

# Basic block vectorization for shader compilers

by

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## Abstract

Increasingly complex graphics shaders and new use-cases like OpenCL provide larger opportunities for vectorization.

*“The purpose of the abstract, which should not exceed 150 words for a Masters’ thesis or 350 words for a Doctoral thesis, is to provide sufficient information to allow potential readers to decide on relevance of the thesis. Abstracts listed in Dissertation Abstracts International or Masters’ Abstracts International should contain appropriate key words and phrases designed to assist electronic searches.”*

— MUN School of Graduate Studies

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— MUN School of Graduate Studies

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# Chapter 1

## Introduction

### 1.1 Getting started

This is the introductory chapter. This will give you some ideas on how to use L<sup>A</sup>T<sub>E</sub>X [1] to typeset your document. Here is a sample quote using the `\munquote` environment:

*“L<sup>A</sup>T<sub>E</sub>X is a system for typesetting documents. Its first widely available version, mysteriously numbered 2.09, appeared in 1985. L<sup>A</sup>T<sub>E</sub>X is now extremely popular in the scientific and academic communities, and it is used extensively in industry. It has become a lingua franca of the scientific world; scientists send their papers electronically to colleagues around the world in the form of L<sup>A</sup>T<sub>E</sub>X input.” [1]*

The citation at the end is optional — if you don’t need it, then use `\munquote` without any arguments:

*“Here is a quote that does not have an associated citation after it. You can specify the citation before or after the quote manually.”*

By default, all text is double spaced, however, quotes and footnotes must be singled spaced.<sup>1</sup> The left margin is slightly wider than the right margin. This is to compensate for binding.

An example mathematical formulae is show in Equation 1.1.

$$\sum_{i=0}^n i^2 \tag{1.1}$$

A slightly more complicated equation is given in Equation 1.2:<sup>2</sup>

$$i\hbar \frac{\partial}{\partial t} \Psi(x, t) = -\frac{\hbar^2}{2m} \nabla^2 \Psi(x, t) + V(x) \Psi(x, t) \tag{1.2}$$

## 1.2 Cross References

In addition to using `\ref` to refer to equations, you can also use it (in conjunction with the `\label` command) to refer to sections and chapters without hard coding the numbers themselves. For example, this is Section 1.2 of Chapter 1. You can also refer to Appendix ??, Subsection 1.7.1.1 below or any other place that has a `\label`. You can also use labels to refer to a page. For example, Chapter 2 starts on page 7.

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<sup>1</sup>This is a single spaced footnote. SGS requires that footnotes be singled spaced and this can be done with the `\munfootnote` command.

<sup>2</sup>Equation taken from the *Schrödinger equation* entry on *Wikipedia*



## 1.3 Some Suggestions

Here are a few recommendations:

- Before using this template, make sure you check with your supervisor.
- MUN's library provides electronic access to some L<sup>A</sup>T<sub>E</sub>X related textbooks which can be read online. Use the search term `latex (computer file)` on the Library's web page.
- If you run into a problem, Google may be a helpful resource.
- Concentrate on content, let L<sup>A</sup>T<sub>E</sub>X handle the typesetting.
- Don't worry about warnings related to:
  - overfull `hboxes`/`boxes`
  - underfull `hboxes`/`vboxes`

These can be corrected with modest rewording of your text prior to submission of your final copy.

## 1.4 The Makefile

You can use `make` to “build” your thesis on the Linux command line<sup>3</sup> This will automatically run the `bibtex` program to create your bibliography and will also re-run `latex` as necessary to ensure that all references are resolved. A device independent

---

<sup>3</sup>Linux is available on all machines running LabNet in *The Commons* and in other computer labs on campus.

file (`thesis.dvi`) will be created, by default. If you are using this template in another environment other than the Linux command line, then the `Makefile` will probably not be useful to you.

- To make a PostScript copy of your thesis, type the following at the command line:

```
make thesis.ps
```

- To generate a PDF copy of your thesis, run:

```
make thesis.pdf
```

- To generate a PDF/A-1b copy of your thesis (which should satisfy the SGS's thesis submission requirements):

```
make ethesis.pdf
```

- To remove all the files generated by `bibtex` and `latex`, use the command:

```
make clean
```

- To remove the intermediate files, but leave the PostScript and DVI/PDF files intact, use the command:

```
make neat
```

As you add or remove figures, chapters, or appendices to your thesis, make sure you keep the `Makefile` upto date, too (see the `FIGURES` and `FILES` macros in the `Makefile`).

## 1.5 Changing Fonts

Change fonts: Large, verbatim `~@#$$%^&*(){}[]`, SMALL CAPS, *slanted text*, *emphasized text*, typewriter text.

## 1.6 Accents and Ligatures

Some accents: é è ô ü ç ï í ñ ā ă ǎ

Some ligatures: flæffi

## 1.7 Some Lists

Here is a nested enumeration:

1. An enumerated list of items.
  - (a) which can
  - (b) nest
    - i. to arbitrary
    - ii. levels
2. More items
3. in the top
4. level list.

Another enumeration:

1. (a) Main 1 part 1

(b) Main 1 part 2

2. (a) Main 2 part 1

(b) Main 2 part 2

### **1.7.1 Subsection**

#### **1.7.1.1 Subsubsection**

This section is referred to by Section 1.2.

#### **1.7.1.2 Subsubsection**

<Empty subsection>

# Chapter 2

## Figures and Tables

### 2.1 Figures

We can include encapsulated PostScript<sup>TM</sup> figures (`.eps`) in the document and refer to it using a label. For example, MUN's logo can be seen in Figure 2.1.

Figure 2.1: This is MUN's logo

Figure 2.2 shows a chart of MUN's Fall enrollment from 2005 – 2009.<sup>1</sup> The figure

---

<sup>1</sup>From *Memorial University of Newfoundland — Fact Book 2009*.

Figure 2.2: MUN Fall Enrollment 2005 – 2009

was created using the **Calc** spreadsheet application of the office suite **OpenOffice.org**.<sup>2</sup> This figure was reduced by 50%.

For larger figures, we can use landscape mode to rotate the page and display the figure using the `\munlepsfig` command, as shown in Figure 2.3. The figure will be the only thing on the page when typeset in landscape mode. (The figure is reduced to 85% of its original size.)

Alternatively, if we just want to rotate the figure, but not the entire page, we can specify an `angle` attribute in the default argument of the `\munepsfig` command. The result is shown in Figure 2.4. If the figure is too large or if there isn't sufficient text, then the figure may appear on its own page.

Note that all three of the enrollment figures are basically the same file, but with different names — on Linux, they are symbolic links to the same file. The filenames

---

<sup>2</sup>This office suite can be downloaded at no cost from <http://openoffice.org/>. Unlike other commercial office suites, **OpenOffice.org** may be legally shared with colleagues and fellow students. There are versions for Linux, Microsoft Windows, Mac OS X and Solaris. Also, unlike commercial offerings, **OpenOffice.org** does not require activation using registration keys.



Figure 2.4: MUN Fall Enrollment 2005 – 2009 (rotated)

have to be different because the reference labels need to be unique.

Figure 2.5 shows a Petri net created using the `xfig` program (<http://www.xfig.org/>) which has very good support for  $\text{\LaTeX}$ . This figure has been reduced to 40% of its original size.

Figure 2.5: A deadlocked Petri net



We can also create figures of text (such as short code snippets) using the `\muntxtfig` command, as show in Figure 2.6.

---

```
#include <stdio.h>

int main(int argc, char **argv)
{
    printf("Hello world!\n");
    exit(0);
}
```

---

Figure 2.6: Hello World

## 2.2 Tables

We can also create tables, as seen by Table 2.1. Note that, as required by SGS guidelines, the caption for a table appears above the table whereas figure captions appear below the figures. Tables and figures can “float” — they may not appear on the page on which they are mentioned. L<sup>A</sup>T<sub>E</sub>X tries to handle figure and table placement intelligently, but if if you have a lot of them without a reasonable amount of surrounding textual content, the figures and tables can accumulate towards the end of the chapter. Generally speaking, if there is sufficient text explaining the tables and figures or if the tables/figures are relatively small, this may not be a problem. However, if you have a lot of tables or figures, it may be a good idea to put them in an appendix and refer to them as the need arises.

Table 2.2 shows a different table in landscape mode.<sup>3</sup> This is useful if your table

---

<sup>3</sup>This data was also taken from the *Memorial University of Newfoundland — Fact Book 2009*.

Table 2.1: Fall Semester Enrollment

	Undergraduate			Graduate		
	F/T	P/T	Total	F/T	P/T	Total
2004	13,191	2,223	15,414	1,308	879	2,187
2005	13,184	2,143	15,327	1,375	920	2,295
2006	12,809	2,224	15,033	1,373	899	2,272
2007	12,634	2,155	14,789	1,403	899	2,302
2008	12,269	2,208	14,477	1,410	1,005	2,415
2009	12,382	2,323	14,705	1,567	1,106	2,673

is too wide for the page. Tables are double-spaced by default. To single-space a table, change the `\baselinestretch` before beginning the table environment. Remember to restore it after the environment has ended.

Table 2.2: Masters Degrees Conferred

Degrees	2009		2010
	May	Oct	May
Master of Applied Science	14	2	1
Master of Applied Social Psychology	1	5	1
Master of Applied Statistics	0	0	0
Master of Arts	37	49	2
Master of Business Administration	14	16	2
Master of Education	107	87	12
Master of Employment Relations	8	9	0
Master of Engineering	20	19	2
Master of Environmental Science	3	3	0
Master of Marine Studies	2	0	0
Master of Music	4	1	0
13 Master of Nursing	7	8	1
Master of Oil and Gas Studies	0	0	0
Master of Philosophy	5	4	0
Master of Physical Education	0	2	0
Master of Public Health	0	8	0

# Chapter 3

## Dealing with Errors

L<sup>A</sup>T<sub>E</sub>X can produce cryptic error messages at times. However, with some experience, it is usually not too difficult to determine what the problem is and how to fix it.

As mentioned earlier, appropriate search terms in Google may help you fix these error messages.

# Chapter 4

## Lorem Ipsum

Now, for your reading pleasure, some *Lorem ipsum*, courtesy of:

`<http://www.lipsum.com/>`

This gives a good view of the margins — note that the left margin is a bit wider than the right margin to accommodate binding.

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam odio elit, viverra eu tempor non, pulvinar ac nisi. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Sed adipiscing, dui quis viverra facilisis, quam libero adipiscing justo, vitae dictum libero mauris ac magna. Aenean sem ligula, vulputate at vestibulum eu, pellentesque in justo. Sed et eros mauris, sed placerat nulla. Maecenas nulla velit, facilisis et rutrum nec, volutpat id lorem. Duis vestibulum odio velit, id elementum tortor. Sed pellentesque leo ac nibh iaculis at fermentum orci lobortis. Suspendisse arcu magna, porta nec pretium non, feugiat vitae orci. Vivamus at enim arcu, at sagittis nisl. Vestibulum at mi enim, vel malesuada justo. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos.

Nullam sed nunc at enim posuere sagittis. Vivamus augue turpis, mattis a blandit non, sollicitudin non nisl. Integer vestibulum, est vitae cursus adipiscing, elit libero pretium leo, in scelerisque augue felis volutpat nisl. Donec commodo posuere arcu, eget feugiat dui ornare nec. Nullam eros mi, condimentum ac ultricies ac, euismod lobortis nibh. Cras ac ligula pharetra risus elementum pharetra vel in quam. Fusce ac augue vulputate nibh imperdiet convallis sit amet et quam. Integer porttitor dictum fermentum.

Nullam id ante arcu. Nulla facilisi. Vestibulum sodales, mi sodales ultricies pulvinar, orci leo dictum diam, quis imperdiet turpis lacus ut sem. Nulla rutrum odio sit amet elit aliquam blandit gravida nunc placerat. Aenean et neque ut leo condimentum vehicula. Fusce quis orci vitae enim dapibus tincidunt in vel ipsum. Phasellus auctor neque ac eros egestas sit amet ultricies erat vestibulum. Ut erat ligula, pharetra vel hendrerit vitae, mattis ac turpis. Ut malesuada diam vitae lacus vestibulum a tempus nisl posuere. Ut nisi sem, dictum eu laoreet sed, commodo eget enim. Morbi vel lacus neque, tempus fringilla tellus. Nunc id egestas felis. Nullam eu mollis neque. Ut non mauris malesuada eros sagittis congue. Cras vitae felis ut nisl mollis semper ut quis risus. Sed eu arcu urna, et commodo sapien. Donec vestibulum, libero sit amet ultrices blandit, erat lorem volutpat lectus, sed feugiat leo elit in orci. Aliquam vitae leo tellus, placerat pulvinar massa. Nulla at sapien hendrerit diam varius vehicula.

Curabitur et orci nulla. Phasellus euismod, massa non hendrerit dictum, dolor enim imperdiet sapien, vitae commodo lorem tellus eu quam. Duis egestas felis velit. Sed in orci nec nulla rutrum posuere. Suspendisse potenti. Nunc vel quam nisi. In at molestie libero. Aenean hendrerit vestibulum orci, ut hendrerit nulla volutpat lacinia. Vestibulum sit amet sapien vitae lectus gravida vehicula. Suspendisse ac purus sit

amet est congue auctor.

Morbi pellentesque, quam vel mattis molestie, augue purus vestibulum lorem, nec consequat enim eros eu augue. In odio dolor, scelerisque a lobortis porttitor, commodo ut lacus. Maecenas sit amet diam nec tellus accumsan bibendum. Praesent in turpis velit, malesuada commodo sapien. Nunc ornare urna enim. Sed at diam non metus porttitor suscipit. Aliquam erat volutpat. Duis aliquet magna in mauris semper placerat. Ut eget quam orci. Ut egestas, dolor at dapibus accumsan, leo nibh egestas urna, ac consectetur dui odio quis eros. Nam libero dolor, lacinia eget imperdiet non, malesuada vehicula diam. Etiam id ipsum eget turpis consectetur tristique id at ante. Vivamus blandit nunc eu nisl varius sed accumsan odio molestie.

# Chapter 5

## Handling Citations

BibTeX can be used to handle all your bibliographic needs. Simply add references to the file `ref.bib` and BibTeX will take care of the rest. An example of a BibTeX book, conference paper and journal article are given in the sample `ref.bib` file. Many online journals have links to BibTeX citations that you can download and incorporate into the `ref.bib` file.

The order of the fields is unimportant. BibTeX will display them in the correct order when constructing your bibliography. Also note that you can specify information about a reference that may not even be included in the actual bibliography. For example, the ISBN field is not required by the bibliography, but you can, if you want, put the ISBN to the BibTeX entry.

We can cite a journal article [3] and a conference paper [2] in the same way as a book citation. More information can be found in [1].



# Chapter 6

## Conclusions

That's all folks!

# Bibliography