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Bird Classification

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DESCRIBE THE PROBLEM

SCOPE

- *"Business objective": Describe the project's goal and "business impact."*

  Many animal species are under the threat of extinction. Many biologists/scientists are monitoring the birds using AI. The technology helps them to determine the location of animals, traveling patterns, date of sighting and animal social group. This is relevant information for the scientists, so that they can preserve these animal groups in the best manner. In this project we will look at and classify bird species.

- *How will the solution produced in the project be used? What similar solutions already exist / how is the problem solved today? How would you do the task manually without using machine learning?*

  This solution will help the scientists/biologists to analyze the wildlife, so they can protect the animals. It can detect and stop illegal trafficking of animals.
  It could also be a solution to launch the model on a website where people can upload images to and get a guess of which animal/bird it is.
  The way it would have been done manually would be to analyze the data by hand. Look at where the birds have migrated. Look at the statistics for each species. It would take much more time, and animal species could be extinct by the time the data would have been processed manually.

- *How will the performance be measured via "business metrics"?*

- *If your machine learning model will be part of a more extensive "pipeline" or system, describe the system's components. Consider how changes in one part of the system may impact other parts.*
  The model expects the input data have the shape 3x224x224, which translates to a square image with side lengths of 224 pixels and 3 color channels. To better allow the user control over what part of the image becomes input for the model, an form data with offsets and a scale is sent with the image data, the image is then scaled and cropped to the correct sizes, before it is passed to the model. After the model has returned an prediction, the species name and the models score for the given species is extracted and returned in a json format to the client.

  If the machine learning model will be part of a more extensive system, it will need the following:

- Data from the scientists which would contain images and info about the animal species they research.
- A model that predicts the animal species. If/when a new species is found, it could be included into the model. Which model that is being used may also be substituted. Depending on the technology at hand.
- The developers have a responsibility to select and update a machine learning model. They will maintain and launch the model on a website.
- A website where people can submit a picture of a given animal (bird in our case) and get a prediction of the bird with some basic information about the animal.
- It would be beneficial to make two separate editions. One for the public and one for the experts. The experts can analyze the data and add more pictures and animals to the model. The public may use the website to get facts about the desired animal.

- *Describe the stakeholders of the project*

  The stakeholders of the projects will be the scientists/biologists. The ones who are studying animal wildlife and maybe especially bird life the world over. There would also be a market for bird watchers/enthusiasts, for them to explore and learn more about different species.

- *Describe a tentative timeline for the project. Include milestones.*

  - Choose a project
  - Read about the bird-classification project
  - Start writing on the report
  - Start on a notebook for the project
  - Explore the data
  - Prepare the data
  - Find a model which will work on this dataset (fastai with a pretrained model)
  - Fine-tune the model
  - Present the solution
  - Launch, maintain and monitor the system
  - Make a website for the machine learning model, so that people may use it to identify birds of their choosing.
  - Get users to the website. Maintain the website and model, so if there are new species of birds it will be included in the model.
  - Maybe for another iteration make a section for adding pictures to the dataset, if the bird species cannot be identified by the model.

- *Define what resources, for example, computational resources and personnel, will be required to complete the project.*

  To make this a project which can be used for research, it would need the data from the researchers and from the photographers who are taking the pictures. This may help the algorithm detect the bird species easier.

It would also need developers who are monitoring and maintaining the model and continue developing the website.

METRICS

- *Describe the minimal "business metric" performance for the project to be considered a success*

  The minimal "business metric" performance for this project to be considered a success will be detecting bird species with high degree of precision. This is important so that bird groups that are low in number, will be protected from extinction.
  The website should also be user-friendly and easy to upload a photo to the website.

- *Describe machine learning and software metrics or objectives that will be used to measure whether the system/solution is working. Here you should use metrics that can be easily calculated. Accuracy, mean squared error, latency, and throughput are examples. Describe how they are connected to the "business objective" you described earlier.*

  The performance will be measured in the following metrics:
  - Prediction
  - Actual
  - Loss
  - Accuracy
  - Most confused species
  - Probability

  The metrics are connected to the business objective above in the sense that it is important for the researchers get precise data. If the predicted species does not line up with the actual species, the consequences could impact that species. Maybe a species which is low in number, does not get the attention it deserves, that species could be extinct.
  From an enthusiast point of view, the downside would be that the model gets the prediction wrong. Which could result in learning about the wrong bird.

DATA

Describe what data and labels you will use. What kind of data is it? Where will you obtain data / how can you collect data? How much data is already available, and how much do you estimate is needed? If the problem is to be attacked using "supervised

learning" methods, describe how you will get the "ground truth" labels. How will you ensure that the labels are sufficiently accurate? That they are consistent?

The dataset is retrieved from the Kaggle competition "BIRDS 450 SPECIES- IMAGE CLASSIFICATION" and it contains 450 different bird species with 76,242 training images, 22500 test images and 2250 validation images. There is only one bird per image, where the bird takes up 50% image space.

Describe any privacy issues or other relevant ethical considerations.

- The image may include more than just an animal. Maybe it includes people, and their privacy must be respected. However, images uploaded by users will agree to them being used by the model simply by uploading the image.
- There might be some issues about copyright if we collect data on images users input to test, but currently images are not being saved.
- The model might be used during hunting to determine wether a given bird is allowed to be hunted or not, if the model then makes a wrong prediction, consequences might fall onto the distributor of the model as an application
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How will the data be represented for the machine learning models? Describe potential needs for data cleaning, feature engineering, scaling, and the like.

The data will be transformed by using toTensor. This will normalize the images with pixel range [0,255] to a PyTorch floatTensor with range [0.0, 1.0]. This makes the machine learning model learn faster because it deals with lesser range in data.

MODELING

Describe which machine learning models you will explore. Describe how you plan to estimate baseline performance and baseline behavior. Remember that your first models should be simple. Baseline performance can typically be estimated using simple models or even non-machine learning-based solutions. You can also search for results obtained by others on the same or a similar task. You can also estimate "human-level performance" if relevant. Describe how you plan to investigate prediction mistakes and "feature importance" and how this will be used to improve your results.

The machine learning model we used is called fastai. Fastai uses many pretrained models, which are:

The fastai library includes several pretrained models from torchvision, namely:

- resnet18, resnet34, resnet50, resnet101, resnet152
- squeezenet1_0, squeezenet1_1
- densenet121, densenet169, densenet201, densenet161
- vgg16_bn, vgg19_bn
- alexnet

For this models usage, the resnet34 networks was a perfect candidate for the model, yielding good results on unseen data. Resnet is short for Residual Networks. Residual Networks looks ordinary networks, but adds connection between layers further apart, allowing data to skip across a few layers. This prevents the issue of gradient exploding and vanishing, when the number of layers become larger.

DEPLOYMENT

How will the model(s) be deployed? How will the predictions be used? What are your plans for monitoring and maintaining the machine learning system? If relevant, how do you plan to improve the system after deployment?

The model will be deployed on a website. A user may upload an image to the website, and the model will predict the submitted image, and classify which bird it is. Then the result will be sent back to the user, together with the image uploaded.
To monitor and maintain the machine learning system the nearby solution will be to feed it with more data.
In the future it will be good practice to look into other machine learning models, if the model starts to decline in performance. Since machine learning is a growing field, it will be a good idea to look for better models than what this project used.

REFERENCES

List sources you've used during the planning of the project. The list of references should indicate the feasibility of your project.

Residual Networks (ResNet) - Deep Learning - GeeksforGeeks
https://www.kaggle.com/datasets/gpiosenka/100-bird-species
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