CHUNYANG GAO

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EDUCATION

ETH Zürich - Dept. of Civil, Environmental and Geomatic Engineering **Zürich, Switzerland**
Master of Science in Geomatics *Sep 2022 – Jun 2025*
Language of Instruction: English
Thesis: Leveraging Diffusion Models for Urban Change Detection and Classification from Historical Map

Wuhan University **Wuhan, China**
Bachelor of Science in Geographical Information Science *Sep 2018 – Jun 2022*
Honors: National Scholarship, Outstanding Graduate
Thesis: The Impact of Different Built Environment Variables on Traffic Congestion in Wuhan

RESEARCH INTERESTS

Machine Learning; Computer Vision; Remote Sensing; Geographical Information Science; Urban informatics

RESEARCH EXPERIENCE

Leveraging Diffusion Models for Urban Change Detection and Classification from Historical Map
Master thesis *Sep 2024 – Mar 2025*
Advisors: Prof. Lorenz Hurni, Sidi Wu, Dr. Yizi Chen (ETH Zürich)

- **Conceptualized Urban Change Types:** Defined urban change categories for large-scale time spans, such as road construction and building addition and removal.
- **Vector Data Manipulation**: Developed methods to automatically modify vector data for simulating various urban change scenarios, by using Python libraries such as geopandas, shapely.
- **Diffusion model refinement (ControlNet):** Improved baseline diffusion models to control spatial composition and semantic layout for generating plausible pre-change and post-change map outputs based on vector inputs.
- **Change Detection and Classification:** Trained change detection algorithms (ChangeFormer and MambaBCD) using simulated pre-change and post-change data. Evaluated trained models on real-world datasets.

ICESat-2 Spaceborne LiDAR as Complementary Data Source for Biomass Mapping **ETH Zürich**
Group project *Mar 2024 - Jul 2023*
Advisors: Prof. Konrad Schindler, Ghjulia Sialelli, Arno Rüegg

- **Dataset Creation:** Aligned ICESat-2 data with Sentinel-2 tiles. Developed a pipeline to generate 150x150 meter patches centered on the GEDI footprints from Sentinel-2 and ICESat-2 datasets for training models. Extracted relevant features such as spectral bands, geographical coordinates, and biomass density values.
- **Above Ground Biomass Density (AGBD) Estimation:** Designed and trained a Fully Convolutional Neural Network (FCN) to estimate AGBD, using Sentinel-2 and ICESat-2 bands as input features and GEDI AGBD as target feature.
- **Inference & Visualization:** Ran inference on the tiles with no biomass density ground truth. Created overlapping patches that are weighted to have less influence towards the edges, fused these, and visualized the results.

Modelling Integrated Water Vapour with Machine Learning and Meteorological Data **ETH Zürich**
Personal project *Sep 2023 - Dec 2023*
Advisors: Prof. Benedikt Soja, Laura Crocetti, Dr. Matthias Schartner

- **Data Integration:** Designed a data processing pipeline to preprocess and integrate high-resolution ERA5 meteorological data and GNSS station Integrated water Vapour observations.
- **Integrated water Vapour (IWV) prediction:** Developed machine learning-based models (XGBoost and Lasso regression) to predict IWV from meteorological variables, geographical location, and temporal data across global GNSS stations. Conducted both station-wise and time-wise prediction tasks to evaluate spatial and temporal generalization performance.

- **Model interpretation (XGBoost):** Analyzed feature importance and identified specific humidity at lower atmospheric levels as the most influential variable for accurate IWV prediction.

Building Block Vectorization of Atlas Municipal **ETH Zürich**
Group project (Research Topics in Cartography) *Mar 2024 - Jun 2024*
Advisor: Yizi Chen

- **Project overview:** Developed deep learning-based models for the vectorization of building blocks from historical maps of Paris (1866–1937), enabling the digitization of urban evolution.
- **Semantic segmentation:** Implemented and evaluated three semantic segmentation models (U-Net, ResUnet, and SwinUnet) for building block detection, using pixel- and instance-based evaluation metrics such as F1-score and panoptic quality.
- **Building block vectorization:** Developed a data processing pipeline for model training, testing, and vectorization, including the use of image augmentation, mask generation, and post-processing techniques like the Douglas-Peucker algorithm for polygon generalization.

Geospatial Data Acquisition and Total Station Automation **ETH Zürich**
Group project (Geospatial Data Acquisition) *Sep 2024 - Dec 2024*
Advisors: Zhaoyi Wang, Lorenz Schmid

• **Manual Measurement with a Total Station**: Conducted repeated point measurements using a Leica TS60 total station, following the ISO 17123-3 standard. Developed a Python script for data format conversion and processing, streamlining the measurement process and ensuring accurate horizontal direction testing.

• **Automatic Measurement with a Total Station via GeoCOM:** Automated the configuration and operation of a Leica TS60 total station using GeoCOM interface. Designed software to autonomously **measure sets** of points (angles, distances).

• **Assessing Meteorological Effects on Vertical Coordinates:** Investigated the impact of meteorological factors on slope distance measurements taken with a total station. Analyzed the manufacturer's distance correction model, applied atmospheric corrections, and evaluated the effectiveness of high-end and low-end meteorological sensors to enhance measurement accuracy in geodetic monitoring.

3D Data Acquisition, Modeling, and Visualization of Archaeological Sites **ETH Zürich**
Group project (Geodetic Project Course) *Jun 2024 - Jul 2024*
Advisors: Bingxin Ke, Julia Azumi Koch (ETH Zürich)

• **Project overview:** Collaborated in a team of 5 students to reconstruct and visualize Steinsberg Castle and Fortezza Rohan, two archaeological sites in Switzerland, using GNSS, TLS, drones, and cameras.

• **Fieldwork and data acquisition:** Contributed to the data acquisition process, including setting up GNSS RTK networks, operating Leica RTC360 laser scanners, and conducting drone-based photogrammetry.

• **Data processing:** Processed and aligned point clouds and images using Cyclone Register 360, Reality Capture, and Bernese software for precise **3D modeling**.

• **3D modeling and visualization:** Created high-fidelity 3D models for archaeological analysis and public demonstration, incorporating advanced techniques like Neural Radiance Fields (NeRF) for scene synthesis, and delivered fly-through visualizations and textured renders.

Analysis of the Built Environment and Spatiotemporal Traffic Congestion in Urban Areas
Bachelor thesis *Feb 2022-Jun 2022*
Advisors: Zhongliang Cai (Wuhan University)

- Analyzed temporal and spatial characteristics of urban traffic congestion in Wuhan.
- Calculated built environment variables and analyze their spatial distribution characteristics.
- Analyzed influencing factors of traffic congestion based on Geographically weighted model.

SuperMap Cup Competition 2020: Created a map to visualize the spatial pattern and analyze the global effects of COVID-19 pandemic, Excellence Award

PROFESSIONAL EXPERIENCE

Research Intern | Hubei Provincial Academy of Eco-environmental Sciences *Mar 2022-May 2022*

- Collected, processed, and analyzed environmental monitoring data related to air and water quality across multiple sampling stations.

• Assisted in preparing technical reports for environmental impact assessments (EIAs) and pollution source investigations.
• Applied GIS tools to visualize pollution distribution patterns and supported spatial analysis for regulatory planning.

SELECTED COURSES

• **Machine learning & computer vision related:** Computational Methods for Geospatial Analysis Introduction to Machine Learning Image Analysis and Computer Vision
• **Subject-related courses:** Advanced GIS Geodetic Earth Monitoring Research Topics in Cartography

SKILLS

• **Language:** Chinese (Native), English (Fluent)
• **Programming:** Python, Pytorch, LATEX, R, MATLAB
• **Software:** ArcGIS, QGIS, GEE, ENVI
• **Version Control:** Git

EXTRACURRICULAR ACTIVITIES & INTERESTS

Summer Practice Activity **Vancouver, Canada**
Team Leader *Jul 2019 - Aug 2019*
• Led a team to Vancouver to investigate the differences in environmental protection policies and culture between Canada and China and won the Second Prize of Summer Social Practice of Wuhan University.