The Nature and Tools of Research in Computer Science

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ABSTRACT

An academic researcher in any discipline spends time in three primary activities: research, teaching and service. This is no different in the field of computer science. In this paper we will explore the mechanics of doing research. Specifically, we will look at initial steps to beginning a research project through tools needed to analyze data and write papers.

1. INTRODUCTION

For this paper, we are tasked with reviewing information related to the mechanics of doing computer science research. Another difference from our previous assignment is that our sources of information include not only written papers but transcribed interviews with experts in academic research from our own department. In the following sections I will review the recommendations from both sources.

2. ARTICLES ON DOING RESEARCH

In this section I will discuss what I found in researching the topic of tools of research in computer science.

2.1 Models of Argument

One article took a different approach to the analysis of research than I had seen before. It outlined several styles of research and pointed out that research in computer science actually uses a wide variety of methodologies. The models were the following: proof by demonstration, empiricism, mathematical proof, and hermeneutics.

Proof by demonstration is a common methodology in computer science. If a new idea can be implemented its validity is immediately shown. Empiricism is a classic scientific method where a hypothesis is generated and confirmed or refuted. It can be difficult to apply to computer science when clear hypotheses cannot be generated for the problem at hand.

For the theoretical areas of computer science the preferred

method of research is the mathematical proof. Hermeneutics is related to mathematical proofs in that it is a method of argument, but it relies on linguistic interpretation rather then mathematical.

2.2 Related Fields

Although the second article I read had numerous recommendations, many of which overlap with those presented below in the interviews section, I chose to focus on one section regarding related fields. The author points out that many research fields overlap with computer science and it can enhance your work to have some familiarity with these areas. The article itself is written from the point of view of an artificial intelligence researcher, so the fields he lists are most pertinent to that area (such as philosophy, linguistics, psychology, and neuroscience). Still, it is easy to see that this principle would be true for any area of computer science. For example, a systems researcher might benefit from some training in math, physics, or electrical engineering.

3. EXPERT INTERVIEWS

In a previous year of the Research Methods class, students interviewed professors in the computer science department at UTSA to get their thoughts on the mechanics of academic research and discuss how their research process works.

3.1 Read Papers

A near-universal recommendation from the interviews of expert researchers at UTSA is to read, read, and then read some more. A thorough understanding of your chosen field is the basis upon which to build future research ideas. Plus, as several of the experts mentioned, you don't want to waste time on an idea that has already been investigated and published.

Depending upon the type of paper, different reading styles may be warranted. For example, when reading a foundational paper in a journal, it may be more important to focus on its context within the field and the breadth of knowledge. Whereas when reading conference publications, it might be most important to quickly review articles to gain an understanding of the current state of the field and potential open questions that may be investigated further.

3.2 Tools

Tools of research mentioned by the experts fell into several categories: article search, data generation and analysis, and

writing. The most common sources for searching for articles were online libraries and internet sources such as Google Scholar.

Data generation and analysis tools tended to be specific to each subfield. For example, one of the experts who specializes in analysis of algorithms listed "paper" as a tool, since he spends time proving theorems. Another expert in artificial intelligence uses specialized software designed for machine learning. Many mentioned the use of statistical packages to analyze data, although as one expert pointed out, "We don't really have hypothesis and standard scientific method."

The standard tool mentioned by name by almost all experts for writing research papers is the typesetting program LAT_EXI ts importance cannot be overstated and our experts take it as a given that student researchers will learn it. A couple of experts also mentioned plotting software, such as gnuplot. This is useful for creating plots of data and these charts can be included in LAT_EX papers.

3.3 Collaboration and Other Human Factors

Several experts pointed out the importance of discussing your ideas with others, including your advisor, other professors in your field of interest, and other students. Not only can this help with refining your idea, it can lead to new project ideas or future collaborations. One expert said it is a good idea to consider whether a potential project is a good fit for you. Specifically, do you have time to complete it, the skills to complete it, and the right personality for the job? Also, it is important to consider whether your project adds to your field and if other researchers would be as excited about it as you are.

4. CONCLUSIONS

Our exploration of the details of the research process in computer science has yielded several conclusions. One, although computer science comprises a wide range of subfields, there are some remarkable consistencies in how research is done. For example, there is near universal agreement on the use of the typesetting software IAT_EX for writing research papers. Also, the importance of reading papers and staying current in your field was emphasized by every expert. Truly, the universality of reading extends beyond computer science to every academic field. Another common thread was the importance of talking with others to gain understanding of your work and theirs.

5. REFERENCES

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