



# AI-Driven Archaeological Site Mapping

Leveraging Deep Learning for Heritage Conservation

Presented by Prabhakar A | Protecting Ancient Sites with AI

# Protecting Our Archaeological Heritage

- Archaeological sites face threats from erosion, vegetation overgrowth, and time.
- Traditional mapping methods are time-consuming and limited in scope.
- Automated, scalable solutions are needed for site analysis and conservation.



# An Intelligent 3-in-1 AI Platform



## Vegetation & Ruins Segmentation

Utilizing U-Net Deep Learning for pixel-level feature identification.



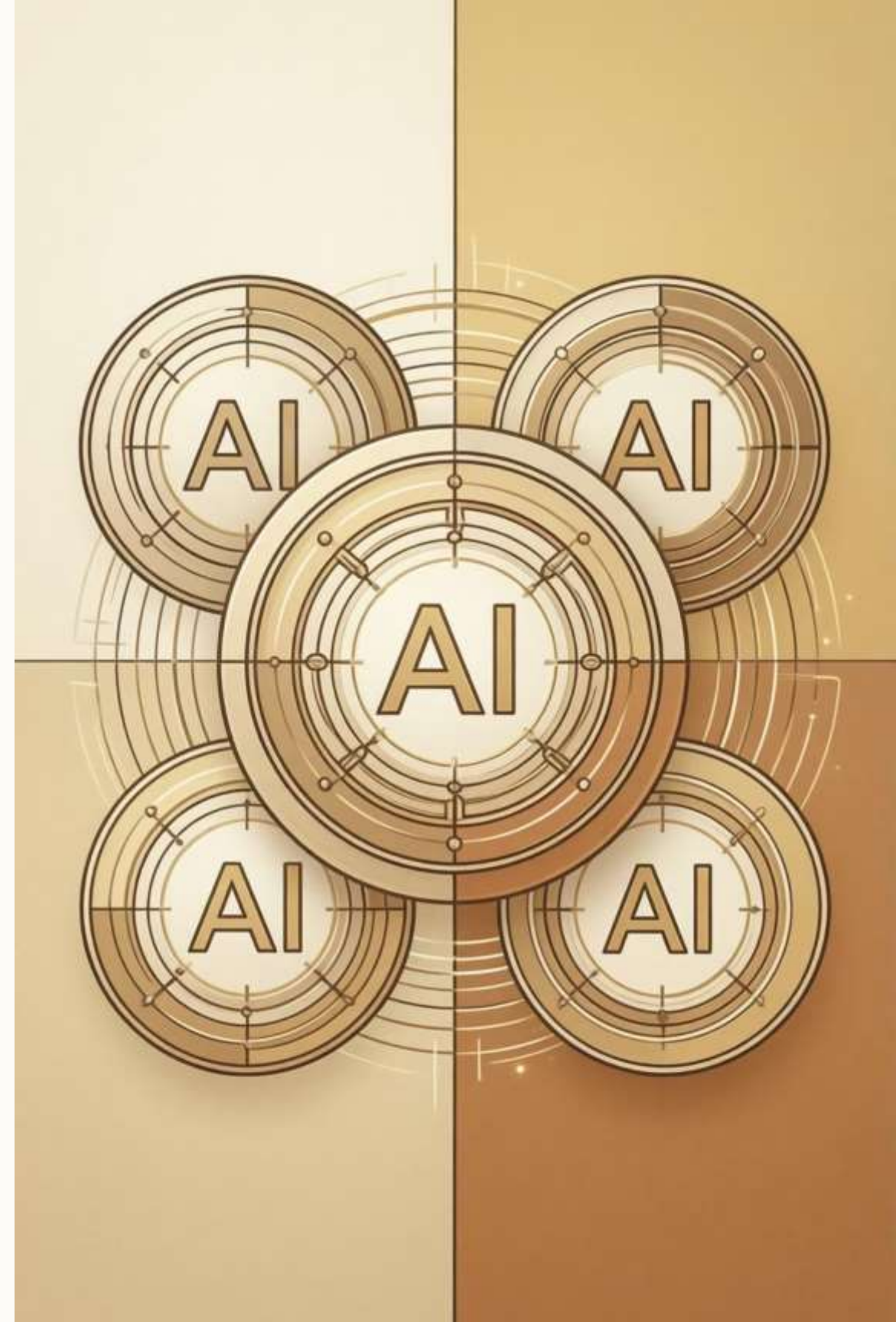
## Artifact Detection

YOLOv5 Object Detection model for precise artifact localization.



## Erosion Risk Prediction

XGBoost Machine Learning to assess site vulnerability.





# System Architecture & Technology Stack

- **Data Sources:** Sentinel-1/2 Satellite Data, Drone Imagery, SRTM DEM
- **Deep Learning Models:** U-Net, DeepLabV3+, YOLOv5
- **ML Models:** XGBoost, Random Forest
- **Deployment:** Streamlit Web Application for user interaction

# Identifying Ruins & Vegetation

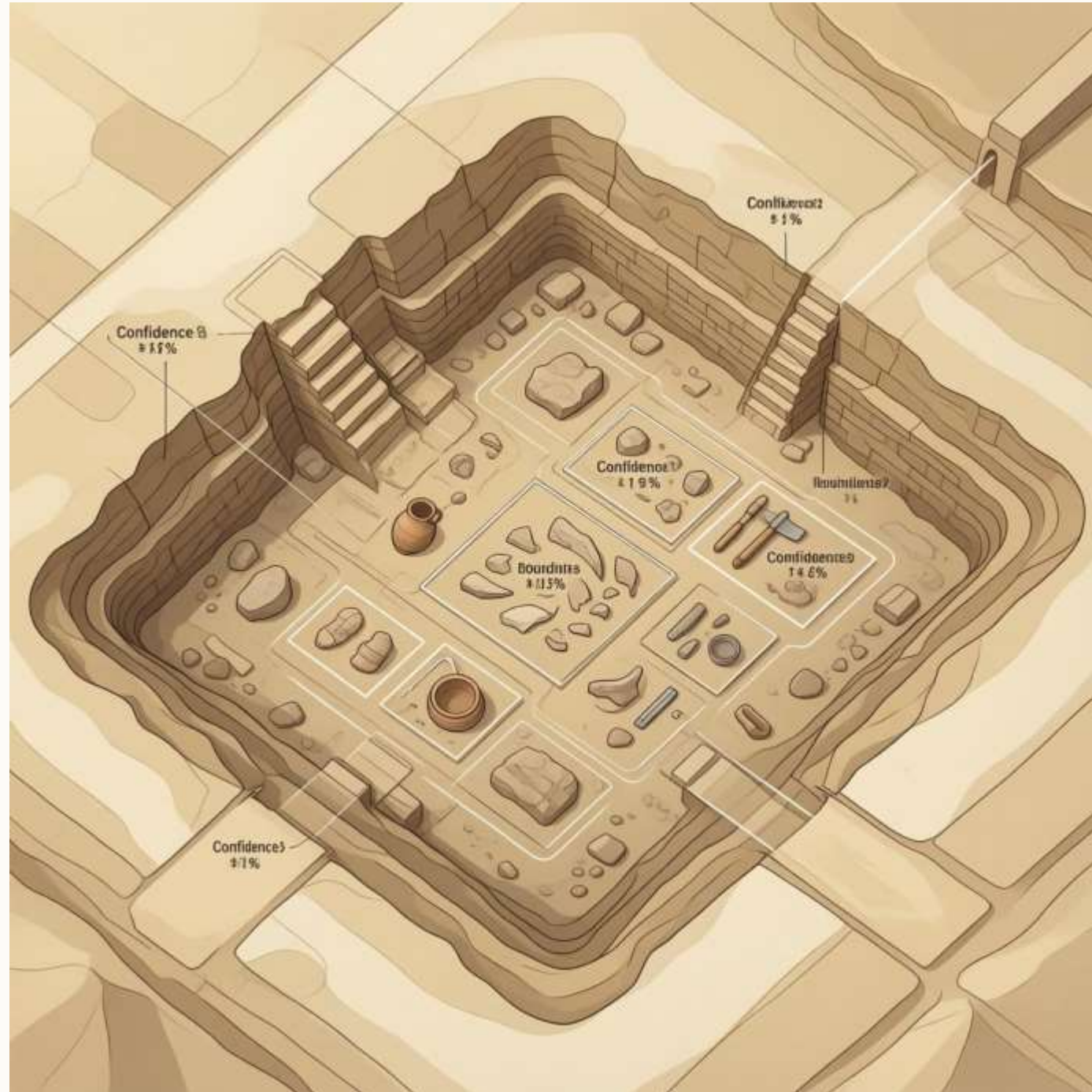
Semantic Segmentation with U-Net

- **Model:** U-Net with ResNet-34 encoder
- **Training:** 50 images, 512×512 resolution
- **Performance:** IoU Score 0.69, Dice Score 0.82
- **Impact:** Pixel-level identification of archaeological features and environmental context.



# Locating Archaeological Artifacts

Real-time Object Detection with YOLOv5

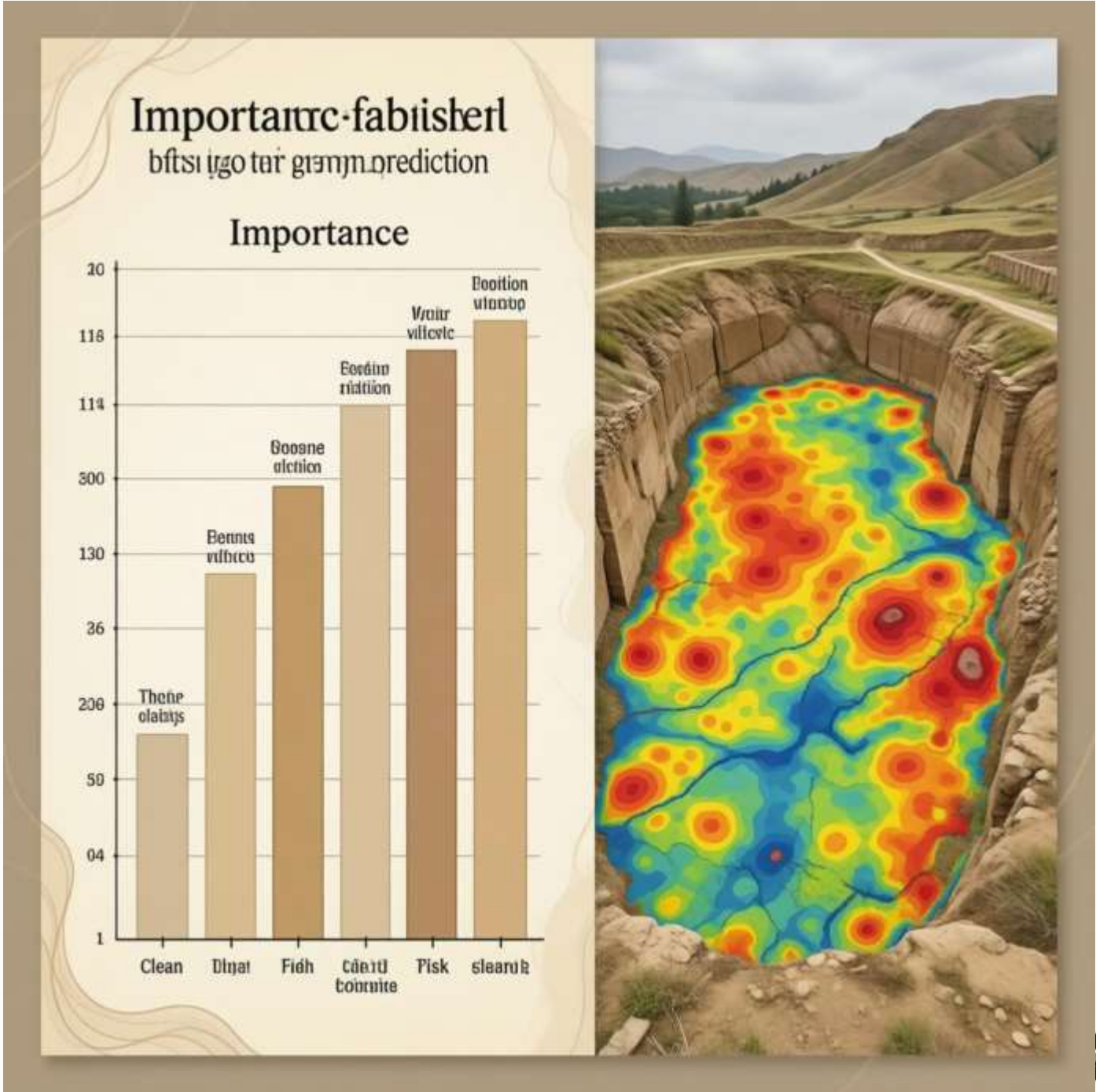


- **Model:** YOLOv5 for efficient, real-time object detection
- **Training:** 47 training images, 23 test images
- **Performance:** mAP 0.488, Precision 0.999, Recall 0.42
- **Detection Classes:** Pottery, stones, tools, structure pieces

# Predicting Site Vulnerability

## Erosion Risk Assessment

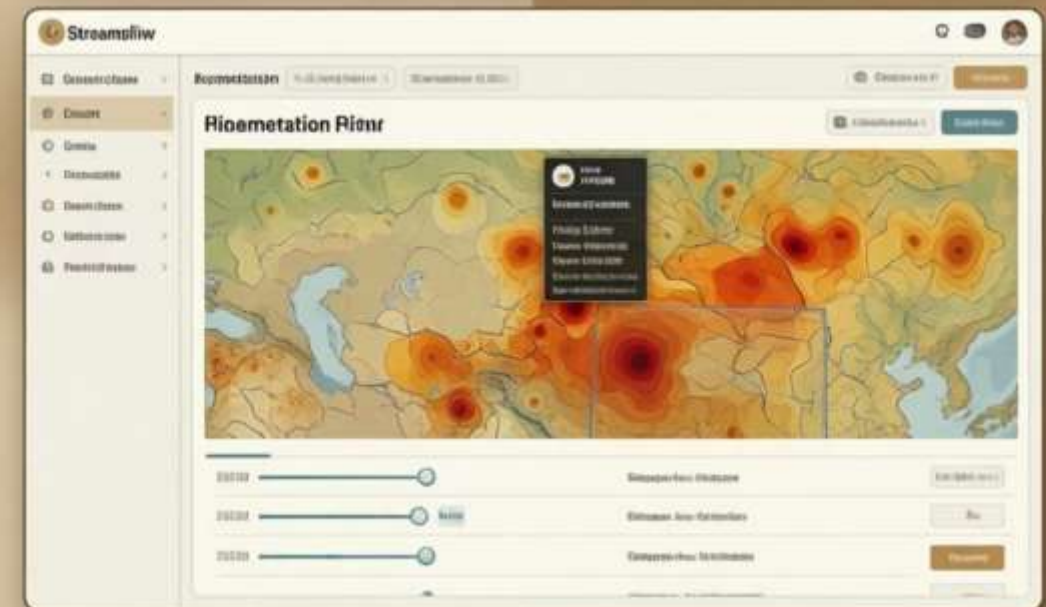
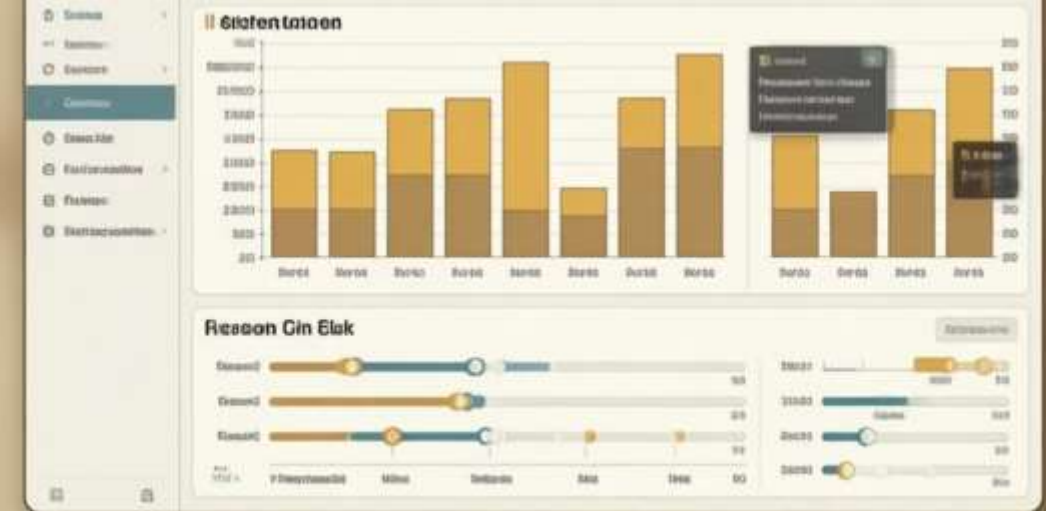
- **Dataset:** 9,864 terrain samples with 12 environmental features
- **Features:** Slope, rainfall, NDVI, soil properties, elevation, and more.
- **Models:** Random Forest & XGBoost (demonstrating best performance)
- **Output:** Clear risk categories (Low/Medium/High) and estimated erosion rates.



# Interactive Dashboard

## Streamlit Web Application

- Real-time model inference accessible through an intuitive interface.
- Three integrated modules: Segmentation, Detection, and Erosion Analysis.
- Image upload capability allows for custom analysis of new data.
- Visual outputs with clear, color-coded results for easy interpretation.



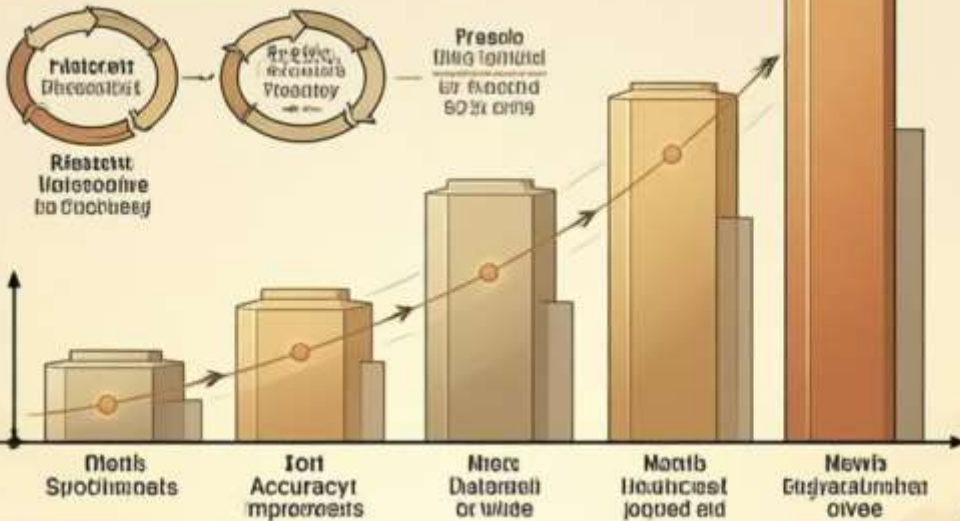
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# Achievements & Real-World Impact



## Key Achievements

Successfully completed an end-to-end AI pipeline within an 8-week timeline.



## Multi-Model Integration

Unified three distinct AI models into a single, cohesive platform.



## Impact for Archaeologists

Enables faster site assessment, data-driven planning, and scalable conservation efforts.

# Next Steps & Vision

- **Larger Multi-Region Datasets:** Expanding data scope for global applicability.
- **Real-time Satellite Feed Integration:** Enhancing monitoring capabilities.
- **3D Terrain Analysis:** Adding depth to site vulnerability assessments.
- **Temporal Erosion Tracking:** Monitoring changes over time for proactive preservation.



# Deep Learning & ML Models

## Deep Learning Models

### U-Net Architecture

- **Task:** Semantic Segmentation (ruins & vegetation)
- **Encoder:** ResNet-34 (ImageNet pretrained)
- **Input:** 512×512 RGB satellite images
- **Output:** Pixel-wise classification masks

### YOLOv5

- **Task:** Real-time artifact object detection
- **Framework:** PyTorch
- **Input:** High-resolution drone imagery
- **Output:** Bounding boxes with class labels & confidence

## Machine Learning & Data Stack

### XGBoost Regressor & Classifier

- **Task:** Terrain erosion risk prediction
- **Input:** 12 environmental features (slope, NDVI, rainfall, soil properties)
- **Output:** Erosion rate & risk categories

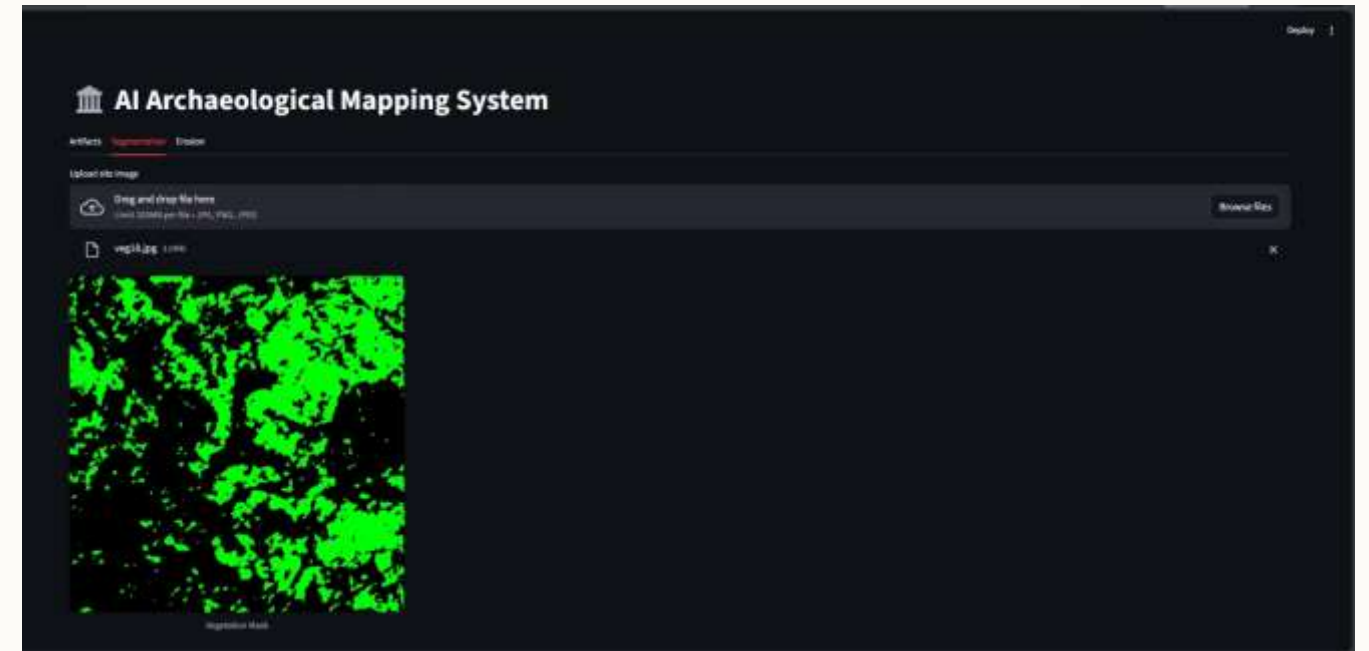
### Key Libraries

- **Data Processing:** Pandas, NumPy
- **Image Processing:** OpenCV, PIL, Rasterio
- **Geospatial:** GeoPandas, Folium
- **Visualization:** Matplotlib, Seaborn
- **ML Framework:** Scikit-learn

# Deployment & Development Stack

## Deployment & Interface

- Web Application: Streamlit Framework
- Interactive web dashboard
- Real-time model inference
- Multi-module navigation
- Image upload & visualization
- Responsive UI components



Live Streamlit Dashboard Interface

### Development Environment - Tools

Google Colab, Jupyter Notebook, VS Code

### Data Sources

Sentinel-1/2, OpenAerialMap, SRTM DEM, Google Earth Engine

### Annotation & Version Control

Annotation: CVAT, Labelbox  
Version Control: Git/GitHub