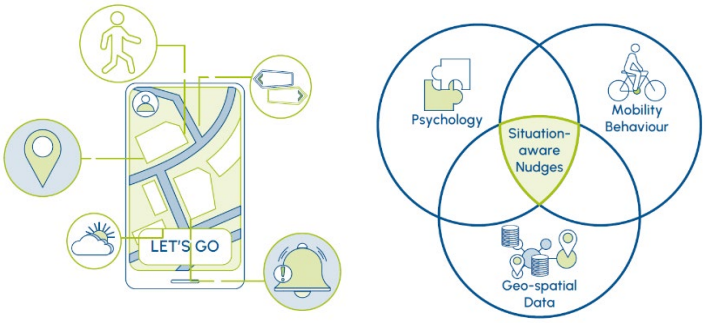
Master Thesis Topics - Spring Semester 2024

The following list covers a collection of possible thesis topics for Master students in Geomatics.

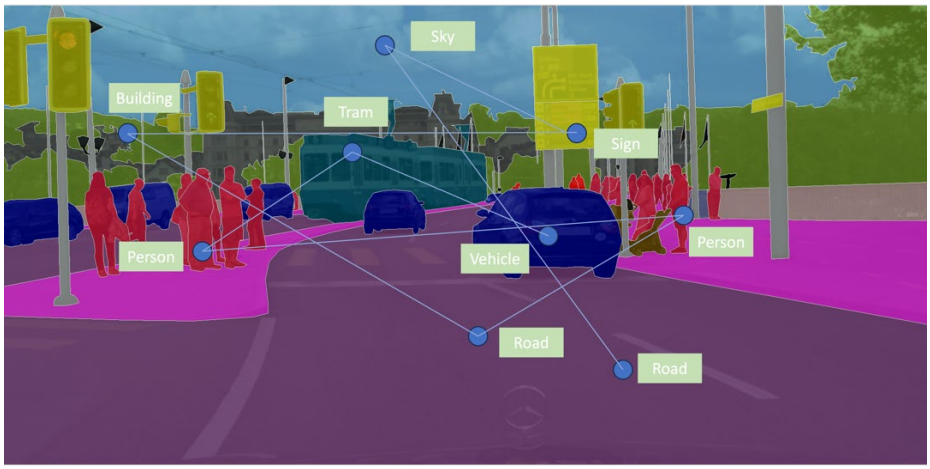
Your individual assignment will be adjusted with respect to scope and research/practical focus. You are also welcome to suggest topic adjustments to account for your individual interests.

Please contact the advisor / supervisor of each respective topic for more information.

Content:

Chair:	**Geoinformation Engineering**
Supervisor	Prof. Dr. Martin Raubal, mraubal@ethz.ch
Advisors / further supervisors	Ayda Grisiute (agrisiute@ethz.ch) Dr. Bingjie Cheng (bcheng@ethz.ch)
Thesis Title:	**Leveraging spatial analytics to proactively incorporate context-aware nudges into the planning of active mobility**
Abstract:	Mobile applications that consider contextual data are frequently employed to nudge users toward sustainable mobility behavior [1], such as cycling. These apps might, for instance, present CO_2 emissions for various transportation modes during trip planning. However, evaluating nudging effectiveness often happens post-intervention — after the app has been deployed and the user's behavioral data, e.g., movement trajectories, were collected [2]. **There is limited exploration into predicting how urban environments affect the effectiveness of these nudges.** For example, bike lane density or bike-sharing station locations may inform how nudges related to cycling may be distributed across the city. If understood, predictive assessments of nudging strategies could be already included in the planning of bike networks, or the development of context-aware mobile apps [3]. Spatial analytics methods, leveraging contextual data, provide a toolkit to analyze the potential spatial distributions of different nudges.  Figure: Conceptual components of context-aware mobile application for sustainable mobility (Luger-Bazinger et al., 2023) [4] In this thesis the student will assess the bike network in Zurich for the potential of different nudging techniques' effectiveness before the actual implementation. The primary objective of the MSc thesis will be to develop a workflow that utilizes spatial analytics techniques such as clustering, to match existing context-aware nudges with local spatial properties, such as demographics, infrastructure, and historical weather data. Next, the student will estimate the potential nudging impact across multiple network scenarios under uncertainty given these properties and perform sensitivity analysis, e.g., using mobility simulation. The GIS-based workflow will enable the identification of spatial markers that trigger effective nudges for sustainable mobility patterns. **References:** [1] Anagnostopoulou, E., Bothos, E., Magoutas, B., Schrammel, J., & Mentzas, G. (2018). Persuasive Technologies for Sustainable Mobility: State of the Art and Emerging Trends. Sustainability, 10(7), 2128. https://doi.org/10.3390/su10072128 [2] Cellina, F., Simão, J. V., Mangili, F., Vermes, N., & Granato, P. (2023). Sustainable mobility persuasion via smartphone apps: Lessons from a Swiss case study on how to design point-based rewarding systems. Travel Behaviour and Society, 31, 178–188. https://doi.org/10.1016/j.tbs.2022.12.001

	[3] Loidl, M., Kaziyeva, D., Wendel, R., Luger-Bazinger, C., Seeber, M., & Stamatopoulos, C. (2023). Unlocking the Potential of Digital, Situation-Aware Nudging for Promoting Sustainable Mobility. Sustainability, 15(14), 11149. https://doi.org/10.3390/su151411149 [4] Claudia Luger-Bazinger, Michael Thelen, David Leistner, Veronika Hornung-Prähauser, Martin Loidl, Matthias Seeber (2023): Handbook: Digital nudging for sustainable mobility. Salzburg: Salzburg Research. ISBN: 978-3-200-09441-3
Particularities (e.g. comments on group work etc.):	A more specific introduction will be given by the advisor upon request. The thesis is supervised by the Chair of Geoinformation Engineering and the Chair of Organizational Behavior.
Total number of students per topic:	1-2 students.

Chair:	**Geoinformation Engineering**
Supervisor (incl. e-mail):	Prof. Dr. Martin Raubal (mraubal@ethz.ch)
Advisors / further supervisors:	Lin Che (linche@ethz.ch), Dr. Peter Kiefer (pekiefer@ethz.ch)
Thesis Title:	**Real-Time Gaze Attention Understanding in Dynamic Environments**
Abstract:	The rapid advancement in computer vision and eye-tracking technologies has significantly expanded the possibilities of human-computer interaction. The integration of object recognition offers an in-depth analysis of visual scenes, while eye-tracking provides critical insights into human attention and cognitive processes. Recent research, such as GazeSam, leverages gaze as an input prompt for the Segment Anything Model (SAM), which efficiently generates real-time segmentation masks, notably improving the efficiency of clinical practices [1]. However, applying these integrated technologies for real-time gaze attention understanding in outdoor dynamic environments, such as pedestrian wayfinding tasks remains limited.  The primary objective of this thesis is to develop a deep learning model capable of identifying and recognizing the objects observed by a user. This model will not only recognize these objects but also analyse their sequence and the duration of the user's attention in real-time. From a cognitive science perspective, this model can be used to deepen our understanding of human environmental perception. Simultaneously, it holds significant potential for practical applications in human-computer interaction, particularly in guiding and monitoring user attention towards designated objects and areas. This approach promises to advance interactive technologies and offer practical tools for various applications, ranging from educational interfaces to enhanced user experiences in digital environments. Reference: [1] Wang, B., Aboah, A., Zhang, Z., & Bagci, U. (2023). Gazesam: What you see is what you segment. arXiv preprint arXiv:2304.13844.
Particularities (e.g. comments on group work etc.):	Depending on the student's interests, there is room for discussion regarding the specific thesis topic, methodology and application details. The student should have experience with Python, Deep Learning and Computer Vision.
Group work:	No

Chair:	**Chair of Geoinformation Engineering**
Supervisor:	Prof. Dr. Martin Raubal, mraubal@ethz.ch
Advisors / further supervisors:	Adrian Sarbach, asarbach@ethz.ch
Thesis Title:	**Increasing Spatial Awareness of General Aviation Pilots using an Extended Reality Tool**
Abstract:	This master thesis has the goal of developing an extended reality (XR) tool to support the spatial awareness of general aviation pilots, with a particular focus on visualising non-visible aeronautical information (e.g., air space structures, radio beacons, waypoints, etc.), hard-to-see hazards (e.g., wires, cable cars, antenna towers, traffic, etc.), and aiding pilots with their tactical flight operation (e.g., nearest airport for diversion, space to turn in a closed valley, etc.). Similar research has been conducted by Katins et al. (2023), where however only airports and traffic were visualised, and the focus was on workload, not situation awareness.  *How an XR tool for aviation could look like, showing traffic and an airport [Katins et al. 2023]* This master thesis will start with deciding on what features to implement, and subsequently implementing the chosen features. In a second step, a user study will be conducted and evaluated, to judge how the XR assistance is perceived by prospective users, with a focus on situation awareness and user experience. Reference: Katins et al. 2023. Exploring Mixed Reality in General Aviation to Support Pilot Workload. In Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems. ACM, New York, USA. https://doi.org/10.1145/3544549.3585742
Particularities (e.g. comments on group work etc.):	The student should have experience with programming an application for HoloLens (or another extended reality device).
Group work:	No

Chair:	**Geoinformation Engineering**
Supervisor:	Prof. Dr. Martin Raubal (mraubal@ethz.ch)
Advisors / further supervisors:	Dr. Yanan Xin (yanxin@ethz.ch)
Thesis Title:	**Estimating impacts of new car-sharing stations on induced demand**
Abstract:	Car-sharing, as a sustainable mobility concept, has shown to be effective in reducing the number of privately owned cars, leading to multiple sustainable outcomes, such as the reduction of CO_2 emissions, traffic jams, and parking spaces. To encourage the utilization of car-sharing services, new car-sharing stations are often introduced to increase their accessibility to potential users [1]. However, it remains a challenging question as to where to place these new car-sharing stations to attract new users or encourage more usage of these shared vehicles. This question cannot be addressed without a good understanding of the causal effects of new stations (*cause*) on car-sharing demand (*effect*), especially considering the spatial heterogeneity of the population served by each station and spatial spillover effects caused by adjacent stations. The goal of this thesis is to develop methods to estimate the spatial causal effects of a new car-sharing station on induced demand over time and across different spatial contexts, considering the spatial heterogeneity and interference effects [2].  *Image credit: https://www.mobility.ch/en/sustainability/e-mobility* Reference: [1] Mühlematter, D.J., Wiedemann, N., Xin, Y. and Raubal, M., 2023. Spatially-Aware Car-Sharing Demand Prediction. arXiv preprint arXiv:2303.14421. [2] Wang, Q., Guo, B., Cheng, L., Yu, Z. and Liu, H., 2023. CausalSE: Understanding Varied Spatial Effects with Missing Data Toward Adding New Bike-sharing Stations. ACM Transactions on Knowledge Discovery from Data, 17(2), pp.1-24.
Particularities:	A more specific introduction to the topic will be given by the advisors upon request. The student will need to sign a non-disclosure agreement to be able to work with car-sharing demand data.
Group work:	No