Deloitte.

Davis Vercher – Capstone

Deloitte Mentor: Dr. John Helms

Data Society Mentor: Dr. Veronica Red

AI Guild Apprentice Program

Technology Guild Program | 2023

Finding Feral Hogs:

Using Wildlife Trail Camera Images To Help Eradicate North America's Most Damaging Invasive Species

Davis Vercher

AI Guild Capstone

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08 June 2023

About Me

Interest in the AI Guild

- **Going from "Zero to One" with machine learning**
  -Going from a no-code background to creating my own ML projects applicable to my life
- **AI applied to Defense**
  -Learning how to contribute my domain knowledge to Department of Defense AI projects
- **Bridging the AI knowledge gap at Deloitte**
  -Connecting non-technical colleagues like me to the skilled AI practitioners of the AI Guild

Background

- **BA in Political Science** – 2017
- **USMC combat arms officer** – 2017 to 2021
- **Consultant at Deloitte** – 2021 to Present
- **Student, MS in Computer Science & AI**– May 2023 –May 2025

Davis Vercher

Level:	Consultant
Industry:	Commercial / Life Sciences
Offering Portfolio	Customer & Marketing
Offering	Advertising, Marketing, & Commerce
Role:	Digital PMO
Office:	Dallas

Capstone Background

Background

***Sus domesticus* (farm pig)**

***Sus scrofa* (wild boar)**

- *Sus domesticus* vs *Sus scrofa*
- What happens when a domestic pig escapes into the wild (goes feral)?
- **Why does it matter?**

Situation

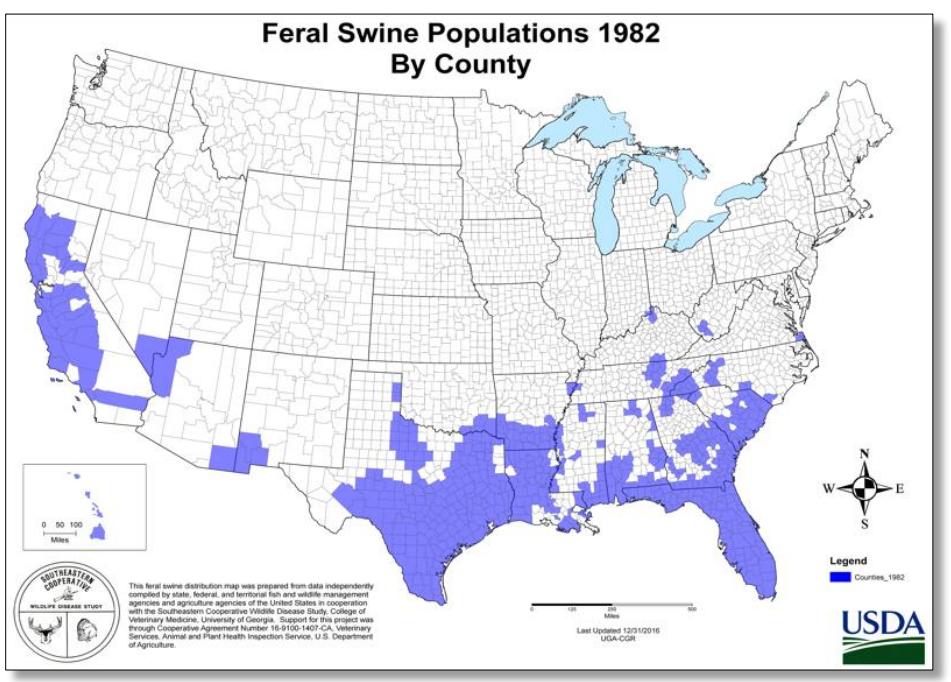
Good ground disturbance (farm pigs)

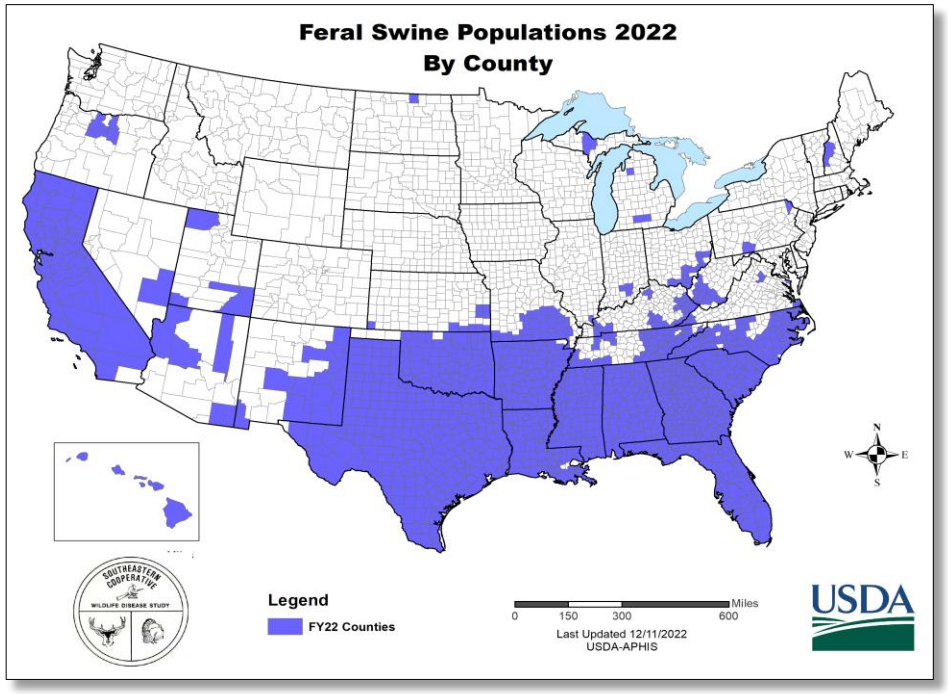
Pigs are natural tillers

Bad ground disturbance (feral pigs)

- Feral pigs cause $2.5 billion in damage a year in the US
- Ground disturbance by wild pigs releases trapped CO_2 equivalent to 1 million cars annually
- **What keeps the pigs in check?**

Complication



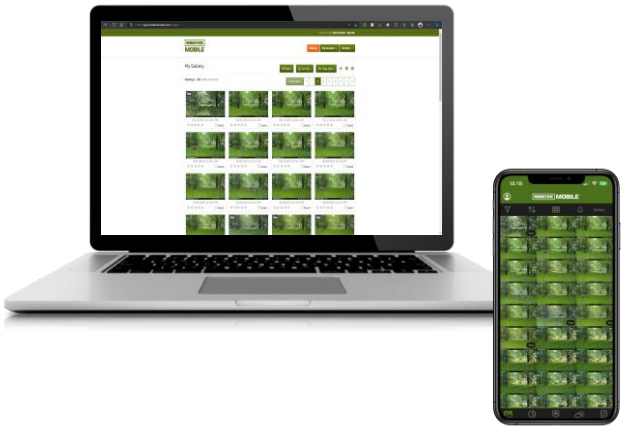


Feral pig populations have exploded in the last 40 years

- Wild pigs have few natural predators in North America, and their breeding biology enables explosive growth
- The US population of wild pigs today is estimated to be more than 6 million
- **Wild pig herds (sounders) are hard to find and harder to eradicate**

Current Solution

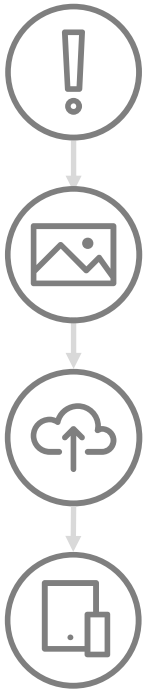
Hunting Trail Cameras: The best solution for finding wild pigs today



Motion Sensor Triggered → Camera Activated & Photo Taken → Photo Uploaded to Cloud → Photo Pushed to End User

AI-Enabled Solution

CURRENT STATE



Motion Sensor Triggered

Camera Activated & Photo Taken

Photo Uploaded to Cloud

Photo Pushed to End User

FUTURE STATE

Motion Sensor Triggered

Camera Activated & Photo Taken

Photo Uploaded to Cloud

Image Classification Model Filters for Target Animal

Photo Pushed to End User Only if Target Animal Detected

Capstone

Approach

PHASE 1

BINARY IMAGE CLASSIFICATION

Goal: conduct first learning on CV, CNNs, & TensorFlow

- MVP image classification model
- White-tailed deer vs wild hogs
- Primary learning for me on CV, TensorFlow, & CNNs

PHASE 2

MULTI-CLASS IMAGE CLASSIFICATION

Goal: deepen exposure to image classification with TensorFlow

- GTM image classification model
- Deer, hog, person, vehicle, coyote, raccoon, rabbit, vulture (most common in my area)
- Deepen exposure to image classification techniques with TensorFlow

PHASE 3

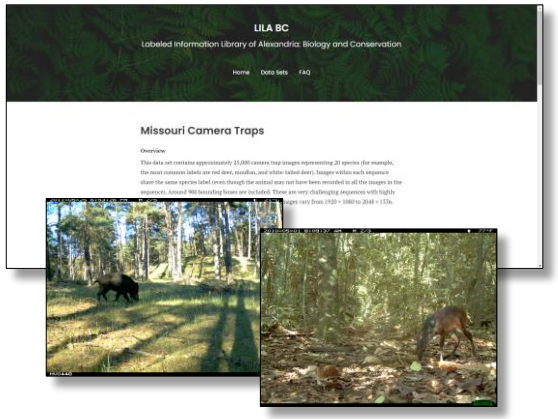
APP BUILDING

Goal: create an MVP product to demo

- Move from notebooks to AWS
- Create a working browser “app”

Approach | Phase 1

DATASET



Missouri Camera Trap Image Dataset
Labeled Library of Alexandria

- >25,000 images belonging to 20 classes (different species)
- Trail camera images (2048 x 1536 x 3)
- Labeled and formatted according to scientific standards for camera traps
- Extracted only two classes for Phase 1 (wild hogs and white-tailed deer) – 1200 images per class (50/50 split)… about 1.5 GB

PREP

colab + 

TensorFlow

Pipeline creation and pre-processing

- Google Colab connected to Google Drive
- TensorFlow used to create two data generators (train/test) to create three sets (train/val and test sets)
- Train ImageDataGenerator used to apply standardized augmentations in a stream (e.g., resize, horizontal shift, vertical shift, flip) to train and validation sets

BUILD MODELS & TEST

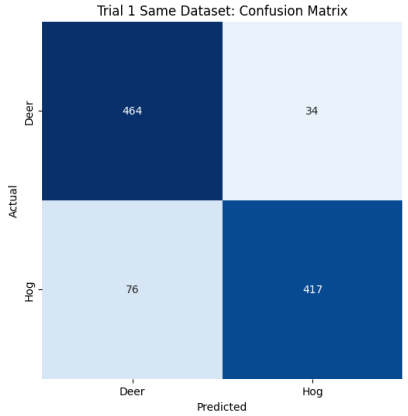
Experiment to find the best model

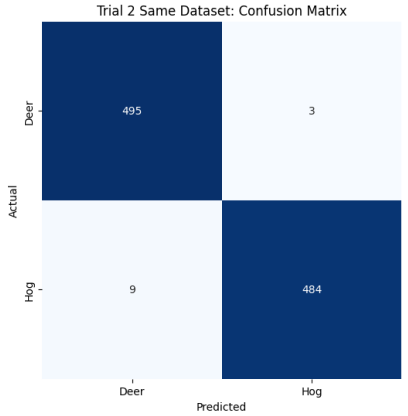
- Evaluated four models to determine best performing:
  1. CNN from scratch
  2. Transfer learning with no added layers
  3. Transfer learning with added dense layers
  4. Transfer learning with added convolutional layers
- Scored for:
  - Accuracy
  - Precision
  - Recall
  - F1
- Threshold was constant throughout (0.5)
- Final test was performance on new data from my own trail cam on my property

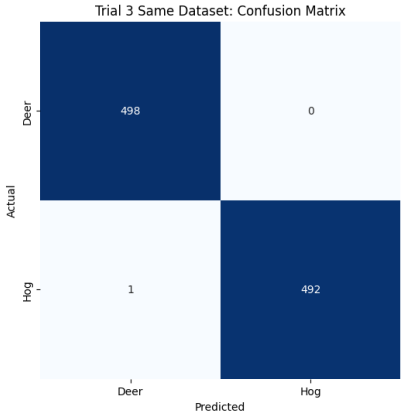
Results | Phase 1

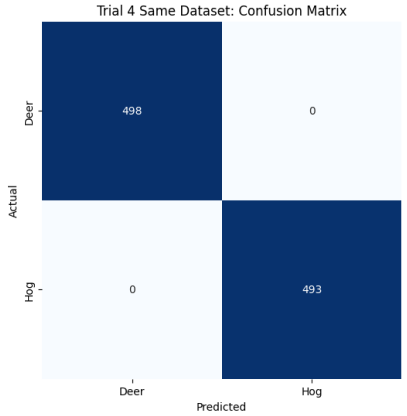
Trial 1	Trial 2	Trial 3	Trial 4
CNN from scratch	**Transfer learning w/ no added layers**	**Transfer learning w/ dense layers**	**Transfer learning w/ convolutional layers**

Performance on Test Set (same dataset)

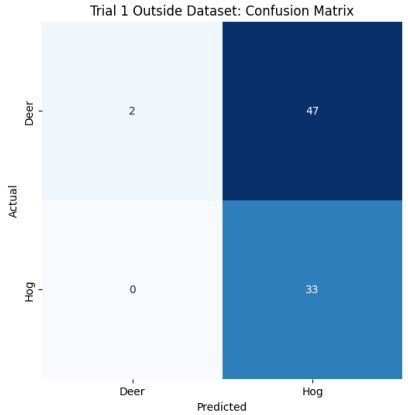


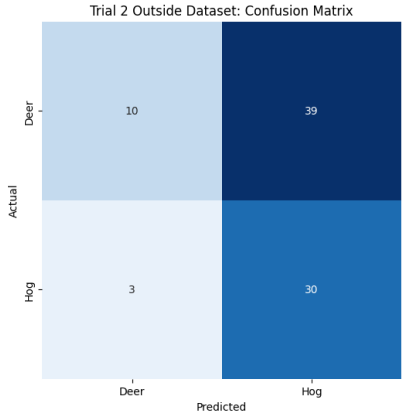


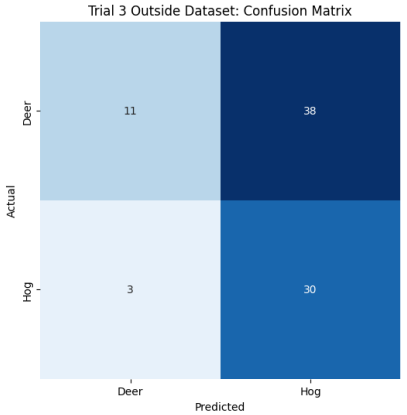


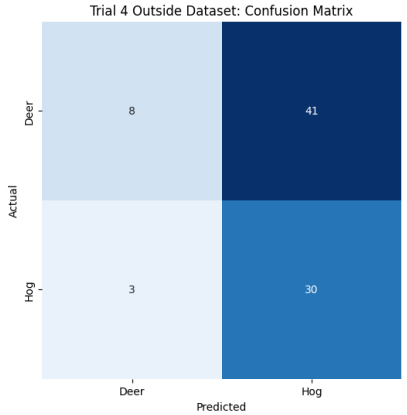


Performance on Final Test Set (new data; my property)









Quick Demonstration

Takeaways & Next Steps

Key Learning Takeaways

- **Work smarter not harder**
  -I originally intended to only make a “from scratch” CNN model for this – but transfer learning proved to be more effective
- **Its easy to get lost when pulling levers**
  -When I started to tune parameters (“pulling levers”) I realized that simple variables (i.e., learning rate, split %, etc.) made things messy without a disciplined approach
- **Good ideas have probably already been thought of by someone else**
  -I first had this idea for image classification applied to commercial trail cameras two years ago (when zero companies had AI applied to cellular trail cameras). Fast forward to the start of this capstone and there are at least 2 companies that have already brought this idea to market.

Next Steps

- **Finish Phase 2 and 3 to create an actual MVP**
- **Get out of notebooks and into AWS & train new models with a more diverse and much larger dataset (1.3 TB)**
- **Deepen complexity with Object Detection and Image Segmentation**

Thank you!

Appendix

Sources

- What Will It Take to Tackle America's Feral Hog Problem? - Modern Farmer
- Study: Wild Pigs Are Releasing as Much Carbon Dioxide as Millions of Cars - Modern Farmer
  Unrecognized threat to global soil carbon by a widespread invasive species - O'Bryan - 2022 - Global Change Biology - Wiley Online Library
- Feral hogs cause up to $2.5 billion in damage a year, so the government is boosting efforts to fight them | Wild Pigs (tamu.edu)
- Feral Hog Reproductive Biology – Feral Hogs (extension.org)
- Natural Predators of Feral Hogs – Feral Hogs (extension.org)
- Missouri Camera Traps - LILA BC
- North American Camera Trap Images - LILA BC