

PARALLEL IMPLEMENTATION OF FRINGE SEARCH

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The hard page limit is 6 pages in this style. Do not reduce font size or use other tricks to squeeze. This pdf is formatted in the American letter format, so the spacing may look a bit strange when printed out.

ABSTRACT

Describe in concise words what you do, why you do it (not necessarily in this order), and the main result. The abstract has to be self-contained and readable for a person in the general area. You should write the abstract last.

1. INTRODUCTION

This project was part of the course *Design of Parallel and High-Performance Computing* given by Torsten Hoefler and Markus Püschel in autumn 2013 at ETH Zürich.

Motivation. Pathfinding is an important part in many applications, especially in computer games and robotics. A very popular algorithm for pathfinding is A*, an algorithm that will find an optimal path between two nodes on a graph with a best-first search approach using a priority queue. A path is called optimal if it is the shortest possible path between two points.

Fringe search is an alternative to A* that was introduced in [?]. It doesn't use a priority queue to store the nodes and therefore generally outperforms A* [?]. The trade-off is that Fringe Search, compared to A*, does not guarantee to find the shortest path. It's rather used to find a good path, which might not be optimal, but short enough in order to be a reasonable path.

The goal of this paper was the implementation and benchmarking of a parallel version of Fringe Search similar to [?] but in a shared memory environment.

Related work. This paper is mainly based on two papers. The Fringe Search algorithm was introduced in [?]. S. Brand and R. Bidarra implemented a parallel version in a distributed memory environment described in [?] and a bit more specific in the Master Thesis of S. Brand [?]. In this paper the implementation was done for a shared memory environment.

2. BACKGROUND: SHORTEST PATH PROBLEM

In this section we formally define the shortest path problem we consider and introduce two algorithms that are used to solve it including a cost analysis.

Single source shortest path. A problem where the goal is to find the shortest path between a start and an end node in a directed or undirected graph. In our case we used a directed graph.

A*. A very popular algorithm that uses a best-first search approach in order to find the shortest path. It always finds the shortest possible path and therefore it's called optimal. It uses a priority queue for the nodes and therefore each insert into the queue has complexity $O(\log n)$.

Fringe Search. bllal

As an aside, don't talk about "the complexity of the algorithm." It's incorrect, problems have a complexity, not algorithms.

3. YOUR PROPOSED METHOD

Now comes the "beef" of the report, where you explain what you did. Again, organize it in paragraphs with titles. As in every section you start with a very brief overview of the section.

In this section, structure is very important so one can follow the technical content.

Mention and cite any external resources that you used including libraries or other code.

4. EXPERIMENTAL RESULTS

Here you evaluate your work using experiments. You start again with a very short summary of the section. The typical structure follows.

Experimental setup. Specify the platform (processor, frequency, maybe OS, maybe cache sizes) as well as the compiler, version, and flags used. If your work is about performance, I strongly recommend that you play with optimization flags and consider also icc for additional potential speedup.

Then explain what kind of benchmarks you ran. The idea is to give enough information so the experiments are reproducible by somebody else on his or her code. For sorting you would talk about the input sizes. For a tool that performs NUMA optimization, you would specify the programs you ran.

Results. Next divide the experiments into classes, one paragraph for each. In each class of experiments you typically pursue one questions that then is answered by a suitable plot or plots. For example, first you may want to investigate the performance behavior with changing input size, then how your code compares to external benchmarks.

For some tips on benchmarking including how to create a decent viewgraph see pages 22–27 in [1].

Comments:

- Create very readable, attractive plots (do 1 column, not 2 column plots for this report) with readable font size. However, the font size should also not be too large; typically it is smaller than the text font size. An example is in Fig. ?? (of course you can have a different style).
- Every plot answers a question. You state this question and extract the answer from the plot in its discussion.
- Every plot should be referenced and discussed.

5. CONCLUSIONS

Here you need to summarize what you did and why this is important. *Do not take the abstract* and put it in the past tense. Remember, now the reader has (hopefully) read the report, so it is a very different situation from the abstract. Try to highlight important results and say the things you really want to get across such as high-level statements (e.g., we believe that is the right approach to Even though we only considered x, the technique should be applicable) You can also formulate next steps if you want. Be brief. After the conclusions there are only the references.

6. FURTHER COMMENTS

Here we provide some further tips.

Further general guidelines.

- For short papers, to save space, I use paragraph titles instead of subsections, as shown in the introduction.
- It is generally a good idea to break sections into such smaller units for readability and since it helps you to (visually) structure the story.
- The above section titles should be adapted to more precisely reflect what you do.

- Each section should be started with a very short summary of what the reader can expect in this section. Nothing more awkward as when the story starts and one does not know what the direction is or the goal.
- Make sure you define every acronym you use, no matter how convinced you are the reader knows it.
- Always spell-check before you submit (to us in this case).
- Be picky. When writing a paper you should always strive for very high quality. Many people may read it and the quality makes a big difference. In this class, the quality is part of the grade.
- Books helping you to write better: [2] and [3].
- Conversion to pdf (latex users only):

```
dvips -o conference.ps -t letter -Ppdf -G0 conference.dvi
```

and then

```
ps2pdf conference.ps
```

Graphics. For plots that are not images *never* generate the bitmap formats jpeg, gif, bmp, tif. Use eps, which means encapsulate postscript. It is scalable since it is a vector graphic description of your graph. E.g., from Matlab, you can export to eps.

The format pdf is also fine for plots (you need pdflatex then), but only if the plot was never before in the format jpeg, gif, bmp, tif.

7. REFERENCES

- [1] M. Püschel, “Benchmarking comments,” online: <http://people.inf.ethz.ch/markusp/teaching/263-2300-ETH-spring11/slides/class05.pdf>.
- [2] N.J. Higham, *Handbook of Writing for Mathematical Sciences*, SIAM, 1998.
- [3] W. Strunk Jr. and E.B. White, *Elements of Style*, Longman, 4th edition, 2000.