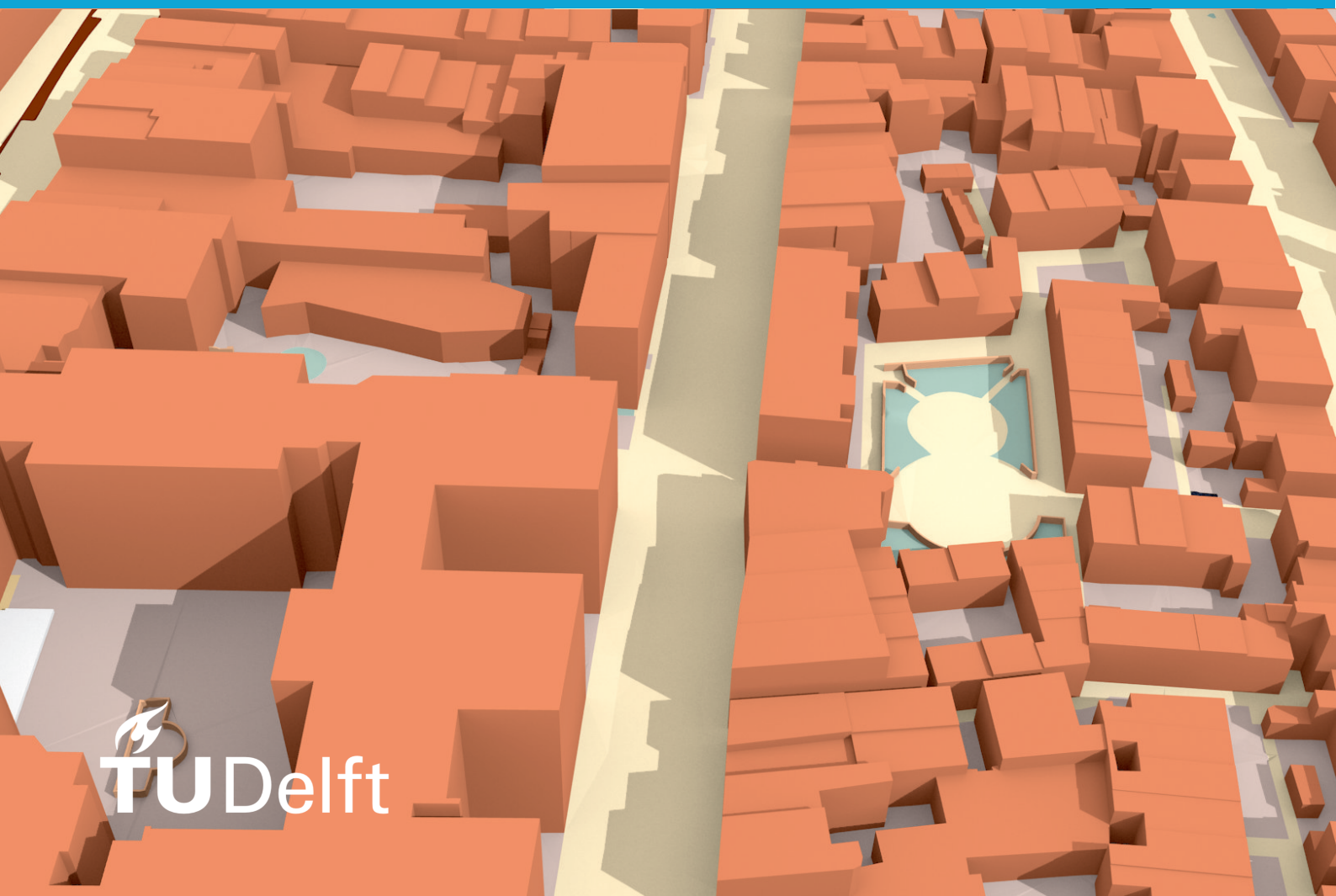
MSc thesis in Geomatics for the Built Environment

The optimal Delaunay triangulation of cheesy songs

Céline Dion

2016



TU Delft

MSc thesis in Geomatics

The optimal Delaunay triangulation of cheesy songs

Céline Dion

February 2020

A thesis submitted to the Delft University of Technology in partial fulfillment of the requirements for the degree of Master of Science in Geomatics

The work in this thesis was carried out in the:

3D geoinformation group
Department of Urbanism
Faculty of the Built Environment & Architecture
Delft University of Technology

Supervisors:	Prof.dr. Jan Smit
	Dr. Gerard Joling
Co-reader:	ir. Gordon Heuckeroth

Abstract

[Should fit on one page.]

Bacon ipsum dolour sit amet porchetta beef turkey, bacon turducken boudin hamburger venison ball tip. Brisket pork loin bresaola short loin ground round leberkas pastrami tongue jerky cow turducken beef ribs. Pork ribeye landjaeger prosciutto pig venison tenderloin. Swine beef ribs kielbasa, porchetta tenderloin salami venison pork belly tail. Bacon ipsum dolour sit amet porchetta beef turkey, bacon turducken boudin hamburger venison ball tip. Brisket pork loin bresaola short loin ground round leberkas pastrami tongue jerky cow turducken beef ribs. Pork ribeye landjaeger prosciutto pig venison tenderloin. Swine beef ribs kielbasa, porchetta tenderloin salami venison pork belly tail. Bacon ipsum dolour sit amet porchetta beef turkey, bacon turducken boudin hamburger venison ball tip. Brisket pork loin bresaola short loin ground round leberkas pastrami tongue jerky cow turducken beef ribs. Pork ribeye landjaeger prosciutto pig venison tenderloin. Swine beef ribs kielbasa, porchetta tenderloin salami venison pork belly tail.

Acknowledgements

Thanks to everyone, especially to my supervisors and my mum. And obviously to the ones who made that great template.

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...

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DT Delaunay triangulation 6
GIS geographical information system 6
TIN triangular irregular network 6

1 Introduction

This is a complete template for the MSc Geomatics thesis. It contains all the parts that are required and is structured in such a way that most/all supervisors expect. Observe that the MSc Geomatics at TU Delft has no formal requirements, how the document looks like (fonts, margins, headers, etc) is entirely up to you. We basically took the template `arsclassica` (by Lorenzo Pantieri), which is an adaption of the original `classicthesis` package from André Miede, added the front/back matters (cover page, copyright, abstract, etc.), and gave examples for the insertion of figures, tables and algorithms.

It is not an official template and it is not mandatory to use it.

But we hope it will encourage everyone to use LaTeX for writing their thesis, and we also hope that it will *discourage* some from using Word.

If you run into mistakes/problems/issues, please report them on the GitHub page, and if you fix an error, then please submit a pull request.

`https://github.com/tudelft3d/MScGeomaticsThesisTemplate`.

1.1 How to get started with LaTeX?

Basically everything you need to know—from installation to details—is there:
`http://en.wikibooks.org/wiki/LaTeX`

To compile this template, you need a full installation of either:

- MiKTeX (Windows);
- MacTeX (MacOS).
- TeXLive (Linux);

We suggest the following editors:

- TeXnicCenter (Windows);
- TeXShop (MacOS), which is bundled with MacTeX;

but any text editor will do.

1.2 Cross-references

The command `autoref` can be used for chapters, sections, subsections, figures, tables, etc.

Chapter 1 is what you are currently reading, and its name is Introduction. Section 1.9 is about pseudo-code, and Section 1.3.1 is about something else. The next chapter (Related work; title which can span multiple lines), is on page 7.

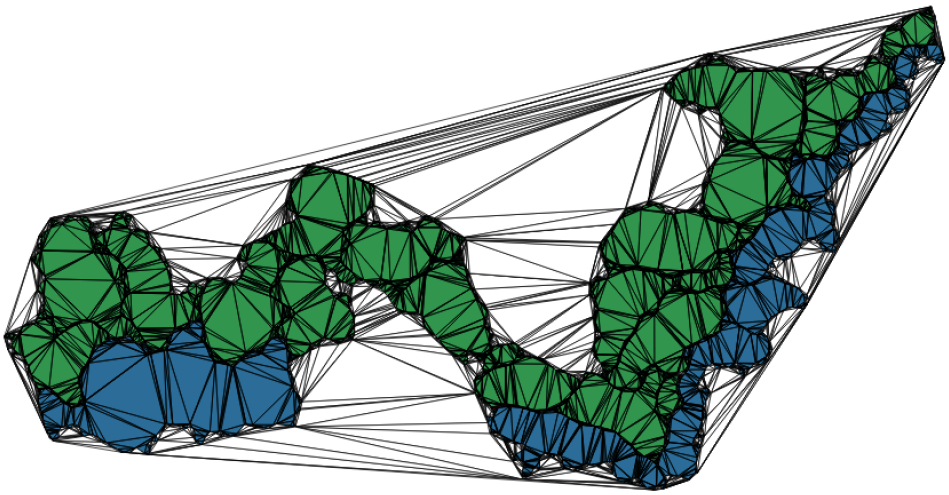
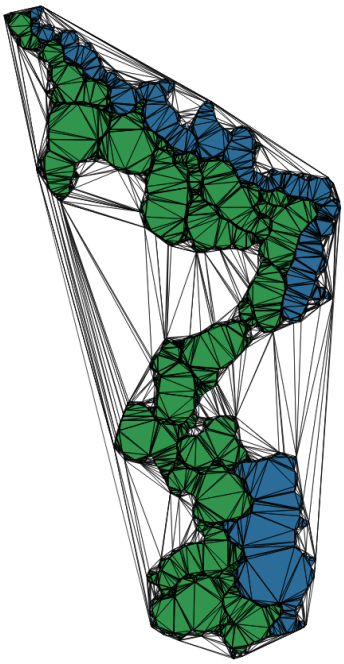


Figure 1.1: One nice figure

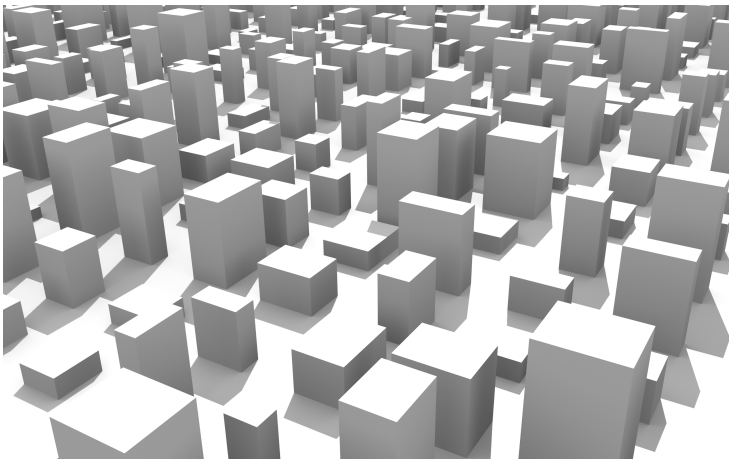
1.3 Figures

Figures 1.1 is a simple figure. Notice that all figures in your thesis should be referenced to in the main text. The same applies to tables and algorithms.

It is recommended *not* to force-place your figures (e.g. with commands such as:



(a)



(b)

Figure 1.2: Two figures side-by-side. (a) A triangulation of 2 polygons. (b) Something not related at all.

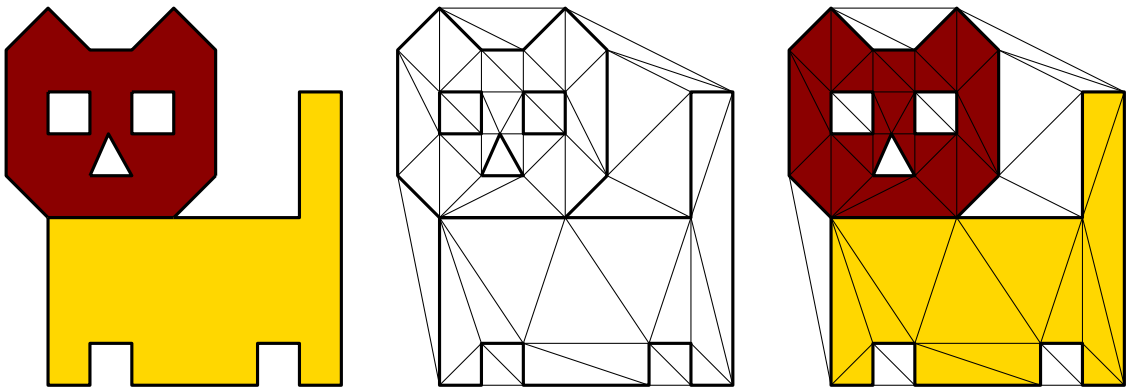
or by forcing a figure to be at the top of a page). LaTeX usually places the figures automatically rather well. Only if at the end of your thesis you have small problem then can you solve them.

As shown in Figure 1.2, it is possible to have two figures (or more) side by side. You can also refer to a subfigure: see Figure 1.2b.

1.3.1 Figures in PDF are possible and even encouraged!

If you use Adobe Illustrator or Ipe you can make your figures vectorial and save them in PDF.

You include a PDF the same way as you do for a PNG, see Figure 1.3,



(a) 2 polygons (b) CDT (c) with colours

Figure 1.3: Three PDF figures.

	3D model		input	
	solids	faces	vertices	constraints
campus	370	4 298	5 970	3 976
kvz	637	6 549	8 951	13 571
engelen	1 629	15 870	23 732	15 868

Table 1.1: Details concerning the datasets used for the experiments.

1.4 How to add references?

References are best handled using BibTEX. See the `myreferences.bib` file. A good cross-platform reference manager is JabRef.

Descartes [1637] wrote this and that [Voronoi, 1908; Delaunay, 1934]. Instead of citing the whole paper [Delaunay, 1934], it is also possible to cite only the authors (e.g. Delaunay).

1.5 Footnotes

Footnotes are a good way to write text that is not essential for the understanding of the text[1].

1.6 Equations

Equations and variables can be put inline in the text, but also numbered.

Let S be a set of points in $\mathbb{R}^d$. The Voronoi cell of a point $p \in S$, defined $\mathcal{V}_p$, is the set of points $x \in \mathbb{R}^d$ that are closer to p than to any other point in S; that is:

$$\mathcal{V}_p = \{x \in \mathbb{R}^d \mid \|x - p\| \leq \|x - q\|, \forall q \in S\}. \tag{1.1}$$

The union of the Voronoi cells of all generating points $p \in S$ form the Voronoi diagram of S, defined VD(S).

1.7 Tables

The package `booktabs` permits you to make nicer tables than the basic ones in LATEX. See for instance Table 1.1.

1.8 Plots

The best way is to use matplotlib, or its more beautiful version (seaborn). With these, you can use Python to generate nice PDF plots, such as that in Figure 1.4.

In the folder `./plots/`, there is an example of a CSV file of the temperature of Delft, taken somewhere. From this CSV, the plot is generated with the script `createplot.py`.

[1] but please do not overuse them

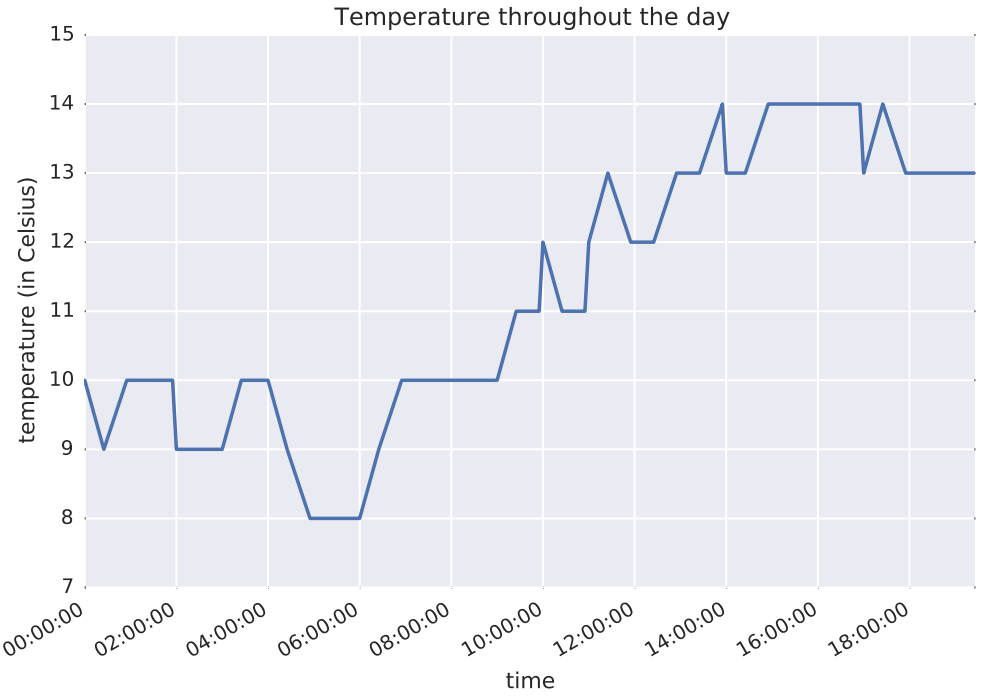


Figure 1.4: A super plot

1.9 Pseudo-code

Please avoid putting code (Python, C++, Fortran) in your thesis. Small excerpt are probably fine (for some cases), but do not put all the code in an appendix. Instead, put your code somewhere online (e.g. GitHub) and put *pseudo-code* in your thesis. The package `algorithm2e` is pretty handy, see for instance the Algorithm 1.1. All your algorithms will be automatically added to the list of algorithms at the begining of the thesis. Observe that you can put labels on certain lines (with) and then reference to

Algorithm 1.1: WALK ($\mathcal{T}$, τ, p)

Input: A Delaunay tetrahedralization $\mathcal{T}$, a starting tetrahedron τ, and a query point p
Output: τ_r: the tetrahedron in $\mathcal{T}$ containing p

```
1 while τ_r not found do
2     for i ← 0 to 3 do
3         σ_i ← get face opposite vertex i in τ;
4         if Orient(σ_i, p) < 0 then
5             τ ← get neighbouring tetrahedron of τ incident to σ_i;
6             break;
7     if i = 3 then
          // all the faces of τ have been tested
8         return τ_r = τ
```

them: on line 4 of the Algorithm 1.1 this is happening.

If you want to put some code (or XML for instance), use the package `listings`, e.g. you can wrap it in a Figure so that it does not span over multiple pages.

```
<gml:Solid>
  <gml:exterior>
    <gml:CompositeSurface>
      <gml:surfaceMember>
        <gml:Polygon>
          <gml:exterior>
            <gml:LinearRing>
              <gml:pos>0.000000  0.000000  1.000000</gml:pos>
              <gml:pos>1.000000  0.000000  1.000000</gml:pos>
              <gml:pos>1.000000  1.000000  1.000000</gml:pos>
              <gml:pos>0.000000  1.000000  1.000000</gml:pos>
              <gml:pos>0.000000  0.000000  1.000000</gml:pos>
            </gml:LinearRing>
          </gml:exterior>
          <gml:interior>
          ...
      </gml:surfaceMember>
    </gml:CompositeSurface>
  </gml:interior>
</gml:Solid>
```

Figure 1.5: Some GML for a `gml:Solid`.

1.10 Acronyms

If you want to have a list of acronyms you use in your thesis, use the `acronym` package. The first time you speak about geographical information system (GIS), it will be spelled out. Further use, GIS, you'll get the acronym plus a hyperlink to the list in the preambule of the thesis.

Add yours to `front/acronyms.tex`. Notice that only these used are printed, e.g. Delaunay triangulation (DT) and triangular irregular network (TIN).

1.11 Miscellaneous

In the file `mysettings.tex`, there are some handy shortcuts. This is the way to properly write these abbreviations, i.e. so that the spacing is correct.

You should use one - for an hyphen between words ('multi-dimensional'), two -- for a range between numbers ('1990–1995'), and three --- for a punctuation in a sentence ('I like—unlike my father—to build multi-dimensional models').

2 Related work; title which can span multiple lines

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A Reproducibility self-assessment

A.1 Marks for each of the criteria

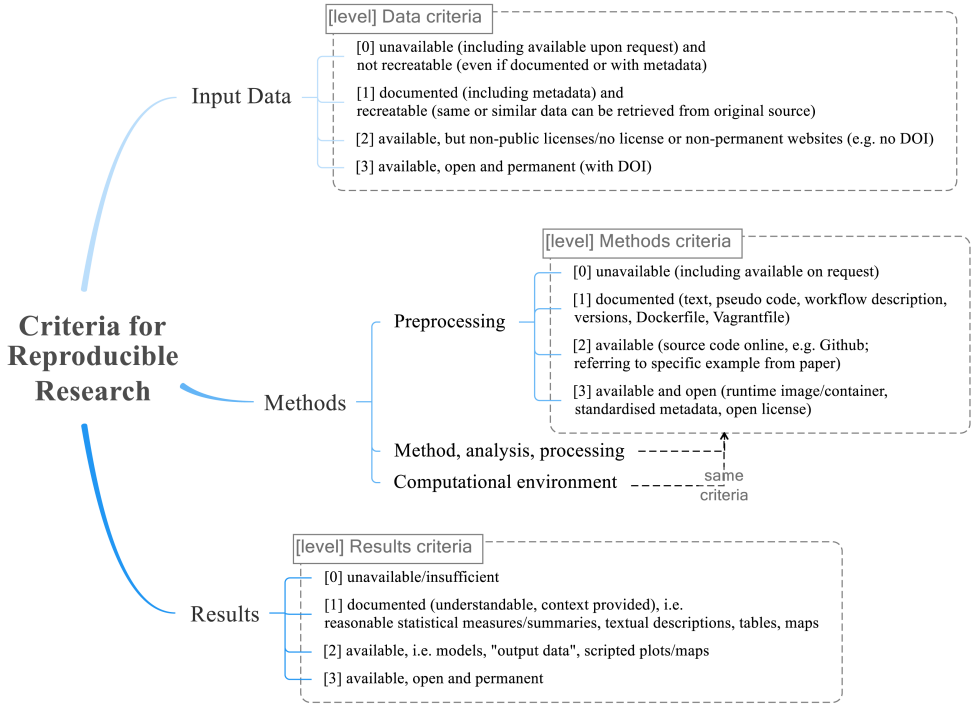

Figure A.1: Reproducibility criteria to be assessed.

Grade/evaluate yourself for the 5 criteria (giving 0/1/2/3 for each):

1. input data
2. preprocessing
3. methods
4. computational environment
5. results

A.2 Self-reflection

A self-reflection about the reproducibility of your thesis/results.

We expect maximum 1 page here.

For example, if your data are not made publicly available, you need to justify it why (perhaps the company prevented you from doing this).

B Some UML diagrams

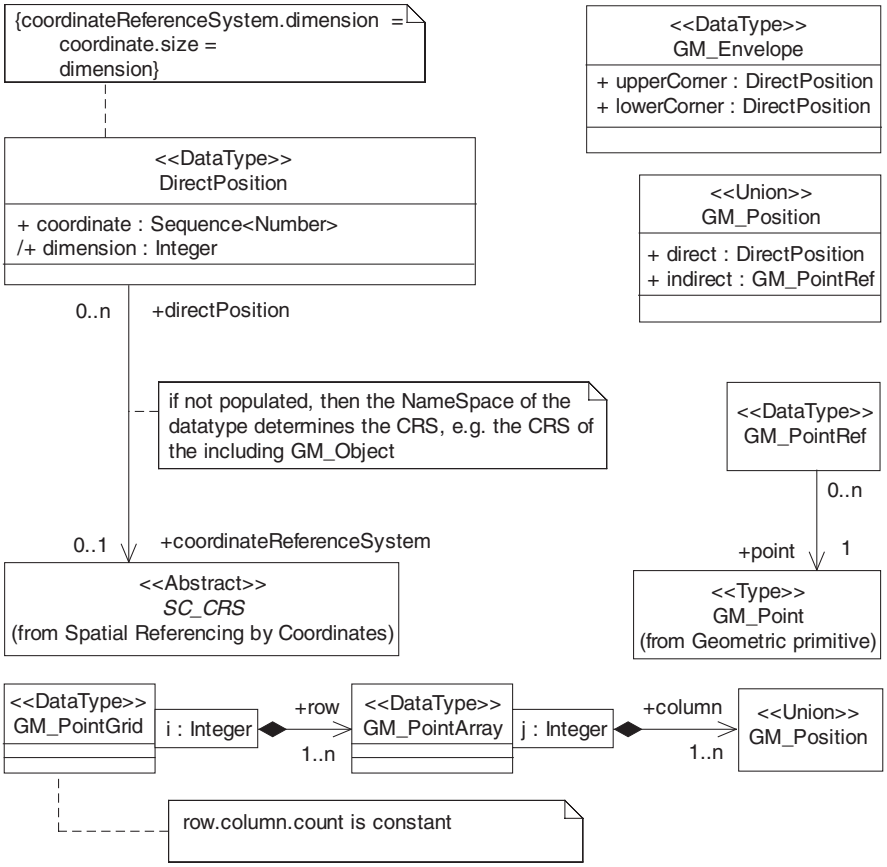

Figure B.1: The UML diagram of something that looks important.

Bibliography

Delaunay, B. N. (1934). Sur la sphère vide. *Izvestia Akademia Nauk SSSR, Otdelenie Matematicheskii i Estestvennyka Nauk*, 7:793–800.

Descartes, R. (1637). *Discours de la méthode*. Jan Maire, Leyde.

Voronoi, G. M. (1908). Nouvelles applications des paramètres continus à la théorie des formes quadratiques. *Journal für die Reine und Angewandte Mathematik*, 134:198–287.

Colophon

This document was typeset using LaTeX, using the KOMA-Script class `scrbook`. The main font is Palatino.