Analysis of Current and Future Computer Science Needs via Advertised Faculty Searches for 2022

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Abstract

This work uses the same methodology applied over eight years to study where Computer Science departments are choosing to invest faculty positions using data obtained from advertised tenure-track searches for the current hiring season. This work also provides an opportunity to continue to understand the effects of the COVID-19 pandemic on faculty hiring in Computer Science for hires starting in 2022.

We analyzed ads from 400 institutions seeking to fill hundreds of tenure-track faculty positions in Computer Science. This number is a 70% increase from last year at this time (mid-November) and is a comparable number to the 394 institutions searching for 2020. The number of tenure-track positions sought is doubled from last year and up 6% from two years ago indicating a recovery in demand after a one-year drop due to the pandemic. The number of BS/BA institutions seeking faculty is at an eight-year high with top PhD and private PhD institutions at eight-year highs in the number of positions being sought.

We clustered the specific Computer Science topics mentioned in ads into 16 areas. In terms of specific areas, we again found that the clustered area of AI/Data Mining/Machine Learning accounts for the most with 18% of all sought positions and Security again second at 17%, although these percentages are a bit lower than last year. The area of Data Science is at 11% of positions, but aggregating the Data Science, AI/DM/ML and Databases clusters again resulted in close to a third of all hires sought in these data-oriented areas. The area of Systems/Networking was fourth in the percentage (9%) of positions sought.

Differences are also seen when analyzing results based on the type of institution. As was the case last year, positions in the clustered area of AI/Data Mining/Machine Learning have the highest percentages for PhD institutions. Again positions related to Security have the highest percentages for MS and BS/BA institutions. Theory/Algorithms is the second-most sought area for PhD institutions while Data Science is the second-most sought area for MS and BS/BA institutions.

1 Introduction

The number of faculty searches in Computer Science during this hiring season for tenured and tenure-track positions starting in 2022 again affords the opportunity to study areas of Computer Science where departments are choosing to invest in new faculty hires. This is the eighth such report detailing results from a study of faculty hiring ads in Computer Science. It uses a similar methodology as done in previous years [1, 2, 3, 6, 8, 9, 10, 11]. In addition, the longitudinal aspect of this work provides a continued opportunity to examine the effects of the COVID-19 pandemic on faculty hiring in Computer Science.

The focus of this work has always been to study where departments specifically, and the discipline more generally, are choosing to invest precious tenure-track faculty positions. It is an opportunity to understand where Computer Science departments think they are in terms of current needs as well as where they think they are going, but this year in particular it is an opportunity to see how many institutions are searching and with how many positions.

With this focus, there are a number of caveats to our study:

1. Our study is not exhaustive in that it does not necessarily take into account all searches currently underway for this hiring season. We describe the methodology used to discover ads, but ads may have been only placed in other venues or not have been placed in the timeframe of our study.

2. While our study focuses on preferred areas for faculty applicants, not all ads identify such preferred areas. These searches are accounted for in the data, but are not considered when analyzing particular areas of interest.

3. Similarly not all ads identify the specific number of positions being sought. In analyzing these searches we make an assumption on the number of positions being sought.

4. Our study analyzes searches and not hires. The number and areas of actual faculty hires may not match what is being sought.

2 Methodology

We used four primary sources for obtaining ads for Computer Science faculty positions: the Computer Research Association (CRA) Job postings[1] the Association for Computing Machinery (ACM) list of jobs[2], the Chronicle of Higher Education Vitae site[3] and the HigherEdJobs site[4]. We again augmented these sources with positions posted on the SIGCSE mailing list, which often includes ads for more undergraduate-focused institutions. We considered ads posted on these venues between August 2021 and mid-November 2021, which is the same timeframe used in our previous studies. Last year's study found the announcement of searches were delayed due to the impact of the COVID-19 pandemic. By using the same timeframe for our study, we can understand whether that impact again accounts for delayed searches.

[1] https://cra.org/ads/

[2] http://jobs.acm.org/jobs/search

[3] https://chroniclevitae.com/job_search/new

[4] https://www.higheredjobs.com/faculty/

Only ads for tenured and tenure-track positions by departments containing Computer Science or closely-related programs were considered. We did not consider non-tenure-track positions such as lecturers, instructors or researchers and we only considered institutions awarding at least a BS or a BA degree. Searches for Deans or Department Chair positions were noted, but not considered because they do not reveal information regarding areas. Similarly, searches for other departments and programs with interest in faculty with Computer Science background were noted, but also not considered.

3 Results

3.1 Institutions and Positions

Using this methodology our resulting dataset contains information for faculty searches from 400 institutions (366 are in the U.S.). 288 (72%) of these institutions indicate a specific number of positions being searched for with the remaining searches using non-specific phrases such as "multiple positions," "several positions" or just "positions" to indicate the number. As comparison, our previous-year study [10] with a comparable timeframe found searches for 235 institutions (182 in the U.S.) with 77% of these institutions indicating a specific number of positions being searched for. Last year was significantly affected by the COVID-19 pandemic. This year's results are comparable to our study two years ago [9], which found searches for 394 institutions (356 in the U.S.) with 77% of these institutions indicating a specific number of positions being searched for.

The left-side of Figure 1 shows all eight years of results for the number of institutions searching for tenure-track faculty. It shows that after a one-year dip the number of institutions searching for tenure-track faculty has returned to numbers in the previous years.

In terms of the total number of positions, in the past we experimented with treating such "Multiple Position" searches as meaning two, three or four positions and settled on a value of three. In related work [4, 5, 7] where we surveyed institutions on their hiring outcomes we found those seeking multiple positions responded seeking a median of 3 and mean of roughly 3.5 positions. The right-side of Figure 1 shows the total number of positions searched for using a value of three for "multiple position" searches for a total of 825 positions, which is a 100% increase from last year. Again after a one-year drop, this year's number is up by 6% from two years ago. We analyze the number of institutions and positions based on the type of institution later in the report.

Finally, in terms of institutions and positions we did encounter additional ads for Computer Scientists that were noted, but not considered in our analysis. We found 18 Dean and Chair leadership searches (up from seven last year, but the same as two years ago) as well as many faculty searches in other departments. These other departments include Electrical & Computer Engineering, Information School/Science/Technology, Bio-related, Health and Business. Ads found for these other departments were not considered in our analysis.

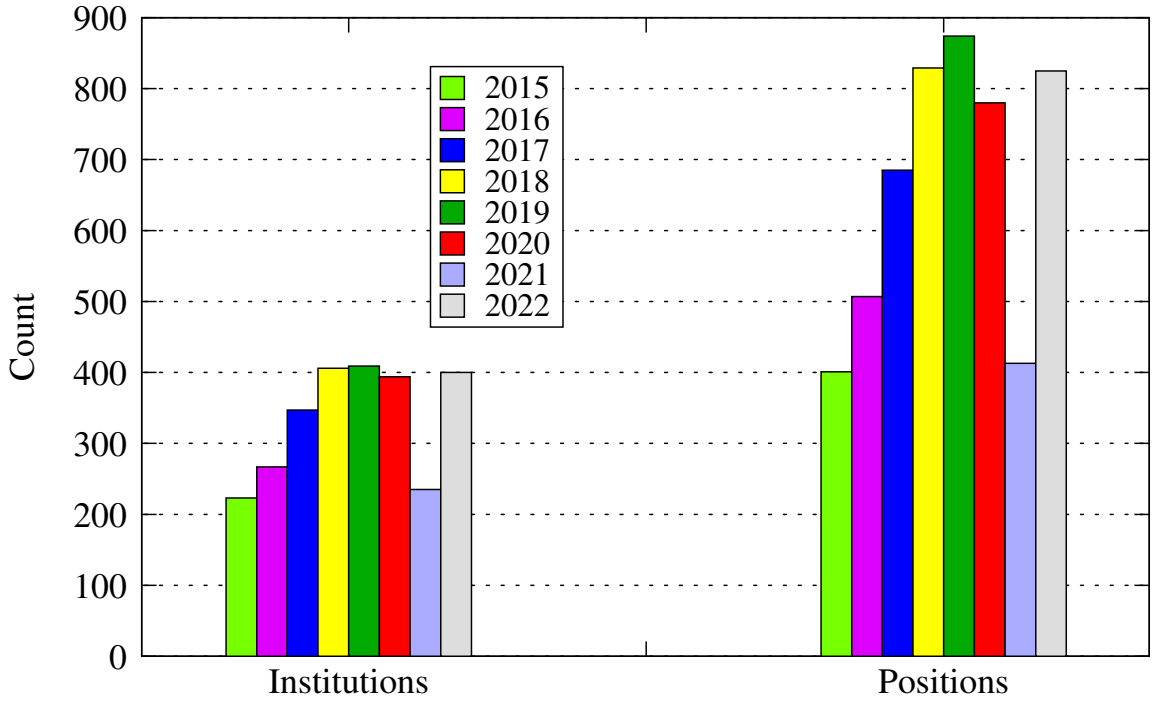

Figure 1: Eight-Year Results for Number of Institutions Searching and Total Number of Positions Being Sought

3.2 Results by Topic

In the same way that not all ads list a specific number of positions, it is also the case that not all ads list specific or preferred topics of interest[5]. 288 (72%) of the 400 institutions listed specific topics, similar to the 75% from last year. In studying particular topics of interest, we only considered the ads from these institutions for our analysis.

In the initial step of our study, we determined the number of times that a specific topic was mentioned in an ad. Thus an ad for a single faculty position with preferred interest for the topics of HCI, Security, Machine Learning and Robotics would count one "mention" for each of these four topics. Another institution looking to focus three positions for the topic of Security would be one mention for Security. A total of 1333 specific topics are mentioned in ads (versus 810 last year and 1357 two years ago).

While mentioned topics are one metric, another approach is to consider a faculty search as a "vote" for a topic of current and future need. Using this approach a single position with four topics of interest would be investing 0.25 positions for each topic, while three positions focused in a single topic would invest 3.0 positions in that single topic.

The problem with weighting topics based on the number of positions is that not all ads list a specific number of positions. We again use the fixed value of three for multiple-position searches resulting in a total of 825 "positions" being searched for with 611 (74%) of the positions indicating preferences for specific topics. Figure 2 shows the percentage of mentions and positions for topics

[5]We use the term "topic" to refer to a sub-domain of Computer Science listed in ads and the term "area" to refer to a clustering of topics.

with at least one percent for either mentions or positions. They are shown in rank order based on the percentage of positions.

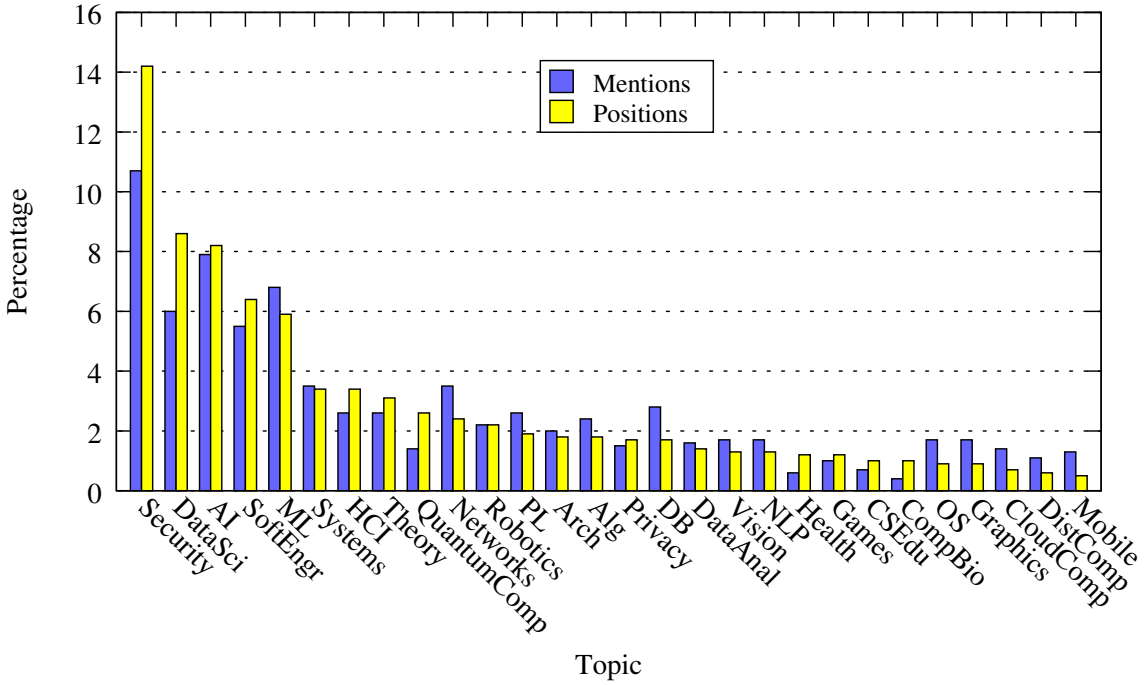

Figure 2: Topic Percentage by Mentions and by Positions

The results show that the topic of Security again accounts for the highest percentage of both mentions and positions, although it accounts for relatively more positions. Security was also the top topic for each metric the past five years. Data Science has the second highest percentage of positions with AI having the second highest percentage of mentions and third highest percentage of positions. Machine Learning is third in the percentage of positions. Software Engineering is fourth in the percentage of positions and Data Science is fourth in the percentage of mentions. Other topics with smaller percentages, but significant increases relative to last year in the percentage of positions include HCI and Systems.

3.3 Clustering Topics into Areas

Figure 2 does not show topics that appear less frequently in ads nor does it group similar topics, such as Data Science and Data Analytics or Security and Privacy. To address these issues, we clustered topics into 16 areas. These clustered areas and the set of topics constituting the area are shown in Table 1. Topics with a small number of mentions and not clearly fitting into a cluster are included in two other clusters—one with topics in traditional Computer Science (OtherCS) and one with topics more interdisciplinary in nature (OtherInter). These are the same clustered areas as used in previous studies.

Table 1: Topics Grouped in Each Clustered Area

Area	Constituent Topics
AI/DM/ML	Artificial Intelligence, AI Ethics/Fairness, Data Mining, Deep Learning, Machine Learning, Multi-Agent Systems, Natural Language Processing, Optimization, Reinforcement Learning, Text Mining
Arch	Architecture, Computer Organization, Hardware
Compiler/PL	Compilers, Programming Languages
CompSci	Biological Computing, Bioinformatics, Biomedical, Biometrics, Computational Biology, Computational Neuroscience, Computational Science, Network Science, Scientific Computation
DataSci	Big Data, Data Analytics, Data Science, Data Systems, Visualization
DB	Databases, Data Management, Information Retrieval, Information Systems
HCI/IntMedia	Affective Computing, Animation, Augmented Reality, Cognitive Science, Entertainment Computing, Games, Human-Computer Interaction, Virtual Reality
ImageSci	Graphics, Image Processing, Pattern Recognition, Vision
Mobile	Human-Centered Computing, Mobile Systems, Pervasive Computing
Robotics/CPS	Autonomous/Vehicular Systems, Cyber-Physical Systems, Embedded Systems, Human-Robotic Interaction, Intelligent Systems, Internet of Things, Robotics
Security	Anonymity, Block Chain, Cryptography, Forensics, Fraud Detection, Privacy, Security, Trusted Computing
SoftEngr	Software Design, Software Development, Software Engineering, Software Quality, Software Systems
Sys/Net	Cloud Computing, Distributed Computing, Edge Computing, High Performance Computing, Networking, Operating Systems, Parallel Computing, Performance Modeling, Storare, System Administration, System Analysis, Systems
Theory/Alg	Algorithms, Formal Methods, Logic, Quantum Computing, Theory, Verification
OtherCS	CS Education, Data Structures, Ethics, Information Science, Information Technology, Introductory CS, Modeling, Simulation, Social Computing, Software, Web Technologies
OtherInter	Astroinformatics, Business Analytics, Computer Engineering, Digital Humanities, Economics Financial Technology, Geospatial, Health, Health Informatics, Interdisciplinary, Learning Science, Medicine, Project Management, Statistics

3.4 Results Based on Clustered Areas

Given the clustered areas in Table 1, Figure 3 shows the same results as Figure 2 except it uses the 16 areas rather than the topics directly. The areas are again ordered by percentage of positions. For the third year in a row it shows that the AI/DM/ML clustered area has both the highest percentage of mentions (19%) and positions (18%). The Security area again ranks second in percentage of mentions (13%) and positions (17%) with DataSci having the third highest percentage of positions (11%) with Sys/Net tied for the second highest percentage of mentions (13%) and the fourth most positions (9%).

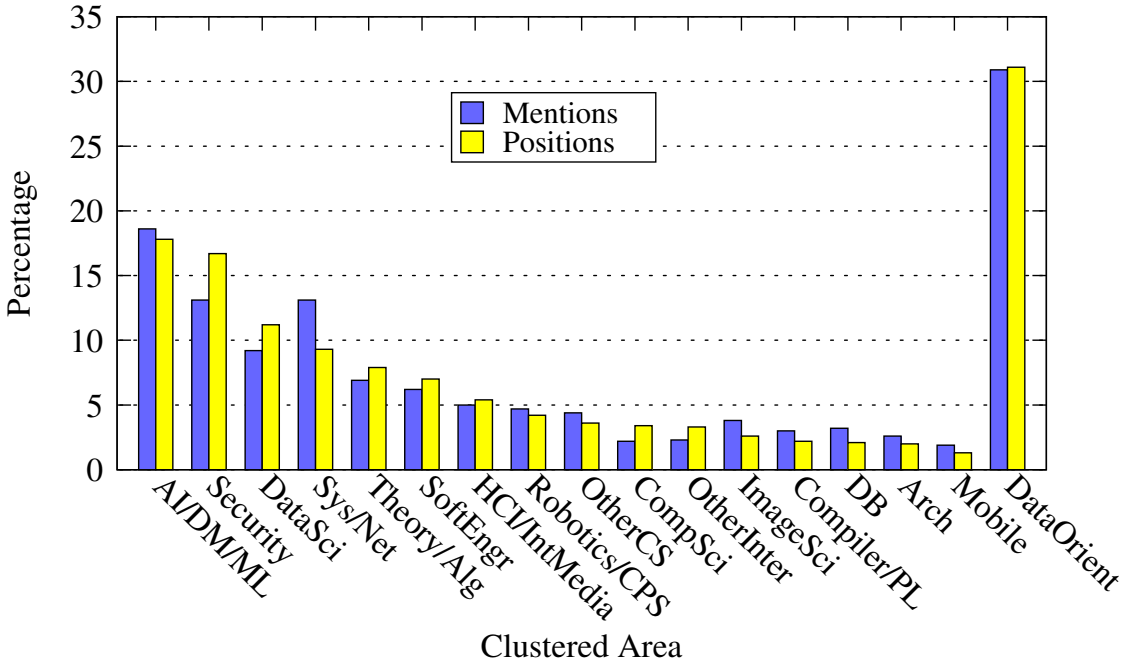

Figure 3: Clustered Area Percentage by Mentions and Positions

The right-most clustered area in Figure 3 is the Data Oriented cluster that further aggregates results for the DataSci, AI/DM/ML and DB clusters. This aggregated cluster was introduced because of overlap between the three data-oriented clusters while still retaining the three distinct clusters as defined in Table 1. As shown in the figure, this aggregated cluster accounts for 31% of mentions and positions.

3.5 Results Comparison with Previous Years

Figure 4 shows a more complete comparison of clustered area results based on percentage of positions for the past five years of our studies. Clustered areas percentages for all years were determined based on the 2022 clustering of topics shown in Table 1. Clustered areas are ordered based on 2022 percentages.

The results shows the previous steady growth in percentage of positions being targeted for AI/DM/ML hires did drop from 20% to 18% this year. The Security area again ranks second with

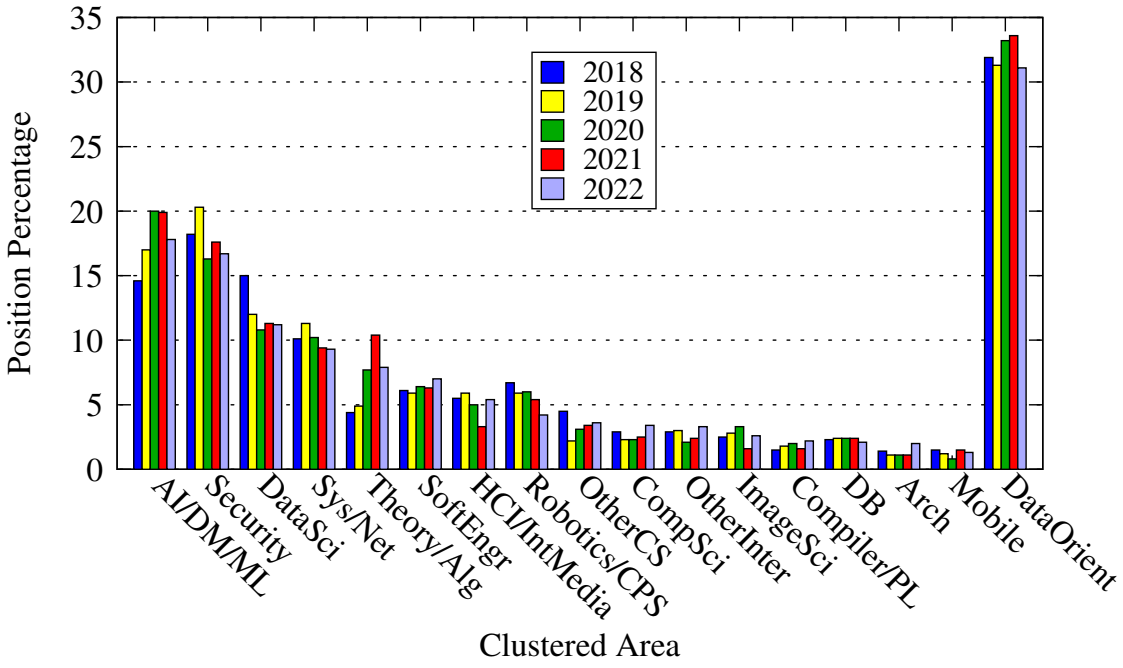

Figure 4: Five-Year Comparison of Clustered Area Percentage by Positions

DataSci still ranked third. The Sys/Net ranks fourth with the Theory/Alg area dropping by two percentage points in positions. The aggregated DataOrient (AI/DM/ML, DataSci and DB) cluster dropped to a five-year low despite continuing to have close to a third of all positions being sought for these areas.

4 Results by Type of Institution and Highest Degree Offered

As means to better understand the results we augmented the dataset to include additional information about each institution.

4.1 Results by Type of Institution

Table 2 shows a breakdown of results based on whether the institution is public, private or non-U.S.-based. The results show that 189 (47%) of the institutions are public and account for 422 (51%) of the total positions. These percentages are up from 45% and 43% in last year's study. There are 177 (44%) private institutions accounting for 301 (36%) of positions. The 34 non-U.S.-based institutions account for 9% of the total and 102 (12%) of positions.

4.2 Results by Highest Degree Offered

We also characterize each institution based on the highest degree it offers. For example, undergraduate-only programs may not have the same needs as PhD programs. For this portion of the study we augmented our dataset to include the highest degree offered by each program—BS/BA, MS or PhD.

Table 2: Summary of Position Searches by Institution Type

Institution Type	Number of Institutions	Advertised Number of Positions 1	2	3+	Multiple	Total Positions	% Positions w/ Specific Topic
Public	189	95 (50%)	38 (20%)	20 (11%)	36 (19%)	422	77%
Private	177	119 (67%)	21 (12%)	4 (2%)	33 (19%)	301	66%
Non-U.S.	34	6 (18%)	5 (15%)	9 (26%)	14 (41%)	102	84%
All	400	220 (55%)	64 (16%)	33 (8%)	83 (21%)	825	74%

Our dataset includes 169 PhD institutions—significantly up from 104 last year, but down from 183 two years ago. In order to study faculty investments at the most prominent U.S. programs, we further subdivided this group by using the U.S. News Rankings of the 100 Best Graduate schools[6] for the top-100 U.S. and then more PhD institutions including those not in the U.S. The "PhD100" list accounts for 48 (vs. 82 last year) institutions in our dataset. The remaining PhD programs, including 34 non-U.S.-based, are denoted as "PhDMore." Table 3 shows summary results based on the four highest degree types. The left-side of Figure 5 shows longitudinal results for the number of institutions searching over a eight-year period. All types increased over last year with the number of BS/BA institutions at an eight-year high.

Table 3: Summary of Position Searches by Highest Degree Offered

Institution Type	Number of Institutions	Advertised Number of Positions 1	2	3+	Multiple	Total Positions	% Positions w/ Specific Topic
PhD100	85	11 (13%)	7 (8%)	13 (15%)	54 (64%)	326	77%
PhDMore	84	23 (27%)	21 (25%)	15 (18%)	25 (30%)	212	80%
MS	72	41 (57%)	24 (33%)	5 (7%)	2 (3%)	112	75%
BS/BA	159	145 (91%)	12 (8%)	0 (0%)	2 (1%)	175	61%
All	400	220 (55%)	64 (16%)	33 (8%)	83 (21%)	825	74%

Table 3 reveals differences between the different types of institutions. Ads for 91% of the BS/BA institutions are for a single position while 64% of the ads for PhD100 institutions are for multiple positions, which is up from last year and comparable to two years ago. As shown, the distributions translate into a total number of 326 positions (up from 267 two years ago) for PhD100 institutions. We note that this number is particularly sensitive to the number of positions assumed for "multiple position" searches as over half of these searches are not specific in the number of positions being sought.

The right-side of Figure 5 shows eight-year results for the number of positions being searched for by the four types of institutions. It shows that the number of positions being sought by PhD100

[6] https://www.usnews.com/best-graduate-schools/top-science-schools/computer-science-rankings

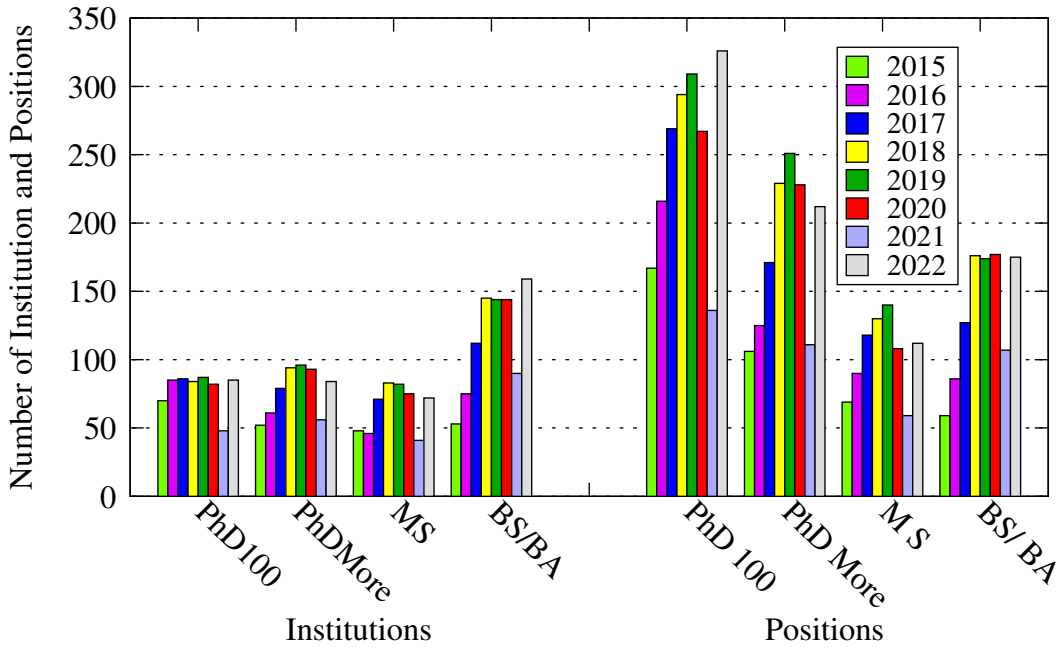

Figure 5: Eight-Year Counts of Institutions Searching and Positions Being Sought by Highest Degree Offered

institutions is at an eight-year high. The number of positions for other types of institutions is comparable to two years ago.

The last column of Table 3 shows that only 61% of positions from BS/BA institutions identify specific areas of interest while 80% of PhDMore institutions do so with the percentages for PhD100 and MS institutions in between. In order to understand differences on areas of interest between different types of institutions for 2022 searches, we break down the results in Figure 3 based upon the type. Figure 6 shows the results (in the same rank order as Figure 3) grouped by the four types of institutions.

Figure 6 shows a number of interesting results. AI/DM/ML is of most interest for PhD100 and PhDMore institutions. Positions related to Security have the highest percentages for MS and BS/BA institutions. DataSci accounts for a higher percentage of positions for BS/BA institutions. Each of these results by institution type were in evidence last year as well.

The Theory/Alg area is particularly strong for PhD100 institutions with this area having the second-highest percentage for this set of schools. The Sys/Net area has the second-highest percentage for MS institutions. Finally, the last set of results show that 35% of positions being sought by PhD100 institutions are for the Data Oriented aggregated cluster with the other type of institutions a bit less.

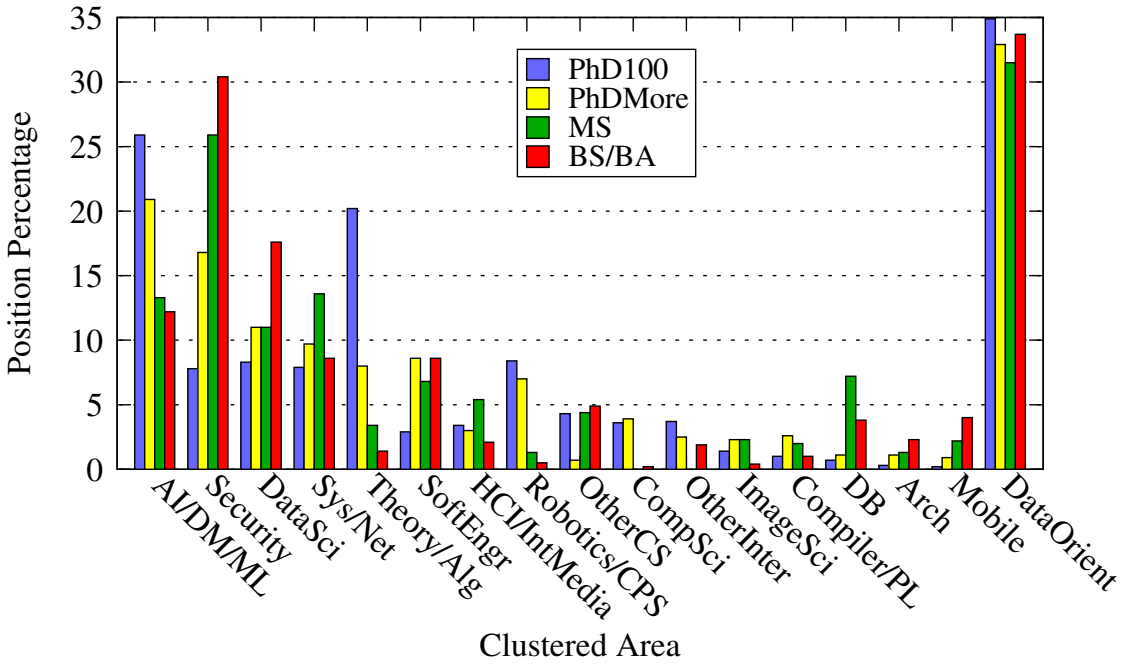

Figure 6: Clustered Area Percentage by Highest Degree Offered

4.3 Results by Combination of Institution Type and Highest Degree Offered

A third summary of positions searches is shown in Table 4 where institutions are classified based on a combination of type and highest degree offered. For this analysis, PhD100 and U.S. PhDMore institutions are combined as are U.S. MS and BS/BA institutions (designated as "MB" in the table and subsequent graphs). The non-U.S. institutions are dropped in this analysis, but their results are shown in Table 2 as well as included in Table 3 and Figure 5.

Table 4: Summary of Position Searches by Institution Type and Highest Degree Offered

Institution Type	Number of Institutions	Advertised Number of Positions 1	2	3+	Multiple	Total Positions	% Positions w/ Specific Topic
Pub/PhD	86	20 (23%)	18 (21%)	16 (19%)	32 (37%)	281	79%
Prv/PhD	49	8 (16%)	5 (10%)	3 (6%)	33 (67%)	155	72%
Pub/MB	103	75 (73%)	20 (19%)	4 (4%)	4 (4%)	141	73%
Prv/MB	128	111 (87%)	16 (12%)	1 (1%)	0 (0%)	146	60%
All U.S.	366	214 (58%)	59 (16%)	24 (7%)	69 (19%)	723	73%

The results in Table 4 show that public institutions account for the majority of PhD-producing schools while there is a higher number of private MS&BS/BA institutions. 67% of private PhD institutions are searching for multiple positions while over 75% of PhD institutions identify specific topics on interest in their ads. Figure 7 shows eight-year results for the number of institutions

searching and the number of positions sought based on this institution classification. The left side of the figure shows a one-year increase for all institution groups. It shows the number of private PhD and MS&BS/BA institutions searching to be at eight-year highs.

The right side of the figure shows the number of positions sought increased in 2022 for each grouping of institutions. It shows the number of positions being sought to be at an eight-year high for private PhD institutions and comparable to the eight-year high for public PhD institutions. Again, a caveat is that the high percentage of "multiple position" ads for private PhD institutions makes the count highly dependent on the number of positions assumed for such ads.

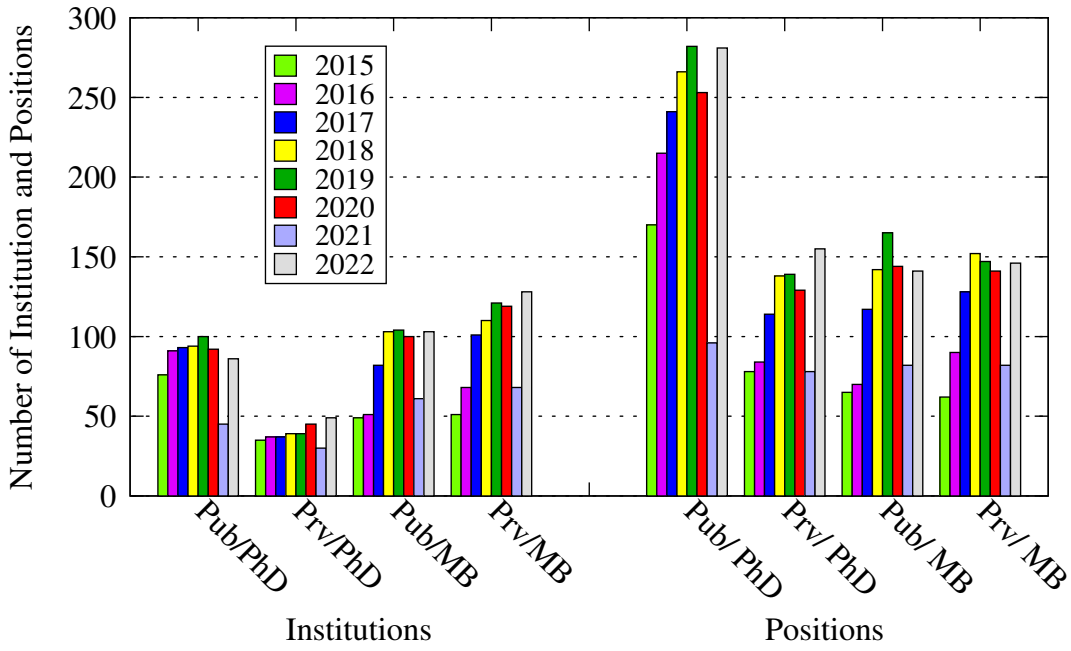

Figure 7: Eight-Year Counts of Institutions Searching and Positions Being Sought by Institution Type and Highest Degree Offered

Figure 8 shows the percentage of positions for each of the clustered areas using this classification for institutions. The figure both shows similarities and differences with results shown in Figure 6. The area of AI/DM/ML accounts for 29% of the positions for private PhD institutions, 19% for public PhD institutions and a smaller percentage for MS&BS/BA institutions. In contrast, Security is again the area of most interest for both MS&BS/BA institution type combinations. The DataSci clustered area has the smallest representation (8%) for public PhD institutions. In contrast, Theory/Alg (20%) is the area with the highest representation for public PhD institutions and is the second-most represented area (with 14% of positions) for private PhD institutions. This area has low representation for MS&BS/BA institutions. The last set of results in Figure 8 shows that 42% of positions for private PhD institutions are in the Data Oriented cluster with 27% for public PhD, 31% for private MS&BS/BA, and 36% for public MS&BS/BA institutions.

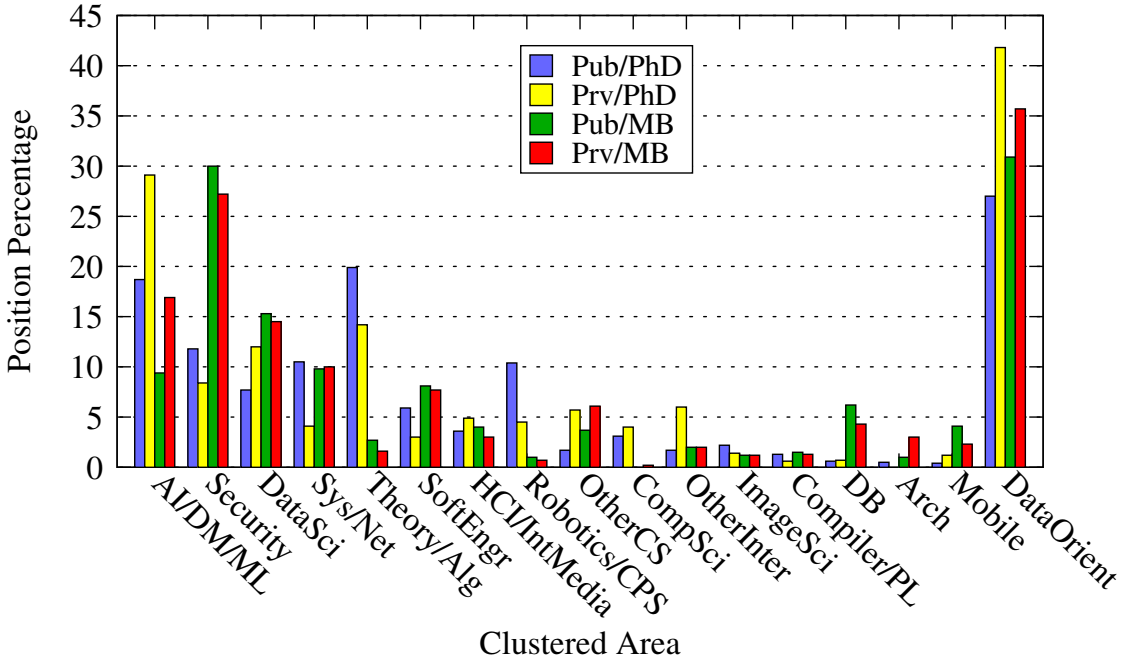

Figure 8: Clustered Area Percentage by Institution Type and Highest Degree Offered

5 Summary and Future Work

This work uses the same methodology applied over eight years to study where Computer Science departments are choosing to invest faculty positions using data obtained from advertised tenure-track searches for the current hiring season. This work also provides an opportunity to continue to understand the effects of the COVID-19 pandemic on faculty hiring in Computer Science for hires starting in 2022.

We analyzed ads from 400 institutions seeking to fill hundreds of tenure-track faculty positions in Computer Science. This number is a 70% increase from last year at this time (mid-November) and is a comparable number to the 394 institutions searching for 2020. The number of tenure-track positions sought is doubled from last year and up 6% from two years ago indicating a recovery in demand after a one-year drop due to the pandemic. The number of BS/BA institutions seeking faculty is at an eight-year high with top PhD and private PhD institutions at eight-year highs in the number of positions being sought.

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Differences are also seen when analyzing results based on the type of institution. As was the case last year, positions in the clustered area of AI/Data Mining/Machine Learning have the

highest percentages for PhD institutions. Again positions related to Security have the highest percentages for MS and BS/BA institutions. Theory/Algorithms is the second-most sought area for PhD institutions while Data Science is the second-most sought area for MS and BS/BA institutions.

A continued direction for future work is to examine how these searches translate into actual hires. Such follow-up was done in previous years [4, 5, 7], but not done this past year.

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