2021 embedded vision summit

VIRTUAL | MAY 25-27

Tools and Strategies for Quickly Building Effective Image Datasets

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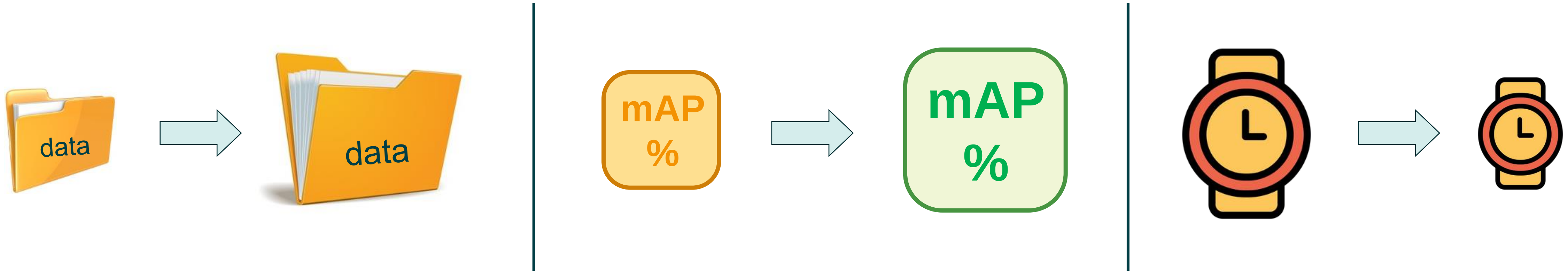
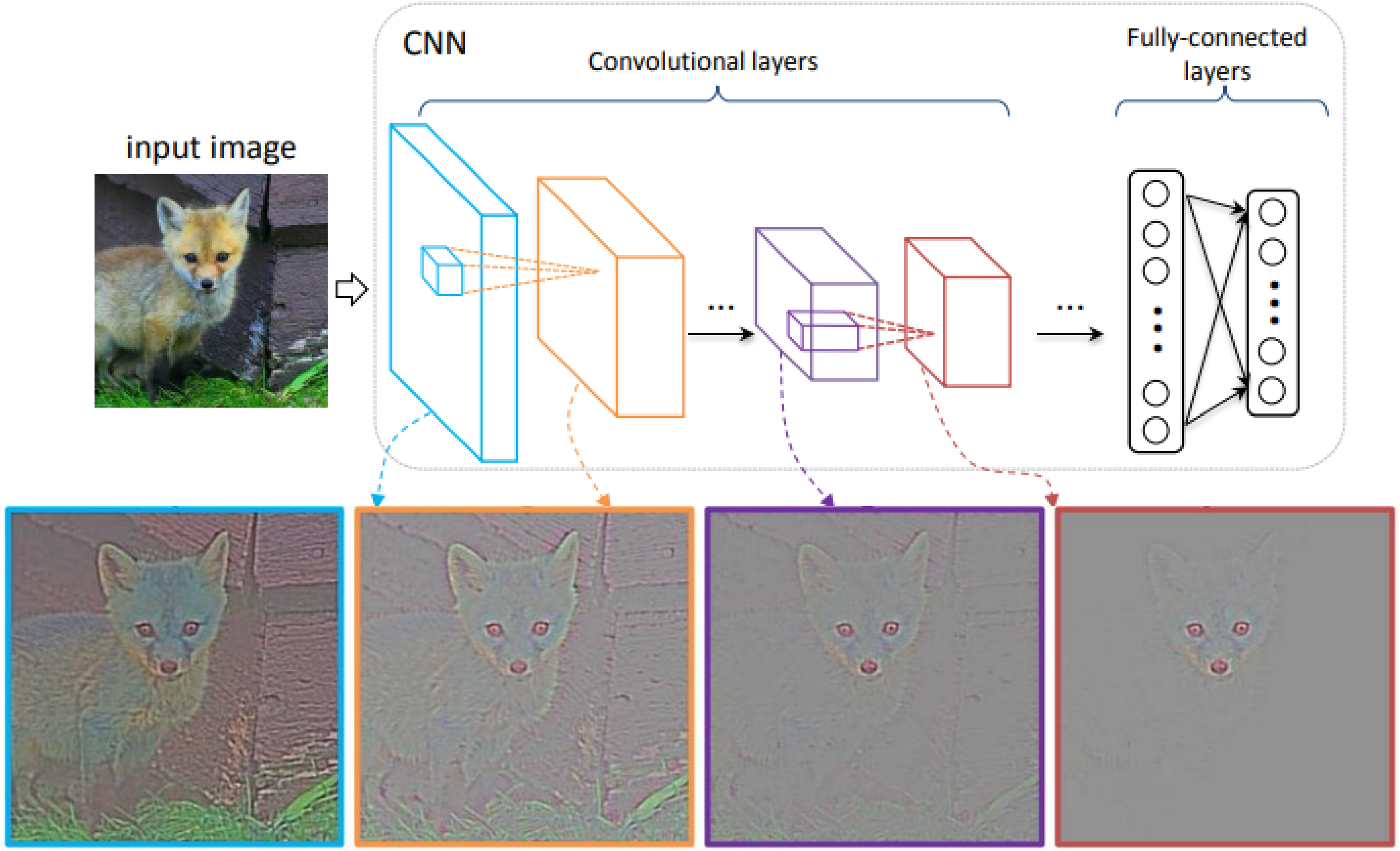
Purpose

- Demonstrate practical strategies and tools for quickly building image datasets
- Train higher-quality models with less time investment
- Focus on object detection models



Object Detection Neural Networks

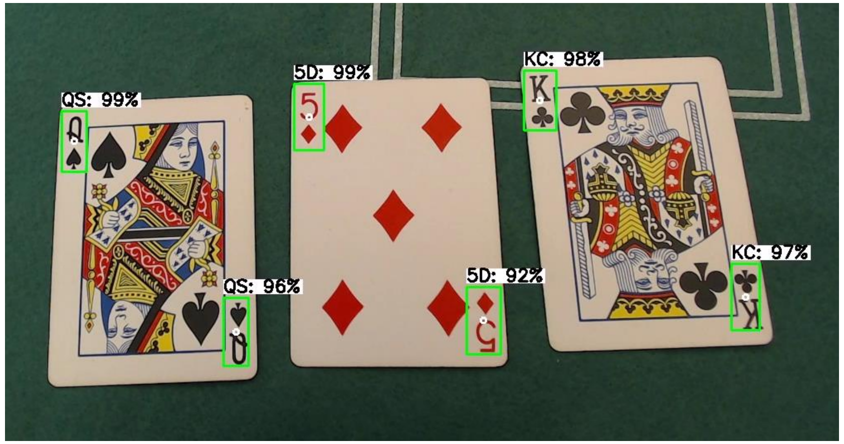
- Object detection models locate and identify objects in images
- Use CNNs to find features in images and correlate them to known objects they've been trained on
- For this presentation, "training" is transfer learning and fine-tuning



Visualizing and Comparing Convolutional Neural Networks
arXiv: 1412.6631v2

Applying Object Detection Models

- **Scope of application determines amount of training images needed**
- **Constrained applications with limited variety of visual conditions:**
  - Lower generalization of model is okay
  - Fewer training images needed
- **Applications with wide variety of visual conditions:**
  - Need to be accurate at different light levels, angles, coloration, distance from camera, etc.
  - Larger number of images are needed



Playing card detector – low variance

Self-driving car – high variance

How can we Quickly Create an Object Detection Dataset?

- **Problem: to train a new object detection model, a large image dataset is needed**
  - Manually gathering and labeling images is time consuming

- **Solution: Use these strategies to accelerate dataset creation!**
  - Using datasets already available online
  - Capturing images from video
  - Using sleek annotation and automated methods tools to quickly label data
  - Synthetic image generation and data augmentation

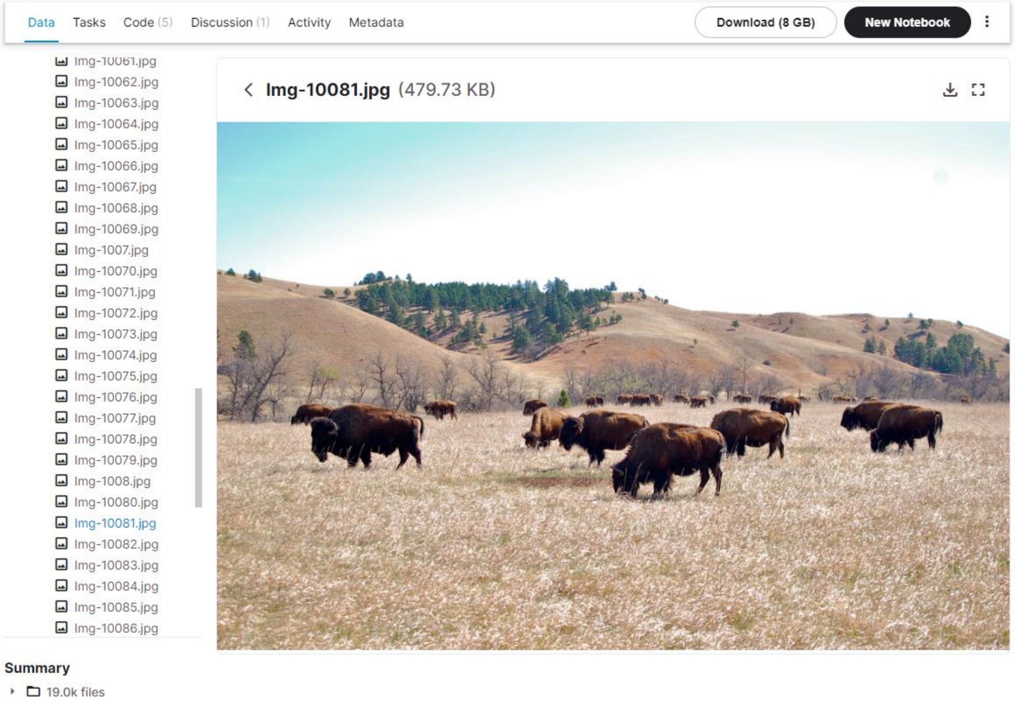
NO AUDIO
NBC NEWS NOW
CLOIE MUSUMEC
WOMAN PLAYS DEAD AFTER TRIPPING
RUNNING AWAY FROM BISON AT YELLOWSTONE

My example – Bison distance detector

Using Online Image Datasets

- **Datasets available online can be a good starting point**
  - Academic datasets such as Open Images Dataset, ImageNet, COCO, etc.
  - User-contributed datasets from TensorFlow, Kaggle, or other sources
- **Issues with online datasets**
  - Can be filled with poor quality images or label data
  - Datasets not be available or appropriate for your application
  - Copyright and licensing: need to be careful using copyrighted material for commercial purposes

kaggle



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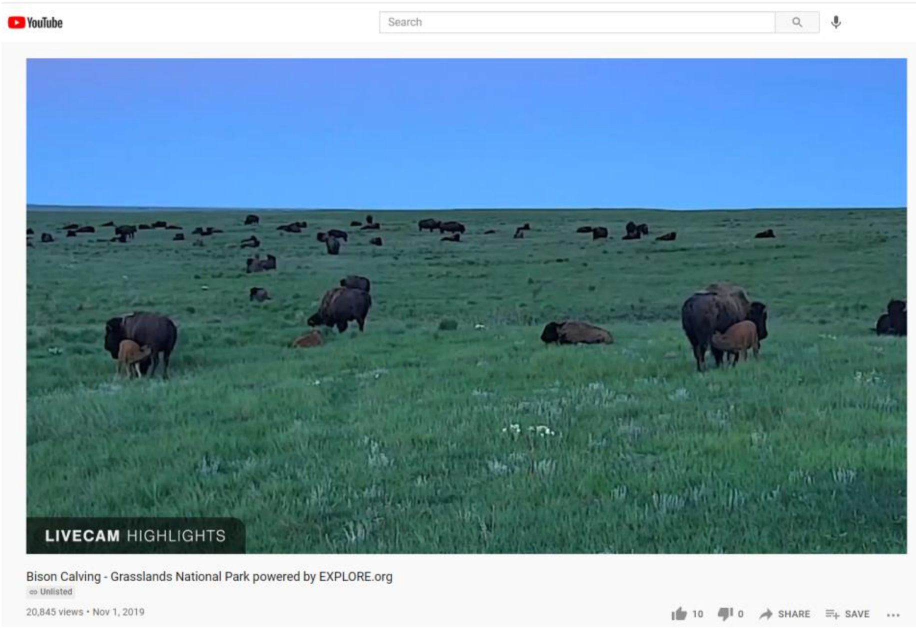
Summary

19.0k files

Capturing Images from Video

- **Gathering images from the camera used by the application significantly improves accuracy**
- **Various methods for capturing images specific to your application:**
  - Set up cameras in situations similar to actual in-situ application, record video, and grab frames from video
  - Use multiple cameras in multiple locations and aggregate videos to a central server
  - Use online video or live camera streams of objects you are interested in

Capturing Images from Video, Continued



Bison Calving - Grasslands National Park powered by EXPLORE.org

20,845 views • Nov 1, 2019

Python script to extract individual frames from a video:
github.com/EdjeElectronics/Image-Dataset-Tools#FrameGrabber

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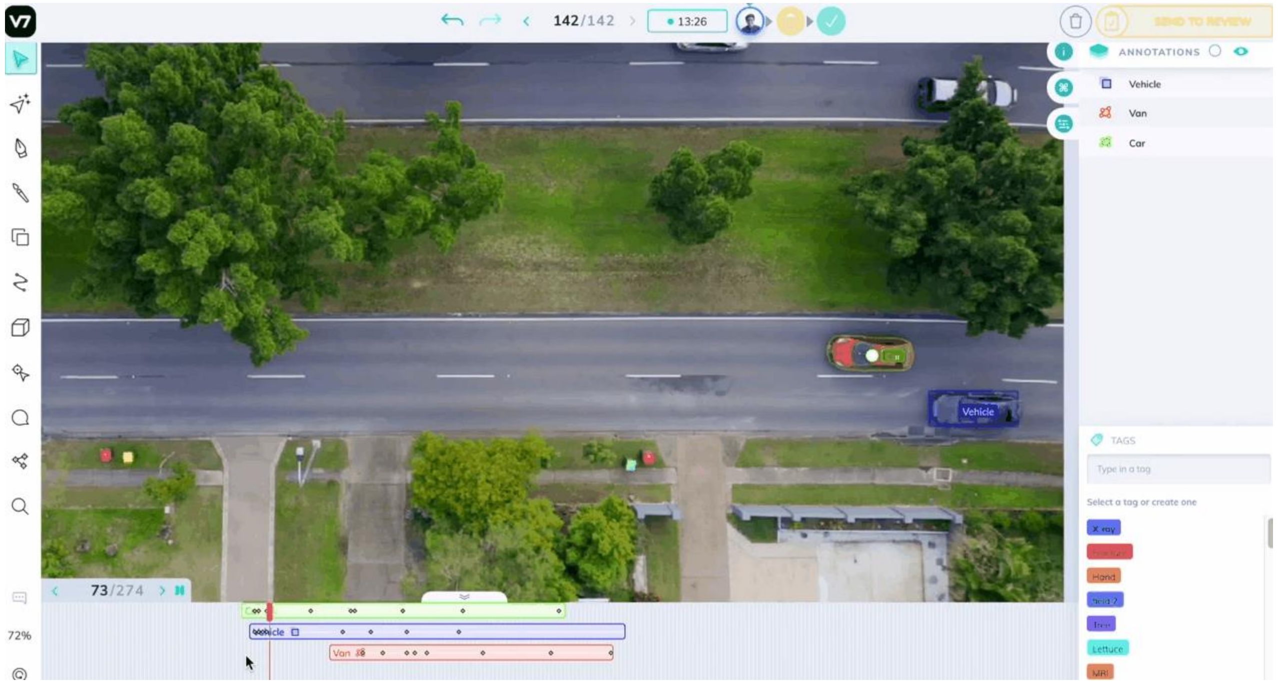
Image Annotation Tools

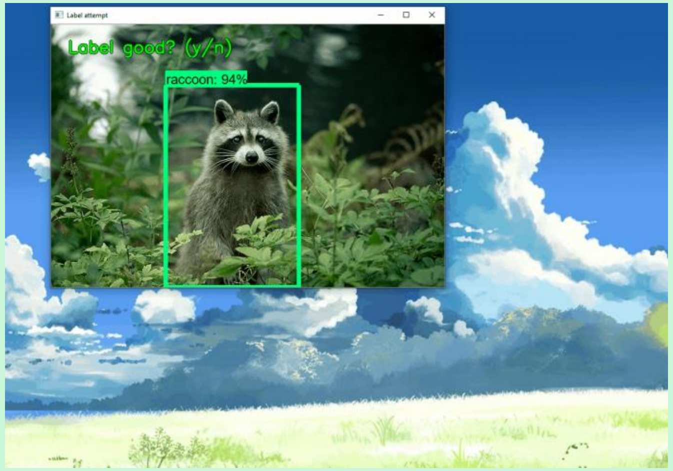
- **Many annotation tools are available to help accelerate the image labeling process**
- **Paid annotation tools:**
  - V7 Darwin
  - Supervisely
  - Hive – pay humans to annotate your data
  - Lionbridge – pay humans to annotate your data
- **Free annotation tools:**
  - CVAT
  - LabelImg



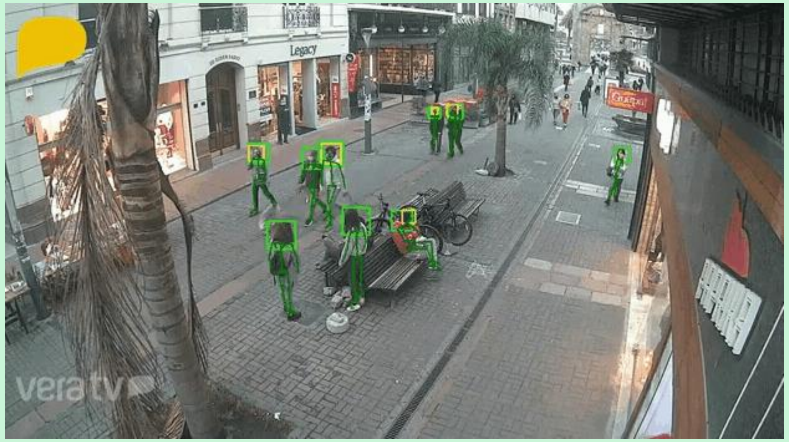
Video annotation tool from V7

Automated Labeling Methods

- **Supervised automated labeling**
  - Train a model off a small portion of the dataset
  - Use that model to automatically label the rest of the dataset, while manually rejecting poor labels and re-labeling them
  - github.com/EdjeElectronics/Image-Dataset-Tools#AutoLabeler
- **Other creative methods**
  - Tryolabs example uses OpenPose to automatically locate positions of heads in a frame



Automatically labeling raccoon images



Face mask detection in street camera video streams using AI: behind the curtain

(Courtesy of Tryolabs)

Synthetic Image Generation and Data Augmentation

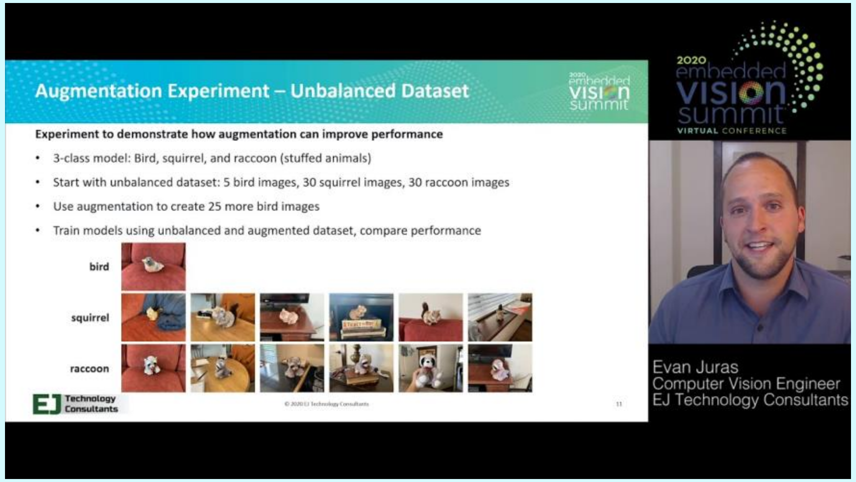
Synthetic Image Generation

- **Tools are available to synthetically generate images**
  - Mindtech
  - KineticVision

Synthetic scenario video from Mindtech

Data Augmentation

- **Generate new images from existing ones**
  - Increase visual variety of images
  - Resolve class imbalances
  - Great for 2D objects and perspectives



Augmentation Experiment – Unbalanced Dataset

Experiment to demonstrate how augmentation can improve performance

- 3-class model: Bird, squirrel, and raccoon (stuffed animals)
- Start with unbalanced dataset: 5 bird images, 30 squirrel images, 30 raccoon images
- Use augmentation to create 25 more bird images
- Train models using unbalanced and augmented dataset, compare performance

bird
squirrel
raccoon
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Check out my data augmentation talk from EVS2020!

Limitations of These Methods

- **Still need some manual groundwork involved in collecting images**
  - Searching for datasets, setting up video recording, auditing labels for accuracy
- **Other limitations**
  - Difficult to use for uncommon objects or applications
  - Won’t bring model up to highest accuracy possible – for best performance, need to carefully curate and refine dataset, which takes time

Conclusions

- **There are various methods for quickly building an object detection dataset**
  - Online datasets
  - Fast image capture
  - Sleek annotation tools and automated labeling
  - Synthetic image generation and data augmentation
- **Depending on application, may still need to manually curate dataset for best accuracy**
- **Same concepts can be applied to image classification models**

Example of Resource Slide

Resource Links

Browser-based free annotation tool (CVAT):
https://cvat.org

Using TensorFlow's built-in datasets:
https://www.tensorflow.org/datasets/overview

Handy scripts for working with image datasets:
https://github.com/EdjeElectronics/Image-Dataset-Tools

Contact Information

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References

[1]: M. Zeiler, R. Fergus (2013). Visualizing and Understanding Convolutional Networks. arXiv:1311.2901

[2]: W. Yu, K. Yang, Y. Bai, H. Yao, Y. Rui (2014). Visualizing and Comparing Convolutional Neural Networks. arXiv:1412.6631v2