On the History of AI Applications, II:

IEEE Conference on Artificial Intelligence Applications

Daniel E. O'Leary, University of Southern California

AN UNDERSTANDING OF THE history of AI applications through its primary conferences is important for several reasons. First, a historical perspective of AI and the conferences that support the development of its applications provides insight into some of the pioneers to the field and their contributions. Second, an examination of the organizations represented by people presenting papers at the conferences sheds light on the nature of the contributions of academic and nonacademic organizations to the field of AI applications. Such historical analyses could be useful to external sources, concerned with developing measures of the primary organizations contributing to the field of AI. Third, the national origins of the organizations supporting AI applications reflect the international structure of AI applications. Such historical insights might help guide organizational and government policy.

Accordingly, this review focuses on

- the authors of papers specializing in AI applications and their organizations and countries of origin, and
- the program committee members, and their organizations and countries of origin.

THE IEEE CONFERENCE ON ARTIFICIAL INTELLIGENCE APPLICATIONS (CAIA) IS ONE OF THE FIRST AND LONGEST RUNNING APPLICATIONS CONFERENCES TO SPECIALIZE ON AI APPLICATION ISSUES. THIS ARTICLE PROVIDES AN INITIAL VIEW OF THE HISTORY OF THE CAIA AND OF AI APPLICATIONS IN GENERAL SINCE 1984.

Quantitative history

This review takes a quantitative approach to analyzing the history of AI applications. As Aydelotte[1] argues,

A quantitative presentation of the available information can help to direct the student's attention to the questions most worth investigating. Since it brings the whole of evidence, on the point it covers, into intelligible focus, the general character of the findings can be more readily perceived and relationships and differences emerge that could not so easily have been observed without this reduction of data. Such an analysis reveals what events or issues were of special interest, in the sense of involving change through time or departures from the norm and hence might particularly repay investigation.

Accordingly, this review analyzes each of the proceedings of the 11 CAIA conferences to date. It gathers information regarding both the research papers and committee members, the two primary sources of data in the proceedings.

This article considers quantity issues, making inferences based on various statistics. However, it ignores what might be called quality issues. We disregard quality as an issue, since each paper goes through the same referee process required for the conference. Typically, this involves soliciting multiple referee comments before deciding on whether to include a paper in the proceedings.

Table 1. Total IEEE CAIA conference papers.

Year	Month	Number in Table of Contents	Poster	Number Not in Time	Total
1984	December	106		6	100
1985	December	72	40		112
1987	February	48			48
1988	March	55	16		71
1989	March	35			35
1990	March	44			44
1991	February	73			73
1992	March	45			45
1993	March	61	19		80
1994	March	63	21		84
1995	February	43	12		55
Total		639	108	6	747

Specific methodology issues

We gathered information regarding each paper, including the authors, their organizations, and the countries in which their organization were located. We included all papers listed in the proceedings' table of contents, except those that were submitted too late to be included. We treated all papers the same, whether presented, just published, or in a poster session.

For each paper, each author received two numbers. The first, called actual, refers to the

Table 2. Most prolific CAIA writers, listed by total appearances.

Rank	Author	Total Appearances	Adjusted Appearances	Rank	Author	Total Appearances	Adjusted Appearances
1	Gautam Biswas	6	2.5	49	Craig Thompson	2	2
2	Stephen C-Y Lu	5	2.08	50	Madeleine Bates	2	1.5
3	Sargur Srihari	5	1.83	51	Bruce Buchanan	2	1.5
4	Judea Pearl	4	3	52	Rina Deckter	2	1.5
5	Jonathan Hull	4	2.83	53	Andrew Gelsey	2	1.5
6	Toru Ishida	4	2.66	54	Paul Jacobs	2	1.5
7	Ramesh Jain	4	2.33	55	Tsuyoski Kitani	2	1.5
8	Keki Irani	4	2	56	Ho Soo Lee	2	1.5
9	Edmund Durfee	4	1.66	57	Pattie Maes	2	1.5
10	Chidanand Apte	4	1.59	58	Alex C-C Meng	2	1.5
11	R.L. Kashyap	4	1.58	59	Wolfgang Nejdl	2	1.5
12	Katia Sycara	4	1.41	60	Gordon Novak	2	1.5
13	Tim Finin	4	1.33	61	Masayuki Namao	2	1.5
14	Hiroyuki Mizutani	4	1	62	Lisa Rau	2	1.5
15	Mary Malliaris	3	2	63	Marshall Schor	2	1.5
16	S. Sitharam Iyengar	3	1.83	64	Robert Simmons	2	1.5
17	Jin Kim	3	1.83	65	Stephen Smoliar	2	1.5
18	Tin Nguyen	3	1.83	66	Saundra Wallfesh	2	1.5
19	Meyer Billmers	3	1.75	67	Rolf Adams	2	1.33
20	Darwin Kuan	3	1.75	68	Gerhard Friedrich	2	1.33
21	Bruce D'Ambrosio	3	1.7	69	Howard Smith	2	1.33
22	John Oommen	3	1.58	70	Jianping Zhang	2	1.33
23	Michiel Noordwier	3	1.5	71	John Boose	2	1.25
24	Dhiraj Pathak	3	1.5	72	B. Chandrasekaran	2	1.25
25	Robert Kass	3	1.33	73	H. Niemann	2	1.25
26	Dan Moldovan	3	1.33	74	W.K. Utt	2	1.25
27	Andew Wong	3	1.33	75	Bradley Whitehall	2	1.25
28	Piero Bonissone	3	1.25	76	Albert M.K Cheng	2	1
29	K.G. Kempf	3	1.25	77	Paul Cohen	2	1
30	K.L. Boyer	3	1.25	78	Charles Elkan	2	1
31	K.S. Fu	3	1.25	79	Yousri El Fatteh	2	1
32	Rick Kjedlsen	3	1.16	80	Kurt Fedra	2	1
33	James Hendler	3	1.08	81	Amir Hekmatpour	2	1
34	Robert Haralick	3	1.06	82	Michael Hewitt	2	1
35	A.C. Kak	3	1.06	83	Rattikorn Hewitt	2	1
36	Stan Matwin	3	1.06	84	T.S. Huang	2	1
37	C.D. Rowles	3	0.91	85	Michel Huhns	2	1
38	Takahuki Matsudaira	3	0.75	86	Gary Kahn	2	1
39	Yasuko Nakayama	2	0.75	87	Diane Litman	2	1
40	John Arnold	2	2	88	Paul O'Rorke	2	1
41	J.A. Gadsden	2	2	89	David Plaisted	2	1
42	Walter Hamscher	2	2	90	James Reggia	2	1
43	Maurice Karnaugh	2	2	91	Edwina Rissland	2	1
44	C.W. Liew	2	2	92	Linda Salchenberger	2	1
45	Michel Mitri	2	2	93	Julius Tou	2	1
46	Gregory Provan	2	2	94	Larry Travis	2	1
47	R. Bharat Rao	2	2	95	Lothar Winkelbauer	2	1
48	S.A. Stansfield	2	2				

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Table 3. Ranking of universities employing authors in IEEE CAIA proceedings by adjusted number of appearances (based on at least 3.50 adjusted appearances).

Rank	Institution	Score
1.	University of Illinois	17.58
2.	Carnegie Mellon University	17.16
3.	University of Michigan	11.66
4.	University of Maryland	10.50
5.	Stanford University	10.33
6.	State University of New York, Buffalo	9.50
7.	University of Southern California	9.25
8.	Purdue University	8.75
9.	University of Massachusetts	8.50
10.	University of Pennsylvania	8.50
11.	Rutgers University	8.50
12.	Ohio State	6.58
13.	University of Waterloo	5.16
14.	National University of Singapore	5.00
15.	Texas A&M University	5.00
16.	University of Florida	5.00
17.	Columbia University	4.00
18.	University of Connecticut	3.74
19.	University of Ottawa	3.66
20.	University of California — Los Angeles	3.50
	Total	161.87

Table 4. Ranking of nonacademic organizations employing authors in IEEE CAIA proceedings by adjusted number of appearances (based on at least 3.50 adjusted appearances).

Rank	Organization	Score
1.	IBM	23.00
2.	Texas Instruments	17.58
3.	Toshiba	9.00
4.	NTT Information Systems Laboratories	8.80
5.	Digital Equipment Corporation	8.50
6.	AT&T Bell	8.25
7.	GE Corporation	8.00
8.	Honeywell, Inc.	7.00
9.	FMC Corporation	6.15
10.	BBN Laboratories	5.50
11.	Hughes Aircraft	5.50
12.	Lockheed, Inc.	4.83
13.	Boeing Aerospace	4.50
14.	Carnegie Group	4.00
15.	INRIA	4.00
16.	Oak Ridge National Laboratories	3.80
17.	Siemans	3.66
18.	Schlumber-Doll Research	3.66
19.	Telecom Research Laboratories	3.50
20.	Unisys	3.50
	Total	142.73

number of times an author was an author of a paper. There were 1,715 total author appearances. The second, called adjusted appearances, measures individual contributions to each paper. (The contribution of each coauthor was estimated at $1/n$, where n was the number of authors on a particular paper.) There were 747 total papers, which was also the sum of the number of adjusted appearances. We excluded six papers since they were received too late for inclusion in the proceedings.

We took author appearances as listed. In some cases it was not clear what organization a particular author represented. This resulted in 34 entries without organization and country data.

We also gathered information regarding conference committee and program committee members. We aggregated the statistics for the two committees because each member was concerned with the overall conference. Also, for some of the conferences, the program and committee members were aggregated into a single list. We viewed each occurrence on a committee in a different year as an appearance. There was no adjusted appearance category for committee members. The first year the conference was given, no affiliations were given for committee members.

We did not adjust for name changes. All analyses assumed that each publication or appearance on the program committee was done using the same name. As a result, our review would not capture name changes, such as those due to marriage.

Eleven conferences

During February, 1995, the 11th Annual IEEE CAIA took place in Los Angeles. Including that conference, there have been 11 conferences in 12 years, with 1986 the only year missed. Two IEEE CAIA meetings took place in December (1984 and 1985). The other nine (1987-1995) convened at roughly the same time of year: February to March.

Each conference has been fairly large, with the number of papers in the table of contents ranging from 35 to 112. For example, at the recent conference in Los Angeles, there were 43 meeting papers and 12 poster papers. Table 1 lists the number of papers at each conference.

The data does not seem to reflect any trends, with one exception. Although five of the 11 conferences had poster sessions (or equivalents), each of the last three conferences had poster sessions.

All the meetings have taken place in the US. There have been five conferences in Florida, four in California, one in Texas, and one in Colorado.

Contributing authors

Table 2 lists those authors with two or more total appearances in IEEE CAIA. Only one author (Gautam Biswas) had six total appearances. Two authors have five appearances, 11 had four appearances, 24 had three

appearances, and 57 had two. As a result, 95 authors combined for 14.34% of the total author appearances. Of the 1,715 total author appearances, 1,469 were for a single appearance.

Assume that the core of researchers are those whose research appears two or more times. In that case, the core of researchers for CAIA was 95 authors who had a total of 246 appearances, for an average of about 22 core group appearances in each of the 11 meetings. This number seems low, but no comparison is readily available.

Only one author had three or more adjusted appearances: Judea Pearl. Three other authors had 2.5 or more adjusted appearances (Gautam Biswas, Jonathon Hull, and Toru Ishida). There were 138.79 adjusted appearances by the core of researchers in Table 2, accounting for 18.58% of the adjusted appearances.

Organizations. Our review broke author home organizations into two groups: universities and nonacademic organizations. We gathered each organization with 3.5 or more adjusted appearances, resulting in 20 universities (Table 3) and 20 nonacademic organizations (Table 4). The 20 top universities accounted for 161.87 of the total adjusted appearances (21.67%), while the 20 top nonacademic organizations accounted for 142.73 (19.10%). Accordingly, researchers from these top 40 contributing organizations accounted for 40.67% of the total adjusted appearances. This seems to be a relatively con-

Table 5. Ranking of countries with authors contributing to IEEE CAIA.

Rank	Country	Total Appearances	Total Adjusted Appearances
1.	United States	1204	544.34
2.	Japan	104	37.63
3.	Canada	72	30.01
4.	Italy	41	12.00
5.	United Kingdom	38	21.00
6.	France	38	15.17
7.	Germany	33	17.00
8.	Australia	25	8.83
9.	Austria	18	9.00
10.	Singapore	16	5.00
11.	Belgium	10	4.00
12.	India	10	3.00
13.	Finland	9	4.00
14.	China	9	3.00
15.	Taiwan	8	3.00
16.	Scotland	7	3.00
17.	Korea	7	1.50
18.	Mexico	6	2.00
19.	Spain	5	3.00
20.	Israel	5	1.00
21.	USSR	3	1.00
22.	Norway	2	1.00
23.	Portugal	2	1.00
24.	Brazil	1	1.00
25.	Egypt	1	1.00
26.	Sweden	1	1.00
27.	Saudi Arabia	1	.20
28.	Unknown	34	13.00
	Total	1715	747.00

Table 6. CAIA program committee members

Rank	Member	Total Appearances
1.	Jan Aikins	8
2.	Se June Hong	8
3.	Vasant Dhar	7
4.	Chidanand Apte	6
5.	Fumio Mizoguchi	6
6.	Daniel O'Leary	6
7.	David Waltz	6
8.	Tim Finin	5
9.	Mark Fox	5
10.	Lee Erman	4
11.	Donald McKay	4
12.	Sanjay Mittal	4
13.	Howard Shrobe	4
14.	Ron Brachman	3
15.	Richard Duda	3
16.	Paul Harmon	3
17.	Peter Hart	3
18.	Phil Hays	3
19.	Gary Kahn	3
20.	Elaine Kant	3
21.	Bernadette Kowalksi Minton	3
22.	Elaine Rich	3
23.	John Roach	3
24.	Peter Selfridge	3
25.	Sanjaya Addanki	2
26.	Alic Agogina	2
27.	Miro Benda	2
28.	B. Chandrakaran	2
29.	Bob Engelmore	2
30.	Michael Fehling	2
31.	Robert Filman	2
32.	Brian Gaines	2
33.	Marc Goodman	2
34.	Curt Hall	2
35.	Robert Haralick	2
36.	Haym Hirsh	2
37.	Nancy Martin	2
38.	Roy Maxion	2
39.	Eric Mays	2
40.	John McDermott	2
41.	James Miller	2
42.	Robert Milne	2
43.	Steven Minton	2
44.	Ramesh Patil	2
45.	Jeff Pepper	2
46.	Charles Petrie	2
47.	Anil Rewari	2
48.	Earl Sarcedoti	2
49.	Linda Shapiro	2
50.	Elliot Soloway	2
51.	Duvuruu Sriram	2
52.	Craig Stanfil	2
53.	Marilyn Steinzner	2
54.	Katia Sycara	2
55.	Chris Tong	2
56.	Oliver Vadas	2
57.	Wolfgang Wahlster	2
58.	Michael Williams	2

centrated contribution of research papers, as would be expected. However, that concentration is less than that for *IEEE Expert*[2] where the top contributing 37 organizations accounted for 49% of the adjusted contributions.

There is substantial overlap between the top 12 contributing universities for IEEE CAIA and for *IEEE Expert*. Ten of the top 12 universities were also listed in O'Leary[2] as the primary organizations supporting contributions to *IEEE Expert* (Illinois, Carnegie Mellon, Michigan, Stanford, Southern California, Purdue, Massachusetts, Pennsylvania, Rutgers, and Ohio State).

A smaller overlap occurred in the nonacademic organizations, where five of the top contributors to IEEE CAIA and *IEEE Expert* were the same: IBM, Digital Equipment, AT&T Bell, Lockheed, and Oak Ridge National Laboratories. Other than funding availability for conferences for nonacademic organizations, it is unclear if there are alternative explanations for this smaller amount of overlap.

Nationality of organizations. Table 5 summarizes the originating countries for the organizations listed by the authors. There were roughly 70.2% of total appearances and 72.87% of adjusted appearances by authors from organizations in the US. This is considerably less than for *IEEE Expert* (78.4% and 78.9%, respectively). Accordingly, IEEE CAIA seems to provide a particularly international forum. Japan and Canada were the second and third largest source of author-based organizations. Italy, the United Kingdom, France, and Germany came next.

Committee members

Table 6 summarizes the list of most frequently appearing committee members. Two committee members have appeared on eight of the 11 CAIA committees: Jan Aikins and Se June Hung. One member appeared on seven committees, four appeared on six com-

Table 7. Ranking of institutions employing committee/program members by total appearances (assuming at least three member appearances).

Rank	Institution	Appearances
1.	IBM	18
2.	University of Southern California	16
3.	Carnegie Mellon University	14
4.	Xerox	12
5.	Stanford University	10
6.	University of Maryland	9
7.	AT&T	8
8.	Carnegie Group	8
9.	New York University	7
10.	Oak Ridge National Laboratory	7
11.	Intellicorp	6
12.	NEC	6
13.	Schlumber-Doll	6
14.	Syntelligence	6
15.	Tokyo Science Institute	6
16.	Digital Equipment Corporation	5
17.	Rutgers University	5
18.	Symbolics	5
19.	University of Texas	5
20.	Machine Vision International	4
21.	Paramax Systems Corporation	4
22.	Teknowledge	4
23.	Texas Instruments	4
24.	Virginia Poly	4
25.	Academic Systems Corporation	3
26.	Cognitive Systems, Inc.	3
27.	Harmon Associates	3
28.	Lockheed	3
29.	Micro-Computer Systems	3
30.	Massachusetts Institute of Technology	3
31.	University of Miami	3
32.	University of California - Berkeley	3
	Total	203

Table 8. Ranking of countries with members of the program/conference committees.

Rank	Country	Appearances
1.	United States	274
2.	Japan	7
3.	Canada	4
4.	Scotland	3
5.	Australia	2
6.	Germany	2
7.	Brazil	1
8.	France	1
9.	Korea	1
	Total	295

Third, there has been what seems to be a genuine international component to IEEE CAIA, with roughly 30% of the contributions coming from outside the US, even though all meetings thus far have taken place there.

A number of committee members have appeared on more than one year's committees. Those members come from a core of organizations (about 68.8% from 32 organizations). Further, over 90% of the committee members were from the US, suggesting less international activity than among the authors.

To extend this examination, future research could examine aggregate data from other conferences with the IEEE CAIA data. In addition, future research could analyze journals and magazines, in a manner similar to this article's companion piece.[2]

mittees, two appeared on five committees, four appeared on four committees, and 35 appeared on two.

About 61.7%, or 182, appeared on at least two or more committees. Unlike the IEEE CAIA authors, this suggests that there was a substantial core of committee members, providing the opportunity for substantial organizational memory.

Organizations. Table 7 lists those organizations that have at least three committee member appearances. The 30 organizations listed account for 68.51% of the appearances. The top five universities were Southern California, Carnegie Mellon, Stanford, Maryland and New York, while the top five nonacademic organizations were IBM, Xerox, AT&T, Carnegie Group, and Oak Ridge National Laboratory.

Nationality of organizations. Table 8 lists the originating countries for the committee members. IEEE CAIA committees reflect a heavy bias towards the US: 92.88% of the committee member appearances were for US-based organizations. This is substantially higher than the participant percentage of roughly 70% mentioned earlier.

*T*HE ANALYSIS OF THE DATA contained in the CAIA proceedings leads to a number of conclusions. First, there is a relatively small core of researchers who have continued to provide research at CAIA. Second, roughly 40% of the contributions seem to come from a relatively small number of universities and nonacademic organizations.

Acknowledgment

References

1. W. Aydelotte, "Quantification in History," *American Historical Review*, Vol. 71, Apr. 1966, pp. 803-825.

2. D. O'Leary, "On the History of the AI Applications, I: *IEEE Expert*, the First Nine Years," *IEEE Expert*, Vol. 10, No. 1, 1995.

Daniel E. O'Leary's biography and contact information appear on page 60.