ID 4717Pg: Enhancing Models of Optimal Polar Bear Movement in the Arctic through Advanced Data Science and Image Processing

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Background

Polar bears depend on sea ice for hunting, travel, and survival, but climate change is accelerating sea ice loss, increasing the energetic demands on these animals.

This project utilizes machine learning and satellite imagery to classify Arctic regions as water or ice, enabling a comprehensive analysis of sea ice distribution and connectivity over time.

By integrating percolation theory and energy cost modeling, this research evaluates how changing sea ice conditions impact polar bear movement efficiency, providing insights into the challenges posed by a warming climate.

Why Sentinel-Hub

Sentinel Hub is the preferred platform for this project due to its access to high-resolution Sentinel-1 and Sentinel-2 imagery. API integration facilitate automated data acquisition and preprocessing, minimizing the need for local storage and computation.

The combination of Sentinel-1 SAR imagery, which penetrates cloud cover and operates in low-light conditions, and Sentinel-2 optical data, which provides detailed spectral information, helps decipher classification of sea ice for manual labeling to feed to the machine learning mode. Additionally, Sentinel Hub offers consistent, open-access data through the Copernicus program, making it a scalable and cost-effective solution for long-term sea ice trend analysis.

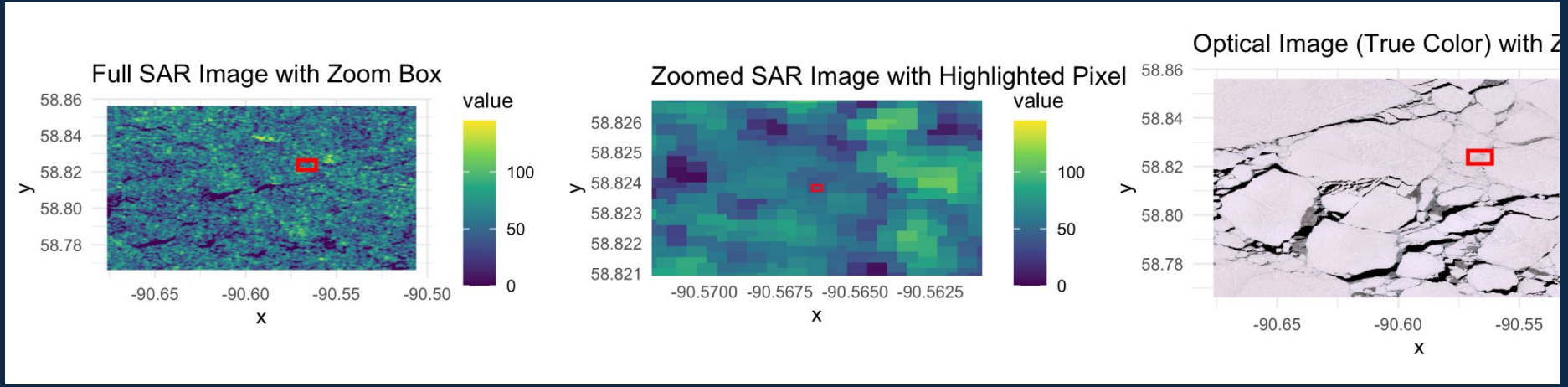
Process

1. **Satellite Image Acquisition** – Sentinel-1 and Sentinel-2 imagery is obtained via the Sentinel Hub API, targeting key polar bear migration periods (November–December and June–August) over the past ten years.

2. **Image Classification** – A machine learning model is developed to classify each pixel as water or ice, from a manually labeled dataset to ensure accuracy in sea ice detection.

3. **Sea Ice Analysis & Energy Cost Modeling** – Percolation theory and statistical metrics are applied to evaluate sea ice characteristics, and energy-efficient polar bear movement paths are assessed using Nicole Forrester's (fellow peer) model. Long-term sea ice trends are analyzed, with model outputs validated against NSIDC sea ice data.

Process

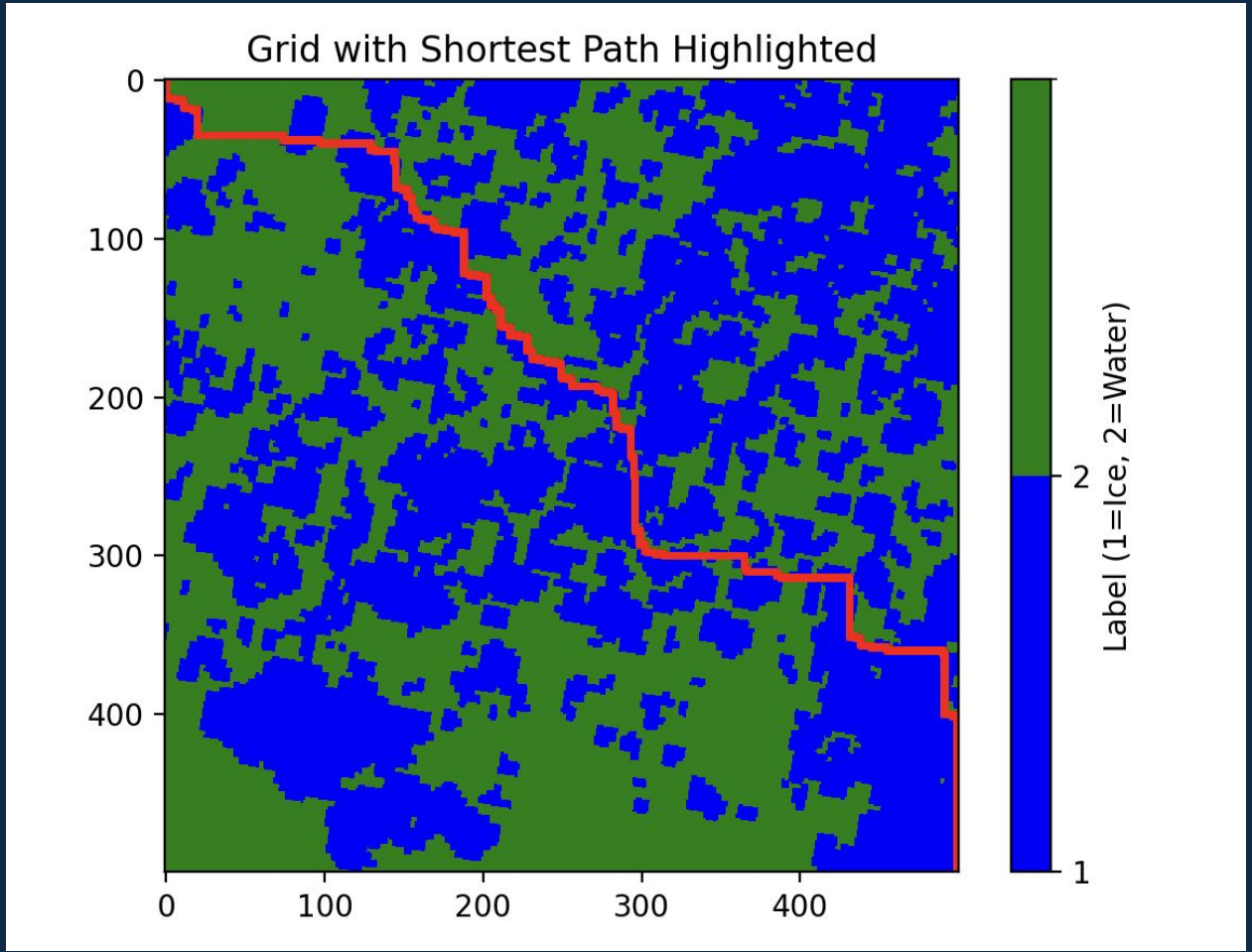


Using a combination of Sentinel - 1 and Sentinel - 2 images, we can more easily label pixels as ice or water for training

Process

Once trained and predictions are made, we can run an algorithm that predicts the shortest (and most energy efficient) path for a polar bear to take across the landscape.

This also allows us to look at other statistics such as spatial correlation and ice concentration over longer periods of time.



Thank you!