An ICEBERG Update and Request for Community Input

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Abstract

The ICEBERG (Imagery Cyber-infrastructure and Extensible Building blocks to Enhance Research in the Geosciences) project (NSF 1740595) aims to (1) develop open source image classification tools tailored to high-resolution satellite imagery of the Arctic and Antarctic to be used on HPDC resources, (2) create easy-to-use interfaces to facilitate the development and testing of algorithms for application to specific geoscience requirements, (3) apply these tools through use cases that span the biological, hydrological, and geoscience needs of the polar community, and, (4) transfer these tools to the larger non-polar community.

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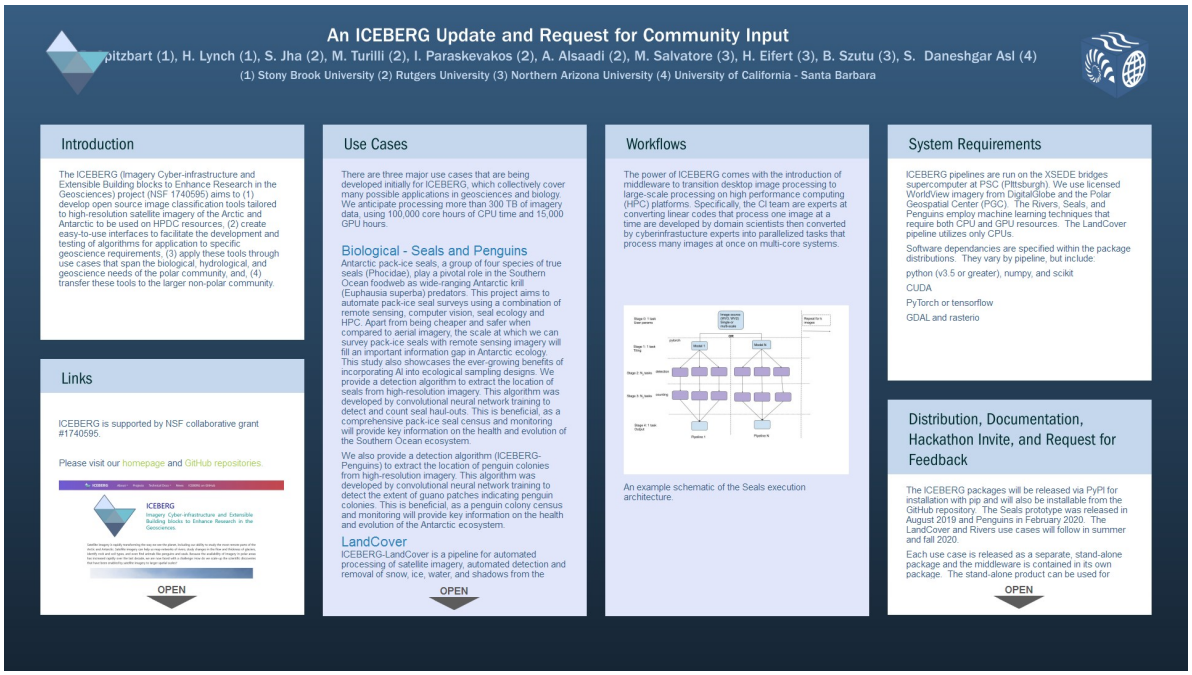

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PRESENTED AT:

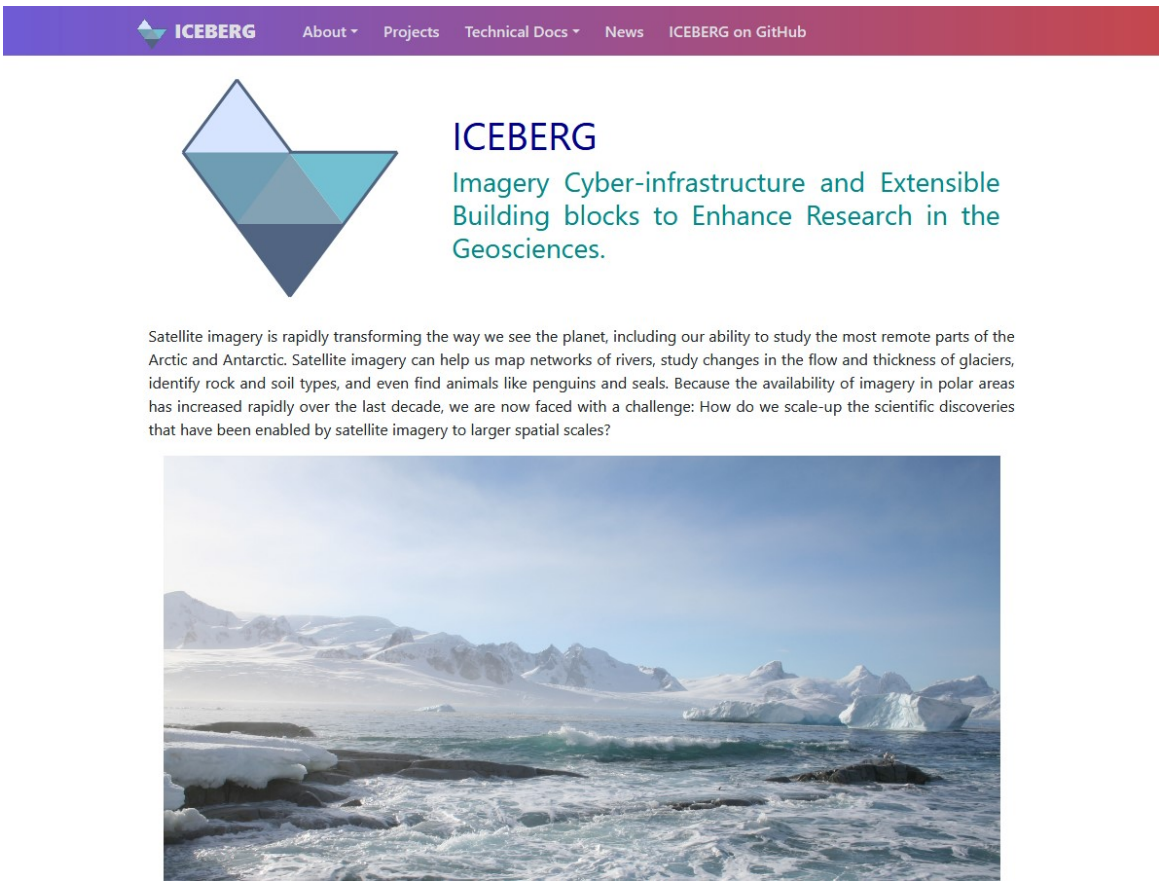
INTRODUCTION

The ICEBERG (Imagery Cyber-infrastructure and Extensible Building blocks to Enhance Research in the Geosciences) project (NSF 1740595) aims to (1) develop open source image classification tools tailored to high-resolution satellite imagery of the Arctic and Antarctic to be used on HPDC resources, (2) create easy-to-use interfaces to facilitate the development and testing of algorithms for application to specific geoscience requirements, (3) apply these tools through use cases that span the biological, hydrological, and geoscience needs of the polar community, and, (4) transfer these tools to the larger non-polar community.

LINKS

ICEBERG is supported by NSF collaborative grant #1740595.

Please visit our homepage (https://iceberg-project.github.io/index.html) and GitHub repositories. (https://github.com/iceberg-project)



(https://iceberg-project.github.io/index.html)

USE CASES

There are three major use cases that are being developed initially for ICEBERG, which collectively cover many possible applications in geosciences and biology. We anticipate processing more than 300 TB of imagery data, using 100,000 core hours of CPU time and 15,000 GPU hours.

Biological - Seals and Penguins

Antarctic pack-ice seals, a group of four species of true seals (Phocidae), play a pivotal role in the Southern Ocean foodweb as wide-ranging Antarctic krill (Euphausia superba) predators. This project aims to automate pack-ice seal surveys using a combination of remote sensing, computer vision, seal ecology and HPC. Apart from being cheaper and safer when compared to aerial imagery, the scale at which we can survey pack-ice seals with remote sensing imagery will fill an important information gap in Antarctic ecology. This study also showcases the ever-growing benefits of incorporating AI into ecological sampling designs. We provide a detection algorithm to extract the location of seals from high-resolution imagery. This algorithm was developed by convolutional neural network training to detect and count seal haul-outs. This is beneficial, as a comprehensive pack-ice seal census and monitoring will provide key information on the health and evolution of the Southern Ocean ecosystem.

We also provide a detection algorithm (ICEBERG-Penguins) to extract the location of penguin colonies from high-resolution imagery. This algorithm was developed by convolutional neural network training to detect the extent of guano patches indicating penguin colonies. This is beneficial, as a penguin colony census and monitoring will provide key information on the health and evolution of the Antarctic ecosystem.

LandCover

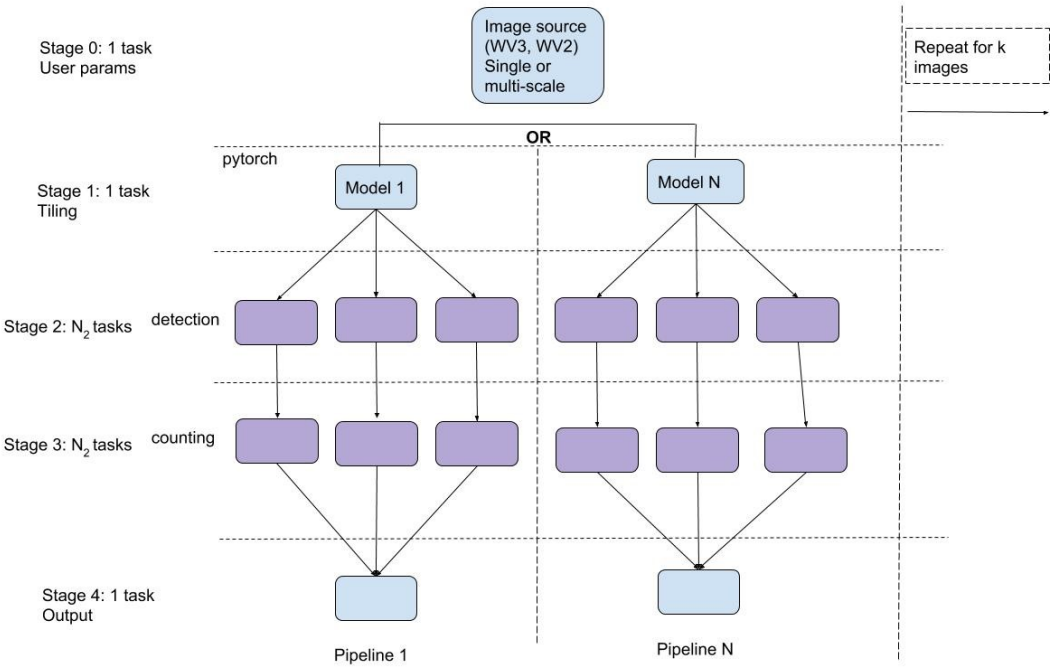
ICEBERG-LandCover is a pipeline for automated processing of satellite imagery, automated detection and removal of snow, ice, water, and shadows from the scene, automated atmospheric characterization and removal, and automated “stretching" of the scenes to provide spatial coverage of surveyed area, reasonable estimates on atmospheric contributions, and comparisons to a spectral library of known geologic materials.

Rivers

We provide a classification algorithm for ice surface features from high-resolution imagery. This algorithm was developed by convolutional neural network training to detect regions of large and small rivers and to distinguish them from crevasses and non-channelized slush. We also provide a detection algorithm to extract polyline water features from the classified high-probability river areas.

WORKFLOWS

The power of ICEBERG comes with the introduction of middleware to transition desktop image processing to large-scale processing on high performance computing (HPC) platforms. Specifically, the CI team are experts at converting linear codes that process one image at a time are developed by domain scientists then converted by cyberinfrastucture experts into parallelized tasks that process many images at once on multi-core systems.



An example schematic of the Seals execution architecture.

SYSTEM REQUIREMENTS

ICEBERG pipelines are run on the XSEDE bridges supercomputer at PSC (PIttsburgh). We use licensed WorldView imagery from DigitalGlobe and the Polar Geospatial Center (PGC). The Rivers, Seals, and Penguins employ machine learning techniques that require both CPU and GPU resources. The LandCover pipeline utilizes only CPUs.

Software dependancies are specified within the package distributions. They vary by pipeline, but include:

python (v3.5 or greater), numpy, and scikit

CUDA

PyTorch or tensorflow

GDAL and rasterio

DISTRIBUTION, DOCUMENTATION, HACKATHON INVITE, AND REQUEST FOR FEEDBACK

The ICEBERG packages will be released via PyPI for installation with pip and will also be installable from the GitHub repository. The Seals prototype was released in August 2019 and Penguins in February 2020. The LandCover and Rivers use cases will follow in summer and fall 2020.

Each use case is released as a separate, stand-alone package and the middleware is contained in its own package. The stand-alone product can be used for small batches of imagery or coupled with the middleware for large-scale production.

The team is also working on Jupyter Notebooks to provide documentation and example workflows. The goal is to promote community adoption and further development.

We will be conducting several internal hackathons via Zoom in the coming weeks to improve the documentation and ease of installation and implementation. We welcome any EarthCube attendees to join. Please contact any of the authors for details.

We encourage any researchers working on high resolution imagery intensive projects to contact any ICEBERG team member via the website for support in implementing ICEBERG.