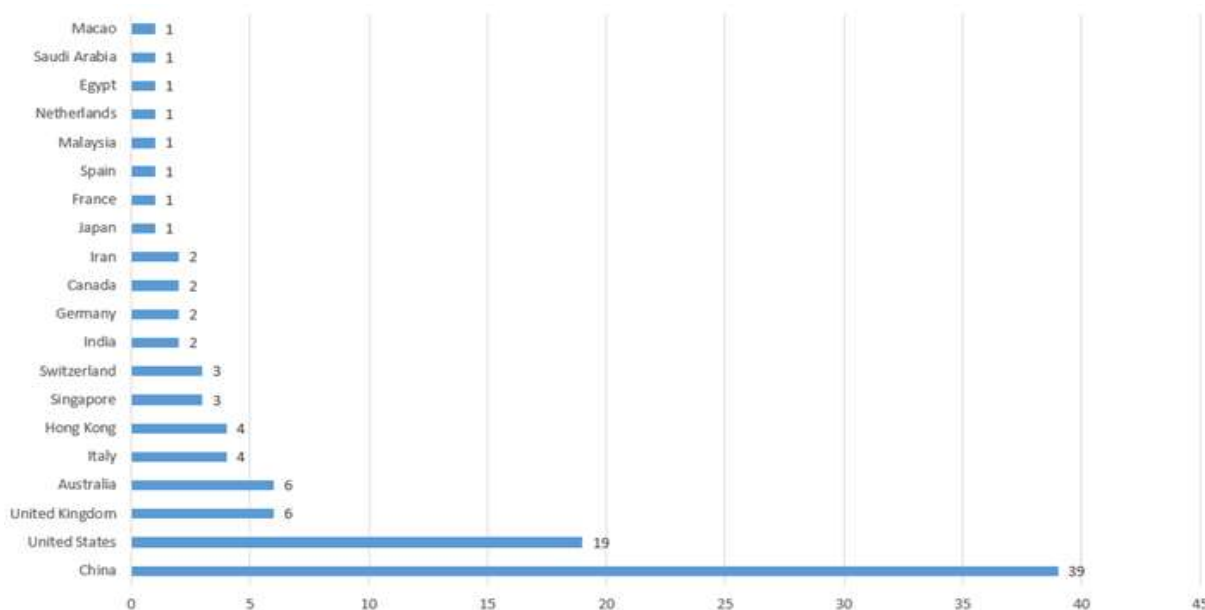
**Figure 5-a. Left, Distribution of AI Research Indices of 100 universities.**

Source: SPRi Analysis.

**Figure 5-b. Right, Comparison of 100 universities and 500 universities.**

Source: SPRi Analysis.

- The top 100 universities included 39 (39.0%) in China, 19 (19.0%) in the US, 6 (6.0%) in the UK, 6 (6.0%) in Australia, 4 (4.0%) in Italy, 4 (4.0%) in Hong Kong, and 3 (3.0%) in Singapore.



**Figure 6. Nationality distribution of the top 100 universities based on the AI Research Index.**

Source: SPRi Analysis.

- **Among the top 10 universities based on the AI Research Index, the US accounted for a high percentage.**
  - US universities ranked first to third in the AI Research Index. US universities accounted for 40% of the top 10 universities.
    - \* University of California at Berkeley, MIT, and Stanford University ranked first, second, and third, respectively.
  - Among the top 10 universities, 4 (40%) were from the US, and one each was from Switzerland, the UK, Singapore, Australia, China, and Saudi Arabia.

**Table 7. Top 10 universities based on the AI Research Index.**

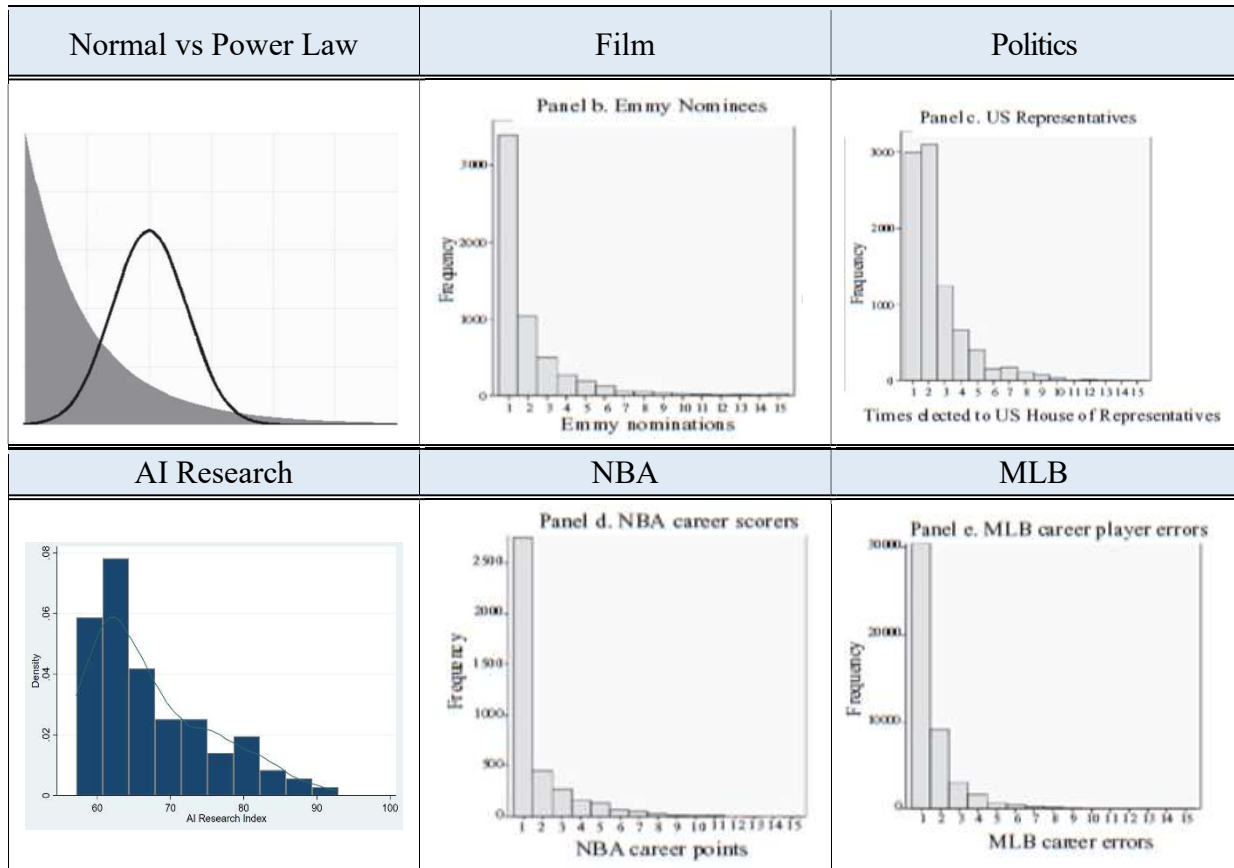
Rank	University	Nationality	AI Research Index
1	University of California at Berkeley	United States	92.93
2	Massachusetts Institute of Technology	United States	87.97
3	Stanford University	United States	85.85
4	Swiss Federal Institute of Technology Zurich	Switzerland	84.77
5	King Abdulaziz University	Saudi Arabia	84.64
6	National University of Singapore	Singapore	82.81
7	Carnegie Mellon University	United States	81.46
8	University of Cambridge	United Kingdom	81.37
9	CAS	China	81.23
10	University of Technology Sydney	Australia	80.06

Source: SPRi Analysis.

### III. Implications

- **There were differences in AI research capacities among universities. The gap between the average level and the leading level was large.**
    - The research capacity distribution was not normal, but in a form of power law distribution, similar to a previous traditional research on human resource distribution.
    - Although the capacity was assumed to be have a normal distribution, the actual capacity appeared in the form of a power law distribution, resulting in a large difference between the average and the excellent group.
- \* 10% of productivity came from the top 1% universities and 26% of the productivity came from the top 5% universities.<sup>11</sup>

**Figure 7. Performance distribution in various fields.**

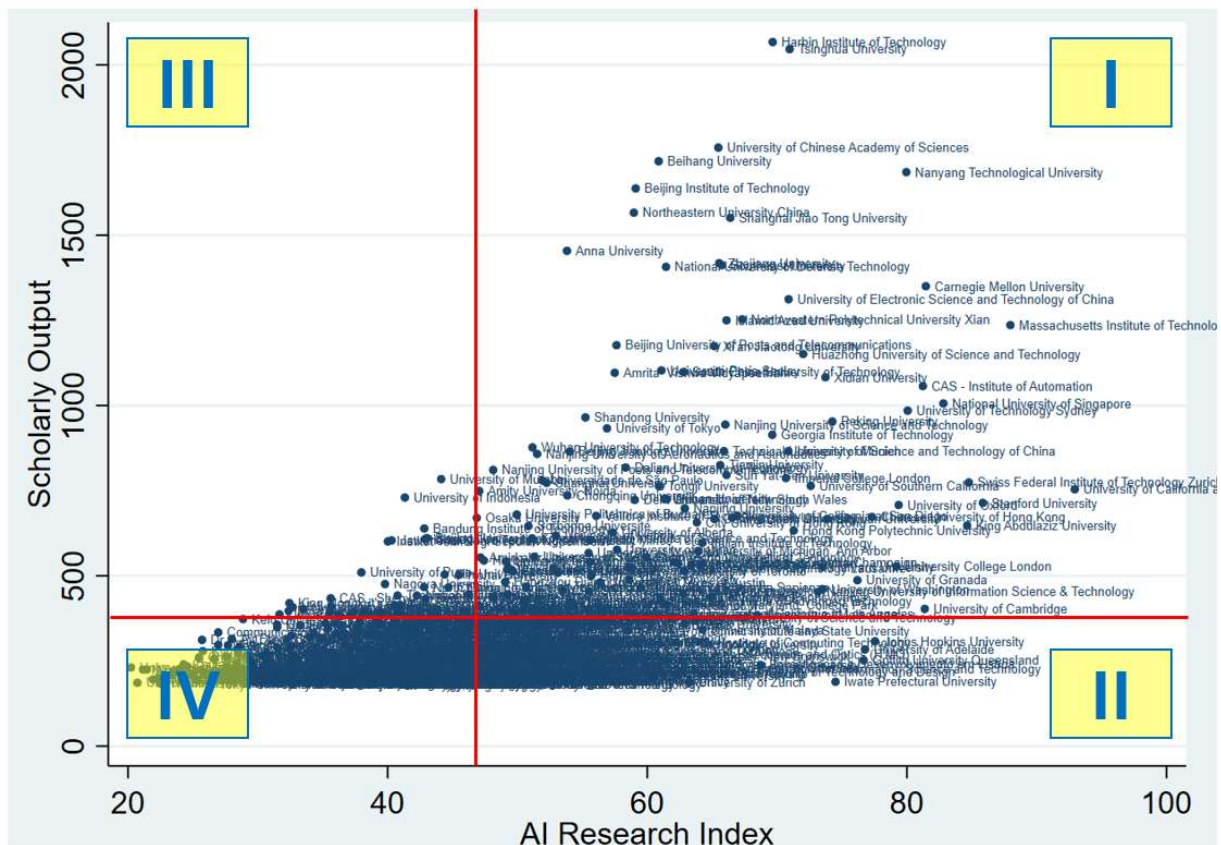


Source: Ernest O'Boyle, Herman Aguinis, “The Best and The Rest: Revisiting the Norm Of Normality Of Individual Performance”, Personnel Psychology 65(1) · March 2012, SPRi Analysis.

<sup>11</sup> Ernest O'Boyle, Herman Aguinis, “The Best and The Rest: Revisiting The Norm Of Normality Of Individual Performance”, Personnel Psychology 65(1) · March 2012.

- It is expected that universities around the world will make quantitative and qualitative efforts to strengthen their AI research capacities. The top universities based on the AI research are mainly located in the US and China. It is expected that universities in China, the UK, and Australia are more likely to enter the top ten in the future.
  - 500 universities can be divided into four quadrants starting with the average number of AI research and the average of AI capacity index. Their competition to enter groups I and II is expected to intensify.
    - Group I: has a high Scholarly Output for AI research and a high research index
    - Group II: has a low Scholarly Output for AI research, but the research quality is excellent
    - Group III: has a low Scholarly Output for AI research, but the research quality is excellent
    - Group IV: has a low Scholarly Output for AI research and a low research index

Figure 8. Scholarly Output and AI capacity index of 500 universities.



Source: SPRi Analysis.

- The top 100 universities included 39 in China, 6 in the UK, and 6 in Australia. These are likely to enter the top 10.
  - \* The University of Oxford in the UK is ranked the 12<sup>th</sup>. Griffith University Queensland in Australia is ranked the 17<sup>th</sup>, and Peking University in China is ranked the 20<sup>th</sup>.

- Although universities in Switzerland were small in number, they possessed strong AI research capacities.
- \* Three Swiss universities<sup>12</sup> were included in the top 500 universities based on the Scholarly Output. They were all included in the top 100 universities, one of which was in the top 10.

**Table 8. Proportion of universities by nationality based on key criteria.**

Nationality of university	Top 10	Top 100	Top 500 based on Scholarly Output
United States	40%	19%	12.2%
China	10%	39%	20.2%
United Kingdom	10%	6%	5.8%
Australia	1%	6%	3.2%
Switzerland	1%	3%	0.6%
India	-	2%	9.0%
Japan	-	1%	5.0%

Source: SPRi Analysis.

- **We need to pay attention to universities arising in the AI field via selection and concentration and seek ways to cooperate with them.**
  - Computer Science (CS) ranking does not necessarily match the AI Research Index. There are universities that are rapidly growing in the AI field via selection and concentration.

**Table 9. Comparison of AI Research Index and CS rankings of major universities.**

Universities	AI Research Index	QS World University Rank 2020 (Computer Science)
UC. Berkeley	1	4
MIT	2	1
Stanford University	3	2
ETH Zurich	4	9
King Abdulaziz University	5	51~100
Carnegie Mellon University	7	3
University of Technology Sydney	10	42
Johns Hopkins University	14	51~100

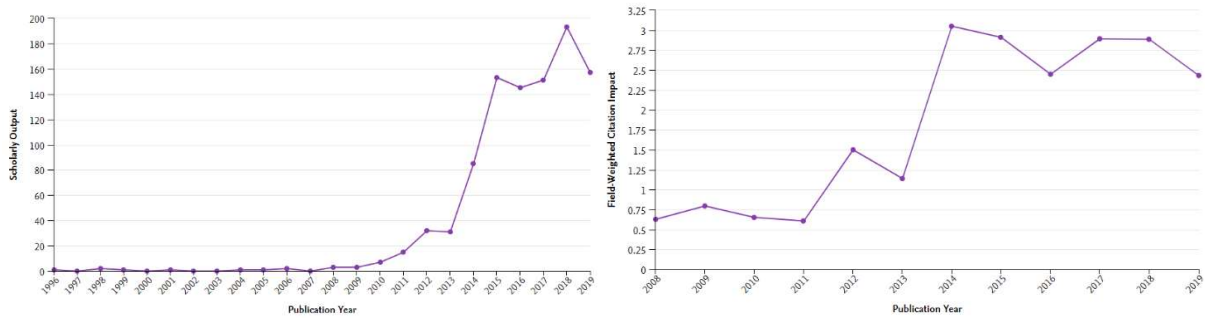
Source: QS World University Rank 2020, SPRi Analysis.

<sup>12</sup> Swiss Federal Institute of Technology Zurich, University of Zurich, Swiss Federal Institute of Technology Lausanne.



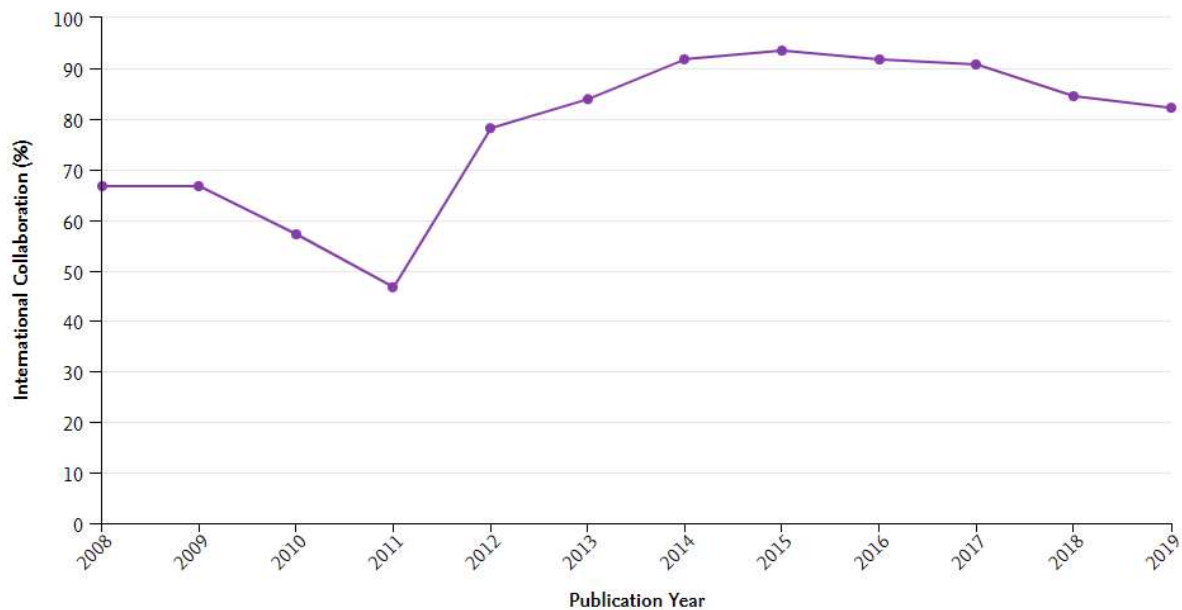
- King Abdulaziz University in Saudi Arabia is growing rapidly in a short period of time. It accounts for a very high proportion in global collaborative research.
- \* Over the last five years, the proportion of AI global collaborative research has approached 90%.

**Figure 9. Changes in Scholarly Output (left) and FWCI (right) for AI at King Abdulaziz University.**



Source: SPRi Analysis.

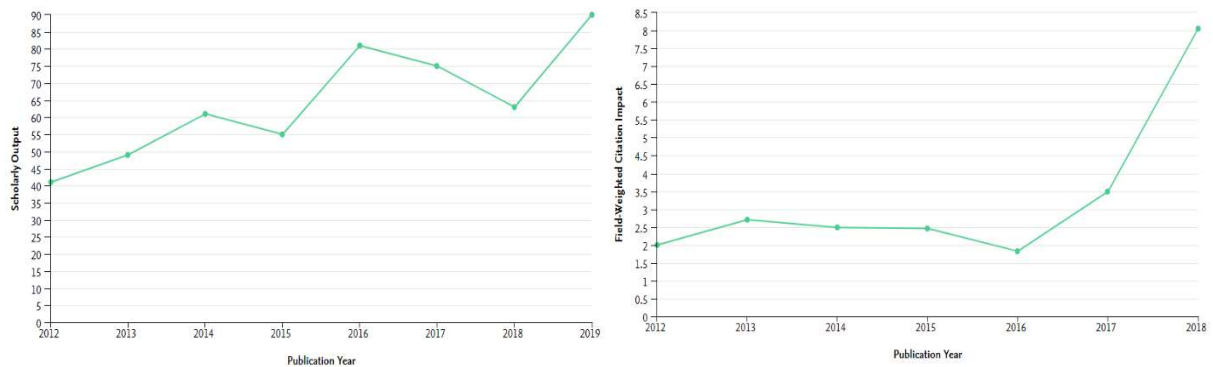
**Figure 10. Changes in proportion of AI global cooperative research at King Abdulaziz University.**



Source: SPRi Analysis.

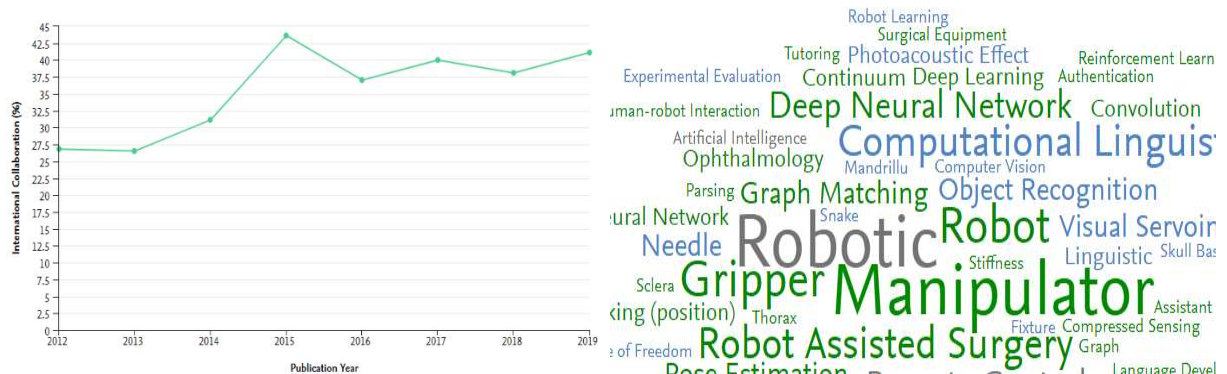
- Johns Hopkins University is combining its strengths in medical field with AI to differentiate its competitiveness.
- \* Johnson Hopkins University's Scholarly Output for AI had increased from 40 in 2012 to 90 in 2019.
- \* The proportion of global collaborative research also exceeded 40%. As a result of analyzing key research themes by leveraging Word Cloud, researches that combine AI with the medical field such as Robot Assisted Surgery are actively underway.





**Figure 11. Changes in Scholarly Output (left) and FWCI (right) for AI at Johns Hopkins University.**

Source: SPRi Analysis.



**Figure 12. The proportion of global collaboration on AI research (left) and Word Cloud (right) at Johns Hopkins University.**

Source: SPRi Analysis.

- **Domestic universities should be aware of pitfalls of three errors related to AI capacities.**
  - It is necessary to compare the power-law type distribution of AI research capacities, CS rankings, and AI Research Index rankings, and to accurately analyze the current location in consideration of universities that could increase their competitiveness through selection and concentration.
    - ① “Our university’s AI capacity is at an average level, and the difference with leading universities is not significant.” → **“The difference is great.”**
    - ② "Since our university's Computer Science (CS) ranking is high, our AI capacity is also high." → **"It does not necessarily match."**
    - ③ "We just have to be enthusiastic in all fields related to AI." → **"Selection and concentration are needed."**

- **Measurement model of AI research index must be continuously developed and a monitoring system must be established**
  - It is necessary to continuously observe AI research capabilities of universities that can change by leveraging the AI research index.
    - Although data of domestic universities were excluded from this study, we need to seek ways to grasp AI capabilities of domestic universities and leverage them to check their direction.
  - It is necessary to explore universities that are growing based on AI Research Indices and seek ways to establish a collaborative system.
  - The measurement model must be continuously improved and subdivided by additionally considering various variables such as patents in addition to performance indices used in this study.
    - This AI Research index was measured as an average concept covering the entire field. A more detailed analysis can be performed in the future by segmenting the AI technology field and classifying competence when measuring.
    - A method of expanding the scope of AI research index from modern studies to enterprises and government-funded institutions must also be considered.

## Appendix 1: Top 100 universities based on their AI Research Indices

Ranking	University	Nationality
1	University of California at Berkeley	United States
2	Massachusetts Institute of Technology	United States
3	Stanford University	United States
4	Swiss Federal Institute of Technology Zurich	Switzerland
5	King Abdulaziz University	Saudi Arabia
6	National University of Singapore	Singapore
7	Carnegie Mellon University	United States
8	University of Cambridge	United Kingdom
9	CAS - Institute of Automation	China
10	University of Technology Sydney	Australia
11	Nanyang Technological University	Singapore
12	University of Oxford	United Kingdom
13	University College London	United Kingdom
14	Johns Hopkins University	United States
15	Chinese University of Hong Kong	Hong Kong
16	University of Adelaide	Australia
17	Griffith University Queensland	Australia
18	University of Granada	Spain
19	Iwate Prefectural University	Japan
20	Peking University	China
21	Sichuan University	China
22	Xidian University	China
23	Harvard University	United States
24	University of Washington	United States
25	Nanjing University of Information Science & Technology	China
26	University of Southern California	United States
27	Huazhong University of Science and Technology	China
28	Hong Kong Polytechnic University	Hong Kong
29	Tsinghua University	China
30	University of Electronic Science and Technology of China	China
31	University of Science and Technology of China	China
32	Imperial College London	United Kingdom
33	Harbin Institute of Technology	China
34	Georgia Institute of Technology	United States

Ranking	University	Nationality
35	Bohai University	China
36	University of Melbourne	Australia
37	Northwestern Polytechnical University Xian	China
38	University of California at San Diego	United States
39	Shenzhen University	China
40	Shanghai Jiao Tong University	China
41	Islamic Azad University	Iran
42	Sun Yat-Sen University	China
43	Nanjing University of Science and Technology	China
44	Technical University of Munich	Germany
45	Southeast University	China
46	Tianjin University	China
47	Zhejiang University	China
48	University of Chinese Academy of Sciences	China
49	Xi'an Jiaotong University	China
50	Central South University	China
51	University of Pennsylvania	United States
52	University of Malaya	Malaysia
53	Italian Institute of Technology	Italy
54	University of Sydney	Australia
55	University of Michigan, Ann Arbor	United States
56	City University of Hong Kong	Hong Kong
57	University of California at Los Angeles	United States
58	Arizona State University	United States
59	University of Zurich	Switzerland
60	Nanjing University	China
61	Thapar University	India
62	University of Toronto	Canada
63	South China University of Technology	China
64	University of Macau	Macao
65	Singapore University of Technology and Design	Singapore
66	Polytechnic University of Milan	Italy
67	CAS - Institute of Computing Technology	China
68	University of Freiburg	Germany
69	University of Illinois at Urbana-Champaign	United States
70	Hong Kong University of Science and Technology	Hong Kong
71	University of New South Wales	Australia
72	University of Maryland, College Park	United States
73	National University of Defense Technology	China

Ranking	University	Nationality
74	Wuhan University	China
75	Université Paris-Saclay	France
76	Shenzhen Institute of Advanced Technology	China
77	University of Edinburgh	United Kingdom
78	Tongji University	China
79	Beihang University	China
80	De Montfort University	United Kingdom
81	Cornell University	United States
82	Guangdong University of Technology	China
83	Tsinghua National Laboratory for Information Science and Technology	China
84	University of Rome La Sapienza	Italy
85	Beijing Institute of Technology	China
86	Delft University of Technology	Netherlands
87	Northeastern University China	China
88	Swiss Federal Institute of Technology Lausanne	Switzerland
89	Xiamen University	China
90	New York University	United States
91	Virginia Polytechnic Institute and State University	United States
92	Southwest Jiaotong University	China
93	Dalian University of Technology	China
94	University of Tehran	Iran
95	Beijing University of Posts and Telecommunications	China
96	Cairo University	Egypt
97	Amrita Vishwa Vidyapeetham	India
98	University of Alberta	Canada
99	Southwest University	China
100	University of Pisa	Italy

## Appendix 2: Examples of journals and conferences that include research capacity analysis

### **There were a total of 4,102 conferences, including:**

CVPR: IEEE/CVF Conference on computer vision and pattern recognition  
NeurIPS: Neural Information Processing Systems  
ECCV: European Conference on Computer Vision  
ICML: International Conference on Machine Learning  
ICCV: IEEE/CVF International Conference on Computer Vision  
ACL: Meeting of the Association for Computational Linguistics  
SIGIR: special interest group on information retrieval  
WWW: The Web Conference  
ACL: Association for Computational Linguistics  
KDD: Knowledge Discovery and Data Mining  
AAAI: Association for the Advancement of Artificial Intelligence  
IJCAI: International Joint Conferences on Artificial Intelligence Organization  
ICLR: The International Conference on Learning Representations  
WSDM: Web Search and Data Mining  
CIKM: Conference on Information and Knowledge Management  
EMNLP: Empirical Methods in Natural Language Processing

### **There were a total of 224 journals, including:**

ACM Transactions on Information System (TOIS)  
Artificial Intelligence (AIJ)  
IEEE Transactions on Knowledge and Data Engineering (TKDE)  
Computational Linguistics (CL)  
Journal of Machine Learning Research (JMLR)  
IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI)  
ACM Transactions on Intelligent Systems and Technology (TIST)  
Information Processing & Management (IPM)  
Information Retrieval (IRJ)  
Journal of the American Society for Information Science and Technology (JASIST)

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