Fifty Years of CDCs: Rises, Falls, and Trends in Systems and Control

In December 2011, we celebrated the 50th anniversary of our flagship annual event—the IEEE Conference on Decision and Control—known to most of us as "the CDC." During the 1960s, it was actually called the IEEE Symposium on Adaptive Processes, and the first time that it took place as IEEE Conference on Decision and Control was in 1971.

The CDC is a mirror of our field. It reflects the interests of our community during the year in which it takes place. Its technical sessions form a microcosm of our activities, developments in specific topics, and trends in the work of different research groups and in new problems and methodologies, either theoretically motivated or driven by emerging technologies and societal interests.

I decided to take a quick look at past CDC programs and proceedings to get a better sense of how specific topics emerged and flourished and how interest in them evolved through the years. As I did so, I observed some trends, many of them predictable, others a little surprising. I eventually decided to collect some real data to quantify my observations, which has led to the main content of this column.

I first chose 12 terms in our field that frequently show up in titles and abstracts of many of our papers: linear, nonlinear, adaptive, robust, stochastic, optimal, identification, event, hybrid, distributed, autonomous, and network. I then searched through the CDC proceedings, starting with 1971, looking for the occurrence of each term in the title or abstract of a paper. Clearly, this is not a complete scientific study of actual papers in specific topics, and the numbers reported here should not be interpreted as such. For example, there are papers whose title or abstract contains two or more of the 12 terms, yet the data have not been filtered to capture this occurrence. Rather, the data should be viewed as hinting at trends and tracking how

Passing of the president's gavel from Rick Middleton to Christos Cassandras at the 2011 CDC.

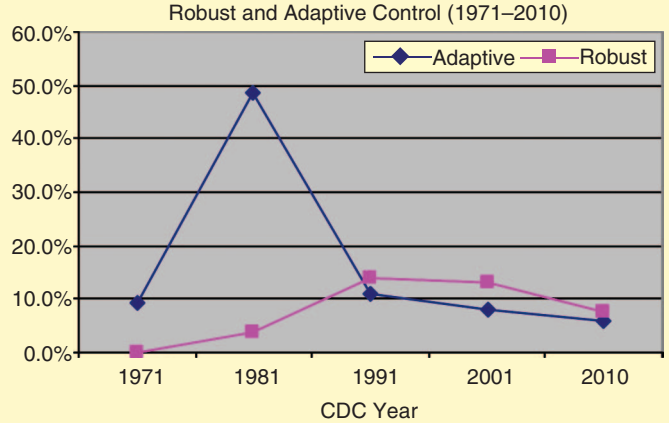

FIGURE 1 Normalized number of papers with the terms "robust" and "adaptive control."

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TABLE 1 The 12 terms over five decades of the CDC.

	1971		1981		1991		2001		2010	
	Number	Fraction	Number	Fraction	Number	Fraction	Number	Fraction	Number	Fraction
Linear	52	26.9%	87	13.4%	254	20.4%	372	22.5%	432	20.5%
Nonlinear	24	12.4%	51	7.8%	192	15.4%	353	21.4%	298	14.1%
Adaptive	18	9.3%	317	48.7%	136	10.9%	135	8.2%	123	5.8%
Robust	0	0.0%	24	3.7%	175	14.0%	217	13.2%	158	7.5%
Stochastic	32	16.6%	39	6.0%	73	5.9%	81	4.9%	149	7.1%
Optimal	43	22.3%	60	9.2%	190	15.2%	181	11.0%	288	13.6%
Identification	13	6.7%	25	3.8%	80	6.4%	83	5.0%	86	4.1%
Event	0	0.0%	2	0.3%	21	1.7%	35	2.1%	34	1.6%
Hybrid	0	0.0%	2	0.3%	15	1.2%	53	3.2%	67	3.2%
Distributed	6	3.1%	24	3.7%	48	3.9%	50	3.0%	153	7.2%
Autonomous	1	0.5%	1	0.2%	6	0.5%	17	1.0%	43	2.0%
Network	4	2.1%	19	2.9%	56	4.5%	73	4.4%	281	13.3%
Total	**193**		**651**		**1246**		**1650**		**2112**	

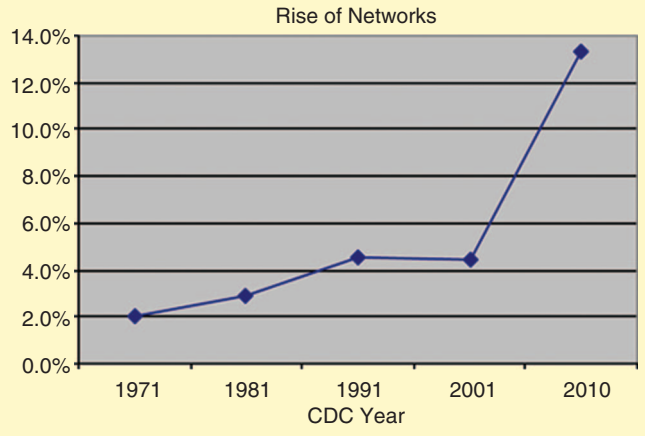

FIGURE 2 The increased use of the term "networks."

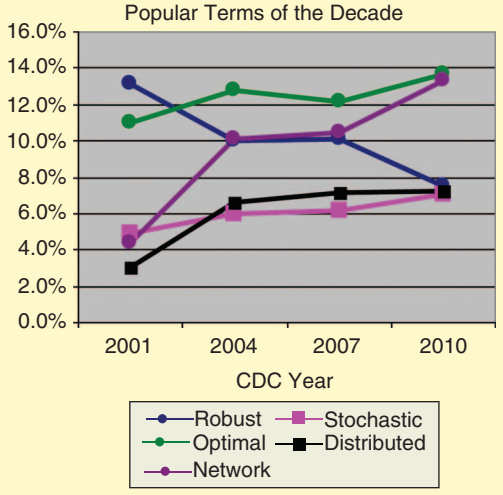

FIGURE 3 The top five terms of the last decade.

popular research topics have captured our imagination over the past five decades.

Table 1 shows data over five CDCs representing five decades: 1971, 1981, 1991, 2001, and 2010 (the 2011 data were not yet available at the time this was written). For each CDC and each of the 12 terms, the number of papers with that term in the title or abstract is shown, along with a normalized version (the fraction of these papers with respect to the sum of all papers identified in the search, which clearly does not include all papers in the associated proceedings). The first observation is the obvious steady growth of papers in each CDC, from 193 in 1971 to 2112 in 2010 (again, these numbers only include the papers tagged with one of the 12 terms and some may be counted more than once). Another predictable observation is the increase of interest in nonlinear systems or nonlinear methodologies, relative to linear ones, seen in the first two rows of Table 1.

What is of most interest in these data is the large variability one sees in the numbers associated with certain topics compared to others. For example:

- The term "adaptive" shows up in nearly 50% of papers in Table 1 in 1981, with only 5.8% in 2010.
- In contrast, the term "identification" shows little variability (3.8% to 6.7%).

The aforementioned variability takes different forms. Some topics have clearly gone from attracting little or no attention to a near-frenzy of research for a good decade before interest seemingly dwindles. Others were literally nonexistent in the 1970s or early 1980s before hitting their stride in the 1990s and, in some cases, just starting to peak in recent years:

- The term "robust" appeared in zero titles or abstracts in 1971 before showing up in 13–14% of papers in 1991 and 2001.
- The terms "event," "hybrid," and "autonomous" were virtually nonexistent in CDCs of the 1970s and early 1980s before representing 8–12% of papers over the past decade.
- The term "network" was sporadically used in the 1970s and 1980s before taking a prominent place in the research agendas of CSS activities in the past decade.

The trajectories of "robust" and "adaptive" were particularly intriguing to me, so I include a graphical representation of the normalized numbers of papers with these terms in titles or abstracts in Figure 1. The rise of "networks" is also graphically seen in Figure 2.

Although it is always interesting and instructive to look at the past, I suspect that many of us are more curious about the present and future. This is better reflected by recent CDCs, so I collected similar data over four CDCs this past decade: 2001, 2004, 2007, and 2010. Rather than showing more tabulated data, I extracted the 2010 top five (out of the 12 chosen terms, excluding the more generic "linear" and "nonlinear") and plotted the normalized numbers in Figure 3. The ones that are clearly eye-catching are "network" and "optimal."

I would like to close by cautioning once again against any over-interpretation of the data shown here. Though not properly filtered, the picture they paint in terms of where the CSS technical activities and priorities have evolved over the past 50 years is sufficiently clear in showing how dynamic the field has been. We have sustained research in fundamental issues that continue to motivate some, while being responsive to new problems in the world around us that others among us are seeking to solve.

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