




Ectatomma tuberculatum observed in Peru by manimiranda.
Photo via iNaturalist (CC BY-NC 4.0)

Training Machines to Identify Species using GBIF-mediated Datasets

Serge Belongie

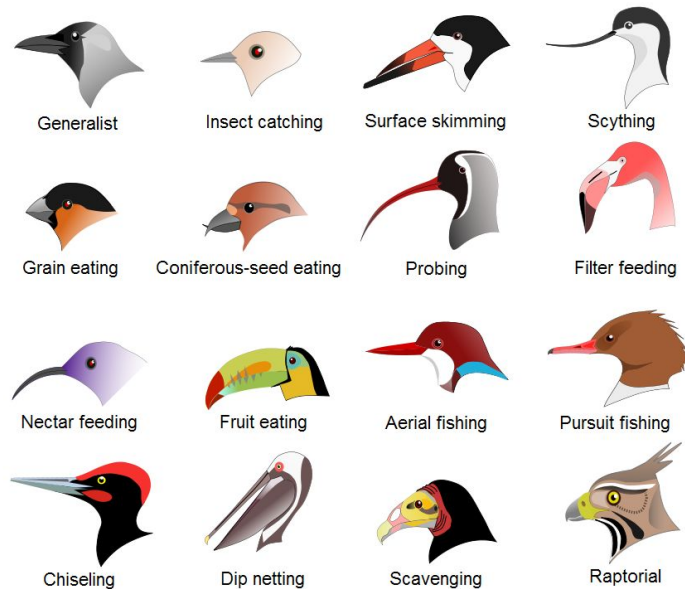
A faint, light red geometric graphic in the background, consisting of several overlapping hexagons and lines that form a complex, abstract shape.

Part I: Visipedia

Capturing & Sharing Visual Expertise

What Is Visipedia?

- A user-generated encyclopedia of visual knowledge
- An effort to associate articles with large quantities of well-organized, intuitive visual concepts



<http://en.wikipedia.org/wiki/Bird>

Motivation

- People will willingly label or organize certain images if:
 - They are interested in a particular subject matter
 - They have the appropriate expertise



Ring-tailed lemur



Thruxton Jackaroo

(A) Easy for Humans



Chair? Airplane? ...

(B) Hard for Humans



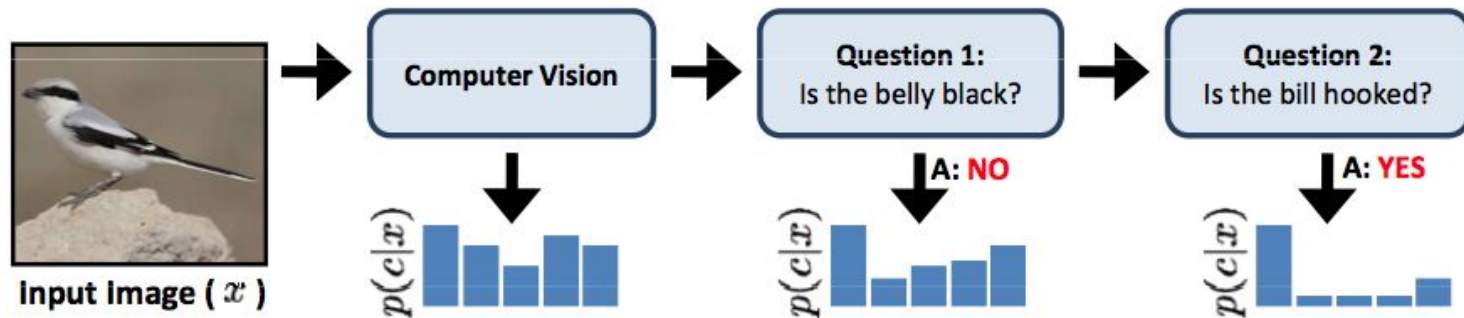
Finch? Bunting?...

(C) Easy for Humans



Yellow Belly? Blue Belly? ...

Visual 20 Questions



Algorithm 1 Visual 20 Questions Game

- 1: $U^0 \leftarrow \emptyset$
 - 2: **for** $t = 1$ to 20 **do**
 - 3: $j(t) = \max_k I(c; u_k|x, U^{t-1})$
 - 4: Ask user question $u_{j(t)}$, and $U^t \leftarrow U^{t-1} \cup u_{j(t)}$.
 - 5: **end for**
 - 6: Return class $c^* = \max_c p(c|x, U^t)$
-

antedeepluvian

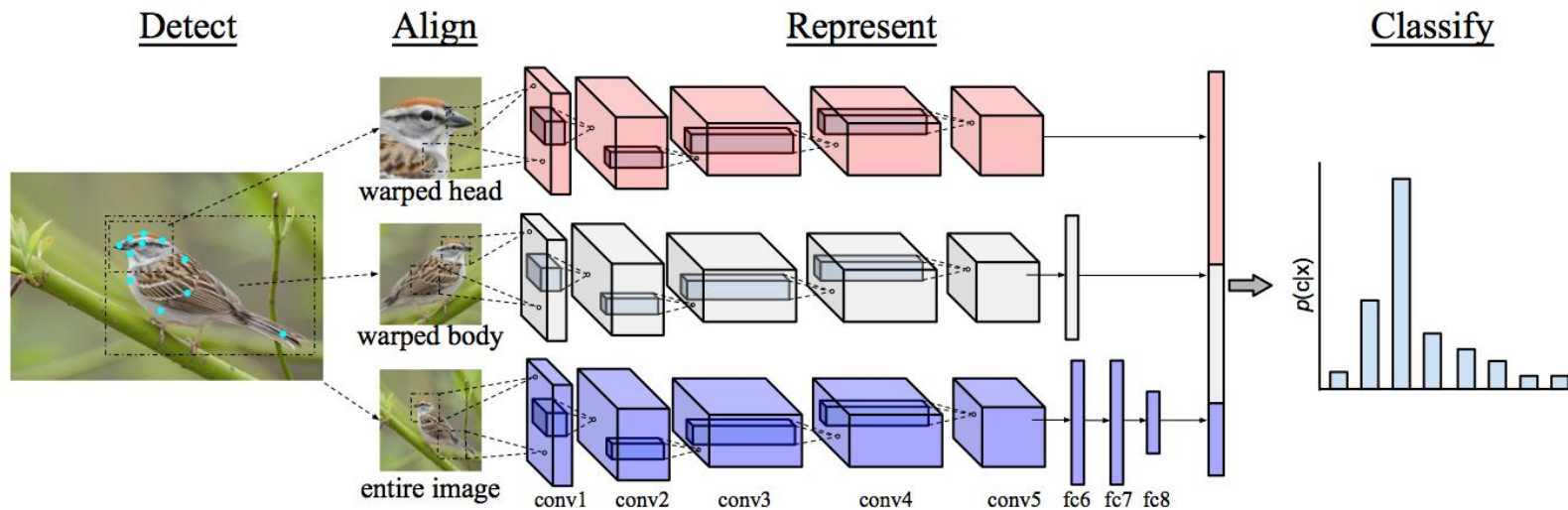
an·te·deep·lu·vi·an

ˌan(t)ēdēpˈlōōvēən/

adjective

1. before the flood of deep learning papers
2. “Histograms of vector quantized filter responses are *antedeepluvian* features.”

Pose Normalized Deep ConvNets



[Van Horn, Branson, Perona, Belongie BMVC 2014]

A close-up photograph of a bald eagle's head, showing its white feathers, yellow beak, and intense gaze. The eagle is looking slightly to the left. The background is dark and out of focus.

CCUB NABirds includes:

- For more information contact: Ryan Farrell (farrell@eecs.berkeley.edu)

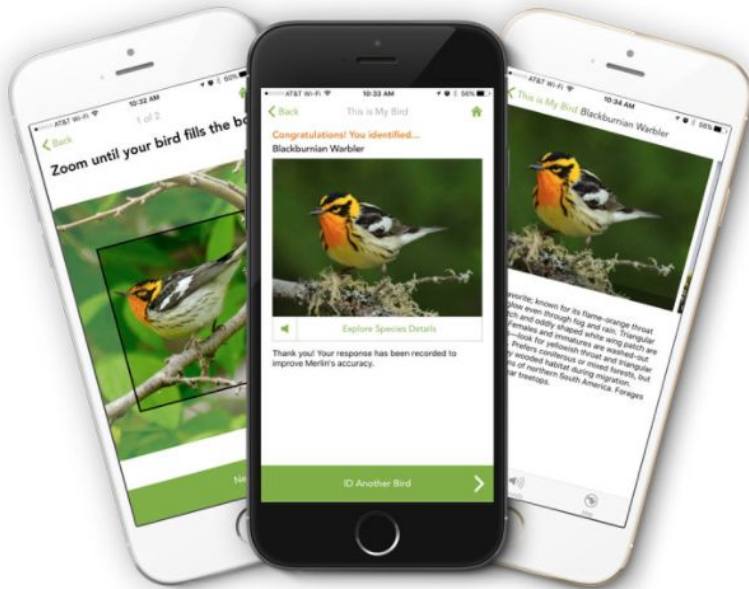
The **Cornell** Lab
of Ornithology



Merlin (iOS & Android)

Photo ID now in mobile apps

A new advanced version of the Photo ID tool is now available for download in the latest version of Merlin Bird ID for [Android](#) and [iPhone](#). Select an image from your smartphone image gallery or snap a shot from the back of your camera's viewfinder, and Merlin will walk you through the 2 quick steps before showing you a list of possible species.



eBird.org

Search LTE 1:08 PM

About

Photo ID

Photo ID was developed in collaboration with Dr. Pietro Perona's computational vision lab at [Caltech](#), and Dr. Serge Belongie's computer vision group at [Cornell Tech](#), collaborators on the Visipedia project. Merlin Photo ID uses computer vision technology to identify birds in photos. Merlin learns to recognize bird species based on training sets of hundreds of thousands of photos from birders at [eBird.org](#). When using photo ID, enter the date and location where you took the photo; those clues improve Merlin's accuracy by helping it focus on the species you most likely encountered there.

What's Next?

With your input, we'll work to keep adding more species to Merlin, creating new features, and improving Merlin's performance. We welcome your feedback! If you enjoy using Merlin, please consider helping us by making a [donation](#).

Have Questions?



675K IMAGES

iNaturalist Google
Large Scale Species Classification Competition

Results presented at CVPR 2017 Hawaii at 4th Workshop on Fine-Grained Visual Categorization

5000 SPECIES

https://github.com/visipedia/inat_comp

FGVC4 iNaturalist.org Google



iNaturalist Competition 2018

8,000 species
Long Tail Distribution

FGVC5 iNaturalist



iWildCam
Competition
2018

FGVC5



Flower Classification
Challenge 2018

1,000 species

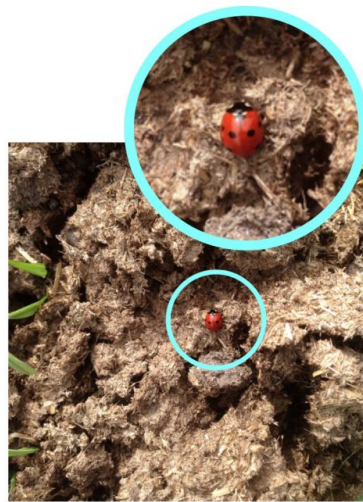
FGVC5

 PictureThis

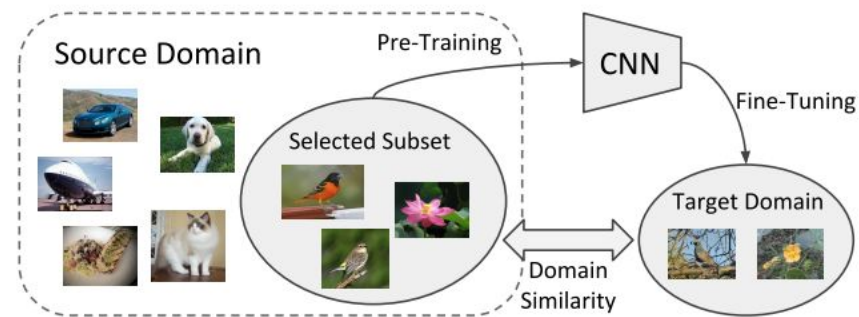
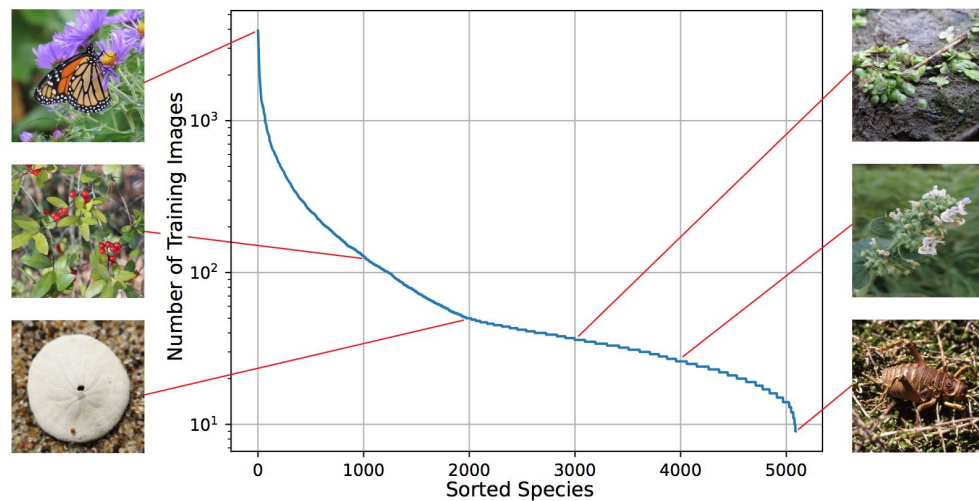
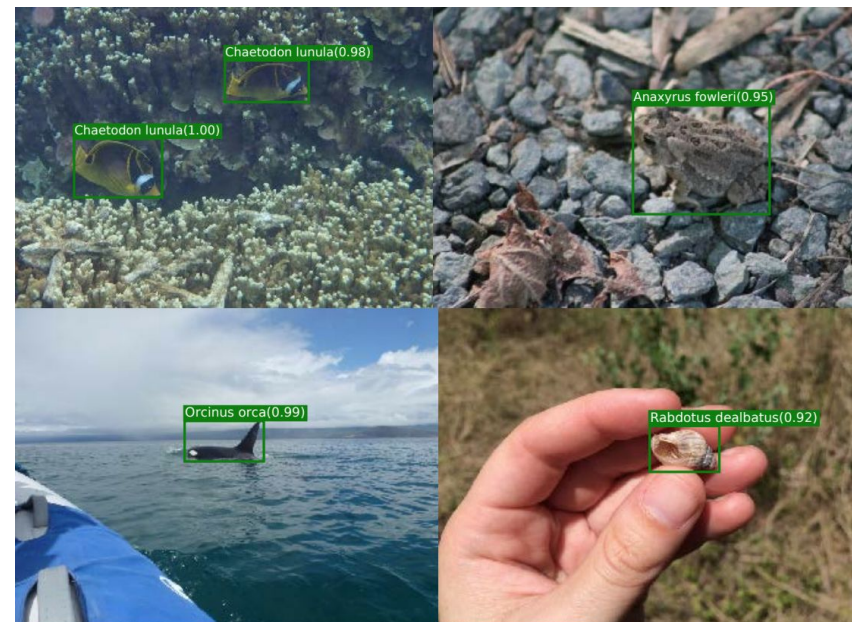




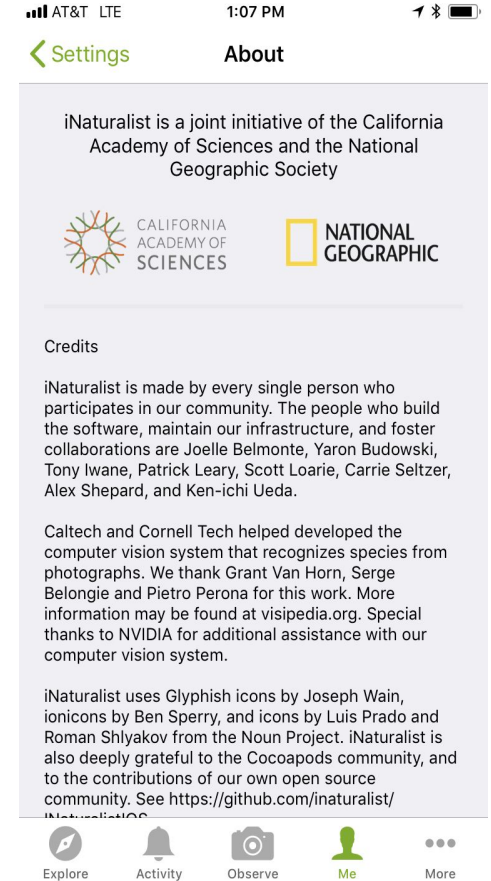
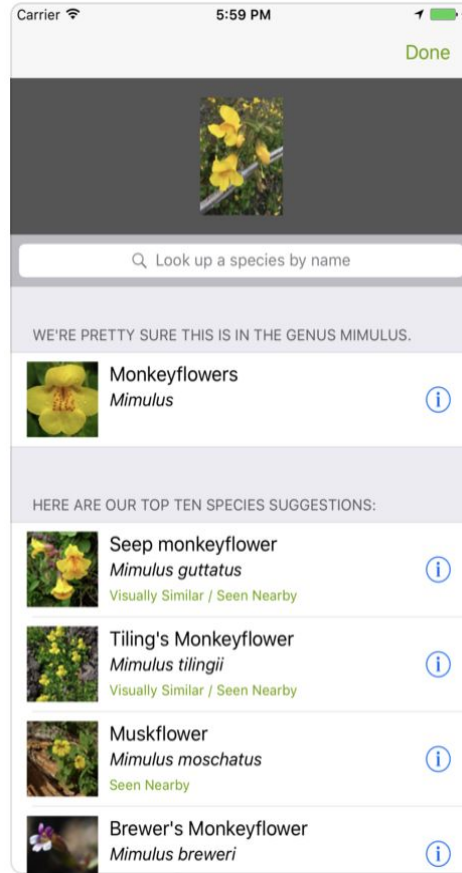
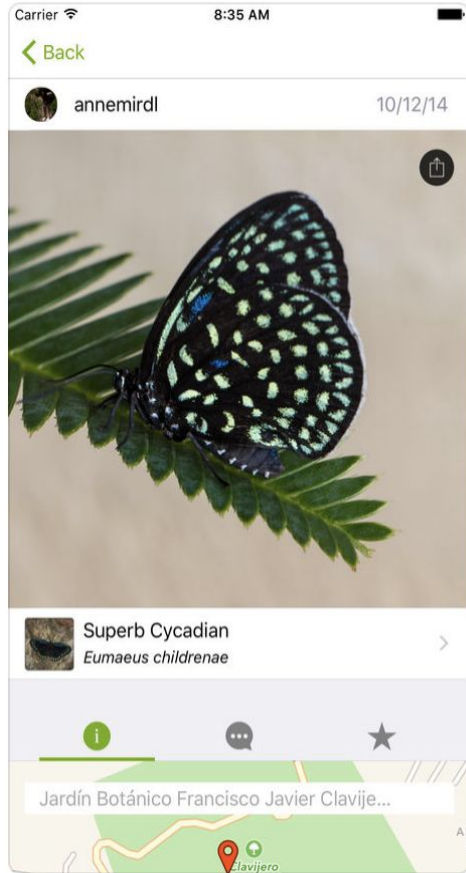
Two-spotted ladybug
Adalia bipunctata



Seven-spotted ladybug
Coccinella septempunctata



iNaturalist (iOS & Android)

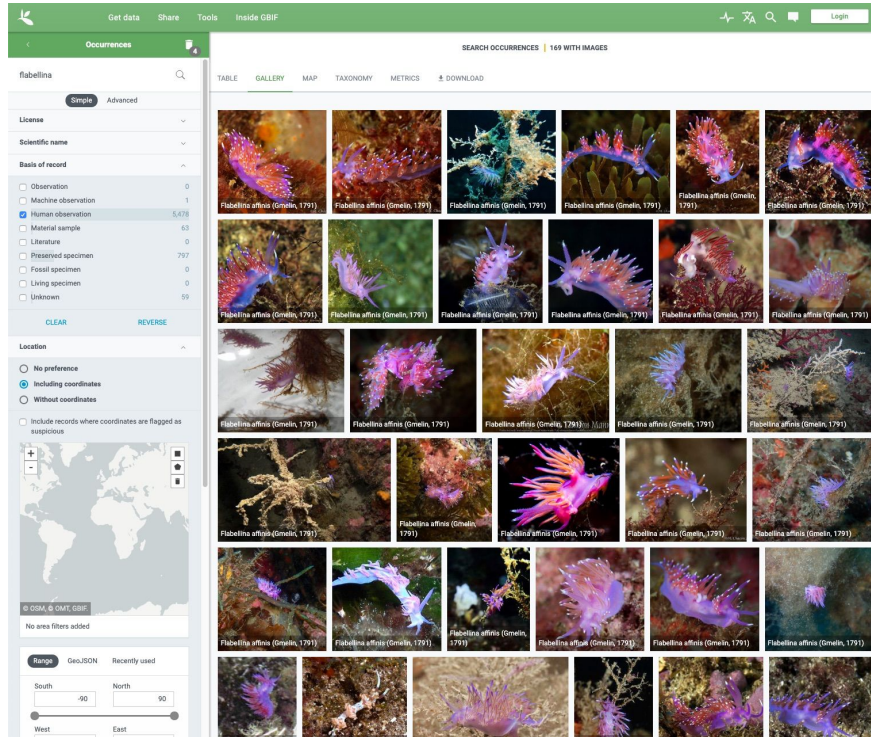




Part II: Mediated Machine Vision

Scaling up with GBIF

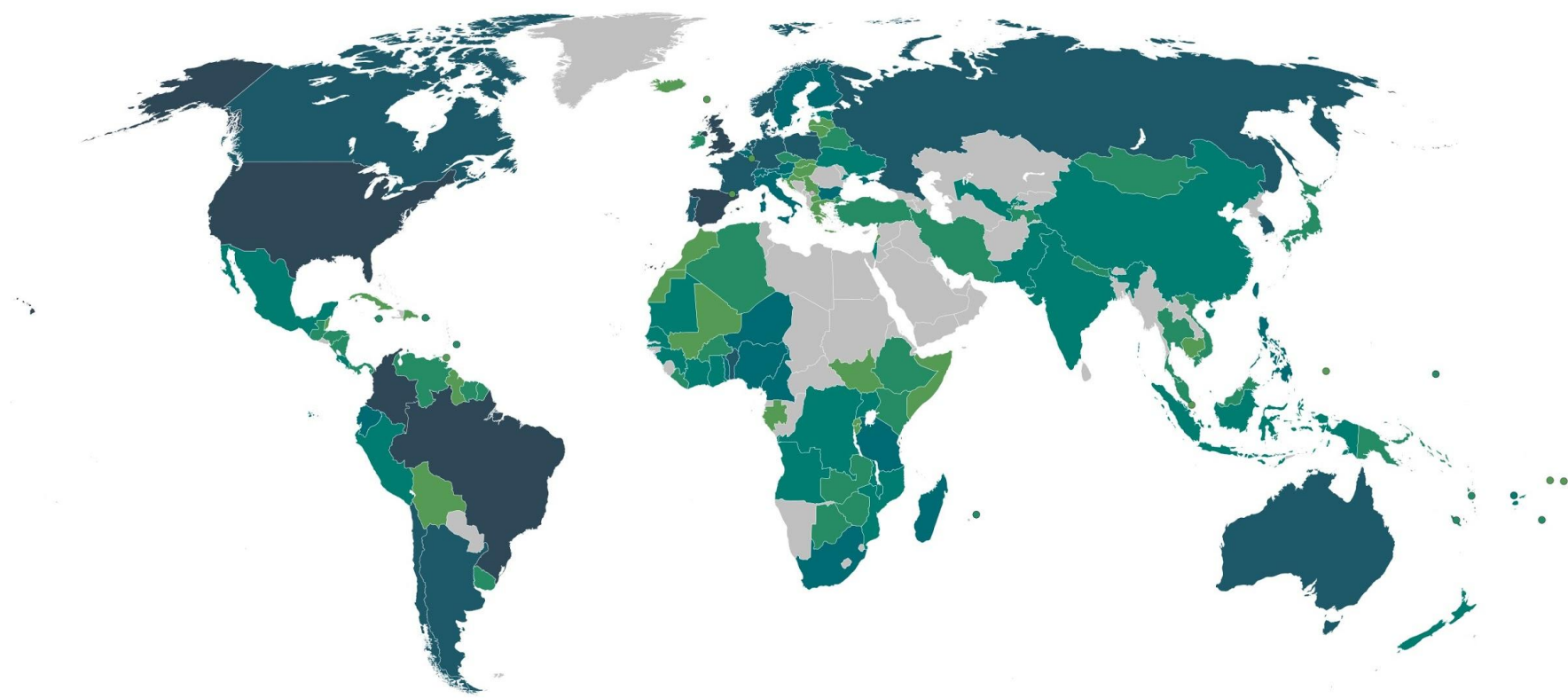
Global Biodiversity Information Facility: Infrastructure



1. Distributed network of data publishers
2. Real-time data indexing with sophisticated search and download capabilities
3. 47M records with images
 - a. +19M in 11 months
 - b. labelled with date, location and scientific identification

<https://www.gbif.org>

GBIF Community

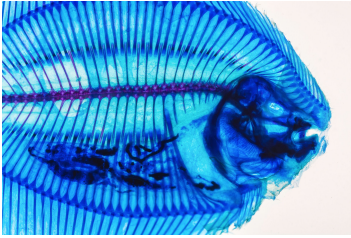


Countries of institutions
publishing data

Goals

1. Make it easy to use machine vision models in our community
2. Promote responsible use of data
 - a. Open data licenses
 - b. Clear citation practice and track use
3. To connect communities
 - a. Discuss sociological issues surrounding this use of data
 - b. Connect data publishers, users, biological domain experts and computer vision scientists

Challenges



University of Texas, Biodiversity Center, Ichthyology Collection (CC0)



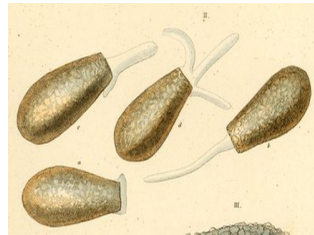
D. Hobern (CC-BY)



Royal Botanic Gardens, Kew (CC-BY)



Yale Peabody Museum (CC0)

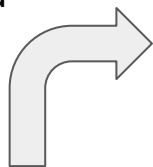


Botanic Garden and Botanical Museum Berlin (CC-BY)

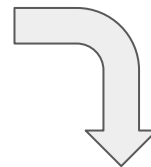
1. **Variety** in images
 - a. Photographs in nature
 - b. Prepared specimens
 - c. Drawings
 - d. Photos of labels
 - e. Photos of evidence (e.g. scat)
2. **Taxonomic** opinion when integrating datasets
3. **Geographic** scope

Mediated machine vision

Datasets registered,
openly licensed, issued
DOI



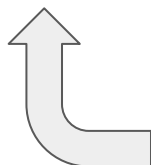
Training datasets
prepared, openly
licensed, issued DOI



**Data
publishers**

**Google
Research &
Visipedia**

Models used in
tools, cited using
DOI



Versioned models
published, openly
licensed, issued
DOI



Two models: 2018 FGVCx Fungi and v2

Get data Share Tools Inside GBIF

TOOL

Mediated Machine Vision




We are working on making it easy to build models using GBIF-mediated data for use in your own applications.

DEMO STATEMENT OF INTENT

Mushroom Recognizer V2

View on TensorFlow Hub

Results

-  **Mycena**
svampe.databasen.org
Cosine similarity: 0.68
-  **Mycena galericulata**
svampe.databasen.org
Cosine similarity: 0.64
-  **Asterophora parasitica**
svampe.databasen.org
Cosine similarity: 0.61
-  **Mycena epipterygia**
svampe.databasen.org
Cosine similarity: 0.60
-  **Mycena abramsii**
svampe.databasen.org
Cosine similarity: 0.57
-  **Mycena arcangeliana**
svampe.databasen.org

Drag and drop an image

Browse URL

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Danish Mycological Society Fungi Embedding Model

Danish Mycological Society, fungal records database

TensorFlow Hub

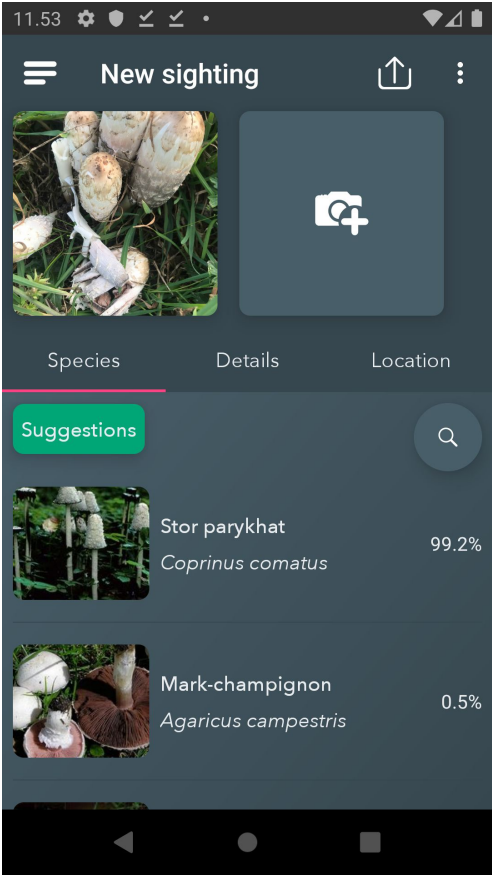
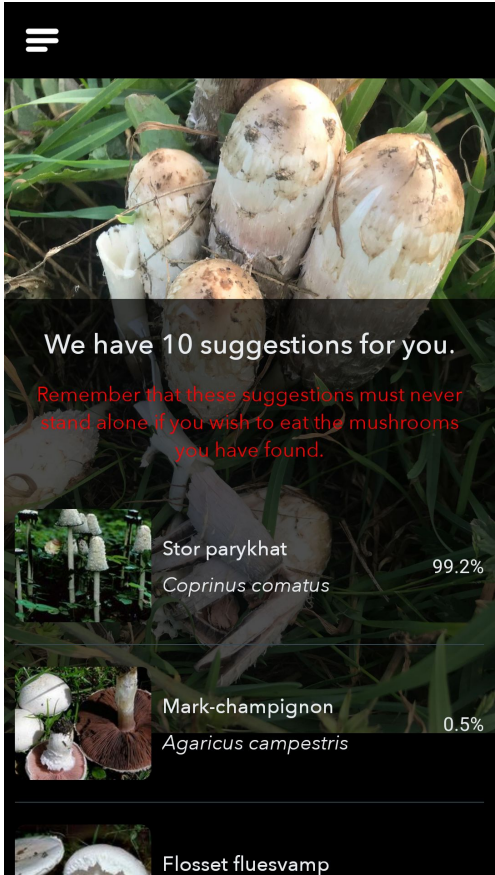
<https://doi.org/10.26161/dhpb-3346>



Demo:

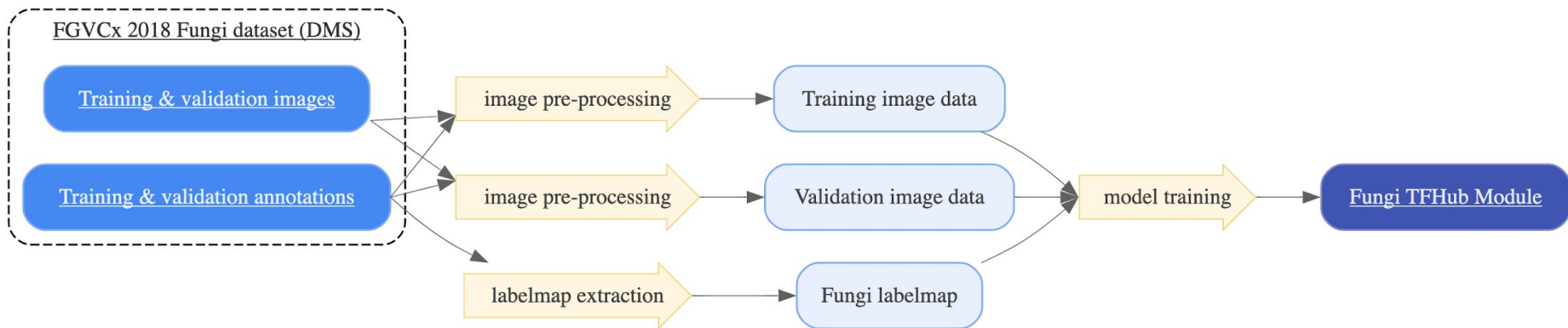
<https://www.gbif.org/tools/machine-vision>

Danish Fungal Atlas (SvampeAtlas)



Building the models

Provenance Graph



Model architecture

- Christian Szegedy, Sergey Ioffe, Vincent Vanhoucke, Alex Alemi: “[Inception-v4, inception-resnet and the impact of residual connections on learning](#)”, 2017.
- Deep ConvNet pre-trained on iNaturalist model, fine tuned on Fungi

Get involved

Status: First models now built piloting the process

Read more: <https://www.gbif.org/tools/machine-vision>

Mailing list: Mediated Machine Vision (<https://lists.gbif.org>)

Fine Grained Visual Categorization (FGVC) workshop

- Conference on Computer Vision and Pattern Recognition (CVPR)
- This Friday (June 19, 2020)

Thank you: Tim Robertson (GBIF), Christine Kaeser-Chen (Google)