# Writing for Computer Science

## Getting Started (Chapter 2)

### P. 9

Thus this chapter concerns the first of the steps involved in doing a research project, which broadly are:

• Formation of a precise question, the answer to which will satisfy the aim of the research.

• Development of a detailed understanding, through reading and critical analysis of scientific literature and other resources.

• Gathering of evidence that relates to the question, through experiment, analysis, or theory. These are intended to support—or disprove—the hypothesis underlying the question.

• Linking of the question and evidence with an argument, that is, a chain of reasoning.

• Description of the work in a publication

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A “Getting Started” Checklist

• Is your proposed topic clearly a research activity? Is it consistent with the aims and purposes of research?

• How is your project different from, say, software development, essay writing, or data analysis?

• In the context of your project, what are the area, topic, and research question? (How are these concepts distinct from each other?)

• Is the project of appropriate scale, with challenges that are a match to your skills and interests? Is the question narrow enough to give you confidence that the project is achievable? • Is the project distinct from other active projects in your research group? Is it clear that the anticipated outcomes are interesting enough to justify the work?

• Is it clear what skills and contributions you bring to the project, and what will be contributed by your advisor? What skills do you need to develop?

• What resources are required and how will you obtain them?

• What are the likely obstacles to completion, or the greatest difficulties? Do you know how these will be addressed?

• Can you write down a road map, with milestones, that provides a clear path to the anticipated research outcomes?

• Do you and your advisor have an agreed method for working together, with a defined schedule of meetings?

## Reading and Reviewing (Chapter 3)

### Research Literature

“Reviewing is a central part of the scientific process. It is important to become an effective reader, by giving each paper neither more nor less time that it deserves. The first time you read a paper, skim through it to identify the extent to which it is relevant—only read it thoroughly if there is likely to be value in doing so. Make the effort to properly understand the details, but always beware of details that may be wrong, or garbled.” (P.21)

### Finding Research Papers

“Comprehensive exploration of relevant literature involves following several intertwined paths:

• Use obvious search terms to explore the Web. You are likely to find, not just papers, but also home pages for projects and teams concerned with the same research area. Be exploratory in your search; sometimes the research in an area is divided across separate communities that have different vocabularies.

• Some of the major search engines have search tools that are specifically for academic papers. They are today the single most effective method for finding relevant work.

• Visit the websites of research groups and researchers working in the area. These sites should give several kinds of links into the wider literature.

• Follow up the references in promising research papers.

• Browse the recent issues of the journals and conferences in the area; search other journals and conferences that might carry relevant papers.

• Search the publisher-specific digital libraries. These include publishers such as Wiley and Springer, and professional societies such as the ACM and IEEE. There are also a wide range of online archives, in particular [www.arXiv.org](http://www.arXiv.org).

• Most conferences have websites that list the papers to appear in the conference that year.

• Consider using the citation indexes.

• Go to the library. The simple strategy of having similar material shelved together often leads to unexpected discoveries, without the distractions that arise when browsing the Web.

• Discuss your work with as many people as possible. Some of them may well know of relevant work you haven’t encountered.” (P. 21)

“Searching and reading are separate activities, and it is a mistake to try and do both at once. I recommend that you uncritically gather material and then later critically analyze and categorize” (P. 23)

### Critical Reading

“Good researchers must demonstrate their ability to objectively analyze the work and claims of others. (…) Work published in a reputable journal or conference is peer-reviewed; work available online could have any history. (…) A cynical but often accurate rule of thumb is that work that is more than one or two years old and has not been published in a significant venue probably has some serious defect. When you find a version of a paper on the Web, establish whether it has been published somewhere. Use evidence such as the quality of the author’s other publications to establish whether it is part of a serious program of research” (P. 23)

“If many researchers trust a particular paper, it is still reasonable to be skeptical of its results, but this needs to be balanced against the fact that, if skepticism is justified, these other researchers are all mistaken. (…) Read papers by asking critical questions of them, such as:

• Is there a contribution? Is it significant?

• Is the contribution of interest?

• Are the results correct?

• Is the appropriate literature discussed?

• Does the methodology actually answer the initial question?

• Are the proposals and results critically analyzed?

• Are appropriate conclusions drawn from the results, or are there other possible interpretations?

• Are all the technical details correct? Are they sensible?

• Could the results be verified?

• Are there any serious ambiguities or inconsistencies?

That is, actively attempt to identify the contributions and shortcomings rather than simply reading from one end to the other.” (P. 24)

### Developing a Literature Review

“Begin a rough literature review as soon as you start reading, and, when you read a paper that you think will need to be discussed, add it in. (You should also capture the bibliographic data as you go, and also keep a copy of every paper you read.) (...) Briefly summarize each paper’s contribution and the evidence used to support the claims, and also note any shortcomings or features that are of interest. You might also want to note, for your own reference, how the work might have been done better: for example, are there obvious experiments that should have been tried, or plausible counter-arguments to the claims? (…) I suggest that in early drafts you be as inclusive as possible. When you do remove discussion of a paper, put the discussion in another file (or comment it out) rather than deleting it altogether, as this text is your record of having read the paper.” (P. 25)

### Contribution

“Contribution is the main criterion for judging a paper. In broad terms, a paper is a contribution if it has two properties: originality and validity. The originality of a paper is the degree to which the ideas presented are significant, new, and interesting. (…) The validity of a paper is the degree to which the ideas have been shown to be sound. (…) In the area of algorithms, proof and analysis are the accepted means of showing that a proposal is worthwhile.” (P. 27)

### Evaluation of Papers

“There are further questions that should be asked of a paper that is under review, which should not just be correct but should be suitable for the likely audience:

• Is the contribution timely or only of historical interest?

• Is the topic relevant to the venue’s typical readership?

• What is missing? What would complete the presentation? Is any of the material unnecessary?

• How broad is the likely readership?

• Can the paper be understood? Is it clearly written? Is the presentation at an adequate standard?

• Does the content justify the length?” (P. 28)

### Evaluation of Papers

Speaks about peer reviewing, not that relevant ATM. (P. 30 – 33)

## Hypotheses, Questions, and Evidence (Chapter 4)

“The first stages of a research program involve choice of interesting topics or problems (…) The research is given direction by development of specific questions that the program aims to answer. These questions are based on an understanding (…) of how something works, or interacts, or behaves. (…) —in other words, a hypothesis. (…) In outline, an example research program might proceed as follows:

• A researcher investigating algorithms might speculate as to whether it is possible to make better use of the cache on a CPU to reduce computational costs.

• Preliminary investigation might lead to the hypothesis that a tree-based structure with poor memory locality will be slower in practice than an array-based structure with high locality, despite the additional computational cost.

• The hypothesis suggests the research question of whether a particular sorting algorithm can be improved by replacing the tree structure with the array structure.

• The phenomenon that should be observed if the hypothesis is correct is a trend: for example, as the number of items to be sorted is increased, the tree-based method should increasingly show a high rate of cache misses compared to the array-based method.

• The evidence is the number of cache misses for several sets of items to be sorted. Alternatively, external evidence might be used, such as changes in execution time as the volume of data changes.” (P. 35 – 36)

Hypothesis must be specific and precise. Examples of what to and what not to do on P. 36-37.

### Defending Hypotheses

In constructing an argument, it can be helpful to imagine yourself defending your hypothesis to a colleague, so that you play the role of inquisitor. (P. 39)

### Forms of Evidence

“**Proof**. An proof is a formal argument that a hypothesis is correct (or wrong). It is a mistake to suppose that the correctness of a proof is absolute—confidence in a proof may be high, but that does not guarantee that it is free from error (…)

**Model**. A model is a mathematical description of the hypothesis (or some component of the hypothesis, such as an algorithm whose properties are being considered) and there will usually be a demonstration that the hypothesis and model do indeed correspond. (…)

**Simulation**. A simulation is usually an implementation or partial implementation of a simplified form of the hypothesis, in which the difficulties of a full implementation are sidestepped by omission or approximation (…)

**Experiment**. An experiment is a full test of the hypothesis, based on an implementation of the proposal and on real—or highly realistic—data (…)

When choosing whether to use a proof, model, simulation, or experiment as evidence, consider how convincing each is likely to be to the reader” (P. 40- 42)

### Approaches to Measurement

“As you develop your research questions, then, you should ask what is to be measured? and what measures will be used?” (P. 43)

### A “Hypotheses, Questions, and Evidence” Checklist

Checklist regarding hypotheses and questions, and evidence and measurement on P. 49

## Writing a Paper (Chapter 5)

“To begin a paper, the first task is to describe your aims. An effective exercise is to write down everything that motivated you to start the research. What did you want to achieve? What problems did you expect to address? What makes the problems interesting? Next, define the scope of the work that you plan to write up. To do so, it is necessary to make choices about what to include, and thus it is necessary to identify what might be included. Typically, by this stage your research has become focused on investigation of a small number of specific questions, and you have preliminary experimental or theoretical results that suggest what the core contribution of the work is going to be. You might start, for example, by asking questions such as: (…)” (P. 51 – 52)

“There are several common ways for structuring the body of a paper, including as a chain, by specificity, by example, and by complexity. Perhaps the most common structure is the first of these alternatives, a chain in which the results and the background on which they build dictate a logical order for presentation of the material” (P. 54)

### Organization

Paper organization is described on pages 56 – 62

### First draft

“A consequence of having a sloppy first draft is that you must edit and revise carefully; initial drafts are often awkwardly written and full of mistakes. But few authors write well on the first draft anyway. The best writing is the result of frequent, thorough revision” (P. 63)

### From draft to submission

“A useful discipline is to choose the section titles before writing any text (…). For a novice writer who doesn’t know where to begin, a good starting point is imitation. Choose a paper or thesis whose results are of a similar flavour to your own, analyze its organization, and sketch an organization for your results based on the same pattern. The habit of using similar patterns for papers—their standardization—helps to make them easier to read. Students should keep a comprehensive file of notes as they proceed. This can include records of:

• Meetings.

• Decisions.

• Ideas.

• Expectations of outcomes.

• Papers you have read.

• Sketches of algorithms.

• Code versions.

• Theorems.

• Sources of data.

• Experiments and outcomes

• Sketches of proofs” (P. 64 – 65)

### Getting it Wrong

**Irrelevance**: “When I first see a paper, impressions form in a minute or two, influenced by layout, readability, and so on. With some papers, though, a positive initial response is gradually followed by a sinking feeling: I cannot figure out what this paper is about. Something elementary is utterly missing.” (P. 68)

**Inconsistency, Inadequacy, and Incompleteness: “**Some papers seem reasonable in parts, but the parts don’t belong in the same document” (P. 69)

**Incompreensibility:**  “when presented with an incoherent abstract or introduction, the reader immediately feels that the work cannot be of value” (P. 70)

**Ugliness:** “The look of a document is another respect in which problems can be immediately obvious” (P. 70)

**Ignorance: “**An example of this is when much of a paper is spent explaining an elementary concept that will be familiar to any likely reader and maybe even to undergraduates” (P. 71)

### A “Writing-Up” Checklist

Checklist regarding the scope of the work, how the write-up is organized and presented, and approach to the work in P. 72 – 73