Name - Prabhakar A
B.E - CSE(AIML)
Projects
1.Real-Time Emotion Detection Using Facial Expressions with OpenCV and Deep Learning
2. Emotion Detection from Text Using Deep Learning
3. Fashion Classification with Deep Learning
Courses
1. Artificial Intelligence (Infosys Springboard)
2.

Mile Stone 1 Dataset Collection and Preparation

WEEK-1 Day-1

This project focuses on AI-Driven Archaeological Site Mapping, which includes segmenting ancient ruins and vegetation, detecting and classifying artifact structures, and predicting erosion-prone zones.
For this, we collect data specific to each task from various resources. For real-time and open datasets, we use OpenAerialMap and Google Earth Engine.

1. Ruins Segmentation (Find walls & mounds)

Meaning: Detect geometric ancient structures on ground.
Main Dataset: Sentinel-1 Radar (SAR) → shows buried/roughness patterns.

2. Vegetation & NDVI (Crop marks near ruins)

Meaning: Identify vegetation health + hidden structures under plants.
Main Dataset: Sentinel-2 Surface Reflectance (B4 & B8 → NDVI).

3. Artifact Detection (Small objects)

Meaning: Detect stones, tools, pottery.
Main Dataset: Drone imagery (sub-30cm).
(Sentinel-2 too coarse.)

4. Erosion Risk Mapping

Meaning: Predict soil erosion around archaeological sites.
Main Dataset: SRTM DEM → slope = erosion potential.

Sentinel Data

- **COPERNICUS/S1_GRD** (Sentinel-1 Radar)
- **COPERNICUS/S2_HARMONIZED** (Sentinel-2 TOA)
- **COPERNICUS/S2_SR_HARMONIZED** (Sentinel-2 Surface Reflectance)

Elevation / DEM

- **USGS/SRTMGL1_003** (SRTM 30m DEM)

Land Cover

- **ESA/WorldCover/v200** (2020 Global Landcover)

WEEK-1 Day-2

This section explains **what each dataset actually contains** and **how it helps our project tasks** such as ruins segmentation, vegetation analysis, artifact detection, and erosion prediction.

1. Ruins Segmentation (Finding walls & mounds)

Meaning: Detect geometric ancient structures on the ground.
Dataset: Sentinel-1 Radar (COPERNICUS/S1_GRD)
What the data contains:

- Radar backscatter values (how strongly the ground reflects radar).
- VV/VH polarizations showing surface roughness.
  Why it helps:
- Buried ruins, stone walls, and mounds change ground texture → radar detects these patterns.
- Works even with clouds or low light.

2. Vegetation & NDVI (Crop-marks near ruins)

Meaning: Identify vegetation behavior influenced by buried features.
Dataset: Sentinel-2 Surface Reflectance (COPERNICUS/S2_SR_HARMONIZED)
What the data contains:

- Multi-spectral optical bands (Red, Green, Blue, NIR).
- True ground reflectance after atmospheric correction.
- Bands B4 (Red) & B8 (NIR) used to compute NDVI.
  Why it helps:
- Vegetation grows differently over walls, ditches, or disturbed soil → reveals hidden archaeology.
- NDVI highlights plant stress or unusual growth.

3. Artifact Detection (Small objects)

Meaning: Detect stones, tools, pottery fragments.
Dataset: Drone Imagery (sub-30 cm)
What the data contains:

- Very high-resolution RGB images (2–30 cm/pixel).
- Clear textures, edges, and small features.
  Why it helps:
- Sentinel images are too coarse for small objects.
- Drone imagery provides the detail needed for YOLO/Faster R-CNN.

4. Erosion Risk Mapping

Meaning: Predict soil erosion around archaeological sites.
Dataset: SRTM DEM (USGS/SRTMGL1_003)
What the data contains:

- Elevation values for each pixel (in meters).
- Terrain shape: slopes, valleys, and drainage directions.
  Why it helps:
- Steeper slopes = higher erosion risk.
- Low areas accumulate water and weaken soil around ruins.

Supporting Environmental Dataset

Dataset: ESA WorldCover (ESA/WorldCover/v200)
What the data contains:

- Land cover classes (forest, grassland, cropland, bare soil, built-up).
  Why it helps:
- Shows which areas are vegetated, exposed, or human-modified.
- Useful for understanding ruin visibility and erosion behavior.

WEEK-1 Day-3

This section describes how the datasets from Day-1 and Day-2 are practically collected, including the tools used, the steps followed, the type of files received, and how the downloaded data is verified before processing.

1. Collecting Sentinel-1 Radar Data (Ruins Segmentation)

Purpose: Identify buried walls, geometric shapes, and roughness patterns.

Tools Used

- Google Earth Engine (GEE)
- Dataset: `COPERNICUS/S1_GRD`

How We Download

1. Select area of interest (AOI) around the archaeological site.
2. Filter by radar mode: IW (Interferometric Wide Swath).
3. Select VV and VH polarizations.
4. Choose cloud-free recent images (radar works anytime).
5. Export as GeoTIFF from GEE to Google Drive.

Files Received

- `S1_VV.tif` → Vertical transmit/receive backscatter
- `S1_VH.tif` → Cross-polarized backscatter
- Metadata: date, angle, orbit, calibration info

Quality Check

- Ensure no missing pixels.
- Check for noise or black stripes from orbit gaps.
- Confirm radar intensity range (typical: –25 to 5 dB).

2. Collecting Sentinel-2 Surface Reflectance (Vegetation & NDVI)

Purpose: Understand vegetation patterns that reveal hidden structures.

Tools Used

- Google Earth Engine
- Dataset: `COPERNICUS/S2_SR_HARMONIZED`

How We Download

1. Select AOI around site.
2. Filter by <10% cloud cover.
3. Select key bands:
    - B4 (Red)
    - B8 (NIR)
4. Export bands separately or combined as GeoTIFF.

Files Received

- `S2_B4.tif` (Red band)
- `S2_B8.tif` (NIR band)
- Optional: `S2_RGB.tif`

Quality Check

- Make sure cloud mask (QA60) identifies clouds correctly.
- Verify reflectance values are between 0–1.
- Ensure NIR band has no stripes or missing data.

3. Collecting Drone Images (Artifact Detection)

Purpose: Detect small objects such as tools, pottery, or stones.

Tools Used

- OpenAerialMap
- Manual drone surveys (optional)

How We Download

1. Search for AOI on OpenAerialMap.
2. Filter images by resolution (<30 cm).
3. Download original high-resolution JPEG/PNG or GeoTIFF.
4. If unavailable, manually capture using drone (DJI/Mavic).
5. Organize images into folders based on location.

Files Received

- `drone_image_01.jpg`
- `drone_image_02.jpg`
- GeoTIFF tiles (if orthomosaic available)

Quality Check

- Ensure sharpness (no motion blur).
- Check GPS coordinates (EXIF).
- Verify ground sampling distance (GSD).

4. Collecting SRTM DEM for Elevation (Erosion Mapping)

Purpose: Predict erosion by measuring slopes and drainage.

Tools Used

- Google Earth Engine
- Dataset: `USGS/SRTMGL1_003`

How We Download

1. Select AOI.
2. Clip DEM to site boundary.
3. Export as 30-meter resolution GeoTIFF.

Files Received

- `SRTM_DEM.tif` (elevation in meters)

Quality Check

- Ensure no voids (missing elevation).
- Confirm elevation values align with known topography.

5. Collecting Land Cover (Environmental Context)

Purpose: Understand surface types around ruins.

Tools Used

- Google Earth Engine
- Dataset: `ESA/WorldCover/v200`

How We Download

1. Clip land cover map to AOI.
2. Export as a class-coded GeoTIFF.

Files Received

- `WorldCover_2020.tif` (land cover classes)

Quality Check

- Confirm class values (1–10 categories).
- Check spatial alignment with Sentinel images.

Topic: Dataset Organization & Folder Structure Setup

After collecting Sentinel-1, Sentinel-2, DEM, Drone images, we must organize everything properly for later segmentation, detection, and erosion tasks.

Week-1 Day-4

1. Creating Project Dataset Structure

We create a unified folder structure so all future models (U-Net, YOLO, XGBoost) can easily load data.

```
dataset/
│
├── segmentation/
│   ├── images/        → Sentinel-1, Sentinel-2, Drone RGB
│   └── masks/         → Created in Week-2
│
├── detection/
│   ├── images/        → Drone RGB (high resolution)
│   └── labels/        → YOLO TXT labels (Week-2)
└── erosion/
    ├── dem/           → SRTM_DEM.tif
    ├── ndvi/          → NDVI.tif
    ├── slope/         → slope_map.tif
    └── landcover/     → WorldCover_2020.tif
```

2. Why folder separation is required

- **Segmentation** needs image–mask pairs.
- **Detection** needs high-resolution RGB images for YOLO.
- **Erosion** needs geo-spatial layers (DEM, NDVI, slope).

This structure avoids confusion and prevents file mixing.

3. Verifying all datasets

Checklist:

✔ All images in segmentation/images/ have correct resolution
✔ Drone images higher than 1024×1024 stored in detection/images/
✔ DEM, NDVI, Radar, RGB files stored separately
✔ Filenames follow consistent naming:

```
image_001.tif

image_002.tif

drone_01.jpg

drone_02.jpg
```

4. Backup Repository (GitHub LFS optional)

Large images can be stored using:

- Google Drive
- Kaggle Dataset Upload
- GitHub LFS for .tif files

This completes Week-1 Day-4.

WEEK-1 DAY-5

Topic: Understanding Annotation Tools (Labelbox, CVAT, Label Studio)

Before annotating images, understanding the tools is required.

1. Tools Compared

TOOL	USE-CASE	BENEFIT
Labelbox	Segmentation + Detection	Cloud, easy interface
CVAT	Professional pixel-wise labeling	Best for polygons & masks
Label Studio	Flexible, free	Easy to run locally

2. Annotation required for project

You need to draw:

A) Segmentation Polygons

For each image:

- Ruins (walls, mounds)
- Vegetation
- Background

Output → PNG mask aligned with image.

B) Detection Bounding Boxes

For artifacts:

- artifact_pottery
- artifact_stone
- artifact_tool
- artifact_structure_piece
  Output → YOLO `.txt` or COCO `.json`.

C) No annotation for erosion

DEM + NDVI provide this automatically.

3. Decision

For your project, use **CVAT** because:

✔ Better polygon drawing
✔ Export masks automatically
✔ YOLO export for detection

4. Installation (if local)

```
docker pull cvat/cvat

docker compose up -d
```

Use cloud version → app.cvat.ai

WEEK-2 DAY-1

Topic: Starting Annotation — Segmentation Polygons

1. Create Project on CVAT

Project Name:

```
AI-Driven Archaeology – Segmentation
```

Task:

```
Ruins + Vegetation + Background Segmentation
```

2. Upload Images

Upload 80–150 images from:

```
dataset/segmentation/images/
```

3. Draw Polygons for Each Class

Classes:

- `ruins`
- `vegetation`
- `background`

Use polygon tool in CVAT.

4. Export Masks

After annotation → export format:

✔ "Mask 1.1"
✔ PNG or TIFF mask

Each mask will be named:

```
image_001.png
image_002.png
```

Place masks into:

```
dataset/segmentation/masks/
```

WEEK-2 DAY-2

Topic: Object Detection Bounding Boxes

1. Create New CVAT Project

```
AI-Driven Archaeology – Object Detection
```

Classes:

- artifact_stone
- artifact_pottery
- artifact_tool
- artifact_structure_piece

---

2. Upload Drone Images

Upload from:

```
dataset/detection/images/
```

---

3. Draw Bounding Boxes

Use Rectangle Tool.

Each annotation will generate:

```
class_id  x_center  y_center  width  height
```

4. Export YOLO labels

Export as:

```
YOLO 1.1
```

Save labels into:

```
dataset/detection/labels/
```

WEEK-2 DAY-3

Topic: Preprocessing – Resizing, Normalization, Standard Format

1. Resize all segmentation images

Target size:

```
512 × 512
```

Tools:

- OpenCV
- Pillow
- Albumentations

2. Normalize pixel values

Scale 0–255 → 0–1

Formula:

```
pixel = pixel / 255.0
```

3. Verify mask alignment

Mask must have:

- same shape as image
- same filename

E.g.:

```
image_010.png
mask_010.png
```

WEEK-2 DAY-4

Topic: Train–Val–Test Split

1. Split dataset

Recommended split:

```
Train: 70%
Validation: 20%
Test: 10%
```

2. Folder structure

```
segmentation/
   train/images
   train/masks
   val/images
   val/masks
   test/images
   test/masks
```

Same for detection.

3. Generate CSV or JSON file listing splits

Example format:

```
image,mask,split
image_001.png,mask_001.png,train
...
```

WEEK-2 DAY-5

Topic: Data Augmentation (Very Important)

Purpose: increase dataset size for better accuracy.

1. Augmentations for Segmentation

Use Albumentations library.

Recommended:

- Horizontal flip
- Vertical flip
- Random rotate 90°
- Color jitter
- Gaussian noise
- Contrast increase

Make sure mask is augmented alongside image.

2. Augmentations for Detection

Use:

- Mosaic
- MixUp
- Random crop
- Random brightness

- Motion blur

3. Save augmented data to

```
segmentation/augmented/
detection/augmented/
```

4. Verify shape & label correctness

Check random samples visually.