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On the Optimization and Uncertainty Quantification of Groundwater Models



Master's Thesis

On the Optimization and Uncertainty Quantification of Groundwater Models

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Author declaration

I declare that I have developed and written the enclosed thesis completely by myself and that I have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked.

The thesis was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

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Date

Signature

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1 First Chapter

This test sentence is supposed to span more than one line. Or maybe, we need another sentence for this. And why, you ask, do we need several lines at all? Well, to test the line spacing, of course! Let's have a citation [1] and another one here [2].

We can have enumerations:

1. First important item.
2. Second important item.

and lists:

- Item one.
- Item two.

or how about a description:

big is the opposite of small.

small is the opposite of big.

A mini section

Gives you a small heading that isn't separated too much from the previous text. This section is not part of the index. Please have a look at table 1.1 on page 1. Alternatively, we can use 'vref' to expand a reference automatically, if necessary: see table 1.1. See the 'vref' documentation for more handy reference options.

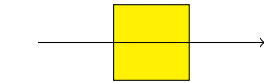
Talking about references, just use 'vref' all the time, also for equations. The package 'amsmath' defines 'eqref' which automatically returns parentheses around the equation number, but in this document we have defined 'vref' to do the same. See equation (1.1) on page 5.

1.1 Equations

The 'amsmath' package provides several environments for equations. For each environment, there is also a starred version that does not use automatic numbering. For a single

This	is	an	example.
Just	useless	content	here.

Table 1.1: An example table.



(a) The first subfigure



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(b) The second subfigure

Figure 1.1: A figure with two subfigures

equation that spans a single line use the ‘equation’ environment:

$$x^2 + y^2 = r^2 \quad (1.1)$$

‘gather’ is used for several equations that should not be aligned:

$$x^2 + y^2 = r^2 \quad (1.2)$$

$$r = 1 \quad (1.3)$$

‘align’ is used for several equations that should be aligned:

$$r^2 = x^2 + y^2 \quad (1.4)$$

$$r = 1 \quad (1.5)$$

If one of your equations gets too long, check out the ‘multiline’ (no alignment) and ‘split’ environments (with alignment). These environments don’t enumerate each line of the equation (which could be suppressed using ‘\notag’).

1.2 Figures

In general use floating figures with the ‘figure’ environment. See this article for an explanation of how Latex places floating figures. If you want to display two figures or tables next to each other, you either need to use minipages (see the ‘subcaption’ docs) or the ‘subfigure’ and ‘subtable’ environments. Of course, we can now again reference both subfigures 1.1a and 1.1b, as well as the whole figure 1.1.

When defining the width of figures, the following lengths may be useful:

\linewidth The width of a line in the *current* environment.

\columnwidth The width of a column (in a multi-column document).

\textwidth The width of the text on the page.

\paperwidth Self-explanatory.

If you use inkscape for your images you may want to use the ‘svg’ file format. Have a look at the ‘svg’ package to do so - it has some nice features. One of them is to automatically save the rendered vector image in the same size as, e.g., a pdf file. This is

```

1 for i in range(10):
    print('Look, a number: %i' % i)

```

Listing 1.1: A simple Python program.

handy, because it allows you to give a copy of a figure of the exact same size as in your document to someone else.

1.3 Source Code Listings

The ‘listings’ package provides syntax highlighting for source code. It allows you to include an external file, you can use inline code (`sqrt(x.^2)`) or use its environment ‘lstlisting’:

```

1 for i = 1:10
2     fprintf('Look, a number: %i\n', i);
end

```

A simple MATLAB program.

It is probably better to use a floating environment for bigger listings, like the Python code example 1.1. Also, in the Matlab example we didn’t set a caption, but a title. This means that it is not listed in the list of listings and that it does not receive a code listing number.

A chapter that does not get enumerated

This chapter is part of the index, but is not enumerated.

And another equation in a new chapter - obviously, because the chapter is not enumerated it fucks up the numbering as the scheme is (chapter__number.equation__number):

$$\sin(\alpha)^2 + \cos(\alpha)^2 = 1 \tag{1.1}$$

So if you really need unnumbered chapters with equations the easiest way to fix this may be to use consecutive equation numbers. See the source and uncomment the ‘chngcntr’ package.

And here we have a reference to an equation from the previous chapter: equation (1.1) on page 2. When using the ‘hyperref’ package, clicking on the reference should send you to the correct equation.

Test.

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Bibliography

- [1] Rudolph Emil Kalman. A new approach to linear filtering and prediction problems. *Journal of basic Engineering*, 82(1):35–45, 1960.
- [2] Wolfgang Nowak, Sascha Tenkleve, and Olaf A Cirpka. Efficient computation of linearized cross-covariance and auto-covariance matrices of interdependent quantities. *Mathematical geology*, 35(1):53–66, 2003.