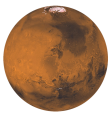
Mars Center for Outstanding Developments 

The title of the project

The subtitle of the project

N.B.: Here you can add a brief summary of your project such that someone can quickly see what it is about, do not spend more than two lines on it.

Maintainer:
Maya Toitovna (*mtoitovna*), Mars Center for Outstanding Developments

Contributors:

Maya Toitovna	(*mtoitovna*),	Mars Center for Outstanding Developments
Frank Chalmers	(*fchalmers*),	Mars Institute of Technology
Ann Clayborne	(*aclayborne*),	Mars Laboratory for Great Achievements
Arkady Bogdanov	(*abogdanov*),	Mars University of Fundamental Research

Contents

1 Overview

This document shows an example of how to use the `project-logbook` LaTeX class. This class is based upon the `article` class and may be used together with other packages for additional functionality. This class implements functionality for simplifying writing project/research logbooks and unifying its layout. We will go over the different functionalities to display how to use them.

1.1 Preamble

In the preamble of the document you may set several parameters of this document.

1.1.1 Maintainer and contributors

Everyone who contributes to this document, should be added as a contributor. In this way it is know who contributed and we can also use this to identify who added some elements. Adding a contributor is done with `\CreateContributor{<key>}{<name>}{<id>}{<affiliation>}`, where

`<key>` is the shorthand used to internally identify a contributor and to retrieve its data, this should be a short word without special characters.

`<name>` is the full name of the contributor to display on the front page (but may also be used in other situations if desired).

`<id>` is the abbreviation of the contributor name, to display when associating the contributor to a note (see below) or a meeting minutes box (see below).

`<affiliation>` is the affiliation of the contributor, mainly to display on the front page.

This document is maintained by a unique maintainer, which is automatically defined as a contributor with key `maintainer`. The maintainer can be set in the preamble with `\SetMaintainer{<name>}{<id>}{<affiliation>}`. The meaning of the different input parameters is identical to what was seen above for the contributor.

The maintainer name, id, and affiliation can be accessed via the commands `\MaintainerName`, `\Maintainerid` and `\MaintainerInsitution`, which for this case gives: Maya Toitovna (name), mtoitovna (id), and Mars Center for Outstanding Developments (affiliation).

In a similar way, a contributor can be accessed via the commands `\ContributorName{<key>}`, `\Contributorid{<key>}`, and `\ContributorInstitution{<key>}`, which for this case gives (for key `chalmers`): Frank Chalmers (name), fchalmers (id), and Mars Institute of Technology (affiliation).

1.1.2 Project title, subtitle, and header name

The project title (which appears in the center of the front page) can be set in the preamble of the document with `\SetProjectTitle{<title>}`, where `<title>` is the title we wish to set.

Below the project title we can have a project subtitle, which can also be set in the preamble of the document with `\SetProjectSubtitle{<subtitle>}`, where `<subtitle>` is the subtitle we wish to set.

1.1.3 Maintainer institution logo

On the top right corner of the front page you can add the logo of the institution of the maintainer. This can be done in the preamble with the command `\SetInstitutionLogo{<path_to_file>}`, where `<path_to_file>` is the path to a .pdf or .png file. If you do not want to show a logo, use a white figure.

1.2 Body

The front page is generated with the command `\MakeFrontPage`. This automatically adds the table of contents on the second page of the document, with direct links to the sections, for quick access.

One important section is the Meetings section, which is subdivided into External and Internal. The External subsection contains the minutes of the meetings with external partners and the Internal sections contains the internal meetings associated to the institution of the Maintainer. Any contributor (including the maintainer) can be an author of Meeting minutes.

Following the Meetings section, any number of sections can be added focussing on specific topics. The goal of these is to discuss the current state of the development of a particular part of the project. More discussed below.

Following these sections, there is an Appendix, containing the list of references (papers to use as reference later when writing a paper), a list of resources such as a link to a video presentation, a tutorial, or something else that is less formal than a reference. In the end, you have a list of TODOs that have been defined in the document. They appear in the order in which they appeared in the document, not by writing date.

2 Meetings

2.1 External

2022-05-15: aclayborne

This is what happened in the meeting.

$$\int_{\Omega} \varphi(x)\,\mathrm{d}x \tag{2.1}$$

Quisque ullamcorper placerat ipsum. Cras nibh. Morbi vel justo vitae lacus tincidunt ultrices. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. In hac habitasse platea dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi. Aenean placerat. Ut imperdiet, enim sed gravida sollicitudin, felis odio placerat quam, ac pulvinar elit purus eget enim. Nunc vitae tortor. Proin tempus nibh sit amet nisl. Vivamus quis tortor vitae risus porta vehicula.

2022-05-11: abogdanov

We discussed that the `MeetingMinutes` environment produces alternating background colours for easier visualisation.

$$\int_{\Omega} \varphi(x)\,\mathrm{d}x \tag{2.2}$$

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

We can anything inside meeting minutes, including (high priority) todo notes inside the minutes on the same day (or any other day), see Section **??** for more details.

2022-05-10, **fchalmers**: Compute the error between mode-downsampled segmentation state vectors at 1000 Hz and state vectors computed at 400 Hz. This needs to be performed to check that the segmentation algorithm is not overfitted to 1000Hz. If error is significant, retrain segmentation at 400 Hz or use 1000 just for segmentation (if Matlab 2022a improvements are true there should be no problem)

or a (low priority) todo note by another contributor, for example

2022-05-12, **aclayborne**: Do not forget to first check this less important aspect.

2022-05-10: fchalmers

This time, these meeting minutes, were written by the contributor Frank Chalmers, as can be seen by the id fchalmers on the header of the box.

During this meeting the following points have been addressed

- This first very important point.
- Followed by this second also important point.
- This other less important point was also discussed at the end.

For this meeting this equation was important

$$\int_\Omega \varphi(x)\,\mathrm{d}x\,. \tag{2.3}$$

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Meeting minutes boxes can extend over to the next page (or more) if needed.

We can also list some things to do and highlight the ones already done, as they are done:

- First task is done.
- Second task still needs to be done.

2022-05-09: mtoitovna

This first meeting's minutes were added by Maya Toitovna (the maintainer of this project logbook), as can be seen by the id mtoitovna on the header of the box.

In this first meeting the following equation was discussed

$$\int_\Omega \varphi(x)\,\mathrm{d}x\,. \tag{2.4}$$

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

2.2 Internal

2022-05-15: fchalmers

You can also add internal meetings when the participants are only from your group, no external people are involved.

$$\int_\Omega \varphi(x)\,\mathrm{d}x\,. \tag{2.5}$$

Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla.

Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

3 Topic A to focus on

We can use sections organize the text into different parts such that specific topics are addressed in their own section.

Sections always start at the top of a new page in order to generate clearly separated parts of the document. In this first section (Overview) one should introduce what this project is about, in a high level so you can do a simple explanation of the topic and the research challenges, who is involved, etc.

Since this information is important, we have added it within a `HighlightedNote` environment. This is the version without a title.

You can add multiple things inside a `HighlightedNote`

And this is the version with a title. You can use the title for example if you want to clearly state what is is, or if you want to make a larger note and give an idea of what it is about.

You can add equations to clarify your ideas

$$e^{i\pi} + 1 = 0 \tag{3.1}$$

Some tables

	A	N	S	A/S
a	292	117	409	0.714
b	104	386	490	0.212
c	24	7	31	0.774
d	28	27	55	0.509
e	183	1958	2141	0.085
	631	2495	3126	0.202

and other elements.

With a fancy title

The `HighlightedNotes` environment that generates these fancy boxes, can be used with a title `\begin{HighlightedNotes}{the_title_text}`, as in this case, or without a title `\begin{HighlightedNotes}{}`, as in the previous case.

3.1 A subsection

You can subdivide your section in a finer level using `\subsection`.

3.1.1 A subsubsection

The subsections can be subdivided with `\subsubsection`.

3.1.1.1 A subsubsubsection

And an additional level was added to subdivide subsubsections named `\subsubsubsection`. This should give more than enough subdivision levels to your text for fine grained organisation.

In most Machine Learning research projects you will be using some kind of samples from a Dataset to learn a model. Thus it is extremely important that you carefully describe the dataset and why you believe is a good dataset for the project and what type of preprocessing are you going to apply.

As usual, you can use your references to cite relevant articles as [**einstein**] and [**knuth-fa**].

You can use tables and, of course, make references to them, like the amazing Table 3.1.

	A	N	S	A/S
a	292	117	409	0.714
b	104	386	490	0.212
c	24	7	31	0.774
d	28	27	55	0.509
e	183	1958	2141	0.085
	631	2495	3126	0.202

(a) Training Set

	A'	N'	S'	A'/S'	S'/S
a	40	40	80	0.5	0.20
b	49	49	98	0.5	0.20
c	4	3	7	0.57	0.23
d	5	5	10	0.5	0.18
e	53	53	106	0.5	0.05
	151	150	301	0.50	0.10

(b) Validation Set

Table 3.1: Population properties $A \equiv$ Abnormal, $N \equiv$ Normal, $S \equiv A + N$

3.2 Another subsection

Relevant equations can be added

$$x_i' \leftarrow \frac{x_i - \bar{x}}{\sigma} \tag{3.2}$$

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i \qquad \sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x}) \tag{3.3}$$

Strike-through

Often you will be wrong on your assumptions, but do not throw them away completely, just cross them out in case you need them later using the `\sout` command and it will look like ~~this~~ or `\soutthick` command and it will look like ~~this~~

~~Medoid computation is perfomed at $f_s'' = f_s'/5 = 200\,\text{kHz}$ to speed computation. Simple analysis was performed to check that the features extracted from these 200Hz-medoids were approximately the same as the ones extracted from the 1khz-medoids.~~

~~Downsampling can be seen as a problem of information loss in the frequency spectrum. If the frequency content $f > f_s/(2N)$ is mostly empty for N when we downsample by said N we will only be losing information in that range.~~

TODOs

You will often have pending tasks that you need to track. This project logbook allows you to include both high and low priority todos that will be summarised in a list at the end of the file. Use the commands `\hightodo{<date_added>}{<author_key>}` and `\lowtodo`, including a date is recommended for tracking purposes.

Note: define your `userId` in the preamble

2016-05-23, **fchalmers**: Try the code in the newest version of numpy compiled with optimized BLAS.

2016-05-27, **mtoitovna**: Perform convergence analysis with the latest version of the code.

4 Topic B to focus on

4.1 Algorithms

Sometimes the most straightforward way to explain a procedure is just to give it in a algorithmic format, it takes a little time but it will force you to go through the steps and you will most likely be able to reuse it on you paper. For the full documentation see here https://texdoc.org/serve/algorithmicx/0.

Algorithm 1 Euclids algorithm

procedure EUCLID(a, b) ▷ The g.c.d. of a and b
  $r \leftarrow a \bmod b$
  while $r \neq 0$ **do** ▷ We have the answer if r is 0
    $a \leftarrow b$
    $b \leftarrow r$
    $r \leftarrow a \bmod b$
  return b ▷ The gcd is b

4.2 Code

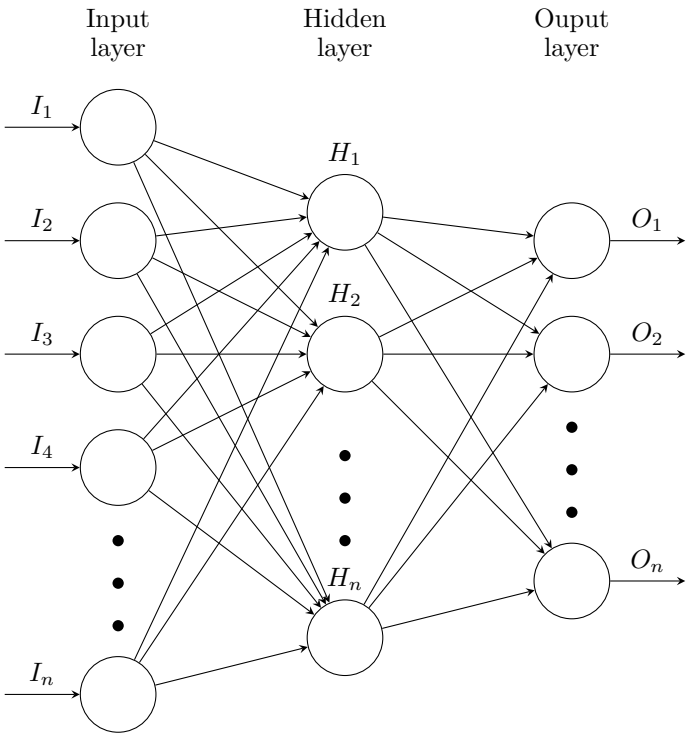
If the algorithm is too vague and you feel like you need the source code you can also insert it. You can put LaTeX code inside by using `<@ @>` delimiters, highlight small pieces of the code with `<| |>` delimiters, and highlight full lines (see the source code). For now only Python colored syntax highlighting is available, but most languages are supported and the color scheme can be added. More information available here https://www.overleaf.com/learn/latex/Code_listing.

Note that these pieces of code in the LaTeX document must start with no indent.

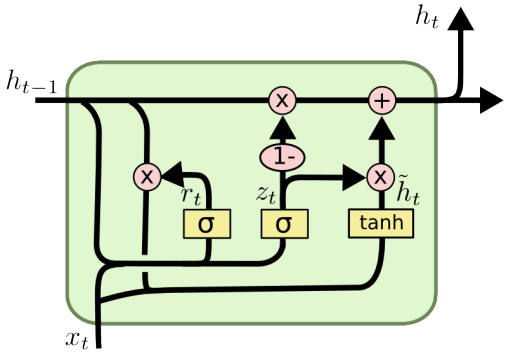
```
def DTW_distance(s1, s2):
    """
    Function to compute the Dynamic Time Warping in Python between two
   signals
    """
    DTW={}

    for i in range(len(s1)):
        DTW[(i, -1)] = float('inf') # By default ∞
    for i in range(len(s2)):
        DTW[(-1, i)] = float('inf') # By default ∞
    DTW[(-1, -1)] = 0

    for i in range(len(s1)):
        for j in range(len(s2)):
            dist= (s1[i]-s2[j])**2
            DTW[(i,j)] = dist + min(DTW[(i-1, j)],DTW[(i, j-1)], \
                DTW[(i-1, j-1)])

    return sqrt(DTW[len(s1)-1, len(s2)-1])
```

4.3 Diagrams

For simple diagrams I highly recommend learning TiKZ, you will be drawing the diagrams in pure LaTeXwhich has a steep learning curve but once you get used to it, it can be quite easy to display and do `for` loops to draw multiples line at once.



However, sometimes you will need more complicated diagrams (or maybe you do not like TiKZ, in that case I recommend a vector drawing tool such as Inkscape which allows LaTeX embedding)



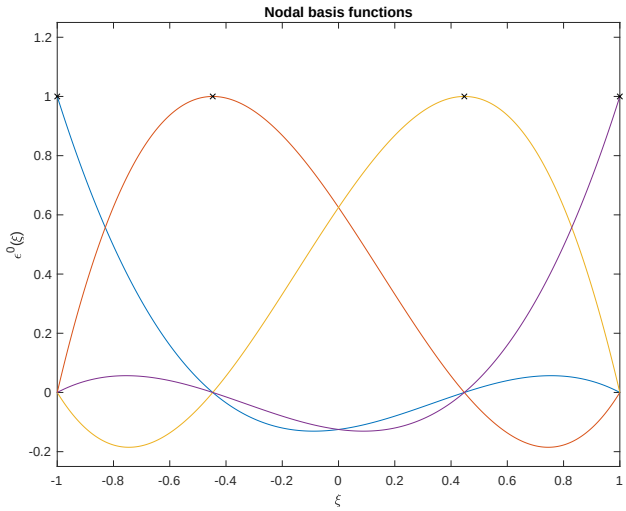
$$z_t = \sigma\left(W_z \cdot [h_{t-1}, x_t]\right)$$
$$r_t = \sigma\left(W_r \cdot [h_{t-1}, x_t]\right)$$
$$\tilde{h}_t = \tanh\left(W \cdot [r_t * h_{t-1}, x_t]\right)$$
$$h_t = (1 - z_t) * h_{t-1} + z_t * \tilde{h}_t$$

Figure 4.1: Gate Recurrent Unit in a Long Short Term Memory Neural Netwok (GRU-LSTM). Credit to https://colah.github.io/posts/2015-08-Understanding-LSTMs/

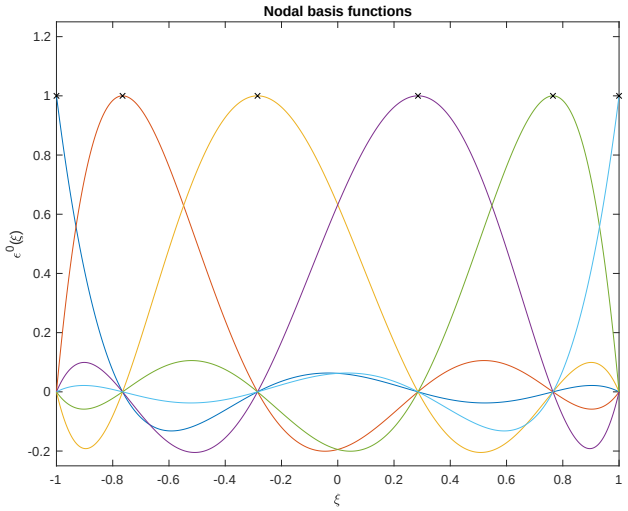
5 Topic C to focus on

5.1 Figures

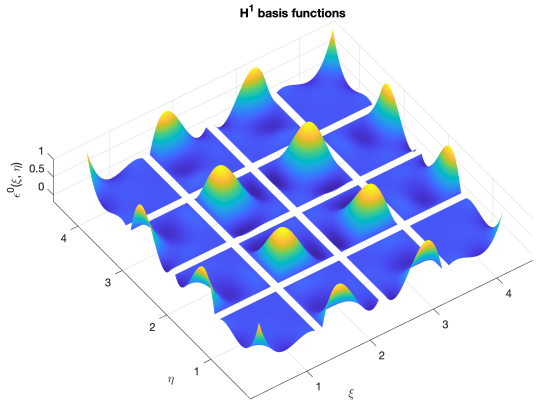
In general the best way to visualize your results will be some figures, I recommend Python's matplotlib for generating them or any other tool you are familiar with.



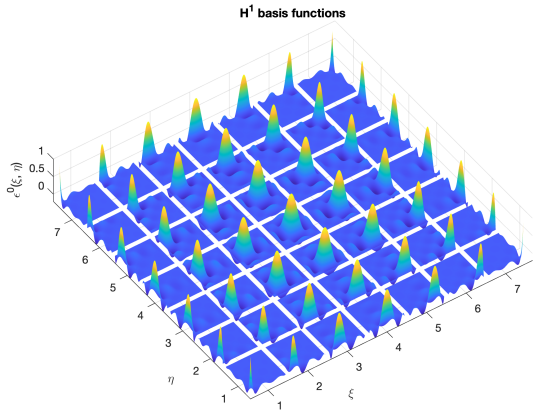
(a) One-dimensional spectral element basis functions of polynomial degree $p = 3$ for subspace $G_3 \subset H^1(\Omega)$, $\Omega \in \mathbb{R}$.



(b) One-dimensional spectral element basis functions of polynomial degree $p = 5$ for the subspace $G_5 \subset H^1(\Omega)$, $\Omega \in \mathbb{R}$.



(c) Two-dimensional spectral element basis functions of polynomial degree $p = 3$ for subspace $G_3 \subset H^1(\Omega)$, $\Omega \in \mathbb{R}^2$.



(d) Two-dimensional spectral element basis functions of polynomial degree $p = 5$ for the subspace $G_5 \subset H^1(\Omega)$, $\Omega \in \mathbb{R}^2$.

Figure 5.1: Example basis functions for the spectral finite element method in 1D and 2D.

5.2 Tables

LaTeX booktab environments are really good to showcase and track your results, however they can get fairly messy. My suggestion is to generate them via Python automatically and store the results in either a plain text file or a spreadsheet (there are packages to read spreadsheets with Python)

$\sigma \setminus \tau$	0	1	2	3	4	5	6	7	8
0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0.6	98.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0.8	84.7	99.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1.0	28.1	98.3	99.9	100.0	100.0	100.0	100.0	100.0	100.0
1.2	1.3	88.7	99.4	99.9	99.8	99.9	100.0	99.9	100.0
1.4	0.0	57.1	96.2	99.3	99.0	99.3	99.4	99.8	99.7
1.6	0.0	18.6	81.2	93.0	93.7	94.8	95.6	92.3	93.3
1.8	0.0	2.4	42.8	67.0	70.1	72.1	69.0	69.1	68.6
2.0	0.0	0.1	9.0	23.1	24.5	26.9	28.2	27.3	27.3
t(ms)	27.92	40.23	77.30	157.27	252.05	342.18	381.46	399.85	413.72

Table 5.1: Performance of the algorithm for 128-bit key and with multiple readings per key

A References

Do not forget to cite the papers that you are using in your research, this way your work will be infinitely easier to write down and to review when the time comes.

B Resources

It is a good idea to record sources that explain concepts or provide tools so the research is both better documented and if someone has to continue it there is enough supporting documentation.

- Quick read in DTW and Keogh Lower Bounding.
  http://alexminnaar.com/time-series-classification-and-clustering-with-python.html
  http://nbviewer.jupyter.org/github/alexminnaar/time-series-classification-and-clustering/blob/master/Time%20Series%20Classification%20and%20Clustering.ipynb
- Parallelizing DTW – Good article on making a parallel version of DTW. Uses Keogh lower bound not as a linear approximation but as a pruning device.
  https://www.andrew.cmu.edu/user/mmohta/15418Project/finalreport.html
- Deep Learning
  - Intro to LSTM
    https://colah.github.io/posts/2015-08-Understanding-LSTMs
  - Intro to CNN
    https://colah.github.io/posts/2014-07-Conv-Nets-Modular/
  - Why are LSTMs are so useful, impressive result in character pattern and syntax learning
    https://karpathy.github.io/2015/05/21/rnn-effectiveness/

C TODOS

Here you will have all your TODOs grouped with anchor links to the parts of the document where they are. Really handy if you do not know where to continue with your project.

Todo list