

How to Start a Research Work in Computer Science: A Framework For Beginners

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ABSTRACT

Research is one of the key factors behind the improvement and evolution of any subject in the world. However, the skills to perform the research are rarely taught in the school or during the undergraduate courses. This paper provides a practical and efficient framework or method called ‘Eight-Step Approach to Research’, which will guide you to learn ‘how to start doing research’ in a particular area of computer science. Although this paper is meant for students and researchers in computer science but it should be kept in mind that this methodology can be applied to any research area in any field of study.

Categories and Subject Descriptors

A.1 [Introductory and Survey]

General Terms

Documentation.

Keywords

Research, Computer Science, Brainstorming, Hints

1. INTRODUCTION

After being a researcher, one has to read several research papers in order to serve many purposes such as reviewing them for a conference or a journal or a class, to remain updated in the that field of study, or for a literature survey of a new field or to contribute a brick to the wall of knowledge n that research area. This was actually mentioned properly in an article published by S. Keshav [1] regarding “How to Read a Paper”. Although there are very good articles on the methodical ways to read a research papers but most of the articles fail to teach students the primary need to start a research work.

In order to read and write technical or non-technical research work, one have to understand and learn about the skills by which they can start doing research in a particular topic or an area. For this reason the sole purpose of this paper is to teach new students and researchers in the field of computer science regarding how they can start a research work.

In the next section we will first discuss about the motivation of the idea that ultimately made me write about this paper and in section three we will learn about the simple “Eight-Step Approach to Research”, which will

give the readers the idea of preliminaries to start a research work. Then in section four we will review the limitations and experience of using this framework and in section five, some related work.

2. MOTIVATION

The skills, which are needed to pursue a research, are generally taught during postgraduate study, either at the end of master’s level before starting the master’s dissertation or at the beginning of Ph.D./M.Phil. study. But computer science is one of the widely evolving and fast paced subjects in the world because of its applications. This demands for more skillful programmers and researchers in this subject. But most of the schools and undergraduate study centers fail to teach students the basic necessity to learn about the skills to start research work.

In the year 2012, a survey, which was performed on 235 students (of undergraduate and master’s level study) of the Computer Science Department of St. Xavier’s College (Autonomous), India, to check how many students are comfortable in participating in a technical writing/poster competition. But to the surprise of the survey conductor, one of the most common questions that was asked in contrary opposing to the survey by the students was “Where and How to start a Research Work?”. Thus, 198 students out of 235 students had the same query.

The same survey was performed in the year 2013 on 594 students of the School of Computer Science of the University of Manchester, comprising of students from undergraduate and master’s taught study. Out of 594 students, 419 had the same query as before regarding where and how to start research. Hence the survey statistics provide that 84.26% of computer science students at the St. Xavier’s College (Autonomous), India, and 70.54% of computer science students of the University of Manchester, had no clue or vague idea regarding how to start a research work.

The skills to perform research are generally taught during postgraduate studies by the respective supervisors or tutors or mentors of the students, but these skills are not well taught during the school or during undergraduate studies. Now a days, technology is developing very fast

and most of the children are also learning of the different uses of technology, but teaching the essentials skills to performing a research is even more crucial.

3. THE EIGHT-STEP APPROACH TO RESEARCH

In this section we will learn the simple eight-step approach that we can use to start a research work or perform research.

The methodology is shown in the block-diagram format in figure 1.

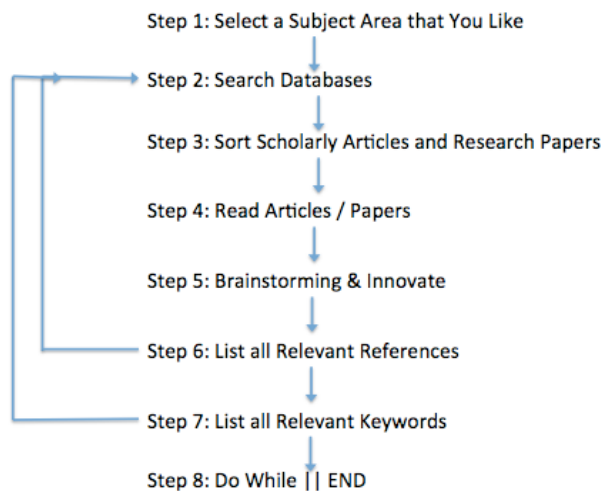


Figure 1: Block Diagram of “Eight-Step Approach to Research”

The steps that are provided in the figure 1 is to make the readers at ease because they might feel right at home while looking at the block diagram which portrays the algorithmic ‘Step’ approach of the methodology, but it can also be understood by any reader in any filed of study if they follow the explanation of the methodology in the next paragraph.

3.1 Step 1: Select a Subject Area that You Like

This first step can be tricky yet very enjoyable. When you are studying any subject, which in this case is computer science and engineering, try to choose the areas or topics in the subject that you really enjoy to read and ponder onto it. Once you selected or chosen the topics, write them down or scribble them onto a piece of paper.

3.2 Step 2: Search Databases

After performing the first step of selecting your favorite topics, you should perform a search from databases. Now, whenever people thinking of searching for something (except physical world), they always think of searching ‘that’ on Google Search Engine or on Wikipedia online dictionary or Bing or Yahoo Search Engines. But, it should be kept in mind that the search results that are provided by those search engines are general in nature, and those sources may also be not trust worthy.

For this reason, it is advisable to search for the key-terms or ‘something’ related to scholarly articles or papers on Scholarly search engines or databases or in archiving systems. Since this paper is mainly focused for computer science study, the most relevant research articles/papers’ databases are ACM Digital Library [7], IEEEExplore Digital Library [8], INSPEC IET Digital Library [9], DBLP [10], Elsevier Publishing Facilities [11], Scopus [12], ScienceDirect [13], Springer Publishing Facilities [14], etc. Note that the list of databases provided are not exhaustive in nature, but some of the popular choices that most computer scientist or industry practitioners publish their work in. The search option can also be performed on Google Scholar Search Engine [15] or on Microsoft Academic Search [16] or on ArXiv Archiving facilities [17] or on SAO/NASA Astrophysics Database [18], etc. If a search is performed on Google Scholar, Microsoft Academic Search, ArXiv, NASA ADS, then you might get search results, which are not only restricted to the fields of computer science.

3.3 Step 3: Sort Scholarly Articles and Research Papers

When I say sort articles or research papers, I do not mean that you should start sorting the articles or the papers using sorting algorithms such as quick sort or merge sort. This step is rather tricky than it sounds and actually needs human intervention rather than computer sorting.

But before explaining this step, first you need to understand the types of research papers or scholarly articles. In general research papers can be either of two types [2]: Argumentative Research Paper Or Analytical Research Paper.

Argumentative research paper consists of arguments that the author will either take a stance for or against. In this kind of paper the author introduces an argument and persuade the reader to believe in the provided argument by providing logical evidences.

In case of Analytical Research Paper, the author basically analyses a topic or logic and provide his own views or perspectives regarding that topic.

Now, after searching the databases for the list of scholarly articles and papers on your favorite topic, you need to select the articles or papers that suits your purpose and interest the most. But in order to do that, you need to read the title and abstract of the research paper in order to get a vague idea about what kind of research paper it might be (either an argumentative or analytical research paper). This may take some practice before you can become an expert in performing this step, but once you have got an idea about the type of the paper, it will be easier for you to decide whether the paper or the article is relevant for your research work or not.

Thus in this step, you need to select the research papers or articles based on your interest and the type of research paper that will suit your purpose.

3.4 Step 4: Read Articles/Papers

For this step it is recommendable that you read a paper written by Keshav [1] regarding “How to Read a Paper”, which basically proposes a three-way approach to read a paper effectively and efficiently so that you can understand the basic notion regarding the paper or the article.

3.5 Step 5: Brainstorming and Innovate

When I say brainstorming, it does not mean that think about what you have read in the paper or the article for few seconds or few minutes. For this you have to be very analytical and critical about the paper. Do not take all the logics and arguments provided in the article or paper for granted and you should try to think both analytically and critically about it. It might be difficult in the beginning but as a head start to make you think critically ask the following questions regarding the paper:

- What is the problem addressed in the paper?
- What is the solution?
- How are the solutions evaluated? (Reproducibility, benchmarks used to evaluate the solution, etc.)
- What are the assumptions in the paper?
- What are the limitations of the research in the paper?
- What is the main prior work?
- Can I/we improve it? Ideas for future work!
- What is the overall assessment of the paper?

Once you have asked the aforementioned questions and answered them then you would be able to produce your own views or logic or theories regarding the argument or analysis provided in the paper. And this is the moment when you innovate. But, at the same time it should be kept in mind that you may not be able to answer all the aforementioned questions. In that case, try to answer as many as possible, share your views with your colleagues or friends, who are pursuing the same research, or take some help from a person, who can provide his own perspective regarding that research. This step is the most crucial, yet fun ridden part of pursuing research. So always keep in mind that after reading a paper or article, do brainstorming and then innovate.

Also keep in mind that networking is an essential part of research. The more views you have regarding a particular topic, the more open minded you will be in your research and that will strengthen you not to be biased regarding something in your research area.

3.6 Step 6: List all Relevant References

In this step, you actually need to make a list of the citations that are provided in the reference section. The important question you may have regarding this step is

“Why do I need to list the references?”. This can be seen as a future investment. Make a list of the references that are relevant to that research area and may aid you to understand the paper properly. Sometimes a research paper may give you only one picture or perspective of a scenario, but in order to understand the complete scenario, you may need to explore the ideas and arguments provided in other papers or articles, those are cited by the research paper that you are recently reading. After generating the list, you can perform the step 2 using this list, so that you can read those papers to get a broader view in that research area.

3.7 Step 7: List all Relevant Keywords

In this step, you need to do the same thing that you did in the previous step, but now instead of making a list of references, you need to make a list of keywords from the research paper that you are reading. Select the relevant keywords and use the list to perform step 2 in order to discover relevant papers in that research area.

3.8 Step 8: Do While || END

This step is the last but final step, which can be seen as a concluding step to your research, i.e. this step should only be performed when your research is complete in a particular topic. Until then you should perform step 2 and follow up to step 7, and keep performing these steps till you have reached the climax of your research.

4. Limitations and Experience of this Approach

It should be kept in mind that this is not a hard and first rule to perform research but this provides a basic scientific framework for beginners so that they can start doing research at some point using this simple technique.

Although the method, proposed in this paper, is meant for beginners and computer science students, but this approach can be used by any person in order to start a research on a particular topic. It should also be kept in mind that some researchers or supervisor may have some different approach to research but this approach is one of many approaches that is easy and logically sound enough to perform.

I have started doing research in various fields of computer science since first year of my undergraduate study. Since I didn't have a computer science background before pursuing a college degree in this subject, it was very hard for me to perform research in a topic without a supervisor. But over the years I learned from my experience and others too, and devised this approach to help new students and researchers to start research on their own. For last 4 years I have shared this approach with many students and researchers and they have found this approach very helpful.

Although this paper may provide you an approach to start research but you need to always keep in mind that the key to every research is to network ideas and to ask ‘Why and How’.

5. Related Work

Before you start applying this eight step approach to research, it is advisable that you should better read the article on “How to Read a Paper” by Keshav [1]. If you need help in writing technical papers then it is worthwhile to read the articles written by Schulzrinne [3] and Whitesides [4]. And if you need to know is Research then it is recommendable that you read the web article by Johnson [5] or look at the presentation prepared by Somers [6] regarding “What is Research?”

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