PUFFIN REALLY MATTERS

IMAGE RECOGNITION TO IDENTIFY INDIVIDUAL PUFFINS

THE CHALLENGE

Project Puffin was created by the Audubon society to advance the science of sea bird conservation[i]. Since the 1970's they have worked to restore puffin populations to their historical nesting sites off the coast of Maine[ii]. Researchers in the program have been putting leg bands on the birds before they fledge so they can be identified in the future[iii]. The banding causes several issues for both researchers and the puffins[iv]. It is a costly and invasive method that requires capturing the animal. This can lead to injuries to the bird and it is limited to the number of puffins that can be captured. With thousands of birds in a population it is not practical to band a majority of them. How can the researchers identify more individual puffins more cost and time effectively?

CORE BUSINESS PROBLEM

Studying individuals of a population is one of the most important tools a biologist has for understanding social behavior, life history, and survival rates among families[v]. However, identifying individuals from bands is difficult due to the small size of the band, difficulty reading it from far away, and limited number of animals that can be banded. If there was an automated way to reliably identify individuals from a distance, then more individuals could be studied using significantly less effort. The data collection process will be significantly easier for the researcher and less intrusive for the puffins.

RESEARCH AGENDA

Image recognition software has advanced over the last decade[vi]. Scientists at Dartmouth have created a software application called Wild-ID that can be used to very accurately identify individual animals based on patterns or markings visible on the animal. The nearly zero error rate that they have achieved identifying giraffes has allowed them to stop capturing and banding the animals in order to identify the individuals[vii]. This Wild-ID software is open source and available to anyone. The software has been used to successfully identify other individuals such as Cheetahs, Elephants, and African Penguins[viii]. By feeding images of puffins into the Wild-ID software we can identify individuals much easier than before.

The hypothesis we are testing is:

Individuals in populations of Atlantic puffins cannot be reliably identified using the patterns on their beaks and feathers using image recognition software.

By testing the null hypothesis, the scientists demonstrate that it is possible to identify individuals using the Wild-ID software and patterns on the animals.

Researchers are sent out into the field to capture images of the puffins during 5 sampling periods over the summer. There are several islands in Maine with populations of puffins that we use to gather data. Using long telephoto lenses and high resolution cameras we are able to zoom in on individual birds and take clear images of the markings from multiple angles. There are blinds setup that allow the researchers to get close without disturbing the birds. Researchers attempt to photograph each bird several times and they collect over twenty thousand images. There is some unintended bias in our sampling due to the difficulty identifying which birds have already been photographed. To try and compensate for this bias the team returns multiple times and makes use of different photographers from different vantage points. This volume of image data for puffin identification has not been collected before.

Images with birds that are already banded serve as a test for the accuracy of the image recognition software. Researchers look at the bands to identify the birds in the image manually and see how well the software is able to match the images with the already human identified individuals. Clumping of individuals is problematic so the images are cropped closely to remove as much background as possible and only show the markings on the beak and head of individuals. The software detects the patterns in each photo (Fig. 1) and attempts to match it with other photos in the collection. The velocity of analysis allows for hundreds of individuals to be identified in a few seconds. The accuracy of matches identified by the software and verified by the researchers demonstrates that it's possible to uniquely identify puffin individuals using the pattern matching algorithms of the software.

The Wild-ID software successfully identifies puffins with a 95% success rate. The error rates were very low and the team identifies more individuals than was possible with banding alone.

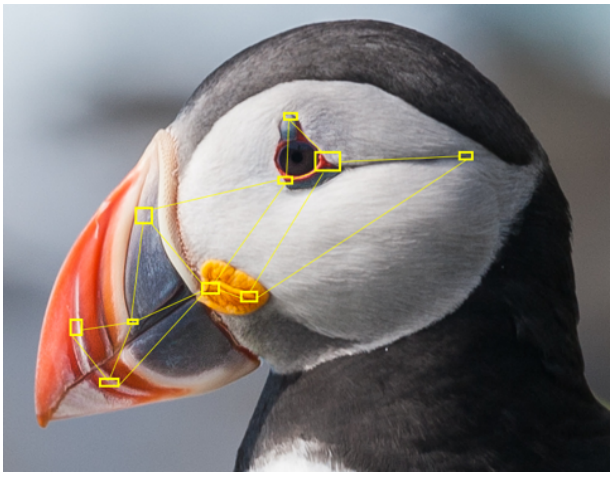

Figure 1[ix]. Visualization of pattern identified by software on a puffin.

Making the Decision

Before researching the hypothesis, the Audubon society decided that if there was a 90% success rate with the image recognition software they would expand the use of the software in future research.

Over the summer the researchers demonstrated the viability of identifying individuals in the puffin populations they studied with a 95% success rate. Once equipment has been purchased the costs for identifying individuals is very low and the number of individuals that can be identified has been increased significantly. The effort to band animals manually could possibly be replaced with image recognition technology thus saving time, effort, and costs, and reducing interference with the animals. The organization has been happy with these results and has decided to fund another year to improve the accuracy of the software and to use it as a method for identifying individuals during the summer breeding season.

One question the organization is deciding on is should they continue to spend money and effort to manually band individuals in the population? Tradition is very strong in this organization and while they are open to new methods, throwing out old ones is more difficult. They need very compelling evidence to stop using a method that's worked in the past. Based on the research and limited sample of the study they have decided to continue banding the birds. While their goal is to reduce the efforts needed to identify individuals the research has not proven that the same individuals can be tracked over several years. One problem with puffins is that their colorful beaks turn dull during the winter when they are at sea[x]. The colorful markings return in the spring for breeding season and can then be observed by the researchers again. A longer study testing the image recognition software would need to be conducted to see if the same patterns are evident in the same individuals over several years. Another similar problem is that the chicks don't have the distinct markings when they are born so the image recognition software wouldn't be able to track them until they are of breeding age.

Conclusion

Even if individuals can only be identified during the breeding season the scientists now have an increasing volume of individuals that they can reliably identify during this time. This allows researchers to create new hypotheses to test on a greater number of individuals that they are now able to identify. This has a positive impact for the organization as they can use this growing amount of research to improve efforts to conserve the puffins.

After seeing the advantages of the image recognition software used with puffins the organization is now interested in expanding this method to identify other species of birds that they are researching. They are excited to see how this solution opens up new avenues of biology research.

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[i] http://projectpuffin.audubon.org/

[ii] http://projectpuffin.audubon.org/about/what-project-puffin

[iii] http://projectpuffin.audubon.org/about/what-project-puffin

[iv] http://onlinelibrary.wiley.com/doi/10.1111/j.2041-210X.2012.00212.x/full

[v] http://onlinelibrary.wiley.com/doi/10.1111/j.2041-210X.2012.00212.x/full

[vi] http://www.nytimes.com/2014/11/18/science/researchers-announce-breakthrough-in-content-recognition-software.html

[vii] http://www.dartmouth.edu/press-releases/wildlifetrackinging02315.html

[viii] http://onlinelibrary.wiley.com/doi/10.1111/j.2041-210X.2012.00212.x/full

[ix] https://upload.wikimedia.org/wikipedia/commons/thumb/a/aa/Papageitaucher_Fratercula_arctica.jpg/1920px-Papageitaucher_Fratercula_arctica.jpg

[x] https://en.wikipedia.org/wiki/Atlantic_puffin#Description