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Visualisation of AIS message for the Norwegian Coastal Administration

A more secure ocean for the norwegian people

Bachelor's thesis in computer engineering
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May 2026

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Faculty of Information technology and electrical engineering
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ABSTRACT

Write an abstract/summary of your thesis, and state your main findings here.

A summary should be included in both English and any second language, if this is applicable, regardless if the thesis is written in English or in your preferred language. These should be on separate pages, the English version first.

PREFACE

Write the preface of your thesis here.

You may include acknowledgements and thanks as part of your preface on this page, or you may add it as a new chapter after the preface.

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ABBREVIATIONS

List of all abbreviations in alphabetic order:

- **AIS** Automatic Identification System
- **NTNU** Norwegian University of Science and Technology
- **NCA** Norwegian Coastal Administration

CHAPTER
ONE

INTRODUCTION

Information about the seafaring vessels around the Norwegian coast are paramount for national security and the security of said vessels, thus it is paramount that such information is available in a concise and easy to understand format for the professionals working in the Norwegian coastal administration. Every day millions of anomaly messages are sent out from a ships AIS messaging unit, and parsing through all these messages to see which are more important than others is a significant and important task for our government.

1.1 Motivation

Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incident ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? Quis autem vel eum iure reprehenderit qui in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur?

At vero eos et accusamus et iusto odio dignissimos ducimus qui blanditiis praesentium voluptatum deleniti atque corrupti quos dolores et quas molestias excepturi sint occaecati cupiditate non provident, similique sunt in culpa qui officia deserunt mollitia animi, id est laborum et dolorum fuga. Et harum quidem rerum facilis est et expedita distinctio. Nam libero tempore, cum soluta nobis est eligendi optio cumque nihil impedit quo minus id quod maxime placeat facere possimus, omnis voluptas assumenda est, omnis dolor repellendus. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum hic tenetur a sapiente delectus, ut aut reiciendis voluptatibus maiores alias consequatur aut perferendis doloribus asperiores repellat.

1.2 Project description

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1.2.1 Stakeholders

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CHAPTER
TWO

THEORY

2.1 Equations

A simple equation can be included as:

$$r = 2\pi^2 \quad (2.1)$$

The text below shows an example of how to align equations on the equal sign, with only one reference for both. This may be useful for when they are linked and are actually only one equation but splitting them up makes it more readable.

$$\begin{aligned} a &= \sin^2(\Delta\phi/2) + \cos(\phi_1) \cdot \cos(\phi_2) \cdot \sin^2(\Delta\lambda/2) \\ d &= 2R \cdot \arcsin(\sqrt{a}) \end{aligned} \quad (2.2)$$

The whole equation can be referenced as "equation (2.2)", here showing the Haversine formula. One may also align sub-equations such that they are numbered the same but have a letter differentiating them as shown below. This can be used when they are linked, but you will need to reference both individual parts.

$$SSD = \sum_{i=1}^n (\vec{x}_i - \vec{\mu}_q)^2 \quad (2.3a)$$

$$SSE = \sum_{q=1}^k \delta_{rq} SSD \quad (2.3b)$$

These equations can be referenced by their specific sub-equation as "equation (2.3a)", or by the whole group as "equations (2.3)". The "double backslashes" in the .tex creates line spaces and gives more room around the equations and paragraphs. Use them as you think feels right.

2.2 Tables and footnotes

Here is an example of both a regular table with data and a table with split headers, for scientific usage. Do not use horizontal/vertical rulers between the data, or encase the table with rulers.

Statistic	Velocity	Altitude	1/Angle	Temp.
Mean	122.68	240.98	93.75	13.95
Std	224.51	145.88	60.39	4.44
Q1	28.00	111.60	34.15	10.60
Median	63.00	223.20	99.59	13.30
Q3	137.00	359.10	151.99	16.70
Min	0.00	1.00	0.00	3.30
Max	14519.00	616.70	180.00	32.10

Table 2.2.1: Table of dynamic feature statistics where outliers are included, for all data points. Velocity is given in *m/h*, the altitude in *mamsl*, the inverse trajectory angle in 1/degrees, and temperature in degrees Celsius.

Area 1	Start date	End date
2018	03.06	29.06
2019	03.06	03.07 or 31.08 ¹
2020	03.06	05.09

Area 2	Start date (farm 1/2)	End date
2012	09.06	07.09
2013	23.06 / 15.06	25.08
2014	05.06 / 25.06	10.09
2015	13.06 / 03.07	06.09
2016	17.06	22.07

Table 2.2.2: Selected time ranges for the data in all areas and all years.

¹A footnote explaining something.

2.3 A single figure

Figure 2.3.1 is included as an example. The square brackets before the caption description contains the title of the figure, which is what will be written in the list of figures. This should be short and concise. The same layout applies to tables and other floats. Remember to change the title as well as the caption if you are copying these examples. In the list of figures and tables all the different floats will be grouped together by chapter. Remember to always reference all your figures and tables in the text at least once.

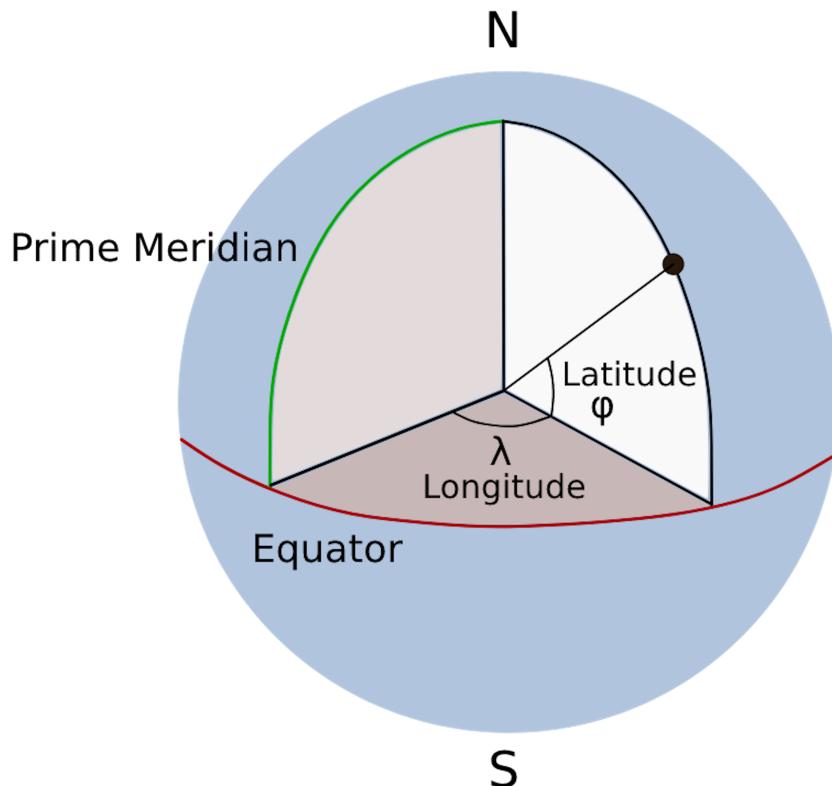


Figure 2.3.1: Illustration of the earth, and how latitudes and longitudes are calculated with respect to the equator and the prime meridian.

2.4 Citations

Here are some examples on how to reference a source (where none is relevant to the text but just for illustration purposes only). One may cite a single reference by calling [wolves_of_mount_mckinley], or several in the same bracket by calling [machine_learning, clustering_impossibility] when they are all related to the same statement. There are many different styles on how to cite, and how the layout and order of your citation style is presented. This is my favorite, as I find it neat and tidy [sheep]. It will show up in order of appearance in the references section.

CHAPTER
THREE

METHODS

Include the complete description of the methods used in your research here.

Below is an example of how subsectioning works. The sections and subsections will be included in the table of contents, while subsubsections will not be in the table of contents but still have their own title in the text.

3.1 Section one

3.1.1 Subsection one

3.1.1.1 Subsubsection one

3.1.1.2 Subsubsection Two

3.1.2 Subsection Two

3.2 Section two

CHAPTER FOUR

RESULTS

4.1 More figures

This section includes some examples of different types of figures to include. A simple single figure is shown in figure 4.1.1, while figure 4.1.2 shows how three subfigures can be included together. Remember to change both the caption and the title in the square brackets before the caption, which will show up in the list of figures.

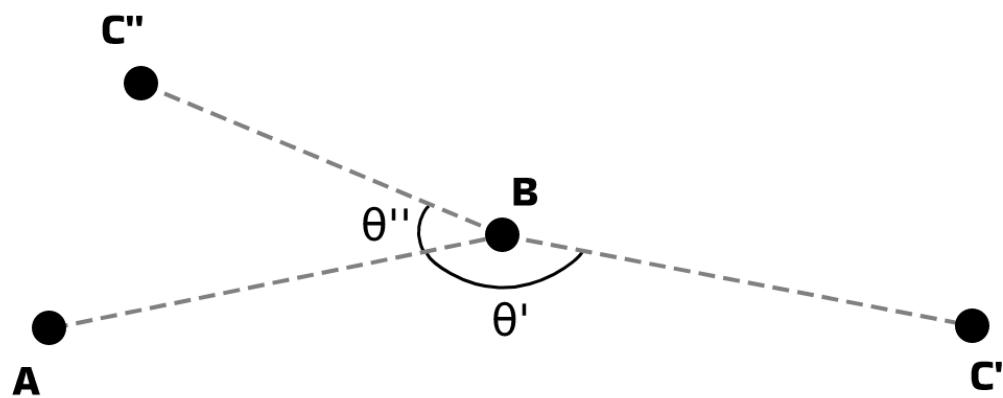


Figure 4.1.1: The trajectory angle found for the trajectory ABC between the three points A, B and C. The two different C-points show the angle gotten for relatively unchanged directional trajectory with C', and opposite directional trajectory with C''.

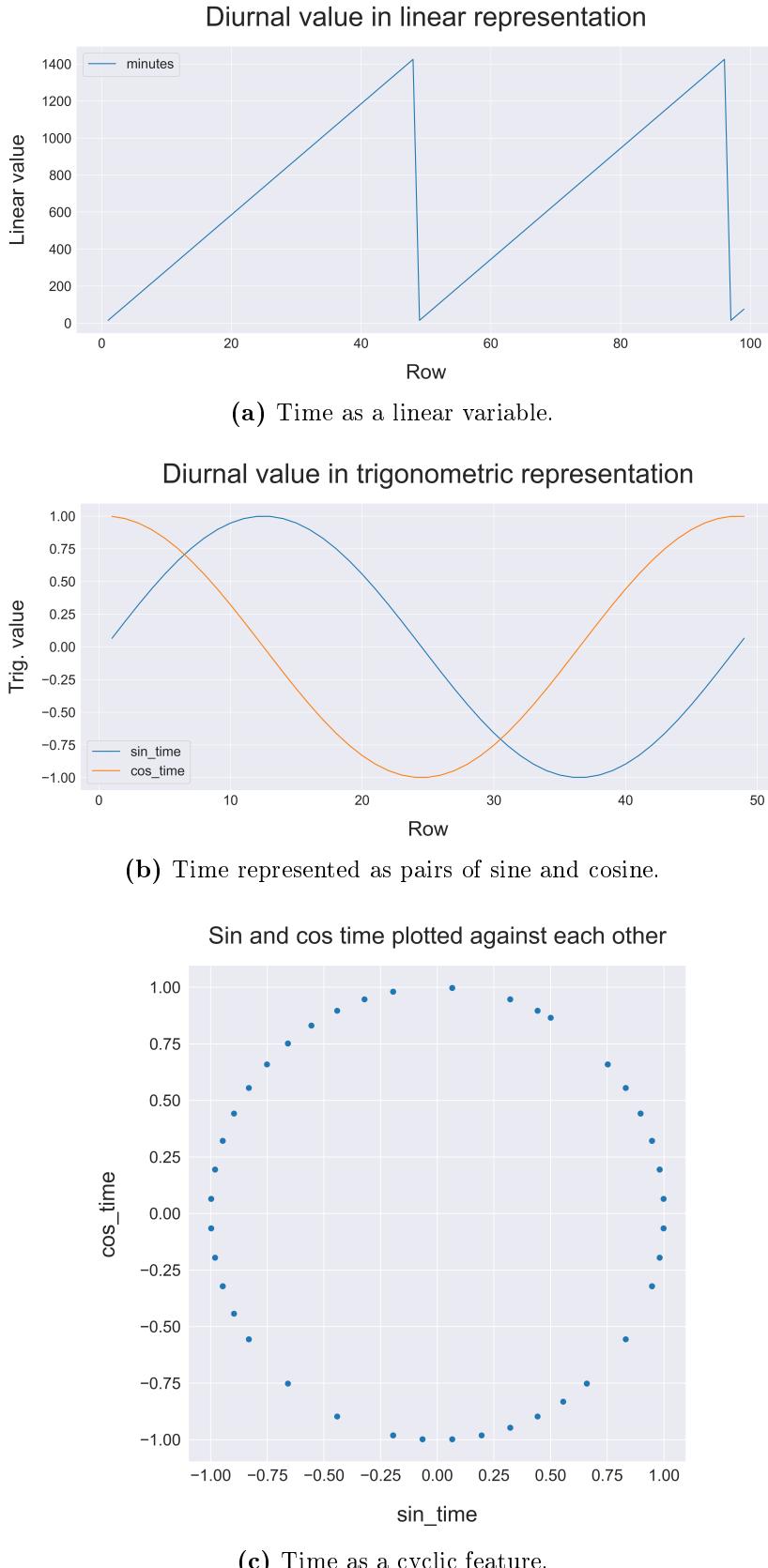


Figure 4.1.2: Figure (a) shows the time variable in the data for the first 100 rows using linear time as minutes past midnight, figure (b) shows the trigonometric time representation for one cycle where each time point has a unique sine and cosine-pair value, and figure (c) shows time as a cyclic feature with the trigonometric pairs.

CHAPTER
FIVE

DISCUSSION

Discuss your results here.

5.1 Future work

Include a section about what should or could be done in future research, or explain any recommended next steps based on the results you got. This should be the last section in the discussion.

CHAPTER
SIX

CONCLUSIONS

Give a concise summary of your research and finding here, and include a short summary of any future work as well.

APPENDICES

A - GITHUB REPOSITORY

All code and latex-files used in this document are included in the Github repository linked below. Further explanations are given in the readme-file.

Github repository link

- https://github.com/ninasalvesen/thesis_latex_template

B - SIDENOTE STATISTICS

B1 - Some random table

Remember to only include one thing per page in the appendices.

Statistic	One	Two
Count	387317	283960
Mean	130.66	134.18
Std	248.09	230.32
Q1	31.00	21.00
Median	67.00	63.00
Q3	142.00	159.00
Min	0.00	0.00
Max	14519.00	14253.00

Table B.1: Table of statistics on some sidenote data.

B2 - Some other random table

Statistic	Three	Four
Count	387317	283960
Mean	130.66	134.18
Std	248.09	230.32
Q1	31.00	21.00
Median	67.00	63.00
Q3	142.00	159.00
Min	0.00	0.00
Max	14519.00	14253.00

Table B.2: Table of statistics on some other sidenote data.

B3 - Some random figure

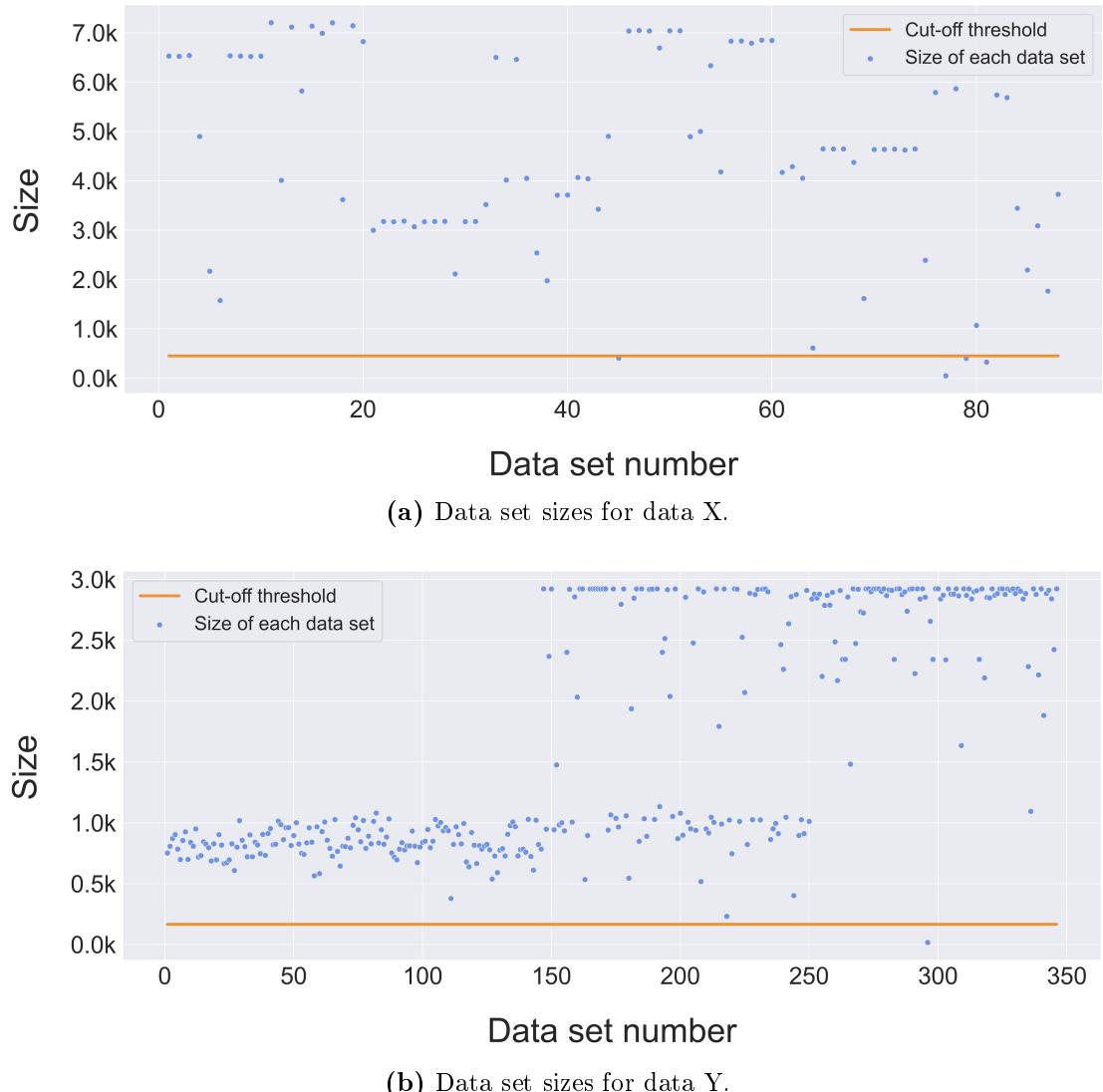


Figure B.1: The figures show the data set sizes of X and Y and the proposed cut-off threshold at 10 % of the mean set size.