One pager on Acacias classifier in Remotely-sensed forests

21st July 2025

The Challenge

Challenge name/tagline: *Save the Forest, chase invaders!*

Challenge one-liner: use multiple remote-sensing resources to **chase the spread of forest invaders**, specifically of the genus *Acacia,* in Mediterranean forests.

Introduction

Climate change and world commerce concurred to expose Mediterranean forest to alien tree and shrub species that find good soil and weather conditions to thrive and have little to no natural counterbalances in the ecosystem. The spread of such invaders threatens local species, reduces local biodiversity and usually unbalances the pre-existent ecosystem, humans included. With unforeseen consequences towards a new balanced condition still unknown and likely with a lesser ecological value.

The species of the Acacia genus[1] originate in the warmer climates of the Southern hemisphere and they've been imported as timber, decorative trees and seeds but they also arrive unwittingly in spores coming in ships. Moreover, there is an increased risk factor in Mediterranean forests as Acacias are pyrophytes to the point that they spread after wildfires as they grow faster and are more fire-tolerant than local competing species.

In the end, it is us humans that spread the acacias through multiple paths:

- World Commerce » import alien Acacia genetic material » new land for Acacias to prosper
- Climate change » global warming » heat-tolerant Acacias prosper
- Climate change » dryer summers » forest fires » pyrophyte Acacias prosper

So, it's up to us, humans, to fix this mess ☺

The core of the challenge

One of the early stages of this endeavour is to map and monitor the spread of Acacias across time and territory. There are multiple sources of geo-referenced data from

- Satellite,
- Aerial photography (legacy)
- Airborne LiDAR from crewed (airplanes and helicopters) and uncrewed aircraft
- Multi-spectral photography from UAS[2]
- Chartered surveys

[1] The most common in the Iberian Peninsula are *Acacia cyclops, Acacia dealbata, Acacia longifolia and Acacia pycnantha*.

[2] UAS = Uncrewed Aircraft Systems, a.k.a. UAV = Unmanned Aerial Vehicles or VANT in Portuguese: Veiculos Aéreos Não Tripulados or "*drones*".

Many of these data sources are public and free but our company can contribute with additional proprietary data, typically with a limited spatial range but with higher resolution and, in some cases, with multiple instances sampled years apart. Whenever the data comes from a client, the source is acknowledged and we thank the client for the kind consent to use it in this academic not-for-profit purpose.

The goal is to produce an application using as many data sources as feasible and useful, using the methods that are most appropriate, to compute the spatial distribution of Acacia in the Portuguese forest. The company will supply samples of territory surveys encompassing data from multiple technologies and with varying quality and spatial resolution. In some cases (technologies) different dates can be available.

At least one sample – ideally a few samples – of 2 hectares or smaller will be kept from candidates during the training and programming datasets to be used for the validation/appraisal stage.

The level of achievement will be measured according to the triple criteria:

1. Correctness of the solution[3]:
    a. Additive scoring of True Positives; weight= 0.5.
    b. Subtractive scoring for False Negatives; weight = 0.3.
    c. Subtractive scoring for False Positives; weight = 0.2.
2. Detail of the solution (the smallest the "atomic" entity, the better).
3. Dependence of the solution from future data acquisition (the least expensive the better).

Future potential and benefits

The Portuguese Direcção Geral do Território has recently issued a LiDAR model of the Portuguese Mainland Territory with a density of 10 points/m^2. Also, every few days, the Portuguese Mainland is surveyed by Copernicus Satellites Sentinel-2.

Creating a tool that could "suggest" Acacia distribution in a moment and time and follow it with Sentinel-2 data combined with purpose-flown LiDAR (or other technologies) surveys could provide an insight into:

- the actual risk of Acacias across the landscape
- which extant species are most affected and which resist better to Acacia
- how Acacia spread relate to wildfires
- how to minimise fire risk by controlling Acacias
- how Acacia spread relate to changing climate conditions
- which and where Acacia eradication measures are most effective

Since other countries around the Mediterranean are also subject to Acacia invasion and they are likely to have access to similar remote sensing techniques, this proposal could be extended to territories that are multiples of the 89 thousand square kms of Portugal Mainland. To some extent, methods and sensors might also be used for other species in the future.

[3] Assume that 183 "entities" were correctly classified as Acacia, 65 were incorrectly classified as other species and 47 were mistakenly classified as Acacia. The score would be 200*(183 * 0.5 – 65* 0.3 – 47 * 0.2)/(183+65+47) = 42,4.