Deep Learning Projects

Introduction

The goal of these projects is to design a deep learning methodology to solve a task on a provided dataset. This involves:

- Implementing methods to load and preprocess the data
- Implementing and training several relevant models and/or one model with several parameter sets
- Computing relevant metrics and analyzing the results
- Visualizing results

Choose one of the five projects proposed in the next sections.

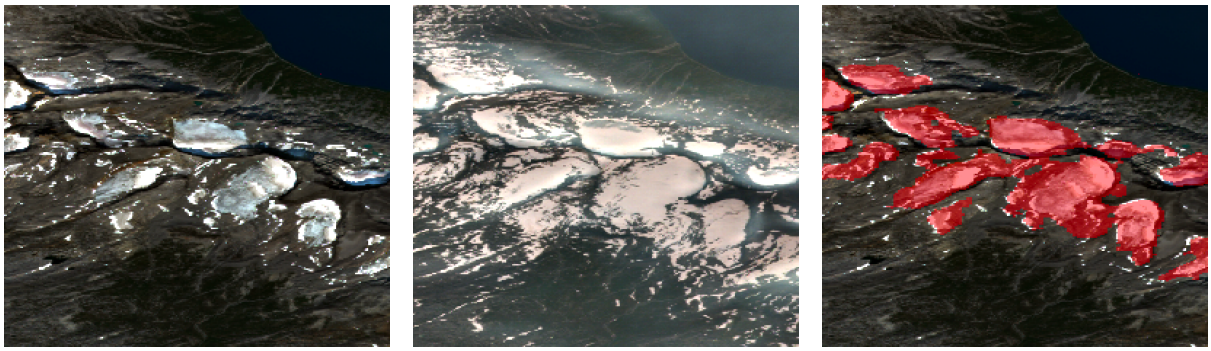
Then you can download the dataset you need for your project here.

2 Mapping Glaciers with Sentinel-2 Imagery and GLIMS Database

Task Monitoring changes in glacier extent and volume is essential for understanding climate change impacts. In this project, we aim to spatially map glaciers (i.e. semantic segmentation) in Greenland and do a temporal comparison using multi-temporal satellite imagery. Specifically, the goal of this project is two-folded:

- At a fixed date, train a neural network for segmentation on a glacier area and evaluate it on another one.
- Evaluate the neural network at a different date for temporal comparison.

Data This dataset is composed of two glacier areas in Greenland near Narsarsuaq, one for train and the other for test. Using S2 images as inputs and GLIMS database as a reference, these two areas are tiled into 128×128 patches. As you see on Figure 2, images both from July and August 2023 will be provided. The training and spatial evaluation will be conducted on August images while July images will be used for temporal comparison.
Images: The input images come from Sentinel-2 (S2), a European Earth observation satellite mission providing high-resolution multispectral data with a 5-day global revisit time. It supports agriculture, forestry, disaster management, and environmental monitoring applications, offering freely accessible data through the Copernicus program. In this project, you will deal with 10m resolution RGB+NIR images from two different times in Summer 2023.
Labels: The labels come from the Global Land Ice Measurements from Space (GLIMS) database, a comprehensive and globally recognized repository of information related to Earth's glaciers and ice-covered regions. Established in 1995, GLIMS is a valuable resource for researchers studying glaciers and their response to climate change. GLIMS provides coverage of glaciers and ice-covered regions from all around the world.



(a) S2 image from August 2023 (b) S2 image from July 2023 (c) (a) overlayed with GLIMS

Figure 2: Changes in glaciers between July and August 2023

Challenges

- The images of the training set and the test set come from two different glaciers, so the neural network might need to be robust to this domain change.
- Inconsistencies in labels may arise due to temporal disparities between the GLIMS database and Sentinel-2 imagery, potentially introducing bias in metrics, so the results must be critically evaluated. Transitioning from small tiles suitable for neural network inputs to large-scale images better for human evaluation is thus recommended. Code will be provided for this.
- Since two different dates of Sentinel-2 images are provided, this project allows us to explore temporal changes in glacier extent and to assess the effectiveness of the deep-learning models over time. It will be possible to incorporate images from both dates during training to improve the robustness of the neural network to this problem.

References Xie, Z., Haritashya, U. K., Asari, V. K., Young, B. W., Bishop, M. P., & Kargel, J. S. (2020). GlacierNet: A deep-learning approach for debris-covered glacier mapping. IEEE Access, 8, 83495-83510.