Outcomes of Advertised Computer Science Faculty Searches for 2019

Craig E. Wills

Computer Science Department
Worcester Polytechnic Institute
WPI-CS-TR-19-04

October 2019

Abstract

This work directly follows previous work that analyzed current and future Computer Science needs via advertised tenure-track faculty searches for 2019. This follow-on work looked to understand the relative success of institutions in hiring the tenured/tenure-track faculty in the areas of Computer Science that were being sought.

Responses to a survey were obtained from 147 institutions that reported seeking tenure-track faculty in 2019. The summary results continue to show a mix of success with just 56% of institutions hiring at least the number of faculty they were seeking. In terms of areas, AI/DM/ML, Databases and Data Science collectively represent a third of the positions filled, although PhD production in these areas was not this high. There continues to be stronger demand for positions in Security than PhD production or positions actually filled, although the differences are a bit less than were found in 2018.

1 Introduction

This work directly follows previous work analyzing current and future Computer Science needs via advertised tenure-track faculty searches for 2019 [2]. The work seeks to understand the relative success of institutions in hiring the tenured/tenure-track faculty in the areas that were being sought. This report also follows on from a similar study of tenure-track faculty hiring outcomes in 2018 [1].

The primary tool used for this work is a survey sent to the advertised search committee contact or head of the department (or related program). Survey results are analyzed and as appropriate, the analysis takes into account ads that were posted by each institution (and summarized in [2]) as well as pertinent results reported in the 2018 CRA Taulbee Survey of PhD-producing Computer Science departments [3]. The remainder of this report elaborates on the methodology used to obtain data and the results from analyzing it.

2 Methodology

A survey consisting of four numeric-answer questions and one open-text-response question was constructed using the Qualtrics survey tool, which created a survey that could be taken online. The four numeric questions asked about the number of faculty sought to hire, the number that were hired, the number of faculty hired in a list of areas and the previous positions of the faculty hired. The open-response question allowed respondents to provide any additional feedback. The survey instructions and questions are shown in Appendix A.

Invitations were emailed to 460 institutions (some with multiple search contacts) in September 2019. These institutions placed ads between August and December 2018 for tenure-track positions to begin in 2019. The previous report on hiring needs [2] was based on ads placed by 408 institutions prior to November 15, 2018, but ads for the dataset continued to be collected through calendar-year 2018. The email message sent to each search included a URL for them to use in participating. The URL contained the email address for each contact so that survey results could be linked to information from the ads for each institution.

3 Results

We obtained survey responses from 147 institutions (vs. 176 and 155 in past studies) that reported seeking tenure-track faculty in 2019. Survey responses were dropped if the number of faculty positions being sought was zero or not specified. Multiple responses from the same institution were combined in cases that multiple searches from the institution led to multiple survey responses. 39 of the respondents provided written-text feedback as part of their response.

The remainder of this section reports results from analyzing the survey responses. As appropriate, the analysis take into account ads that were posted by each institution and summarized in [2] as well as pertinent results reported in the 2018 Taulbee Survey of PhD-producing Computer Science departments [3]. Written-text feedback is included as appropriate.

3.1 Faculty Positions Being Sought

A summary of the faculty positions sought for the 147 institutions based on responses to the survey is shown in Table 1. Information from the ads dataset is used to classify each institution according to the highest Computer Science degree it offers. As done in [2], PhD-granting institutions are further classified into PhD100 and PhDMore using the U.S. News Rankings of the 100 Best Graduate schools[1], for the top-100 U.S. and then more PhD institutions including those not in the U.S.

Table 1: Summary of Faculty Positions Sought by Highest Degree Offered

Highest Degree	Number of Institutions	Number of Positions Sought 1	2	3+	Total Positions
PhD100	42	2 (5%)	12 (29%)	28 (67%)	155
PhDMore	23	9 (39%)	4 (17%)	10 (43%)	64
MS	25	8 (32%)	9 (36%)	8 (32%)	58
BS	57	40 (70%)	13 (23%)	4 (7%)	78
All	147	59 (40%)	38 (26%)	50 (34%)	355

The table shows that 40% of all institutions responding to the survey were seeking to hire one tenure-track faculty member, 26% were seeking to hire two, and 34% were seeking to hire three or more tenure-track faculty members. Not surprisingly there is variation based on the type of institution with 70% of BS institutions reporting they sought to hire one faculty member while 67% of PhD100 institutions reported seeking to hire three or more.

The last column in Table 1 shows that the 147 institutions reported seeking to fill a total of 355 tenure-track faculty positions (vs. 363 and 327 in past studies). The largest number (155) of these positions are for PhD100 institutions with MS institutions reporting the smallest number (58).

A natural and important question to ask is if the institutions responding to the survey are representative of all institutions seeking to hire tenure-track faculty for 2019. As a means to answer this question we examined four sets of institutions in terms of the number of positions they were seeking to hire. The first set (Nov18Ads) uses total positions for all institutions with ads placed by November 15, 2018, which were the set of ads used for the analysis of needs report [2]. The second set (2019Ads) uses total positions of ads for 2019 tenure-track positions placed by the end of the 2018 calendar year, which is the set of faculty invite to participate in the survey. The third set (SurveyAds) uses the total positions specified in the ads placed by the survey-responding institutions. The final set (SurveyResp) uses the total positions reported by survey respondents.

Figure 1 shows the representation for each degree type of institution for each of the four sets of institutions. The relative proportions are shown for each of institutions and faculty positions. The relative proportion of all types of responding institutions (SurveyResp) are within 9% percent of the 2019Ads set with PhD100 and BS institutions responding at higher rates and PhDMore and MS institutions responding at lower rates.

Similarly the relative proportion of all positions for responding institutions are within 10% of all positions for the 2019Ads set with the biggest discrepancy for the PhD100 institutions. As

[1] `http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-science-schools/computer-science-rankings`

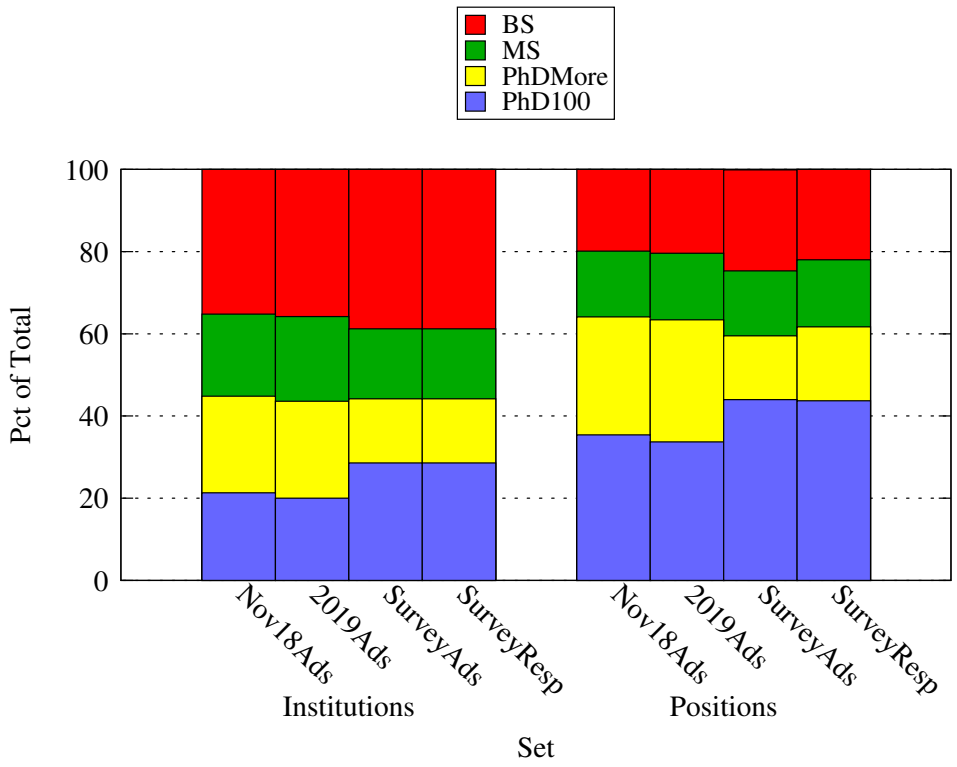

Figure 1: Comparison of Institution and Position Percentages by Highest Degree Offered

described in [2] determining the number of positions being sought by an institution based on an ad is not always clear. Non-specific phrases include "multiple positions," "several positions" or just "positions." Position proportions in Figure 1 based on ads use an estimate of three positions for such non-specific searches. We note that 21% (31/147) of the institutions responding to the survey used non-specific numbers of positions in their ads. Using survey results for these institutions, we obtain a median of 3 and a mean of 3.5 for the actual number of positions being sought. We also observe that the ads of the remaining institutions indicated specific numbers of positions for a total of 183, yet the survey respondents for these institutions responded with a total of 237 positions seeking to be filled. These discrepancies indicate that the number of positions in ads are only an approximation of the actual number being sought.

The end result is that the relative closeness of proportions between the complete set of institutions and those responding to the survey allow us to have confidence that results for the responding set are representative of the larger set.

An addition to the ads dataset compiled for [2] allows us to also analyze the results based on whether a response is from a U.S. public, U.S. private or non-U.S institution. Table 2 shows results for positions being sought using this institution type combined with highest degree offered. For this analysis, PhD100 and PhDMore institutions are combined as are MS and BS. Five non-U.S. institutions responding to the survey are dropped in this analysis.

The results show that many more public (43) than private (18) PhD institutions responded to the survey. In contrast more private MS&BS institutions (53) responded in comparison to public MS&BS institutions (28). Responses for private institutions reported seeking only a single position

Table 2: Summary of Faculty Positions Sought by Institution Type and Highest Degree Offered

Type/ Degree	Number of Institutions	Number of Positions Sought 1	2	3+	Total Positions
Pub/PhD	43	10 (23%)	8 (19%)	25 (58%)	141
Prv/PhD	18	1 (6%)	8 (44%)	9 (50%)	54
Pub/MSBS	28	11 (39%)	11 (39%)	6 (21%)	58
Prv/MSBS	53	37 (70%)	11 (21%)	5 (9%)	74
All	142	59 (42%)	38 (27%)	45 (32%)	327

at a higher rate than for public institutions. This result is consistent with results reported in [2].

3.2 Positions Being Filled

The survey results provide more precise, but similar information on positions being sought as obtained from posted ads. However the survey is needed to understand the success of institutions in filling these positions. Table 3 shows the number of tenure-track faculty positions filled based on the responses by the 147 institutions participating in the survey. The table shows these institutions reported filling a total of 267 positions with PhD100 institutions filling the most positions with 116 and MS institutions filling the least with 45.

Table 3: Summary of Positions Filled by Highest Degree Offered

Highest Degree	Number of Institutions	Number of Positions Filled 0	1	2	3+	Total Positions	Overall Success %
PhD100	42	1 (2%)	11 (26%)	13 (31%)	17 (40%)	116	75%
PhDMore	23	1 (4%)	7 (30%)	6 (26%)	9 (39%)	54	84%
MS	25	2 (8%)	11 (44%)	5 (20%)	7 (28%)	45	78%
BS	57	15 (26%)	35 (61%)	5 (9%)	2 (4%)	52	67%
All	147	19 (13%)	64 (44%)	29 (20%)	35 (24%)	267	75%

Looking at the number of positions filled by each institution we see 13% of all institutions reported having a "failed" search where no faculty positions were filled (it was 22% and 18% in previous studies). 26% of BS institutions reported having failed searches (vs. 31% and 24% in previous studies). Not surprisingly, PhD100 institutions had the lowest proportion of failed searches (2%) and the highest proportion making three or more hires (40%).

The last column in Table 3 combines results from it and Table 1 to show an overall search success rate of 75% where 267 positions were filled out of a total of 355 positions being sought. As expected there is variation amongst institution type with PhDMore institutions having an overall 84% success rate, MS having a 78% rate, PhD100 having a 75% rate and BS having a 67% success rate.

Table 4 shows the same results as Table 3 based on classifying institutions by type and highest degree offered. Combining with results from Table 2, both public and private PhD institutions

show similar overall success rates of 79% and 74%, but public and private MS&BS institutions have overall success rates of 67% and 69%. The PhD success rates are lower and the public MS&BS rates are higher than the previous year.

Table 4: Summary of Positions Filled by Institution Type and Highest Degree Offered

Type/ Degree	Number of Institutions	Number of Positions Filled 0	1	2	3+	Total Positions	Overall Success %
Pub/PhD	43	1 (2%)	13 (30%)	11 (26%)	18 (42%)	112	79%
Prv/PhD	18	1 (6%)	5 (28%)	8 (44%)	4 (22%)	40	74%
Pub/MSBS	28	5 (18%)	15 (54%)	3 (11%)	5 (18%)	39	67%
Prv/MSBS	53	12 (23%)	31 (58%)	7 (13%)	3 (6%)	55	74%
All	142	19 (13%)	64 (45%)	29 (20%)	30 (21%)	246	75%

As comparison, Table F2 in the 2018 Taulbee Survey [3] presents similar aggregate search results for PhD-granting institutions in 2016-17. Those results report a tenure-track search success rate of 79% (250/315) for all U.S. Computer Science Departments. This success rate is virtually the same as the combined success rate for U.S. PhD-granting (Pub/PhD and Prv/PhD) institutions of 78% (152/195) in our survey responses.

3.3 Positions Being Filled for Each Institution

A problem with the aggregated results is they do not take into account the specific results for each institution. For example, an institution seeking to hire three faculty and only hiring two is not a "failed" search, but it is less than successful. In contrast an institution may be seeking two faculty, but it is more than successful in being able to hire three faculty. The result is an aggregated success of 100% (5/5) for these two institutions, where the results of the individual searches is lost.

As a means to analyze the search results for each of the 147 institutions responding to the survey seeking to fill at least one faculty position, we defined four categories of institutional search results:

1. *failed* if no faculty were hired,
2. *less* than successful if the number of faculty hired was at least one, but less than the number being sought,
3. *success* if the number of faculty hired was that same as the number being sought, and
4. *more* than successful if the number of faculty hired was more than the number being sought.

Figure 2 shows the percentage of institutions in each of these categories based both on the number of positions sought as well as the institution type. The left grouping in the figure shows that 13% of all searches for all types of institutions failed, 31% were less than successful, 52% of searches were a success and 4% were more than successful. Overall, 56% of institutions responding to the survey reported success or more in their search. This result is comparable to the 53% and

54% results in the past two years. The first grouping also shows that 24% (28% and 38% in past years) of all single-position searches failed with the remaining 76% (72% and 62% in past years) at least succeeding. Two-position searches failed for 13% (17% and 13% in past years) of institutions and were at least successful for 50% (compared to 37% and 53%) of institutions. Finally, searches for three or more positions failed for 0% of institutions and were at least successful for 36% (39% and 43% in past years) of institutions.

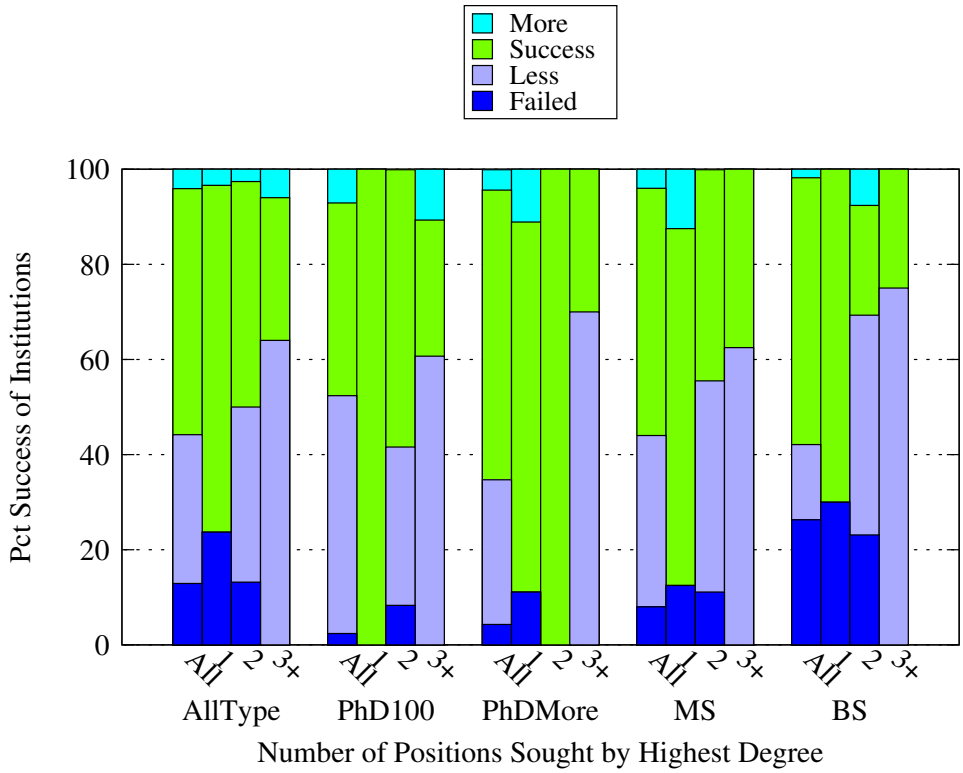

Figure 2: Percentages of Search Success by Highest Degree Offered

The remaining groupings in Figure 2 show the breakdown based on highest degree offered. Searches for all PhD100 institutions failed for 2% and were at least successful for 48%. Searches for all PhDMore institutions failed for 4% and were at least successful for 65%. Searches for all MS institutions failed for 8% and were at least successful for 56%. Searches for all BS institutions failed for 26% and were at least successful for 58%. These percentages indicate that PhD100 institutions were the least successful (they were most successful last year) and PhDMore institutions the most successful in hiring at least as many tenure-track faculty as were being sought.

Figure 3 shows a similar breakdown based on a combination of institution type and highest degree offered. Searches for all public PhD institutions failed for 2% and were at least successful for 58%. Searches for all private PhD institutions failed for 6% and were at least successful for 50%. Searches for all public MS&BS institutions failed for 18% and were at least successful for 46%. Searches for all private MS&BS institutions failed for 23% and were at least successful for 64%. These percentages indicate that private MS&BS institutions were the most successful and public MS&BS institutions the least successful in hiring at least as many tenure-track faculty as

were being sought.

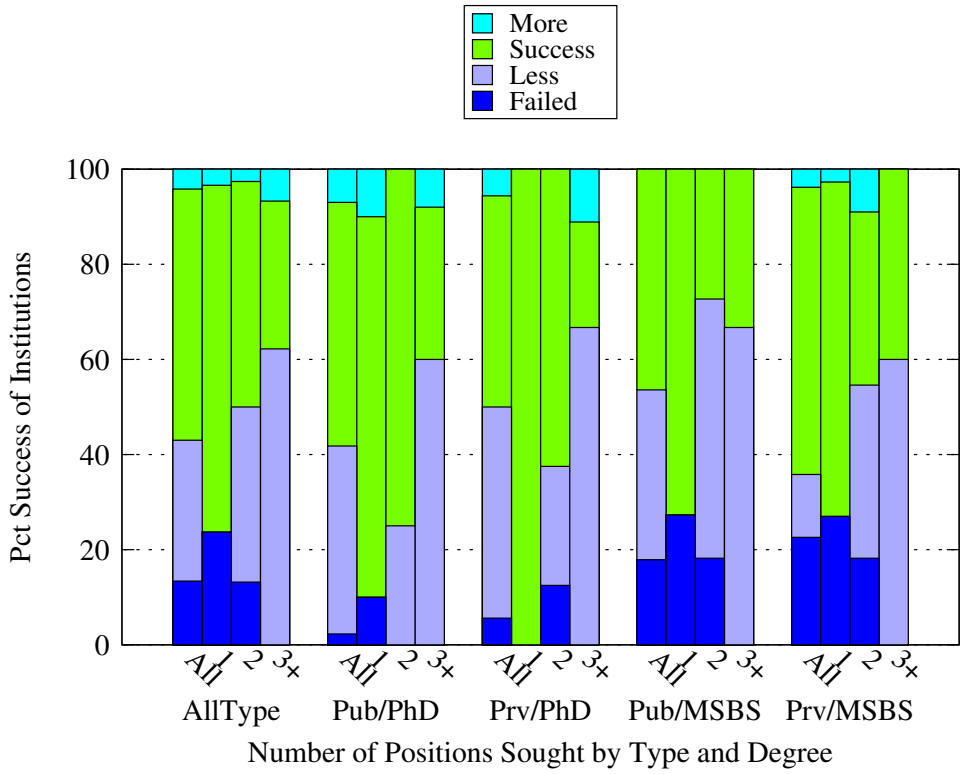

Figure 3: Percentages of Search Success by Institution Type and Highest Degree Offered

In comparison, the 2018 Taulbee Survey [3] only aggregates the number of faculty positions filled or unfilled, but does not provide per-institution results. However Table F2a in that report does provide reasons why positions are left unfilled with the top three being 51% due to offers turned down, 27% due to hiring in progress and 14% due to not finding a person who met hiring goals. The report goes on to provide gender and ethnicity information for new hires, which was not collected as part of our survey.

Many of the comments received from our survey respondents had to do with reasons why institutions were less than successful. These reasons included a reduced number of qualified applicants, the need for increased salaries leading to failures in hiring candidates or salary inversion with existing faculty, and competition from industry. Other comments included needing to hire in different area, observations on the difficulty of the hiring calendar and the lack of objective letters.

3.4 Previous Position of Hired Faculty

Another question in the survey obtained the previous position held by each of the new faculty that were hired. Table 5 shows the proportion for each type of previous position for all institutions and for institutions based on highest degree offered. Previous positions are ordered based on numbers from most to least for all institutions. Note there may be small inconsistencies in the total number of positions compared to Table 3 due to variations in survey responses for the number of filled positions for different questions.

Table 5: Summary of Previous Positions Held for Hired Faculty by Highest Degree Offered

Previous Position	All Types	Highest Degree PhD100	PhDMore	MS	BS
PostDoc	78 (29%)	39 (34%)	17 (32%)	12 (26%)	10 (19%)
PhD	70 (26%)	26 (23%)	14 (26%)	18 (39%)	12 (23%)
T/TT	60 (23%)	30 (26%)	15 (28%)	6 (13%)	9 (17%)
NTT	24 (9%)	5 (4%)	3 (6%)	4 (9%)	12 (23%)
ABD	19 (7%)	9 (8%)	2 (4%)	2 (4%)	6 (12%)
NonAcad	11 (4%)	6 (5%)	0 (0%)	2 (4%)	3 (6%)
Other	4 (2%)	0 (0%)	2 (4%)	2 (4%)	0 (0%)
All	266 (100%)	115 (100%)	53 (100%)	46 (100%)	52 (100%)

The results show that 29% of all hired faculty were previously in post-doc/researcher positions (26% and 23% in past years). 26% start with a newly-earned PhD (31% and 29% in past years). 23% were previously in a tenured or tenure-track position at another institution (26% and 27% in past years). These again were the three primary previous positions with the remaining options (non-tenure-track faculty, all-but-dissertation, non-academic and other) each less than 10%.

Results for different degrees offered showed some variation with PostDoc/Researcher positions the most prevalent previous positions for PhD100 and PhDMore institutions. There was more variation for the previous position of MS and BS institution hires with 39% of positions for MS institutions filled by new PhDs with BS institution positions filled by new PhDs and previously non-tenure-track faculty.

Table 6 shows the same results based on institution type and highest degree offered. The largest percentage of public PhD institution hires were PostDoc/Researchers and new PhDs each at 29%. Private PhD institutions hired the most PostDoc/Researchers at 46%. Public and Private MS&BS institutions made the most hires (42% and 24%) who are new PhDs.

Table 6: Summary of Previous Positions Held for Hired Faculty by Type and Highest Degree

Previous Position	All Types	Type/Degree Pub/PhD	Prv/PhD	Pub/MSBS	Prv/MSBS
PostDoc	71 (29%)	33 (29%)	18 (46%)	8 (20%)	12 (22%)
PhD	69 (28%)	33 (29%)	6 (15%)	17 (42%)	13 (24%)
T/TT	50 (20%)	24 (21%)	12 (31%)	5 (12%)	9 (16%)
NTT	24 (10%)	7 (6%)	1 (3%)	4 (10%)	12 (22%)
ABD	18 (7%)	9 (8%)	1 (3%)	3 (8%)	5 (9%)
NonAcad	11 (4%)	5 (4%)	1 (3%)	2 (5%)	3 (5%)
Other	3 (1%)	1 (1%)	0 (0%)	1 (2%)	1 (2%)
All	246 (100%)	112 (100%)	39 (100%)	40 (100%)	55 (100%)

The 2018 Taulbee Survey does not provide any data on where new faculty hires come from, but Table F5 in that report does provide data on faculty losses. 31% of those losses are due to retirement and another 42% took academic positions elsewhere, which is the other side of the 23%

of all new hires (and 24% (36/151) of Pub/PhD and Prv/PhD new hires) in our survey results that came from a tenured/tenure-track position at another institution.

3.5 Areas in Which Faculty Were Hired

Our previous report on faculty hiring [2] clustered topics into 16 areas. The table defining these areas and the constituent topics for each is reproduced in Table 7 from the previous report. These same areas (along with a link to this table) were provided to survey respondents to identify the area in which new faculty members were hired.

Table 7: Topics Grouped in Each Clustered Area

Area	Constituent Topics
AI/DM/ML	Artificial Intelligence, Computational Linguistics, Data Mining, Deep Learning, Knowledge Representation, Machine Learning, Natural Language Processing, Optimization
Arch	Architecture, Computer Organization, Hardware
Compiler/PL	Compilers, Programming Languages
CompSci	Biological Computing, Biomedical, Bioinformatics, Computational Biology, Computational Life Science, Computational Neuroscience, Network Science, Neuro Engineering, Numerical Analysis, Scientific Computation
DataSci	Big Data, Data Analytics, Data Engineering, Data Science, Visualization
DB	Databases, Data Management, Information Management, Information Retrieval
HCI/IntMedia	Augmented Reality, Accessibility, Animation, Computer-Supported Cooperative Work, Cognitive Science, Digital Media, Disability Technology, Games, HCI, Immersive Systems, Interactive Computing, Multimedia, Virtual Reality
ImageSci	Graphics, Image Processing, Medical Imaging, Vision
Mobile	Human-Centered Computing, Mobile Systems, Ubiquitous Computing
Robotics/CPS	Autonomous/Vehicular Systems, Cyber-Physical Systems, Embedded Systems, Intelligent Systems, Internet of Things, Real-Time Systems, Robotics
Security	Block Chain, Cryptography, Forensics, Information Assurance, Malware, Privacy, Reverse Engineering, Risk Analysis, Security, Trusted Computing
SoftEngr	Software Engineering, Software Systems
Sys/Net	Cloud Computing, Computer Systems, Distributed Computing, High Performance Computing, Infrastructure, Networking, Operating Systems, Parallel Computing, Storage Systems, System Analysis, Systems
Theory/Alg	Algorithms, Computational Geometry, Formal Methods, Logic, Theory, Verification
OtherCS	Analysis, CS Education, Data Structures, Information Technology, Informatics, Introductory CS, Modeling, Next Generation Computing, Quantum Computing, Simulation, Social Computing, Software, Speech Recognition, Web Technologies
OtherInter	Computer Engineering, Electrical Engineering, Environmental Informatics, Financial Technology, Health, Health Informatics, Intelligent Tutoring, Interdisciplinary, Learning Science, Operations Research, Systems Engineering

Table 8 shows the numbers and percentages of hires for all institutions and based on highest degree offered. Table rows are ordered based on the number of hires in each area (save for Other) with 69 hires in AI/DM/ML, which constitutes 26% (up from 19% in 2018) of the 267 total positions. Again the total positions shown may be slightly different than Tables 3 and 5 due to inconsistencies in survey responses.

Table 8: Summary of Areas for Hired Faculty by Highest Degree Offered

Area	All Types	Highest Degree PhD100	PhDMore	MS	BS
AI/DM/ML	69 (26%)	36 (31%)	10 (19%)	9 (20%)	14 (27%)
Security	42 (16%)	15 (13%)	7 (13%)	18 (40%)	2 (4%)
Sys/Net	23 (9%)	13 (11%)	2 (4%)	4 (9%)	4 (8%)
Theory/Alg	19 (7%)	9 (8%)	2 (4%)	1 (2%)	7 (14%)
HCI/IntMedia	18 (7%)	6 (5%)	5 (9%)	3 (7%)	4 (8%)
DataSci	15 (6%)	4 (3%)	7 (13%)	1 (2%)	3 (6%)
Compiler/PL	12 (4%)	8 (7%)	1 (2%)	0 (0%)	3 (6%)
Robotics/CPS	12 (4%)	4 (3%)	7 (13%)	1 (2%)	0 (0%)
SoftEngr	10 (4%)	4 (3%)	3 (6%)	1 (2%)	2 (4%)
CompSci	8 (3%)	3 (3%)	2 (4%)	1 (2%)	2 (4%)
ImageSci	7 (3%)	4 (3%)	3 (6%)	0 (0%)	0 (0%)
DB	3 (1%)	3 (3%)	0 (0%)	0 (0%)	0 (0%)
Mobile	2 (1%)	1 (1%)	1 (2%)	0 (0%)	0 (0%)
Arch	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
OtherCS	14 (5%)	1 (1%)	2 (4%)	5 (11%)	6 (12%)
OtherInter	12 (4%)	6 (5%)	2 (4%)	1 (2%)	3 (6%)
All	267 (100%)	117 (100%)	54 (100%)	45 (100%)	51 (100%)

The table shows that Security accounts for 42 (16%) of all filled positions with Systems/Networking for 23 (9%) and Theory/Alg accounting for 19 (7%) of filled positions. AI/DM/ML was the most popular area for all offered degrees except for MS for which Security was the most popular. Security was the second-most popular area for PhD100 and PhDMore with AI/DM/ML second for MS and Theory/Alg second for BS institutions.

Table 9 shows the same numbers and percentages of hires based on classifying institutions by type and degree offered. Again the AI/DM/ML area was most popular for all combinations except for public MS&BS institutions, which shows Security as most popular.

3.6 Areas Sought Compared with Areas Filled

While important to understand where hires were made, linking survey results to areas specified in faculty ads allows us to compare the areas for positions that were sought with the areas for positions that were filled. This analysis was done by filtering the ads dataset to include only the 147 institutions that responded to the survey. We then repeated analysis that was done in [2] to determine the percentage of positions sought in each of the 16 areas. As was previously done, institutions not identifying specific areas in their original ad did not contribute to this analysis. Ads for the survey institutions identified specific areas for 70% of the advertised positions, which is a bit smaller than the 2019Ads dataset.

Figure 4 shows the results of scatter plotting each of the 16 areas based on their percentages of positions sought vs. positions filled for all 147 institutions regardless of type. Areas further from the origin represent the most popular areas. Areas close to the diagonal (a line is drawn for

Table 9: Summary of Areas for Hired Faculty by Institution Type and Highest Degree Offered

Area	All Types	Type/Degree Pub/PhD	Prv/PhD	Pub/MSBS	Prv/MSBS
AI/DM/ML	64 (26%)	28 (25%)	16 (39%)	7 (18%)	13 (24%)
Security	42 (17%)	18 (16%)	4 (10%)	16 (41%)	4 (7%)
Sys/Net	22 (9%)	9 (8%)	5 (12%)	4 (10%)	4 (7%)
Theory/Alg	18 (7%)	8 (7%)	2 (5%)	1 (3%)	7 (13%)
HCI/IntMedia	15 (6%)	7 (6%)	1 (2%)	3 (8%)	4 (7%)
DataSci	14 (6%)	7 (6%)	3 (7%)	0 (0%)	4 (7%)
Compiler/PL	12 (5%)	6 (5%)	3 (7%)	0 (0%)	3 (6%)
Robotics/CPS	10 (4%)	7 (6%)	2 (5%)	0 (0%)	1 (2%)
SoftEngr	8 (3%)	4 (4%)	1 (2%)	1 (3%)	2 (4%)
CompSci	6 (2%)	2 (2%)	1 (2%)	1 (3%)	2 (4%)
ImageSci	6 (2%)	5 (4%)	1 (2%)	0 (0%)	0 (0%)
DB	3 (1%)	3 (3%)	0 (0%)	0 (0%)	0 (0%)
Mobile	1 (0%)	0 (0%)	1 (2%)	0 (0%)	0 (0%)
Arch	1 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
OtherCS	13 (5%)	1 (1%)	1 (2%)	4 (10%)	7 (13%)
OtherInter	11 (4%)	7 (6%)	0 (0%)	2 (5%)	2 (4%)
All	246 (100%)	112 (100%)	41 (100%)	39 (100%)	54 (100%)

reference) are areas in which the percentage of positions filled is roughly the same as positions sought. Areas plotted above the diagonal indicate a higher percentage of positions were filled than were sought. Areas plotted below the diagonal indicate a higher percentage of positions were sought than were reported to be filled.

Below the diagonal, Security was sought for 18% of positions, but only 16% of positions were filled in this area. Similarly DataSci was sought for 15% of positions, but reported to be filled for only 6% of positions. Above the diagonal, the AI/DM/ML area has 8% net more filled than sought positions. Other areas have a net difference of 2% or less between sought and filled positions.

Many factors contribute to the areas with the largest discrepancies between percentages of positions sought and filled. These factors include:

1. A fraction (30%) of positions filled were from institutions not identifying areas of interest in their ad. It is possible that areas being sought by these institutions did not match the same distribution of areas as discerned from ads that did identify areas of interest.

2. Institutions simply did not hire in the areas of interest. These institutions either could not find candidates in an area of interest or they found better candidates in other areas. Some written comments indicated such outcomes.

3. A filled position was actually in a sought area, but the area discerned from the ad simply did not match the identified area of the hire in the survey. For example, an institution could have advertised for a hire in Data Analytics (in the area of DataSci as shown in Table 7), but identified the hire in the survey as being in the area of AI/DM/ML. In [2] we addressed

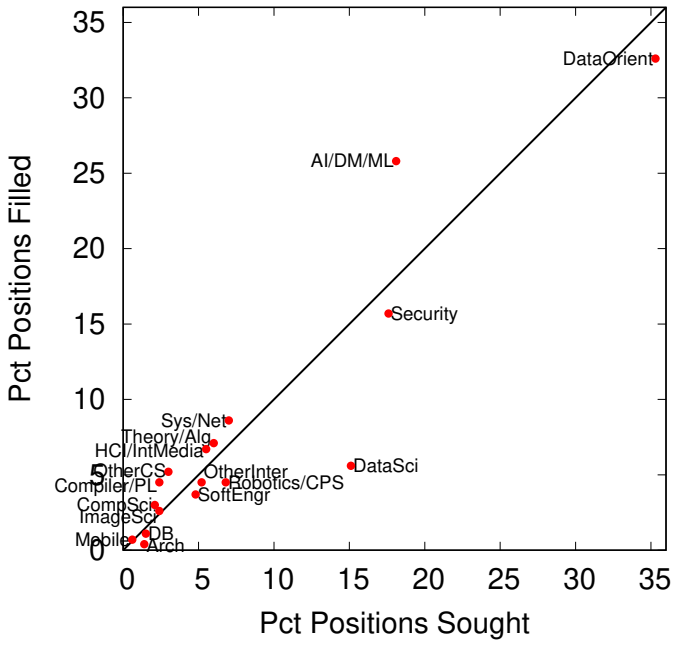

Figure 4: Percentages of Areas Sought vs. Areas Filled for All Institutions

this specific issue by further clustering the AI/DM/ML, DataSci and DB areas into a data-oriented "DataOrient" area. As shown in Figure 4, this aggregated area accounted for 35% of sought positions and 33% of filled positions.

3.7 Areas Sought Compared with Areas Filled By Institution Type

Figure 5 repeats the same analysis after dividing all institutions into PhD-granting (PhD100 and PhDMore) and non-PhD-granting (MS and BS) institutions. As reference, results in Table 3 show that 64% of filled positions were done so by PhD-granting institutions.

The plot on the left for PhD institutions shows a larger share of positions in data-oriented areas (41% of sought and 35% of filled positions) than the results shown in Figure 4. The plot on the right for MS and BS institutions shows that 25% of sought and 28% of filled are in the DataOrient aggregated area. Above the diagonal on the right, the OtherCS area has the largest net discrepancy with 4% of sought positions, but 12% of filled positions. Below the diagonal, DataSci has the largest difference with 14% of sought and 4% of filled positions, while SoftEngr has the next largest difference with 7% of sought, but only 3% of filled positions.

Figure 6 repeats the same analysis after dividing institutions into public and private. As reference, results in Table 4 show that 61% of filled positions were done so by public institutions. The plot on the left for public institutions shows DataSci as having the largest net discrepancy (10%) between sought and filled positions. DataOrient is also below the diagonal with 30% of filled positions. The right plot for private institutions shows DataOrient is closer to the diagonal and larger with 38% of filled positions. DataSci (12%) and Security (5%) each have a smaller share of filled than sought positions. Above the diagonal, the percentage share of filled OtherCS positions is 6%

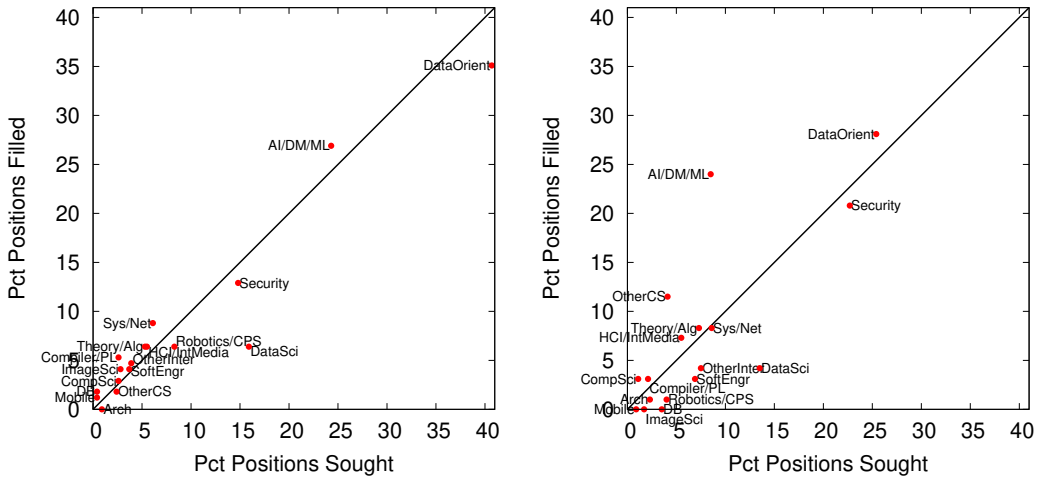

Figure 5: Percentages of Areas Sought vs. Areas Filled for PhD and MS&BS Institutions

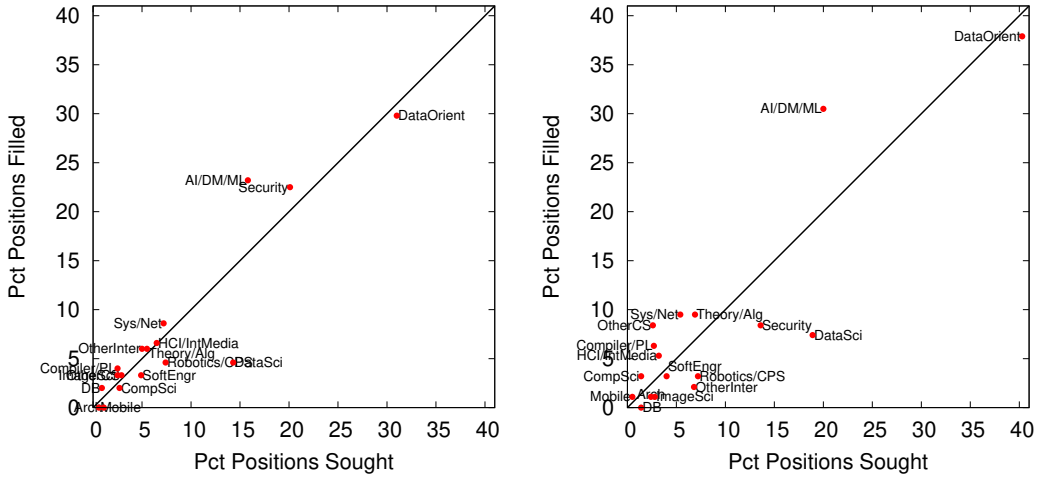

Figure 6: Percentages of Areas Sought vs. Areas Filled for Public and Private Institutions

more than sought.

3.8 Faculty Hiring and PhD Production

The 2018 Taulbee Survey [3] does not provide any information on areas in which faculty were sought or hired, but Table D4 in that report does provide information on "specialties" in which PhDs were produced as part of results on employment of new PhD recipients. These 2018 data are one year removed from the 2019 faculty hiring season, but provide a means to compare areas of PhD production with areas of faculty hiring.

For this analysis we use the grand total of all PhDs produced regardless of their subsequent employment. Table 10 shows the number (and percentage) sorted in decreasing order for each specialty as given in [3]. No additional explanation for the content of each specialty beyond the name is provided in the text of that report. Based on text in previous reports, the Other specialty also includes unknown responses.

Table 10: 2018 Taulbee Survey New PhD by Specialty

Specialty	Cnt (%)	Corresponding Area
Artificial Intelligence/Machine Learning	297 (17%)	AI/DM/ML
Software Engineering	126 (7%)	SoftEngr
Networks	119 (7%)	Sys/Net
Security/Information Assurance	114 (6%)	Security
Databases/Information Retrieval	92 (5%)	DB
Graphics/Visualization	91 (5%)	ImageSci
Theory and Algorithms	89 (5%)	Theory/Alg
Robotics/Vision	74 (4%)	Robotics/CPS
Human-Computer Interaction	72 (4%)	HCI/IntMedia
Hardware/Architecture	56 (3%)	Arch
Information Science	55 (3%)	
Informatics: Biomedical/Other Science	52 (3%)	
Operating Systems	52 (3%)	Sys/Net
High-Performance Computing	47 (3%)	Sys/Net
Programming Languages/Compilers	45 (3%)	Compiler/PL
Social Computing/Social Informatics	26 (1%)	
Information Systems	23 (1%)	
Scientific/Numerical Computing	18 (1%)	CompSci
Computing Education	16 (1%)	
Other	273 (15%)	
Total	1787 (100%)	

The last column in Table 10 shows the corresponding area from Table 7 that matches each specialty. In cases where a good match is not clear then no corresponding area is shown. Not all of the correspondences are an exact fit with "Robotics/Vision" a specialty where we define "Robotics/CPS" as an area with the topic of Vision in the ImageSci area. Similarly, the "Graphics/Visualization" specialty is mapped to the ImageSci area even though the topic of Visualization

is clustered under the DataSci area. The result is that 12 of the 18 areas from Table 7 are associated with a specialty in Table 10.

The two graphs in Figure 7 plot the percentage of PhDs produced against the percentage of faculty positions sought and the percentage of faculty positions filled for all institutions (as previously shown in Figure 4). The 12 areas most clearly corresponding to specialties in Table 10 are shown in each graph.

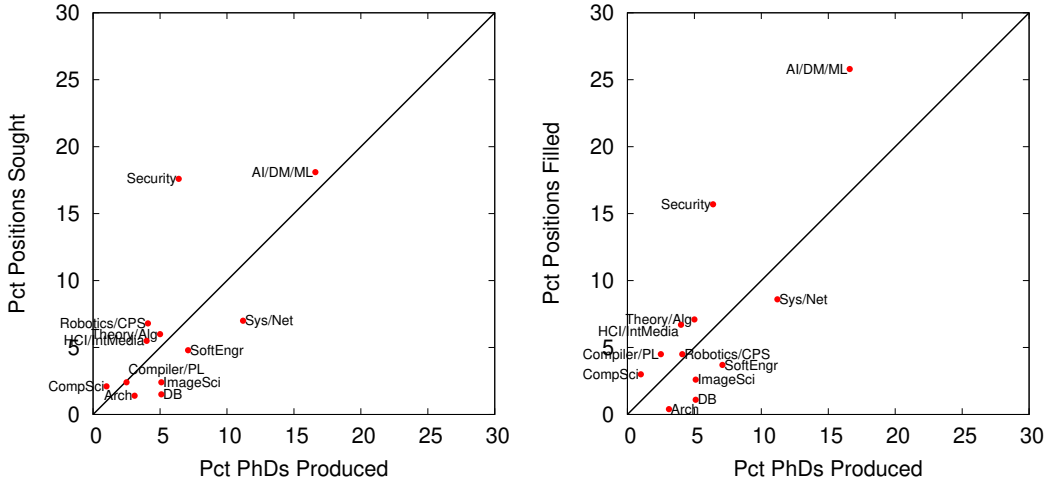

Figure 7: Percentages of Areas of PhDs Produced vs. Areas Sought/Filled for All Institutions

In the left graph of Figure 7, Security is the area with most obvious discrepancy between percentage of PhDs produced (6%) and faculty positions sought (18%). Most other areas are relatively close to the diagonal indicating similar percentages of PhDs produced and positions sought. The areas of DB and Sys/Net each have approximately 4% lower net percentage of positions sought than PhDs produced.

In the right graph of Figure 7, Security and AI/DM/ML are the areas with the highest discrepancy between PhDs produced and positions filled with a net of 9% more positions filled. On the other side of the diagonal, DB has the highest net percentage discrepancy (4%) of PhDs produced more than positions filled.

4 Summary and Future Work

This work directly follows previous work that analyzed current and future Computer Science needs via advertised tenure-track faculty searches for 2019. This follow-on work looked to understand the relative success of institutions in hiring the tenured/tenure-track faculty in the areas of Computer Science that were being sought.

Responses to a survey were obtained from 147 institutions that reported seeking tenure-track faculty in 2019. The distribution of survey responses based on institutional type was in roughly the same proportion as for all institutions that were searching for tenure-track faculty. Survey respondents reported seeking a total of 355 faculty positions.

Survey respondents reported filling a total of 267 tenure-track faculty for an aggregate success rate of 75%, which is comparable to previous years of this study. Examination on the success of the search for each of the 147 institutions found that 13% of institutions failed to hire any faculty, while 56% succeeded in hiring at least as many faculty as were being sought. These failed search results are better than and the institutional success results are comparable to survey results from 2018. In terms of results for different types of institutions, the top-100 PhD institutions had the smallest failed search rate of 2% while BS institutions had the highest failed search rate of 26%. Private MS&BS (64%) and public PhD (58%) institutions had the highest rate of hiring at least as many faculty as were being sought. Public MS&BS (46%) institutions had the lowest reported rate in hiring as many faculty as were being sought.

Reported results on the previous position for hired faculty show that three types of such positions continue to be dominant. 29% were previously in a post-doc/researcher position, 26% of hired faculty start with a newly-earned PhD and 23% were previously in a tenured or tenure-track position at another institution. The post-doc/researcher results are higher than results from a similar study in 2018.

Survey respondents reported on the number of hires in each of 16 clustered areas. The clustered area of AI, Data Mining and Machine Learning (AI/DM/ML) accounted for 26% of the filled positions (up from 19% in 2018). Security accounted for the next most with 16% of the filled positions (up from 14% in 2018) while Systems/Networking (9%), Theory/Algorithms (7%) and HCI/Interactive Media (7%) were the next areas in terms of filled positions. Further clustering of results for the AI/DM/ML, Databases and Data Sciences areas finds that 33% of hires were "Data Oriented," which is up from 28% in 2018.

In comparing the areas of filled positions with the areas in which positions were sought, the AI/DM/ML area shows the biggest net positive net difference percentage of positions filled and sought. In contrast, the area of Security showed a smaller (than 2018) negative difference with 16% of filled positions, but 18% of sought positions. The area of DataSci had a 9% negative net percentage difference between filled and sought positions. Data-oriented areas accounted for 35% of sought positions and 33% of filled positions. In general, the net percentage differences between areas sought and filled were smaller than similar results in 2018.

A final analysis uses Taulbee Survey results to compare areas for PhD production with area of faculty positions sought and filled. Security is the area with most obvious discrepancy between percentage of PhDs produced (6%) and faculty positions sought (18%). Security and AI/DM/ML are the areas with the highest discrepancy between PhDs produced and positions filled with a net of 10% and 9% more positions filled than PhDs produced.

In summary, the results continue to show a mix of success with just 56% of institutions hiring at least the number of faculty they were seeking. In terms of areas, AI/DM/ML, Databases and Data Science collectively represent a third of the positions filled, although PhD production in these areas was not this high. There continues to be stronger demand for positions in Security than PhD production or positions actually filled, although the differences are a bit less than were found in 2018.

A direction for future work is to continue to improve the survey instrument. Continued collection of ad data and subsequent surveys allows the success of faculty hiring to be tracked over time. Better integration with the Taulbee Survey could help to understand why searches succeed or fail.

Acknowledgment

We would like the acknowledge the 147 institutions that responded to the survey. A list of these institutions is included in Appendix B. Without these responses this report would not be possible. A better understanding on the relative success of faculty hiring in Computer Science is important for us all. Thank you.

References

[1] Craig E. Wills. 2018 computer science tenure-track faculty hiring outcomes. *Computing Research News*, 30(7), August 2018. Full report at
http://www.cs.wpi.edu/~cew/papers/outcomes18.pdf.

[2] Craig E. Wills. Analysis of current and future computer science needs via advertised faculty searches for 2019. *Computing Research News*, 31(1), January 2019. See technical report for details of study.
https://cra.org/crn/2019/01/analysis-of-current-and-future-computer-science-need

http://www.cs.wpi.edu/~cew/papers/CSareas19.pdf.

[3] Stuart Zweben and Betsy Bizot. 2018 CRA Taulbee Survey. *Computing Research News*, 31(5), May 2019.
https://cra.org/wp-content/uploads/2019/05/2018_Taulbee_Survey.pdf.

A Survey

The following shows the instructions and questions used for the survey completed by respondents. All numeric questions are answered with a radio-button selection of 0, 1, 2, 3, 4, 5-6, 7-8, or 9+. No response for a question is mapped to 0.

A.1 Questions

Q1 Please complete the following short survey concerning your department's outcome in hiring of tenured/tenure-track Computer Science (or closely related program) faculty in 2019. At the end of the survey you will be able to see tabulated results from other respondents. An analysis of the results will be made available to the community similar to the report on hiring outcomes from 2018 available at `https://web.cs.wpi.edu/~cew/papers/outcomes18.pdf`. Again this survey is only for the hiring of tenured/tenure-track faculty. Thank you

Q2 How many tenured/tenure-track faculty were you seeking to hire in 2019 (to begin in 2019 or 2020)?

Q3 How many tenured/tenure-track faculty have you hired in 2019 (to begin in 2019 or 2020)?

Q4 How many tenured/tenure-track faculty were hired in each of these area clusters (total across all areas should reflect the total number of hired faculty)? As reference, constituent topics for each area are available at `https://web.cs.wpi.edu/~cew/papers/topicareas19.pdf`

AI/Data Mining/Machine Learning
Architecture
Compilers/Prog Languages
Computational Science
Data Science
Databases
Human Computer Interaction/Interactive Media
Image Science
Mobile/Ubiquitous Computing
Robotics/Cyber-Physical Systems
Security
Software Engineering
Systems/Networking
Theory/Algorithms
Other CS
Other Interdisciplinary

Q5 How many tenure/tenure-track faculty were hired with the immediately-preceding position (total across all previous positions should reflect the total number of hired faculty)?

All, But Dissertation
Newly Completed PhD
Post Doc/Researcher
Other Non-Tenure-Track Faculty Position

Tenured/Tenure Track Position at Another Institution
Non-Academic Position
Other

Q6 Please provide any additional feedback you would like to provide on hiring tenured/tenure-track faculty in 2019. Any feedback will not be shared in the public survey tabulation.
[Open Text Response]

Q7 After continuing from this page you are done with the survey and will be redirected to a link showing numerical tabulation of results received thus far. Thank you for your contribution.
[Respondents redirected to page showing aggregated responses for Q2-Q5.]

B Participating Institutions

The following 147 institutions provided responses to the survey. They are listed based on highest degree offered with PhD institutions sub-divided if they have a top-100 U.S. ranking. Institutions are further denoted as public U.S. (no designation), private U.S. (designated with *), or non-U.S. (designated with †).

B.1 PhD100

Auburn, Boston*, Brown*, California Santa Barbara, California Santa Cruz, California Institute Technology*, Case Western*, Central Florida, Chicago*, Clemson, Colorado, Colorado St, Cornell*, Florida St, George Mason, George Washington*, Georgia Tech, Harvard*, Illinois Chicago, Indiana, Iowa, Maryland, Massachusetts, Michigan, Minnesota, North Carolina St, New Mexico, Northeastern*, New York*, Pennsylvania*, Rensselaer*, Southern California*, Stevens Institute Technology*, SUNY Stony Brook, Syracuse*, Texas A&M, Tufts*, Utah, Virginia Tech, Washington University*, Wisconsin, Worcester Polytechnic Institute*.

B.2 PhDMore

Alabama, Alabama Birmingham, Colorado Colorado Springs, Dalhousie†, Denver*, Kansas St, KAUST†, Massachusetts Boston, Massachusetts Lowell, Memphis, Michigan Tech, Montana St, Naval Postgraduate, Nevada Reno, New Mexico St, Oklahoma St, Simon Fraser†, SUNY Binghamton, Texas Arlington, Texas St, Wayne St, Wyoming, York†.

B.3 MS

Adelphi*, California St Sacramento, Houston-Victoria, Illinois Springfield, Midwestern St, Missouri St Louis, Montclair St, North Carolina Greensboro, North Central*, Northern Iowa, Northern Kentucky, Pennsylvania St Harrisburg, San Diego St, San Jose St, Seattle*, Southern Connecticut St, Tennessee Tech, Texas Rio Grande Valley, Texas Tyler, Villanova*, Wake Forest*, Western Ontario†, Western Washington, Wisconsin Platteville, Wisconsin Whitewater.

B.4 BS

Air Force, Amherst*, Bard College*, Belmont*, Benedictine*, Boston College*, Bryn Mawr College*, Canisius College*, Carleton College*, Claremont McKenna College*, Coastal Carolina, Colby College*, Colgate*, College New Jersey, Colorado College*, Connecticut College*, Davidson College*, Denison*, Drake*, Eastern University*, Gannon*, Hamilton College*, Hartford*, Harvey Mudd*, Haverford*, Kings College*, Loyola Marymount*, Luther College*, Marian*, Middlebury*, Milwaukee School Engineering*, Montana Tech, Mount Union*, Oberlin*, Rhodes College*, Ripon College*, Rollins College*, Rose Hulman*, Seattle Pacific*, Sioux Falls*, Slippery Rock*, Southwestern*, St Lawrence*, St Norbert College*, Stonehill College*, SUNY Brockport, Trinity College*, Truman St, Union College*, Valdosta St, Vassar College*, Wabash College*, Wentworth Institute Technology*, Wheaton College Massachusetts*, Williams College*, Winona St, Worcester St.