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 (expected)*
Language of Instruction: English

Wuhan University **Wuhan, China**
Bachelor of Science in Geographical Information Science *Sep 2018 – Jun 2022*

HONORS

- Outstanding Graduate (Wuhan University) 2022
- Zhonghaida Scholarship (Wuhan University) 2021
- Merit Student (Wuhan University) 2019
- National Scholarship (**top 3%**, Wuhan University) 2019

RESEARCH INTERESTS

Machine Learning (Image processing); Computer Vision (**Remote sensing** datasets and historical map datasets); Remote Sensing (biomass mapping); **Geographical Information Science** (Spatiotemporal data analysis); **Urban informatics**

ESSAYS

*Some essays can be found on my homepage [*https://gicooaidun.github.io*].*

RESEARCH EXPERIENCE

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

- **Conceptualized Urban Change Types:** Define urban change categories for large-scale time spans, providing a refined framework for analyzing qualitative and quantitative transformations in urban environments.
- **Vector Data Manipulation**: Develop methods to automatically manipulate vector data for simulating various urban change scenarios, such as road construction and building addition and removal, by using automated vector manipulation techniques.
- **Diffusion model refinement (ControlNet):** Improve baseline diffusion models to accurately simulate urban changes based on vector inputs, controlling spatial composition and semantic layout for generating plausible map-based outputs.
- **Change Detection and Classification:** Train a change detection algorithm using simulated pre-change and post-change data.

ICESat-2 Spaceborne LiDAR as Complementary Data Source for Biomass Mapping **ETH Zürich**
Master Semester Project II *Mar 2024 - Jul 2024*
Advisors: **Prof. Konrad Schindler, Ghjulia Sialelli, Arno Rüegg** (ETH Zürich)

- Investigated the integration of ICESat-2 LiDAR data with **GEDI and Sentinel-2** imagery to improve **Above Ground Biomass Density (AGBD) estimation** in sub-arctic regions.
- **Data preprocessing**: Identified and downloaded ICESat-2 GeoTIFF files overlapping with Sentinel-2 tiles. Merged and reprojected ICESat-2 data into a single mosaic aligned with Sentinel-2's bounds. Cropped ICESat-2 to Sentinel-2 bounds and prepared the datasets for patch creation.
- **Data Creation:** Developed a pipeline to generate **150x150 m^2 patches** centered on the GEDI footprints from Sentinel-2 and ICESat-2 datasets for training machine learning models. Extracted relevant features such as spectral bands, geographical coordinates, and biomass density values.
- **Machine Learning:** Designed and trained a **Fully Convolutional Neural Network (FCN)** to estimate Above Ground Biomass Density (AGBD), using Sentinel-2 and ICESat-2 bands as input features and

GEDI AGBD as target feature. Utilized **ensemble learning** to enhance prediction accuracy and reduce model variance by training multiple models with different initializations and averaging their predictions.
- **Inference & Visualization:** Ran inference on the tiles with no GEDI data. 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**
Master Semester Project I *Sep 2023 - Dec 2023*
Advisors: **Prof. Benedikt Soja, Laura Crocetti, Dr. Matthias Schartner** (ETH Zürich)
- Developed a machine learning-based model using **XGBoost** to predict Integrated Water Vapour (IWV) from meteorological variables, geographical location, and temporal data across 457 GNSS stations globally.
- Designed a data processing pipeline to preprocess and integrate high-resolution **ERA5 meteorological data** and **GNSS station observations**.
- Conducted comparative analysis between XGBoost and Lasso regression, demonstrating superior performance of XGBoost, especially in areas with denser GNSS station networks.
- Analyzed feature importance and determined specific humidity at lower atmospheric levels as the primary factor for accurate IWV predictions.

Building Block Vectorization of Atlas Municipal **ETH Zürich**
Research Topics in Cartography (Course Project) *Mar 2024 - Jun 2024*
Advisors: **Yizi Chen** (ETH Zürich)
- Developed deep learning-based models for the vectorization of building blocks from historical maps of Paris (1866–1937), enabling the digitization of urban evolution.
- 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.
- 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.

ACADEMIC PROJECTS

Geospatial Data Acquisition and Total Station Automation **ETH Zürich**
Course project for Geospatial Data Acquisition *Sep 2023 - Dec 2023*
Advisors: **Lorenz Schmid, Nathalie Ryter, Zhaoyi Wang** (ETH Zürich)
- **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 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), enabling precise data collection.
- **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**
Course project for Geodetic Project Course *Jun 2023 - Jul 2023*
Advisors: **Bingxin Ke, Julia Azumi Koch** (ETH Zürich)
- Collaborated in a team of 5 students to reconstruct and visualize Steinsberg Castle and Fortezza Rohan, two archaeological sites in Switzerland, using **GNSS, Terrestrial Laser Scanning, drones, and cameras**.
- Contributed to the data acquisition process, including setting up GNSS RTK networks, operating Leica RTC360 laser scanners, and conducting drone-based photogrammetry.
- Processed and aligned point clouds and images using Cyclone Register 360, Reality Capture, and Bernese software for precise **3D modeling**.
- 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 analyzed 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

SELECTED COURSES

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

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

SKILLS

Programming: Python, Pytorch, LATEX, R, MATLAB, SQL, Google Earth Engine (GEE)

Language: Chinese, English