Automated Bird Monitoring by Machine Learning-based Algorithms

Jyothi R*
Indian Institute of Technology, Delhi
Email: jainjyothi.91@gmail.com

Did you know that a tree stopped reproducing in Mauritius since after the 1600s? Thereason is extinctionof "Dodo" bird which helped in the reproduction of this tree. The little-known "Dodo" bird used to eat the fruits of this tree. It helped to remove the external seed coat which helped in the germination process. But, how did it become extinct? The bird used to live in the island of Mauritius and eat fruits which fell from the tree. But,when in 1505 the hungry Portuguese came to this islandfirst, they saw Dodo as a source of meat. Within 100 years, the Dodo bird became extinct and the last Dodo was killed in 1681!! To make matters worse, only 21 out of the 45 bird species originally found in Mauritius managed to survive.

Another alarming statistic reported by 2018 state of the world's report is that around 40 % of the world's 11,000 species are in decline!! We still do not know what the possible consequences of this extinction could be. Sylvia Dolson, a naturalist and author rightly said, "Like us, animals feel love, joy, fearand pain, but they cannot grasp the spoken word. It is our obligation to speak on their behalf ensuring their well-being and lives are respected and protected". Hence, at least now we need to conserve our birds. This can be done by continuously monitoring the number of birds in a locality. Since birdwatching for a long time is a laborious task, automatic monitoring is needed. Researchers at the Indian Institute of Technology, Mandi have already started to work towards achieving this goal. The team led by Dr Padmanabhan Rajan, Dr Dileep AD, and Dr Arnav Bhavsar at Multimedia Analytics and Systems Lab started to analyse the bird data and monitor the bird species.

---

* Ms. Jyothi R, Ph.D. Scholar from Indian Institute of Technology, Delhi, is pursuing her research on "Algorithms for Problems in Signal Processing and Machine Learning." Her popular science story entitled "Automated Bird Monitoring by Machine Learning Based Algorithms" has been selected for AWSAR Award.

In birdwatching, the watchers keep their eyes and ears alert so that they can spot birds at the right time without missing out any of them. Following the same strategy, the researchers captured both the audio and image data. The audio data was captured using microphones and the images of the birds were captured using the camera. For a computer engineer, the task of classification may sound straightforward. "The task of classification isn't straightforward. The data contains a lot of other sounds such as the sound of the rain, wind and animals" said Dr Padmanabhan Rajan, one of the lead researchers of the project. Also, the images of the birds obtained could be blurred or blocked by leaves or, even worse, only a part of it is captured. Expert birdwatchers could identify the birds from these corrupt images or sounds. Hence, the task is to make the machine as good as this expert.

The only possible way to make the machine as good as humans is to train the machine to think and process information like humans. The name for this process in the science world is "Machine Learning". How do humans learn to identify an object? Humans first "train" themselves to identify objects by registering some of the important "features" and, later based on the training, we recognise the object. Similarly, to build an algorithm which can classify the species automatically there are two stages training and testing. To train the algorithm, image and audio data of various species is fed into the system. Then, using audio and image processing tools,the algorithm learns to classify the species. In the testing stage, the algorithm automatically differentiates the species given the audio or image data.

However, before classifying the species, it is important to find out that in the given audio recording, bird sound is present or not. Otherwise, we simply waste our resources by running the algorithm even for the non-bird recordings. Indian Institute of Technology, Mandi has developed the Bird Activity Detection(BAD) framework to achieve this goal. They developed a simple and powerful algorithm using Support Vector Machines (SVM) with Mel Frequency cepstral coefficients (MFCC) as features. But, what is the specialty of MFCC? Or why MFCC? It is said that the human ears act as filters. They are more sensitive to sounds which have low frequency. MFCC mimics this human ear behavior and henceis the favoritechoice of speech/audio signal researchers. They used SVM with Probability Sequence Kernel which basically gives a value on how well the given feature vector matches the bird and non-bird class. They were able to get an accuracy of 77% and 85% on the online dataset – Warblr and Free field respectively.

The next step is to classify the sounds, given that the audio recording is having bird sounds. Similar tothe previous algorithm, Mel Frequency cepstral coefficients were used as feature vectors. These features were fed to Deep Neural Networks to classify the bird species. I am sure the name "Deep Neural Network" will ring a bell for biologists – especially the second word. Yes, it has something to do with the human brain. Neural networks were built by taking inspiration the way how human brain processes the information. Similar to the human brain,the neural network has neurons which process the input and gives an output. Since it mimics the way human process information it is quite popular in the machine learning world. But it became very popular only after the invention of Graphical Processing Units (GPUs). The application of GPU for Deep Neural Network happened in the year 2009. Before this, Deep Neural Networks were trained

using multi-core CPU's. It was found that training with GPUs was 70 times faster when compared to multi-core CPU's. To test how well the Deep Neural Network classifies the birds, researchers at Indian Institute of Technology, Mandi classified the26 bird species found in the lower Himalayan region. They were able to obtain 95% accuracy which shows that MFCC Deep Neural Network framework could be used for the bird classification task.

To classify birds from images, the first step is to mask out the regions which do not contain birds. Hence, one obtains images which have only birds. Then from these images, certain important features such as beak shape, wings, tail etc. are obtained. Deep Neural Network was used to classify the birds using these features.

The research team has won the Judge's award at the recently held Bird Activity Detection (BAD) challenge conducted by the Machine Learning Lab of Queen Mary University, London. Also, the research team has published papers on Bird Activity Detection and classification.