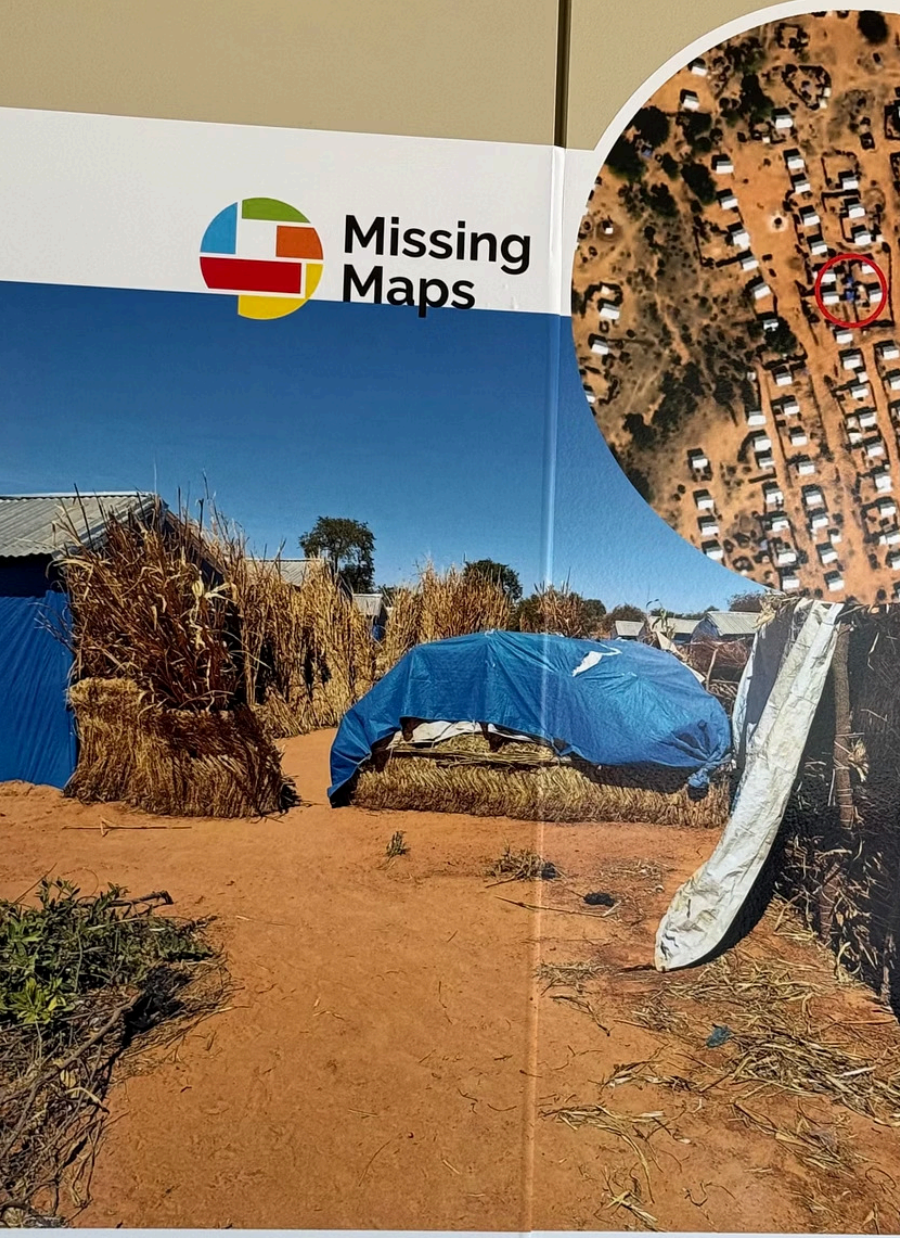


Internship Presentation

By: Kshitij Raj Sharma

28 - August - 2025

Supervisor: Dr. Lorenz Wendt

Duration: June–August 2025

MEDECINS SANS FRONTIERES
DOCTORS WITHOUT BORDERS

GEOHUM

Agenda

1 Introduction & Motivation

Introduction about the presentation topic , why standardization matters and its significant use cases , the purpose of this research

2 Part I: Metadata Standards and Model Standardization

Exploring the significance of metadata standards and their impact on model standardization, how it fills the gap and what i have figured out during my study

3 Part II: Self-contained Model Delivery (Google Buildings Pipeline)

The experiments i have conducted to package the complex model into self-contained container delivery using the Google Buildings full pipeline.

4 Reflections, Key Takeaways, and Discussion

Reflecting on the main points, extracting key insights, and engaging in interactive discussions.

Introduction & Motivation: Humanitarian MLOps

Humanitarian organizations face significant operational challenges when applying machine learning to geospatial data. While ML can provide timely insights at scale , it needs to be transparent , easily accessible and reproducible

The key pain points include:

1 **Lack of Transparency & Auditability**

2 **Difficulty Ensuring Reproducibility**

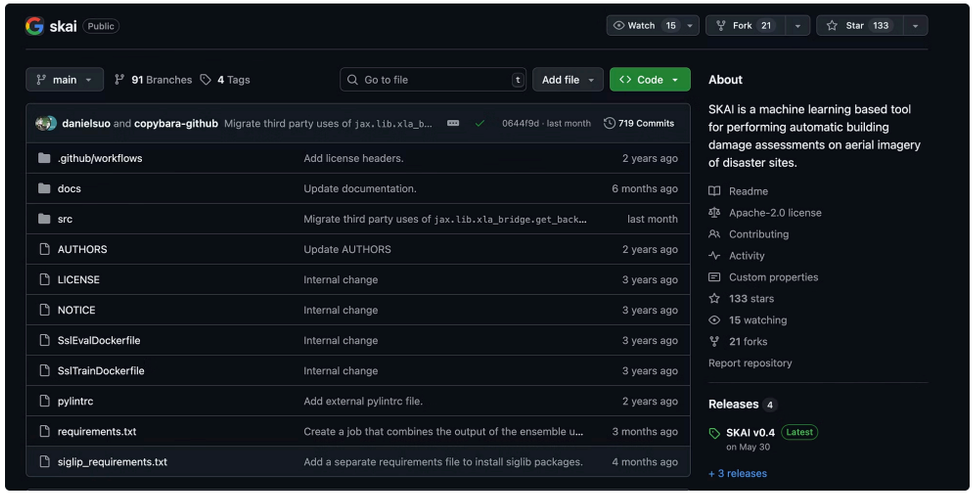
3 **Limited Accessibility for Non-Technical Users**

4 **High learning curve & Reusuability**

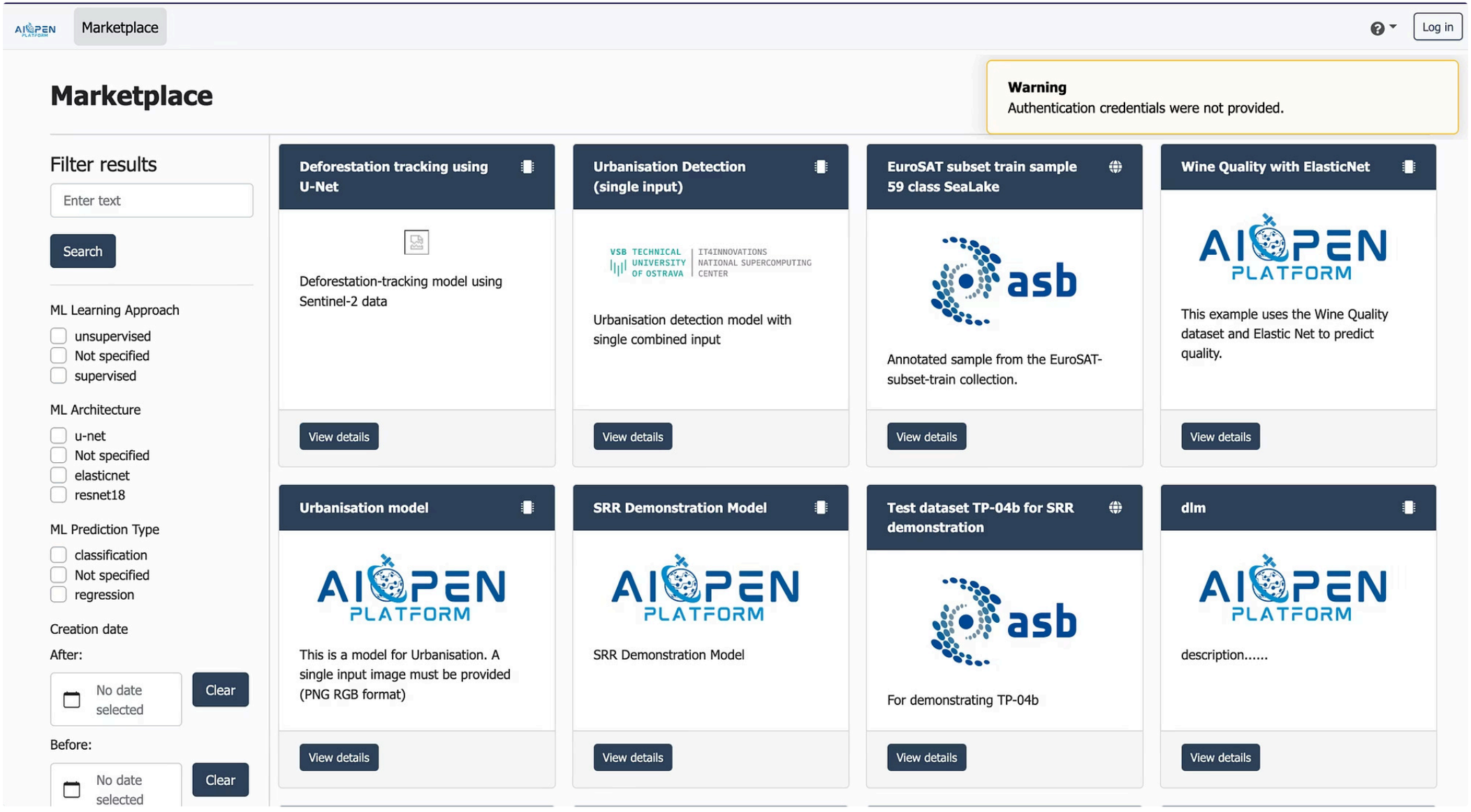
Part I

The Challenge of Geospatial Data Standards

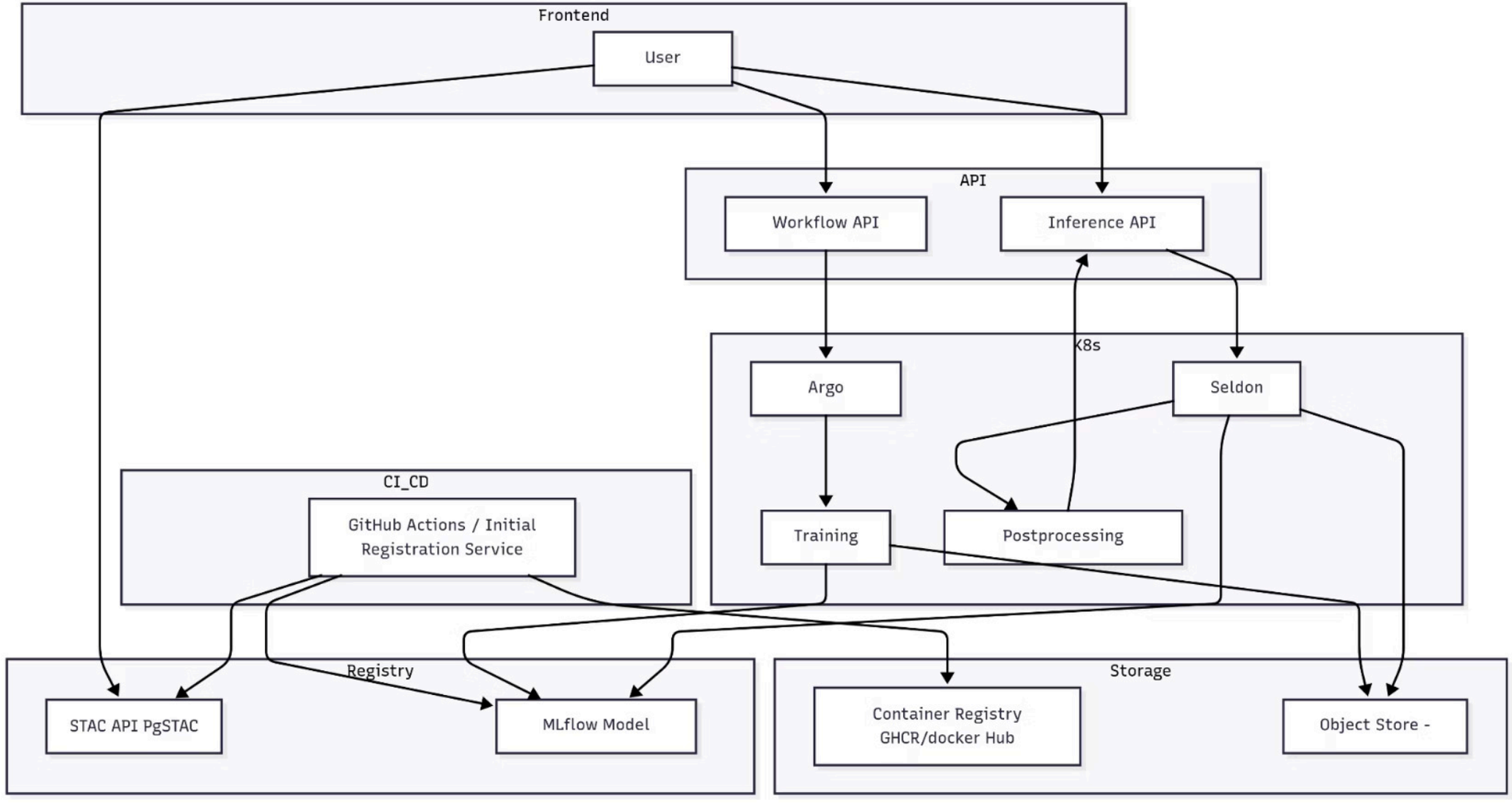
AI models for maps often work alone, which makes it hard for different groups to work together and use them effectively. My research aimed to create a common way for these AI models to communicate, so they can easily work with different systems and organizations.



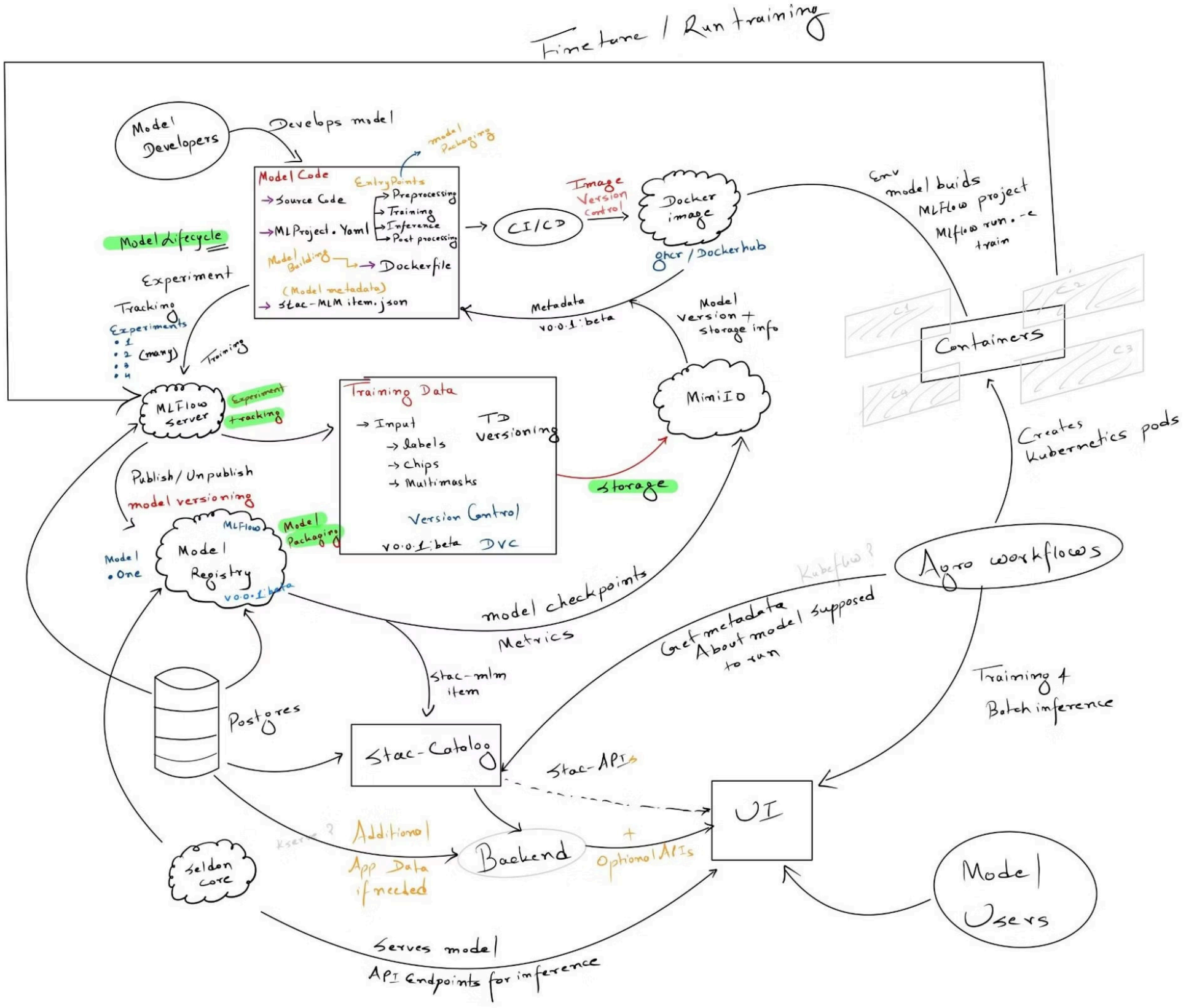
- **Problem:** Geo AI models for maps are hard to use together, recreate, or share.
- **My Approach:** I have looked at existing data standards (like STAC) and changed them for AI models that use map data, I have tried to encode them in a practical way and started from the training process , including how they work with other platforms like ArcGIS.
- **What I tried:** I applied these standards to a model that finds refugee camps as a pilot model. This helped me explore the pipeline, track and document the model metadata
- **Difficulties:** I faced issues with ArcGIS and Windows systems, plus problems getting all pieces together to work.
- **What I learned:** It's super important for these tools to be simple, work well, and be easy to reproduce for real-world humanitarian use.



Existing Efforts and Implementation

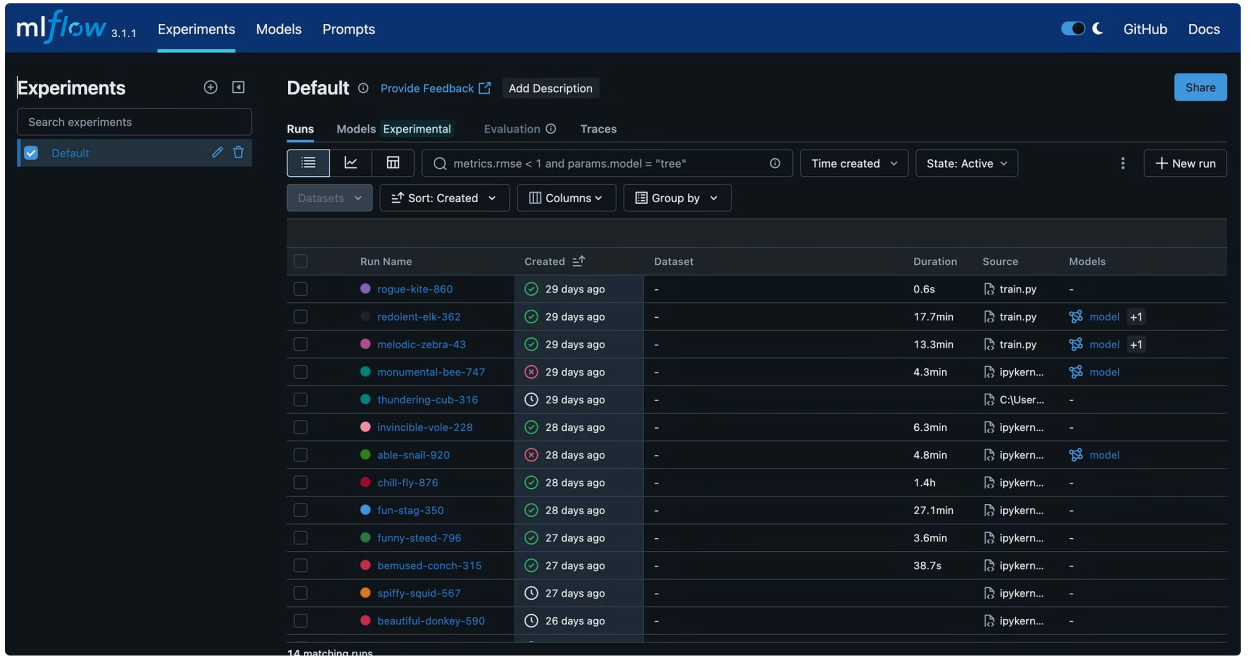


Highlevel Architecture Planned



Detailed Workflow

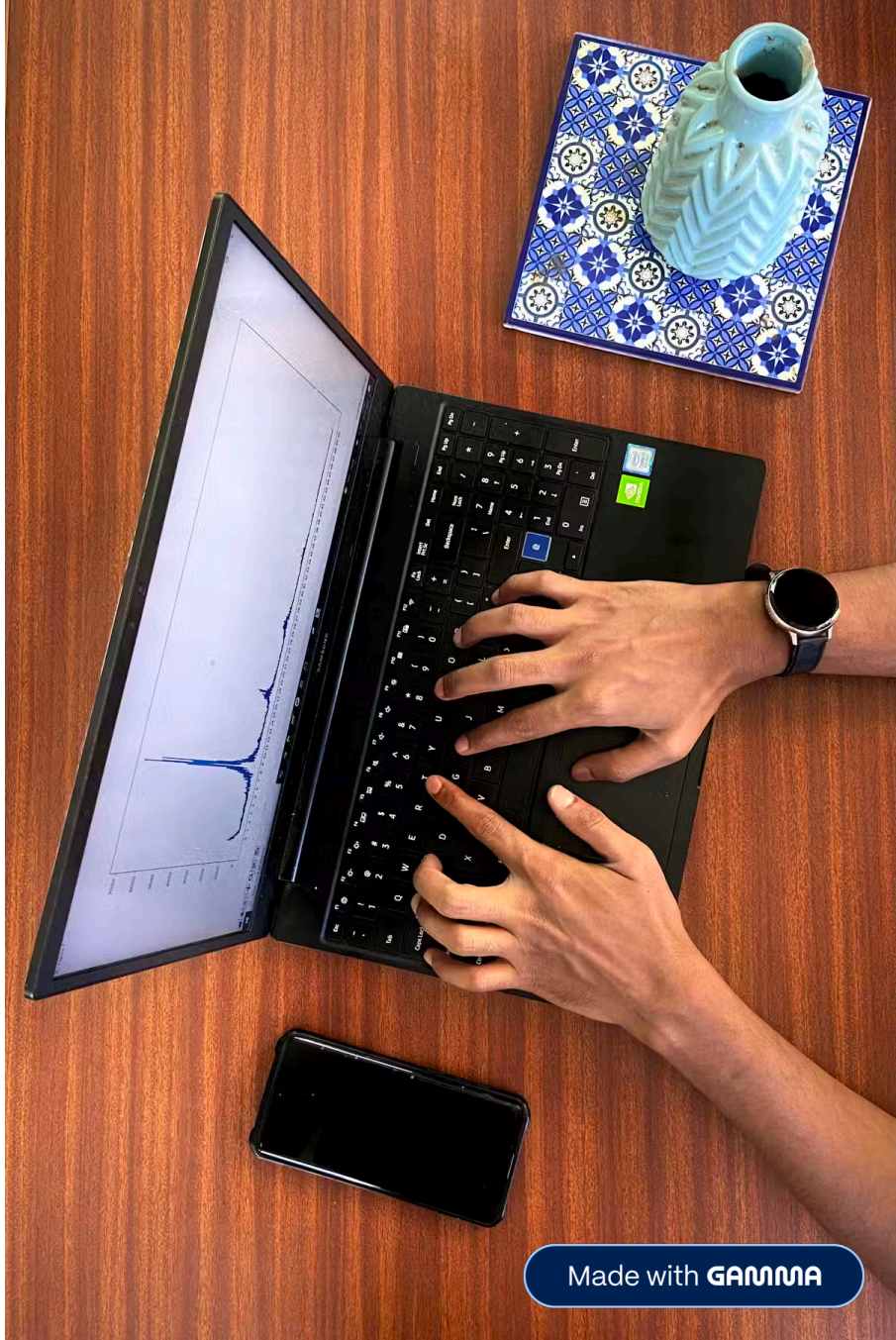
Metadata example : Refugee Camp Detection



In the picture is an example how AI model training processes documented using the stac-mlm standard , tracked into the server I hosted , There can be multiple models pointed to the server for other people to see or in the instance

Model was developed using unet alike architecture just to experiment the metadata and tracking

Demo !



Part II

Self-Contained Model Delivery: Google Buildings Pipeline

01

Problem:

MSF needed user-friendly geospatial AI workflows (google buildings) directly in their infrastructure.

02

Pipeline Development:

From imagery preprocessing to model execution and post-processing for building detection.

03

Packaging & Delivery:

Leveraging Docker containers for portability, with experiments on Windows deployment.

04

Challenges:

Navigating infrastructure constraints and complex dependency management in diverse field settings.

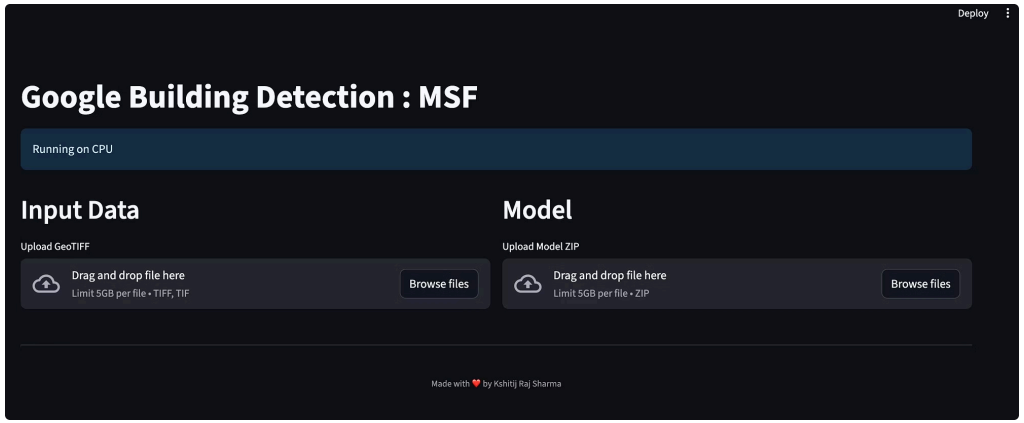
05

Outcome:

Full pipeline delivered to MSF, complete with a user interface and automated scripts for seamless operation.

Google Buildings Pipeline

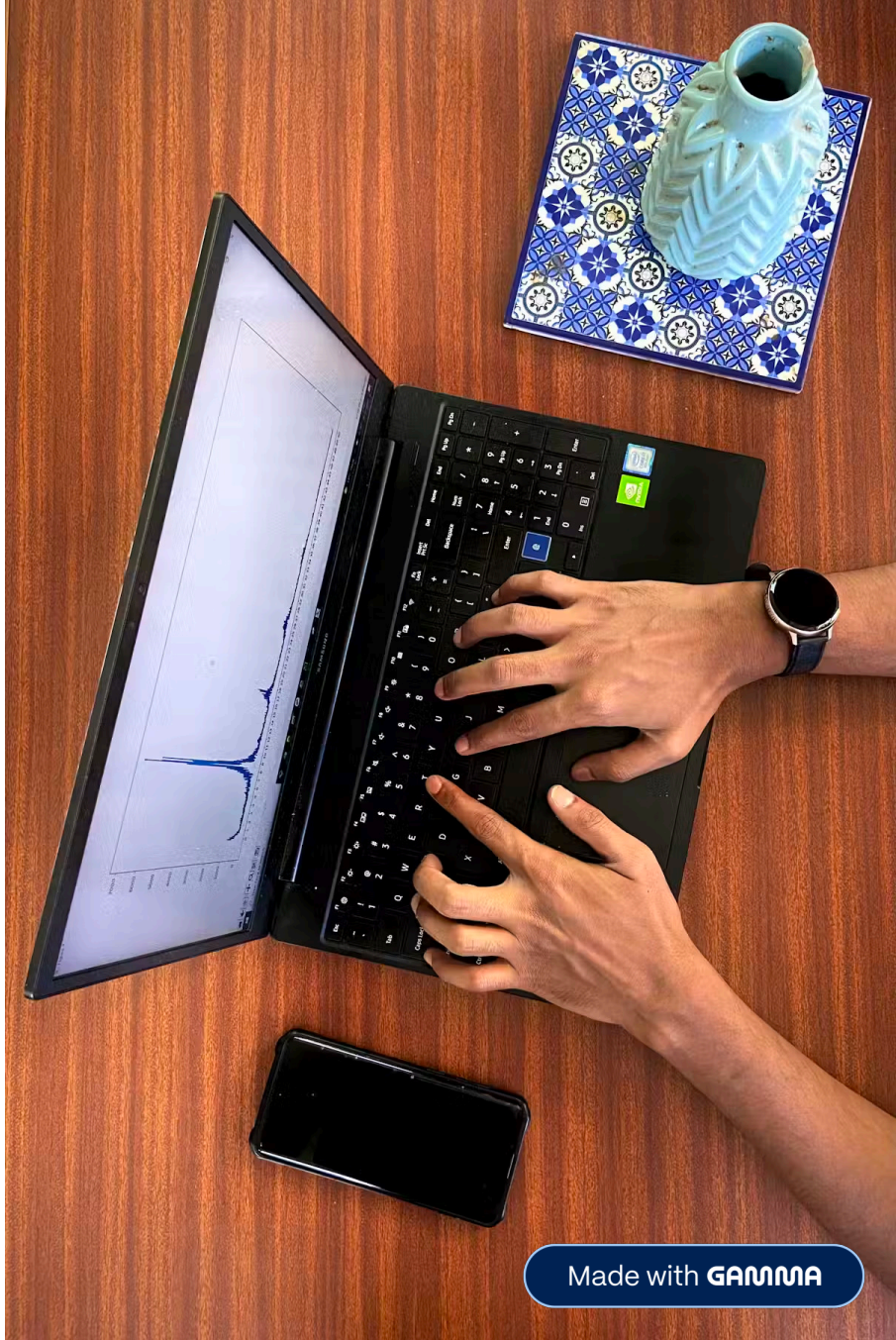
This project adapted Google's building footprint detection pipeline for MSF's specific needs, allowing for rapid, localized analysis of infrastructure in crisis zones.



I have tried to follow the same workflow i proposed initially but without publishing them to hub rather self contained container ! CI / CD frontend , model packaging follows the similar logic

- **Preprocessing:** Efficient handling of high-resolution drone imagery. (there is a fast cog2tiles lib developed to be able to produce efficient tiles from large cog)
- **Model Execution:** Adapting the Google Buildings model with both cpu and gpu based environments & versioning of the pipeline, I developed a python package that encapsulates all of them indepedently
- **Post-processing:** Converting model outputs into actionable GIS data formats for humanitarian practitioners including prediction mosaicking and rasterization
- **User Interface:** Development of a simple, intuitive UI for non-technical users to run the pipeline.
- **Scripts:** Automated scripts for installation, execution, and troubleshooting, minimizing manual intervention.

Demo !



Looking back....

1

Week 1: Foundations

Onboarding & AGIT 2025 conference; Preliminary research on AI standardization and feasibility.

2

Week 2: Pilot Development

Researched tools/platforms; Developed pilot refugee camp detection model & documented its process.

3

Week 3: Cloud Infrastructure

Set up server & S3 for model artifacts; Created workflow for stack MLM items; Hosted full workflow on DigitalOcean.

4

Week 4: MSF Integration

Familiarized with MSF's Windows/ArcGIS environment; Developed ArcGIS conversion scripts; Tested model; Attended FOSS4G Europe.

5

Week 5: On-site Adaptation

Collaborated at MSF Vienna; Adapted workflow for practical usability; Managed Windows Python environments & resolved compatibility issues.

6

Week 6: Pipeline Delivery

Developed full Google Buildings pipeline for MSF; Implemented preprocessing, model execution, output conversion & UI for delivery.

7

Week 7: Reporting

Prepared comprehensive reports and presentation materials summarizing internship work and outcomes.

Reflections

What Worked Well

- Proactive communication with MSF, iterative development, and focusing on needs.
- Adaptation with the requirements and tried to better use of the time
- Even though we couldn't move forward with initial plan due to resource constraints , research and the consultation went well

What Didn't Work

- Initial underestimation of environmental complexities and cross-platform compatibility issues.
- My infamiliarity with windows and arcgis delayed things a lot
- I had to switch to self contained solution rather than the hosted mlflow to keep things simple and effective

Personal Learnings & Takeaway

- The art of adapting theoretical knowledge to real-world humanitarian constraints.
- The level of complexity involved to be able to execute the workflows that are developed in diverse env specifically with windows is huge and serious
- We need to take operational constraints in to account always along with the processes and results

Discussion

Open Questions

- How do we find a middle ground between research , implementation and usecases. Are we simplifying the process or adding burden to sys admin ?
- What is the optimal role for open-source solutions in this ecosystem? Is it worth filling out the metadata ? or just too much work !

Future Directions

- Expanding the geospatial AI model hub with more diverse applications & completing the prototype
- Exploring the .exe packaging directly from the metadata
- Developing clearer guidelines for metadata creation and utilization across various data types.

Conclusion

I think this internship gave me a key takeaway how a system from research to the actual implementation can differ across diverse environment. It was weeks of learning , pushing my every possible limits , testing , debugging and lot of coffee . People I have worked with really supported me a lot and I owe to them thousands.

Key Contributions:

- Explored the value of metadata standards for geospatial AI interoperability.
- Delivered a fully operational Google Buildings pipeline tailored for MSF's field operations.
- Identified critical challenges and practices for deploying AI in complex operational environments.

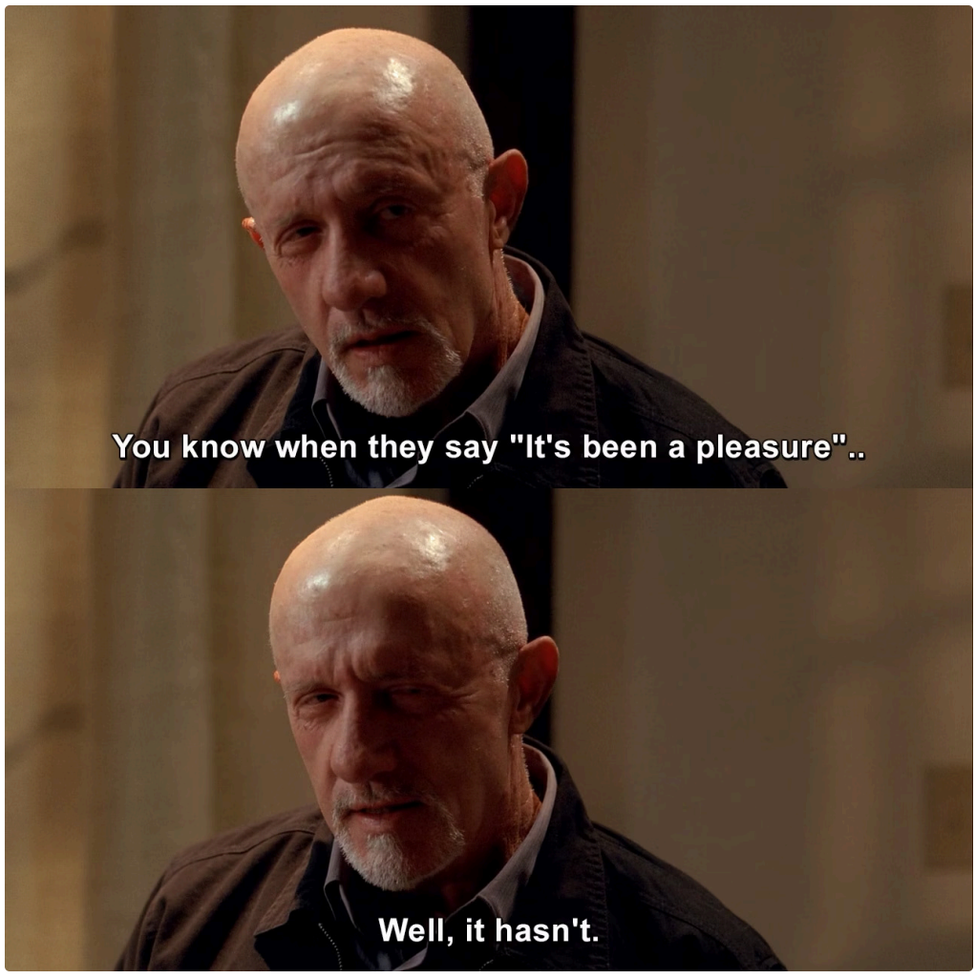
Namaste !!!

Acknowledgments

Special thanks to the entire MSF Vienna EO team (Ann, Leslie and Yann) , Dr. Lorenz Wendt for his invaluable guidance, and the Christian Doppler Laboratory , GeoHum at Paris Lodron University for hosting me.

Resources

Questions ?



It's been thrilling roller-coaster ride !