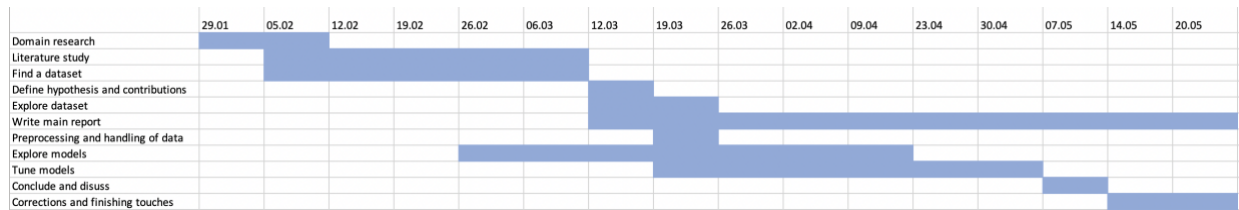


Project manual

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Gant diagram



My Gant diagram is a fairly simple one. As the project is a research project, most of the work consist of research, experiments and writing a report. Machine learning projects are iterative processes. Therefore, we use many weeks to try out different models and to tune them. The simplicity of the Gant diagram has been discussed with the supervisors.

Summoning of meetings

We discussed different ways of summoning during our first meeting. The supervisors wanted to receive the summon as a recurring event in Google Calendar. Therefore, I have no explicit meeting summons to include in the appendix. We had weekly meetings. The agenda for the meetings were discussed in the meeting one week before. As the time between meetings were short, we felt no need to send out agendas in writing. In-between the meetings, we also communicated on slack.

Meeting summaries

All our meetings were held on appear.in/bacheloroppgave. The time of the meetings was set to 13:00-14:00.

Meeting summaries

Meeting summary 29.01.2019

01/19: Collaboration tools

We agreed upon using:

- Appearin for meetings: <http://appear.in/bacheloroppgave>
- Slack for day-to-day communication
- Google drive for documents
- Overleaf for the thesis. Invitation will be sent when the document is created.

02/19: Routines

We will have weekly meetings with an exception for holidays. Bjarte, Edvard and Sindre participates each week. Ole Christian tries to appear on a regular basis. Tuesdays 13:00 is the optimal time for everyone. Sindre sends meeting invitations in the form of a recurring event in google calendar.

Timesheets as well as short weekly summaries will be shared on google drive.

03/19: Documentation

The handbook is mandatory. Everything that is required in the handbook, including the gant-diagram, has to be made. Vision document and system requirements is not needed. Relevant parts of the system documentation can be written towards the end of the project. Installation guide and user manual should be included.

It is important that it is possible to recreate the results achieved in our main report.

04/19: Formalities

Sindre expands the contract to include a fourth field named: "Ekstern veileder". The contract will then be sent to everyone by mail.

NTNU may have available GPU-resources. To gain access one will have to submit an application. Sindre writes the application and sends it to Ole Christian when the literature study is completed.

04/19: Plan for the coming weeks

Should start with a literature study on the domain of biometric authentication and search for public datasets. Bjarte sends a folder of articles which they found useful at the Norwegian Computing Center

Sindre publishes links to the discovered datasets on google drive.

Discussion of problem description:

- Could be interesting to explore how much data we need to authenticate a user.
- Some datasets only contains data collected from the same device. Studies on these datasets have shown better results than datasets with multiple devices.
- Remember to take notes when performing the literature study to remember important sentences. It also makes it easier for the supervisors to gain insights in the work.
- We need to identify subproblems.
- The data should if possible be collected in an uncontrolled environment. This is the most realistic scenario for user authentication.
- It can be interesting to use gyroscope data in combination with accelerometer data.

Eventually

Nothing

Meeting summary 05.02.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Sindre Toft Nordal

Not present: Ole Christian Eidheim

Dataseett

Kaggle biometric has one unique user per device. It will therefore be a large risk of identifying device and not user.

Motionsense has both accelerometer and gyroscope data. The subjects performs a given activity such as walking, standing, walking in stars e.l. Can be a good dataset for authenticating users while they perform an activity.

Further work

- Can be interesting to explore human activity recognition first, and then expand the model to perform authentication.
- It is possible to study how to identify a user based on how they perform a given activity.
- Can be interesting to explore in which activity it is the easiest to authenticate a user.
- Can try to collect data and build our own dataset. However, this may demand too much work to be included in a bachelor thesis.
- It is interesting to know how much data we need to authenticate a user. By how much, we think about how long of a continuous segment we need.
- Some studies authenticate users based on a "signature in the air". This works well to authenticate users.
- Can be interesting to identify unique subsets of user sessions which users often repeat.

Before next meeting

Write a document which summarizes the domain of accelerometer data. Questions which should be answered are:

- Which tasks are solved by the use of accelerometer data in the domain of accelerometer data.
- Which factors impact the data quality in a negative way.
- Which factors impact the data quality in a positive way.
- With authentication of a user as our target, which simpler subproblems can help us achieve the goal?

Meeting summary 12.02.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Ole Christian Eidheim, Sindre Toft Nordal

Not present:

Agenda:

- Feedback on the document “akselerometerdata”
- What to work with until 26.02

Feedback on the document “akselerometerdata”

- Well written.
- Would have been nice to have the document in English. From now on, all documentation will be written in English.
- Could have been written in a more academic fashion (references etc.)
- Include a table containing: Dataset, Problem, Angle of attack and comments
- The sub-problems could have been divided into even smaller problems.
- Go even more in depth in identifying the factors that affect the quality of the dataset.
- Should mention and explain “continuous authentication”

What to work with until 26.02

- Translate the document “akselerometerdata” to English.
- Further develop the document on the basis of the feedback.
- Start to fill in the table which is requested.
- Send the work done this week on slack 15.02.

General

- It's important to document the approach and the problems that occur and not only the result.
- Can check which scientific articles that have referenced certain datasets. This makes it easy to find out what problems others have solved with the given data.
- The thesis statement is not yet decided. It's important to have an overview of the domain before settling on a specific problem.
- One solution could be to improve an existing solution.
- Reproduction is not desirable, but to make a problem more difficult than it currently is, and then to solve it, could be interesting. This could be in the form of trying to use smaller samples, a more realistic dataset etc.

Meeting summary 26.02.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Sindre Toft Nordal

Not present: Ole Christian Eidheim

Agenda:

- Orienting about the progress of the literature study
- What to work with until 06.03

Orientation about the progress of the literature study

- Have found multiple articles that describe methods of using accelerometer data for continuous authentication of smartphone users. The validity of the studies are uncertain.
- HMOG seems like the best publicly available dataset for our project.

What to work with until 06.03

- Make an outline for the main report which includes structure and headlines.
- Break down problems into even smaller pieces eg:
 - How does sample length affect authentication accuracy?
 - What's the easiest problem and what makes it more difficult?
- Identify possible problem statements
- Bjarte and Edvard reads HMOG and "Continuous User Authentication via Unlabeled Phone Movement Patterns".(Ref. random-chanel slack)

General

- An interesting side study is to use controlled data to find out how neural networks reacts to small changes in data.
- Important to describe both data and process in detail.

PS: Next meeting is moved from March 5th to March 6th at 13:00.

Meeting summary 06.03.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Sindre Toft Nordal

Not present: Ole Christian Eidheim

Agenda:

- Feedback on document "complexity of problems"
- Thoughts about the paper "Continuous user authentication via unlabeled phone movement patterns"

- What to work with until 12.03

Feedback on the document “complexity of problems”

- A bit difficult to understand. Problems are given a class from easy to hard, but it is not specified what makes them hard or easy. Should try to classify the problems into groups and identify what makes that kind of problem challenging.
- What is the difference between the easy ones and the hard ones? Is it the amount of data, the problem they solve, the sampling rate etc.?
- Try to ignore what has been done in the past. Identify groups as activity recognition eg user verification and figure out what makes each problem harder or easier.

Thoughts about the paper “Continuous user authentication via unlabeled phone movement patterns”

- The fact that they have something they classify as “bad users” is not good.
- They make assumptions about the sampling rate which may distort their research. It is possible that their model actually identifies just the sampling rate and not the user.

What to work with until 12.03

- Sindre will present a GANT-diagram to make sure we’re all satisfied with the planned progress.
- Edvard will try to present his findings in regards to axis which makes the problem harder or easier.
- Rewrite “complexity of problems” or start writing a new document where I focus in groups of problems and not articles.
- Start writing on the main report.

General

- Sindre will schedule a meeting with Bjarte in Oslo March 15th.

Meeting summary 12.03.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Ole Christian Eidheim, and Sindre Toft Nordal

Not present:

Agenda:

- Thoughts about HMOG-dataset
- Decide a direction for the project
- Feedback GANT diagram
- General

Thoughts about HMOG-dataset

- The fact that they use only one device for the collection is positive.
- Is a good dataset to use in the further study.

Decide a direction for the project

- Ole Christian thinks it's interesting to try to recreate results from some articles. Would be interesting to see if we'll manage to achieve the same results.
- After recreating models from one or more articles, we can explore the possibilities of expanding the model or include more features.

Feedback GANT diagram

- Should start exploring models ASAP
- Looks good

What to work with until meeting 19.03

- Sindre and Bjarte discusses models, challenges and writing of main-report
- Move "explore models" forward by one week in the GANTT-diagram
- Continue developing the main report
- Start building an autoencoder and work with feature engineering.

General

- We must be sure that we do need exploit hidden identities in the data like different sampling rate, device etc.
- The husky-problem does not seem likely to be relevant in our case
- An interesting thought could be how different architectures of neural nets performs on our data. This may be a bit to theoretical for this thesis, but can be interesting to explore in the end given that we have much time left
- Must include chapter with definitions of terms like Equal Error Rate and False Acceptance Rate etc.

Meeting summary 19.03.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, and Sindre Toft Nordal

Not present: Ole Christian Eidheim

General:

- The work done on the report looks good. Bjarte and Sindre had an effective meeting discussing the main report.

- The Gant diagram now looks perfect.
 - The LSTM model seems like a better fit than the autoencoder
 - Keep developing the model in parallel with the main report.
-

Meeting summary 26.03.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Ole Christian Eidheim, Sindre Toft Nordal

Not present:

Agenda:

- Feedback on the main report
- Model progress

Feedback on the document “akselerometerdata”

- Rewrite and make summary of contributions more accurate

Modell progress

- Created LSTM with ca. 40% accuracy for 10 people.
- Maybe try something even less complex
- Need more gpu-resources for tuning and experimenting

For next meeting

- Continue on developing a functioning model
 - Continue writing the report
 - Write mail to NTNU about access to GPU-resources
 - Describe problem-types e.g windows of smaller sizes, compare results with published articles, experiment with sampling rate etc.
-

Meeting summary 02.04.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, and Sindre Toft Nordal

Not present: Ole Christian Eidheim

General:

- Has not been much progress on the model.
- Has not been much progress on report.

- Keep on working as you do.
 - Remember to write down the choices that you make during this stage of the project. The choices are subject of discussion in the report.
-

Meeting summary 09.04.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Ole Christian Eidheim, Sindre Toft Nordal

Not present:

Agenda:

- Progress report and discussion

Progress report and discussion

- Having troubles with the NTNU GPU-clusters. Will need to visit them to seek a solution.
- As previously mentioned: it is important to document the process.
- While exploring the model on a small subset of users, it is important to switch up the sample to prevent overfitting the model.
- Transfer-learning to allow previously unseen users into the authentication framework is not a priority at this point.
- Remember to keep all the results.
- An interesting idea is to write the report as a happy story and then include a chapter of mistakes and errors that arise.

For next meeting

- Continue with model.
 - Need progress on the report.
-

Meeting summary 23.04.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, and Sindre Toft Nordal

Not present: Ole Christian Eidheim

General

- Are we able to identify users that are more similar than others?
- Build a validation set that is completely separate from training and testing data.

- Can include a study of the computational cost of different models.
- Does it have value to compare to models?
- Have to agree on contributions to build a continuous line in the report.
- The fine tuned model needs to be ready soon.
- Need to do a physical visit of to HPC-lab to solve our problems with computation.
- It is not realistic that everyone performs the same set of activities. Try to solve this problem by subsampling the training data.

Meeting summary 30.04.2019

Present: Sindre Toft Nordal, Bjarte M. Østvold and Edvard K. Karlsen

Not present: Ole Christian Eidheim

Discussion of the report:

- Discussion of the hypothesis. Sindre sends proposal on Slack and will discuss formulations.
- Try to avoid words like “prove”. They seem to direct and it is difficult to defend the claim. Consider using “assess” instead.
- To compare two models, it is important that our baseline model holds a certain standard. ca. 85% seems reasonable.
- Important to explain our choice to experiment with limiting training data. Should include how it affects the activities and variance in the dataset.
- Needs a strong argument for validation of our results. Either explicit explanation of data preparation, multiple runs or cross-validation.
- Important to visualize and include figures to break up the text.
- Do not focus the study on gait. Or goal with subsampling the data is to approach a real life scenario, and not to
- Include threats to validity.

Meeting summary 07.05.2019

Present: Bjarte M. Østvold, Edvard K. Karlsen, Ole Christian Eidheim, and Sindre Toft Nordal

Not present:

Problems with the temporal dependency in the data

- We do not need to keep the temporal dependency between windows.

- Remember to argument for this choice in the main report.
- Include anomaly detection in related work.

Main report

- Reference the person which has given you information about “Awesome possum”.
- Reduce the amount of strong expressions. “We prove..”, “We are sure”. Replace with weaker words as “We assess” or “We consider”. This is important as it is extremely hard to defend the use of strong expressions.
- The hypothesis should be more general and not as ambitious. We need a hypothesis which better models all of our experiments, and not only one of them. Try with a version of “We are able to re-authenticate users using accelerometer data”.
- Ole Christian questions whether related work should be in the start or in the end. After a short discussion he agrees that it can be smart to have it in the end.
- Contributions need to be a specific result and not a process. Rephrase the contributions to specific results.
- Remove the discussion and references about LSTMs from architecture. It belongs in the theory chapter.
- Typeset A4 to change formatting.

Meeting summary 14.05.2019

Present: Bjart M. Østvold, Edvard K. Karlsen, Ole Christian Eidheim, and Sindre Toft Nordal

Not present:

Main report

- Remember to explain new expressions on first-time use.
- Remove “obviously false” after hypothesis unless you have a way to prove the statement.
- You do not need to justify your hypothesis. Remove first and last sentence of the paragraph.
- Discuss the fact that we simulate the authentication scenario. We test on prerecorded data. Can be included as a sentence in the introduction and discuss in a later chapter.
- Remember to ask Ole Christian to focus on the technical chapters when reviewing the report.
- We really need to get the results into the report. It is not important to develop the chapter, but we need some numbers soon.
- Need to evaluate whether the further work should be before or after the conclusion.

- Remember to tie related work even closer up to our study.
- Could be usefull with another meeting on Thursday. Sindre sends meeting summoning via google calendar.
- It is time to perform cosmetic changes in latex and to correct spelling and sentences.

Meeting summary 16.05.2019

Present: Bjart M. Østvold, Edvard K. Karlsen, and Sindre Toft Nordal

Not present: Ole Christian Eidheim

Main report

- Move the relevance section into the introduction chapter.
- Explain our experience with negative samples.
- Still some sentences including “strong” assertions. Tone them down.
- Include a section at the end of the introduction which describes the structure of the thesis.
- The result chapter can be included in the experiment chapter.
- Create a dummy experiment chapter. This allows us to give you better feedback before you write the rest of the chapter.
- Include fancypage and hyperref packages in latex.

Timesheet with status reports

Date	Hours	Comment
29.01	2	Start up meeting
30.01	7,5	Scientific method
31.01	7,5	Scientific method
01.02	4,5	Domain reasearch
02.02		
03.02		
04.02	6,5	Exploring datasets
05.02	5,5	Exploring datasets
06.02	5	Exploring datasets
07.02	4	Experimenting on datasets
08.02		
09.02		
10.02	5	Literature study
11.02	5,5	Literature study
12.02	4	Literature study
13.02	5	Literature study
14.02	6,5	Literature study
15.02		
16.02		
17.02	4	Literature study
18.02	8	Literature study
19.02	5,5	Simple model exploration
20.02	6	Simple model exploration
21.02	6	Simple model exploration
22.02	6	Simple model exploration
23.02		
24.02		
25.02	7	HMOG literature study
26.02	6,5	Literature sudy
27.02	6	Literature study
28.02	4	Exploration of HMOG dataset
01.03	4	Exploration of HMOG dataset
02.03	8	Models for HMOG dataset
03.03	7	Models for HMOG dataset
04.03		
05.03		
06.03	4	Finding subproblems for the problem desription
07.03	7,5	Preprocessing HMOG
08.03	10	Preprocessing HMOG and subproblems
09.03		
10.03		
11.03		
12.03	2	Discussion og problem and progress
13.03		
14.03		
15.03	7,5	Finding inspiration for models from literature
16.03	7,5	Problem description
17.03	7,5	Main report
18.03	6	Main report
19.03	7,5	Main report
20.03		
21.03	6	Preprocessing and loading of data
22.03	7,5	Preprocessing and loading of data
23.03	8	Preprocessing and loading of data
24.03	8	Preprocessing and loading of data
25.03	7,5	Implementation of models

26.03	7,5	Implementation of models
27.03		
28.03		
29.03	7,5	Main report
30.03	7,5	Re-implementation and tuning
31.03	7,5	Main report
01.04	6	Main report
02.04	6	Main report
03.04	6	Main report
04.04	8	Main report
05.04	6,5	Experiments and model tuning
06.04	6	Model tuning
07.04	6	Model tuning
08.04	6	Model tuning
09.04	6	Model tuning
10.04		
11.04	5	Implementation of new model
12.04	5	Model tuning
13.04	5	Model tuning
14.04	5	Main report
15.04	5	Main report
16.04		
17.04		
18.04		
19.04		
20.04	5	Exploring HPC-lab
21.04	5	Rewriting programs for optiization
22.04	5	Exploring HPC-lab
23.04	5	Main report
24.04	5	Exploring HPC-lab
25.04		
26.04	6	Discussion and experiments
27.04	6,5	Run experiments on HPC-lab
28.04	6	Main report
29.04	6	Tune and rerun experiments
30.04	1	Meeting
01.05		
02.05	7,5	Starting on conclusion and discussion
03.05	8	Main report
04.05	8	Main report
05.05		
06.05		
07.05	8	Exploring with different negative sampling
08.05	6	Re-run experiments and main report
09.05	8	Main report
10.05	7,5	Main report
11.05		
12.05		
13.05	7,5	Run experiments for validation
14.05	7,5	Finalizing main report
15.05	5	Correting comments in main report
16.05	8	Correcting comments in main report
17.05	3	Code cleanup
18.05	10	Discussion and correcting of main report
19.05	12	Finishin main report and documentation
20.05	2	Documentation and submission

Month	Hours
January	15
Feburary	110,5
March	145,5
April	132
May	108
Total	511,00

Reports

Week 5 & 6

- Made decisions regarding collaboration tools.
- Established routines regarding meetings and documentation.
- Signed contract with supervisors.
- Discussed the potential of building our own dataset.
- Found the datasets Motionsense and Kaggle biometric which can potentially be used during our work.
- Started studying relevant literature.

Week 7 & 8

- Wrote a document detailing the domain of accelerometer data.
- Identified subproblems which can be discussed in the thesis.
- Decided to write the thesis in English.
- Discussed the desired results. Reproducing scientific literature is regarded as valuable.
- Continued the literature study.

Week 9 & 10

- Discovered the HMOG dataset. This is the dataset that seems most promising so far in relation to our problem description.
- Discovered multiple studies regarding continuous authentication using accelerometer data.
- Divided the problem description into subproblems.
- Wrote a document "complexity of problems" describing different subproblems and their difficulty.

- Explored the possibilities of using an autoencoder.

Week 11 & 12

- Created a Gant diagram.
- Received confirmation from supervisors regarding the HMOG dataset and its' usability.
- Went to Oslo for a meeting with Bjarte.
- Studied accuracy measurements for authentication algorithms such as equal error rate and false acceptance rate.
- Created a simple LSTM model.

Week 13 & 14

- Evaluated the results of the LSTM. Achieved an accuracy of 40% for 10 users.
- Explored the possibilities of using an multi-layer perceptron. The results were worse than with the LSTM.
- Wrote mail to NTNU regarding access to GPU clusters.
- Described problem types e.g. smaller window sizes, reproduction and comparing, and different options of subsampling the sample velocity.
- Wrote an outline for the main report.

Week 15 & 16 8.april – 21.april

- Got access to the GPU cluster, but had major issues running my python scripts.
- Tested the GPU cluster with simple python models in Keras without positive results.
- Contacted the technicians at the IDUN cluster for help without receiving any.
- Wrote the first chapters of the main report.

Week 17 & 18 22.april – 5.mai

- Solved the issues with the GPU cluster and managed to run my models.
- Concretized the hypothesis and the summary of contributions after discussion with supervisors.
- Achieved promising results using one binary LSTM classifier for each user. The accuracy was around 70%.
- Tuned the hyperparameters of the model, resulting in an increase of the accuracy to around 80%.

Week 19 to 21 6.mai – 20.mai

- Ran the final experiments to be used for our report.
- Wrote the rest of the main report including conclusion and discussion.
- Corrected the main report after feedback from supervisors.
- Made a small change in the sampling algorithm for the negative users.
- Compared our approach with other studies.
- Wrote documentation needed for the submission of the thesis.