Integrating Activities for Advanced Communities

D6.2- Workshop Report on Artificial Intelligence and Machine Learning for Arctic Research

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Lead partner for deliverable: AFRY
Authors: Maria Erman, Markus Skogsmo, Ruben Cubo and Thèrése Skarstedt

Dissemination Level		
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Publishable Executive Summary

This document compiles the topics presented during the mini workshops on June 10th, 2020, the workshop held on September 23rd, 2020, as well as the ideas expounded on during the ensuing discussions. Station managers and researchers engaged in the International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT) were invited.

The purpose of the workshops was to gain insight into how the participants involved in work package (WP) 6 could help the INTERACT network, and to discuss ideas for further projects and/or collaborations. Moreover, key ambitions were also to increase awareness of artificial intelligence (AI) and machine learning (ML), what can be achieved, and pre-requisites for using them. The workshops were conducted virtually via Zoom due to travel restrictions pertaining to the COVID-19 pandemic.

During the workshop, participants gained knowledge of the basics of AI/ML - including its history, how it is presented in popular culture, as well as major areas of AI/ML, such as computer vision (CV), natural language processing (NLP) and reinforced learning. There were also demonstrations on professional tools in areas such as face recognition, deep learning (DL), and NLP techniques to gain information from and analysing text.

With regards to the subsequent discussions, participants showed enthusiasm and interest in how AI/ML could be applied in their daily field work to reduce manual work, hence saving valuable working hours that are more efficiently allocated to advanced research. Several researchers present at the workshops expressed that they were new to this field and stated how AI/ML algorithms might benefit their work on Arctic research.

The contents of this report will serve as inputs for upcoming WP6 deliverables, in which inquiries and problem formulations from station managers and researchers, as well as identifying datasets etcetera, are to be collated into a preliminary study. In addition, D6.2 will also serve as an input to D6.3, which concerns demonstrating AI/ML algorithms and methods on researchers' data.

Table of Acronyms

AI	Artificial intelligence
API	Application programming interface
BAS	British Antarctic Survey
CV	Computer vision
DL	Deep learning
GPS	Global positioning system
IoT	Internet of things
ML	Machine learning
NLP	Natural language processing
OCR	Optical character recognition
WP	Work package

1. Introduction

1.1.Background

Academia has made great progress in documenting change, albeit now it is accepted that "there are many ways of knowing". Moreover, in addition to conventional and traditional knowledge, there are many hidden resources on environmental change and these resources may be used to extend the records and existing knowledge.

AI and ML have been recognised as powerful research tools in many scientific areas. In addition, there is an increasing demand for the applications of these tools to combat climate change. While AI is about mimicking human intelligence, ML is one set of tools, techniques and algorithms to achieve AI [1].

Due to many climate prediction problems being data limited, current climate models deal with this by relying on physical laws. These models are structured in terms of coupled partial differential equations that represent physical processes like cloud formation, ice sheet flow and permafrost thaw [2]. ML models may provide new techniques for solving such systems efficiently in a data-driven way [3], and apart from being used for prediction, ML can also be used to identify relationships between climate variables [4].

The workshops comprise D6.2 and were arranged by AFRY and were held virtually due to COVID-19 travel restrictions. Additionally, D6.2 lays an important foundation for further deliverables in WP6.

AFRY is a Swedish-Finnish engineering, consulting and design company within the fields of technology, energy, industry and infrastructure. It was founded in 1895 in Sweden and now has around 17000 employees globally, and offices in more than 40 countries.

1.2.Purpose and Goals

One of the many goals of INTERACT III is to develop usage of AI and ML from the invaluable data that is collected by the many dedicated researchers involved in INTERACT III. Several research stations undertaking work in the Arctic regions, already possess large volumes of data dating several decades back [5]. These data volumes have often been collected without AI or currently modern techniques in mind; however, with modern computing power and techniques, they may be of potentially great use today in different contexts [6].

The idea behind arranging workshops in INTERACT III, has been to dispel some of the myths of AI, as well as going beyond the buzz surrounding AI/ML, with the aim of showcasing methods that can aid in automating manual work. In addition, the workshops have been utilized as an interdisciplinary meeting point to come together, every person in their respective field, to engage in fruitful discussions. In order to find a common ground previous to engaging in discussions, an introduction to AI/ML was provided, as well as demonstrations on ML techniques.

1.3. Tasks

The aim of D6.2 is to introduce and raise awareness of AI/ML to researchers and station managers in INTERACT III. This includes giving information on the applications and areas, where these techniques excel, their constraints, as well as introducing pre-requisites needed to use them. The aim of WP6 is also indirectly to cause change by showcasing how employing AI/ML techniques do not have to be a huge undertaking, and that small efforts may greatly benefit researchers. Another goal of these workshops has been to expound on the latest AI trends and algorithms available today that can be of benefit to Arctic researchers, as well as giving a taste of what may be available in the future.

1.4. Outline

Section 1 presents a background, as well as the purpose and goals of the conducted workshops. Section 2 introduces key concepts of AI and ML. Further, section 3 dives into the various modules of the workshops which include an exposition of AI Hype and ML, computer vision, optical character recognition (OCR), NLP and state-of-the-art ML services. Section 4 summarises the relevant points gathered from the discussions of the workshops. Finally, section 5 provides a conclusion.

2. Artificial Intelligence, Machine Learning and Deep Learning

2.1.Introduction

During the 21st century, especially since 2015, the interest in AI has exploded. Discussions about AI are rampant, and everyone seems to have an opinion. Companies and institutions are making adjustments for an AI transition, worries are rising on how AI will affect the job market, ponderations on complex ethical questions, and on the more dramatic side, the rise of the machines!

AI has become a buzz word, and buzz words tend to become unfashionable at a certain point, which is why it is important to shed light on the areas and applications, at which AI excel, and highlight why it is here to stay. Furthermore, an important question to answer is: “How can we start benefitting from these powerful techniques today?”. Before answering the question, a good place to start is to clarify what AI is, what it can and cannot do, and to cut through the hype.

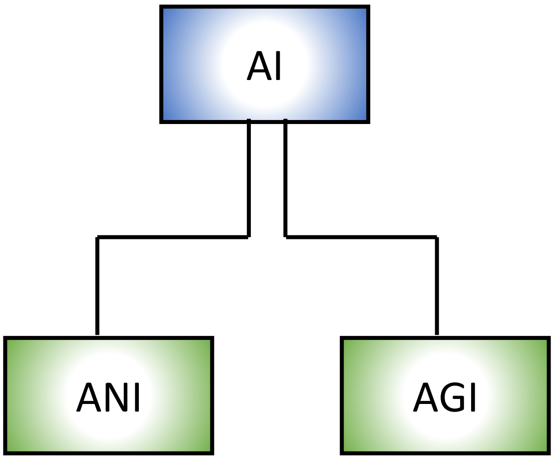


Figure 1: AI divided into two categories, artificial narrow intelligence and artificial general intelligence. Source: Adapted from [7]

As Andy Ngo stated in his excellent course, “AI for Everyone” [7], a way to demystify AI is to divide AI into two categories: artificial narrow intelligence and artificial general intelligence, see Figure 1. The former concept is AI that does one thing, such as face recognition, self-driving cars, recommendation systems, analysis of text, etcetera. Artificial general intelligence on the other hand is the concept of AI emulating humans as a whole and even surpassing humans. Whereas artificial narrow intelligence is creating immense value and has seen massive progress, there has hardly been any progress on artificial general intelligence at all.

Additional terms used in conjunction with AI, are ML and DL. “What do these terms mean and how do they relate to each other?”. In short, AI is a superset of ML, which in turn is a superset of DL, see Figure 2, and can concisely be described as follows:

- AI is the concept of emulating and mimicking human intelligence, behavioural patterns, interactions, sensations etcetera.
- ML is one approach of reaching AI, by learning from data itself without being specifically programmed to do so, and further, improving from experience.
- DL is the concept of employing ML techniques by using artificial neural networks (ANNs) [8].

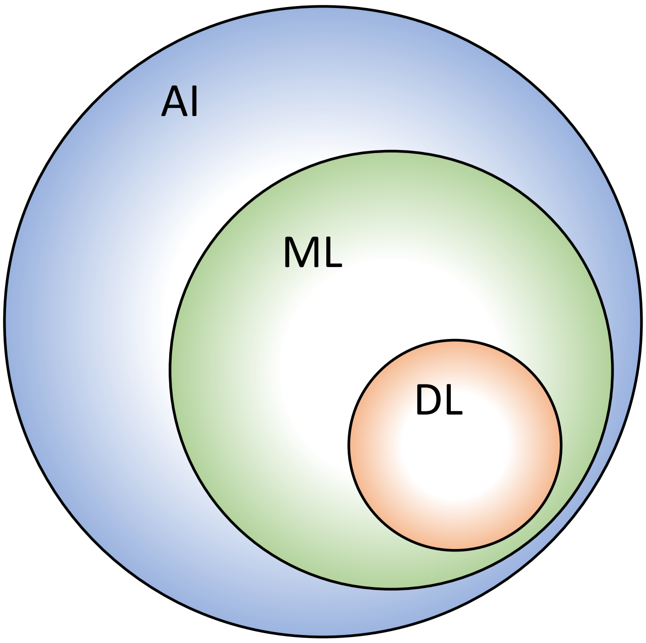


Figure 2: Artificial intelligence, of which machine learning and deep learning are conceptual subsets.

2.2.A Gentle Introduction to Artificial Neural Networks

As was set forth in 2.1, deep learning is generally concerned with artificial neural networks (ANN). ANNs are a technology inspired by how a brain operates with its biological neural network, and as such ANNs aim to mimic how a brain finds patterns or relationships among vast amounts of data [9].

An ANN consists of interconnected neurons or nodes structured in layers: An input layer, an output layer and what is denoted as hidden layers that exist between the input and the output layers, see Figure 3. Each layer extracts a different set of features from the input data, where an input, for instance, might be an image, and a set of features being edges. With every layer, the feature detection becomes more and more refined [10].

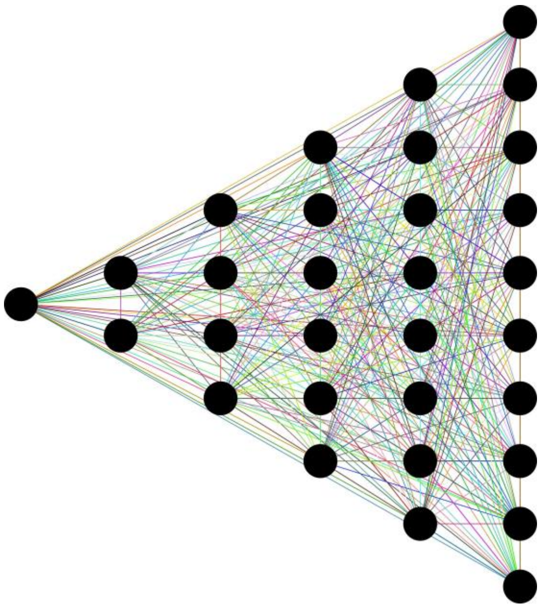


Figure 3: Artificial neural network with interconnected neurons.

For a basic overview of how ANNs work, the example of inputs being images and outputs being classes, for instance bird and polar bear, can be used. Firstly, the network is trained, or e.g., a few thousand images are fed into the network. The network then adjusts itself, or the weights of the nodes to be more specific, in accordance with optimization techniques, i.e., we know what images we feed into the network and we know the output classes. The network, after being properly trained, is now ready for unknown images to be fed into it and then output the correct class, see Figure 4 [6].

Figure 4: An image recognition neural network model detecting animals and classifying them into correct species. (a) Bird. (b) Polar bear. [6]

In a similar way, a neural network can be trained on text. For the network to be accurate, usually text of the order of a few thousand books might be needed. Whilst dependent on the algorithm, many cutting-edge NLP algorithms works by words being mapped to vectors, and after training, patterns can be discerned with similar words being closer to each other, see Figure 5. The results will be highly reliant on the data it was trained on, and in this case the data was trained on a BBC News data set [1] [11].

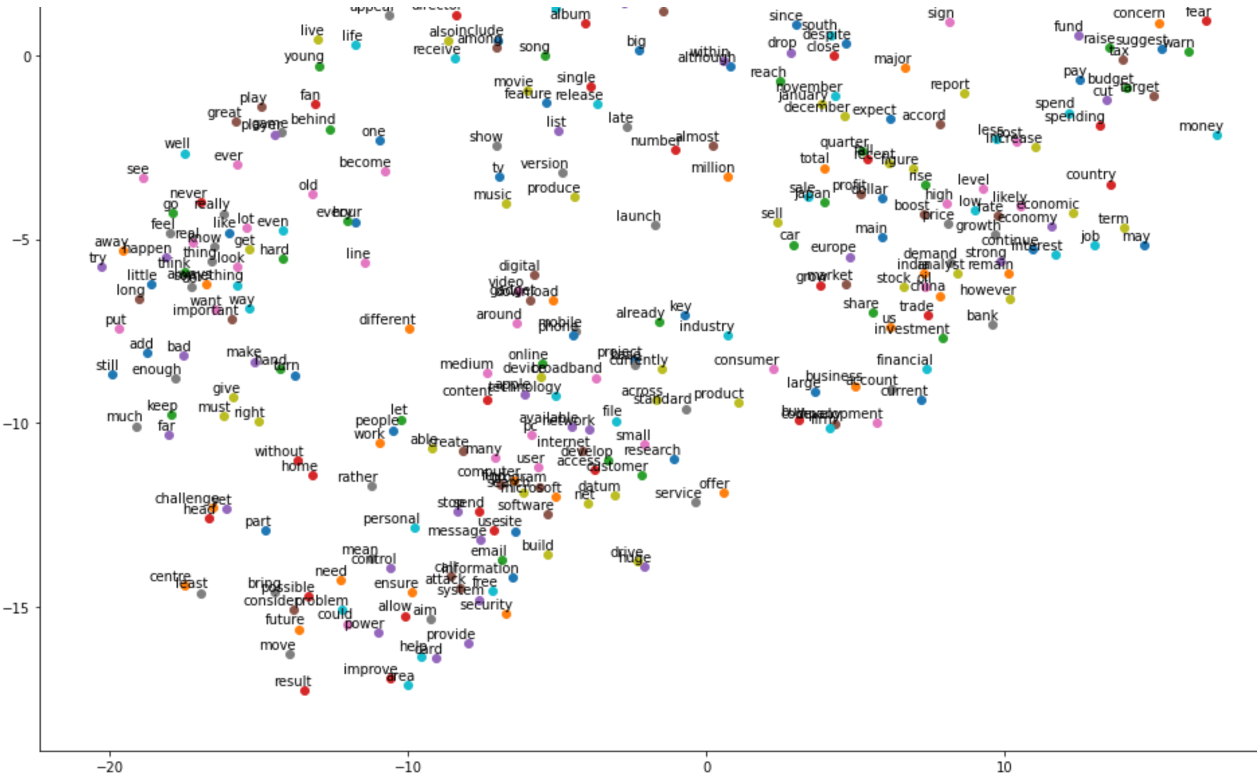


Figure 5: The result of a neural network being trained on text, using a BBC News data set.

Training on huge amounts of data can be problematic, since it is difficult to oversee whether the original data is inherently biased, or worse, there being scathing controversies sparked due to outputs, no matter how rare, being racist, sexist, ageist, etcetera, as was recently the case with the South Korean chatbot, Lee Luda, trained on 10 billion real-life conversations, and consequently suspended from Facebook for hate speech [12].

ANNs are used in a wide variety of applications, for instance, in time series forecasts, image recognition, classification, self-driving cars, generation of incredibly realistic CGI faces, recommender systems, automatic translation, text to speech, sentiment analysis, etcetera.

[1] The Natural language processing algorithm Word2Vec [28] was implemented, using the Gensim Python library [29].

3. AI/ML Workshop Agenda

3.1. Background

The mini-workshop held in June by Maria Erman and Ruben Cubo was divided into two parts:

1) A 40-minute presentation about AI [13].
2) A dialogue with station managers and Arctic researchers regarding how AI/ML can be applied in their respective domains.

Due to the global reach of the network, both sessions were organized to accommodate all potential attendees, one in the morning and one in the evening. Material was sent out with example discussion topics, see Appendix A.

The main workshop was held in September by Maria Erman, Markus Skogsmo and Ruben Cubo. It was divided into four modules:

- The first module introduced AI and its concepts.
- The second module went further into CV.
- The third module brought up OCR and NLP into more detail.
- The fourth module delved into ML Services.

Finally, attendees engaged in discussions on AI/ML, and how these techniques could be applied in their areas of expertise. Furthermore, questions were posed during the main workshop, using a tool called Mentimeter [14]. The answers to these questions can be found in Appendix B.

The following subsections will outline the September workshop, its modules and agenda in more detail.

3.2. Module 1 – A Background of AI and its Concepts

A presentation of WP6 was given by Maria Erman. Next, the concept of AI was introduced and its history. Noticeably, much of the theory behind AI/ML techniques and their algorithms were introduced as early as the 1950s. However, AI didn’t gain momentum until the 2000s, due to there being limitations of computational power and memory, which prevented its breakthrough. In addition, milestones of AI were introduced, such as when Deep Blue defeated the then reigning world champion in chess [15], and with Google’s AlphaGo defeating Lee-Se-dol in Go [16]. AI was mentioned in connection to its pop cultural impact in movies such as Metropolis, Frankenstein, 2001: A Space Odyssey, Terminator, Ghost in the Shell, etcetera.

Ruben Cubo went further into ethical considerations of AI. Thereafter, an explanation of pattern recognition and DL followed. A video demo was shown of “Flowity”, a social distancing detector product from AFRY [17], see Figure 6.

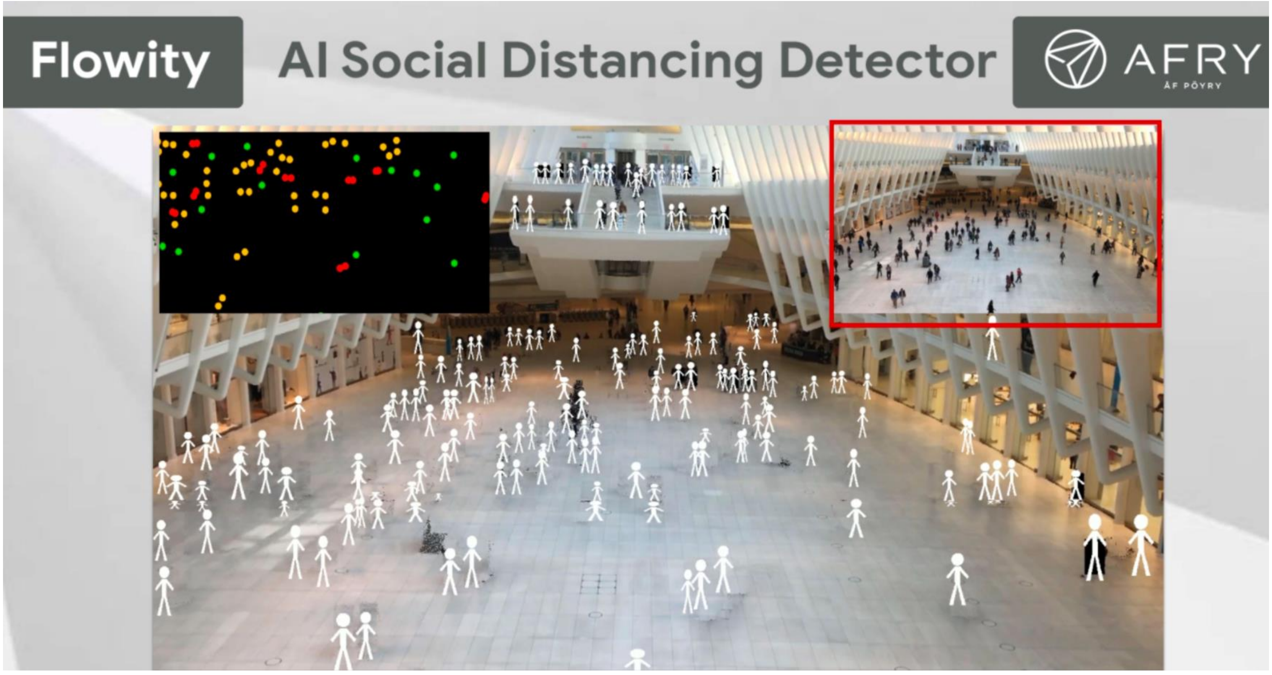


Figure 6: The social distance detector, Flowity. [17]

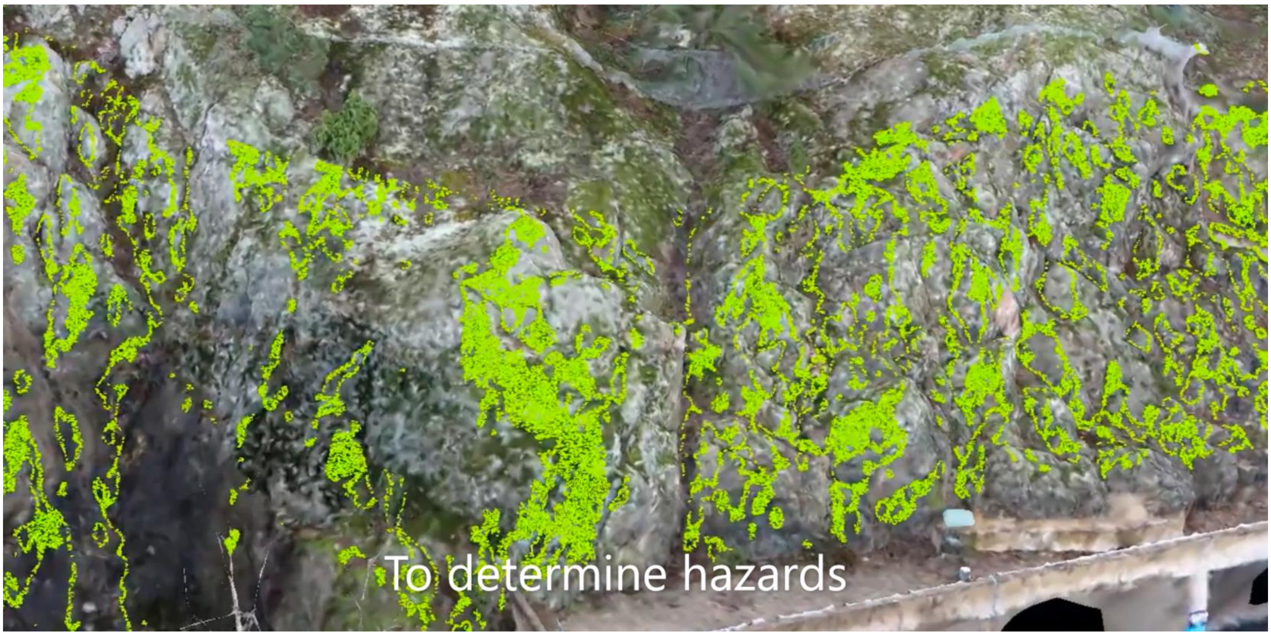


Figure 7: Determining hazards with geology pattern recognition, using ML techniques. [18]

Additionally, geology pattern recognition with ML techniques from the AFRY Austria division [18] was shown, see Figure 7. Thereafter, the concepts of regression, classification, clustering, dimensionality reduction and neural networks were introduced.

Maria Erman followed this up by introducing OCR, NLP, and previously mentioned state-of-the-art ML services such as Amazon Rekognition, Amazon Deeplens, Apple Siri, Google Assistant, and the Azure Cognitive Series etcetera.

3.3.Module 2 – Computer Vision

Markus Skogsmo led this module and started by introducing terminology and some pre-requisites associated with analyzing digital images, such as pixels, bands and intensity. Afterwards concepts of Digital Image Processing were introduced such as filtering and segmentation. More specifically computer vision, neural networks and the deep learning model convolutional neural networks, that has become essential for today's CV, were explained. Convolutional neural networks have layers that use the mathematical convolution operation, i.e., it transforms the input by using a filter. Subsequently, object detection and recognition were brought up in connection with self-driving cars.

Moreover, Markus Skogsmo demonstrated how a convolutional neural network works in real-time with training and classification by using the tool "Teachable Machine" [19]. Figure 8 illustrates Markus capturing images for the class Plant by using his webcam. Thereafter, he trained on the classes Book, Water bottle, Markus inside, and Markus outside. After training, Markus in real time showed how the algorithm proceeded with classifying, by Markus directing his webcam toward the various classes, and with the algorithm showing the prediction confidence values. Figure 8 shows how the algorithm recognized the Water bottle class with a prediction confidence of 100%.

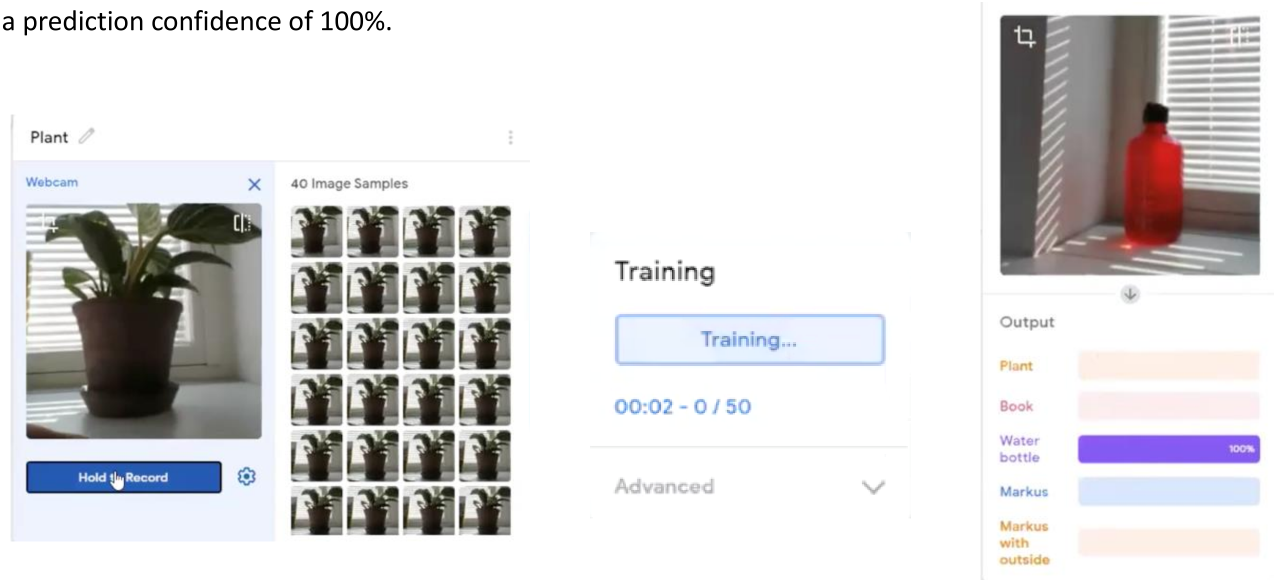


Figure 8: (a) Capturing data for the Plant class via the webcam. (b) The neural network in progress of being trained. (c) The neural network recognizing what class the image belongs to, and how confident it is.

Next Markus introduced the master thesis work "Image Augmentation to Create Lower Quality Images for Training a YOLOv4 Object Detection Model" [6] by Tim Melcherson conducted under Interact III. This work investigated how cutting-edge models can recognize old images, and how different ways of degrading images will affect the performance of modern ML algorithms.

Furthermore, Markus Skogsmo talked about CV in connection to his own master thesis work "A Scalable Approach for Detecting Dumpsites using Automatic Target Recognition with Feature Selection and SVM through Satellite Imagery" [20], which aimed to use satellite imagery to detect positions of large accumulation of waste, by letting a ML model observe features in the frequency domain.

The CV module was concluded by presenting Shuzhi Dong's master thesis work "Deep Learning for Iceberg Detection in Satellite Images" [4], which was conducted under Interact III. This work looked into how synthetic aperture radar image data could be used to classify icebergs and ships by employing and comparing various state-of-the-art ML algorithms.

3.4.Module 3 – Optical Character Recognition and Natural Language Processing

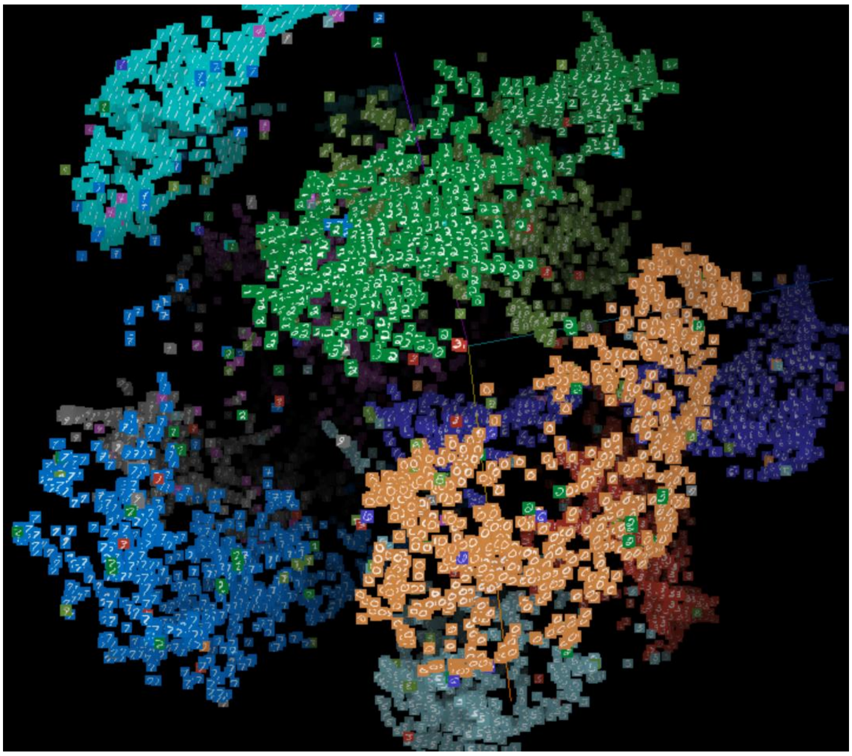


Figure 9: Visualizing clustered handwritten digits.

Maria Erman was responsible for Module 3. She started with introducing OCR and explained how it has progressed with increasing complexity, with present algorithms using deep learning. Furthermore, relevant and illustrative examples of use cases were presented, such as converting handwritten logbooks to text, making computerized images searchable, and performing sentiment analysis on text.

A demo of the technique was presented with the tool "Visualizing Digits in High-Dimensional Space with ML" [21], where thousands of handwritten digits, treated as high-dimensional datapoints had been fed into a neural network, clustering the images of digits based on their similarity, see Figure 9.

Next, the background and subsequently the procedure of NLP were explicated, after which a demonstration was given on how words as vectors can be illustrated by using the same tool "Visualizing Digits in High-Dimensional Space with ML". See Figure 10 for clusters of words, with similar words according to context and meaning, being close to each other.

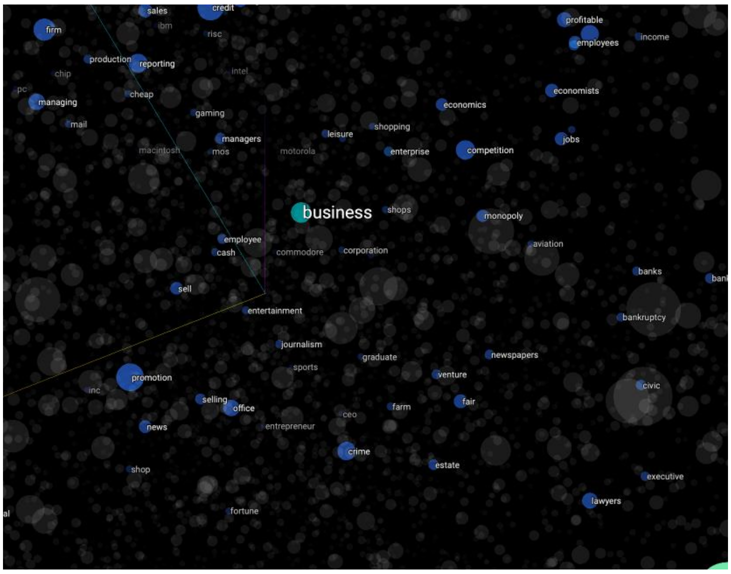


Figure 10: Words mapped to vectors using Word2Vec.

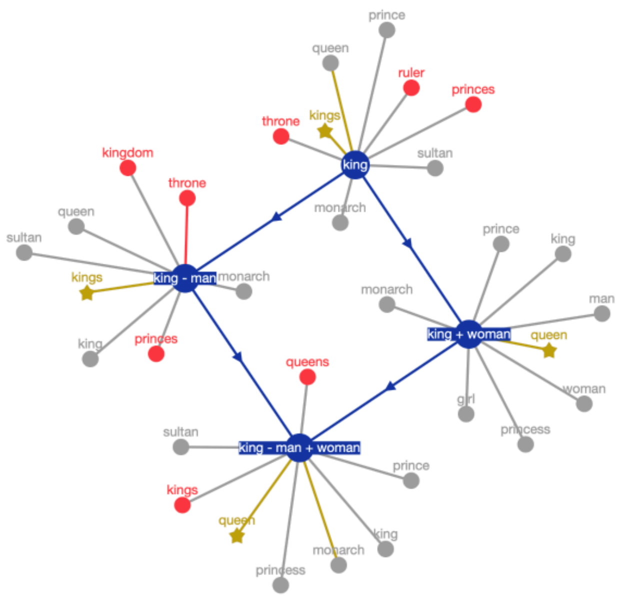


Figure 11: Vector arithmetic with words.

Since words can be represented by vectors, it follows that vector arithmetic can be performed on words. To demonstrate this, the tool "Dash Word Embeddings Arithmetic" was used [22]. A classic example of vector arithmetic is: $king - man + woman = queen$. This can be interpreted as: King relates to man, as woman relates to queen. See Figure 11 for an illustration of the vector representation of $queen$, denoted by a yellow star vector being closest to $king - man + woman$.

3.5.Module 4 – ML Services

Ruben Cubo took the lead for Module 4 that included state-of-the-art technology, cloud computing platforms, and examples of ready-to-use/hands-on services, such as Apple Siri, Azure Cognitive Services, Amazon Comprehend, Google Cloud Natural Language and Amazon Polly.

Amazon Rekognition [23] was demonstrated due to its simple API and powerful capabilities. Rekognition is a pre-trained deep learning tool that can be used for facial analysis, text detection, inappropriate content detection, video analysis etcetera.

Figure 12: Image recognition, matching suspects with an intruder. (a) Intruder. (b) Suspects.

A demonstration was carried out, using the Amazon Rekognition API, to illustrate how advanced computer vision capabilities are commercially available to anyone and can be used professionally. Figure 12 illustrates an intruder in a conference room of AFRY, trying to steal a chair. Three suspects, see Figure 12, are compared to the intruder, with the algorithm correctly identifying the intruder as suspect 1 with very high confidence. Figure 13 shows the output of the algorithm with there being a match of the intruder between the first suspect. It can be seen that despite different facial angles, and missing glasses in the intruder picture, Rekognition still manages to find a match with 99% confidence.

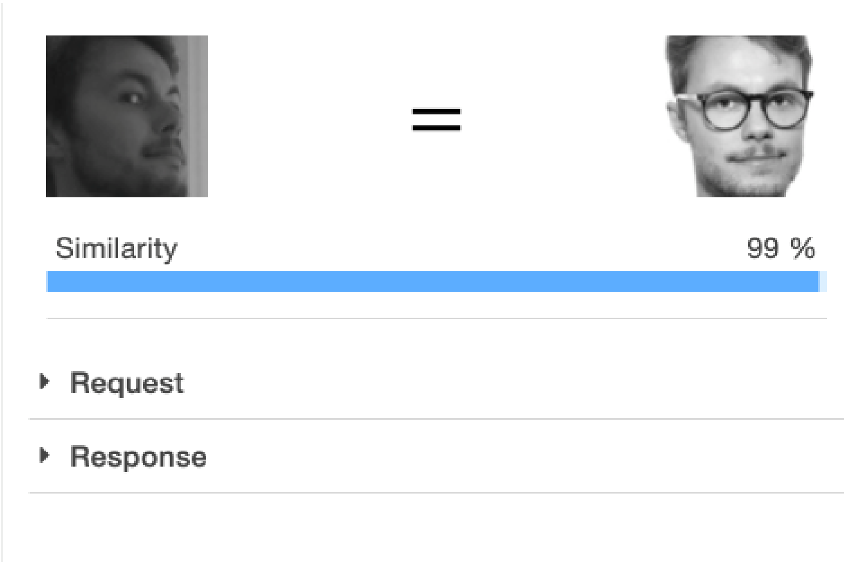


Figure 13: Amazon Rekognition matching two faces with each other with 99% confidence.

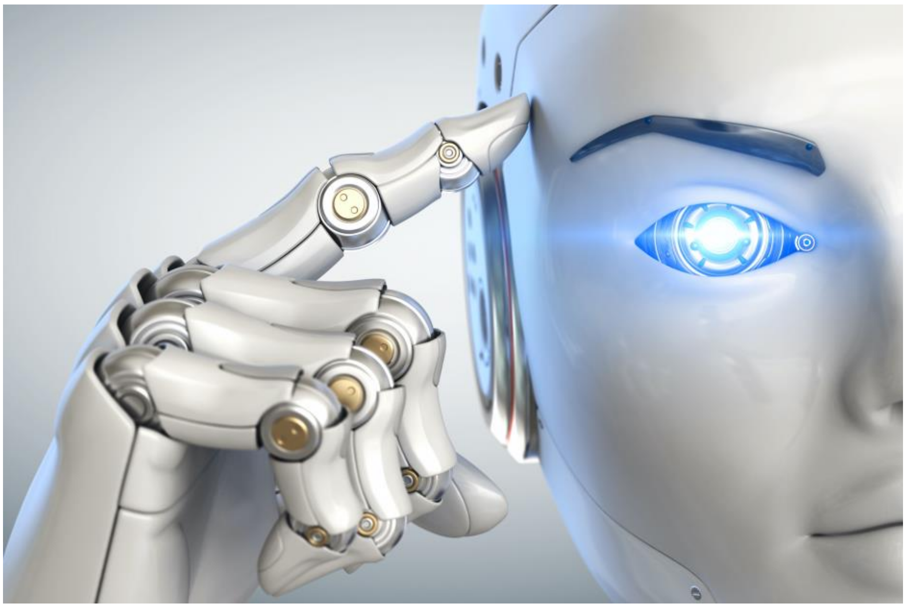
Furthermore, Amazon Comprehend was demonstrated, which is a commercial NLP service. It features extracting key phrases such as places, people, events etcetera, and can perform sentiment analysis, syntax analysis as well as identifying languages.

In conclusion of Module 4, The Mechanical Turk [24] was introduced, which is a crowdsourcing marketplace for collective outsourcing. Sometimes, manual tasks are necessary, even when using machine learning techniques, for instance, to create or improve a training data set, and Amazon's service The Mechanical Turk is a way to outsource simple and discrete tasks, such as categorizing images, collecting information from texts and websites etcetera.

3.6.Module 5 – Questionnaire and Discussions

In the final session, attendees were encouraged to fill in a questionnaire that will lay the foundation for D6.1. Moreover, this session was devoted to discussions where attendees were grouped together in breakout rooms in Zoom. The following example questions were provided to spark conversations:

- Can you think of any possible applications of AI/ML in your areas of expertise?
- Do you have any research ideas?
- How could implementation/integration of these types of technologies help your work?
    - What could it lead to?
    - Do you think it could lead to new/other interesting results/remarks related to what you are studying?
    - What kind of information would be interesting?
- What do you need, or need to do to be able to provide data for future development?



4. Discussions

Fruitful discussions were held, and the subsections below represent an attempt at summarizing the main topics and ideas brought up by the various participants of the workshops.

4.1.Data and Services

4.1.1.Problem Formulation

A vast amount of data can easily overwhelm our minds. AI and ML are tools that can aid in analysing these data, and in addition provide us with unexpected information. The idea is to use computers for pattern finding, with people providing a set of rules governing the work.

Properly defining and constraining the problem at the beginning is thus essential to ensure the best possible results. This is a challenge in the AI community and is something to be taken into consideration within the context of Arctic research and INTERACT.

4.1.2.Possible Lack of Data for AI Algorithms

A data set from an Arctic research perspective can be quite large. However, for many AI algorithms, which are often trained with millions of data points, that same data set can be considered very small which can be a challenge in some areas.

Another potential challenge is using existing older data, such as old photographs and transcripts. However, these data often have been collected with a different purpose in mind and adapting it to new problems can add some difficulty.

4.1.3.AI as a Service

One theme that was brought up often during the discussions was the usage of AI as a Service, i.e., there is a trained system that can be used in several places. One such example would be a polar bear AI that can process other similar data. This could be developed as a toolbox or a software package and should be useful for processes that are used repeatedly over many years.

4.1.4.Using IoT

When it comes to data collection in remote sensing, it takes a while to actually collect the data from cameras or other sensors. Using IoT (Internet of Things), hardware that can stream data directly towards a research station can be used.

4.2.Snow Studies

Snow is very important in an ecosystem and melts differently in different areas. One could use remote sensing to recognize whether there is snow or not with higher resolution in time and space. Both data on the ground and satellite data can be used for this purpose.

These data can be used to model snow melting patterns and permafrost. This is useful not only for Arctic research but also for other areas such as safety from, e.g., avalanches. For the latter case at least the slope angle, the direction, the wind, the precipitation and the temperature would be required.

4.3.Phenology Studies

Phenology is defined as the life cycle of a living creature and it is a hot area of research in the Arctic region. This has been a recurring theme in the network, being, e.g., part of a WP in INTERACT I.

There are questions regarding plants such as tracking (i.e., what is happening to them) or when they are blooming. Taking measurements is extremely time consuming however, because of the large amounts of species and their associated life cycles to be tracked. AI can in a mechanical and automated way identify the species and where they are in the life cycle (e.g., in the process of blooming, fully in bloom etcetera).

Another area of interest related to phenology is pollination. During the discussions it was mentioned that there is a system developed by one group outside of INTERACT that monitors pollinators (e.g., species, phenology of the pollinated plants etcetera) and they have millions of pictures of data.

4.4.Glaciology Studies

Some researchers within the network are involved into analysing glacier properties as well, such as its size. Image recognition can be used to see which part of the glacier is melting and which is not. It would be of interest to predict the size of the glacier, e.g., in a year as well.

4.5.Fauna Analyses

Analysing the presence of the local fauna and its evolution over time is a very important topic in Arctic research and has been a large part of the discussions during the workshops.

4.5.1.Humans Affecting Animal Life

An issue with fauna monitoring in the Arctic is the interference between humans and animals. This can be either from a research perspective (e.g., measuring, recording, autopsies) or a more societal perspective (e.g., tourism, settlements). One idea is to use an automated network of cameras or stealthy trap cameras. Another is to use drones to record data, although it is unclear how many stations are using drones for this purpose.

It could be worthwhile to analyze how animals are reacting to the lack of human presence due to the lockdowns during the COVID-19 pandemic as well as to see how this will change when people's behaviors return to normal. This part would be related to WP9, which is looking into protecting the Arctic environment from unsustainable tourism.

4.5.2.Recognition of Species

The first step to understand the fauna is to recognize the species in, e.g., a photograph, or recorded sounds. This is a time-consuming process that could be automated. Different algorithms and training processes will have to be used in different INTERACT stations due to the variability of the environment.

4.5.3.Recognition of Individuals

It is of interest to recognize individuals within a given species as well. This has been done with sounds and with images, using different patterns present in different individuals. There are several possible areas:

- Birds: Using their sounds, it is possible to distinguish between different individuals.
- Reindeer: Using IoT sensors to connect the GPS necklaces that will register how many reindeer that have been positioned in certain areas on a regular basis.
- Polar bears: Using a camera and ML, individuals can be identified, and a story can be built around different individuals, which can be interesting as a touristic attraction.
- Whales: Identification by their fins. There is a citizen science project, Happywhale [25], that does this manually. Data could potentially be obtained from canoeing clubs for example.
- Penguins. British Antarctic Survey has looked into this in the past.
- Albatrosses using high resolution satellite images. This is an area of research of the British Antarctic Survey (see [26] for more info).
- Recognizing seals are also of interest by using satellite images.

There are other initiatives such as Rovbase [27] where one can look at an animal and click and follow it, and there is an estimate of where the animals are.

4.6.Climate Data

A large amount of climate data has been collected from research stations, (e.g., Abisko) and ships (e.g., whaling vessels), sometimes spanning hundreds of years.

However, it is cumbersome to manually transcribe these data, which include, among others, temperatures, ocean temperature, air temperature and sea ice conditions. It could be worthwhile to use AI to automate at least parts of this process, making it possible to mobilize large amounts of data quickly, although it is not clear whether these can be put into an ML framework.

4.7.Cultural Heritage

There are numerous transcripts of traditional knowledge and interviews. Manually relating these to a geographic location is cumbersome. Areas such as land usage by native populations over time or linkages between different populations can be of interest for Arctic research.

Using OCR or speech recognition for both the notes and audio would be interesting. This can be used not only to automate processes, but also to find hidden patterns not seen in manual work. Even though available datasets are not large, adapting an existing NLP framework with little training data is a possibility. Machine translation could be another option to look into.

5. Conclusions and Future Work

The specified goal of D6.2., has been to conduct workshops, and demonstrating technology available today and what is to be expected in the future in the areas of ML and AI technology.

Several attendees of the workshops have communicated that their knowledge of AI/ML is sparse, however, at the same time expressing an interest and curiosity of artificial intelligence. The input, thoughts and creative ideas expressed by the attendees during the discussions of the workshops have laid a solid foundation for how WP6 is best to proceed with subsequent deliverables.

An aim has been to showcase concepts that can be conducive to Arctic climate research, and it is our hope to have spurred curiosity and to have demonstrated that AI/ML is much more than its hype suggests. Whether causality or correlation, the participants of WP6 have noticed an increased interest in AI/ML among Interact III researchers, starting from the mini-workshops having taken place in June, proceeded by the workshop in September, up to the interviews being held in preparation for D6.1.

From the perspective of WP6, insights have been gained on how field work is conducted, what data is measured, and what parameters are of interest in the great variety of research fields pertaining to Arctic climate research. This knowledge is valuable when WP6 continues its work toward future deliverables.

Future work for WP6 is to collate interviews and datasets from station managers and Interact researchers with regards to inquiries and problem formulations, and further, to distil this information into a pre-study. This will serve as a basis for further work on demonstrating tangible results on Interact III researchers' data sets by using machine learning algorithms.

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Appendix A

The following text was e-mailed to prospective participants in advance of the workshop as a discussion basis.

Introduction

As part of the WP6 mini workshop, we will have a discussion on how artificial intelligence (AI) and machine learning (ML) can be applied in your domains. For the purpose of triggering discussions, we have compiled a few ideas below, that may or may not be relevant, due to our limited understanding of Arctic research. We would appreciate it if you could browse through this document before the workshop and bring your own ideas if you can.

Deliverable 6.1 will be a pre-study on inquiries and needs from identified station managers and researchers, to identify possible datasets and types of questions to be answered. Hence, we would appreciate further discussions, and would be happy if you contacted us at: maria.erman@afry.com and ruben.cubo@afry.com.

Possible Studies

Polar Bear Health Status

Drones can be used to record populations of bears, using image processing to automatically label them as e.g., "Sick/Malnourished":

- Proportion of sick bears compared to other years.
- Geographical analysis. Which areas are the most affected?

Major pros of using drones:

- Crossing inaccessible terrain/accessing small islands.
- Minimal disturbance for the bears.
- More frequent observations.
- Safer for humans. Hungry bears are dangerous one would guess?

We can relate these with regular polar bear movement data over time:

- Time series (do you track polar bear populations?).
- Population analysis (coarser).

We can relate these with local temperature data:

- Fine-grained in particular would be interesting. Similar to the reindeer case where several die after an extreme event.
- Ex: what happens if there is a several-day-spike in temperature?

Small pilot study already underway to classify “artificially old” photographs of polar bears compared to e.g., birds.

Fish Monitoring

There is a dataset in lake Oulujärvi:

- Fish population, species.
- Fish reports? What has been done here exactly?
- Lake temperature? How does it affect the fish?
- How is global warming/pollution affecting the fish?

Vegetation

Several areas can be explored, such as:

- Evolution over time
  - Take old photos and compare vegetation with current ones.
  - Comparing them could be tricky, we have to make sure the season and the area are the same.
  - Image registration, i.e., matching as best as possible two similar images by means of rotation or translation, is needed for a fair comparison. Still, we need to be able to get the same image under similar circumstances.
  - Comparison and relation with vegetation indices/GIS data.
- Arctic flora
  - Classification of arctic species. It is possible that they are not encountered often and thus are not in benchmark datasets used to develop and evaluate AI algorithms.
  - Time evolution, if we have the images. Look at e.g., petal size, color (unlikely to obtain though) and density.
- Short-time changes to anomalous events
  - Could be done via satellite as long as satellite revisit times, i.e., how often they pass above a certain spot on Earth, are short enough.
  - Idea is to record data during a temperature spike and see how vegetation react. Maybe not applicable to trees, but flowers, bushes?

Fluctuations: Part of WP4. A Joint Effort could be Worthwhile

An example of fluctuation would be meteorological events such as polar storms, cloud classification or northern lights.

Info from Expedition Journals

- OCR (for printed documents).
- Handwriting recognition + OCR (for hand-written notes).
- Aim: Digitalization. Maybe filtering with keywords?

Validating Analyses of Old Photos/Notes with Satellite Imaging

One example would be to get a "modern" set of ground images and journals and compare them to satellite imaging. That way, we would have a kind of "ground truth".

Still, depending on the problem we might run into biases (especially if they are unstructured notes such as logs or diaries) and/or lack of data (because e.g., the explorer could not report thoroughly enough).

Fractures in Geology/Glaciers

Another AFRY group is looking into geological fractures using AI (will show a small video during the mini workshop).

For our purposes this can be applied to e.g., permafrost evaluation using remote sensing. Currently, a small pilot study with iceberg detection from satellite radar data is underway.

Large-Scale Text Analysis

This refers to already digitized text. Old, digitized text could be part of this. Two ideas that we have:

- Sentiment analysis: "Estimating" what is the sentiment behind a document.
- Recommender systems: A small pilot study already underway that will recommend papers with similar content to researchers.

Ideas Based on Interact II Work with Drones where AI can be Applied

- Count animal populations/segmentation (see example of the polar bears above).
- Granulated snow coverage, which would be sensible, especially during the change of seasons (e.g., spring meltdown, start of the snow season).
- Usage of data to complement old photographs.
- Automated sampling: The drone would detect an interesting patch of land automatically and collect a sample of its soil.
- Exploration: One would expect some of the explorer logs to be old and sending human expeditions there is expensive. A quick visit by a drone could be interesting and automating the analysis (even onboard preprocessing) could save a lot of time.

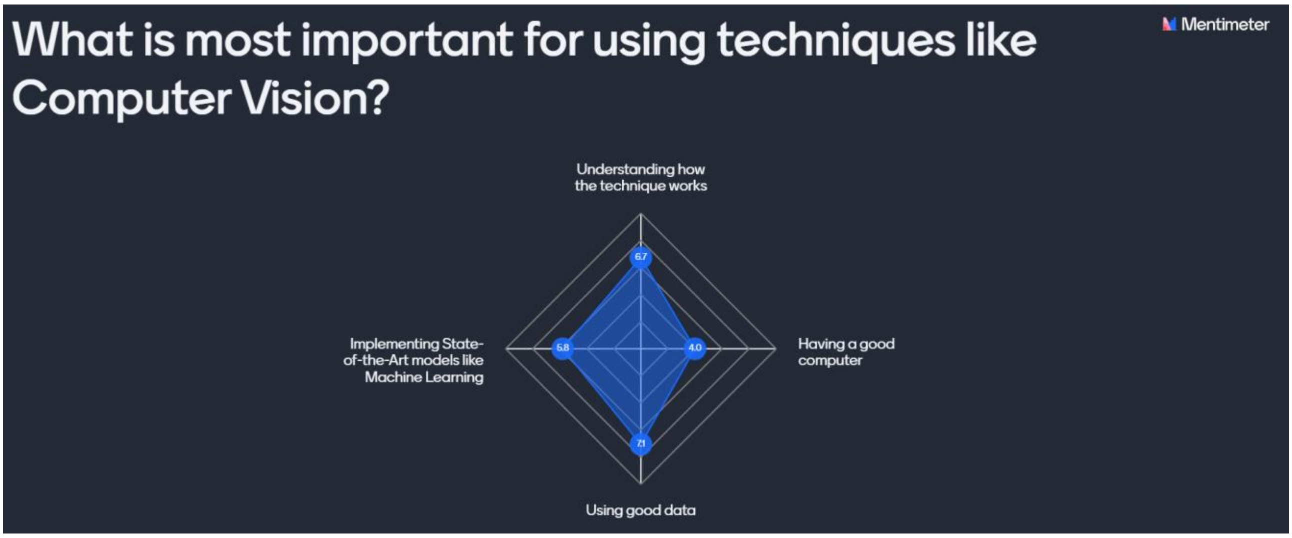
Visualization

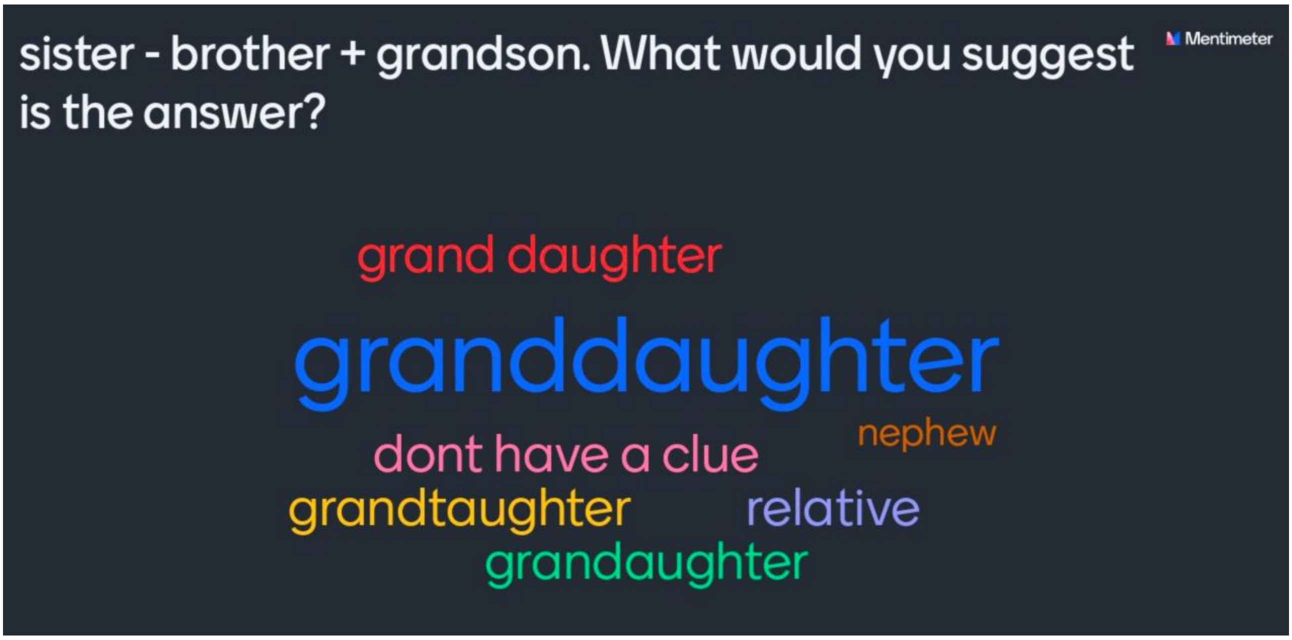
Open to ideas! Some areas to focus on:

- Presentation in a good way to peers in the INTERACT community.
- Scientific dissemination to society.
- Interactive plotting and dashboards.
- Keep it as simple as possible in any case.

Appendix B

Below are answers for the questions that were posed to the attendees of the workshop using the tool Mentimeter [14]:




sister - brother + grandson. What would you suggest is the answer?
Mentimeter
grand daughter
granddaughter
nephew
dont have a clue
grandtaughter
relative
grandaughter