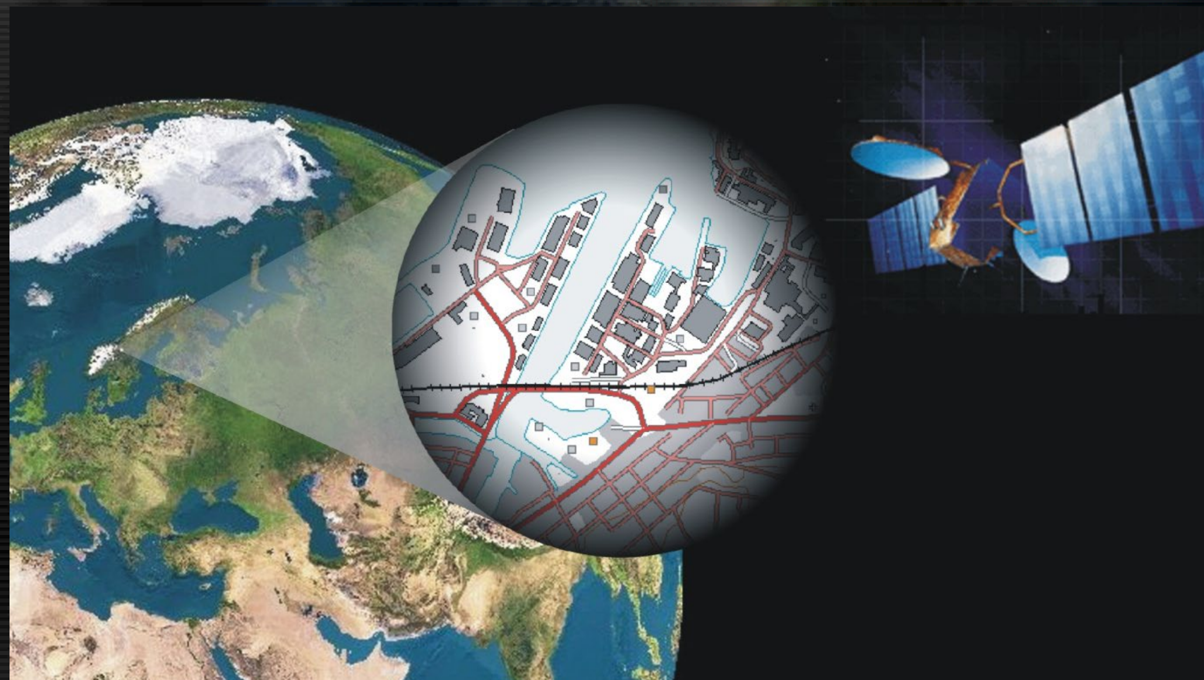
Geomatikk fordypning 2023



- Fordypningsemne
- Prosjekt

Geomatikk fordypning

Mål:

Videregående og avanserte temaer og metoder innen Geomatikk blir presenteret, diskutert og anvendt. Emnet konsentrerer seg om forskningsbaserte temaer og ny utvikling innen Geomatikk. Studenten skal være i stand til å lese litteraturen på en kritisk måte, samt å bidra aktivt i presentasjonen av delemner i kollokvier. Innholdet i emnet vil, til en viss grad, bli tilpasset pågående aktivitet og forskning ved gruppe for Geomatikk. Studenten skal velge 2 tema à 3,75 stp.

Modular

- Fordypningsemne 7,5 studiepoeng

  Velje 2 av desse modulane

- GPS
- Geografisk informasjonsvitenskap
- 3D digital modelling
- Modul ved datateknikk (avtale med faglærar på datateknikk)

GISc/Kartografi

Geografisk informasjonsvitenskap VK, 3,75sp

Innhold: Kurset vil ta utgangspunkt i nyare forsking innan geografisk informasjonsvitenskap. Visualisering er spesielt vektlagt, men også andre tema er aktuelle (t.d. generalisering, VR/AR, web/mobilbaserte metodar og algoritmer og datastrukturar for geografisk informasjon).

Undervisningsform: Kollokvium

I praksis:

- Fokus på ein del tema
- Gjerne knyta opp mot prosjektarbeid
- Deltakarane med å velje ut litteratur
- Innbyrdes presentasjonar i kollokvium – diskusjonar

3D modellering

- Sjå eigen vedlagt Powerpoint med oversikt over tidlegare versjon av emnet

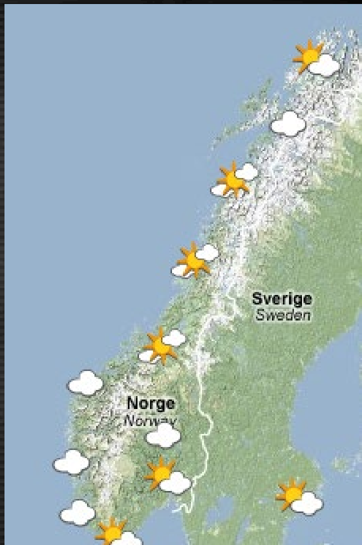
GPS

- Forelesingsserie om avanserte tema innan satellittgeodesi. 2t i veka gjennom semester

PROSJEKTFORSLAG:

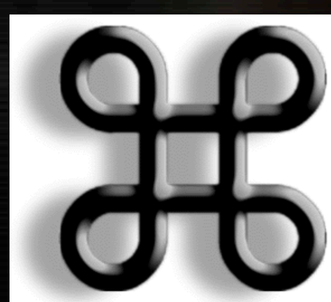
Forslag innan kartografi, visualisering, GIS

Følgjande oppgåver, kontakt: Terje Midtbø



Beste reiserute

- Utgangspunkt: Du har ein del stader du vil besøkje, men ynskjer optimal kombinasjon av vêr og andre faktorar når du er på kvar lokasjon
- Lag prototyp for Web-applikasjon for å finne beste reiserute for å vere innom alle stadane



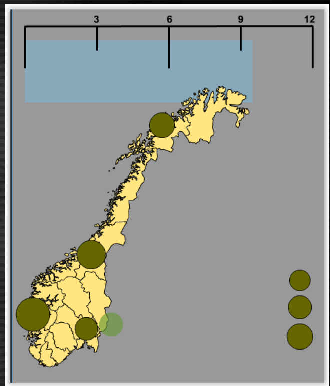
Studere muligheiter for bruk av Microsoft Hololens 2

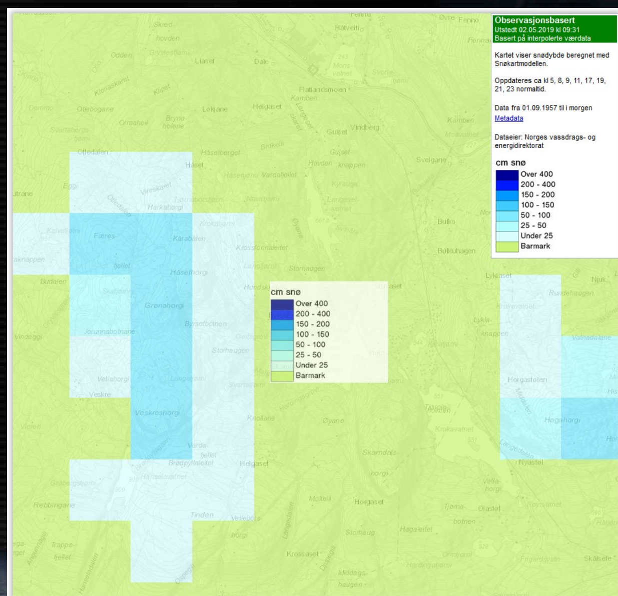
- Studere teknologi og bruk av utstyret, spesielt i geografisk samanheng
- Sjå spesielt på georeferering
- Kopling av kart og navigering
- Modellar basert på data frå Norge Digitalt?
- Eventuelt lage prototypar for å demonstrere konsept

VR (Oculus Rift) for studiar av kartbruk

- Sjå på metodar for å handtere kart i Oculus Rift ved hjelp av eigne «input» verktøy
- Utvikle prototypar for ulike måtar å handtere «virtuelt kart»
- Vurdere metodane i pilotstudium?
- Kan vidareførast med eksperiment i masteroppgåve

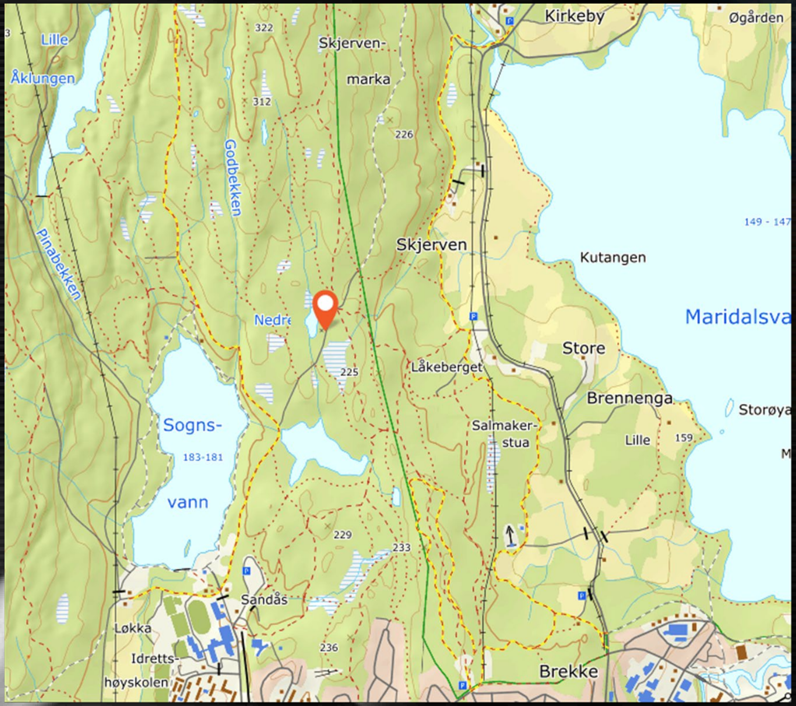
Teiknforklaring i Web - applikasjon





- Studere litteratur om teiknforklaring, spesielt på Web
- Vurdere nye metodar
- Vurdere teknologi som kan
- brukast
- Eventuelt lage prototypar

Tyngdepunkt-applikasjon

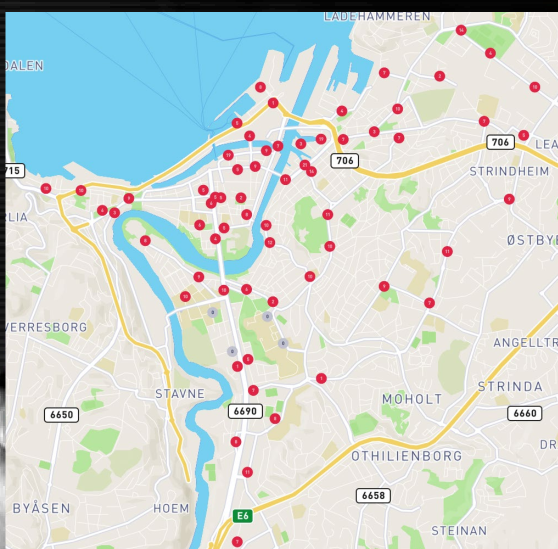


- Studere relevant litteratur
- Lage applikasjon – enkel input
- Tyngdepunkt i land/fylke
- Ta hensyn til øyer?
- Ta hensyn til volum?
- Ta hensyn til befolkning?
- Plassere på kart

Forslag innan kartografi, visualisering, GIS

Følgjande oppgåver, Linfang Ding

Spatiotemporal analysis of city bike data



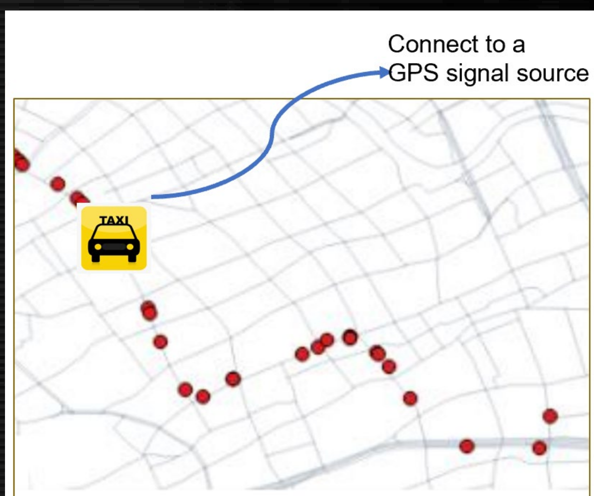
- City bike data are increasingly applied for the analysis of urban dynamic patterns and for applications like traffic flow estimation and forecasting; urban planning; city bike management.

- Test data: open city data in Trondheim

- Answer questions like
  - Are there daily/monthly bicycle usage patterns?
  - What are the spatial distribution patterns? Hot spots?
  - Are there any spatiotemporal changes before/after COVID?
  - Imbalance/rebalanc of bikes?
  - ...

Derivation and visual analysis of commuting patterns from GPS floating taxi data

- Unlike city-bike data, floating car data contain full GPS trajectories of the vehicles. Commuting patterns can be derived from the big movement data, which helps in estimating infrastructure demands.

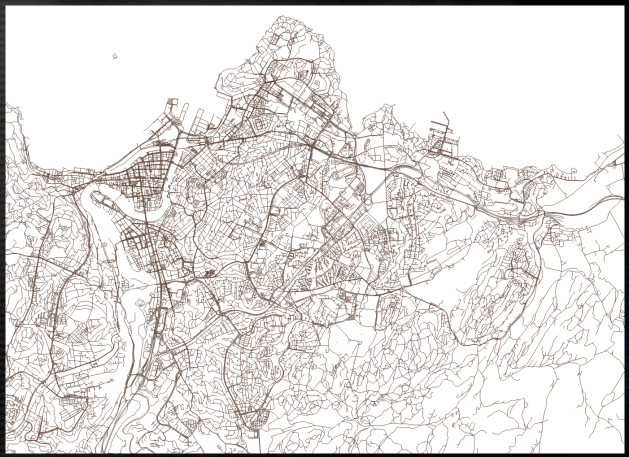


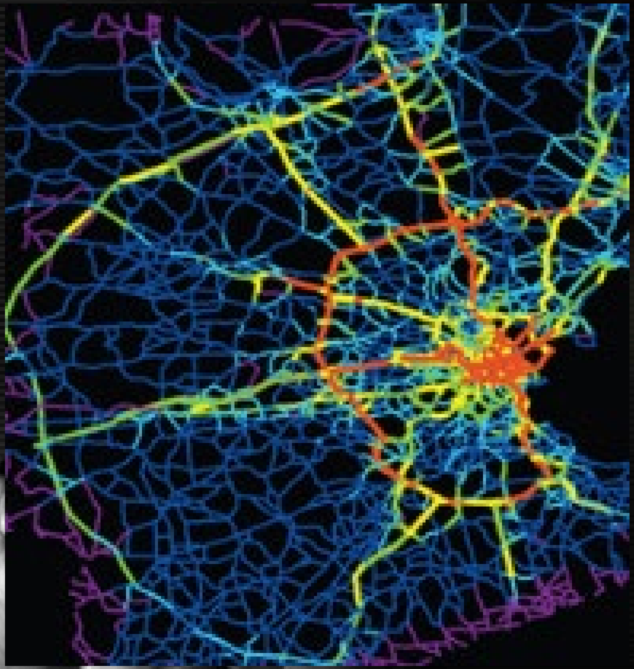
- Test data: floating taxi data in Shanghai

- Investigate:
  - Temporal patterns passenger pick-up/drop off
  - Spatial clustering
  - Derivation of regions of interests of commuting trips

  - An interactive visual analytical interface for exploration of commuting patterns (e.g., distances, dense/sparse distributions)

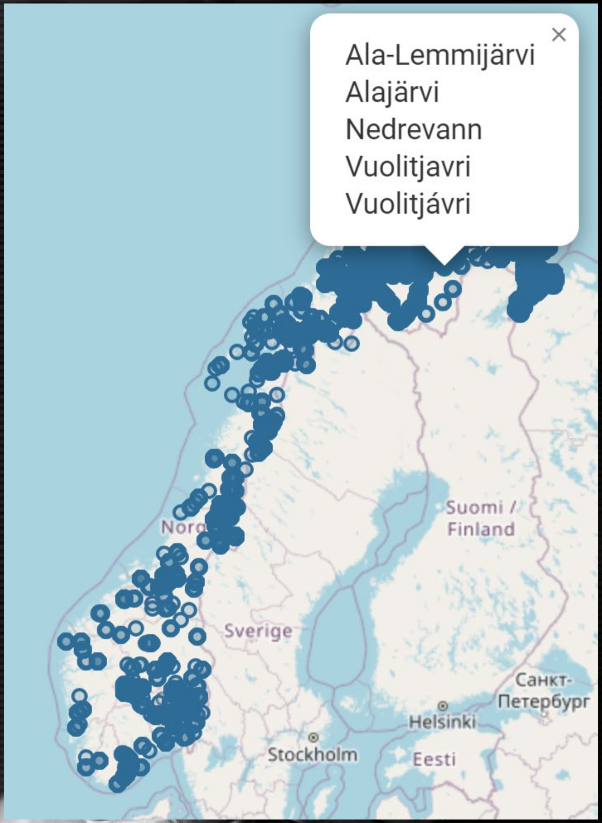
Multi-scale centrality analysis of road network





- Street network plays an important role in movement and vehicular flow in a city
- Centrality measures describe essential properties of networks and the relative importance of a vertex within the graph. The measure can be used for e.g., mobility prediction
- Test data: *OSM* street network data
- Investigate the centrality at multiple spatial scles
- Evaluation against traffic data (e.g., *Geonorge)*
  - Are there any ‘gaps’ between this centrality measure and actual traffic flow?

Analyzing and mapping of geographical names from linked geodata



- A named place often has one to several geographical names due to historical/cultural reasons
- INSPIRE & Kartverket published named places, their geographic names and administrative units in Norway as linked data
- Examine and visualize
  - spatial distributions of different numbers (e.g., 1, …, n) of geographical names
  - the distribution patterns of different languages, endings
  - spatial correlations with administrative boundaries/ natural objects/cultural backgrounds?

Topic suggestion for specialized projects (and master thesis)

Prof. Dr. Hongchao Fan

02.05.2023

Topic 1:

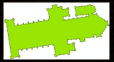
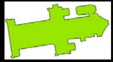
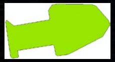
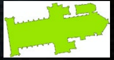
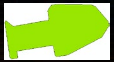
Performance assessment for drone mapping with multispectrual camera

- Positional accuracy
- Geometries
- Radiometry

Topic 2:

Calculating shape similarity of polygons

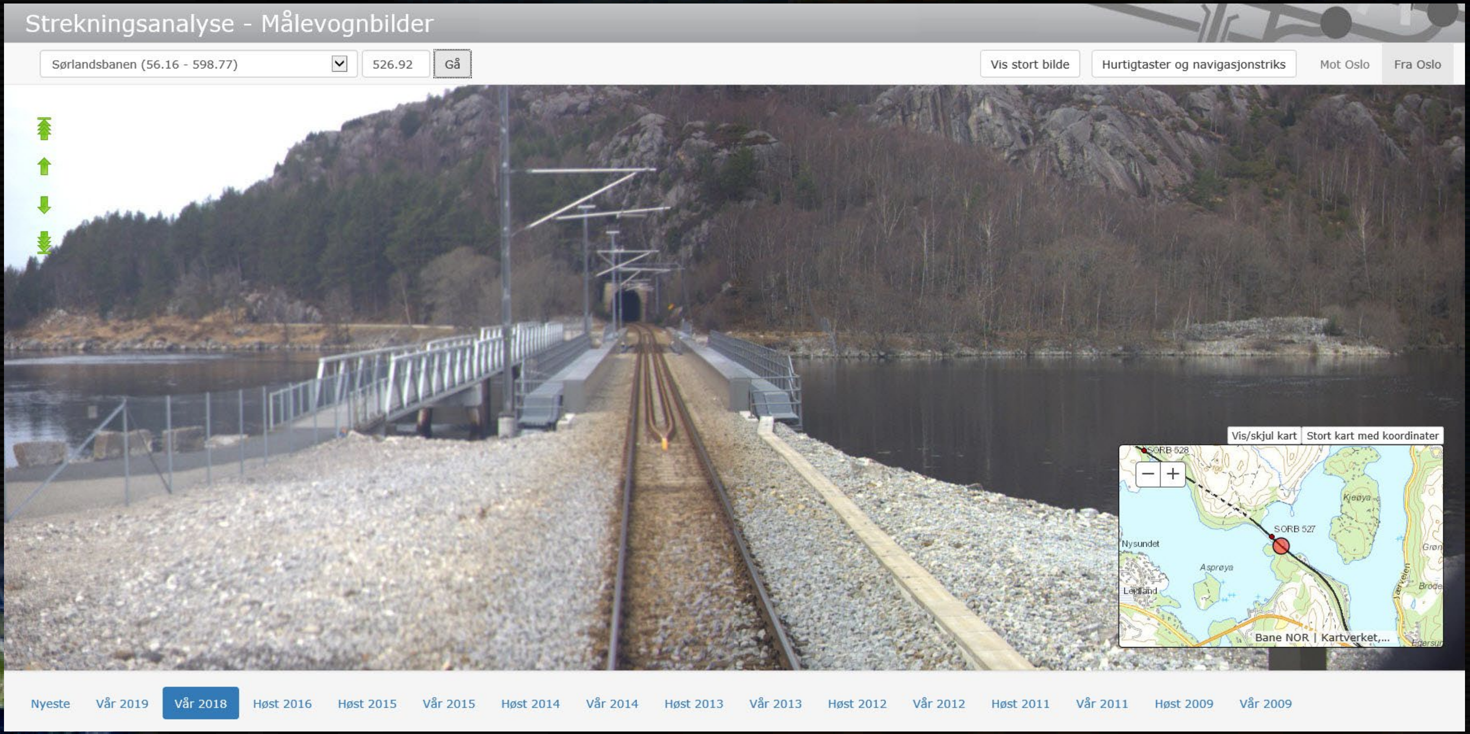
Find out or develop a method to represent polygons, so that the similarity can be calculated.

Shape similarity		Original polygon	Tolerance 3 m	10 m	20 m	35 m
						
Original polygon		1.00	0.90	0.82	0.75	0.72
3 m		0.90	1.00	0.85	0.77	0.76
10 m		0.82	0.85	1.00	0.77	0.78
20 m		0.75	0.77	0.77	1.00	0.91
35 m		0.72	0.76	0.78	0.91	1.00

Topic 3:

Object detection from video sequences for the purpose of train positioning

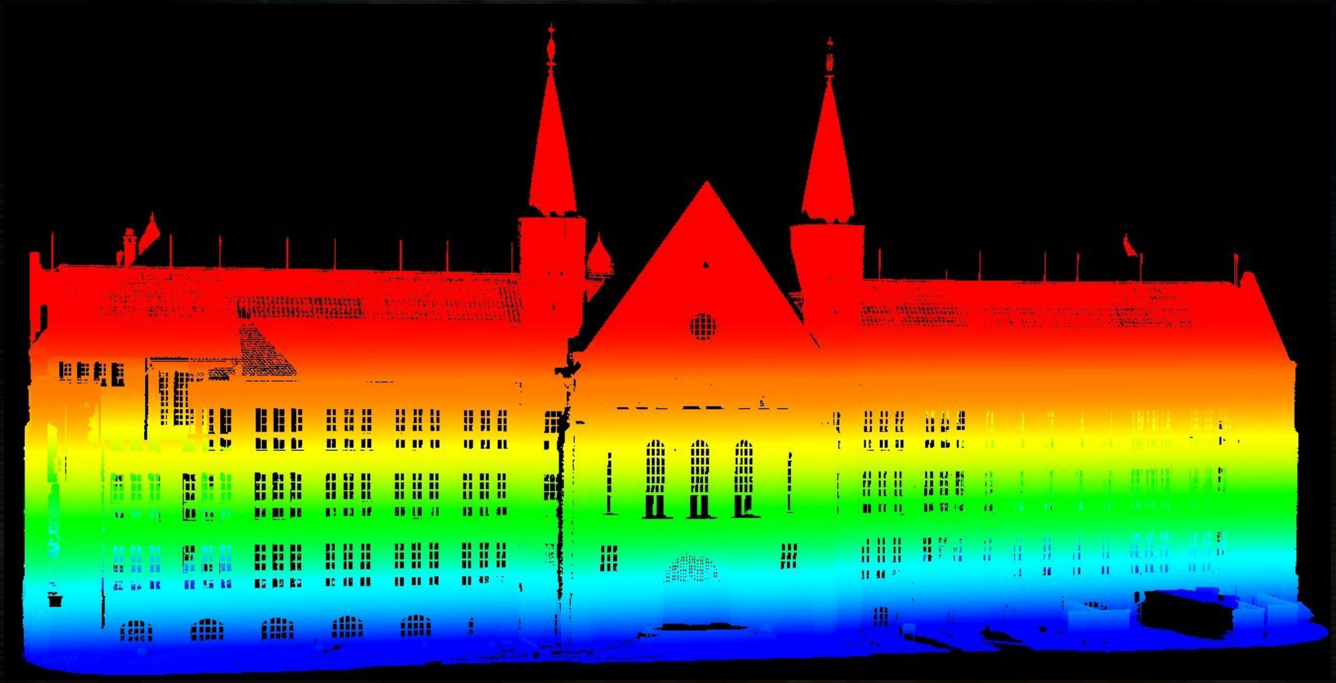
BANE NOR



Topic 4:

Window detection from ALS point clouds

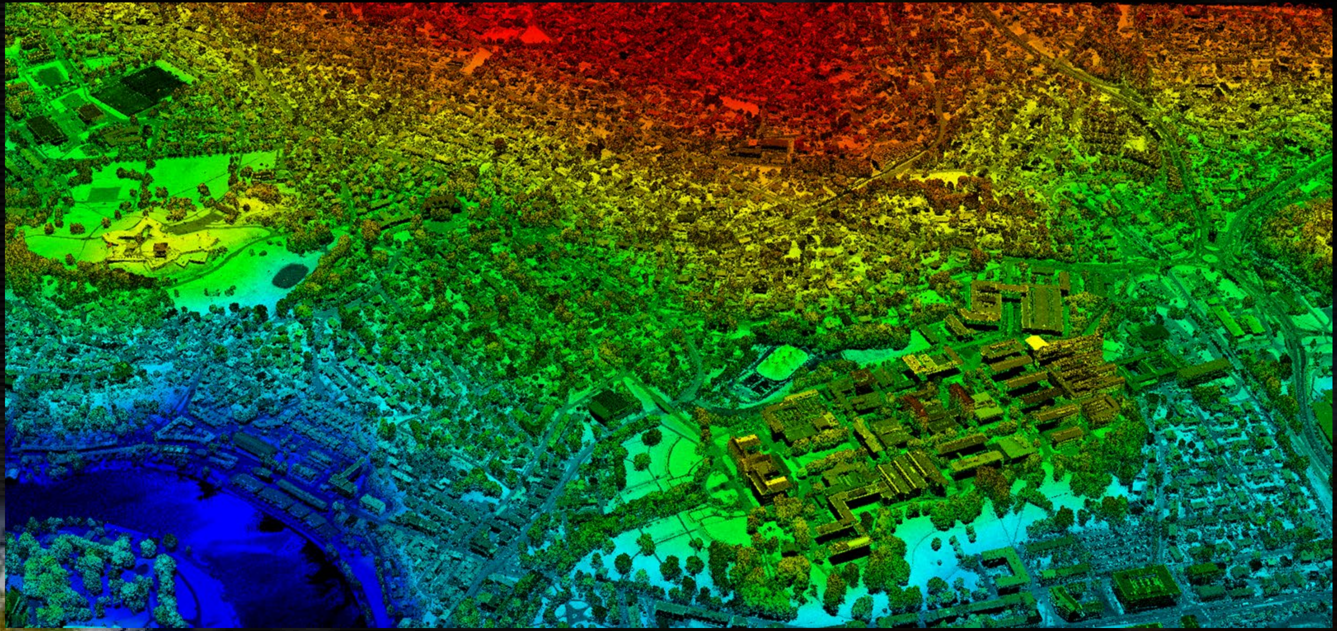
- Deep learning based method
- Feature engineering



Topic 5:

Detecting and mapping trees from ALS point clouds

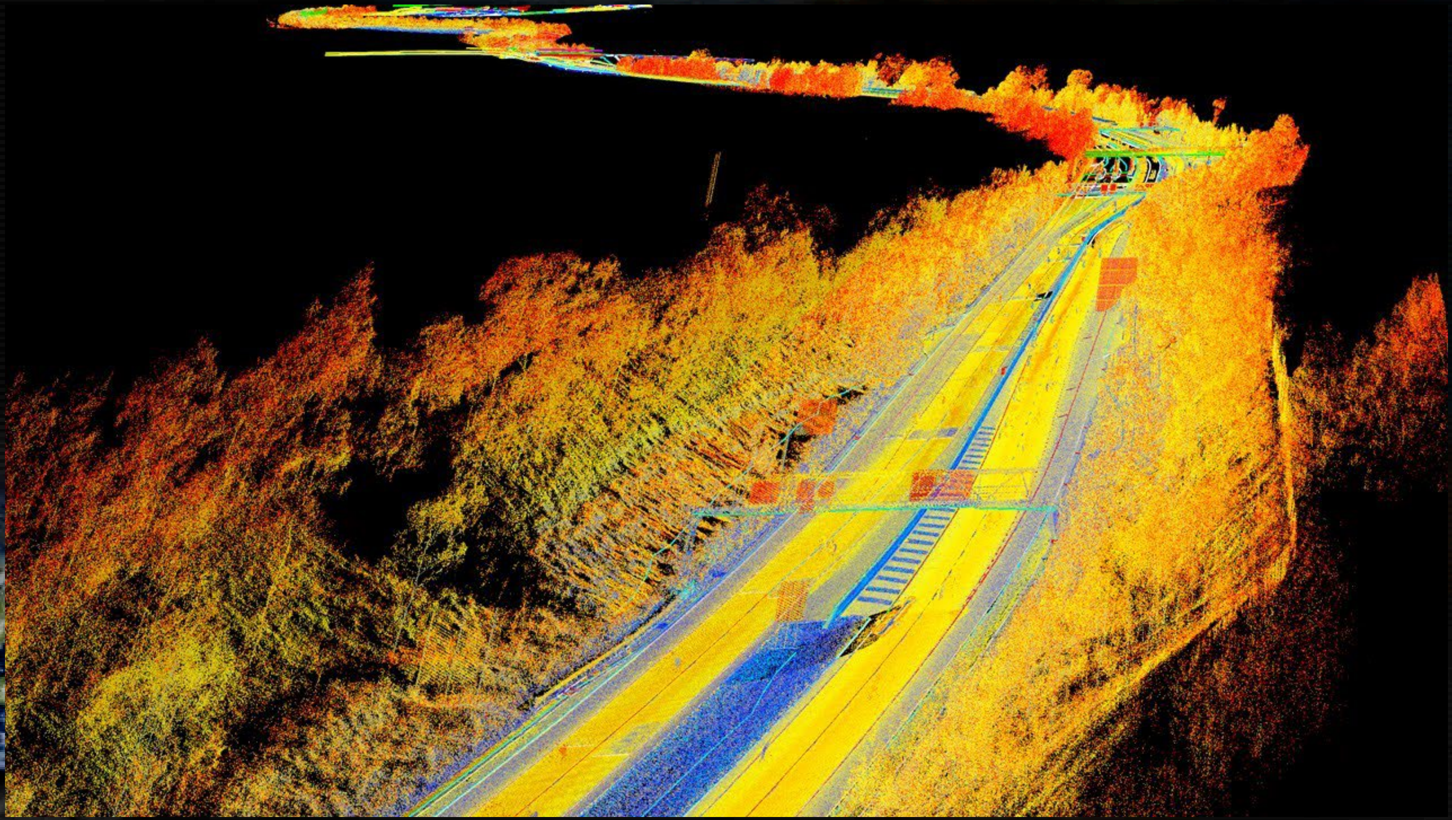
- Training data generation
- Improvement based on existing deep learning approaches



Topic 6:

Improve the georeferencing of MLS point clouds data by using map matching

- Feature object detection from MLS point clouds
- Map matching

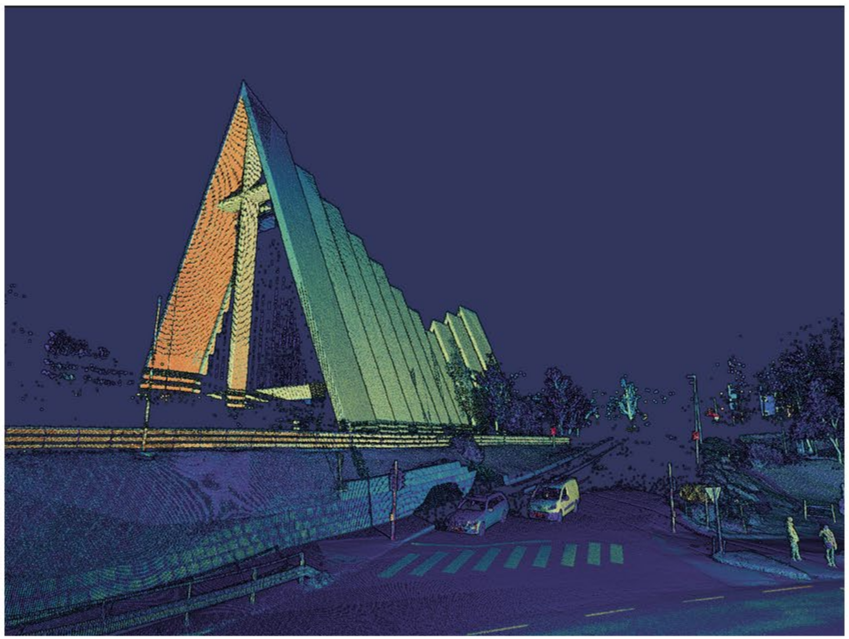


Topic 7 :

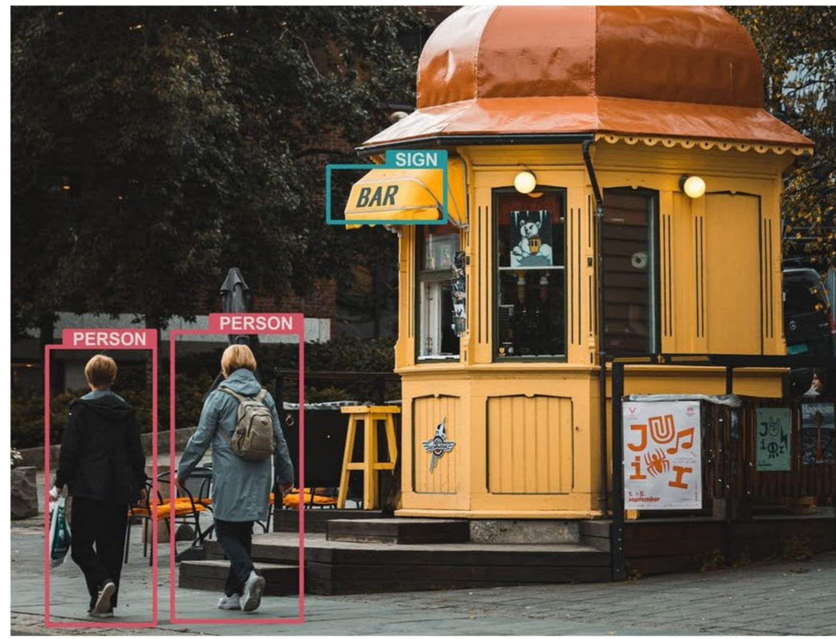
Comparing scanning performance between Leica Scanstation P40 and Trimble Multistation

CAPIA

https://capia.no



Punktskyanalyse



Objektgjenkjenning

Topic 8 :

Project 1 - Digital inspection tool for road network in Norway

Capia develops a digital inspection tool for roads, tunnels and bridges. Being able to conduct inspections digitally in a virtual environment will improve the quality and safety of roads as well as the work of maintenance personnel. Inspections can be performed safely and time efficiently independent from weather and traffic conditions also in potentially dangerous locations like tunnels and bridges. Interrupting traffic for inspections of roads but especially tunnels and bridges can be minimised by performing digital-pre-inspections and by planning maintenance jobs in advance digitally in detail.
Digital inspections will make road maintenance planning more efficient and allow for allocation resources from inspecting to fixing issues.

The data comprises measurements collected from 1-3 LiDARs mounted on a vehicle, generating up to 50 million points per kilometre. Labeled point cloud data can be provided by the beginning of August 2023.

Topic 8 :

Challenge 1A - Classification of point clouds, without assistance from images

The aim is to develop a machine learning-based method for automatically classifying point clouds based solely on their geometric properties, such as point density, distribution, intensity, and curvature, which are all intrinsic to the point cloud data. The method will not rely on image-based data, such as photographs or RGB information, to classify the point clouds.

The objects of interest are mainly road-related objects, such as cars, road signs, and guard rails. To achieve this goal, the proposed method could for example be built on top of existing models such as PointNet, a deep learning architecture designed for processing point cloud data directly.

The result of this project will empower users to filter out unwanted objects from point clouds. This is useful when they are navigating the 3D environment, or for further analysis of the point cloud.

Topic 9 :

Challenge 1B - Road marking classification from mobile LiDAR point clouds

The aim of this master thesis is to implement an unsupervised method for road markings segmentation and evaluate its performance using datasets from 500+km of roads in Norway. For example, by using a graph attention network (GAT_SCNet) to simultaneously group road markings into categories (Fang et al., 2022).

Topic 10 :

Challenge 1C - Point cloud navigation and inspection tools for VR

The main focus within this topic would be to extend an existing browser-based application to allow users to navigate and inspect point cloud data in a virtual reality environment. The project would involve modifying and enhancing the existing codebase to enable the application to work seamlessly with VR headsets and controllers, as well as integrating additional functionality such as measurement tools and point cloud manipulation tools. There are several problems which can be addressed.

Problems to solve:

- Synchronising application state across VR devices
- Avatar position, orientation and hand gestures
- Measures, labels and other world bound objects
- Virtual laser pointers
- Voice
- Saving collaborative work (Operational Transform or CRDT)
- Tools of virtual measure devices
- UI/UX in virtual environments

The result will enable users to collaboratively do virtual inspections, and prepare plans and improve safety for physical inspections in risky environments.

Topic 11 :

Project 2 - Inventory of endangered marine species

Capia is working on automatically detecting and counting endangered marine species on underwater video footage. Manual counting observations from many hours of video can be very mentally and physically challenging, is time consuming and costly. Automated evaluation of underwater videos allows monitoring of endangered species in certain areas timely and economically. The results can for example be used (1) to identify areas which need to be protected and (2) for further research about the impact of climate change and humans on marine ecosystems.

Topic 11 :

Challenge 2A - Classification of marine species

The aim of this master thesis is to identify, test and compare relevant models to classify marine species in underwater videos.
Currently about 50 hours of labeled videos with 15 species is available. This database is continuously growing since new footage and more species are added.

This master thesis requires a good knowledge of Python and machine learning frameworks.

Topic 12 :

Challenge 2B - Estimating three-dimensional structures from two-dimensional image sequences

The aim is to make a georeferenced, coloured, 3D point cloud from video alone, through using methods like photogrammetry, visual odometry, optical flow, motion estimation etc. This addresses the technical challenges in the sea that most lidar scanners have quite short range underwater, and echo sounders have quite low resolution. Hundreds of hours of video data are available which can be used to test if it is possible to accomplish sufficient resolution and coverage. Combined with machine learning classifiers, this would be really helpful to map out and georeference each ML inferred observation. This also gives the possibility to provide 3D navigational tools of the data for end users.

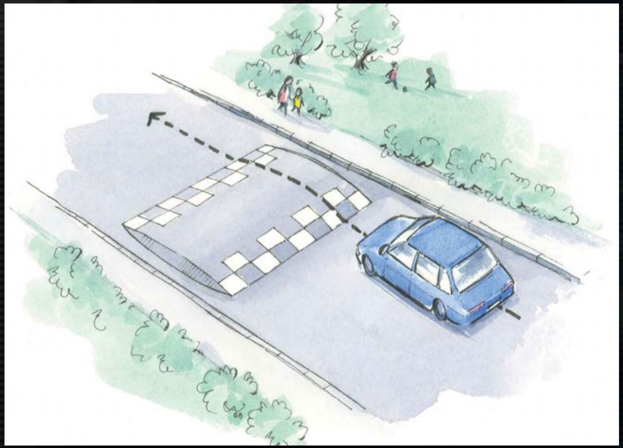
Topic 13 :

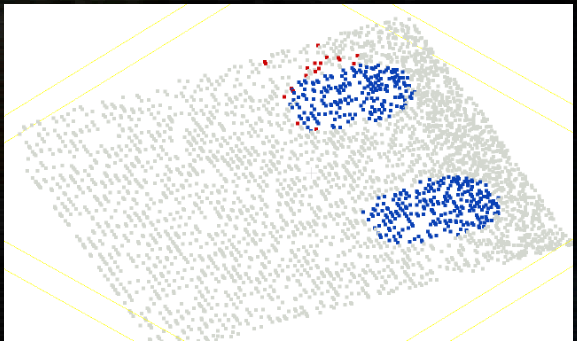
Challenge 2C - Video object tracking

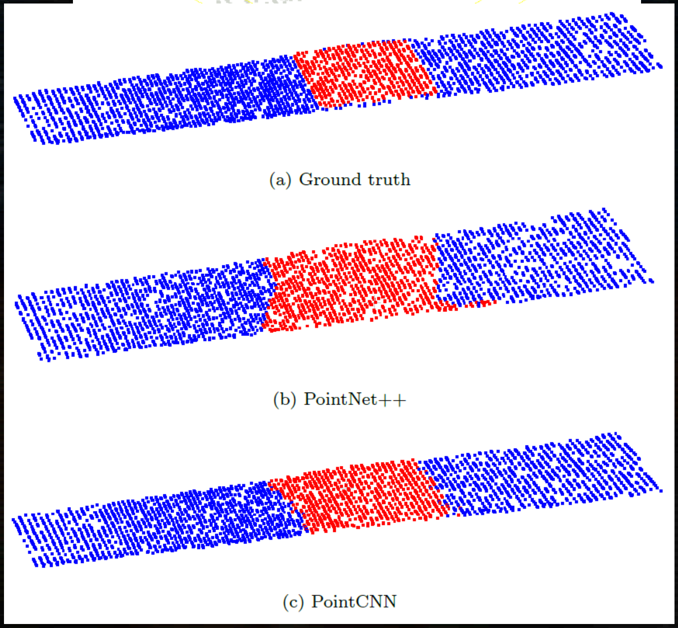
With machine learning on video streams, it is common that the model might lose track of an object, for then to reacquire it (i.e. the object is not identified on each frame of the video). The aim is to track identified objects so that when counting identified objects each object is just counted once even when it 'disappears' for a few frames. Besides getting more precise counts of objects, the results can also be used to augment / improve the position data of the camera which is mounted on a moving platform in relation to stationary objects detected in the video stream. We provide data from a preliminary model detecting marine species. Our videos are taken under water which adds additional challenges e.g., a fairly long shutter speed, that makes frames quite blurry during fast movements. This project could build on existing methods: KCF, CSRT, MedianFlow, Goturn, MIL, Mosse, TLD and further develop them.

Topic 14 :

Speed bump detection







(a) Ground truth

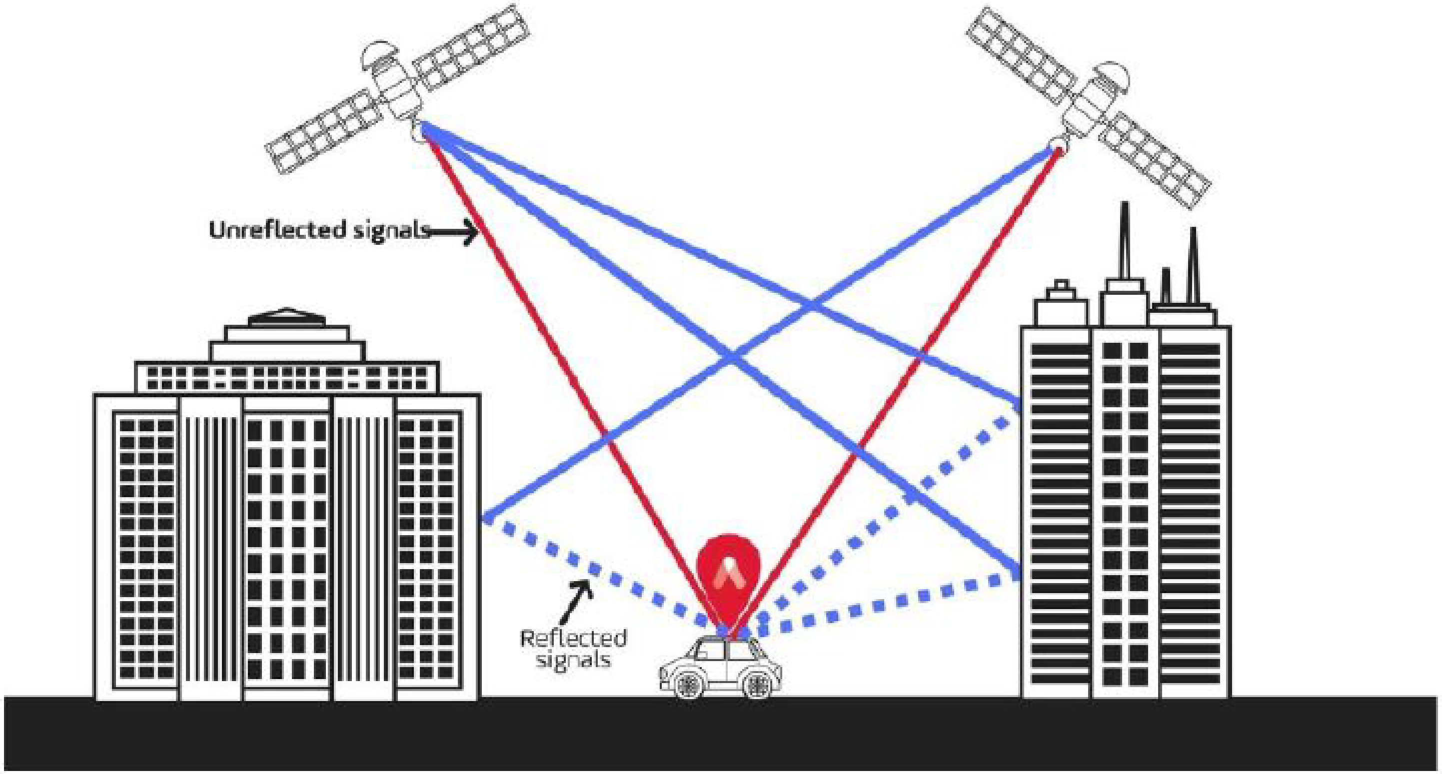
(b) PointNet++

(c) PointCNN

Forslag innan GPS, geodesi,….

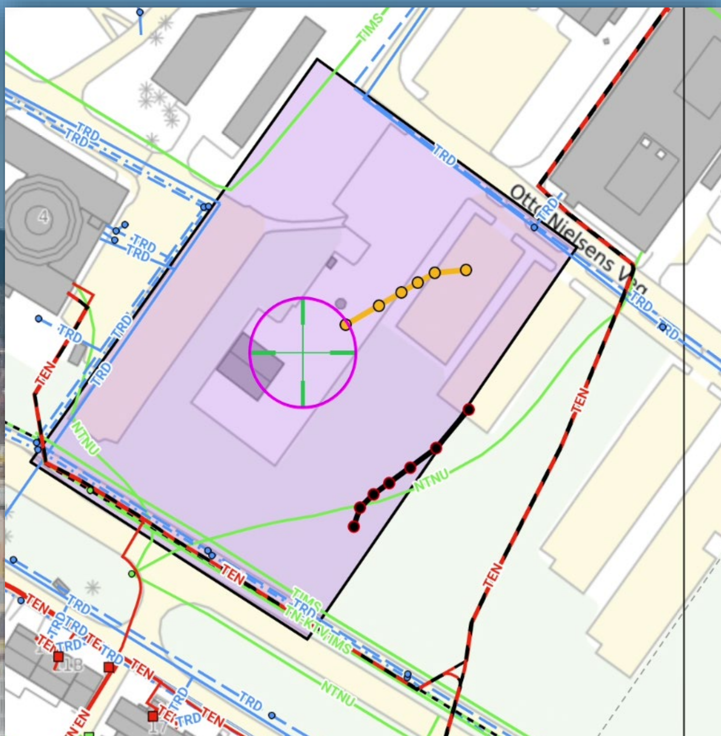
Kontakt: Hossein Nahavandchi

High-precision GNSS Positioning with Smartphones in Urban environment



Geomatikk AS

Forbedring av nøyaktighet i ledningsdokumentasjon: AI/ML-basert deteksjon av infrastruktur



- Maskinlæring/Kunstig Intelligens
- Samfunnsnyttig prosjekt med et reell datagrunnlag
- Jobb tett med stort in-house utviklingsmiljø i Trondheim

Statens vegvesen

Oppaveforslag fra Statens vegvesen 2023

1. Undersøke (med fysiske målinger) og validere nøyaktigheten for nasjonal digital høydemodell i områder med ulik topografi og vegetasjon.
   - Ta utgangspunkt i standarden Geodatakvalitet.
   - SVV behøver slike erfaringer for å tallfeste krav til «feil» i sin nye retningslinje (systematisk + tilfeldige feil).
2. Georeferere punktskyer fra Vegvesenets målebiler ved hjelp av andre data (f.eks. fra Hoydedata.no), og evt. vektorisere objekter fra skya.
3. Analyse av Kartverkets GNSS-data fra monitorerings-stasjonene.
4. Metoder for posisjonsbestemmelse i fart (HYPOS), se word-dokument.

Equinor

- 2D datasets into 3D datasets
- 3D model generation without georeferenced information
- Geospatial and Cloud Computing using Azure. How to process big vector/raster data
- In depth comparison of geospatial dashboarding tools
- GIS Verktøy for Vindturbin Plassering

Kartverket

- Exploration of Copernicus Contributing Mission (CCMs) for geoscientific and land mapping applications
- Identifisering og tolking av stedsnavn i eldre kart
- Detektering av dreneringslinjer (flomveier)
- Detektering av grøfter
- Bruk av kunstig intelligens til klassifisering av laser punktsky fra flybåren datafangst
- Undersøkelser av posisjonerings-ytelse for Kartverkets CPOS tjeneste

Norkart

- Ai-basert saksbehandler
- Automatisk kartlegging av piper
- Automatisk kartlegging av solceller
- Demokratisk byggesak med Ai
- “Diffusion models” for å forbedre AI-bygningsdeteksjoner
- Automatisk vurdering av kvalitet på bygningstegninger
- LLMs - GIS-analysens død?

- 3D features from vertical and oblique images
- 3D feature segmentation and detection from point clouds
- Real-time image classification and object detection from video stream
- Språkmodeller som tolker planbestemmelser
- State of the art segmentering - hvor mye bedre er de nyeste modellene?
- Utvikle Ai-benchmark-data for Norge

Trondheim kommune

- Digital tvilling Trondheim
- Automatisk detektering av FKB-takkant
- Detektering av FKB kartobjekter fra laser- og dronedata
- Automatisk generering av 3D-bygg
- Bruk av fjernanalyse/maskinlæring/AI for å identifisere AR5-dyrkamark som ikke er i drift
- Detektere arealtyper fra multispektrale bilder og laserdata

Tidshorisont - prosjekt

- Diskuter aktuell oppgåve med faglærar eller ekstern partnar
- Bestem deg for oppgåve
- Meld frå på Nettskjema innan 15. juni
- Start å jobbe med prosjekt seinast i august (men det er viktig å starte tenkinga i løpet av sommaren…)