### A History of ISCIE International Symposium on Stochastic Systems Theory and Its Applications 1968 - 2018<sup>1</sup>

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### Abstract

This article is an extended version of my lecture on a history of the Symposium on Stochastic Systems Theory and Its Applications (SSS) delivered at the 50th Anniversary meeting on November 1, 2018 [1]. It is shown why and how the Symposium was launched in Kyoto 1968, and activities of SSS for the past 50 years are briefly reviewed chronologically from my personal point of view.

# 1 Introduction

In 1968, at the first Symposium on Stochastic Control Theory, I presented a paper on nonlinear filtering, when I was a PhD student studying estimation and control in the Laboratory of Prof. Sawaragi, Department of Applied Mathematics and Physics, Kyoto University. Ever since, this Symposium has become an important meeting place in my career. In this note, first I briefly mention the scientific advancement and organizational developments of automatic control in the post-war period. I will then refer to the founding of the Japan Association of Automatic Control Engineers (JAACE) in Kyoto 1957, and to the research on statistical studies of nonlinear control systems in the Laboratory in 1950s and early 60s; I believe that both of them were crucially related to the birth of SSS in 1968. Moreover, based on Symposium reports and old documents about the SSS, I will provide an overview of the activities of SSS for the past 50 years.

# 2 Automatic Control 1945 - 1960

After World War II, automatic control techniques developed during the war were released to the public as new textbooks for the analysis and design of control systems in the US and Europe. Thus automatic control has greatly been advanced both in the theory and applications, and at the same time, we saw that many societies and institutions were reorganized so as to include automatic control as a distinct new discipline, and that great efforts were directed to standardizing terminology to be used in automatic control area [2,3]. Also, the concept of feedback has attracted a wider audience due to the publication of Cybernetics and subsequent autobiographical books by N. Wiener, which also helped automatic control to spread worldwide [2]. Further, in 1950s, several international conferences on automatic control were held as shown in Table 1 [4–7].

Year	Conference Name	Place
1951	Automatic Control	Cranfield, UK
1953	Frequency Response Symposium	New York, US
1956	Problems of Automation	Milano, IT
1956	Automatic Control	Heidelberg, DE
1960	The First IFAC World Congress	Moscow, SU

Table 1: International Conferences in 1950s and the First IFAC World Congress.

During the automatic control conference at Heidelberg 1956, in a meeting held at University of Heidelberg, it was adopted by members from 18 countries to establish International Federation of Automatic Control (IFAC),

<sup>&</sup>lt;sup>1</sup>http://sci-sss.org/Arc.html (Homepage of SSS)

where Prof. Izawa (Tokyo Inst Tech) attended the meeting. In the next year, the IFAC constitution was voted in the First General Assembly in Paris, where Prof. Ishigai (Osaka Univ) represented the Japan National Organization. Thus IFAC was established in September 1957 to promote science and technology of automatic control and international cooperation [3,4]; IFAC related earlier activities in the US and Italy are found in [6] and [7], respectively; see also [8] for a history of control engineering in Japan.

Supported by a large number of researchers and engineers in Kansai area, the JAACE was founded in Kyoto, June 1957; the inaugural meeting was held at the Central Electric Club, Osaka [10, 11]. Also, in September 1957, just after the birth of IFAC, the National Committee of Automatic Control<sup>2</sup> was organized in the Science Council of Japan, by inviting members from 12 Societies and Institutions involved in automatic control. Then, the first National Automatic Control Conference, Japan, jointly organized by Societies in the National Committee of Automatic Control, was held at the Osaka Chamber of Commerce and Industry in November 1958 [12]. Presented were four plenary papers and over 100 contributed papers in the area of control theory, components, and industrial applications.

In 1960, the first IFAC World Congress was held in Moscow; a number of distinguished professors, including N. Wiener, R. Bellman, etc. attended this Congress [6,13,14], which ushered in a new era of automatic control science and technology. In fact, it announced the advent of modern control theory based on state-space technique due to R. E. Kalman [15]. The number of papers accepted was 286; the number of participants was about 1200. From Japan 18 papers were accepted; but only nine delegates, including Prof. Sawaragi, attended the Congress. It was the year 1964 that overseas travel was deregulated in Japan, so it was not easy to visit the Soviet Union in 1960.

# 3 From Statistical Analysis of Nonlinear Control Systems to Theory of Stochastic Control Systems

In 1950s, one of the projects<sup>3</sup> in the Laboratory of Prof. Sawaragi was statistical studies of nonlinear control systems. At the Heidelberg meeting in 1956, Prof. Sawaragi presented a new statistical linearization method, a key technique in the project, to analyze nonlinear control systems subjected to both a sinusoidal signal and a random noise [9]. In 1962, results of the research project that involved many people in the Laboratory were published as a book [16], which was well circulated abroad. We note that the statistical linearization techniques were developed in Russia, the US and Japan, and are still used today in the analysis of complex nonlinear dynamical systems subjected to sinusoidal and/or random inputs; see e.g. [17].

Year	Topic of Joint Seminar	Place
1966	Applied Stochastics	Tokyo
1968	Applied Stochastics	Washington, D.C.
1971	Stochastic Methods in Dynamical Systems	Kyoto

Table 2: NSF-JSPS Joint US-Japan Seminars.

After the publication of the research monograph, Prof. Sawaragi organized a series of the Joint US-Japan Seminars on Applied Stochastics with researchers interested in stochastic methods in engineering, see Table 2. The first Joint US-Japan Seminar was held in Tokyo 1966, where Prof. Sawaragi reviewed statistical studies on nonlinear control systems in the Laboratory. Before the first Joint Seminar, in January 1966, Associate Prof. Y. Sunahara in the Laboratory visited Brown University, and stayed at the Lefschetz Center for Dynamical Systems, where he met many active researchers in the area of nonlinear filtering and stochastic controls. I guess that he witnessed many new trends in stochastic controls during his stay in the US, and he probably decided that he should move from classical statistical analyses of nonlinear control systems to the study of stochastic systems using stochastic differential equations. He returned to Kyoto in August 1967; then in April 1968, he was promoted to full Professor of Kyoto Institute of Technology, where he set up a new Laboratory of stochastic control in the department of mechanical engineering.

The preprints of the second Joint US-Japan Seminar<sup>4</sup> includes 20 papers, the authors of which are listed

<sup>&</sup>lt;sup>2</sup>This committee has been playing the role of the IFAC NMO, Japan.

<sup>&</sup>lt;sup>3</sup>Other projects were: Nonlinear vibration of mechanical systems, Rheology (dynamics of visco-plasto-elastic materials), Classical relay and sampled-data controls, and process controls.

 $<sup>^{4}</sup>$ The second Joint Seminar was held for September 19–24, 1968. Preprints of the first (1966) and third (1971) Joint Seminars are unfortunately missing, so that details of two Joint Seminars are not known.

	Authors from Japan	Authors from the US
1	H. Akaike (Inst Statist Math)	W. Gersch (Purdue U)
2	Y. Sawaragi, T. Katayama (Kyoto U)	R. Sridhar (Caltech)
3	T. Isobe, H. Kobatake, I. Sato (U Tokyo)	B. Friedland (General Precision Systems, Inc.)
4	S. Fujii, S. Y. Sheu (U Tokyo)	F. Kozin, C. H. Kozin (Brooklyn Polytechnic)
5	Y. Yamanouchi (Ship Research Inst)	J. L. Bogdanoff, A. Shiff (Purdue U)
6	I. Nakamura (Railway Technical Research Inst)	R. H. Lyon (Bolt Beranek & Neuman, Inc.)
7	H. Shibata, M. Miyamoto (U Tokyo)	R. F. Drenick (Brooklyn Polytechnic)
8	Y. Ishii (Inst of Space & Aeronautical Science)	P. H. White (Measurement Analysis Co., LA)
9	I. Kaneshige (Isuzu Motors)	M. Shinozuka, Jann-Nan Yang (Columbia U)
10	Y. Sunahara (Kyoto Inst Tech)	A. H. Gray (U California., Santa Barbara)

Table 3: Authors of Papers for the Second NSF-JSPS Joint US-Japan Seminar.

in Table 3 [18], where we see many names from Tokyo areas. Then the third Joint US-Japan Seminar was held in 1971 at Rakuyu Kaikan, where I had a chance to present a paper on nonlinear filtering under uncertain observations. The purpose of the series of Joint Seminars was to promote research activities on stochastic systems by exchanging information and ideas among participants. It was also a good opportunity to see whether stochastic estimation and control are promising as a research area of the Laboratory. But, I should say that at least by 1970, Prof. Sawaragi decided to tackle difficult global issues in systems sciences, including environmental pollution controls, etc. Hence, studies on stochastic control systems were taken over by Prof. Sunahara at Kyoto Institute of Technology and partly by myself at Kyoto University.

### 4 Birth of Symposium

At the 1968 planning committee meeting of JAACE, Prof. Sawaragi proposed to launch a new symposium called "Stochastic Control Theory". The proposal was approved in the Board Meeting of JAACE, and Prof. Sunahara was appointed to the chair of organizing committee of the new symposium [19]. The first Symposium on Stochastic Control Theory 第1回統計学的制御理論シンポジウム was held at Rakuyu Kaikan in November 1968 by the enormous efforts of Prof. Sunahara; he decided the format of Symposium, including Abstracts, Proceedings, Presentation in English, etc. Thus he made a great contribution to the SSS; in fact, Prof. Sunahara was the chair of organizing committee of SSS until 1994.

The above is a short story why and how the SSS started in Kyoto 1968; I should say that the leadership of Prof. Sawaragi and the hard work of Prof. Sunahara brought the success of SSS today. The following are my personal view on the activities of SSS for the past 50 years; the main sources of information are SSS related articles and reports appeared in the Journal of our Society. Also, the documents prepared for the special session on Stochastic Systems for the 50th Anniversary Meeting of ISCIE in 2006 [20] are very helpful, since it includes all the titles of papers from the first (1968) Symposium until the 37th (2005) Symposium.

# 5 Name Change of SSS

Table 4:	Name	Change	of	SSS
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Year	Name of Symposium
1968	第 1 回統計学的制御理論シンポジウム (The First Symp. on Stochastic Control Theory)
1975	第7回確率システムシンポジウム (The 7th Symp. on Stochastic Systems Theory and Its Applications)
1985	The 17th JAACE Symp. on Stochastic Systems Theory and Its Applications
1988	The 20th ISCIE Symp. on Stochastic Systems Theory and Its Applications
1995	The 27th ISCIE International Symp. on Stochastic Systems Theory and Its Applications

The change of name of the Symposium is depicted in Table 4. As mentioned above, the first Symposium was held in 1968 at Rakuyu Kaikan, Kyoto University. The official name of SSS was in Japanese until 1984. The Journal "Control Engineering" featured the first SSS in the special issue of August 1969 [19]; I noticed from the English contents of the issue that 統計学的制御理論 was translated as "Stochastic Control Theory" as in Table 4. Although 統計学的  $\approx$  "statistical", I understood for the first time that the word "stochastic" in stead of "statistical" has been used from the start of the Symposium.

In 1975, the Symposium's name was changed from 統計学的制御理論 to 確率システム; see Table 4. This name change gave a feeling of uneasiness to some of the participants as we can see in the article documented in [20]. In fact, by the change from "statistical" to "stochastic", the scope of the Symposium may be narrowed, so that papers on statistical signal/image processing and applications of simple statistical analyses may be rejected, resulting in the reduced number of papers and participants. I will be back to "statistical" and "stochastic" issue later in Section 7 to show according to the scope of the IFAC Technical Committee on Stochastic Systems that "stochastic" includes both "statistical" and "probabilistic".

Then, in 1985, the English name became the official name of the Symposium, so that it was decided that only the papers written in English were acceptable. Also, oral presentation in English was recommended; but this was not mandatory at that time. In 1988, the name of our Society was changed to the Institute of Systems, Control and Information Engineers (ISCIE) [21]. Accordingly, JAACE in the name of Symposium was changed to ISCIE. Moreover, International is added to the Symposium title in 1995. So, we are using the present name of SSS for nearly 25 years; this name is now widely accepted in control community of Japan.

### 6 A Half Century of SSS

Activities of SSS for the past 50 years are reviewed. For convenience, dividing the 50 years into five decades, we summarize the activities of Symposiums in each decade as tables, including the place, the number of papers<sup>5</sup>, and special lecture(s) with some remarks. We also explain memorial events held every ten years.

#### 6.1 The first decade 1968-1978

	Year	Place	Papers	Special Lecture(s)	Remarks
1	1968	Kyoto, Rakuyu Kaikan	28/85	Y. Sunahara	2-day meeting
2	1970	ditto	30/83		3-day meeting
3	1971	ditto	23/90		
4	1972	ditto	26/91		
5	1973	ditto	33/123		
6	1974	ditto	24/88	T. Nishimura	
7	1975	ditto	41/105		Name change
8	1976	ditto	29/79		
9	1977	ditto	38/93		
10	1978	Holiday Inn, Kyoto	50/96	F. Kozin, K. Ito	

Table 5: Symposiums 1968-1978

Table 5 displays the year, the symposium site, and the number of papers/the registrants for the first ten symposiums. The first nine symposiums were held at the same place, Rakuyu Kaikan. The first Symposium was a two-day meeting with a single track. The second Symposium was held in 1970 as a three-day meeting with a single track, and this latter style of meeting was continued until the 17th Symposium in 1985. We note that the second Symposium was held in 1970 with an interval of one year. This was due to the fact that the Symposium organizer could not decided whether the Symposium should be held every year or every other year. Since the first two Symposiums were successfully received good number of papers and participants, it was decided that the SSS should be held every year from the third Symposium.

At the first Symposium in 1968, Prof. Sunahara gave a special lecture on the second Joint US-Japan Seminar (see Table 3)<sup>6</sup>, and at the sixth meeting in 1974, Prof. Nishimura gave a special lecture on linear/nonlinear

<sup>&</sup>lt;sup>5</sup>Both the number of papers and of registrants are shown.

<sup>&</sup>lt;sup>6</sup>The preprints of the first SSS does not include his paper, so that details of the lecture are not known.

Kalman filters in the space science in the US based on his long experiences at the JPL. And, in 1978, the 10th Anniversary Symposium was held at Holiday Inn, Kyoto; we had two invited lectures by Profs. Kozin and Ito on stochastic differential equations. It was quite interesting that the title of the talk of Prof. Ito was on the Stratonovich integral.

#### 6.2 The second decade 1979-1988

	Voar	Place	Papers	Special Lecture(s)	Bemarks
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11	1979	Tokyo, Fujitsu	48/95	T. Kitagawa	3-day meeting
				Y. Takahashi	
12	1980	Kanazawa Inst Tech	30/83	S. Ueno	
13	1981	Kyoto Inst Tech	51/82	F. Kozin	
14	1982	Kobe, KICC	34/79		
15	1983	Kyoto Seminar House	44/76		
16	1984	Hamamatsu, Murakushi-so	40/64		
17	1985	Kansai Seminar House	53/75		International
18	1986	Tokyo, Mita Press	68/ -		2 parallel tracks
19	1987	Kyushu Univ	38/71		
20	1988	Osaka, Mita Press	56/86	J. Balas, F. Kozin	

Table 6: Symposiums 1979-1988

Table 6 shows the list of the Symposiums for the next ten years. The 11th Symposium was held in Tokyo for the first time at the Institute for Social Information Science, Fujitsu Laboratory. We had two interesting special lectures: "Statistical Control Processes in Quality Control" by Prof. T. Kitagawa (Fujitsu & Kyushu Univ) and "Progress in Control Engineering – Interaction between Technology and Science" by Prof. Y. Takahashi (Toyohashi Univ of Tech & Berkeley). Ever since, it was decided that the Symposium should change the place every year. In fact, we visited Kanazawa, Kyoto Institute of Tech, Kobe, Kyoto Seminar House, Hamamatsu, Kansai Seminar House, Tokyo, Kyushu Univ, and Osaka as shown in Table 6.

In 1985, the Symposium became an international symposium by the effort of the Chair, Prof. Sunahara. This fact was certainly stimulated by the fact that we had the 8th IFAC Kyoto World Congress in 1981, the president of which was Prof. Sawaragi. In 1986, abandoning the long tradition of the single track meeting due to the increase of number of submissions from overseas, the SSS became a three-day meeting with two parallel tracks. Also, the poster session started this year; though continued until the 24th SSS in 1992, it was discontinued since we had many no-show papers.

In 1988, we celebrated the 20th Anniversary of SSS at the Mita Press, Osaka; Profs. Balas and Kozin gave special lectures on the nonlinear filtering and the statistical linearization, respectively.

#### 6.3 The third decade 1989-1998

Table 7 shows the Symposiums held during 1989 – 1998. We also visited many places: Tokyo, Hiroshima, Osaka, Kyoto, Osaka, Beppu, Kyoto, Tokyo, and came back to Kyoto in 1998.

I should mention that the 1993 Proceedings was published for the first time in the history of SSS. Table 7 includes three numbers in the column of Papers from the 25th Symposium of 1993; the first one denotes the number of papers in the Proceedings published after reviews and revisions, the second is the number of papers presented at the Symposium, and the third is the number of participants. Today, we can look at and download all the papers in the Proceedings from 1993 through the webpage of J-STAGE without charge.

A part of the Preface in the first Proceedings is quoted below, since I believe that the idea of Prof. Sunahara is well expressed in it.

- Organization of the Symposium was motivated by the fact that there has been a great upsurge in research activities in the field of Stochastic Control Theory – both among mathematicians and engineers. Since the first Symposium, a quarter century has passed and the SSS in 1993 constitutes the 25th International Symposium. For this occasion, publication of the proceedings of the Symposium has been inaugurated. It goes without saying that the principal objective of the SSS is to bring together groups of the researchers and provide a forum for presentations and discussions on the recent advances in stochastic control theory and application in various

fields of estimation, control, identification, stochastic system analysis, etc. with particular emphasis on the coupling of theory and application techniques [22].

	Year	Place	Papers	Special Lecture(s)	Remarks
21	1989	Tokyo, Fujitsu System Lab	49/65	T. Kitagawa	3-day meeting
22	1990	Hiroshima, Information Plaza	40/71	J. Weizenbaum	
23	1991	Osaka, Mita Press	48/64		
24	1992	Kyoto, Ritsumeikan Univ Suekawa Memorial Hall	56/67		
25	1993	Osaka, Mita Press	41/47/73	G. P. Rao	Proceedings
26	1994	Osaka, Mita Press	32/36/61		
27	1995	Beppu, B-Con Plaza	42/ - / -		
28	1996	Kyoto, Ritsumeikan Univ	27/ - / -		
29	1997	Tokyo, Waseda Univ	50/-/-	G. Kitagawa	
30	1998	Kyoto, Kyodai Kaikan	44/48/78	K. Nishiguchi G. Giannakis, P. Stoica	

Table 7: Symposiums 1989-1998

In July 1997, the 11th IFAC Symposium on System Identification SYSID'97 was held at Kitakyshu, where Prof. Sunahara was supposed to be Chair of the Symposium; but he unfortunately passed away August 1994, after returning from the IFAC SYSID'94, Denmark, July 1994. The future organization and steering of SSS were discussed; and it was decided that senior Profs. S. Sagara (Kyushu Univ), K. Akizuki (Waseda Univ) and T. Nakamizo (National Defense Academy) should take over the role of late Prof. Sunahara, and that Chair will not be fixed, and a local organizer will be nominated for each future SSS. This is now the standard procedure of the organization of SSS. In 1994, the SSS organized by Prof. Sagara was held at the Mita Press, Osaka; see Table A in Appendix for the past chairs of SSS. In 1998, the 30th Anniversary was held at Kyodai Kaikan, Kyoto Univ. We set up Sunahara Memorial Lecture in order to commemorate the long time contribution of Prof. Sunahara to the Symposium organization. Thus, in addition to a special lecture by Dr. K. Nishiguchi on the large deviation, we had two Memorial Lectures by Prof. P. Stoica on Spectral estimation and by Prof. G. Giannakis on Cyclostationary signal analysis. Sunahara Memorial Lectures have continued until 2009.

#### 6.4 The fourth decade 1999-2008

	Year	Place	Papers	Special Lecture(s)	Remarks
31	1999	Tokyo, Keio Univ	58/ - / -	A. Nehorai	2-day meeting
32	2000	Tottori, Hotel Monarque	50/59/84	S. Bittanti	
33	2001	Ashikaga Inst Tech	48/ - / -	M. Bremer	
34	2002	Fukuoka, Papillon-24	44/ - / -	A. H. Sayed	
35	2003	Ube, Yamaguchi Univ	52/56/ -	T. Katayama	
36	2004	Tokyo Denki Univ	61/ - / -	C. F. Martin, G. Picci	
37	2005	Otemon Gakuin Univ	45/47/98	H. Takayasu, G. Peskir	
38	2006	Suwa, Hananoi Hotel	33/40/67	S. Kondo	
39	2007	Saga Univ	40/51/80	O. Bay, Y. Ikegami	
40	2008	Kyodai Kaikan	62/66/119	J. Oommen, B. K. Ghosh	

Table 8: Symposiums 1999-2008

Table 8 displays the Symposiums during 1999 to 2008. We visited Yokohama, Tottori, Ashikaga, Fukuoka, Ube, Hatoyama, Osaka, Suwa, Saga, and came back to Kyoto in 2008. Since the 31st Symposium at Keio Univ in 1999, the SSS was shortened to a two-day meeting. Also, a session of mathematical finance was organized by specialists for the first time in 1999. Moreover, I should mention that during this decade, a number of distinguished guests from overseas were invited to Sunahara Memorial Lecture, including Profs. A. Nehorai (US), S. Bittanti (IT), A. Sayed (US), C. F. Martin (US), G. Picci (IT), G. Peskir (UK), Bay (US).

In 2006, besides the 38th Symposium in Suwa, the SSS organized a special session for the 50th Anniversary of the ISCIE at SCI'06 [20]. The 40th Anniversary of SSS was held at Kyodai Kaikan in 2008, where we had two Sunahara Memorial Lectures: Prof. Oommen, Learning Automata, and Prof. Ghosh, Visual model of freshwater turtles. Some of the senior members were invited to the banquet of the Anniversary; see Photo 1.



Photo 1: A group photo with some senior professors at the banquet of the 40th SSS 2008, Kyodai Kaikan, Kyoto Univ, Kyoto. The first row from the left: Profs. A. Ichikawa (Kyoto U), N. Baba (Osaka Kyoiku U), M. Nakamura (Saga U), K. Uosaki (Osaka U), T. Katayama (Kyoto U), B. J. Oommen (Carleton U), M. Ohta (Hiroshima U), T. Ono (Osaka Prefecture U), T. Nishimura (JAXA) & his wife, B. K. Ghosh (Texas Tech U), C. F. Martin (Texas Tech U), H. Kano (Tokyo Denki U)

#### 6.5 The fifth decade 2009-2018

	Year	Place	Papers	Special Lecture(s)	Remark
41	2009	Kobe, Konan Univ	52/61/111	A. Isaksson	2-day meeting
42	2010	Okayama Univ of Sci	44/48/82	H. Kunita	
43	2011	Lake Biwa, Ritsumeikan Univ	61/69/101	H. T. Banks, F. Kappel	
44	2012	Kokushikan Univ	51/61/84	S. Sugimoto/T. Katayama	
45	2013	Univ Ryukyus	63/78/128	M. Yamazato	
46	2014	Kyoto Inst Tech	39/53/ -	A. Ohsumi	
47	2015	Waikiki Marriott, Hawaii	53/86/ -	B. K. Ghosh	
48	2016	Fukuoka Inst Tech	34/52/72	M. Nagahara	
49	2017	Hiroshima Inst Tech	32/47/70	T. Moriya	
50	2018	Hotel Granvia Kyoto	40/72/107	T. Katayama	

Table 9: Symposiums 2009-2018

Table 9 shows the Symposiums in the last ten years. The last Sunahara Memorial Lecture was given by Prof. A. Isaksson on a model predictive control at the 41st SSS in 2009. From this year, English presentation became mandatory. So it was quite recent that we had the present style of Symposium. Then, in 2010, we went to Okayama. In 2011, we had the Symposium on the boat Bianca at Lake Biwa in the first day and at Ritsumeikan Univ, Kusatsu in the second day. We then went to Tokyo for the 2012 Symposium. In 2013, the SSS went to Okinawa, where we had 128 participants; see Photo 2 below.



Photo 2: A picture of participants at the banquet of the 45th SSS 2013 at University of the Ryukyus, Okinawa

In 2014, we had SSS at Kyoto Inst Tech, and in 2015, the SSS was held overseas in Hawaii for the first time in the history of SSS. We had the Symposium in Fukuoka in 2016, and visited Hiroshima in 2017. Further, we had the 50th Anniversary Symposium at the Hotel Granvia, Kyoto, November 1–2, 2018, where Profs. S. Sagara, K. Akizuki, T. Nakamizo, A. Ohsumi, M. Sugisaka and K. Wada joined the banquet in the evening of November 1, 2018. It was really pleasant to see each other on a great occasion like this. Also, I should mention that the 51st SSS was held at the Aizu Univ, Fukushima, in November 2019.

## 7 On "Statistical" and "Stochastic"

Prior to concluding, I should make a brief comment on "statistical" and "stochastic" mentioned in Section 5.
I was Chair of IFAC Technical Committee (TC) 1.4: Stochastic Systems for three years from 1999 to 2002.
The IFAC has 40 TCs, most of which organize their own Symposium or Workshop every three years. But TC 1.4 does not have its own Symposium, but co-sponsors Symposiums and Workshops related to stochastic systems. Probably, they decided that it was difficult to have Symposiums every 3 years under the keyword: Stochastic Systems. The scope of TC1.4 says: - TC 1.4 focuses on statistical and probabilistic methods in modelling, analysis, estimation, identification, decision, control, etc. Stochastic systems arise in various disciplines within engineering and science, such as control, communications and networks, signal processing, biology and finance [23].

"Stochastic" is usually translated as 確率的な in English-Japanese dictionaries<sup>7</sup>; but the Scope of TC1.4 clearly indicates that "stochastic" includes both "statistical" and "probabilistic". In modern probability theory, we solve forward problems by giving a mathematical model together with a probability space; this is a deductive reasoning that derives useful theorems on the model. In statistics, however, we consider inverse problems, i.e. we test or estimate a model (hypothesis) based on given data. Hence, the latter include inductive reasoning based on data, but it also fully utilize knowledge from the probability theory, i.e. a deductive method . The conclusion of the reasoning in statistics is therefore not necessary true, but there is a possibility that it expands the knowledge about the system under study; see Table 10 below. In general, methods of sciences should include both deductive and inductive reasoning as in the hypothetico-deductive method [24]. Scientists often combine deductive and inductive reasoning quite easily in their daily research activities. Both probabilistic and statistical methods are needed in our SSS for analyzing, modeling, and designing stochastic systems. Hence, I believe that we should understand that the scope of our SSS includes both statistical and probabilistic methods; we should not narrow the scope of our Symposium.

<sup>&</sup>lt;sup>7</sup> "Stochastic" is often used in the context of dynamic system such as stochastic processes,  $\sim$  differential equations, etc.

Probability theory	Statistics
Forward problems	Inverse problems
Model $\oplus$ Probability space $\rightarrow$ Theorems	Data $\oplus$ Model $\oplus$ Probability space
	$\rightarrow$ Model estimation or model validation
Deductive reasoning	Both deductive and inductive reasoning are included
Premise is true $\rightarrow$ Conclusion is always true	Premise is true $\rightarrow$ Conclusion is not necessarily true
Information does not increase	Information increases

Table 10: Probability Theory vs. Statistics.

### 8 Conclusions

The birth of the Symposium on Stochastic Systems Theory and its Applications in 1968 and the subsequent activities for the past 50 years have briefly been reviewed. To consider why the Symposium started in 1968 Kyoto, I explained the status of automatic control in 1950s and the related research activities of the Laboratory of Prof. Sawaragi at Kyoto University. Also, to describe the past events related to SSS, I basically used the activity reports on Symposiums published in the Journal of the Society. Since the reports used are so many that they are not listed as references. But, I found that reports about the past Symposiums are not complete, i.e. some of them are missing, so that I could not recover all the Symposiums of the past 50 years. Thus some of the data in the columns of Papers in Tables 6 to 9 are missing. I hope that Tables should be updated in future.

In the coming age, our social system will heavily be influenced by new technologies, including big data sciences and AI; so is our SSS. In fact, we are in a rapidly changing world quite different from that of 50 years ago when our SSS started in 1968. It is important to adapt ourselves to a new trend quickly; but it is more important to have a solid foundation to get an insight into the underlying key issues of the new trends, for which I believe the statistical analyses and probabilistic reasoning play key roles. I sincerely hope that the future of the SSS in the next 50 years is successful in developing new ideas and methods, especially by the intelligence and continuing efforts of younger people, i.e. coming generations.

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#### Appendix

1	1968~(1st)~-~1993~(25th)	Y. Sunahara (Kyoto Inst Tech)
2	1994 (26th)	S. Sagara (Kyushu Univ)
3	$1995~(27 {\rm th})~-~1996~(28 {\rm th})$	K. Akizuki (Waseda Univ)
4	$1997 (29 \mathrm{th}) - 2000 (32 \mathrm{nd})$	T. Nakamizo (Ashikaga Inst Tech)
5	2001 (33 rd) - 2011 (43 rd)	T. Katayama (Kyoto Univ)
6	$2012~(44 {\rm th})~-~2018~(50 {\rm th})$	S. Sugimoto (Ritsumeikan Univ)

Table A: Chairs of Organizing Committee of SSS 1968 – 2018.