

Course Description:

This course explores the integration of Artificial Intelligence (AI) and Deep Learning (DL) techniques in the analysis of Earth Observation (EO) data. Students will learn how to apply machine learning models to remote sensing imagery and geospatial data for applications such as land use/cover classification, change detection, object detection, and environmental monitoring.

Course Objectives:

By the end of the course, students will be able to:

- Understand fundamental AI and DL concepts applied to Earth observation.
- Process and prepare satellite data for machine learning workflows.
- Implement machine learning and deep learning models for environmental applications.
- Critically evaluate model performance and interpret results.
- Understand ethical considerations in AI for environmental data.

Prerequisites:

Basic knowledge of remote sensing, GIS, Python programming, and introductory machine learning.

Textbooks and References:

- *Deep Learning* by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (recommended)
- *Deep Learning for the Earth Sciences* by Gustau Camps-Valls, Devis Tuia, et al.
- Selected journal articles and online tutorials (provided weekly)

Software and Tools:

- Python (TensorFlow, PyTorch, scikit-learn, Keras, Xarray, GDAL)
- Google Earth Engine (GEE)
- QGIS with Machine Learning Plugins
- Jupyter Notebooks

Weekly Topics:

Week	Topics
1	Introduction to Earth Observation and AI
2	Overview of Machine Learning for EO (Supervised, Unsupervised Learning)

Week	Topics
3	Fundamentals of Neural Networks
4	Convolutional Neural Networks (CNNs) for Image Classification
5	Data Preprocessing: Normalization, Augmentation, and Labeling
6	Transfer Learning and Pre-trained Models (e.g., ResNet, U-Net)
7	Object Detection (YOLO, Faster R-CNN) and Segmentation Tasks
8	Case Study 1: Land Cover Classification from Satellite Imagery
9	Time Series Analysis: Recurrent Neural Networks (RNNs) and LSTMs
10	Generative Adversarial Networks (GANs) for Synthetic EO Data
11	Explainable AI (XAI) and Model Interpretability
12	Challenges in Big EO Data: Cloud Computing and Data Fusion
13	Ethical Issues: Bias, Fairness, and Environmental Justice in AI
14	Final Project Presentations and Course Wrap-up

Assessment:

- Homework Assignments and Labs (30%)
- Midterm Project (20%)
- Final Project (30%)
- Class Participation and Discussion (10%)
- Short Quizzes (10%)

Final Project:

Each student will develop and present a project applying an AI/DL model to an Earth observation dataset. Example topics include:

- Deforestation detection using Sentinel-2 imagery.
- Urban expansion monitoring using Landsat time series.
- Marine debris detection using remote sensing.

Course Policies:

- Active participation and timely submission are expected.
- Collaboration is encouraged, but work must be original.
- Academic integrity is mandatory.

Important Dates:

- Midterm Project Due: Week 8
- Final Project Proposal: Week 10
- Final Project Due: Week 14

