Mouhamad Ali Elamine

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Experience

Applied Research Associates 01/2024 – Ongoing
Deep Learning and Computer Vision Engineer *Raleigh, NC*

- **Satellite Weather Segmentation Enhancement**
  - Overhauled a U-Net-based segmentor for satellite imagery, resolving class imbalance and severe misclassification, while conducting extensive data analysis to identify and refine mislabeled data using filtering techniques.
  - Replaced undersampling with targeted augmentations (rotations, noise injection) to improve generalization.
  - Transitioned from Dice loss to Jaccard loss for object-wise segmentation, improving dense cloud classification.
  - Designed a novel solution to snow-cloud confusion by integrating NASA snowfall probabilities as an additional image band based on geospatial metadata, reducing confusion to 5%.
  - Improved segmentation by leveraging multispectral band differentials to approximate optical flow, helping the model distinguish between static snow and dynamic clouds, boosting the model's IoU from 82% to 93%.
- **Tree Segmentation for Improved DSM Generation**
  - Developed and deployed a tree segmentation model to enhance Digital Surface Model (DSM) accuracy by masking trees post-photogrammetry.
  - Reduced labeling time by leveraging multi-viewpoint projection and automated annotation with SAM.
  - Optimized model performance by fine-tuning Detectree model on high-resolution pan-sharpened MSI.
  - Improved tree-shadow differentiation by using infrared bands and reduced domain variance by clustering data with NDVI, creating a specialized model zoo for different environments.
  - Integrated model visualization tools (WandB) for in-depth training analysis and deployed the final solution in a containerized Flask-based service for seamless integration into the pipeline.
- **Building Segmentation and Height Estimation with DepthAnythingV2 and DINOV2**
  - Developed a multi-task deep learning model for building segmentation and height estimation from satellite imagery by modifying DAV2 to predict both tasks using a shared DINOV2 backbone.
  - Integrated a custom segmentation head into DAV2 after Mask R-CNN fine-tuning failed to generalize on data.
  - Implemented scale-aware depth estimation by predicting relative depth & scale factors using reference objects.
  - Enhanced accuracy by tiling high-resolution images instead of resizing, integrating satellite metadata (elevation and azimuth angles) as auxiliary inputs, and adding shadow masks as an input band to help the model inference.
  - Integrated model visualization tools (WandB) for in-depth training analysis and deployed the final solution in a containerized Flask-based service for seamless integration into the pipeline.
  - Achieved 95% IoU on building segmentation and optimized height evaluation by focusing only on segmented pixels, leading to low RMSE in height estimation.
  - Clustered building facade and rooftop types using DINOv2 feature extraction, PCA, and K-Means, successfully grouping buildings based on color and material properties.
  - Integrated the repository as a Git submodule in the main pipeline, dockerized it, and deployed it via Flask
- **Optimizing GitLab CI/CD Pipelines and Kubernetes Integration**
  - Modularized YAML configurations with anchors and references, integrating structured testing jobs, and refactoring environment management via a Python utility package—eliminating complex shell scripting.
  - Acquired practical experience with Kubernetes by configuring PVs, PVCs, and pods for testing volume mounting manually running GitLab jobs, and configuring various CI runners for Kubernetes and Argo.

Technical Skills

Programming Languages & Scripting: Python, C++, JavaScript, Shell Scripting
Deep Learning Frameworks: PyTorch, TensorFlow, Scikit-Learn, Keras
Data Science & Machine Learning: Pandas, OpenCV, NumPy, HuggingFace, TensorBoard
DevOps & MLOps: Git, GitLab, Flask, Docker, Argo, Python Packaging, Model Monitoring & Registry, Job Scheduling
Tools & Environments: Remote Debugging, Linux (Bash), WSL
Distributed Systems & Big Data: PySpark, AWS S3, Kubernetes Pods & Runners

Education

University of Minnesota Twin-Cities 2023
Master's of Science in Computer Science. Specialization in ML and Computer Vision *Minneapolis, MN*

American University of Beirut 2022
Bachelor of Engineering in Computer Engineering. Specialization in Communication *Beirut, Lebanon*