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1993-1994 CRA Taulbee Survey

Ph.D.s Holding Steady

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For 24 years the Computing Research Association and its predecessor--the Computer Science Board--have been charting the growth of Ph.D. production and employment of computer scientists and computer engineers in North America.

The accompanying tables present the results of this year's CRA Taulbee Survey of Ph.D.-granting departments of computer science (CS) and computer engineering (CE)--and combinations thereof--in the United States and Canada. Each September, the survey is mailed to all organizations included on the CRA Forsythe List of departments that offer a Ph.D. in computer science or computer engineering.* The tables include all responses received by the end of January.

Information on degree production and enrollment applies to the last academic year (1993-94). Information on faculty applies to the current fiscal year (1994-95). Faculty salaries reflect those in effect as of Jan. 1, 1995.

The response rate--especially from computer science departments--once again was quite high. This greatly enhances the utility of the data. However, one should keep in mind that the results are from Ph.D.-granting departments only. There are hundreds more departments that award only bachelor's or master's degrees.

The survey was revised and expanded this year. I will describe the changes and rationale for them. The remainder of the article comments briefly on the most important results and trends.

Additions and changes

This year's survey questionnaire appeared to be much longer than in the past (10 pages versus four), much to the dismay of some department chairs. Part of the increased length was due merely to using a more graphical layout and including general instructions. We did seek some additional information.

The 1994 CRA Conference at Snowbird pointed out the need for more detailed information on Ph.D. production and demand such as subfields in which dissertations are done and the need for a more complete view of the "pipeline" of bachelor's and master's students. This year's information is interesting in its own right; it should prove especially useful in years to come, because it will give us more detailed information on trends.

The other additions to the survey grew out of our desire to have data that is comparable in scope, detail and reporting periods to that used by federal agencies in the United States and Canada. Consequently, we clarified the reporting periods, added enrollment information and changed categories for ethnic origin and residence status.

Many questions were reworded to make them more consistent and precise. Finally, questions about students were expanded to distinguish between students in computer science and computer engineering degree programs, and to distinguish between full-time and part-time students.

Perhaps as a result of the increased length and complexity of the survey, the response rate was down slightly from last year (from 94% to 92% of CS/CE departments).

Results and trends

To a first approximation, academic computing has reached a steady state, at least within Ph.D.-granting departments. The number of Ph.D.s awarded has leveled out, and the number of Ph.D.-granting departments was up only slightly, after dramatic growth in the 1980s. Enrollment in Ph.D. programs was fairly stable. Anecdotal evidence indicates that enrollment also was fairly stable in undergraduate and master's programs, after a dramatic fall in undergraduate enrollment in the late 1980s. Faculty sizes in individual departments also were virtually unchanged. Moreover, departments no longer expect the number of faculty positions to grow much over the next five years, despite previous predictions of growth of 10--20% over five years. (Such predictions always have been overly optimistic; this year's numbers are probably much more realistic.)

The number of Ph.D.s reported this year (1,005 for both computer science and computer engineering) appears to be down somewhat from the past three years. However, ever since CE programs have been included in the survey, it has been difficult to get a high rate of response from departments offering CE degrees. And those departments sometimes have had difficulty separating out CE from EE degrees. (The

response rate from CS also is down slightly this year.) Still, we believe this year's figures on Ph.D. production are accurate, and that those from the previous few years were slightly higher than they should have been. Hence, Ph.D. production has for all practical purposes been steady during the 1990s.

Table 5 presents the employment status of last year's Ph.D. recipients and includes new information on degree areas (specialties). Not surprisingly, there are significant differences between the numbers of Ph.D.s in various specialties, and the specialty and employer mix. Despite horror stories and student fears, it appears that most of last year's graduates found jobs. However, the data could be somewhat misleading, because some students might have deferred graduation. Postdoctorates were not listed as a separate category. The list of specialties may need to be refined. (It looks like other's was a good category to be in last year.)

The percentage of female Ph.D. recipients in computer science continued to increase (from 12% in 1992, to 14% in 1993, and 17% in 1994). Moreover, 23% of the new hires for tenure-track faculty positions were women, so they were hired into such positions in a higher proportion than their presence in last year's graduating class.

However, there is no clear trend in the numbers of female professors at various ranks: the number of assistant professors was up slightly (133 to 137), and the number of associate professors is up significantly (87 to 102), but the number of female full professors decreased (66 to 59). (This year's information combines CS and CE faculty, so it is possible some EE faculty erroneously have been included.)

The percentage of degrees awarded to women last year was almost the same for bachelor's (18%), master's (19%) and Ph.D. degrees (17%). Tables

18-26 report on faculty salaries. Most readers most likely have already studied these tables in detail and made their own interpretations.

For these tables, each department was asked for the minimum, mean and maximum salary for each category of professor. Because tables show the minimums and maximums of the minimums and maximums reported by each department, these figures reflect salaries of individual professors. Also shown are the means of the minimums and maximums reported by each department. Finally, the average of all salaries is the average of the means reported by each department. If a department gave only a partial answer for a category of professor, it was discounted. All Canadian salaries are in Canadian dollars.

Rankings

For Tables 1, 12 and 18-26, which group computer science departments by the rank of 1-12, 13-24 and 25-36, we based our ranking on information from a 1980 assessment of research--doctorate programs in the United States done under the auspices of the National Research Council. We modified our ranking to include top Canadian universities.

Our top 12 schools are Stanford University, Massachusetts Institute of Technology, Carnegie Mellon University, University of California at Berkeley, Cornell University, University of Illinois at Urbana-Champaign, University of California at Los Angeles, University of Toronto, University of Washington, University of Texas at Austin, University of Wisconsin at Madison and the University of Southern California.

The departments ranked 13-24 are the University of Maryland, Princeton University, Brown University, University of Utah, New York University, University of

Massachusetts at Amherst, the State University of New York at Stony Brook, University of North Carolina at Chapel Hill, University of Pennsylvania, Yale University, Pennsylvania State University and the Georgia Institute of Technology.

The departments ranked 25-36 are the University of California at San Diego, the California Institute of Technology, Columbia University, Ohio State University, Rice University, Duke University, Northwestern University, Syracuse University, Rutgers-the State University of New Jersey, University of California at Irvine, University of Minnesota and the University of Rochester.

Acknowledgments

The staff at CRA headquarters--notably Juan Osuna and Phillip Louis--were responsible for drafting the survey, collecting information and preparing the accompanying tables. Jeffrey Ullman of Stanford University, Duncan Lawrie of the University of Illinois at Urbana-Champaign, and John Savage of Brown University helped refine the survey. Mary Jane Irwin of the Pennsylvania State University provided the interpretation of female statistics noted in this article. Lawrie and Robert Schnabel of the University of Colorado provided useful feedback on this article.

Asian/Nonresident Inaccuracies

In accordance with guidelines set forth by the Education Department, this year's survey attempts to separate nonresident aliens from the ethnic breakdown. Although the survey had asked departments not to classify nonresidents under any ethnic category, many departments did not follow these instructions, especially when classifying Asians and Pacific Islanders.

A close look at the raw data reveals many

departments with more than 50 Asian graduate students but no nonresident aliens reported. We find this data suspect. When calling back a few of these departments, we found that an error was usually made and that most of their Asian Ph.D.s and graduate students were nonresidents.

Hence, the number of Asian Ph.D.s and graduate students who permanently reside in North America is likely to be substantially less than the statistics indicate, while the number of nonresidents is likely to be correspondingly greater.

The reasons behind this approach are political and practical. Issues of minority representation usually are framed within the political and legal context of North America, where certain ethnic categories tend to be less represented than others. While the ethnicity of foreign students may be of some interest, it is not as critical simply because most foreign students return to their home countries where they are a part of a majority ethnic group and where the issues of representation are dissimilar to those of North America.

The practical reason for distinguishing nonresidents is that it allows us to compare our data with data kept by the Education Department, which may prove useful in determining historical trends.

Footnotes

All ethnicity tables: "Native American" includes Alaskan natives; "Asian" includes people originating from the Pacific Islands, China, Japan, Korea, the Philippine Islands, Samoa, India and Vietnam; "white" includes people originating from Europe, North Africa and the Middle East.

All tables with rankings: Statistics sometimes are given according to departmental rank. Schools are ranked only if they offer a CS degree. Those that only offer CE degrees are not ranked and statistics are given on a separate line, apart from the rankings. In Table 1, the "Ph.D.s Produced"

column shows the number of CS and CE degrees produced throughout the rankings. While CE degrees are mixed into all rank categories, there are no CS degrees in the CE category.

*Totals do not match: The reader may find that totals from certain tables do not equal each other, even though theoretically, they should. These discrepancies stem from inconsistencies in the way departments answered different questions. We tried to minimize this by calling departments that provided inconsistent answers. The horizontal and vertical totals in Table 5 do not equal each other because many departments could not tell us the specialty area of the Ph.D.s.

Nonresident faculty: A small percentage of faculty were nonresident aliens when they were hired to work in fiscal 1994-95. In many cases, these new employees were gaining residency based on their new employment prospects. All faculty tables: The survey makes no distinction between faculty specializing in CS versus CE programs. Although we tried to minimize inclusion of any faculty in electrical engineering, there may be a few who slipped through.

Degree Production

Ph.D. Production

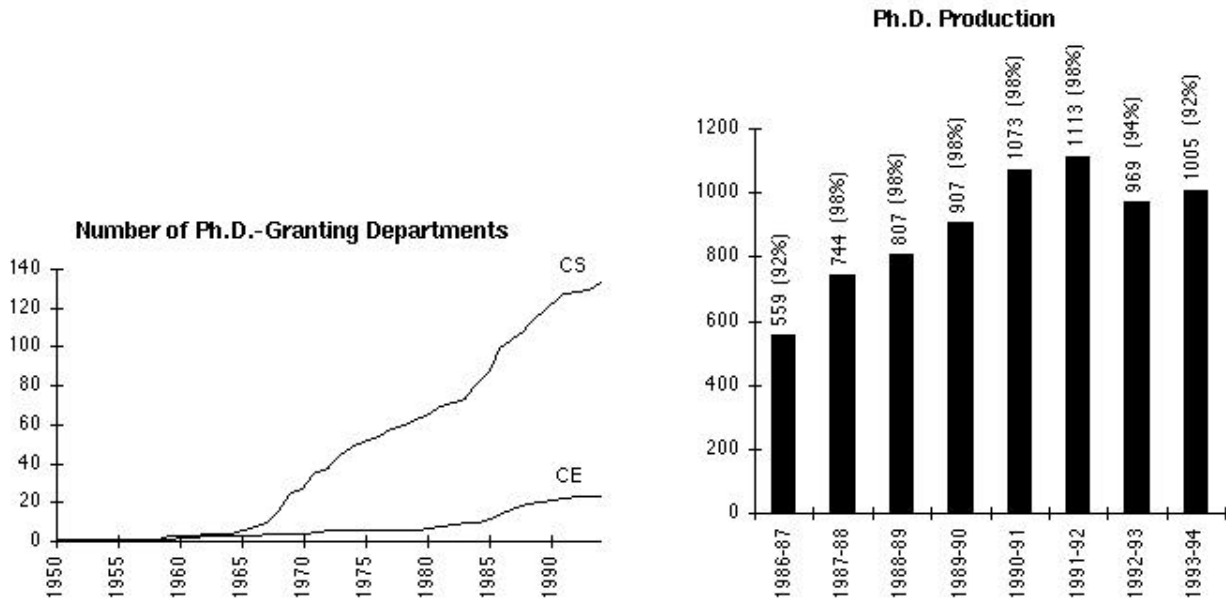**Number of Ph.D.-Granting Departments**

Table 1. Ph.D. Production by Ranking

	Ph.D.s Produced	Average per Dept.	Ph.D.s Next Year	Average per Dept.	Passed Qualifier	Average per Dept.
CS Ranked 1-12	203	16.9	204	17.0	174	19.3
CS Ranked 13-24	124	10.3	152	12.7	152	13.8
CS Ranked 25-36	114	9.5	138	11.5	131	13.1
CS Other	492	5.4	607	6.7	581	6.8
CE	72	7.2	65	6.5	100	9.1
CS&CE	*1005*	*7.3*	*1166*	*7.9*	*1138*	*9.3*

Table 2. Gender and Ethnicity of Ph.D. Recipients

	CS			CE			CS & CE		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Nonresident Alien	239	30	269	51	3	54	300	33	333
African American	10	3	13	1	0	1	11	3	14
Native American	0	0	0	0	0	0	0	0	0
Asian	100	21	121	23	2	25	130	24	154
Hispanic	6	0	6	2	0	2	9	0	9
White	311	66	377	24	5	29	352	72	424
Other	23	3	26	0	0	0	24	4	28
Did Not Indicate	30	3	33	13	0	13	44	4	48
Total	*719*	*126*	*845*	*114*	*10*	*124*	*870*	*140*	*1010*

Table 3. Gender of Ph.D. Recipients by Percentage

	CS	CE	CS & CE
Male	723 (83%)	97 (94%)	848 (84%)
Female	149 (17%)	6 (6%)	157 (16%)
Total	*872*	*103*	*1005*

Table 4. Gender of Bachelor's and Master's Recipients

	Bachelor's	Master's
Male	6742 (82%)	4188 (81%)
Female	1474 (18%)	991 (19%)
Total	*8216*	*5179*

Table 5. Employment of Ph.D. Recipients by Specialty

Ph.D.s Employed Domestically in:	Artifical Intelligence/ Robotics	Hardware Systems/ Architecture	Numerical Analysis/ Scientific Computin	Software Systems	Theory	Other	Total
Ph.D. CS/CE Dept.	42	32	9	36	21	34	187
Non-Ph.D. CS/CE Dept.	12	8	7	25	13	7	73
Non-CS/CE Dept.	2	5	1	2	5	10	25
Industry	60	51	12	85	11	52	295
Government	8	2	2	7	2	5	34
Self-Employed	5	3	0	3	1	1	14
Other Categories:							
Employed Abroad	32	11	6	28	17	39	141
Unemployed	2	0	0	8	3	3	16
Unknown	11	4	6	15	5	30	220
Total	*174*	*116*	*43*	*209*	*78*	*181*	

Table 6. Ethnicity of Ph.D. Recipients by Percentage

	CS		CE		CS & CE	
Nonresident Alien	269	(33%)	54	(49%)	333	(35%)
African American	13	(2%)	1	(1%)	14	(1%)
Native American	0	(0%)	0	(0%)	0	(0%)
Asian	121	(15%)	25	(23%)	154	(16%)
Hispanic	6	(1%)	2	(2%)	9	(1%)
White	377	(46%)	29	(26%)	424	(44%)
Other	26	(3%)	0	(0%)	28	(3%)
Subtotal	*812*	*(100%)*	*111*	*(100%)*	*962*	*(100%)*
Did not indicate	33		13		48	
Total	*845*		*124*		*1010*	

Table 7. Ethnicity of Bachelor's and Master's Recipients

	Bachelor's		Master's	
Nonresident Alien	483	(10%)	1557	(37%)
African American	172	(3%)	82	(2%)
Native American	9	(0%)	1	(0%)
Asian	810	(16%)	755	(18%)
Hispanic	164	(3%)	64	(2%)
White	3198	(65%)	1702	(40%)
Other	99	(2%)	75	(2%)
Subtotal	*4935*	*(100%)*	*4236*	*(100%)*
Did Not Indicate	3476		953	
Total	*8411*		*5189*	

Table 8. Degrees Awarded to People with Disabilities

	Bachelor's	Master's	Ph.D.
CS	25	9	3
CE	1	3	0
CS&CE	26	14	3

Student Enrollment Tables

Table 9. Gender of Enrolled Ph.D. Students

	CS Full Time		CS Part Time		CE Full Time		CE Part Time		CS & CE Full Time		CS & CE Part Time	
Male	5429	(84%)	1119	(83%)	545	(89%)	111	(94%)	6211	(84%)	1271	(84%)
Female	1046	(16%)	232	(17%)	70	(11%)	7	(6%)	1151	(16%)	246	(16%)
Total	*6475*		*1351*		*615*		*118*		*7362*		*1517*	

Table 10. Ethnicity of Enrolled Ph.D. Students

	CS Full Time		CS Part Time		CE Full Time		CE Part Time		CS & CE Full Time		CS & CE Part Time	
Nonresident Alien	2319	(41%)	237	(21%)	170	(41%)	21	(40%)	2589	(41%)	262	(21%)
African American	92	(2%)	28	(2%)	2	(0%)	2	(4%)	98	(2%)	31	(2%)
Native American	27	(0%)	2	(0%)	0	(0%)	1	(2%)	27	(0%)	3	(0%)
Asian	621	(11%)	193	(17%)	137	(33%)	11	(21%)	780	(12%)	210	(17%)
Hispanic	68	(1%)	17	(1%)	6	(1%)	1	(2%)	76	(1%)	20	(2%)
White	2445	(43%)	659	(58%)	98	(24%)	17	(32%)	2667	(42%)	732	(58%)
Other	110	(2%)	3	(0%)	2	(0%)	0	(0%)	132	(2%)	13	(1%)
Subtotal	*5682*	*(100%)*	*1139*	*(100%)*	*415*	*(100%)*	*53*	*(100%)*	*6369*	*(100%)*	*1271*	*(100%)*
Did Not Indicate	779		188		198		59		1005		249	
Total	*6461*		*1327*		*613*		*112*		*7374*		*1520*	

Table 11. New Students in Fall 1994

	Bachelor's Full Time	Bachelor's Dept. Avg.	Master's Full Time	Master's Dept. Avg.	Ph.D. Full Time	Ph.D. Dept. Avg.
CS Ranked 1-12	1191	99.3	515	42.9	247	20.6
CS Ranked 13-24	653	54.4	159	13.3	167	13.9
CS Ranked 25-36	307	25.6	111	9.3	128	10.7
CS Other	6890	59.9	1825	15.9	761	6.6
CE	641	40.1	272	17.0	99	6.2
CS&CE	*9682*	*58.0*	*2882*	*17.3*	*1402*	*8.4*

Faculty Growth Tables

Table 12. Anticipated Faculty Growth

	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	Five-Year Increase	
CS Ranked 1-12	341.0	344.0	350.0	354.0	354.0	354.0	13.0	(4%)
CS Ranked 13-24	301.5	309.5	315.5	319.5	324.5	328.5	27.0	(9%)
CS Ranked 25-36	261.8	267.8	268.8	270.8	272.8	273.8	12.0	(5%)
CS Other	3165.1	3250.1	3319.1	3368.1	3407.1	3445.1	280.0	(9%)
CE	269.0	274.0	276.0	277.0	281.0	282.0	13.0	(5%)
CS&CE	4338.4	4445.4	4529.4	4589.4	4639.4	4683.4	345.0	(8%)

Table 13. Gender of Professors

	Assistant	Associate	Full
Male	614 (82%)	982 (91%)	1157 (95%)
Female	137 (18%)	102 (9%)	59 (5%)
Total	751	1084	1216

Table 14. Ethnicity of Professors

	Assistant		Associate		Full	
Nonresident Alien	29	(4%)	9	(1%)	9	(1%)
African American	15	(2%)	4	(0%)	3	(0%)
Native American	1	(0%)	6	(1%)	2	(0%)
Asian	151	(21%)	198	(20%)	124	(11%)
Hispanic	15	(2%)	10	(1%)	13	(1%)
White	478	(67%)	754	(75%)	964	(85%)
Other	23	(3%)	25	(2%)	19	(2%)
Subtotal	712	(100%)	1006	(100%)	1134	(100%)
Did Not Indicate	40		79		81	
Total	752		1085		1215	

Table 15. Faculty Losses

	With Ph.D.	Without Ph.D.	Total
Died	7	1	8
Retired	43	3	47
Visitors Returing to Employer	46	3	49
Teaching Elsewhere	64	2	66
Left for Non-Academic Position	38	2	40
Returned to Graduate School	1	4	5
Remained, Changed to Part Time	7	1	8
Other	22	4	26
Unknown	3	0	3
Total	231	20	252

Table 16. Gender of Newly Hired Faculty

	Tenured	Tenure-Track	Other
Male	20 (83%)	93 (77%)	110 (80%)
Female	4 (17%)	28 (23%)	28 (20%)
Total	24	121	138

Table 17. Ethnicity of Newly Hired Faculty

	Tenured		Tenure-Track		Other	
Nonresident Alien	1	(5%)	14	(12%)	8	(6%)
African American	0	(0%)	1	(1%)	1	(1%)
Native American	0	(0%)	0	(0%)	0	(0%)
Asian	3	(16%)	22	(19%)	37	(29%)
Hispanic	0	(0%)	2	(2%)	3	(2%)
White	15	(79%)	76	(66%)	75	(59%)
Other	0	(0%)	1	(1%)	3	(2%)
Subtotal	*19*	*(100%)*	*116*	*(100%)*	*127*	*(100%)*
Did not indicate	3		6		17	
Total	*22*		*122*		*144*	

Faculty Salary Tables

Table 18. Nine-Month Salaries, 115 Responses of 136 US CS Departments

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	560 of 567	$30,200	$49,587	$61,600	$52,374	$43,300	$55,394	$70,800
Associate	782 of 787	$36,641	$54,794	$71,400	$60,481	$50,500	$67,300	$93,200
Full	876 of 899	$38,940	$66,341	$103,000	$81,606	$54,998	$101,531	$181,500

Table 19. Nine-Month Salaries, 11 Responses of 11 US CS Departments Ranked 1-12

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	76 of 77	$48,855	$52,616	$60,000	$54,593	$54,200	$58,286	$70,800
Associate	92 of 92	$49,100	$57,750	$63,500	$62,988	$60,156	$70,551	$82,100
Full	142 of 145	$38,940	$65,652	$75,050	$86,431	$84,320	$110,097	$126,400

Table 20. Nine-Month Salaries, 11 Responses of 12 US CS Departments Ranked 13-24

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	52 of 56	$50,000	$52,548	$59,900	$54,971	$53,040	$57,511	$61,200
Associate	93 of 93	$53,183	$59,876	$69,200	$66,242	$63,266	$73,301	$91,982
Full	132 of 133	$58,904	$72,122	$95,500	$91,959	$105,054	$120,411	$142,000

Table 21. Nine-Month Salaries, 10 Responses of 12 US CS Departments Ranked 25-36

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	37 of 37	$35,000	$51,263	$61,600	$54,911	$56,250	$59,534	$70,800
Associate	48 of 48	$56,000	$61,880	$71,400	$66,373	$61,800	$73,332	$86,300
Full	60 of 62	$60,500	$71,508	$86,100	$93,933	$82,246	$124,735	$181,500

Table 22. Nine-Month Salaries, 83 Responses of 101 US CS Departments Ranked Higher than 36

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	395 of 397	$30,200	$48,674	$56,400	$51,502	$43,300	$54,405	$68,178
Associate	549 of 554	$36,641	$53,090	$65,800	$58,719	$50,500	$65,535	$93,200
Full	542 of 559	$43,500	$65,188	$103,000	$78,254	$54,998	$96,012	$145,000

Table 23. Nine-Month Salaries, 10 Responses of 16 US CE Departments

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	55 of 56	$44,637	$49,705	$56,450	$50,819	$44,637	$52,951	$61,720
Associate	60 of 62	$46,573	$55,156	$62,000	$59,756	$53,829	$63,821	$75,500
Full	76 of 78	$53,418	$65,187	$82,500	$77,295	$65,422	$96,819	$136,700

Table 24. 12-Month Salaries, 12 Responses of 15 Canadian CS Departments (Canadian Dollars)

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	67 of 70	$31,639	$49,424	$61,336	$55,514	$52,333	$62,899	$80,961
Associate	154 of 155	$40,815	$59,221	$76,086	$68,884	$66,367	$81,323	$124,987
Full	143 of 145	$52,748	$72,312	$86,388	$87,956	$84,165	$109,672	$159,539

Table 25. Nine-Month Salaries, 125 Responses of 152 US CS and CE Departments

Faculty Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
Assistant	615 of 623	$30,200	$49,598	$61,600	$52,241	$43,300	$55,161	$70,800
Associate	842 of 849	$36,641	$54,828	$71,400	$60,419	$50,500	$66,971	$93,200
Full	952 of 977	$38,940	$66,249	$103,000	$81,269	$54,998	$101,120	$181,500

Table 26. Salaries of Newly Appointed Faculty, 68 Responding CS & CE Departments

Dept. Rank	# Reporting Salary Data	Reported Salary Minimums Min.	Mean	Max.	Avg. of all Salaries	Reported Salary Maximums Min.	Mean	Max.
US: CS 1-12	7 of 7	$49,000	$51,914	$55,500	$52,271	$49,000	$52,629	$55,500

CS: CS 1-12	1 of 1	$15,000	$31,311	$33,000	$32,211	$15,000	$32,023	$33,000
CS 13-24	12 of 12	$50,000	$52,443	$55,000	$53,395	$53,000	$54,709	$58,700
CS 25-36	6 of 6	$53,004	$56,976	$65,900	$56,976	$53,004	$56,976	$65,900
CS Other	62 of 64	$34,000	$47,646	$56,000	$48,742	$34,000	$50,106	$76,000
CE	9 of 9	$40,000	$46,900	$50,500	$47,356	$40,000	$47,715	$52,690
CS&CE	*96 of 98*	*$34,000*	*$49,134*	*$65,900*	*$50,010*	*$34,000*	*$51,086*	*$76,000*
Canadian: CS&CE	14 of 14	$27,500	$47,182	$55,000	$49,915	$45,521	$53,724	$58,000