C964: Computer Science Capstone

Task 2 parts A, B, C, and D

Cara Zablan | 001451728

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Part A: Project Proposal for Business Executives

Letter of Transmittal

July 21, 2023

Racquel Lodge
Bird Watchers International
123 Riverdale Ave,
Riverdale, NY 12345

Dear Ms. Lodge,

The members of Bird Watchers International (BWI) have collectively taken thousands of owl pictures, the pictures predominantly being of Barn Owls, Great Gray Owls, Long-Eared Owls, Snowy Owls, and Striped Owls. We understand that your organization is seeking to provide an additional way for your members to identify the five common owls they encounter, using the latest AI machine learning technology. Our data product can assist your members in identifying the owl species in the pictures they have taken. Our data product is a user friendly, easy to access web based computer program hosted on the Google Colab website. Our proposed solution benefits your organization by providing your members a way of identifying five common owls with just a few clicks on their computers. The total cost for the development of the proposed application will be approximately $16,000.

Our team will work diligently to ensure your members' satisfaction. We have the expertise and experience necessary to deliver a product to fulfill your organization's requirements. Our team of IT and AI specialists are skilled and experienced in the following concentrations:

- Mathematics: Applied Probability and Statistics, Calculus, Discrete Mathematics
- Computer Language Proficiency: Web Development, Scripting and Programing, Data Structures and Algorithms, Artificial Intelligence; and the following computer languages: HTML, CSS, Javascript, C++, Java, Python, and AIML

Please review the materials enclosed with this letter, we look forward to working with you.

Sincerely,

Cara Zablan

Cara Zablan
Junior Developer
Machine Learning Corp.

Project Recommendation

Problem Summary

Bird Watchers International wants to provide its members with the ability to use an AI based program to help them identify the five types of owls they normally encounter. Bird watching is a hobby many people enjoy, but it can become tedious to search through books and catalogues to identify the specific owl species a person has encountered. Our data product can provide a convenient and enjoyable way for BWI members to identify the species of owl in the pictures they upload. BWI members can simply go to the webpage, upload their owl picture, and the AI program will analyze and identify the species of the owl in the picture for them.

With our data product, BWI members can identify the bird they have encountered just by using their computer and uploading a picture onto the website anytime and anywhere they have an internnet connection. A data product powered by AI machine learning for identifying five common owl species, namely, Barn Owls, Great Gray Owls, Long-Eared Owls, Snowy Owls, and Striped Owls, will be delivered. BWI's desire to provide its members with the ability to identify five owl species with the help of AI machine learning will be achieved.

Application Benefits

Our data product can identify five species of common owls. This will assist Bird Watchers International members to identify the common owls they encounter with an upload of their picture. They can easily navigate to the data product webpage, upload an owl picture, and the data product can tell them whether the subject in the picture looks more like a Barn Owl, Great Gray Owl, Long Eared Owl, Snowy Owl, or Striped Owl.

The proposed solution will benefit the Bird Watchers International organization by providing the convenience of instant owl identification to its members, powered by AI machine learning. BWI members will have the ability to use the application on their computers whenever and wherever an internet connection is available to them, providing them with the convenience of a very knowledgeable companion in the form of a computer program. By providing this application to BWI members, the organization is able to enhance their bird watching and owl identification experience.

Application Description

The data product will provide BWI a user friendly and convenient means to identify between five different owl species. BWI members will have the ability to access the data product via the Google Colab webpage it is hosted on. To use the application the user will simply navigate to the data product webpage, scroll down to the bottom section labeled "User Interface", hover over the brackets under the label, click on the play icon that appears, paste an image file into the text box by copying the file path and pressing (ctrl+v), and clicking (enter) on their keyboard. The application will then upload and analyze the uploaded picture, and identify which of the five specific owl species is in the picture.

Data Description

The raw data to be used to train the machine learning model in this project will be sampled from the "BIRDS 525 SPECIES- IMAGE CLASSIFICATION" dataset found on the Kaggle website. The original dataset consists of 89,885 images of 525 birds species. These images are all an equal size of 224x224 pixels in jpeg format. The images are divided into 525 species folders that are inside a train, test, and validation folder. There are 84635 images for train, 2625 images for test, 2625 images for validation, with each folder containing 525 folders for each bird species. The dataset to be used for this project has a total of 791 images.

The data structure will consist of a “data” folder with a “train” and “val” folder, each with a “Barn Owl”, “Great Gray Owl”, “Long Eared Owl”, “Snowy Owl”, and “Striped Owl” folders.

Objectives and Hypothesis

The desired outcome of the project would be for the data product to post a result indicating which of the five owl categories a subject in the submitted picture most resembles. The web application may or may not accurately classify an image as one of the owl species categorized in this project. Users of the application may or may not be able to find the web application helpful.

Methodology

The waterfall software development methodology will be used for this project. This is mainly because the Bird Watchers International organization does not need a working program before job completion. This project is also not very complex, which is well suited to the Waterfall methodology’s predictable and stable structure. Additionally, the waterfall methodology is easy to understand and well documented, allowing us to easily manage updates and modifications to the project.

Outline of the project methodology describing each phase:

- Requirements – In this phase the team will gather information to ensure a successful project. Tasks in the waterfall method will depend on previous steps, which will require forethought. Most of the project timeline will be spent in this planning stage because it is an important part of the waterfall model.
- Design – This phase involves designing the project to meet client requirements, along with specifying and planning of necessary harware and software requirements.
- Implementation – The project will be developed according to the two previous phases; the requirements and design phase.
- Testing – In this phase the development team will hand over the project to the quality assurance team for testing. The quality assurance team will document all found issues and errors.
- Deployment – The project should be finished and free of errors at this phase, and will be ready to be released to the client.
- Maintenance – After the project is deployed, instances when errors and bugs are found by customers will be inspected and corrected. Any updates to the project will also be provided in this phase.

Funding Requirements

Funding requirements will include hardware and office space rent for two weeks totaling $5,000; a software development team consisting of one senior developer and one junior developer working 50hrs with a combined salary of $160/hr, equivalent to $8,000; a quality assurance team with two employees working 30hrs with a combined salary of $100/hr, equivalent to $3,000. Licensing and software tools used will be opensource, freeware, and/or shareware.

Data Precautions

This project will not require the use of any sensitive or protected data. The dataset to be used in this project will be derived from Kaggle.com which is a dataset website that shares datasets publicly. These datasets will be free from licensing restrictions, and any personally identifiable information.

Developer’s Expertise

- Senior Developer – 20 years experience, BS Computer Science, MS Software Development
- Junior Developer – 1 year experience, BS Computer Science

- QA Lead – 10 years experience, BS Computer Science
- QA Analyst – 2 years experience, BS Computer Science

Part B: Project Proposal

The members of Bird Watchers International (BWI) have collectively taken thousands of owl pictures, these pictures predominantly being of Barn Owls, Great Gray Owls, Long-Eared Owls, Snowy Owls, and Striped Owls. We understand that your organization is seeking to provide an additional way for your members to identify the five common owls they encounter, using the latest AI machine learning technology. Our application can assist your members in identifying the owl species in the pictures they have taken. Our application is a user friendly, easy to access web based computer program hosted on the Google Colab website. Our proposed solution benefits your organization by providing your members an additional method of identifying five common owls with the use of a pretrained AI machine learning model. The total cost for the development of the proposed application will be approximately $16,000.

Our team will work diligently to ensure your members' satisfaction. We have the expertise and experience necessary to deliver a product to fulfill your organization's requirements. Our team of IT and AI specialists are skilled and experienced in the following concentrations:

- Mathematics: Applied Probability and Statistics, Calculus, Discrete Mathematics
- Computer Language Proficiency: Web Development, Scripting and Programing, Data Structures and Algorithms, Artificial Intelligence; and the following computer languages: HTML, CSS, Javascript, C++, Java, Python, and AIML

Problem Statement

Bird Watchers International is seeking to provide its members with the ability to use an AI powered program to assist them in identifying five owl species they normally encounter. Bird watching is a hobby many people enjoy, but the process of identifying different owl species by searching through books and catalogues can become tedious and time consuming. Our application can provide a convenient and efficient manner for BWI members to identify one of five specific owl species in the pictures they upload. Navigating to the webpage, uploading an owl picture, and having the AI program to analyze and identify the which of the five owl species is present in the picture will be a great benefit to BWI members.

With our application BWI members can identify the bird they have encountered by using their computer and uploading a picture onto the website anytime and anywhere they have an internnet connection. An AI machine learning application for identifying five common owl species, namely, Barn Owls, Great Gray Owls, Long-Eared Owls, Snowy Owls, and Striped Owls, will be delivered. BWI's desire to provide its members with the ability to identify five owl species with the help of AI machine learning will be achieved.

Customer Summary

Bird Watchers International is a bird watching club lead by Racquel Lodge who is based in New York. The group was established 10 years ago on February 2013. BWI currently has 50,000 members throughout the world, they have a membership fee of $10 a year. Members share bird pictures on their website, these pictures are primarily of owls. BWI is seeking to provide their members with an AI machine learning application that identifies five specific owl species.

Our proposed application will allow BWI to provide their members with an AI machine learning application that identifies five specific owl species. This application is a multi-class image classification powered by the YOLOv8 model, which uses a deep convolutional neural network algorithm to detect and classify target objects in an image file.

Existing System Analysis

BWI members currently rely on google image searches, website forums, books and catalogues to classify between five specific owl species. This method of owl species classification can become tedious and time consuming. Our application can make the identification of these five specific owl species both efficient and convenient.

Data

The Raw dataset can be found in this Kaggle webpage:

https://www.kaggle.com/datasets/gpiosenka/100-bird-species/code

The data comes from a clean dataset with no duplicates, outliers, or incomplete data. This dataset has been organized into folders according to their classification. A main folder contains a "test", "train", and "validate" folder, with each sub folder containing a subset of the 525 class type folders representing each specie of bird in the dataset, these class folders in turn contain images of each corresponding species. The data to be used in this project will come from five classes of the 525 classes within this original dataset. The folder "test" will be deleted, and the "validate" folder renamed to "val", to prepare the data structure for training the pretrained YOLOv8 model.

Project Methodology

The waterfall software development methodology will be used for this project. This is mainly because the Bird Watchers International organization does not need a working program before job completion. This project is also not very complex, which is well suited to the Waterfall methodology's predictable and stable structure. Additionally, the waterfall methodology is easy to understand and well documented, allowing us to easily manage updates and modifications to the project.

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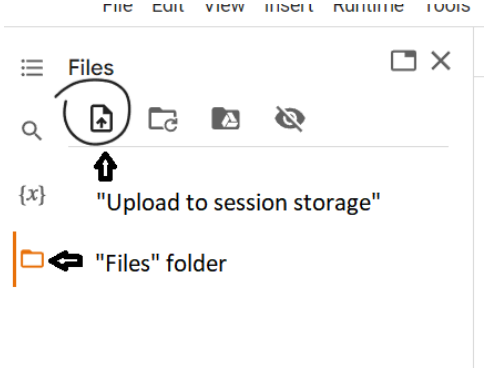
- Deployment – The project should be finished and free of errors at this phase, and will be ready to be released to the client.
- Maintenance – After the project is deployed, instances when errors and bugs are found by customers will be inspected and corrected. Any updates to the project will also be provided in this phase.

Project Outcomes

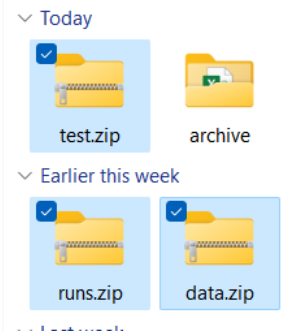
The finished application will be a Google Colab notebook with as Owl Classifyer section, where the user can upload a picture to be analyzed.

User guide:

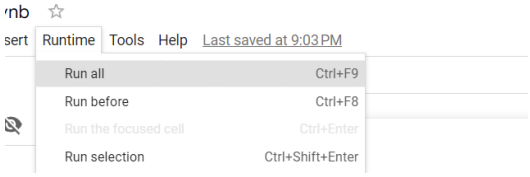
1. Sign-in to Google.
2. Go to: https://colab.research.google.com/drive/1d_aPEcMip5s69glz-cWjPPGnOZA9qYla?usp=sharing
3. Click on the "Files" icon to the left of the page, then click on the "Upload to session storage" icon.*



4. Then upload the "test.zip", "data.zip", and "runs.zip" files.



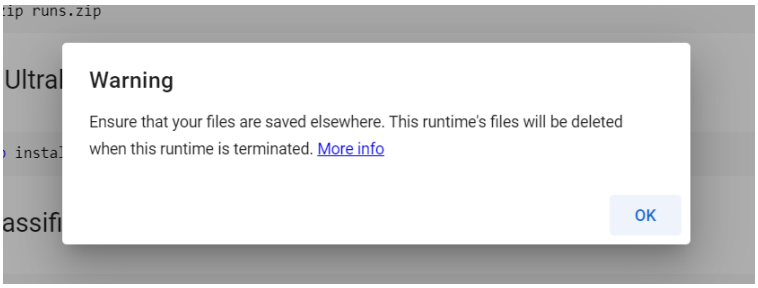
5. Once they have finished uploading, click on "Runtime" in the menu bar, then select "Run all".

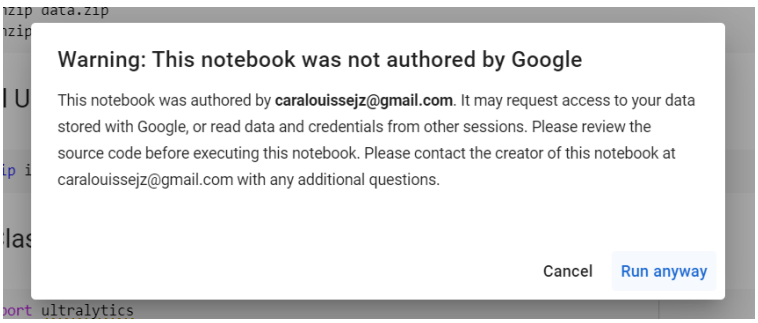


6. A text box prompt will appear at the bottom of the page.

7. Refresh the files tab, to show the extracted “test”, “data”, and “runs” folders, by clicking on the “Files” icon again.
8. Enter the file path of an image in the text box.*
   - You can upload an image file to Colab Runtime, or use an image from the “test” folder.
   - Then hover over and click on the three dots next to its file name and click “Copy path”.
   - Click in the text box prompt and press (ctrl+v) to paste.
   - You can also copy and image URL and paste (ctrl+v) it into the text box.
9. Hit “Enter” on your keyboard and the result will show which of the five specified owl species is most likely in the picture.
10. Enter “Q” or “q” in the text box to quit.

**Notes: Image path files should end in .jpg, .jpeg, or .png*
Click “Ok” and “Run anyway” when the following warnings appear:





Implementation Plan

A meeting will be held to have requirements gathered from the client. The dataset will be dowloaded, cleaned, and the data structure will be formatted and saved as a folder named “data”, to best fit the pretrained YOLOv8 model to be used. Coding will be done on the Google Colab notebook. The model will be customized by training it with the images in the “data” folder. Both the “data” folder and the “runs” folder, that will be created, will be downloaded and zipped and saved as zip files. Testing and validation will be done on the customized model. Clean up of code that will no longer be necessary will be done. The Google

Colab notebook will be saved and the share link will be sent to the client, along with the two “data” and “runs” zip files.

Evaluation Plan

Testing will be done on the custom model by using miscellaneous owl images of varying file sizes. These images will predominantly be sourced from the web. Images from the “test” folder of the original dataset will also be used to inspect the model’s accuracy. The model will be considered successful if it shows a prediction of one of the five specified owl species. Validation is done by the YOLOv8 model, the “data” folder contains “train” and “val” folders. The “train folder is for training the model, so as to customize it for our specific task. The “val” folder is for the validation of the model once it has finished training. The “val” folder contains fewer images than the “train” folder.

Resources and Costs

Computer costs:

- OS: Windows 11 Home: $0 (came pre installed to harware)
- Hardware: DELL Inspiron 14 7000: ($500 – (depreciation rate 33.33% * 3 years)) = $0

Software costs:

- Programming Language: Python 3.10.6: $0
- IDE: Google Colab: $0
- APIs: Ultralytics, Pandas, NumPy, Matplotlib: $0

Estimated labor time and costs:

- Labor time: 80 hours
- Salaries: $11,000

Estimated environment costs of the application:

- Office rent: $5,000

Timeline and Milestones

Projected Timeline

Description	Start Date	End Date
Gather requirements	12/01/2023	12/01/2023
Design and code	12/02/2023	12/06/2023
Testing	12/07/2023	12/09/2023
Deployment	12/16/2023	12/16/2023

Part C: Application

Application link:

https://colab.research.google.com/drive/1VufyXM0gBhl4T6GoGCTh0Q9cpeA-UBlI?usp=sharing

Files:

data.zip

runs.zip

Part D: Post-implementation Report

Organization Vision

Bird Watchers International was seeking to provide its members with the ability to use an AI powered program to assist them in identifying five owl species they normally encounter. Bird watching is a hobby many people enjoy, but the process of identifying different owl species by searching through books and catalogues can become tedious and time consuming. Our application provided a convenient and efficient manner for BWI members to identify one of five specific owl species in the pictures they uploaded.

To use the program the user navigated to the following Colab notebook:

https://colab.research.google.com/drive/1VufyXM0gBhl4T6GoGCTh0Q9cpeA-UBlI?usp=sharing

and followed the user guide provided in this document.

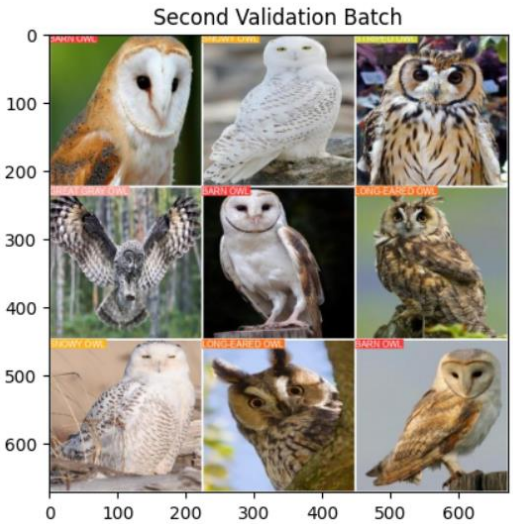
Datasets

The Raw dataset can be found in this Kaggle webpage:

https://www.kaggle.com/datasets/gpiosenka/100-bird-species/code

The data comes from a clean dataset with no duplicates, outliers, or incomplete data. This dataset has been organized into folders according to their classification. A main folder named “archive” contained a “test”, “train”, and “validate” folder, with each sub folder containing a subset of the 525 class type folders representing each specie of bird in the dataset, these class folders in turn contained images of each corresponding bird species. The data used in this project came from five classes of the 525 classes within this original dataset. The main “archive” folder was renamed “data”. The folder “test” was taken out of the “data” folder, and the “validate” folder was renamed to “val”, in preparation of the data structure for training the pretrained YOLOv8 model.

Examples of images used for training and validation:

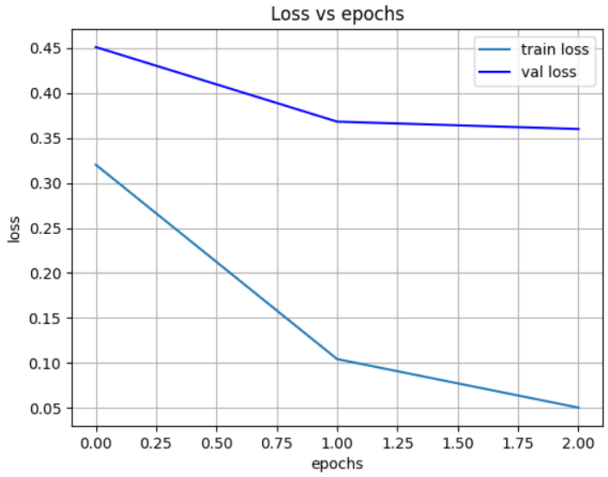


Data Product Code

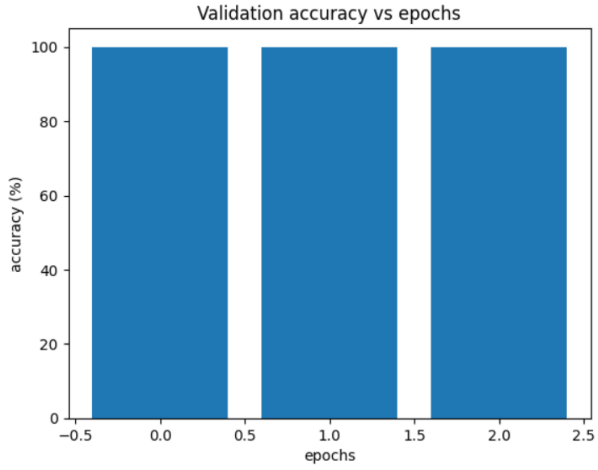
The data used in this project came from five classes of the 525 classes within this original dataset. The main "archive" folder was renamed "data". The folder "test" was taken out of the "data" folder, and the "validate" folder was renamed to "val", in preparation of the data structure for training the pretrained YOLOv8 model.

The following visualizations for this data prouct is used to showcase the metrics of the accuracy, and data loss in each epoch while training and validating the pretrained model.

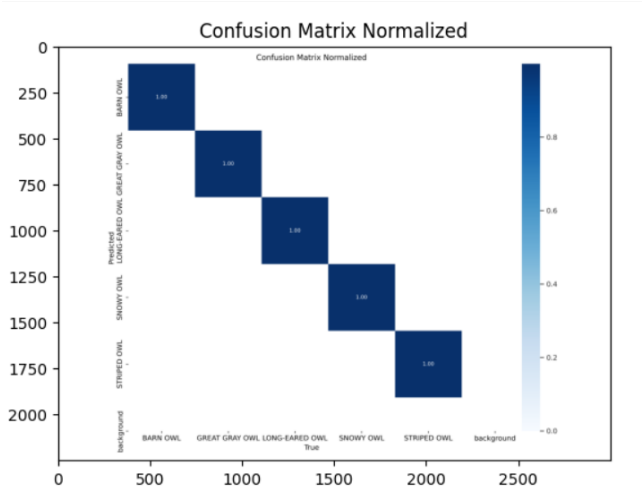
The "Loss vs epochs" chart below shows how well the model fit the training and validation data overtime.



The chart below illustrates the rate the model was able to correctly predict the validation data.



The confusion matrix below shows the rate at which the model was able to correctly predict the validation data.



The model below was used to predict on an image, and classify the object in the image as either a Barn Owl, Great Gray Owl, Long-Eared Owl, Snowy Owl, and Striped Owl. This model underwent supervised training with the image files in the "dat/train" folder for three epochs. The model was then validated with the image files from the "data/val" folder. These methods were appropriate for the project because the pretrained YOLOv8 model is a deep convolutional neural network (CNN) algorithm that is especially designed for image classification.

```
model = YOLO('/content/runs/classify/train4/weights/last.pt')
```

Objective (or Hypothesis) Verification

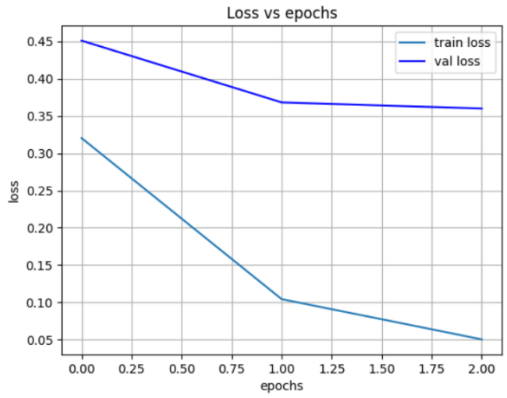
The desired outcome of the project was for the data product to post a result indicating which of the five owl categories an object in the submitted picture resembled. The web application accurately classified images that contained one of the five specified owl species, at a rate of 100%. Users of the application may have not been able to find the web application helpful if the owl in their picture did not fall into one of the five specified owl species in this project.

Effective Visualization and Reporting

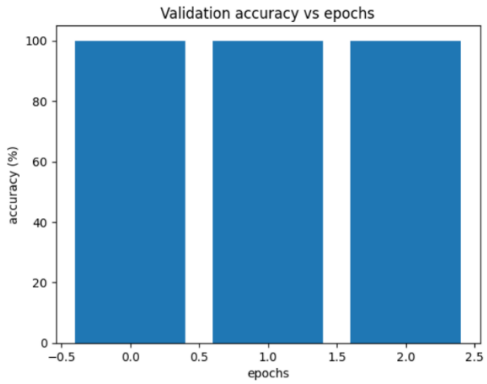
Visualizations used in this project were, a line graph, a bar graph, and a confusion matrix. Data exploration was done manually by checking that the pictures in each class was accurately depicting the owl species it was representing. Images were also inspected manually for any duplicates. Data analysis done after model training and validation was used to guage the model's accuracy when presented with an image with one of the specified owl species. Data summary showed that the model accurately predicted data from the validation set at a rate of 100%.

Analysis application of three visualizations:

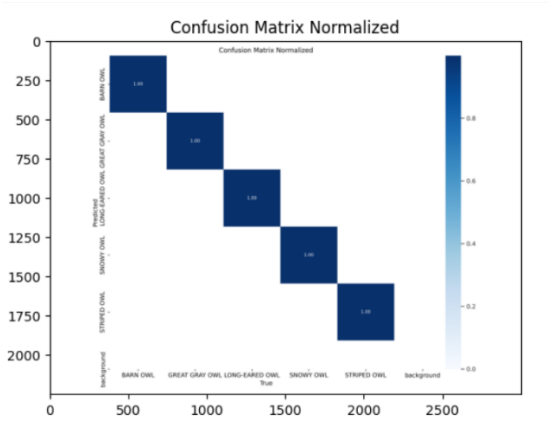
The “Loss vs epochs” chart below shows how well the model fit the training and validation data overtime.



The chart below illustrates the rate the model was able to correctly predict the validation data.



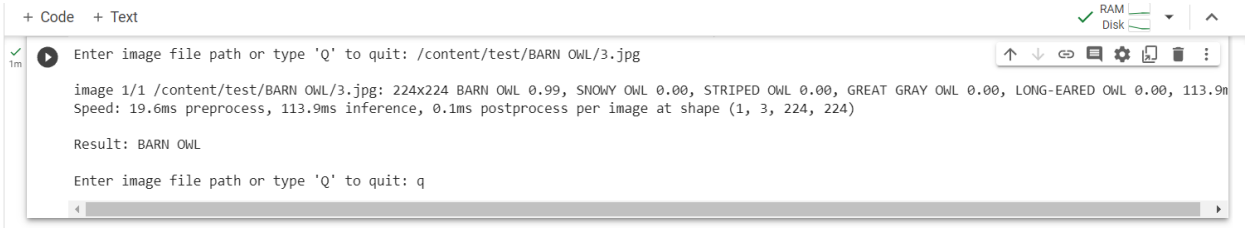
The confusion matrix below shows the rate the at which the model was able to correctly predict the validation data.



Accuracy Analysis

The model used in this project can accurately classify the owl in an image that conatained one of the specified owl species, at a rate of 100%. The model predicted the labeled images used for validation at a rate of 100%. The model cannot accurately classify objects that do not fall into one of the five specified owl species.

In the picture below the model accurately predicted the owl species presented in the the image. The image is that of a Barn Owl, and comes from the extracted "test" folder. The Model displays that the object in the image is 99% "BARN OWL" and displays a result of "BARN OWL".



Application Testing

The model was tested using the YOLOv8 validation code. The testing results verified that the model was customized to classify the five owl species specified in the project. No modification was necessary because the model accurately predicted the labeled data set used for validation.

```
[ ]  # load custom model
     model = YOLO('/content/runs/classify/train4/weights/last.pt')

     # Validate the model
     metrics = model.val()  # no arguments needed, dataset and settings remembered
```

```
Ultralytics YOLOv8.0.141 🚀 Python-3.10.6 torch-2.0.1+cu118 CPU (Intel Xeon 2.20GHz)
YOLOv8n-cls summary (fused): 73 layers, 1441285 parameters, 0 gradients
               classes   top1_acc   top5_acc: 100%|██████████| 2/2 [00:00<00:00,  2.86it/s]
                   all          1          1
Speed: 0.0ms preprocess, 25.1ms inference, 0.0ms loss, 0.0ms postprocess per image
Results saved to runs/classify/val
```

Application Files

The data product can be accessed through a web browser and by navigating to the data product's web page using the following URL:

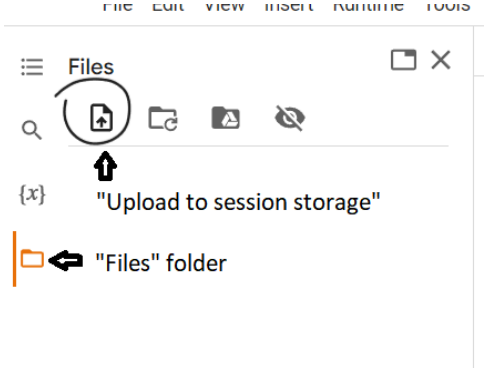
https://colab.research.google.com/drive/1VufyXM0gBhl4T6GoGCTh0Q9cpeA-UBlI?usp=sharing

To execute the data product the three zipped file folders, "test", "data", and "runs" should first be uploaded to the webpage's virtual machine environment, called a runtime, and then the command "run all" in the "runtime" option in the top menu bar, should be executed to expand the zip files and make the files in the folders accessible to the program. The model uses the final epoch results to load the custom model that

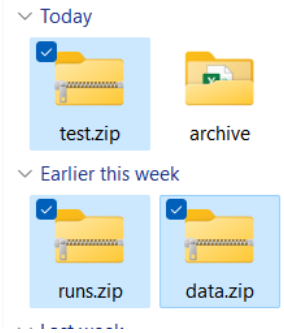
makes the owl species prediciton. The model validation is dependent on the data folder where the “val” folder resides. The “test” folder contains images of the five owl species that were not used in the training of the model, and are also different from the validation data set.

User Guide

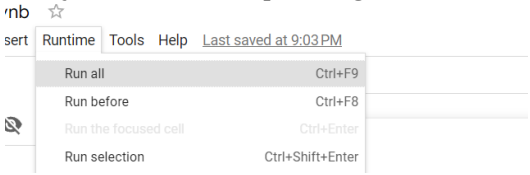
1. Sign-in to Google.
2. Go to: https://colab.research.google.com/drive/1d_aPEcMip5s69glz-cWjPPGnOZA9qYla?usp=sharing
3. Click on the “Files” icon to the left of the page, then click on the “Upload to session storage” icon.*



4. Then upload the “test.zip”, “data.zip”, and “runs.zip” files.



5. Once they have finished uploading, click on “Runtime” in the menu bar, then select “Run all”.



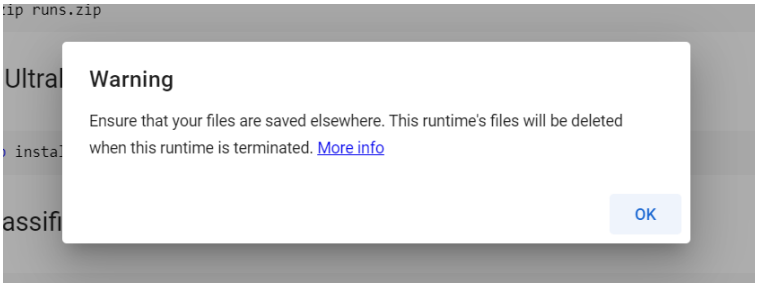
6. A text box prompt will appear at the bottom of the page.

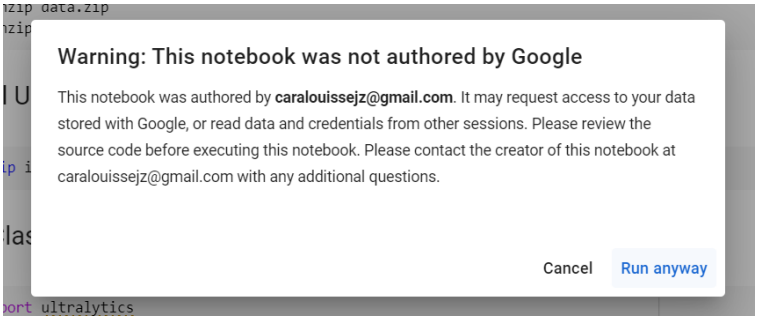
7. Refresh the files tab, to show the extracted “test”, “data”, and “runs” folders, by clicking on the “Files” icon again.
8. Enter the file path of an image in the text box.*
   - You can upload an image file to the Colab Runtime, or use an image from the “test” folder.
   - Then hover over and click on the three dots next to its file name and click “Copy path”.

- Click in the text box prompt and press (ctrl+v) to paste.
- You can also copy and image URL and paste (ctrl+v) it into the text box.

9. Hit “Enter” on your keyboard and the result will show which of the five specified owl species is most likely in the picture.
10. Enter “Q” or “q” in the text box to quit.

**Notes: Image path files should end in .jpg, .jpeg, or .png*
Click “Ok” and “Run anyway” when the following warnings appear:





Summation of Learning Experience

Several of the prior academic courses I completed in this degree program prepared me for this project by helping me understand the basics of machine learning, artificial intelligence, and coding languages such as Python. Most AI Machine Learning algorithm models available online are based on Python. A basic understanding of the Python programming assisted me in coding the program for this project. Additional learning resources used in this project included; Youtube tutorials, Google searches, Udemy courses, Ultralytics documentation, and Stack Overflow answered questions. This experience has broadend my understanding of Data Analysis, Computer Programming, and Artificial Intelligence. The knowledge and skillset I have learned in this experience will contribute greatly to my future career endeavors, knowledge in Computer Programming is a skill sought after by many employers.