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# Comparison of Research Performance by Institute based on Research Keywords

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### Abstract

To propose a new method of comparing performance between studies on the same subject at different institutions, this study obtained information on grant amounts, keywords related to the research, and the number of achievements for all projects from the Grants-in-Aid for Scientific Research (KAKENHI) Database. From this database, the information on research projects between FY 2012 and 2021 was obtained and classified into ten groups according to their budget amounts. Thereafter, 12 research institutes were focused and compared the number of research achievements in each group. Throughout all groups, the institute's performance differences were not apparent based on the comparison of research projects. However, the results revealed that the method of comparing by keywords better indicates the differences in the performance of each institute. To clarify the causes of the differences, the authors compared achievements in common and unique words separately. Consequently, there tended to be significant differences in performance for unique words than common words. More reliable results are expected to be obtained by improving the determination accuracy of the same keywords.

Keywords: KAKENHI, Research performance, University Research Administrator

## **1** Introduction

Most scientists affiliated with research institutions in Japan conduct their research activities by obtaining grants, known as Grants-in-Aid for Scientific Research (KAKENHI), and thereafter, publish the results to give back to society and build on their achievements. Nonetheless, the research institutes employing scientists also track their outcomes and consider the areas in which they can grow their research capabilities. This study aims to find research topics with high performance and differentiate them from others. Here, high performance means the ability to produce many research achievements or outcomes within a limited budget.

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In previous studies on grants, Nomura et al. attempted to classify institutions based on the number of projects selected for funding [1]. Nomura et al. and Nishizawa et al. obtained an index of research activity for each university based on the amount allocated to each research category [2][3][4]. Furthermore, Yabuki used data on the number of applications and grants received for KAKEN to compare research performance between similar research departments [5]. Recently, Hirai led the establishment of the Code for Research Administration (C4RA), a community of University Research Administrators (URAs), and others. This community aims to increase the efficiency and sophistication of research Institutional Research (IR) in Japan by sharing program codes and tools across institutions of affiliation. Community members develop and share programs and tools for analyzing papers and external funding [6]. With the support of the community, Kubo and Hirai developed an application that visualizes the number of adoptions and allocation amounts for each institution by research category or review section. Moreover, this application provides a network among researchers based on the information of collaborators [7].

Certain studies are government-sponsored. The Science for RE-designing Science, Technology, and Innovation Policy Center (SciREX) of the National Graduate Institute for Policy Studies (GRIPS) is developing the SciREX Policymaking Intelligent Assistance System (SPIAS). SPIAS searches the data of papers, patents, and press releases by the research subject, research institute, and researcher. The system can analyze the contribution of past allocations to the industry based on the number of papers published and patents obtained [8]. The Council for Science, Technology, and Innovation (CSTI) has collected and analyzed evidence on research, education, and fundraising status at research institutes. It has established the e-CSTI (Evidence Data Platform) to share this evidence with the government and research institution stakeholders. The e-CSTI provides an analysis of researcher attribution and output, allocation and output, and external fundraising productivity [9][10][11].

The previous studies analyzed research outputs focusing on research category, review section, research project, research institution, and researcher. However, these studies did not extend to detailed thematic analyses. Finding high-performing research topics will help in developing more detailed research strategies.

### **2** Data and Analysis Method

The information on grant amounts, keywords related to the research, and the number of achievements (including journal articles and presentations) for all projects was obtained from the database of KAKEN to support thematic studies. KAKEN is a public database that includes information on adopted projects, assessments, and research achievements from the KAKEN Program. The authors obtained data from this database on research projects conducted between FY 2015 and 2019 and analyzed the differences in performance between two universities in a previous study[12]. This study followed the analytical approach of the previous survey, obtained data from this database on research projects conducted between FY 2012 and FY 2021, and classified them into ten groups according to budget amounts. Table 1 presents the budget size of each group and examples of research categories. The range of amounts in each group is not equally spaced.

Group	Range of Cost (Million yen)	Examples of Research Category
х	$200 \sim 600$	Specially Promoted Research
IX	$100 \sim 200$	Scientific Research (S)
VIII	60 ~ 100	Transformative Research Areas (A)
VII	40 ~ 60	Scientific Research (A)
VI	20 ~ 40	Transformative Research Areas (B) Challenging Research (Pioneering)
v	$10 \sim 20$	Scientific Research (B)
IV	6 ~ 10	Challenging Research (Exploratory)
Ш	4 ~ 6	Scientific Research (C)
Π	2~4	Early-Career Scientists Research Activity Start-up
Ι	1 ~ 2	JSPS Fellows

Table 1: Examples of research categories in each group

To characterize the number of achievements according to the budget amount, the number of accomplishments per project and its conversion per million yen were obtained for each group (Figure 1, Figure 2). For each figure, the horizontal axis is the allocation amounts, and the vertical axis is the number of achievements. The research achievements here include international collaborative research, symposium sponsorships, journal articles, conference presentations, publications, and patents. The diamond marks indicate the median of the achievements. In addition, the vertical error bars indicate the first and third quartiles of the outcomes, and the horizontal error bars correspond to the range of the allocation amount (Figure 1). This is because larger projects tend to have longer durations and include more researchers. Nonetheless, even if research costs doubled, the number of outcomes would not double immediately. The number of outcomes converted per million yen decreases as the budget increases (Figure 2).



Figure 2: The number of achievements per million yen for each group

As Figures 1 and 2 illustrate, comparing projects of different sizes is not appropriate because the scale of the number of achievements varies with the project size. Therefore, 12 research institutes were focused on, and compared the number of research achievements in each group. As these institutions receive a large allocation amount and their research fields are diverse, they have many areas in common. Therefore, it will be easy to compare their research performance. Their achievements will serve as benchmarks for each other. Table 2 summarizes the number of projects, the number of keywords, the allocation amount, and the achievements of each institute from FY 2012 to 2021 for Group I to X. The meaning of the keywords will be explained later. The abbreviations were provided for each institute. For example, Ti stands for Tokyo Institute of Technology, and Os for Osaka University.

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Group		Hk	Th	Tk	Ng	Kt	Os	Ks	Ti	Tb	Kb	Ko	Ws
	Projects	514	804	2,338	531	1,403	824	531	403	457	254	291	460
Ι	Keywords	3,068	4,565	11,873	3,025	7,671	4,544	2,988	2,305	2,923	1,567	1,838	3,005
	Allocation amount <sup>*1</sup>	853	1,356	3,899	873	2,343	1,389	892	687	763	425	482	750
	Achievements	4,087	7,089	17,332	4,701	11,011	6,404	4,311	3,478	3,548	1,947	2,323	3,617
	Projects	1,861	2,784	5,738	1,847	3,810	2,908	2,076	1,018	1,423	1,063	1,035	1,188
П	Keywords	9,890	13,717	25,844	9,870	18,713	13,861	11,138	5,752	8,071	6,309	5,451	7,595
	Allocation amount*1	5,923	8,957	17,197	5,901	11,724	9,385	6,606	3,150	4,492	3,417	3,341	3,600
	Achievements	24,793	36,245	67,163	24,566	47,536	37,645	24,969	14,693	17,070	13,247	11,515	14,008
	Projects	2,376	3,360	4,369	2,299	3,603	3,574	2,730	1,025	1,666	1,597	1,759	971
Ш	Keywords	12,080	15,854	19,527	11,471	17,385	16,197	13,972	5,819	9,486	8,651	8,210	6,626
	Allocation amount*1	10,876	15,248	19,644	10,446	16,398	16,191	12,467	4,710	7,603	7,321	7,976	4,406
	Achievements	39,738	52,183	66,877	38,354	58,840	56,421	41,335	19,075	26,535	26,989	24,181	17,114
	Projects	333	513	833	394	694	562	376	231	249	166	183	124
IV	Keywords	1,851	2,873	4,231	2,144	3,614	2,946	2,252	1,321	1,596	1,045	1,071	882
	Allocation amount*1	2,387	3,590	6,021	2,821	4,939	4,041	2,665	1,622	1,771	1,196	1,342	868
	Achievements	5,390	8,326	13,447	6,289	11,533	9,907	6,646	4,158	4,520	3,370	2,829	2,226
	Projects	961	1,335	2,033	934	1,670	1,257	912	533	607	519	412	383
v	Keywords	5,592	7,365	10,714	5,410	9,172	6,983	5,618	3,257	3,793	3,205	2,507	2,840
•	Allocation amount <sup>*1</sup>	15,960	21,985	32,940	15,377	27,349	20,566	15,012	8,812	9,844	8,466	6,709	6,160
	Achievements	33,160	43,651	65,416	32,717	57,883	46,010	31,363	17,393	20,921	19,403	13,978	15,879
	Projects	150	237	530	168	333	243	173	107	103	54	89	65
VI	Keywords	1,098	1,642	3,293	1,237	2,360	1,635	1,275	754	791	405	631	462
*1	Allocation amount*1	4,039	6,407	14,640	4,715	9,285	6,706	4,833	2,948	2,819	1,438	2,302	1,912
	Achievements	8,086	12,078	23,186	7,449	16,239	12,497	7,970	6,205	4,881	3,152	3,569	4,827
	Projects	171	311	687	215	430	296	218	153	113	57	86	79
VII	Keywords	1,246	2,096	4,092	1,529	2,906	1,930	1,559	1,097	843	429	571	602
vш	Allocation amount*1	7,648	14,065	31,032	9,741	19,411	13,318	9,764	6,917	5,023	2,531	3,896	3,513
	Achievements	12,167	19,635	43,282	13,978	28,337	19,995	13,802	10,460	8,245	5,250	5,466	5,412
	Projects	31	34	88	26	50	64	26	15	16	5	12	5
VIII	Keywords	240	272	657	199	392	502	208	113	129	41	99	31
<b>чш</b>	Allocation amount*1	2,447	2,732	7,111	2,199	4,091	5,252	2,044	1,252	1,224	408	1,035	403
	Achievements	3,419	4,994	9,089	3,099	6,128	6,937	4,078	1,057	1,863	630	849	710
	Projects	38	73	190	61	134	100	50	36	24	18	18	14
IX	Keywords	293	565	1,356	468	964	794	367	290	205	128	126	117
IA	Allocation amount <sup>*1</sup>	5,604	10,632	28,573	9,003	20,574	14,523	7,403	5,264	3,541	2,405	2,808	2,074
	Achievements	5,952	8,391	27,340	7,875	21,753	12,026	7,231	6,564	3,204	3,810	2,287	1,898
	Projects	13	47	178	31	68	55	27	30	7	7	14	10
х	Keywords	96	363	1,174	261	530	427	222	229	57	55	108	94
Λ	Allocation amount*1	3,319	14,903	53,607	8,625	18,368	16,802	7,283	8,621	2,334	1,535	3,399	2,799
	Achievements	3,141	10,014	31,244	6,630	12,239	11,043	4,780	7,191	1,864	947	2,400	2,682
	Projects	6,448	9,498	16,984	6,506	12,195	9,883	7,119	3,551	4,665	3,740	3,899	3,299
T - 4 - 1	Keywords	35,454	49,312	82,761	35,614	63,707	49,819	39,599	20,937	27,894	21,835	20,612	22,254
Total	Allocation amount <sup>*1</sup>	59,056	99,875	214,664	69,701	134,482	108,173	68,969	43,983	39,414	29,142	33,290	26,485
	Achievements	139,933	202,606	364,376	145,658	271,499	218,885	146,485	90,274	92,651	78,745	69,397	68,373

 Table 2: A summary of the number of projects, keywords, achievements, and allocation amount of 12 institutes in each group

Hk: Hokkaido Univ. / Th: Tohoku Univ. / Tk: Tokyo Univ. / Ng: Nagoya Univ. / Kt: Kyoto Univ. / Os: Osaka Univ. / Ks: Kyushu Univ. / Ti: Tokyo Institute of Technology / Tb: Tsukuba Univ. / Kb: Kobe Univ. / Ko: Keio Univ. / Ws: Waseda Univ. \*1 Million yen

## **3** Result of Analysis and Discussion

Using Wilcoxon's rank-sum test (one-tailed, significance level of 5%), the achievements (per million yen) of the 12 institutions were compared for each group. Institutions with fewer than 20 research themes in a group were excluded from the comparison. Table 3 presents the results of comparing each institute's performance by the group. " $\circ(\times)$ " indicates that the institute's achievements displayed in the row are more(less) than those shown in the column, " $\triangle$ " is that there is no significant difference, and "—" means that there is no comparison. For Group VIII or over, it wasn't easy to obtain enough results because there were not many institutes receiving such a huge budget. Although these results are not simply comparable with previous studies that covered different periods, there was no significant discrepancy between their results [12]. However, the institute's performance differences are not apparent, as there are many tie-breaking results throughout all the tables.

	Tab.	le.	3:		mp	Dari	ISO	n o	i e	aci	1 11	isti	lui	e s	ac	nie	ve	me	nts	6 (D	y r	ese			pro	jec	is)			
I Hk Th	Tk 1	Ng	Kt	Os	Ks	Ti	Tb	Kb	Ko	Ws	$\bigcirc$	$\triangle$	$\times$	1 [	П	Hk	Th	Tk	Ng	Kt	Os	Ks	Ti	Tb	Kb	Ko	Ws	$\bigcirc$	$\triangle$	$\times$
Hk ×	$\Delta$	×	Δ	$\Delta$	Δ	Δ	Δ	Δ	$\Delta$	Δ	0	9	2		Hk	Ϊ	0	0	Δ	$\Delta$	0	0	х	0	$\Delta$	Ο	$\Delta$	6	4	1
Th O		$\triangle$	0	0	0	Δ	0	0	$\Delta$	Δ	7	4	0		Th	x	Ϊ	Δ	х	×	Δ	0	х	$\Delta$	$\Delta$	0	$\Delta$	2	5	4
Tk $\triangle$ ×	$\overline{\}$	×	х	$\Delta$	Δ	х	$\Delta$	$\Delta$	$\Delta$	$\Delta$	0	7	4		Τk	х	Δ		$\Delta$	×	0	0	х	0	$\Delta$	0	$\Delta$	4	4	3
Ng O △	0		0	0	0	$\Delta$	0	0	$\Delta$	$\Delta$	7	4	0		Ng	Δ	0	$\Delta$		$\triangle$	Ο	0	х	0	$\Delta$	0	$\Delta$	5		1
Kt ∆ ×	0	×	$\overline{\ }$	$\triangle$	Δ	$\Delta$	$\Delta$	$\Delta$	$\Delta$	$\triangle$	1	8	2		Kt	Δ	0	0	Δ		0	0	×	0	0	0	0	8	2	1
Os $\triangle$ ×		×	Δ		Δ	х	Δ	Δ	$\Delta$	Δ	0	8	3		Os	х	Δ	×	х	×		Δ	×	$\Delta$	$\Delta$	0	$\Delta$	1		5
Ks ∆ ×		×	$\Delta$	Δ	Ϊ	Δ	Δ	$\Delta$	$\Delta$	$\Delta$	0	9	2		Ks	х	х	х	х	×	Δ		×	$\Delta$	x	0	×	1		8
Τί Δ Δ	0	$\triangle$	$\Delta$	0	Δ		0	0	Δ	$\Delta$	4	7	0		Ti	0	0	0	0	0	0	0	$\overline{}$	0	0	0	0			0
Tb ∆ ×		×	$\Delta$	$\Delta$	Δ	×		Δ	$\Delta$	$\Delta$	0	8	3		Tb	x	Δ	×	х	×	$\Delta$	$\Delta$	×	$\overline{\ }$	Δ	0	x	1		6
Kb ∆ ×		×	$\Delta$	$\triangle$	Δ	х	Δ		Δ	Δ	0	8	3		Kb	Δ	Δ	$\Delta$	$\triangle$	×	$\triangle$	0	×	Δ		Õ	$\Delta$			2
Κο Δ Δ		$\triangle$	$\triangle$	$\triangle$	Δ	$\triangle$	$\Delta$	Δ		Δ	0	11	0		Ko	×	x	×	х	×	×	×	×	×	×	$\overline{\}$	×			11
Ws $\triangle$ $\triangle$		$\triangle$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	Δ	$\overline{}$	0	11	0		Ws	$\triangle$	$\Delta$	$\Delta$	$\triangle$	×	$\triangle$	0	×	0	$\triangle$	0		3		2
	-1		_			_	_	_	_		v		v			_		_	_		_	<u> </u>		<u> </u>		V		5	<b>v</b> .	
III Hk Th	Tk 1	Ng	Kt	Os	Ks	Ti	Tb	Kb	Ko	Ws	$\bigcirc$	$\bigtriangleup$	$\times$		IV	Hk	Th	Tk	Ng	Kt	Os	Ks	Ti	Tb	Kb	Ko	Ws	$\bigcirc$	$\triangle$	$\times$
Hk O	0	$\triangle$	$\Delta$	0	О	х	0	Δ	О	×	6	3	2		Hk	Ϊ	${\bigtriangleup}$	Δ	Δ	$\Delta$	$\Delta$	$\Delta$	Δ	$\Delta$	$\Delta$	$\triangle$	$\Delta$	0	11	0
Th ×	$\Delta$	×	×	$\triangle$	$\Delta$	×	$\triangle$	×	О	×	1	4	6		Th	Δ	Χ	$\triangle$	$\Delta$	$\triangle$	$\triangle$	$\triangle$	$\triangle$	$\triangle$	$\Delta$	$\triangle$	$\Delta$	0	11	0
Tk × $\triangle$		×	х	$\Delta$	$\Delta$	×	$\Delta$	×	О	×	1	4	6		Τk	Δ	$\Delta$		$\Delta$	×	×	×	×	$\Delta$	×	$\triangle$	$\Delta$	0	6	5
Ng $\triangle$ O	0		Δ	0	0	х	0	Δ	О	×	6	3	2		Ng	Δ	Δ	Δ		×	х	х	х	$\Delta$	х	$\triangle$	$\Delta$			5
Kt △ O	0	$\triangle$	$\overline{\ }$	0	0	×	0	$\Delta$	0	×	6	3	2		Kt	$\Delta$	$\Delta$	0	0	$\geq$	$\triangle$	$\triangle$	$\triangle$	$\triangle$	$\Delta$	$\triangle$	$\triangle$	2		0
$Os \times \Delta$		×	×	$\overline{\ }$	$\Delta$	×	$\Delta$	×	0	×	1	4	6		Os	$\Delta$	$\Delta$	0	0	Δ	$\overline{\ }$	$\Delta$	$\Delta$	0	$\Delta$	0	$\Delta$	4		0
Ks × ∆		×	×	Δ		×	$\Delta$	×	0	×	1	4	6		Ks	Δ	Δ	Õ	Ō	$\triangle$	Δ	$\overline{}$	$\triangle$	Δ	$\triangle$	Δ	$\triangle$			0
Ti O O		0	0	0	0	$\overline{\ }$	0	0	0	$\Delta$	10	1	0		Ti	Δ	$\Delta$	0	0	$\triangle$	$\Delta$	Δ	$\overline{\ }$	$\Delta$	$\Delta$	$\Delta$	$\Delta$			0
Tb $\times$ $\triangle$	-	×	×	$\triangle$	Δ	×	$\overline{\}$	×	Õ	×	1	4	6		Tb	$\Delta$	$\Delta$	$\triangle$	Δ	$\Delta$	×	$\Delta$	Δ	$\overline{}$	×	$\Delta$	$\Delta$			2
$Kb \triangle O$		$\triangle$	$\Delta$	0	0	×	Õ	$\overline{}$	Õ	×	6	3	2		Kb	$\overline{\ }$	$\square$	0	0	$\triangle$	$\triangle$	$\triangle$	$\triangle$	0		$\triangle$	$\triangle$			0
$K_0 \times X$		×	×	×	×	×	×	×	$\overline{}$	×	0	0	11		Ko		$\triangle$	$\triangle$	$\triangle$	$\triangle$	×	$\triangle$	$\triangle$	$\triangle$	Δ	$\overline{\}$	$\triangle$			1
Ws O O		0	0	0	0	Δ	0	0	0		10	1	0		Ws			$\triangle$	$\triangle$	$\triangle$	Δ	$\triangle$	$\triangle$	$\triangle$	$\triangle$	Δ	$\leq$			0
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V Hk Th	Tk 1	Ng	Kt	Os	Ks	Ti	Tb	Kb	Ko	Ws	$\bigcirc$	$\triangle$	$\times$			Hk	Th	Tk	Ng	Kt				Tb	Kb	Ko	Ws	$\bigcirc$	$\triangle$	$\times$
Hk O	0	$\triangle$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	×	$\Delta$	×	2	7	2		Hk	$\overline{\ }$	$\Delta$	0	$\Delta$	$\triangle$	$\Delta$	$\triangle$	$\triangle$	$\triangle$	$\Delta$	$\Delta$	$\triangle$	1	10	0
Th ×	$\Delta$	$\Delta$	$\Delta$	×	$\Delta$	$\Delta$	$\Delta$	×	$\Delta$	×	0	7	4		Th	$\Delta$		Ο	$\Delta$	$\triangle$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	$\triangle$	×	1	9	1
Tk × $\triangle$	Ż	$\triangle$	$\Delta$	×	${\bigtriangleup}$	Δ	Δ	х	${\sf r}$	×	0	7	4		Tk	×	×	Ϊ	Δ	×	×	$\Delta$	×	×	×	$\triangle$	×	0	3	8
Ng $\triangle$ $\triangle$	$\triangle$		$\Delta$	×	${\bigtriangleup}$	Δ	Δ	х	${\sf r}$	×	0	8	3		Ng	${\sf r}$	${\bigtriangleup}$	Δ	/	$\Delta$	$\Delta$	$\Delta$	Δ	$\Delta$	×	$\triangle$	×	0	9	2
Kt $\triangle$	$\Delta$	$\Delta$	Ϊ	×	${\bigtriangleup}$	Δ	Δ	х	${\sf r}$	×	0	8	3		Kt	${\sf r}$	${\bigtriangleup}$	0	Δ	$\backslash$	$\Delta$	$\Delta$	Δ	$\Delta$	$\Delta$	$\triangle$	×	1	9	1
$Os \triangle O$	0	0	0	/	О	0	Δ	Δ	${\sf r}$	×	6	4	1		Os	${\sf r}$	${\bigtriangleup}$	0	Δ	$\Delta$	/	$\Delta$	Δ	$\Delta$	$\Delta$	$\triangle$	$\Delta$	1	10	0
Ks $\triangle$ $\triangle$	$\Delta$	$\triangle$	$\Delta$	×	Χ	$\Delta$	$\triangle$	×	$\triangle$	×	0	8	3		Ks	Δ	$\Delta$	$\triangle$	$\Delta$	$\triangle$	Δ	Ϊ	$\triangle$	$\triangle$	х	$\triangle$	х	0	9	2
Ti $\triangle$ $\triangle$	$\Delta$	$\triangle$	$\Delta$	×	$\Delta$	Ϊ	$\triangle$	×	$\triangle$	×	0	8	3		Ti	Δ	$\Delta$	0	$\Delta$	$\triangle$	$\triangle$	$\triangle$	$\overline{\ }$	$\triangle$	$\Delta$	$\triangle$	$\Delta$	1	10	0
Tb $\triangle$ $\triangle$	$\Delta$	$\triangle$	$\Delta$	$\triangle$	$\Delta$	$\Delta$		×	$\triangle$	×	0	9	2		Tb	Δ	$\Delta$	0	$\Delta$	$\triangle$	$\triangle$	$\triangle$	$\triangle$	Ϊ	$\Delta$	$\triangle$	$\Delta$	1	10	0
Kb O O	0	0	0	$\Delta$	0	0	0		О	Δ	9	2	0		Kb	Δ	Δ	0	0	$\Delta$	Δ	0	Δ	Δ		0	$\Delta$	4	7	0
Ko $\triangle$ $\triangle$	$\Delta$	$\triangle$	Δ	$\Delta$	Δ	Δ	Δ	х	Ϊ	×	0	9	2		Ko	Δ	Δ	Δ	Δ	$\Delta$	Δ	$\Delta$	Δ	$\Delta$	х		х	0	9	2
Ws O O	0	0	0	0	0	0	0	$\Delta$	0		10	1	0		Ws	$\Delta$	0	0	0	0	$\Delta$	0	$\Delta$	$\Delta$	$\Delta$	0		6		0
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VII Hk Th				Os	Ks		Tb		Ko	Ws	$\bigcirc$	$\triangle$	$\times$		VIII	Hk	Th		Ng		Os		Ti	Tb	Kb	Ko	Ws			$\times$
Hk O		$\triangle$	0	$\triangle$	0	$\Delta$	$\triangle$	$\Delta$	$\triangle$	$\Delta$	4	7	0		Hk		Δ	$\triangle$	$\Delta$	$\Delta$	$\Delta$	$\Delta$	-	—	-	—	-			0
Th ×	$\Delta$	$\triangle$	$\triangle$	$\triangle$	$\Delta$	×	$\triangle$	×	$\Delta$	$\Delta$	0	8	3		Th	Δ	$^{\prime}$	Δ	$\triangle$	$\triangle$	$\triangle$	$\triangle$	—	-	-	—	-	0	6	0
Tk × $\triangle$	X	$\triangle$	$\triangle$	×	Δ	х	х	×	Δ	×	0	5	6		Tk	Δ	Δ	$\searrow$	Δ	$\triangle$	Δ	Δ	-	-	-	—	-			0
Ng $\triangle$ $\triangle$	$\Delta$	$\searrow$	$\triangle$	$\triangle$	Δ	$\Delta$	Δ	×	$\Delta$	$\Delta$	0	10	1		Ng	Δ	Δ	Δ	$\overline{\ }$	Δ	$\Delta$	$\triangle$	-	-	-	—	-	0		0
Kt × $\triangle$	$\Delta$	$\Delta$	$\smallsetminus$	$\Delta$	$\Delta$		×		$\triangle$			7			Kt			$\triangle$			Δ		-	-	—	—	-			0
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Table 3: Comparison of each institute's achievements (by research projects)

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To clarify the differences in performance, the authors decided to recount the results by keywords included in each project. Typically, a single project comprises several keywords related to its content. The principal investigator of each project devises and assigns these keywords. Since a list of candidate keywords is not prepared, there is a problem with orthographical variants. This problem needs to be resolved in the future. In this study, the allocation amount was prorated according to the number of keywords and their order of appearance. The number of keywords varies with each project. If many words are attached to a project, the allocation per word will be smaller. In addition, the importance of the first word will differ from the last. Figure 3 illustrates the percentage of total projects that comprise a particular ranked keyword. This figure includes all projects funded from FY 2012 to 2021. This graph provides the importance of the keywords in each rank. Naturally, all projects included the first keyword. For example, approximately 30% of the projects had the 11th keyword. However, the other 70% of the projects did not need the 11th keyword. Therefore, for a maximum of 10 keywords per project, the budget amount and number of results were allocated according to the relative frequencies, as illustrated in Figure 3.



Figure 3: The percentage of total projects comprising a particular ranked keyword

Table 4 presents an example. Since the project listed in Table 4 includes five keywords, the amounts for each year and the number of achievements are respectively allocated to each keyword proportionally by the ratio calculated from the relative frequencies in Figure 3. This study calculated this for all the projects and thereafter summed them up to obtain the performance for each keyword.

Project		Budget	Amount	Achievments		
Floject		FY2018	FY2019	Achievinents		
Novel spin filter function using graphene	nanoribbon	5,200,000	1,300,000	25		
		4	ļ			
Kaunvorda	Allocation	Budget	Amount	Ashiaumanta		
Keywords	Ratio	FY2018	FY2019	Achievments		
Graphene	21%	1,092,000	273,000	5.25		
Nanoribbon	21%	1,092,000	273,000	5.25		
Topology	21%	1,092,000	273,000	5.25		
Spin filter	19%	988,000	247,000	4.75		
Spintronics	18%	936,000	234,000	4.50		
Total	100%	5,200,000	1,300,000	25		

Table 4: How to distribute the amount for each keyword

When recounting the results by keyword, this study corrected differences in wording and attempted to unify keywords with different terminology that had the same meaning. Specifically, the authors modified the words according to the following criteria:

(1) Convert full-width characters to half-width characters

(2) Delete hyphens

(3) Convert plural words to singular

(4) Remove redundant words

However, the above modifications are insufficient to unify all keywords with the same meaning. This problem will be discussed later.

The top ten most frequent keywords in Groups III, V, and VII, which have many projects, are shown for each institute (Table 5). While some keywords, such as "Machine learning," are found in all institutes, others, such as "Primates" (Kt) and "Pancreatic cancer" (Ks), are found in areas where certain institutes have strengths.

Table 6 compares keyword-based results (per million yen) for each institution. All groups had more significantly different combinations than in Table 3. Furthermore, compared with Table 3, there was no reversal of large and small results. The method of comparison by keyword can better indicate each institute's performance differences.

To clarify the cause of this difference, the two institutes' achievements were compared for common and unique keywords separately. Table 7 presents the number of keywords obtained from Th and Kt projects in Group II. Kt has more projects and, therefore, more keywords. There are 2,787 words common to both, accounting for about 20% of the total number of keywords in Th. Figures 4 and 5 illustrate the histograms for common and unique keywords, classified by the number of results per million yen. Each figure's diamond marks indicate the achievements' median, and the horizontal error bar indicates the first and third quartiles. The vertical axis presents a percentage of the total number. The black bins indicate Th, and the gray is Kt. As illustrated in Figure 4, both are similar. Statistically, there were no significant differences between the two institutes for common keywords. However, comparing the number of achievements obtained from studies on unique keywords reveals that Kt results exceeded those of Th (Figure 5).

			·				-					
Hk	GroupIII		Group V		GroupVII	Ks	GroupIII		Group V		GroupWI	
1	Cancer	35	Genome	16	Nanomaterial	4 1	Pancreatic cancer	56	Mitochondria	15	Regenerative medicine	6
2	Cytokine	22	Climate change	14	Birth cohort	4 2	Mitochondria	41	Pancreatic cancer	15	Cell tissue	5
3	Innate immunity	22	Signal transduction	13	Environmental chemicals	4 3	MRI	37	Signal transduction	13	Plasma	5
4	Virus	21	Virus	12	Maternal and child health	3 4	Macrophage	33	Biomarker	11	CRISPR	5
5	Macrophage	20	Nanomaterial	11	Defatigation	3 5	Oxidative stress	28	Nanomaterial	11	Gene	5
6	NMR	20	Imaging	11	Virus	3 6	Microglia	25	Biotechnology	11	Cancer	4
7	Biomarker	19	Fuel cell	10	Nanoparticle	3 7	Autophagy	25	Cell tissue	11	Inflammation	4
8	Climate change	18	Plant	10	Reaction mechanism	3 8	Signal transduction	24	Crystal growth	11	Machine learning	4
9	Neuroscience	17	Infection	10	Plasmon	3 9	Pancreatic stellate cells	23	Nanoparticle	10	Climate change	4
10	Insect	17	Nanoparticle	9	Imaging	3 10	Inflammation		Electronic microscope	10	Deoxyribonucleic acid methylation	4
		-	1	-	00			-	1	-		
Th	GroupIII		Group V		GroupVII	Ti	GroupIII		Group V		GroupⅦ	
1	Oxidative stress	45	Inflammation	18	Crystal growth	7 1	Machine learning	16	Catalyst	11	Thin-film	5
2	MRI	43	Nanoparticle	18	Nanomaterial	7 2	Autophagy	13	Machine learning	10	Magnetism	4
3	Diabetes	35	Cell tissue	17	Graphene	6 3		12	Evolution	10	Organic chemistry	4
4	Mitochondria	34	Genome	17	Recycling	6 4	Dendrimer	11	Deep learning	10	Chaperone	4
 5	Inflammation	34	Spintronics	16	Asymmetric synthesis	6 5	Photocatalyst	11	Peptide	9	1-axis active control	4
6	Cancer	30	Great East Japan Earthquake	14	Norovirus	5 6	Nanoparticle	10	Nanomaterial	 9	Energy conversion	3
7												
~~ <u>~</u> ~~~	Great East Japan Earthquake	29	Oxidative stress	14	Biomolecules		Thin-film Flaster ab arrister	10	Synthetic chemistry	9	Synthetic chemistry	3
8	Gene	28	Transcription factor	14	Semiconductor properties	5 8	Electrochemistry	10	Nanobiology	8	Ion conductor	3
9	nrf2	27	Cancer	14	Spintronics	5 9	Nanomaterial	9	Nanoparticle	8	Ribosome	3
10	Implant	25	PET	14	Semiconductor	5 10	Crystal structure	9	Solar cell	8	Translation	3
771	- <b>-</b>		6 V		- IW				0 V		G 11	
Tk	GroupIII	~	Group V	20	Group	Tb	GroupIII	10	Group V	14	Group	
1	Signal transduction	64	Signal transduction	39	Signal transduction	17 1	Machine learning		Obesity	14	Exercise	4
2	Machine learning	48	Gene	31	Gene	11 2	Signal transduction		Lifestyle disease	14	Locomotion Interface	4
3	Epigenetics	45	Genome	30	Climate change	10 3	Lifestyle disease	14	Transcription factor	13	Genome	4
4	Cancer	42	Epigenetics	24	Cancer	9 4	Transcription factor	14	Neuroscience	10	Virtual reality	4
5	Neuroscience	42	Imaging	21	Cranial nerve	9 5	Sleep	14	Inflammation	9	Cognitive function	3
6	Biomarker	38	Simulation	20	Machine learning	9 6	Senior citizen	13	Machine learning	9	F-box protein	3
7	Transcription factor	36	Plant	20	Epigenetics	9 7	Simulation	12	Fatty hepatitis	8	Conservation science	3
8	Inflammation	36	Cancer	19	Strongly correlated electron system	9 8	Neuroscience	12	Remote sensing	8	Mutation	3
9	iPS cells	35	Aging	18	Transcription factor	9 9	Radiotherapy	12	Gene	8	Environment	3
10	Simulation	24	M 1' 1 '								T # 1 1 1	2
		34	Machine learning	17	Elementary particle experiment	9 10	Developmental disorders	12	Genome	8	Folkloristics	3
10		34	Machine learning	17	Elementary particle experiment	9 10	Developmental disorders	12	Genome	8	Folkloristics	3
Ng	GroupIII	34	Group V	17	Elementary particle experiment GroupVII	9 10 Kb	Developmental disorders Group III	12	Genome Group V	8	Folkloristics	3
		29	-	23			1 -	12 31		8	<u>I</u>	3
Ng	GroupIII		Group V		Group	Kb	GroupIII	31	Group V		GroupWI	3
Ng 1	GroupⅢ Biomarker	29	Group V Signal transduction Plant	23	GroupⅦ Plant	6 Kb	Group III Diabetes	31	Group V Signal transduction	10	GroupVII Science education	3
Ng 1 2	GroupIII Biomarker Inflammation	29 29	Group V Signal transduction Plant	23 20	GroupVII Plant Machine learning	6 1 6 2	GroupIII Diabetes Inflammation	31 23	Group V Signal transduction Plant	10 9	GroupVII Science education Elementary particle experiment	3
Ng 1 2 3	Group III Biomarker Inflammation Macrophage	29 29 24	Group V Signal transduction Plant Developmental differentiation	23 20 16	Group VII Plant Machine learning Signal transduction	6 1 6 2 6 3	Group III Diabetes Inflammation Biomarker	31 23 21	Group V Signal transduction Plant Science education	10 9 9	GroupVII Science education Elementary particle experiment Electronic excited state	3 1 3 2
Ng 1 2 3 4	Group III Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell	29 29 24 23	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience	23 20 16 15 14	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope	6         1           6         2           6         3           6         4	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy	31 23 21 20 19	Group V Signal transduction Plant Science education Cancer Simulation	10 9 9 7 7	Group VII Science education Elementary particle experiment Electronic excited state Lifetime improvement Model experiment	3 2 2 2 2
Ng 1 2 3 4 5	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome	29 29 24 23 19 19	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation	23 20 16 15 14 12	Group VI Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth	6         1           6         2           6         3           6         4           5         5	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction	31 23 21 20 19 17	Group V Signal transduction Plant Science education Cancer Simulation Rice	10 9 9 7 7 7 7	Group VII Science education Elementary particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction	3 3 2 2 2 2 2
Ng 1 2 3 4 5 6 7	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana	29 29 24 23 19 19 19	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse	23 20 16 15 14 12 11	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience	6         1           6         2           6         3           6         4           5         5           6         5           7         7	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis	31 23 21 20 19 17 17	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome	10 9 7 7 7 7 7 7	GroupVII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance	3 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI	29 29 24 23 19 19 19 19 18	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana	23 20 16 15 14 12 11 11	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial	6         1           6         2           6         3           6         4           5         5	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA	31 23 21 20 19 17 17 16	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis	10 9 7 7 7 7 7 6	Group VII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration	3 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning	29 29 24 23 19 19 19 19 18 16	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging	23 20 16 15 14 12 11 11 11	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry	6         1           6         2           6         3           6         4           5         5           5         6           5         7           4         8           4         9	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism	31 23 21 20 19 17 17 16 15	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise	10 9 7 7 7 7 7 6 6	Group VII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI	29 29 24 23 19 19 19 19 18	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana	23 20 16 15 14 12 11 11	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial	6         1           6         2           6         3           6         4           5         5           5         6           5         7           4         8	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA	31 23 21 20 19 17 17 16 15	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis	10 9 7 7 7 7 7 6	Group VII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration	3 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant	29 29 24 23 19 19 19 19 18 16	Group V Signal transduction Plant Developmental differentation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution	23 20 16 15 14 12 11 11 11	Group/II Plant Machine learning Signal transduction Signalation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence	6         1           6         2           6         3           6         4           5         5           5         6           7         4           4         9           4         10	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer	31 23 21 20 19 17 17 16 15	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare	10 9 7 7 7 7 7 6 6	GroupVII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone	3 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII	29 29 24 23 19 19 19 18 16 16	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V	23 20 16 15 14 12 11 11 11 10	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII	6         1           6         2           6         3           6         4           5         5           5         6           5         7           4         8           4         9           4         10	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII	31 23 21 20 19 17 17 16 15 15	Group V Signal transduction P lant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V	10 9 7 7 7 7 7 6 6 6 6	Group VII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone Group VII	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 Kt 1	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells	29 29 24 23 19 19 19 19 18 16 16 16	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells	23 20 16 15 14 12 11 11 11 10 33	GroupVII Plant Machine learning Signal transduction Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution	6         1           6         2           6         3           6         4           5         5           7         4           4         9           4         10           9         1	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells	31 23 21 20 19 17 17 16 15 15 55	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria	10 9 9 7 7 7 7 7 6 6 6 6 13	Group VII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone Group VII Developmental differentiation	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 7 8 9 10 Kt 1 2	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI	29 29 24 23 19 19 19 18 16 16 16 118 48	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iP S cells Genome	23 20 16 15 14 12 11 11 11 10 33 20	GroupVII Plant Machine learning Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution iP S cells	Kb           6         1           6         2           6         3           6         4           5         5           6         4           4         9           4         9           4         9           4         2           9         10           8         2	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine	31 23 21 20 19 17 17 16 15 15 55 41	Group V Signal transduction Plant Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine	10 9 7 7 7 7 7 6 6 6 6 13 11	Group VII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone Group VII Developmental differentiation Inflammation	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 Kt 1 2 3	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction	29 29 24 23 19 19 19 18 16 16 16 118 48 41	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience	23 20 16 15 14 12 11 11 11 10 33 20 20	Group\II Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence Group\II Evolution iPS cells Machine learning	Kb           6         1           6         3           6         3           6         4           5         5           6         7           4         9           4         10           9         1           8         2           6         3	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell	31 23 21 20 19 17 17 16 15 15 55 41 31	Group V Signal transduction Plant Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene	10 9 7 7 7 7 7 6 6 6 6 13 11 11	GroupVII Science education Penetary particle experiment Electronic excited state Electronic excited state Lifetime improvement Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 5 6 7 8 9 10 10 <b>Kt</b> 1 2 3 4	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes	29 29 24 23 19 19 19 18 16 16 16 118 48 41 36	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iP S cells Genome Neuroscience Signal transduction	23 20 16 15 14 12 11 11 11 10 33 20 20 20	Group/II Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence Group/II Evolution iPS cells Machine learning Oxide	Kb           6         1           6         2           6         3           6         3           6         4           9         1           8         2           6         3           5         4	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Neural stem cell	31 23 21 20 19 17 17 16 15 15 55 41 31 28	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome	10 9 7 7 7 7 7 6 6 6 6 6 13 11 11 9	GroupVII Science education Enentary parick experiment Electronic excited state Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election governance Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 7 8 9 10 10 <b>Kt</b> 1 2 3 4 5	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII IPS cells MRI Signal transduction Diabetes Simulation	29 29 24 23 19 19 19 18 16 16 118 48 41 36 34	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V PS cells Genome Neuroscience Signal transduction Evolution	23 20 16 15 14 12 11 11 11 11 10 33 20 20 20 20 20	GroupVI Plant Machine learning Signal transduction Signalariansduction Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVI Evolution iPS cells Machine learning Oxide Climate change	6         1           6         2           6         3           6         4           5         5           5         6           7         4           9         4           9         10           8         2           6         3           5         4           9         10           5         4           5         5	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Neural stem cell Mesenchymal stem cell	31 23 21 20 19 17 17 16 15 15 55 41 31 28 26	Group V Signal transduction Plant Cancer Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer	10 9 7 7 7 7 7 6 6 6 6 13 11 11 9 9	GroupVII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 <b>Kt</b> 1 2 3 4 5 6	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine tearning Plant GroupIII iPS cells MRI MI Signal transduction Diabetes Simulation Imaging	29 29 24 23 19 19 19 19 18 16 16 16 16 118 48 41 36 34 30	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience Signal transduction Evolution Primates	23 20 16 15 14 12 11 11 11 10 33 20 20 20 20 20 20 19	GroupVII Plant Machine learning Signal transduction Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution IPS cells Machine learning Oxide Climate change Catalyst	6         1           6         2           6         3           6         3           5         5           5         6           4         9           4         9           4         9           6         3           6         3           6         3           5         4           5         4           9         10           8         2           6         3           5         4           5         6	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Mesenchymal stem cell Intestinal bacteria	31 23 21 20 19 17 17 16 15 15 55 41 31 28 26 26	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Immunology	10 9 7 7 7 7 7 7 6 6 6 6 6 8 11 11 11 9 9 8	GroupVII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 10 11 2 3 4 5 6 7	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Imaging Prinates	29 29 24 23 19 19 19 19 19 18 16 16 16 16 118 48 41 36 34 30 29	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience Signal transduction Primates Stem cell	23 20 16 15 11 11 11 11 11 10 20 20 20 20 20 20 19 19	GroupVII Plant Machine learning Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution IPS cells Machine learning Oxide Climate change Catalyst Genome	6         1           6         2           6         3           6         4           5         5           7         4           4         9           4         10           9         1           8         2           6         3           5         5           5         5           5         5           5         6           5         7	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Mesenchymal stem cell Intestinal bacteria Cancer	31 23 21 20 19 17 17 16 15 15 55 41 31 28 26 26 24	Group V Signal transduction Plant Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Immunology Developmental differentiation	10 9 7 7 7 7 7 7 6 6 6 6 6 13 11 11 9 9 8 8 8	Group VII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone Group VII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Melecular dynamics simulation	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 11 2 3 4 5 6 7 7 8	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Inaging Primates Regenerative Medicine	29 29 24 23 19 19 19 18 16 16 16 118 48 41 36 34 30 29 28	Group V Signal transduction Plant Developmental differentiation Rice Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience Signal transduction Evolution Franscuption factor	23 20 16 15 11 11 11 11 11 11 10 20 20 20 20 20 20 19 19 18	Group\II Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence Group\II Evolution IPS cells Machine learning Oxide Climate change Catalyst Genome Asia	Kb           6         1           6         3           6         3           6         4           5         5           5         7           4         9           4         9           10         10           9         1           8         2           6         3           5         5           5         7           8         2           6         3           5         5           5         7           5         8	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Neural stem cell Intestinal bacteria Cancer Retina	31 23 21 20 19 17 17 15 15 55 41 31 28 26 26 24 21	Group V Signal transduction Plant Signal transduction Cancer Simulation Cancer Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Inmunology Developmental differentiation Stem cell	10 9 7 7 7 7 7 7 6 6 6 6 6 11 11 11 9 9 8 8 8 8 8	GroupVII Science education Eenentary particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Molecular dynamics simulation Stem cell	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 <b>Kt</b> 1 2 3 4 5 6 7 8 9 9	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Imaging Prinates	29 29 24 23 19 19 19 18 16 16 16 118 48 41 36 34 30 29 28 27	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iP S cells Genome Neuroscience Signal transduction Evolution Primates Stem cell Transcription factor Imaging	23 20 16 15 14 12 11 11 11 10 33 20 20 20 20 20 20 20 19 19 18 18	GroupVII Plant Machine learning Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution IPS cells Machine learning Oxide Climate change Catalyst Genome	Kb           6         1           6         2           6         3           5         5           6         4           9         1           4         9           4         9           4         9           6         3           5         5           5         6           5         5           5         6           5         5           5         7           5         8           2         6           3         5           5         7           5         7           5         7           5         7	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Neural stem cell Intestinal bacteria Cancer Retina Hypertension	31 23 21 20 19 17 17 16 15 15 55 41 31 28 26 26 26 24 21 21	Group V Signal transduction Plant Cancer Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Inmunology Developmental differentiation Stem cell Regenerative Medicine	10 9 9 7 7 7 7 7 7 7 7 7 7 7 7 7 6 6 6 6 6	GroupVII Science education Ennetary particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Machine learning Regenerative Medicine Cancer Neuroscience Meecurd symmics simulation Stem cell Brain function conection	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 11 2 3 4 5 6 7 7 8	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Inaging Primates Regenerative Medicine	29 29 24 23 19 19 19 18 16 16 16 118 48 41 36 34 30 29 28	Group V Signal transduction Plant Developmental differentiation Rice Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience Signal transduction Evolution Franscuption factor	23 20 16 15 11 11 11 11 11 11 10 20 20 20 20 20 20 19 19 18	Group\II Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence Group\II Evolution IPS cells Machine learning Oxide Climate change Catalyst Genome Asia	Kb           6         1           6         3           6         3           6         4           5         5           5         7           4         9           4         9           10         10           9         1           8         2           6         3           5         5           5         7           8         2           6         3           5         5           5         7           5         8	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Neural stem cell Intestinal bacteria Cancer Retina	31 23 21 20 19 17 17 16 15 15 15 55 41 31 28 26 26 24 21 21	Group V Signal transduction Plant Signal transduction Cancer Simulation Cancer Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Inmunology Developmental differentiation Stem cell	10 9 7 7 7 7 7 7 6 6 6 6 6 11 11 11 9 9 8 8 8 8 8	GroupVII Science education Eenentary particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Molecular dynamics simulation Stem cell	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 10 10 10 10 10 10 10 10 10	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII PS cells MRI GroupIII Inaging Primates Regenerative Medicine Transcription factor Cancer	29 29 24 23 19 19 19 18 16 16 16 118 48 41 36 34 30 29 28 27	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience Signal transduction Evolution Primates Stem cell Transcription factor Imaging Cancer	23 20 16 15 14 12 11 11 11 10 33 20 20 20 20 20 20 20 19 19 18 18	GroupVI Plant Machine learning Signal transduction Signal transduction Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVI Evolution iPS cells Machine learning Oxide Climate change Catalyst Genome Asia Signal transduction Epigenetics	6         1           6         2           6         3           6         4           5         5           5         6           7         4           9         4           9         4           9         10           8         2           6         3           5         5           5         6           7         5           5         6           7         7           8         7           5         6           5         7           8         7           5         9           5         9           5         9           10         0	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Neural stem cell Intestinal bacteria Cancer Retina Hypertension Biomarker	31 23 21 20 19 17 17 16 15 15 55 41 31 28 26 26 26 24 21 21	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Immunology Developmental differentiation Stem cell Regenerative Medicine Database	10 9 9 7 7 7 7 7 7 7 7 7 7 7 7 7 6 6 6 6 6	GroupVII Science education Elementary particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Molecule dynamics simulation Stem cell Brain function connection Social cognition	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 10 12 3 4 5 6 7 7 8 9 10 0 8 9 10 0 0 8	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Imaging Primates Regenerative Medicine Transcription factor Cancer GroupIII	29 29 24 23 19 19 19 19 18 16 16 16 16 16 16 34 34 30 29 28 27 27 27	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V PS cells Genome Neuroscience Signal transduction Evolution Primates Stem cell Transcription factor Imaging Cancer Group V	23 20 16 15 14 12 11 11 11 11 10 33 20 20 20 20 20 20 20 19 19 18 18 18	GroupVII Plant Machine learning Signal transduction Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution PS cells Machine learning Oxide Climate change Catalyst Genome Asia Signal transduction Epigenetics GroupVII EvolutyII	6         1           6         2           6         3           5         6           5         7           4         9           4         9           9         1           2         3           5         6           3         5           5         7           8         2           6         3           5         4           5         6           5         7           5         7           5         9           5         10           Ws         Ws	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Mesenchymal stem cell Intestinal bacteria Cancer Retina Hypertension Biomarker GroupIII	31 23 21 20 19 17 17 15 15 15 55 41 31 28 26 26 26 24 21 21 20	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Cancer Immunology Developmental differentiation Stem cell Regenerative Medicine Database Group V	10 9 7 7 7 7 7 7 7 7 7 7 7 7 6 6 6 6 6 6 13 11 11 11 9 9 8 8 8 8 8 7	GroupVII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Moleculer dynamics simulation Stem cell Brain function connection Scoial cognition GroupVII	3 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 0 0 0 0 0 0 0 0 0 0 0 0 0	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Inaging Primates Regenerative Medicine Transcription factor Cancer GroupIII Autophagy	29 29 24 23 19 19 19 19 19 18 16 16 16 16 118 48 41 36 34 30 29 28 27 27 55	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience Signal transduction Evolution Franscription factor Imaging Cancer Group V Cancer	23 20 16 15 14 12 11 11 11 10 33 20 20 20 20 20 20 20 19 19 18 18 18 16	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution IP S cells Machine learning Oxide Climate change Climate change Climate change GroupVI Genome Asia Signal transduction Epigenetics GroupVII Genome editing	Kb           6         1           6         2           6         3           5         5           5         7           4         9           4         9           4         9           10         10           9         1           8         2           6         3           5         5           5         7           8         2           6         3           5         5           5         9           10         10	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Metanelymal stem cell Intestinal bacteria Cancer Retina Hypertension Biomarker GroupIII Machine learning	31 23 21 20 19 17 17 16 15 15 15 55 41 31 28 26 26 24 21 21 20 13	Group V Signal transduction Plant Signal transduction Cancer Simulation Cancer Genome Photosynthesis Exercise Medical welfare Group V Instrinal bacteria Regenerative medicine Gene Metabolome Cancer Immunology Developmental differentiation Stem cell Regenerative Medicine Database Group V East Asia	10 9 7 7 7 7 7 7 7 7 7 7 7 6 6 6 6 6 6 13 11 11 11 9 9 8 8 8 8 8 8 8 7 7	GroupVII Science education Enemary particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Molecular dynamics simulation Stem cell Brain function connection Scoial cognition GroupVII Accelerator	3 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 10 10 10 10 10 10 10 10 10	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Imaging Primates Regenerative Medicine Transcription factor Cancer GroupIII	29 29 24 23 19 19 19 19 19 18 16 16 16 16 118 48 41 36 34 30 29 28 27 27 27 55 47	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V PS cells Genome Neuroscience Signal transduction Evolution Primates Stem cell Transcription factor Imaging Cancer Group V	23 20 16 15 14 12 11 11 11 11 10 33 20 20 20 20 20 20 20 19 19 18 18 18	GroupVII Plant Machine learning Signal transduction Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution PS cells Machine learning Oxide Climate change Catalyst Genome Asia Signal transduction Epigenetics GroupVII EvolutyII	6         1           6         2           6         3           5         5           5         7           4         9           4         9           4         9           4         9           6         3           5         5           5         5           5         5           5         7           5         5           5         7           5         7           5         7           5         7           7         10           7         10           7         10	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Messenchymal stem cell Intestinal bacteria Cancer Retina Hypertension Biomarker GroupIII Machine learning Media	31 23 21 20 19 17 17 16 15 15 55 41 31 28 26 26 24 21 21 20 13 12	Group V Signal transduction Plant Science education Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Cancer Immunology Developmental differentiation Stem cell Regenerative Medicine Database Group V	10 9 7 7 7 7 7 7 7 7 7 7 7 7 6 6 6 6 6 6 13 11 11 11 9 9 8 8 8 8 8 7	GroupVII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Moleculer dynamics simulation Stem cell Brain function connection Scoial cognition GroupVII	3 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 0 0 0 0 0 0 0 0 0 0 0 0 0	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII iPS cells MRI Signal transduction Diabetes Simulation Inaging Primates Regenerative Medicine Transcription factor Cancer GroupIII Autophagy	29 29 24 23 19 19 19 19 19 18 16 16 16 16 118 48 41 36 34 30 29 28 27 27 55	Group V Signal transduction Plant Developmental differentiation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V iPS cells Genome Neuroscience Signal transduction Evolution Franscription factor Imaging Cancer Group V Cancer	23 20 16 15 14 12 11 11 11 10 33 20 20 20 20 20 20 20 19 19 18 18 18 16	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution IP S cells Machine learning Oxide Climate change Climate change Climate change GroupVI Genome Asia Signal transduction Epigenetics GroupVII Genome editing	Kb           6         1           6         2           6         3           5         5           5         7           4         9           4         9           4         9           10         10           9         1           8         2           6         3           5         5           5         7           8         2           6         3           5         5           5         9           10         10	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Metanelymal stem cell Intestinal bacteria Cancer Retina Hypertension Biomarker GroupIII Machine learning	31 23 21 20 19 17 17 16 15 15 15 55 41 31 28 26 26 24 21 21 20 13	Group V Signal transduction Plant Signal transduction Cancer Simulation Cancer Genome Photosynthesis Exercise Medical welfare Group V Instrinal bacteria Regenerative medicine Gene Metabolome Cancer Immunology Developmental differentiation Stem cell Regenerative Medicine Database Group V East Asia	10 9 7 7 7 7 7 7 7 7 7 7 7 6 6 6 6 6 6 13 11 11 11 9 9 8 8 8 8 8 8 8 7 7	GroupVII Science education Enemary particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Molecular dynamics simulation Stem cell Brain function connection Scoial cognition GroupVII Accelerator	3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
Ng 1 2 3 4 5 6 7 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 Kt 1 2 3 4 5 6 7 8 9 10 10 10 10 10 10 10 10 10 10	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI Machine learning Plant GroupIII PS cells MRI Signal transduction Diabetes Simulation Imaging Primates Regenerative Medicine Transcription factor Cancer GroupIII Autophagy Biomarker	29 29 24 23 19 19 19 19 19 18 16 16 16 16 118 48 41 36 34 30 29 28 27 27 27 55 47	Group V Signal transduction Plant Developmental differentation Rice Neuroscience Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V PS cells Genome Neuroscience Signal transduction Evolution Primates Stem cell Transcription factor Imaging Cancer Group V Cancer Epigenetics	23 20 16 15 14 12 11 11 11 11 10 20 20 20 20 20 20 20 20 19 19 18 18 16	GroupVII Plant Machine learning Signal transduction Simulation Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence GroupVII Evolution IPS cells Machine learning Oxide Climate change Catalyst Genome Asia Signal transduction Epigenetics GroupVII Genome editing Electronic microscope	6         1           6         2           6         3           5         5           5         7           4         9           4         9           4         9           4         9           6         3           5         5           5         5           5         5           5         7           5         5           5         7           5         7           5         7           5         7           7         10           7         10           7         10	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Messenchymal stem cell Intestinal bacteria Cancer Retina Hypertension Biomarker GroupIII Machine learning Media	31 23 21 20 19 17 17 16 15 15 55 41 31 28 26 26 24 21 21 20 13 12	Group V Signal transduction Plant Signal transduction Cancer Simulation Cancer Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Immunology Developmental differentiation Stem cell Regenerative Medicine Database Group V East Asia Economic policy	10 9 7 7 7 7 6 6 6 6 6 6 6 6 13 11 11 11 9 9 8 8 8 8 8 8 7 7 9 6	GroupVII Science education Enematry particle experiment Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Moceute dynamics simulation Stem cell Brain function connection Stem cell Brain function connection Sciel cognition GroupVII Accelerator Media code	3 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
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Ng           1           2           3           4           5           6           7           8           9           10           Kt           1           2           3           4           5           6           7           8           9           10           Os           1           2           3           4	GroupIII Biomarker Inflammation Macrophage Signal transduction Mesenchymal stem cell Exosome Arabidopsis thaliana MRI MRI Plant GroupIII Plant GroupIII Plant Signal transduction Diabetes Simulation Diabetes Simulation Cancer GroupIII Autophagy Biomarker Diabetes Mites Matophagy Biomarker Diabetes Mites Matophagy Biomarker Diabetes Mitechondria	29 29 24 23 19 19 19 18 16 16 16 16 16 118 48 41 36 34 30 29 28 27 27 27 55 47 40 38	Group V Signal transduction Plant Developmental differentiation Rice Simulation Mouse Arabidopsis thaliana Imaging Evolution Group V PS cells Genome Neuroscience Signal transduction Evolution Primates Stem cell Transcription factor Imaging Cancer Group V Cancer Epigenetics Autophagy Inflammation	23 20 16 15 14 11 11 11 11 11 10 33 20 20 20 20 20 20 20 20 19 19 18 18 16 19 19 16 15	Group VII Plant Machine learning Signal transduction Electronic microscope Crystal growth Neuroscience Biomaterial Synthetic chemistry Turbulence Group VII Evolution PS cells Machine learning Oxide Climate change Catalyst Genome Asia Signal transduction Epigenetics Group VII Genome editing Electronic microscope Immunity DNA	Kb           6         2           6         3           6         4           5         5           5         6           7         6           7         1           6         3           5         4	GroupIII Diabetes Inflammation Biomarker Apoptosis Radiotherapy Signal transduction Metabolomic analysis microRNA Arthrorheumatism Cancer GroupIII iPS cells Regenerative Medicine Stem cell Neural stem cell Intestinal bacteria Cancer Retina Hypertension Biomarker GroupIII Machine learning Media Network Optimization	31 23 21 20 19 17 17 16 15 15 15 55 41 31 28 26 26 24 21 21 20 13 12 10 10	Group V Signal transduction Plant Cancer Cancer Simulation Rice Genome Photosynthesis Exercise Medical welfare Group V Intestinal bacteria Regenerative medicine Gene Metabolome Cancer Immunology Developmental differentiation Stem cell Cancer Cancer Cancer Immunology Developmental differentiation Stem cell Cancer Can	10 9 9 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	GroupVII Science education Electronic excited state Lifetime improvement Model experiment Liquefaction Election governance Administration Election management Time zone GroupVII Developmental differentiation Inflammation Machine learning Regenerative Medicine Cancer Neuroscience Molecular dynamics simulation Stem cell Brain function connection Social cognition GroupVII Accelerator Metal oxide Cancer Quantum beam	3 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
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Table 5: The top ten most frequent keywords in Groups III, V, and VII

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Table 6: Comparison of each institute's achievements (by all keywords)

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	Tohoku Univ. (Th)	Kyoto Univ. (Kt)
Projects	2,784	3,810
Common keywords	2,7	87
Unique keywords	10,930	15,926
Total keywords	13,717	18,713

Table 7: Number of keywords in Th and Kt projects in Group II



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5 10 15 Number of achievements (per million yen)

Figure 5: Histogram for unique keywords

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The histogram peaks are significantly different in Figures 4 and 5. Results for common keywords tend to be higher than those for unique keywords. This trend may be because the KAKEN database can refer to the results of other studies comprising the common keywords. If there are previous studies that comprise the common keywords as the ongoing project, their performance will serve as a benchmark. Since we can compare the amount of research output based on common keywords, researchers are expected to produce at least the same level of performance as previous studies. The projects related to unique keywords are valuable in differentiating the institute from others. However, if their performance is inferior, it will trigger a reconsideration of their necessity. Tables 8 presents the survey results, divided into common and unique keywords, for all combinations of institutes in Groups III, V, and VII.

### Table 8: Comparison of each institute's achievements (by common keywords or unique keywords)

(Common keywords)	(Unique keywords)
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V Hk Th Tk Ng Kt Os Ks Ti Tb Kb Ko Ws O $\triangle$ ×	V Hk Th Tk Ng Kt Os Ks Ti Tb Kb Ko Ws O $\triangle$ ×
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$Ng \triangle \triangle \bigcirc \land \land$	$Ng \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \land \land \land \bigcirc \bigcirc \land \land \land \land \land \land \land \land $
$Kt \triangle \triangle \bigcirc \triangle \times \triangle \triangle \bigcirc \triangle \triangle 2 8 1$	$Kt \triangle \bigcirc \triangle \times \checkmark \times \bigcirc \bigcirc \triangle \times \times \times 3 3 5$
	$Os \bigcirc O \bigcirc O \bigcirc O \bigcirc O \bigcirc X \bigcirc X \bigcirc Y \bigcirc 0 \bigcirc 2$
$Ks \ \Delta \ \Delta \ \Delta \ \Delta \ \times \ \ \Delta \ \bigcirc \ \Delta \ \Delta \ \Delta \ 1 \ 9 \ 1$	$Ks \times \Delta \times \times \times \times \times O \times \times \times \times 1 1 9$
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$Ng \bigtriangleup \times \bigtriangleup \bigtriangleup \times \times \times \times \bigtriangleup \bigtriangleup \bigtriangleup 0 \ 6 \ 5$	$Ng \times O O \Delta \Delta O \times \times \times O \Delta 4 3 4$
$\mathbf{Kt} \bigtriangleup \times \times \bigtriangleup \bigtriangleup \times \times \times \times \bigtriangleup \bigtriangleup \bigtriangleup \bigtriangleup 0 5 6$	$Kt \times \Delta \bigcirc \Delta \land \times \Delta \times \times \times \Delta \times 1 4 6$
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$K_0 \bigtriangleup \checkmark \bigtriangleup \bigtriangleup \checkmark \bigtriangleup \simeq - \bigtriangleup \bigcirc \bigcirc \odot \odot \simeq 2$	$K_{0} \times \Delta \Delta \times \Delta \times \Delta \times X \times X \times 0 4 7$
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Compare the left and right sides of Table 8, the left has more  $\triangle$ . It means there are more combinations on the left that are not clearly superior or inferior. One of the reasons for this difference may be that researchers strive not to be inferior to their competitors' research achievements. However, the differences in achievements related to keywords not handled by other institutions create differences in the performance of the institutes.

### 4 Future Work

In the case of Th and Kt in Group II, presented in Table 7, there were 2,787 common keywords, which is lesser than expected. The authors believe this is because the orthographical variants of the keywords were not fully corrected. In the future, it is expected that correcting the variants and increasing the number of common keywords will help clarify the characteristics of keywords unique to each institution. To solve this problem, it is possible to utilize judgments based on cosine similarity between keywords. Shimbaru investigated the relationship between the cosine similarity between sentences as short as keywords and their content agreement. An exhaustive study revealed that in 70% of the short sentence combinations with a cosine similarity of 0.85, the content of both sentences matched. Furthermore, the number of pairs with matching content increased as the cosine similarity increased [13][14]. It may be possible to determine keywords with the same meaning based on the cosine similarity between keywords. More reliable results are expected to be obtained by improving the determination accuracy of the same keywords.

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