

Thesis title

by Mohammad Amin Hasanpour

PhD Thesis



Thesis title

by Mohammad Amin Hasanpour

PhD Thesis

January, 2026

By

Mohammad Amin Hasanpour

Copyright: Reproduction of this publication in whole or in part must include the customary bibliographic citation, including author attribution, report title, etc.

Cover photo: Vibeke Hempler, 2012

Published by: DTU, Department of Applied Mathematics and Computer Science,
Richard Petersens Plads, Building 322, 2800 Kgs. Lyngby Denmark
www.compute.dtu.dk

ISSN: [0000-0000] (electronic version)

ISBN: [000-00-0000-000-0] (electronic version)

ISSN: [0000-0000] (printed version)

ISBN: [000-00-0000-000-0] (printed version)

English Abstract

English abstract goes here.

Dansk Abstrakt

Danish abstract goes here.

Acknowledgements

Acknowledgements go here.

Tool Acknowledgements

In writing this thesis, I have been making use of Generative AI services such as Grammarly and ChatGPT to improve writing and make grammatical corrections.

Contents

English Abstract	ii
Dansk Abstrakt	iii
Acknowledgements	iv
1 Introduction	1
1.1 This is a section	1
1.2 Font and symbols test	1
2 Colours	3
3 Examples of figures, tables, equations and listings	5
3.1 Graphs and charts	5
3.2 Tables and figures	8
3.3 Equations	10
3.4 Listings (code)	11
Bibliography	13

1 Introduction

This template complies with the DTU Design Guide <https://www.designguide.dtu.dk/>. DTU holds all rights to the design programme including all copyrights. It is intended for two-sided printing. The `\cleardoublepage` command can be used to ensure that new sections and the table of contents begins on a right hand page. The back page always ends as an odd page.

All document settings have been gathered in `Setup/Settings.tex`. These are global settings meaning the settings will affect the whole document. Defining the title for example will change the title on the front page, the copyright page and the footer. A watermark can be enabled or disabled in `Setup/Preamble.tex`. You can edit the watermark to display draft, review, approved, confidential or anything else. By default the watermark is printed on top of the contents of the document and has a transparent grey colour.

1.1 This is a section

Every chapter is numbered and the sections inherit the chapter number followed by a dot and a section number. Figures, equations, tables, ect. also inherit the chapter numbering.

1.1.1 This is a sub section

Sub sections are also numbered. In general try not to use a deep hierarchy of sub sections (`\paragraph{}` and the like). The document will become segmented which will make the document appear less coherent.

This is a sub sub section

And those are not numbered. It is possible to adjust how deep hierarchy of numbering sections goes in `Setup/Settings.tex`.

The front and back cover have been made to replicate the examples in the design guide <https://www.designguide.dtu.dk/#stnd-printmedia>. The name of department heading is omitted because it is located in the top right corner (no need to write it twice). Take a look at <https://www.inside.dtu.dk/en/medarbejder/om-dtu-campus-og-bygninger/kommunikation-og-design/skabeloner/rapporter> if you want to make your cover separately.

Citing is done with the `biblatex` package [1]. Cross referencing (figures, tables, ect.) is taken care by the `cleveref` package. Just insert the name of the label in `\cref{}` and it will automatically format the cross reference. For example writing the `cleveref` command `\cref{fig:groupedcolumn}` will output "fig. 3.3". Using `\Cref{}` will capitalise the first letter and `\crefrange{...}{...}` will make a reference range. An example: Figure 3.2 is an example of a stacked bar chart and figs. 3.1 to 3.3 are three consecutive figures.

1.2 Font and symbols test

Symbols can be written directly in the document meaning there is no need for special commands to write special characters. I love to write special characters like æøå inside my `TEX` document. Also á, à, ü, û, ë, ê, î, ï could be nice. So what about the “¿” character. What about ° ª ® † ¥ ü | œ ‘ @ ö ä ¬ « © f ß ª ... ç ñ µ , · ¡ “ £ ™ [] ” . Some dashes -- —, and the latex form - — —

This is a font test

Arial Regular

Arial Italic

Arial Bold

Arial Bold Italic

2 Colours

The design guide define 3 primary colours (dtured, white and black) and 10 secondary colours <https://www.designguide.dtu.dk/#stnd-colours>. Below are codes for the various colour modes. RGB is used for web and Office Programmes. CMYK is used for print. HTML is used for HTML-coding. If you know anything about colour codes you might notice that the RGB codes are ranging from 0-1 instead of the usual 0-255.

color	rgb	cmyk	HTML
dtured	[Color Box]	0 0.91 0.72 0.23	C4000D
white	[Color Box]	0 0 0	FFFFFF
black	[Color Box]	0 0 0 1	000000
blue	[Color Box]	0.12 0.24 1	1F3DFF
brightgreen	[Color Box]	0.31 1 0.34	4FFF57
navyblue	[Color Box]	0 0 0.4	000066
yellow	[Color Box]	0.95 0.83 0.18	F2D42E
orange	[Color Box]	1 0.35 0.14	FF5924
pink	[Color Box]	1 0.65 0.74	FFA6BD
red	[Color Box]	1 0.14 0.35	FF2459
green	[Color Box]	0 0.78 0	00C700
purple	[Color Box]	0.33 0.04 1	540AFF

The default colour mode for this template is cmyk. The current colour model is cmyk which is also illustrated by the underlined numbers in the colour test table above. If you which to change the colour model to rgb go to `Setup/Settings.tex` and change `targetcolourmodel` to `rgb`. In `Setup/Settings.tex` it is also possible to change the background colour of the front and back page. The colours are primarily used for diagrams (the `plotcyclelist DTU`) and the front and back page.

Lighter colours can be achieved as written in the \LaTeX code below. For example to get a tint of 50% you would write `colourname!50`.

Normal dtured 80% dtured 70% dtured 60% dtured 50% dtured

For more information about colours in \LaTeX read the `xcolor` manual.

3 Examples of figures, tables, equations and listings

In the following a bunch of examples of figures and tables have been made. There are advantages to using `tikZ` diagrams over excel diagrams. 1) the font and font size perfectly matches the document 2) the styling and colours are pre-defined to follow the design guide 3) the plots uses vector graphics which reduces the file size, reduces the compile time and looks sharp when zooming in. The possibilities are endless, look at the `pgfplots` gallery for inspiration: <http://pgfplots.sourceforge.net/gallery.html>. However there are still cases where I would recommend to insert a plot as a picture. For example if the plot contains a lot of data: a line graph with 1000 points takes a long time to compile.

Some tips if you want good looking diagrams or graphs which will be inserted as pictures (e.g. in a figure environment with `\includegraphics`): The main font is Arial. Use DTU colours as described in chapter 2. Use high quality pictures. Try to scale the diagram (picture) so the text size of the axis legends match the text size in this document.

Remember to change the label of your figures so there are no duplicate labels. A label should be placed below a caption or after a heading (fx after a `\chapter`).

3.1 Graphs and charts

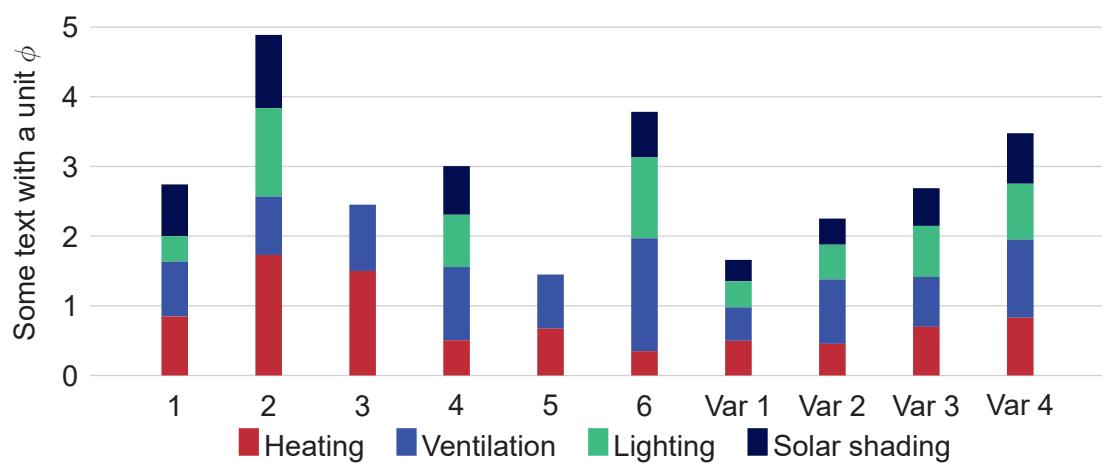


Figure 3.1: Stacked column chart

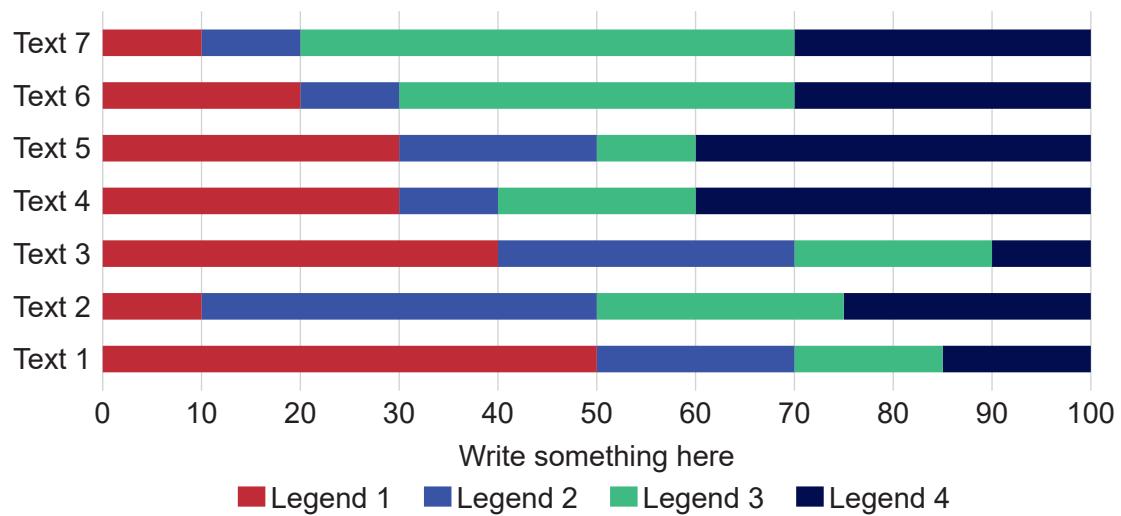


Figure 3.2: Stacked bar chart

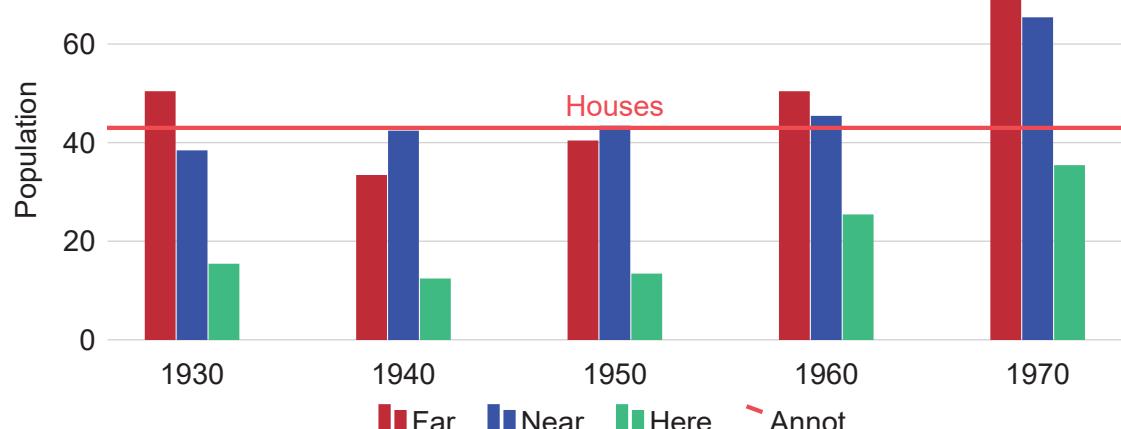


Figure 3.3: Grouped column chart

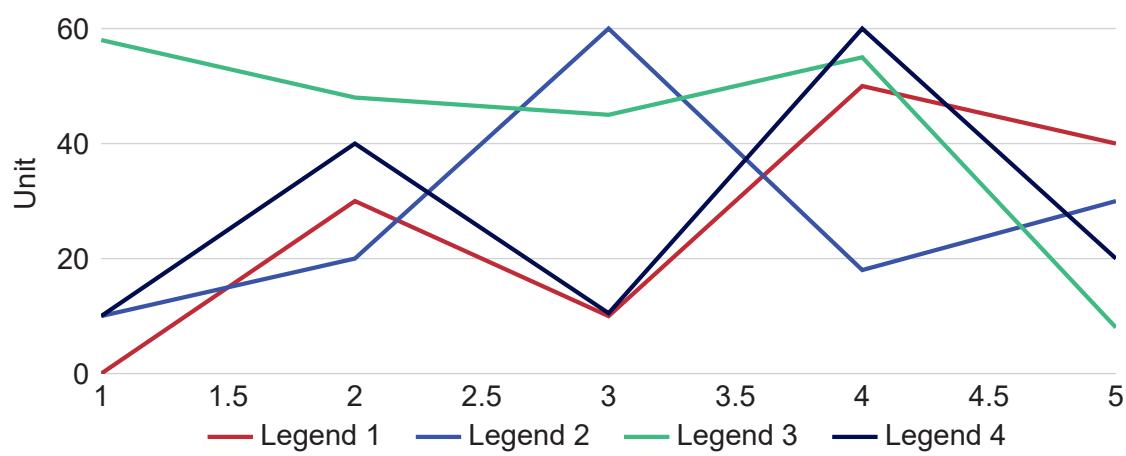


Figure 3.4: Line graph

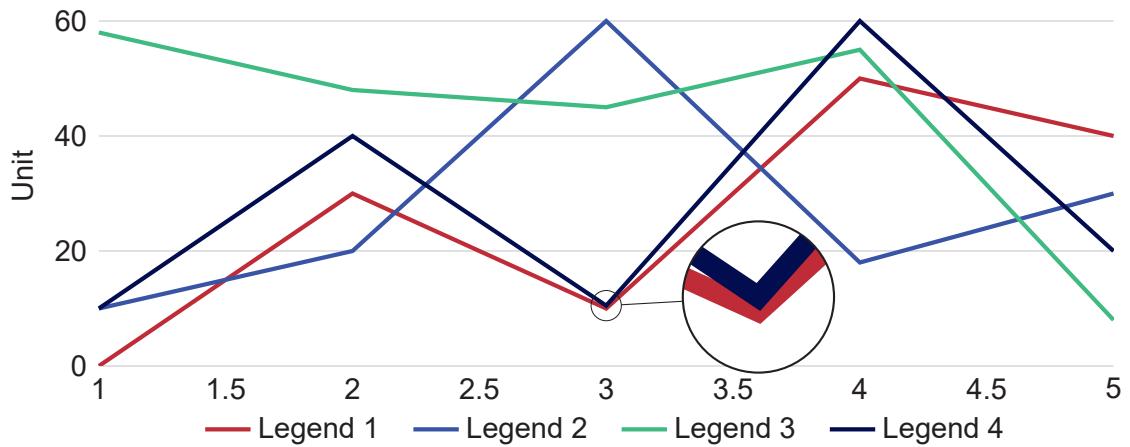


Figure 3.5: Line graph with magnifying glass

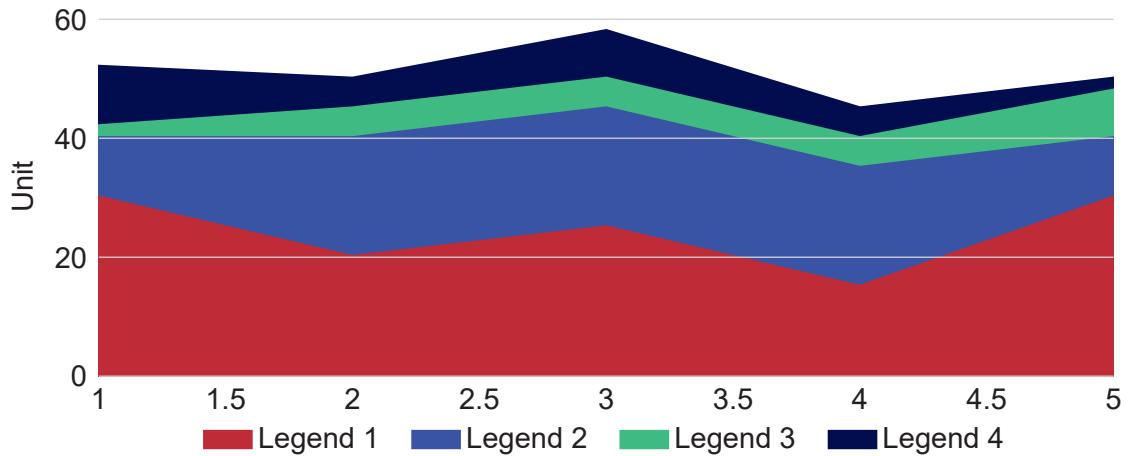


Figure 3.6: Area graph

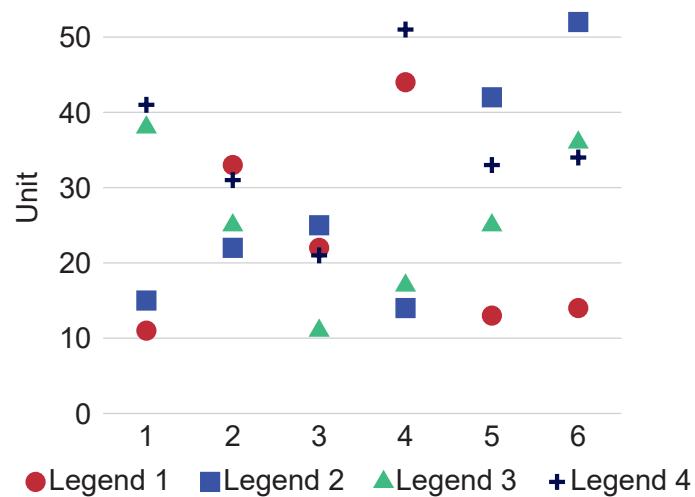


Figure 3.7: Scatter plot

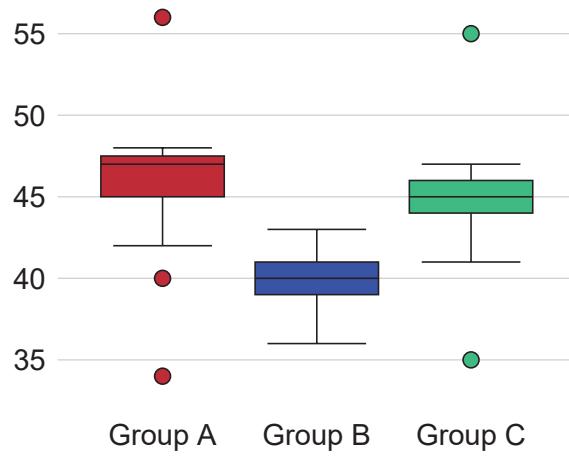


Figure 3.8: Boxplot

3.2 Tables and figures

Table 3.1: This is a booktabs table. Go to <http://www.tablesgenerator.com/> and use the booktabs table style

Item		
Animal	Description	Price (\$)
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

Booktabs tables don't use any vertical lines. Only horizontal lines are used. Table 3.1 begins with a \toprule, ends with a \bottomrule with \midrule in between. The table has 3 columns formatted as @{}l1S@{.}. @{} is cropping the horizontal lines of the table to fit the content (removes column spacing at the left and right edges). l aligns the column to the left and S aligns the column according to the decimal point (siunitx package). You can of course also use r to align right or c to center the contents of the column.

Table 3.2: Wrongly formatted table

	Voltage V	Current A	Power W
Transformer input	234.4	0.50	117.4
Transformer output	25.86	2.72	70.3
Efficiency	60%		

Table 3.3: Correctly formatted table

	Voltage V	Current A	Power W
Transformer input	234.4	0.50	117.4
Transformer output	25.86	2.72	70.3
Efficiency	60 %		

Table 3.2 and table 3.3 have the same contents but there are some subtle differences in formatting which makes table 3.3 the superior table of the two. The most obvious change is removing the midrule between the transformer input and output rows. The efficiency row is the odd man out and a midrule has been used to emphasise the difference between the transformer rows and the efficiency row. The delimiters in the voltage, current and power columns are aligned. The horizontal lines (rules) fits to the content and instead of protruding. The spacing between 60 and the percentage sign is correctly adjusted.



Figure 3.9: Just a normal figure



(a) A subfigure



(b) A subfigure

Figure 3.10: A figure with two subfigures



(a) A subfigure



(b) A subfigure



(c) A subfigure



(d) A subfigure

Figure 3.11: A figure with four subfigures

Referring to the figure as a whole fig. 3.11 or to an individual sub figure fig. 3.11a is done the normal way with `\cref{}` commands.

3.3 Equations

In-line math is easy. Anything surrounded by dollar signs becomes a math field. Here is an example: $f(x) = 2x - 1$. Also anything inside the “`\begin{equation}`” and “`\end{equation}`” environment is also a math field. Examples are shown below.

All equations use the default latex font. Some might say it looks weird with a serif font for equations and a sans-serif font for the body text. However, it is very unpractical to change the math font in latex which is the exactly the reason why this has not been done. One benefit of the serif style math font is the clear distinction between symbols (variables) and units.

On the subject of units, those are all taken care of by the `\siunitx` package. Whenever there is a number followed by a unit one should write `\SI[number]{unit}`. Note this command is case sensitive. If a unit should follow a variable use the command `\si{unit}` (also case sensitive).

The ideal gas law is shown in eq. (3.1).

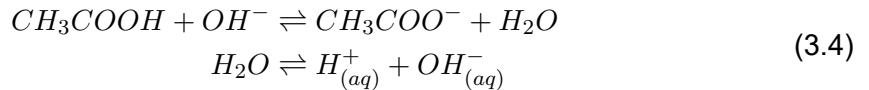
$$p \cdot V = n \cdot R \cdot T \quad (3.1)$$

$$\frac{\partial}{\partial t} \int_0^\delta U dy = -\delta \frac{1}{\rho} \frac{\partial P}{\partial x} - U_f(t)^2 \quad (3.2)$$

$$d_{step} = \sqrt{\frac{\delta}{\frac{dw}{dp_v}} \cdot t} = \sqrt{\frac{1.0 \times 10^{-11} \text{ kg}/(\text{m s Pa})}{\frac{5.4 \text{ kg/m}^3}{233.82 \text{ Pa}}} \cdot 7200 \text{ s}} = 0.001766 \text{ m} = 1.766 \text{ mm} \quad (3.3)$$

$x = \mathbf{x}, \mathbf{X}, \mathbf{x}, x_{1_{2_{3_4}}}^{1^{2^{3^4}}} \cdot \text{hello} * \text{hello world} \cdot \text{equation without number}$

Notice how the `aligned` environment can be used to align the equilibrium arrows in eq. (3.4). Only one equation number is generated using this method. Alternatively if you want an equation number for each line see eqs. (3.5) to (3.6).



$$f(x) = 1 + x - 3x^2 \quad (3.5)$$

$$g(x) + y = 3x - \frac{1}{2}x^3 \quad (3.6)$$

3.4 Listings (code)

Listing 3.1 is a nicely formatted block of code. A listing will automatically continue on the next page if it encounters a page break. Many different programming languages can be highlighted. Check the `listings` package documentation for a list of supported programming languages.

```

1 %% Monte Carlo simulation, estimation of pi
2 m=1E7;
3
4 x=rand(m,1);
5 y=rand(m,1);
6
7 g = x.^2+y.^2-1;
8
9 %dots outside
10 Pf = sum((g)<=0)/m
11
12 pi = 4*Pf

```

Listing 3.1: Monte Carlo simulation to estimate the value of π

Bibliography

- [1] Philipp Lehman et al. *Biblatex – Sophisticated Bibliographies in LaTeX*. 2018. URL: <https://www.ctan.org/pkg/biblatex>.

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Technical
University of
Denmark

Richard Petersens Plads, Building 322
2800 Kgs. Lyngby
Tlf. 45 25 17 00

www.compute.dtu.dk