Acacia Classifier in Mediterranean Forests

Leveraging remote sensing and artificial intelligence to protect Mediterranean ecosystems from invasive Acacia species

The Challenge We Face

Save the Forest, Chase Invaders!

Mediterranean forests face a silent invasion. Alien Acacia species from the Southern hemisphere are spreading rapidly, threatening native biodiversity and disrupting delicate ecosystems.

These invasive trees exploit climate change and global commerce pathways to establish dominance, outcompeting local species and fundamentally altering forest composition.

The Perfect Storm: How Acacias Thrive

Power Lines Construction

The construction of power lines let empty spaces

Climate Warming

Rising temperatures create ideal conditions for heat-tolerant Acacia species to prosper

Forest Fires

Drier summers increase wildfires; pyrophyte Acacias grow faster and survive better than native species

The convergence of these factors creates an ecosystem crisis that demands innovative solutions from the scientific community.

The Acacia Advantage

Pyrophyte Biology

Fire-adapted characteristics enable Acacias to regenerate rapidly after wildfires, establishing dominance whilst native species struggle to recover

Competitive Growth

Faster growth rates and superior fire tolerance give Acacias an overwhelming advantage in post-fire landscapes

Ecosystem Impact

Reduced biodiversity, displaced native species, and unknown long-term ecological consequences threaten forest health

Our Approach: Multi-Source Remote Sensing

Mapping and monitoring Acacia distribution requires integrating diverse geo-referenced data sources to create a comprehensive surveillance system.

Satellite Imagery

Sentinel-2 provides regular coverage of Portuguese mainland every few days, offering consistent temporal resolution

Aerial Photography

Legacy aerial surveys and modern aircraft-based imaging deliver high-resolution spatial data

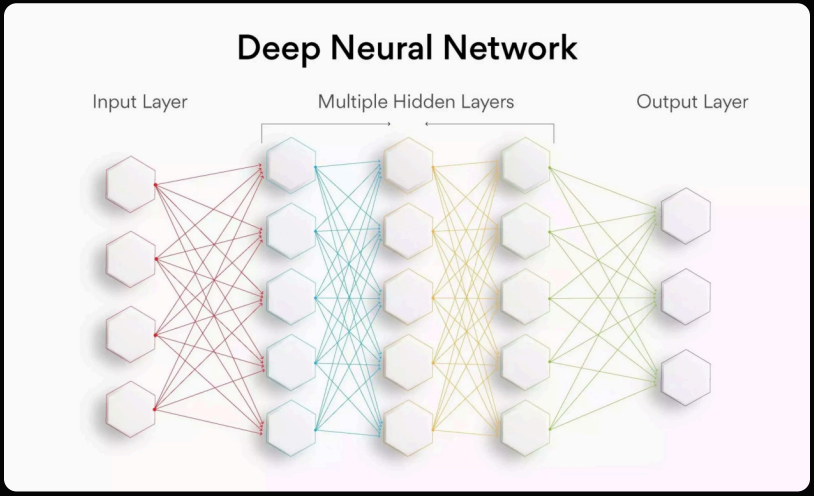
LiDAR Technology

Airborne LiDAR from crewed and uncrewed aircraft captures detailed forest structure with 10 points/m² density

UAS Multi-Spectral

Drone-based multi-spectral photography provides ultra-high resolution data for targeted survey areas

The AI Solution Architecture



Intelligent Classification System

We developed an AI model trained on satellite imagery and multi-source remote sensing data to automatically identify Acacia distribution patterns.

How it works: Users submit satellite photographs, and the model analyses spectral signatures, vegetation indices, and structural patterns to pinpoint current Acacia locations and predict future spread.

The system integrates public datasets with proprietary high-resolution data to achieve unprecedented accuracy across varying spatial scales.

Technical Stack: Acacia Classifier

Our system leverages a robust combination of modern technologies to deliver a high-performance, scalable, and intelligent solution for Acacia detection.

Frontend

- User Interface: React + Tailwind
- Asynchronous Calls: React Query
- Functionality: Displays uploaded images and segmentation masks

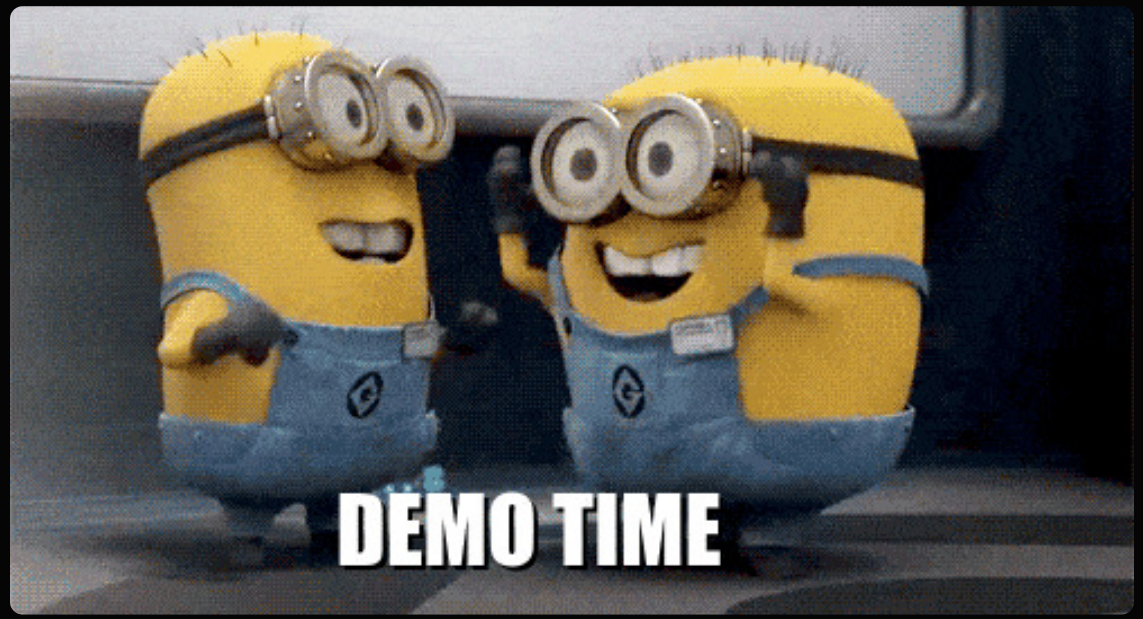
Backend

- API: Python + FastAPI
- Authentication: Firebase Auth
- Metadata: Firebase Firestore (potential update to PostgreSQL + SQLAlchemy)
- Image Storage: AWS S3
- Asynchronous Processing: Celery + Redis

ML Model

- Model: YOLOv8-seg (Ultralytics), fine-tuned on Acacia dataset
- Hosting: Hugging Face
- Communication: Backend communicates via Hugging Face API

DEMO TIME



Solution Advantages

High Detail Resolution

The model identifies individual trees and small Acacia clusters, enabling precise intervention planning. Atomic-level detection ensures no invasion pocket goes unnoticed.

Cost-Effective Monitoring

Leverages freely available Copernicus Sentinel-2 data combined with existing LiDAR coverage, minimising future data acquisition costs whilst maintaining accuracy.

Temporal Tracking

Regular satellite passes enable continuous monitoring of Acacia spread patterns, establishing baseline data for effectiveness of eradication measures.

Scalable Framework

Methodology extends beyond Portugal's 89,000 km² to other Mediterranean countries facing similar invasive species challenges.

Future Potential and Impact

01

Risk Assessment

Quantify actual Acacia invasion risk across diverse landscape types and microclimates

02

Species Resilience

Identify which native species resist Acacia encroachment and which are most vulnerable

03

Wildfire Correlation

Analyse relationships between Acacia distribution and wildfire occurrence patterns

04

Climate Adaptation

Track how Acacia spread responds to changing climate conditions over time

05

Intervention Optimisation

Determine where and which eradication measures deliver greatest ecological benefit

Protecting Mediterranean Forests Together

A Tool for Conservation

Our AI-powered Acacia classifier transforms remote sensing data into actionable intelligence for forest managers, researchers, and policymakers.

By combining cutting-edge technology with ecological expertise, we're creating a scalable solution to preserve Mediterranean biodiversity for future generations.

The challenge is clear. The technology is ready. The time to act is now.

Who Are We

We are a dedicated team of final-year BSc Computer Science and Engineering students from Instituto Superior Técnico, united by a shared passion for preserving the unique biodiversity of Mediterranean forests.

> Our mission is to safeguard Mediterranean ecosystems through innovation, collaboration, and a commitment to data-driven conservation.