🍃 LeafNet : A Deep Learning Solution to Tree Species Identification

Elena Galbally, Krishna Rao, and Zoe Pacalin
CS230 Deep Learning, Stanford University

Abstract

Species identification of vegetation is a key step in plant biodiversity research and conservation biology. Speeding up this process can boost humanity's ability to mitigate climate change impacts by simplifying species conservation efforts and helping educate the public. In this study we used a Residual Network to classify 185 tree species from North America using leaf images.
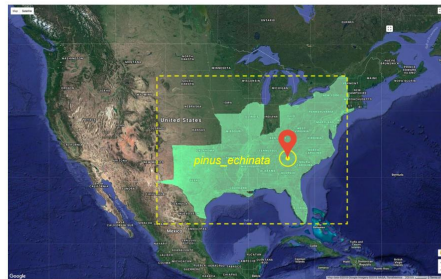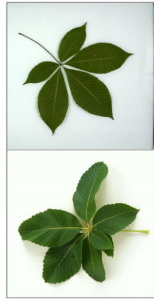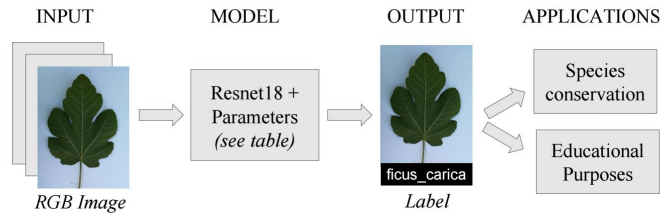
Dataset and Features

LeafSnap dataset:
- 224x224 RGB images
- 185 species
- 23,147 lab images (top)
- 7719 phone images (bottom)

Modifications:
- Geolocation labelling: assign random coordinate pair within the growing region of a species.
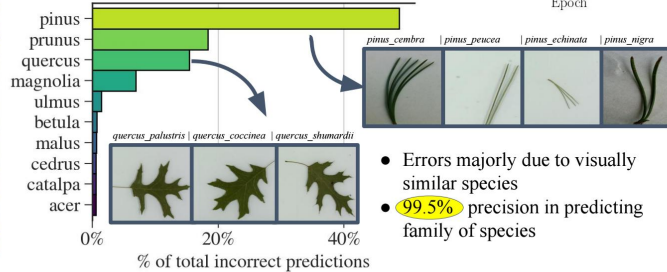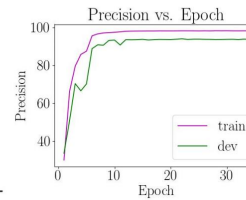- Data augmentation through rotations

pinus_echinata

Model and Results

INPUT   MODEL   OUTPUT   APPLICATIONS

RGB Image → Resnet18 + Parameters *(see table)* → ficus_carica / Label → Species conservation / Educational Purposes

Model	Opt.	Input Size	Epochs	Precision (%)	Comments
Logistic Reg.	SGD	224	35	10.4	Baseline
ResNet18	SGD	16	35	60.5	Low resolution image
ResNet18	SGD	224	35	86.7	Full resolution image
ResNet18	Adam	224	35	41.1	Adam optimizer
ResNet18	**SGD**	**224**	**35**	**93.8%**	**Data augmentation**
ResNet50	SGD	224	78	85.4	Loss not yet stabilized

Performance Criteria
$\Big\{$ Optimizing metric: maximize top-1 precision
Satisficing metric: model < 100 Mb

System performance:
- Beats the highest performing system on the LeafSnap dataset by 7.5%

Precision vs. Epoch

pinus
prunus
quercus
magnolia
ulmus
betula
malus
cedrus
catalpa
acer

pinus_cembra | pinus_peucea | pinus_echinata | pinus_nigra

quercus_palustris | quercus_coccinea | quercus_shumardii

- Errors majorly due to visually similar species
- 99.5% precision in predicting family of species

% of total incorrect predictions

Conclusions

The results of our ResNet model show deep learning offers a high precision and throughput solution for leaf species classification.

Compared to state-of-art methods our system:
- Has the best precision
- Uses a relatively small number of layers
- Requires less epochs to converge

Novelties of the approach:
- Deployed on a phone app
- Geolocation input feature
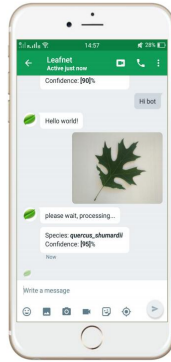- SGD optimizer w/ Nesterov momentum
- Fewer layers

Try it now!

- Open 🟢 Hangouts with leafnetstanford@gmail.com
- Say *"Hi bot"* and start using!
- 😊 server-side app gives **lightning fast** predictions and near real-time performance improvement
- 😞 active internet connection required