Abstracts NCG Symposium 2019

Point clouds

Y. Zang

An improved Coherent Point Drift method for TLS point cloud registration of complex scenes.

Abstracts:

Registration of TLS point clouds is used to obtain complete surface information of local environment. However, for cluttered environments (such as mountainous or urban areas), the automatic registration is still a challenging problem. We propose a registration method based on coherent point drift (CPD) algorithm combined with a covariance descriptor. Out method has two parts: the covariance descriptor construction and Expectation-Maximization optimization based on probabilistic registration framework. The experiments on TLS datasets of various scenes demonstrate the reliability and efficiency of the proposed method. Especially for the environments with vegetation or density variations, this method is more efficient than original CPD algorithm.

L. Truong-Hong

Automatic decomposition of bridge structural components from a terrestrial laser point cloud

Abstract:
Although most of bridges in Europe and parts of the world built after the second world war (WWII) are subjected to deterioration due to increasing freight demand, environmental impact and material degradation, they still take an important role in a transportation network. To prevent any catastrophic collapse, the bridges must be managed, inspected and assessed regularly to timely set up a maintenance planning. It will be a cost-effective system when a three-dimensional (3D) bridge model is used to embed all relevant attributions and information, and can be used in simulating the bridges' behaviour. However, the bridge geometric models of the bridges are mostly not available. Recent development of laser scanning and photogrammetry offering a low-cost, efficient method to capture 3D topographic data of surfaces of a bridge's structures accurately. Moreover, as complexity of the bridge configuration, a current workflow to reconstruct the bridge model from a point cloud is still required intensive labour work with a support of computed aided programs. This presentation introduces a new approach to extract the point cloud of each structural component of the bridge automatically, which is a vital step in generating the 3D model of the bridge. The method employs a quadtree to decompose the point cloud of the bridge into multiple cells. Next, from each cell, a kernel density estimation uses to estimate a point cloud roughly describing a sub-surface of the bridge's components, and the cell-based region growing is developed to extract

the points of the surface. Moreover, knowledge of the bridge's components (e.g. position, orientation, etc.) is introduced to allow the proposed method can sequentially extract the bridge components in an order from superstructure to substructures. Performance of the proposed method is evaluated through experimental tests are applied to concrete box and girder bridges.

S. Karam

Integrating a Low-cost MEMS IMU in Laser-based SLAM for Indoor Mobile Mapping

Abstract:
Indoor mapping techniques are highly important in many applications, such as human navigation and indoor modelling. As satellite positioning systems cannot provide accurate indoor solutions, several alternative sources of indoor navigational information have been used such as inertial measurement units (IMU) and simultaneous localisation and mapping algorithms (SLAM). Surveys such as by Maximov (2013) have shown that the integration of multiple sources of navigational information improves the accuracy of the navigation systems. Therefore, our research aims to investigate the benefits that the integration of a low-cost microelectromechanical system.
(MEMS) IMU can bring into a feature-based SLAM algorithm. Specifically, we calculate pose predictions from the IMU data for our backpack indoor mobile mapping system.

Machine learning for GIScience

Y. Lin

Efficient Training of Semantic Point Cloud Segmentation via Active Learning

Abstract:
With the development of Lidar and photogrammetric techniques, more and more point clouds are available with high density and in large areas. Point cloud interpretation is an important step before many real applications like 3D city modelling. Many supervised machine learning techniques have been adapted to semantic point cloud segmentation, aiming to automatically label point clouds. Current deep learning methods have shown their potentials to produce high accuracy in semantic point cloud segmentation tasks. However, these supervised methods requiring sufficient labelled data for the purpose of proper model performance and good generalization. In practice, manual labelling of point clouds is very expensive and time-consuming. Active learning can iteratively select unlabelled samples for manual annotation based on current statistical models and then update the labelled data pool for next model training. In order to effectively label point clouds, we proposed a segment based active learning strategy to assess the informativeness of samples. Here, the proposed strategy uses one third of the whole dataset to achieve 98.9% of the accuracy got from the model trained on all full dataset.

S. Srivastava

Adaptive Compression-based Lifelong Learning

Abstract:
The problem of a deep learning model losing performance on a previously learned task when fine-tuned to a new one is a phenomenon known as “Catastrophic forgetting”. Lifelong learning restricts new network activations to remain close to the initial ones. The model is updated in a way that it performs well on both old and new tasks, without having access to the old task's training samples anymore. Recently, approaches like pruning networks for freeing network capacity during sequential learning of tasks have been gaining in popularity. Such approaches allow learning small networks while making redundant parameters available for the next tasks. The common problem with these approaches is that the pruning percentage is hard-coded, irrespective of the number of samples, complexity of the task and number of classes in the dataset. Our Bayesian optimization-based method adaptively prunes the network (heavy pruning for small and/or simple datasets while lesser pruning for large and/or complex data) and show its effectiveness in lifelong learning. Experiments on classification and semantic segmentation demonstrate the applicability of learning network compression, where we are able to effectively preserve performances along sequences of tasks of varying complexity.

M. Kuschnerus

Unsupervised Learning on Time Series from Permanent Laser Scan Data

Abstract:

Coastal zones are dynamic areas that are undergoing continuous change. Permanent laser scanning is a promising technique, which delivers 3D representations of a part of the coast at hourly temporal and centimeter spatial resolution. However, the resulting data set is large and information relevant for coastal research is not easily accessible. In order to process this data set in an efficient and automated way, we extract time series in elevation or range and use unsupervised learning algorithms (k-means clustering, DBSCAN and agglomerative clustering) to derive a partitioning of the observed area according to change patterns. These methods allow to identify change processes in a specific area, such as erosion due to waves or sand accumulation by a bulldozer.

G. Fu

A deep-learning-based approach for fast and robust steel surface defects classification

Abstract:
Automatic visual recognition of steel surface defects provides critical functionality to facilitate quality control of steel strip production. In this paper, we present a compact yet effective convolutional neural network (CNN) model, which emphasizes the training of low-level features and incorporates multiple receptive fields, to achieve fast and accurate steel surface defect classification. Our proposed method adopts the pre-trained Squeeze Net as the backbone architecture. It only requires a small amount of defect-specific training samples to achieve high- accuracy recognition on a diversity-enhanced testing dataset of steel surface defects which contains severe non- uniform illumination, camera noise, and motion blur.

Moreover, our proposed light-weight CNN model can meet the requirement of real-time online inspection, running over 100 fps on a computer equipped with a single NVIDIA TITAN X Graphics Processing Unit (12G memory).

C. Valk

Roof change detection with DL using artificial training data for asbestos monitoring

Abstract:
Over the past years, asbestos roofs have been mapped in most Dutch provinces. As the asbestos roofing material is phased out, the provinces want to monitor the replacement progress for these roofs. NEO has developed a deep learning model for this purpose that detects *roof change* on RGB aerial imagery. The main challenge faced was the lack of training data, which was addressed by creating artificial training data using the known building polygons. Results indicate that quality of artificial training data was sufficient to be able to exclude a large proportion of roofs as *not changed* with high confidence.

M. Sales

Better land cover class area estimates using Random Forest's class probabilities: a case study using a big dataset in the Amazon.

Abstract:
One of the goals of land cover classification is to estimate the area of each land cover or land cover change class. Random forest is one of the main algorithms currently used for large scale land cover classification, but the class area estimates obtained from counting the pixels from its classifications are known to be biased. This bias can be corrected using additional reference data, but good estimates of class areas can already be obtained if the class probabilities output from the random forest algorithm are retained and used. We demonstrate this using a recently built big reference dataset from the Brazilian Amazon.

Z. Yang

the classification of ALS point clouds with the use of a 2D vector data map

Abstract:
this presentation will deal with the classification of ALS data, by making use of training data generated from 2d vector map. Using these datasets to train a segmentation based deep learning network. The trained networks are then applied into the same point clouds dataset. The result finds that the segmentation based deep learning network can solve some error in initial labelled ALS point clouds which may be used for updating the original map and change detection in future works.

Remote Sensing applications

M. Koeva

Innovative remote sensing applications to support land tenure mapping in Kenya

Abstract:

There is a clear demand for effective land administration systems that can support the protection of unrecorded land rights, thereby assisting to reduce poverty and support national development. Within the framework of the its4land project, we developed and tested innovative remote sensing applications to support land rights mapping in response to local needs in Kenya. We applied Unmanned Aerial Vehicles (UAV) and developed a method for an automated delineation of visible boundaries based on the acquired UAV images (Figure 1 and 2). For our test areas in Kenya, UAVs were identified as having a high potential for creating up-to-date base maps that can support various current land administration tasks. The automated boundary delineation was found to be useful to simplify the digitization of visible cadastral boundaries.

S. Lobry

Visual Question Answering from Remote Sensing Images

Abstract:
This presentation introduces the task of visual question answering for remote sensing data (RSVQA).
Remote sensing images contain a large amount of information which can be useful for a wide range of tasks.
However, the developed methodology is often task-speci_c, preventing a generic and easy access to the information contained in remote sensing data. With RSVQA, we propose to use questions formulated in natural language as a way to interact with remote sensing images. This way, the images can be queried to obtain high level information about speci_c image content or relational dependencies between the objects sensed. Using an automatic method that we describe in this presentation, we built a dataset of image/question/answer triplets using OpenStreetMap (OSM) data. This dataset can be used to train and evaluate models to solve this task or any of the sub-tasks, such as object detection and counting. In addition, we present one model (based on a Convolutional Neural Network (CNN) for the visual part and on a Recurrent Neural Network (RNN) for the natural language part) showing _rst results on this new task.

Y. Lyu

UAVid: A Semantic Segmentation Dataset for UAV Imagery

Abstract:
Semantic segmentation has been one of the main research interest in computer vision recently. It serves as a perception foundation for many fields such as robotics and autonomous driving. The fast development of semantic segmentation attributes enormously to the large scale datasets, especially for the deep learning related methods. Currently, there already exist several semantic segmentation datasets for complex urban scenes in natural images or remote

sensing images. They have been the standard datasets for comparison among semantic segmentation methods. However, none of them captures urban scenes from an Unmanned Aerial Vehicle perspective. We therefore introduce the UAVid dataset, a new high resolution UAV semantic segmentation dataset as complement, which brings new challenges, such as large scale variation and moving object segmentation.

Visualisaton

D. Peng

Finding parallel events of aggregating land-cover parcels to support smooth zooming

Abstract:
The land-cover parcel is very important on maps. When users zoom out, some land-cover parcels become too tiny to be seen, which result in visual clutters. To avoid this problem, we aggregate the parcels to form larger parcels. We define that an event is aggregating some parcels into a larger parcel. In our method, we require that each event involves exactly two parcels which is completely processed before the next pair is aggregated (all sequential). However, because of the given sequence in which the events are processed one by one, the map users still experience shock changes (because the aggregation transition time of their zooming out can be short). We try to reduce the shock changes by parallel processing the events. In this way, each event has more time to take place, resulting in more smooth zooming. This presentation will show the details of finding and processing parallel events.

I. Dobraja

Dashboard adaptability in Virtual Reality (VR) environment illustrated with origindestination

Abstract:
The characteristics of an analytical dashboard make it suitable for the representation and getting insights into spatio-temporal patterns. Despite these characteristics, a dashboard has limitations regarding the represented levels of details and the dashboard layout. We can solve these limitations by introducing the adaptability. It allows to adapt the dashboard interface and the represented information to user questions.
However, even an adaptable dashboard has some limitations. The space is limited, and the depth perception is missing when represented in a 2D (flat screen) environment. Virtual Reality environment may overcome these limitations by ensuring the almost unlimited space and a immersion user in the environment. However, the new environment brings challenges, which need to be dealt with when designing adaptable dashboards for users to get insights.

M. Wang

Road network structure and e-hailing accessibility – uber etc

Abstract:
The prosperity of e-hailing services has rippled in the communities of GIScience, transportation, and urban planning. Meanwhile, road network structure has been analysed from a network science perspective which focuses on nodes and relational links and aims to predictive models. However, limited empirical studies have explored the relationship between road network structure and e-hailing accessibility through such perspective. This work utilizes the spatial Durbin model to understand the relationship between road network structure and e-hailing

accessibility, proxied by Uber accessibility, through network measures of degree, closeness, and between centrality. Network science provides us both conceptual and methodological measures to understand the association between road network structure and ride-sharing accessibility. In this study, we constructed road network structure measures with OpenStreetMap, which is reproducible, replicable, and scalable because of its global coverage and public availability. The study resonates the notion of cities as the set of interactions across networks, as we have observed time-sensitive heterogeneous effects of road network structure on e-hailing accessibility.

3rd dimension

K. Zhou

LiDAR-guided Edge-aware Dense Matching on Multi-view Images for Creating a Up-to-date 3D City Model

Abstract:
Up-to-date 3D city models are needed for many applications. Airborne LiDAR data is widely used for constructing 3D city models, however, acquiring LiDAR data is expensive so the updating rate is low at state or national level. Very high resolution (VHR) images with high updating rate provide an option for validating and updating LiDAR data. Airborne LiDAR data has accurate geometric information of objects, but are often sparse and irregularly distributed. In addition, near edges of overhanging roofs, points on the ground, walls and roofs get mixed. On the other hand, images have sharp edges, however, generating high quality point clouds is problematic in areas affected by shadows and low texture. This research proposes a LiDAR-guided edge-aware dense matching to use the complementary information in each dataset to detect changes while explicitly address the quality problems of geometric information in LiDAR and image data. In unchanged areas, LiDAR and images are fused to enhance the building outlines; while in changed areas, image point clouds are updated.

H. Liu

Realistic 3D/4D perspective view selection on massive points

Abstract:
Space Filling Curve (SFC) mapping-based indexing works effectively for point clouds management and querying. It maps both points and queries into a one-dimensional SFC space so that one-dimensional indexing structure such as the B+-tree could be utilized. In this project, on top of the basic structure, we devised and built a histogram tree recording point distribution to wisely guide the generation of SFC ranges for queries to improve efficiency. Besides, we proposed and implemented a continuous LoD (cLoD) dimension for smooth and natural scene rendering of points. Based on the compound scheme, we developed the 3D and 4D perspective view selecting function. Testing results indicate that the solution has the potential to realize real-time visualization of massive points.

W. Gao

3D mesh annotation: Towards large-scale semantic 3D urban mesh benchmark.

Abstract:
The rapid development of multiple view geometry techniques has facilitated quick generation of dense urban 3D point clouds and meshes. The generated data can serve as base information for the semantic interpretation of 3D scenes and further automatic reconstruction of highly detailed 3D city models. Although textured meshes, which include both, geometric and radiometric features, contain more information than 3D point clouds, their semantic information has been so far barely explored. This paper introduces a novel approach for semi-automatic annotating urban 3D scene composed of textured meshes acquired by multi-view stereo techniques. The 3D textured meshes generated from images provided by the City of Helsinki.

E. Kalogianni

3D Cadastre within objects' spatial development lifecycle

Abstract:
The current societal demand to improve sustainability performance through collaboration is driving the need to integrate independent systems associated with different aspects and scales of an object's spatial development lifecycle (Figure 1) to deliver smart solutions and services. Land administration is on the centre of this lifecycle, while current practices mainly rely on 2D-based systems to define legal and spatial boundaries of interests.
Nonetheless, infrastructure density leads to complex interleaving triggering legal, organizational and technical challenges of 3D cadastral systems, with many jurisdictions around the world developing advanced solutions towards 3D cadastre implementation. In this scene, the ISO 1952 Land Administration Domain Model (LADM) - which is currently under revision- plays an instrumental role. In the context of this revision and with regards to a lifecycle approach, this research focuses on the reuse of information from various sources, as input for 3D cadastre. Specifically, data derived using various acquisition techniques (e.g.

GPS GNSS data, Galileo data), as well as BIM data (IFC models) are used as input for cadastral registration, aiming to reduce duplicates, mistakes and ambiguities.

Crowd, citizen, assessment

A. Levering

Lessons Learned from Using Geotagged, Crowdsourced Image Data for Detecting Road Accidents

Abstract:
In order to ensure that road infrastructure remains operational, it is important that incidents such as car crashes and flash floods are signalled early. In this work we assessed the use of open crowdsourced image data with geotags in training deep neural networks to recognize incidents in image data. We assessed the role of geographical correlation in incident recognition by testing if incidents can be learned in one region, then recognized in a new region. Our results show that incidents can be learned successfully, and that the influence of geographical correlation in the learning process is expected to be minimal.

F. Hoefsloot

Making consumer-citizens: the datafication of Lima's water infrastructure

Abstract:
Current redevelopments of the water infrastructure in Lima, Peru aim to reduce the unequal distribution of water consumption, water connection, and water coverage by implementing digital information technologies. However, to understand how the introduction of these technologies influences the distribution of water amongst the inhabitants of Lima in practice, we need to consider the production of data in the broader network of material and non-material entities that make up the water infrastructure beyond the digital sphere. Drawing on document analysis and qualitative fieldwork, our research shows that despite the rhetoric of improved management, legibility making practices create differential hydrological geographies in the city beyond the formal/informal dichotomy and performs the citizens of Lima in distinct categories of consumer-citizens. We argue that, as 'smart' technologies are being rolled out in cities worldwide, a relational approach is crucial to understand what data does and their interplay with the city and society.

W. Supinajaroen

Building an Assessment Framework for Continuously Operating Reference Station Implementation

Abstract:
As part of the primary research on Continuously Operating Reference Station (CORS) implementation, this topic seeks the applicability of the Spatial Data Infrastructure (SDI) Body of Knowledge (BOK) to build a CORS implementation assessment framework. The topic elaborates the interconnections between CORS and SDI as critical infrastructures in the

geospatial data field—CORS data is part of and is underlying SDI. Regarding these, potential indicators for CORS implementation will be identified based on SDIs. These indicators can be combined with CORS knowledge in building a framework to assess the situation of CORS implementation.

M. Kuffer (OR in 3-3)

People–Pixels–Privacy: Can gridded datasets protect the privacy of inhabitants in deprived areas?

Abstract:
Urbanization in the global South is accompanied by the increase of deprived neighborhoods. UN-Habitat estimates that currently a billion people live in such neighborhoods with a projected increase to two billion until 2050. However, data on such neighborhoods are very uncertain, commonly dated and incomplete. Very-high resolution imagery and maps can fill such data gaps, but bear the danger to be misused against vulnerable inhabitants (e.g., stigmatization, evictions). To reduce these risks, we promote the use of gridded datasets, providing the degree of "deprivation" per cell. Users can select their thresholds, when categorical maps are required, this protects individual and group privacies in published data, combined with transparency in methods.

Monitoring change

H. Velsink

Deformation analysis with a hypothesis constrained multi-epoch analysis

Abstract:
Geodetic deformation analysis is usually based on the comparison of measurement results, acquired during two or more epochs. The recently developed multi-epoch deformation analysis does not require stable reference points for the comparison. It can test hypotheses on the deformation of several points during several epochs, gives least-squares estimates of deformations and can compute minimal detectable deformations. The theory behind the analysis method is briefly clarified and illustrated with an example. Possible applications are given. First experiences and suitable software are treated.

A. Kulshrestha

On the detectability of subsidence patterns over simulated sinkholes using time series InSAR techniques

Abstract:
Early detection of sinkholes from remote sensing images is still a challenge. Due to their small size

and the irregular distribution of InSAR (Synthetic Aperture Radar Interferometry) measurement points
(IMP) in sinkhole areas, it is a challenge to model spatio-temporal precursory deformation patterns
over affected areas. This research proposes a conceptual framework for assessing the detectability of
precursory deformation patterns. The framework includes a hierarchical clustering as well as Long
Short Term Memory (LSTM) based machine learning methods to model the simulated deformation
patterns. It uses simulated sinkholes[1] shaped with the inverse Gaussian distribution together with
randomly selected IMP spatial locations and IMP deformation time series for sensors from different
satellites. The framework shows that time series InSAR can be used for sinkhole hazard prediction. In
the future, the framework will be used for real sinkhole detection on real images.

R. Toodesh

Functional model selection for predicting the changes in seafloor depths.

Abstract:
Using available time series of bathymetry observations, a library of functional models which includes the stochastic influences are carefully defined for parameter estimation. A statistical hypothesis testing procedure is developed for the functional model selection. This approach is designed to select the most likely model for predicting the probability of the changes in depths and the uncertainties for site specific areas in the Netherlands Continental Shelf (NCS) that are considered to be dynamic, i.e. sand waves are present. This research leads to a probabilistic approach to aid decision making, using the observations, when assigning hydrographic resurvey frequencies in NCS.

M. Kleinherenbrink

The performance of Harmony's sea-ice drift observations.

Abstract:

Sea-ice motion is driven by wind and ocean stress and varies in space in time. Small-scale drifts primarily a_ect the opening of leads, while large-scale drift primarily controls the loss of sea ice. Both the opening of leads and the loss of sea ice play a major role in the energy balance of the Arctic and Antarctic regions. Observation of sea-ice drift is one of the main objectives of Earth Explorer 10 candidate Harmony. We will present the _rst results of a performance analysis of Harmony's observations over sea ice. The passive instruments onboard the Harmony satellites will use Sentinel-1 as an illuminator to provide multistatic observations of the sea-ice surface. Harmony's recon_gurable constellation can either be optimized for a large line-of-sight di_erence (Stereo) or for range-direction sensitivy (ATI). In the Stereo con_guration, it will for the _rst time be possible to obtain instantaneous sea-ice drift vectors. In the ATI con_guration, Harmony enables to acquire high-resolution

sea-ice velocity estimates.

Modelling

A. Shnaidman

LADM Refined Survey Model

Abstract:
Within the extended scope of the LADM revision, a Refined Survey Model is suggested in order to facilitate a comprehensive spatial description which incorporates the diverse elements of the survey component, specifically: different data acquisition and processing techniques, spatial data formats, types of survey documents and the actions which can be applied to a spatial unit. The purpose of this model is to improve work flows of land management organizations where they exist and to propose a systematic, structured approach to linking spatial sources with their counterpart spatial units which in turn contributes to a transparent and accessible survey data (Soffers, 2017).
The presentation outlines the proposed LADM Refined Survey Model, including an extended core LADM class LA_Spatial Source, several association classes and corresponding Code Lists.

A. Alattas

LADM-IndoorGML for exploring user movements in evacuation exercise

Abstract:

The users' movements in indoor environments vary based on the circumstance of the environments. During an indoor emergency, an efficient evacuation is required to help the users to move to the harmless areas. Different incidents could affect the movements of users, and this requires studying the action of the people during the evacuation. The reaction of the users to the incidents could affect the evacuation procedures, and that could lead to different types of injuries or death. The user understands and perceives the indoor environment differently, and this plays a critical role in the evacuation. Furthermore, the users of the indoor environments have different rights to access the indoor spaces, which affects the movements of the users during an incident. This project aims to support the evacuation of a building (educational building) in a crisis by utilizing the integrated model of LADM-Indoor GML and the representation of the 3D model of the building. To reflect evacuation cases, we extended the conceptual model of LADM-Indoor GML to define the access rights for users of indoor environments during a crisis. An evacuation exercise has been held at the Faculty of Applied Science at TU Delft to study the access rights during an incident. During the evacuation, and Wi-Fi data has been collected for the users of the building for further analysis. A 3D model has been built for the Faculty of Applied Science to analyse the movement of the users. The collected data of the Wi-Fi access points have been structured and imported into the open source database PostgreSQL/PostGIS. Furthermore, the geometry of the 3D model was used to visualize the users' movements as individuals and groups of users according to their connection to Wi-Fi access. Appropriate visualization has been created using QGIS. This research

demonstrates the entire process of analysis and visualization of users' movements based on the Wi-Fi logs by using the extended LADM-Indoor GML.

M. Garciaalvarez

A Language for the Definition and Detection of Geographic Events using Sensor Networks and Event Processing.

Abstract:

Data collected by sensor networks provide situation awareness to smart city applications; this ables real-time decision making if data abstractions like geographic events are formally specified in an event processing engine. Event processing (EP) offers advantages when dealing with the big data problem. However, current EP engines lack spatial and temporal matching functionalities to detect geographic events. Moreover, experts in the geographic information domain define a geographic event in several, and sometimes contradicting ways; this adds additional challenges to the task of formally defining events in EP engines. To reduce the underlying complexity behind EP and provide a formal and yet expressive mechanism to specify geographic events, we propose a domain-specific language for the definition and detection of geographic events. With this language, we extend the capabilities of event processing into geographic information domain, as a way to add utility to the pool of data continuously collected by sensors in smart cities.

GNSS / SAR

H. Dun

Precise ranging using sparse multiband radio signals

Abstract:

GNSS can provide precise position solutions in a relatively open field, however, its performance degrades significantly in an urban canyon. With a limited signal bandwidth, it is not possible to resolve relatively dense multipath components caused by nearby objects and buildings. In a terrestrial positioning system, various radio signals can be generated and transmitted for ranging and positioning. Considering the signal bandwidth, using an ultra-wideband (UWB) signal can certainly improve the accuracy of ranging, but it also requires a relatively expensive receiver to acquire the signal. Alternatively, we can use multiple signal bands that are relatively sparsely placed in the signal frequency spectrum. For example, using a few signal bands which are sparsely placed in the available signal spectrum of IEEE802.11ac (for WiFi) and IEEE802.11p (for intelligent transport systems-ITS) to create a large virtual signal bandwidth (see figure). With the benefit of a relatively large virtual bandwidth, the performance of ranging can be further improved, compared to the one using a single narrowband signal only. It can also largely improve the multipath resistance. In this presentation, we will investigate the possibility of precise ranging using the sparse multiband signal.

F. Mirmohamadian

Generate virtual observations applying geometric corrections to the IGS stations

Abstract:
It is substantial to consider changes in the point's coordinates using GNSS1. By relative positioning, a baseline vector can be obtained. Due to the atmosphere effect, the stations should be close. However, there are no permanent stations in some locations. In this research, the construction of a virtual station near the target using real observations of an IGS2 station is investigated. The virtual observations are created by applying the geometric corrections to real observations which is completely different from the VRS3.
1 Global
At least 4 IGS stations around the point are considered. Using the formation of double-difference equations, the unknowns are obtained. The value of these corrections for the baseline from the virtual station to the nearest IGS station is computed by interpolating the network and then is applied to the observations of the IGS station. These corrected virtual observations are then used as a reference. The object of this method is to make an IGS station (by applying only the geometric correction) close to the rover station to eliminate the effect of the atmosphere due to the short baseline.

Phase Inconsistencies in SAR interferometric triplets.

Abstracts:

A common and fundamental assumption in SAR interferometry is that the interferometric phase isconsistentbetween acquisitions. A lack of phase consistency is acknowledged in the literature, butin practice it is generally attributed to random noise and speckle effects.Recent studies have shownthat phase inconsistencies in SAR interferometric triplets ($\mathbf{\Phi}123 = \varphi12 + \varphi23 - \varphi13$) have a systematiccharacter. This points to some underlying physical reason related to multiple scattering effects.
Based on examples we will demonstrate that volume scattering and moisture variation induce signi-ficant closure phase inconsistencies in interferometric triplets and explore the potential for retrie-ving geophysical parameters.

Geo-ethics / critical data science

Y. Georgiadou

Space for ethics I

Abstract:
In 2019, we developed a new 5 EC course at ITC-UT focusing on location privacy and titled *Space for Ethics*. In this presentation, we provide some details of the part of the course that tackles privacy from the socio-political point of view. First, we explain and practice moral reasoning and discuss key concepts—human dignity, privacy and data protection. Then we

analyse the design and enactment of the General Data Protection Regulation and its fundamental components. We discuss needs for location privacy research, especially in the global South.

O. Kounadi

Space for Ethics: A course curriculum to examine, analyze, and protect *Geoinformation Disclosure*

Abstract:
In this presentation, we discuss the part of Space for Ethics that examines and measures geoinformation disclosure and develops technological measures to safeguard location privacy. We start with the types of disclosure, followed by the meaning and implementation of spatial risk of re-identification and inference attacks. Then, we review the location protection methods with a special focus on geographical masking (geomasking). The technical part includes the implementation of geomasking, general data anonymization techniques, as well as an estimation of the (spatial) error of a "protected" dataset.

C. Gevaert

Towards the development of Fair, Accountable, and Transparent algorithms for Remote Sensing

Abstract:
The utility of Remote Sensing data for sustainable development and disaster response forms the foundation of our research institute at ITC. Over the past few years, Machine Learning and Artificial Intelligence is lauded as the answer to quickly translating massive amounts of data into usable information. However, we are also starting to recognize the need for *Fair, Accountable* and *Transparent* algorithms. This presentation gives examples of how the values of responsibility, explainability, accuracy, auditability, and fairness into are applicable for RS machine learning algorithms