Master thesis subject

KG4GEO: A Knowledge Graph for the World Geography

Context

Modeling geographic space is crucial for enriching the capability of machine learning models to comprehend world geography and facilitate research across various domains, such as ecology, sociology, and remote sensing. Geographical information is inherently diverse and multimodal, comprising interconnected and complementary elements that form a comprehensive spatial description. For instance, satellite imagery offers insights into land cover patterns, while Wikipedia articles intricately detail a location's ecosystem, geological characteristics, and cultural significance.

In this project, we will extract geographic information from multimodal sources to construct a knowledge graph that elucidates the complexities of world geography. More specifically, we will explore Wikipedia articles, Sentinel-2 satellite images, and other possible sources (e.g., temperature maps, land cover maps, etc.) with worldwide coverage to extract geography-related information. Leveraging this information, we intend to construct a hierarchical graph structure that offers a nuanced, comprehensive, and knowledge-enriched representation of Earth's locations, incorporating insights from various modalities. Through this integration, we seek to enhance the current encoding of worldwide geographic locations, thereby facilitating deeper understanding and analysis across disciplines.

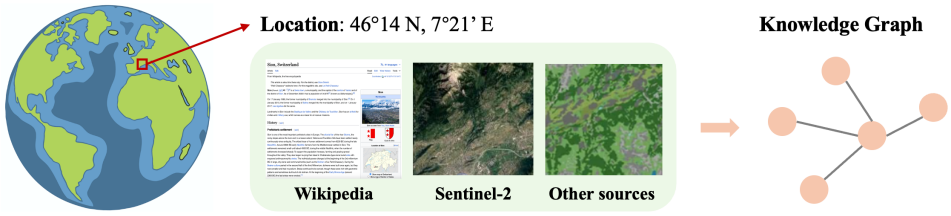

Figure 1: In the project, we will contruct a knowledge using multimodal geographic information for understanding the world geography.

Objectives

- Collecting and cleaning data: clean the existing dataset and collect additional sources that could be useful for geographic understanding.

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- Building a geographic location description system: we will define a hierarchical graph structure to describe the geographical information about a location from several aspects, e.g., geology, ecology, sociology, etc.
- Providing baselines using the geographic knowledge graph for worldwide location encoding.

Requirements and practical info

- Python programming skills
- Machine learning/deep learning experience (in particular, vision and/or NLP).
- Willingness to learn and ability to work independently.

Literature

- Vivanco Cepeda, V., Nayak, G. K., & Shah, M. GeoCLIP: *CLIP-Inspired Alignment between Locations and Images for Effective Worldwide Geo-localization*. NeurIPS 2023.
- Rußwurm, M., Klemmer, K., Rolf, E., Zbinden, R., & Tuia, D. *Geographic Location Encoding with Spherical Harmonics and Sinusoidal Representation Networks.* ICLR 2024.
- Uzkent, B., Sheehan, E., Meng, C., Tang, Z., Burke, M., Lobell, D., & Ermon, S. *Learning to Interpret Satellite Images using Wikipedia*. IJCAI 2019.

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