How to Write a Graphics Paper

Voicu Popescu and Daniel G. Aliaga

Writing papers is one of the most important things you will do as a researcher. It is the way you communicate your thoughts and projects. As a researcher, you are identified by the papers you write. Writing a paper is ***difficult***; it is something you have to learn the same way you learn a foreign language or you learn how to swim. Some learn it more easily than others, but anyone can learn how to write a great paper. Much has been written on writing. Eventually, you will develop your own style (or "formula") for writing a paper. This essay sketches a pragmatic initial approach to writing papers and graphics papers in particular.

This might appear harsh to you, but it justly emphasizes the research process: be the driving force behind your Ph.D. research! Draft the idea, communicate it, defend it, implement it, present it, become famous for it—it will make you and your advisor happy and proud. Since graphics is small, compared to say medicine, you can become the "world expert" in some particular subject. Once you have reviewed related work and published papers, you are the guy who solved that particular problem.

Note that computer science, and graphics, is different from other fields (e.g. engineering, chemistry) in that the amount of innovation that goes into every paper is larger. This also means that there is a non-negligible risk that an idea does not pan out to the great results you sometimes justifiably expect. It is not always clear that setting up the experiment, collecting the data, analyzing the data, and presenting the work clearly is sufficient for a great publication.

Regarding the venue where to submit your work, there is no peer refereed venue that is too small, especially at the beginning, when you start out. Build experience writing, presenting, and work your way up. Of course, there is nothing wrong with submitting to the top venues as soon as possible. As a graduate student you should be submitting a paper every 3-4 months: plan way ahead of time. This helps keep you making progress and helps keep you focused. Write the paper outline as soon as you are getting your early results.

The high-level structure of a paper is fairly standard. The Title, Authors list, Abstract, Introduction, Prior Work, Overview, MyWorkSection1, …, MyWorkSectionN, Results, Conclusions and Future Work, Acknowledgments, and References are the usual parts of a paper.

Title

Before you begin, you have to define what the paper is about. This starts with coming up with the "story" you wish to communicate with the paper. It is very important to have a convincing/interesting/novel story – having a good (bad) story can completely make (break) the paper. There is often a tendency to make the story equal to the details of the solution – rarely is this good. Usually, you have a problem/application to solve and you propose a way to do it. The details of how you did it are in the paper, of course, but the story stands on its own.

Thus, to come up with a title you must think carefully what do you want to communicate with this paper? Put this is the most concise form possible and you usually get a good starting point for the title of your paper. The title will surely change throughout the writing process. For

example, if your work is an algorithm for rendering reflections at interactive rates by approximating the reflected scene with impostors, you pretty much have a title. However, you must be very careful with the words you use – it will give the reader the first impression as well as guide the paper through the review process. You can "spin" your work in different ways depending on the words and story you use – this will influence who reads and reviews the paper. Also, words like "interactive", "real-time", "photorealistic", "optimal", etc., have meanings that you must use carefully. Sometimes a title can be interpreted in different ways --- that means the title is bad, not the reader or reviewer.

Your title, and your introduction will introduce terminology – make sure you use it consistently throughout the rest of the paper.

As a side note, all the following sections (except for Authors List) should start with a paragraph summarizing the rest of the section. Furthermore, each paragraph should start with a sentence summarizing the paragraph. This recursive definition is hard to maintain but is a good goal to strive for to keep your writing clear.

Authors List

There are several criteria people use to decide on authors. The most common method in our field is to sort the authors based on contribution. The first author should understand the whole idea, be able to present it, and know how everything works. It is every advisor's dream to have his/her student as first author on all papers; nevertheless, the student has to meet the first author criteria. Another important aspect is who else to include in the author list. We do not live in a vacuum, and many people contribute one way or another to a project. Since the paper is about presenting a novel approach to solve a problem, a good rule to follow is to only include the collaborators that contributed significant ideas to the work. This leaves out those whose contribution is exclusively in the implementation, in making figures, or in collecting data – they go in the acknowledgment section.

Abstract

There are two types of abstract. A two paragraph abstract will have a paragraph describing the relevance of the problem, the reason it is difficult, and the limitations of current solutions. The second paragraph describes the method and the results. It is appropriate to define the scope of your method in this second paragraph. For example your reflection rendering technique could support dynamic reflected objects but require the reflectors to not change.

The second type of abstract has a single paragraph, namely the second paragraph of the two-paragraph abstract described above. The length of the abstract is usually regulated. The abstract is expected to be dense, so do not hesitate to start from something as long as twice the word limit and to condense it.

Introduction

The introduction is the ***most important*** part of the paper and probably the only part of the paper a reader/review will read closely from beginning to end. Most reviewers decide on acceptance by the end of the introduction, and use the other sections as a source of evidence for their decision. Be prepared to spend a long time writing and revising your introduction

continuously during the paper writing process. Even though you spend most of your "implementation" time in the details of the later sections, the introduction is still the most important part of the paper.

One formula for writing an introduction is to have four parts (or paragraphs). The first paragraph explains what the problem is and why it is relevant. The second paragraph explains why the problem is hard, why it is not a solved problem yet, and optionally references to related work (some styles put the previous work references in the introduction, some do not). The third paragraph highlights the challenges that need to be addressed (these should ideally exactly be the shortcomings of previous work and/or what is not solved yet). The fourth paragraph should introduce your method. Usually, it starts by some sort of insight or inspiration. You might actually have a separate paragraph called "key observation" or you might go straight into an outline of your approach. Do not focus on the implementation details, rather on the key ideas and concepts you use. What is it at the core of your method that makes it work? To which category of prior art methods does it belong? Does it define a completely novel approach? Is it a hybrid approach?

Next you should place some "teaser" information in the introduction. This typically includes a "nice first figure" and a very brief summary of your best results. Put your best foot forward – you are trying to convince the reader you addressed a difficult problem, devised a strong solution, and have excellent results. If not, you would not be writing the paper. Some writing styles explicitly include a list of contributions at this point as well.

Finally, you can finish the introduction by describing the organization of the paper (what each section does). This is particularly useful for longer papers but is often omitted for shorter papers where space is at a premium.

Prior work

This is one of the most boring sections to a reader, in part due to the poor quality of writing that usually goes into this section. If you make your prior work section flow, be relevant to the work at hand, and be comprehensive and fair, you do yourself a world of good. You help reviewers that are not so familiar with the narrow area of your work, you reassure experts in your area that you are knowledgeable and fair. There is nothing worse than a bad prior work section, which indicates not understanding prior work, or which simply exhaustively covers all bases, without contrasting the prior work to your method. Remember, your method has so far only been described by the title, abstract, and introduction, thus you cannot rely on the reader being familiar with the intricacies of your method.

Organize the prior work section on approaches. Define the approach and give concrete examples of work that falls within this category. Choose early (preferably first) and recent work for each approach. For each concrete example, say in a sentence what it does, in another one what it excels at, and in another one what the shortcomings are. Once you are done giving examples for an approach, summarize the general strengths and weaknesses of the approaches and contrast it to your approach. Do not reuse prior work text from other papers. It should be clear that the prior work section has been written in support of the presentation of this new method you propose.

Overview

The overview section (or the "first section of your approach") should give the high-level view of your entire method; use a diagram! Whenever you find that something is difficult to describe, make a figure (e.g., a diagram, an image, a graph, etc.). Your figures should also span the concepts you introduce. This means that if a reviewer just looks at your figures, ideally the reviewer should be able to understand all your innovations (this is hard to accomplish but it a goal to strive for). In general, figures should be of highest quality possible – it takes a significant amount of time to make a good figure, e.g., from minutes to several hours and with multiple revisions. Use a professional tool for making figures. It should be clear, easy to read, not too crowded, and not trivial either. The overview should introduce the main parts, which should match each of the MyWorkSections. The overview is essential. Reviewers are volunteering their time, and you are responsible for making their job as simple as possible. Remember, your work is assumed to be bad until proven good. Your paper is assumed to be rejected until you prove that it has to be accepted.

MyWorkSection1…N

These sections are usually the easiest ones to write. It's what you did. You did it, you know it well. You love what you did and you can't wait to tell people about it. You have to describe your work in sufficient detail such that a skilled graduate student can reproduce your work but do not be overly verbose – be concise and to the point. This means that there should be no innovation left unexplained, but it also means that simple implementation details do not have to be given. Use references for any tool you use and remember, figures are essential. The figure caption should have the figure title, which could be something like "Figure 1. Reflections rendered with a depth image impostor", and a short explanation, like "The diffuse and reflective bunnies intersect. The image is rendered with our method at 34Hz." If the explanation gets too long, move that text to the main text section.

It is a good idea to use the present tense. Do not use the words "can, could, should, would". In these sections, never talk about something you did not do. Save all that "could and should" be done for future work. You have to make it very clear to the reader what your work was. There is nothing worse than giving the reader an uneasy feeling that some of the work described is actually proposed and not done. Also do not overly use strong adjectives such as "very" and "highly" -- they actually weaken what is claimed.

Also if you have to describe some of your work that was published earlier, make that very clear by saying: we use a similar approach for solving X like the one used in [Y]. We review the solution here to make this paper self-contained. Be very careful in the case of double blind reviewing, you have to use the 3rd person for your earlier work. Do not include 10 references to your previous work; that will amount to a blatant disclosure of your identity.

Results

This section gives the results and also discusses them. Make sure to include the hardware used (what PC, what graphics card, etc). Describe the scenes on which you tested the algorithm (refer to the images throughout the paper). Organize carefully for fast readability. Separate quality from performance; for quality use side-by-side images, for performance attempt to derive an asymptotic cost for your method. For example, the parameters are the number of triangles in

the reflector, in the reflected scene, the resolution of the desired image, etc. Include tables and graphs whenever needed. Compare the results to prior work.

Give implementation details, but only the ones that are interesting. Most GPU implementation details are NOT interesting. Simply say what is done on the GPU and what is done on the CPU.

Conclusions and future work

Summarize the strengths and weaknesses (limitations) of your method. Hammer one more time that the method does what it is advertised in the title, abstract, and introduction. Sketch directions for future work. Do not describe small improvements at implementation level. Describe big improvements, starting from well fleshed out current work sounding like future work, and end with something that is farther out (in the distant time horizon – think big).

Acknowledgments

They should be withheld for double blind reviewing but generally covers sponsors (salaries, HW, SW), model sources, contributors that did not make it to the authors list, and even family members if you wish.