Applications of LAR-IAC Data in Urban Forest Planning and Management

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Overview

Project Background

Problem

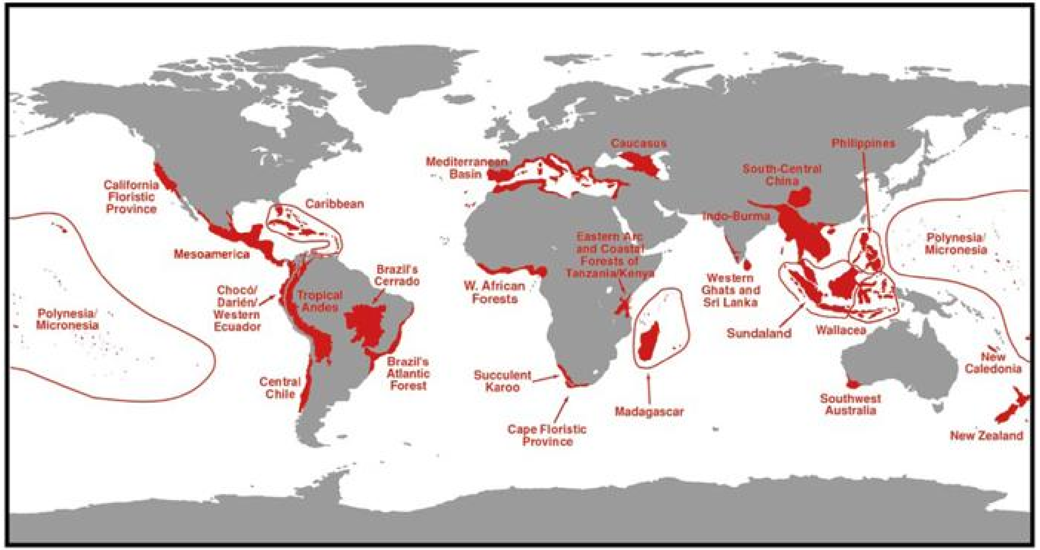
Proposed Pilot Sites

Goals + Objectives

Project Workflow

Project Background

Southern California is a biodiversity hotspot.



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Project Background

1. There are an estimated 10 million trees growing in the City of Los Angeles alone.

2. Tree species richness can be higher in residential urban forests than native forests in the United States (e.g. 31 sp. per ha).

3. There are 562 tree species estimated to occur in LAC .

Problem

Los Angeles County faces public health challenges due to changing climate, increased drought, and natural disasters threatening humans and the places we live.

Trees play a critical role in LAC's infrastructure:

- Address climate change by cooling neighborhoods;
- Clean air and water;
- Improve physical, emotional, social, and economic health of communities.

Problem

- Multiple county departments responsible for public trees.
- County also has interest in protecting and increasing number of private trees, about which relatively little is known.
- Traditional methods for conducting tree inventories are resource-intensive and thus completed infrequently.
- Managing and enhancing our urban forest is a County Board priority adopted in the County Sustainability Plan and the Community Climate Action Plan.
- Public and private trees alike are threatened by drought, fire, pests, and other stressors.

Pilot Sites

Prior to scaling to the entire county, we plan to test our models across three diverse unincorporated areas in urban LA County. We chose these locations due to their diversity in tree species, demographics, and management approaches.

1. Marina del Rey
2. East Los Angeles
3. Altadena

Project Goals

Identify individual urban tree species from remotely sensed imagery and derive canopy metrics over time across three pilot study sites

- Using these results, determining a plant's health status becomes a welcomed future application

Assist stakeholders, who are often burdened with managing urban forest stock manually, to deploy their expertise more efficiently and save time.

Stakeholder Objectives

In order to prioritize the workflow of our model, stakeholder input is a crucial step needed to identify existing operational issues in regional urban forest management and set the top priorities for our pilot project:

- **Individual tree species identification**
- **Canopy cover metrics**
- **Health assessment**

Literature Review

Conducted a literature search using 1) two academic databases (Web of Science & Google Scholar), 2) a secondary search through reference lists of first round results, and 3) recommended articles from those familiar with the project.

- 74 total articles
  - 35 covered species classification,
  - 12 vegetation metrics, and
  - 5 on health assessment

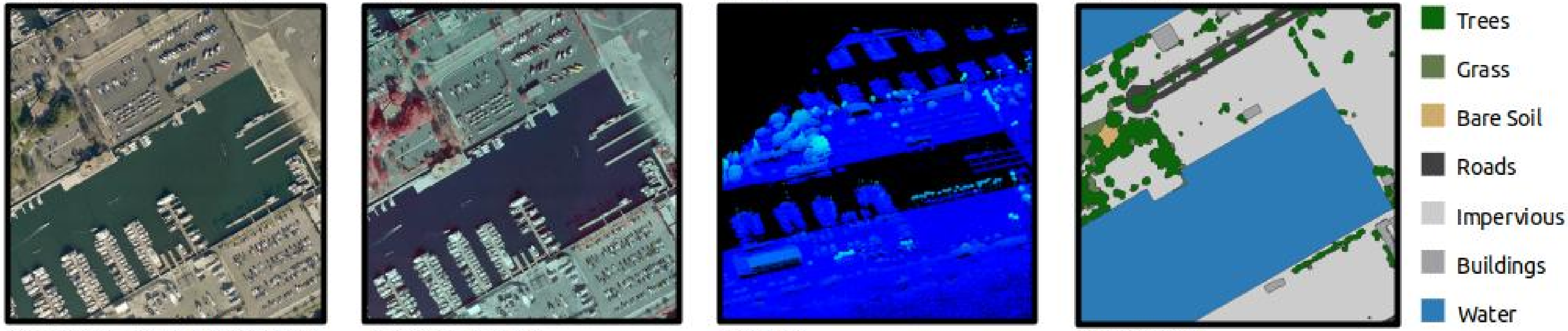
Key Findings – Fused LiDAR

Fusing spectral signatures with a LiDAR point clouds can increase the accuracy of individual species identification.

- This approach also had the potential to separate highly overlapping species classes at the tree crown level.
- Trees with smaller crowns, or those with unique morphologies (i.e. palms), are classified with higher accuracy when using LiDAR as an input.

1. Very High Resolution Imagery – Los Angeles Region Imagery Acquisition Consortium (LARIAC)

Visible (Red, Blue, Green) | **Near Infrared** | **LiDAR** | **Land Cover**



Years: 2006, '08, '11, '14, '17, '21
Resolution: 10.2 cm

2006, '08, '17, '20
10.2 cm

2015, '16

2014, '16, '18
10.2 cm

2. Imaging Spectroscopy – Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)

Hyperspectral Flight Line

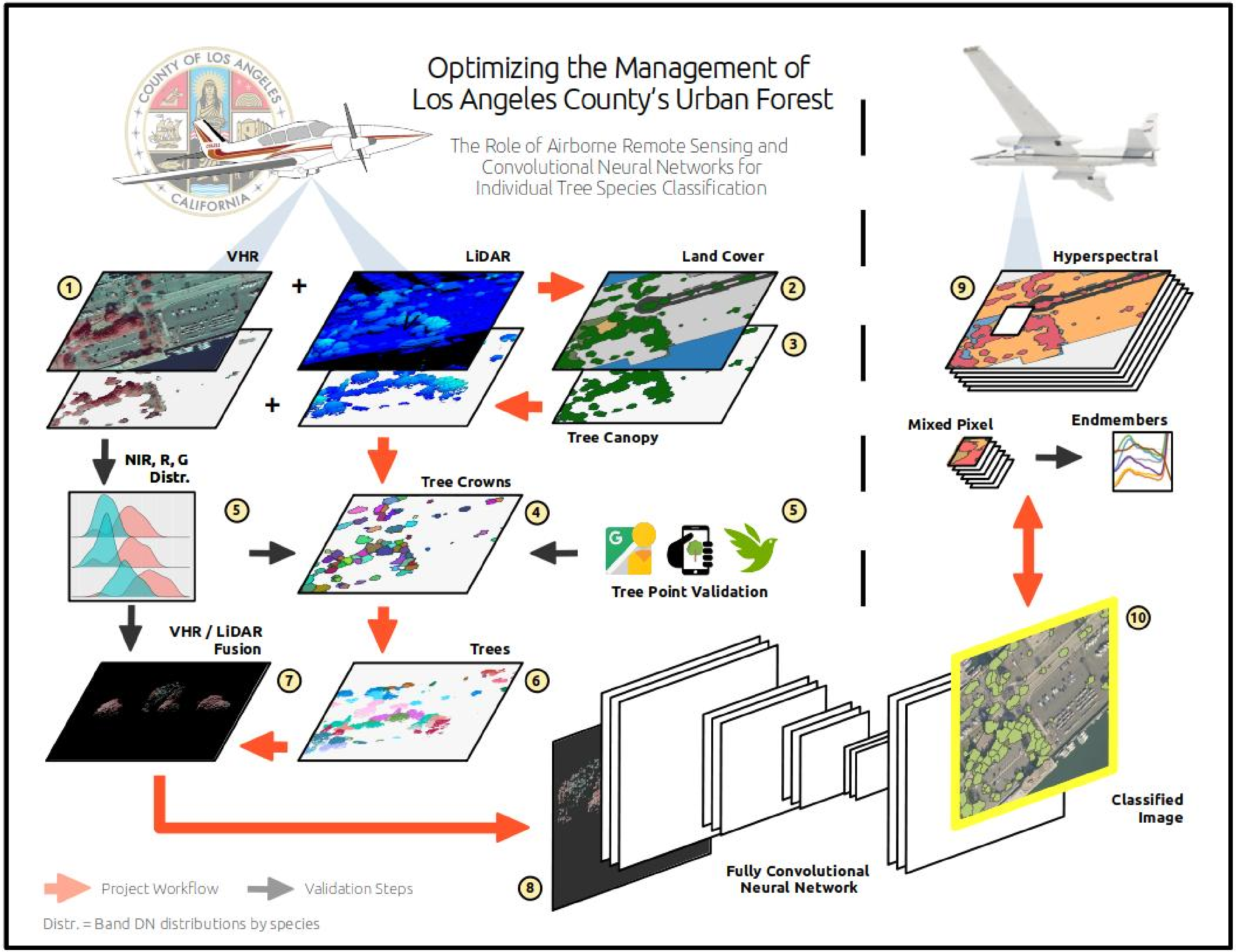
Spatial Resolution: 20 m
Spectral Resolution: 224 bands, 400 – 2500 nm

Image sources: The Los Angeles Region Imagery Acquisition Consortium, NASA Jet Propulsion Laboratory

Key Findings - Classifier

Studies that compared the performance of parametric and non-parametric classifiers reported the latter scoring higher overall accuracies:

- Both approaches produce high accuracies for individual tree classification, but when tested within the same study, non-parametric, such as a fully convolutional neural network or support vector machine, outperformed more traditional statistical analyses.
- In one study, a fully convolutional neural network outperformed two other non-parametric approaches, a random forest and support vector machine.



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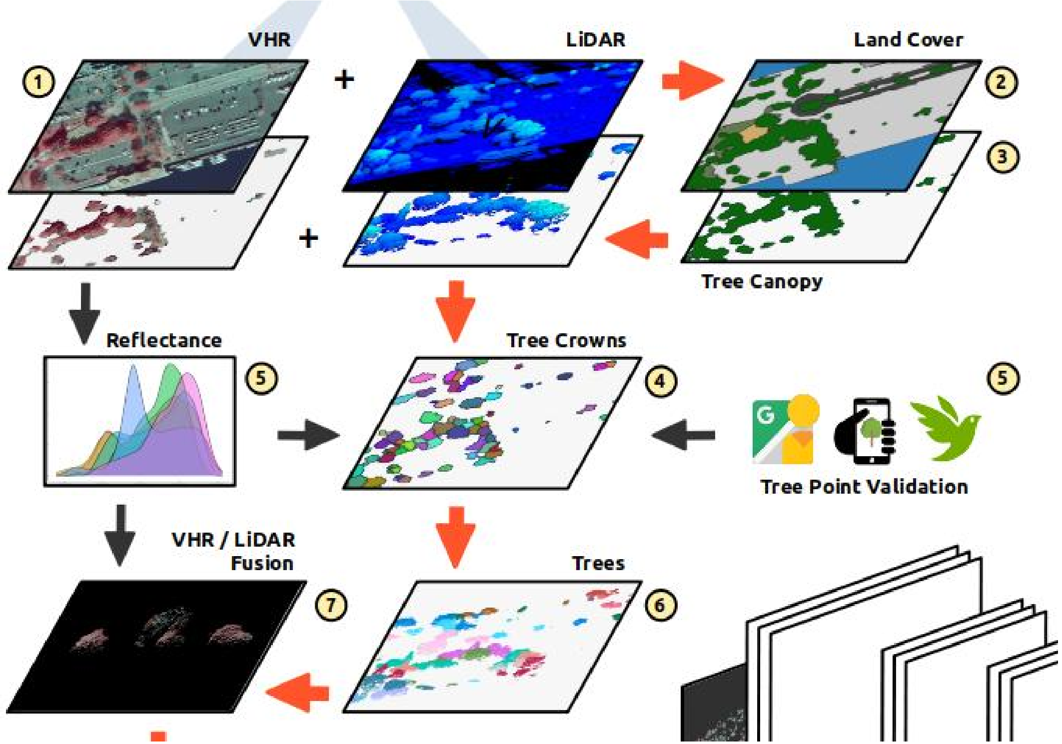
Los Angeles County's Urban Forest
The Role of Airborne Remote Sensing and
Convolutional Neural Networks for
Individual Tree Species Classification
COUNTY OF LOS ANGELES
CALIFORNIA
VHR
LiDAR
Land Cover
Hyperspectral
Tree Canopy
NIR, R, G
Distr.
Tree Crowns
Mixed Pixel
Endmembers
Tree Point Validation
VHR / LiDAR
Fusion
Trees
Classified
Image
Fully Convolutional
Neural Network
Project Workflow
Validation Steps
Distr. = Band DN distributions by species
1
2
3
4
5
5
6
7
8
9
10

Step 1: VHR / LiDAR Fusion



The workflow details VHR and LiDAR processing steps (1, 2) needed to segment individual trees from aerial imagery and obtain reflectance data for each tree crown (3 - 5). The resulting layer is then classified using a fully convolutional neural network to identify tree species at the individual level (6, 7)

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Training Data

Tree point data (20,000+ points)

- iNaturalist -- scraped all target species points in LA County
- Fieldwork
- LA County

    Beaches & Harbors: Marina del Rey annual inventory conducted by the Davey Group

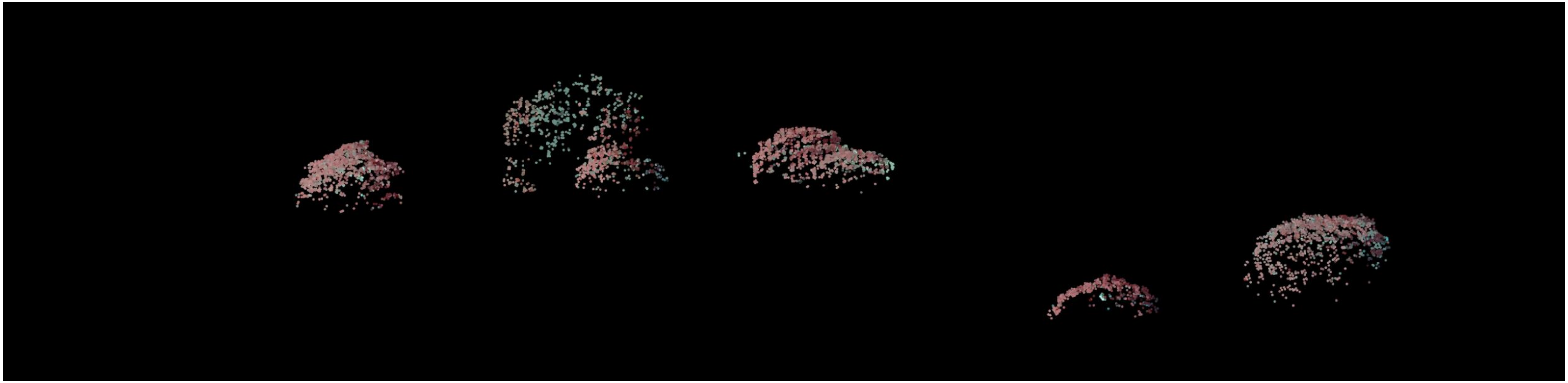
    Parks & Rec: Park inventory phases 1 & 2

    Public Works: Parkway trees

LiDAR Visualization

We can visualize using the individual tree segments from the LiDAR data. We see a canopy shape pattern across all but one tree (second from the left).

VHR / LiDAR Fusion



By merging LARIAC 5 Near Infrared, Red, and Green bands to the tree segments, we visualize a false color plot of the same trees, revealing a different reflectance pattern with the outlier tree.

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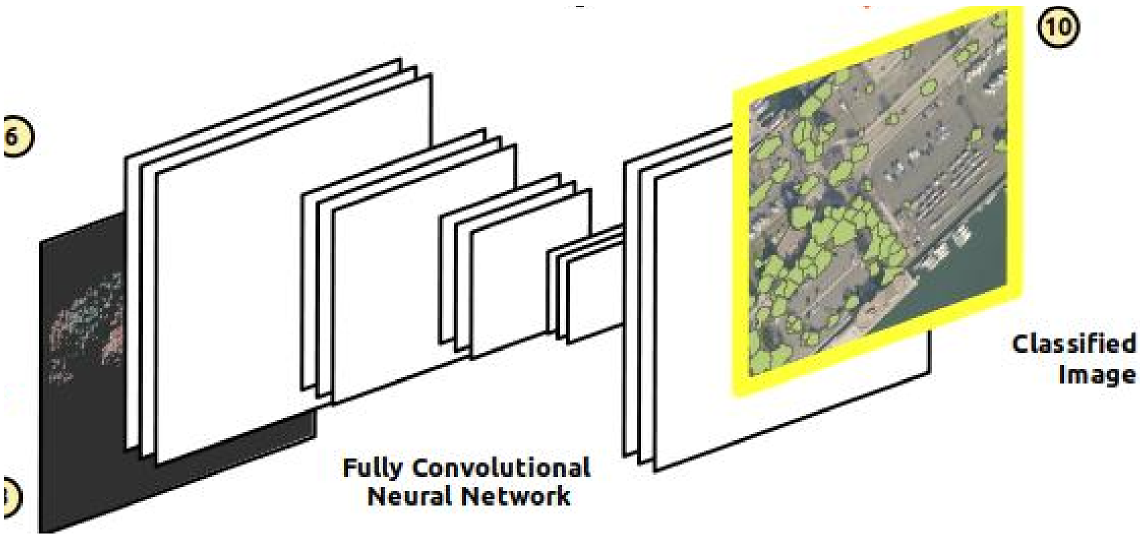
Step 2: Classifying Models



For the first CNN model, a VHR / LiDAR fused point-cloud of individual trees are the input. This allows a computer vision algorithm to determine shape, structure, and reflectance attributes of our target species.

The output are classified point-clouds that can be merged with our tree crown layer for labeling.

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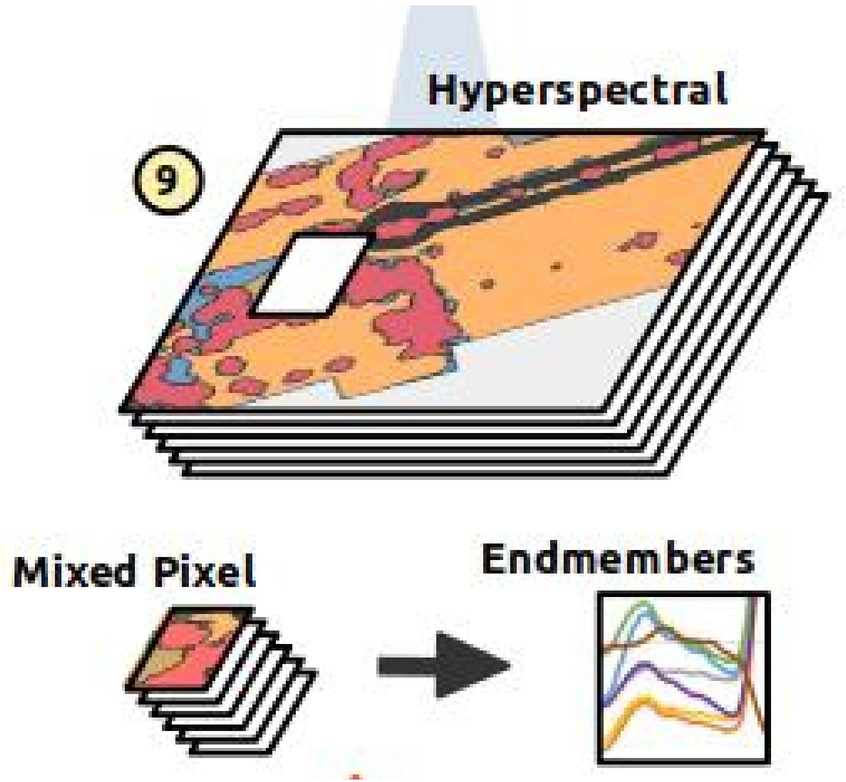
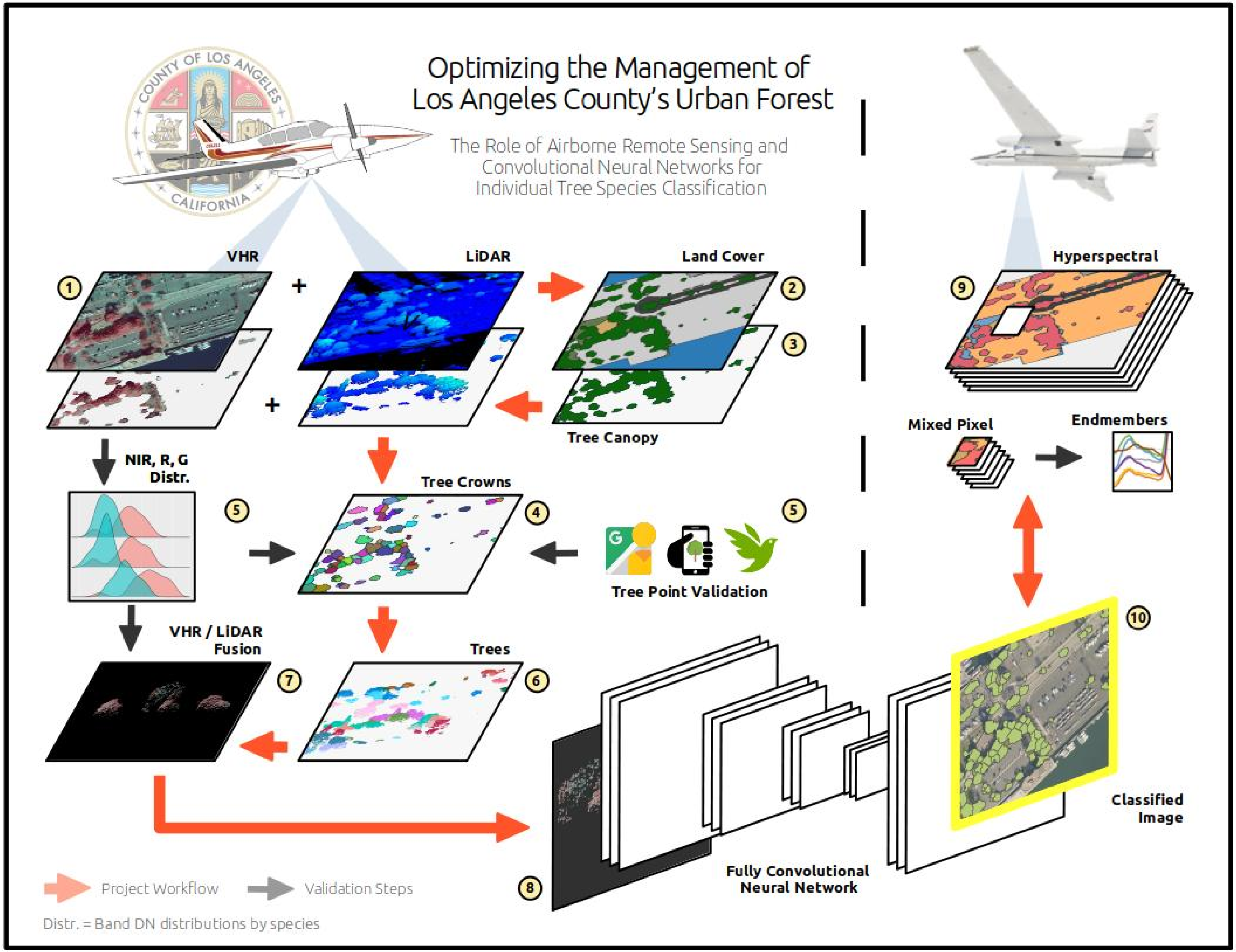
Step 3: Hyperspectral Integration



The classified tree crowns process are then used to unmix larger hyperspectral pixels in concert with predetermined spectral libraries and wavelength regions needed to help identify trees at the crown level (9).

The process will be performed on purer pixels first, and passed through a second CNN model for unmixing/classification.



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Questions?

Thank You!