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An analytical study on the effect of weather changes on birds in a machine learning perspective

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Abstract
Building applications that make use of the speed and specificity of algorithm development can significantly help attempts to quantify and analyze variations in bird behavior in response to weather changes in the age of machine learning. For both endotherms and ectotherms, temperature can affect everything from daily energy budgets to nesting behaviors. In birds, environmental temperature plays a key role in shaping parental incubation behavior and temperatures experienced by embryos. One of the main mechanisms used to mitigate the impacts of climate change on these species in the near future is to assess the current system of protected areas. It is necessary to ensure that these areas will continue being effective in conserving these species even under climate change. The purpose of this paper was to review the challenges faced by birds due to climate change, how it affects their growth, migration, breeding, etc. and how machine learning models can have considerable usage in helping to find out the problems affected by birds due to climate change.

Keywords: Climate change, birds, temperature, machine learning (ML)

Introduction
The dates of bird species' migration and breeding, as well as the timing of other significant life-history events, are already changing as a result of the climate change. Many species are relocating their distributions to the poles and higher elevations. Certain bird species are also being affected by climate change through direct effects on their physiology, particularly through extreme heat and drought. The number of relatively undisturbed ecosystems in the world is decreasing rapidly. Half of all species on Earth may go extinct by 2100, and 15 to 37% of animal and plant species that currently exist on the planet are predicted to go extinct by 2050. The repercussions of climate change for birds, i.e. long-term shifts in average weather, have only recently begun to be addressed. There is already compelling evidence that animals and plants have been affected by recent climate change [6] [13]. These outcomes include earlier breeding, altered migration time, and altered breeding efficiency (egg size, nesting success); variations in population sizes, population dispersion, and selection disparities between different parts of a population.
Modeling climate change's effects on bird habitats is vital as it becomes a factor that disrupts various ecosystems more frequently. Recent studies have already begun to demonstrate distributional shifts and behavioral responses of birds to a changing climate. With more rapid changes in climate projected, it becomes ever more important to understand how bird habitats may shift. In order to predict species distributional changes we must evaluate what habitat features are likely to shape a species distribution. Bird migration is a recurring seasonal phenomena that involves the movement of birds between breeding and wintering habitats along a flyway. Birds travel around in search of food, habitat, and the right time of year. The main effects of climate change on migratory birds include habitat loss due to rising temperatures, changes in migration patterns due to flooding or desertification, competition for breeding sites as a result of the warm climate, and food shortages as a result of many birds arriving earlier. Global warming will also reduce the survival rate of many bird species. To analyze such effects in birds, we have to build an algorithm called Machine learning.

Machine Learning
Machine learning is the study of computer algorithms that get better on their own over time and with the use of data. It is considered to be a component of artificial intelligence.

Without being expressly taught to do so, machine learning algorithms create a model using sample data, also referred to as training data, in order to make predictions or judgments. In many fields, including health, speech recognition, and computer vision, where it is challenging or impractical to create traditional algorithms that can accomplish the required tasks, machine learning algorithms are applied. A labelled data set is used in a supervised learning model to teach the algorithm, which then uses the answers to test its accuracy against training data. In contrast, an unsupervised model presents unlabeled data that the algorithm attempts to make sense of by independently extracting features and patterns. Machine learning frequently uses Bayesian inference. A popular algorithm for supervised learning is Bayesian model averaging. Most classification problems use naive Bayes classifiers. Bayesian inference is a statistical inference technique that uses the Bayes' theorem to update a hypothesis' probability as new data or information becomes available. Bayesian inference is an important technique in statistics and especially in mathematical statistics. We can perform Bayesian inference to train almost all the Machine Learning models. Another supervised learning approach used for classification issues are the Support Vector Machine (SVM) and Random forest algorithm. Both are used for Classification as well as Regression problems. In order to increase the dataset's predicted accuracy, Random Forest uses a variety of decision trees on different subsets of the data provided.

Literature Survey

In "The impacts of climate change on the annual cycles of birds" [4] discusses that in the twentieth century, the Earth experienced moderate warming: surface temperatures rose an average of 0.58C, with concurrent changes in precipitation patterns and an increase in the frequency and severity of extreme weather events [8] [9]. The increase in global temperatures is far from uniform: daily minimum temperatures have risen about twice as fast as daily maxima.

In "Conservation consequences of climate change for birds" [3], describes how birds are affected by climate change. Climate change affects the ecology and population sizes of species in many ways, including by altering ranges, interactions, and phenologies, exceeding species tolerances of temperature and other environmental variables, and altering habitat. Importantly, climate change will interact with many other factors, sometimes in ways that are difficult or impossible to predict. Many bird species have become adapted to particular climate conditions, and as temperatures warm, they may exceed species' thermal tolerances. Species may be able to escape these temperature rises in some circumstances by altering their behavior, for example by spending more time in the shade. Since birds are restricted to specific habitat types, such as grasslands, deciduous forest, or evergreen forest, If the range of a particular habitat type begins to contract because of changing climatic conditions (or any other cause), then the bird species will also decline.

Models of future species distributions Predictions of changes in future ranges are fraught with difficulties and problems. Excluding them could lead to inaccurate predictions of future species distributions because many of the mechanisms and biotic interactions that control species distribution dynamics are rarely discussed. Small distribution data sample sizes can decrease model accuracy, and models rarely take into account some species' capacity for climate change adaptation. These models might be significantly improved by additional data on the distributions, demographics, habitat needs, and ecological interactions of species, but gathering such data can be rather labor intensive. Nevertheless, new remote sensing products are expanding the spatial extent of available habitat and climate data, which can be combined with new modelling approaches to improve the accuracy of distribution models.

In "The impact of climate change on birds" [1] discusses the changes in distribution and geographical range. Speculations that the northward spread of southern species is due to climate change are difficult to substantiate. There is a wide range of potentially confounding factors that might also affect bird distributions. Thus, although the expansion of the range of Dartford Warbler Sylvia undata in the UK since the 1960s is likely to be due to a lack of severe winters, this hypothesis has yet to be tested rigorously. There is a range of suggestions of the potential 'winners and losers' among bird species in the UK with weather change, depending on each species' biological characteristics. Only thorough monitoring and spatial modeling activities will be able to verify the veracity of such conjectures.

The presence or absence of a species can be linked to environmental factors, such as climate, when species distributions are adequately recorded. The use of neural network modelling to link bird distributions to climate conditions in Europe and the UK as a way to investigate the potential effects of climate change scenarios is a more recent development. The Genetic Algorithm for Rule-set Prediction (GARP), an iterative artificial intelligence-based approach, is a method that is comparable. It is used to predict how 1870 species of birds, mammals, and butterflies in Mexico will respond to various climate change scenarios in terms of their ecological niches. The use of climate envelopes to describe the spatial distribution of birds is a useful heuristic approach, but the testing of such predictions can only be made against current patterns of distribution and will need to await measurements of distributional change before they can be properly validated.

In "Climate change and bird extinctions in the Amazon" [14] three distinct algorithms were used to model the prospective species distribution in order to get more accurate forecasts of the species distribution. Maximum Entropy (MaxEnt), which assesses the link between the actual occurrence of the species and the overall research region, is based on a presence-background method. Support Vector Machine (SVM) and Random Forest (RDF) algorithms, on the other hand, are presence-absence models that use occurrence records and contrast them with absence data. They employed the random space allocation technique for algorithms that demand pseudo-absences. For each species, there were the same number of presences as there were pseudo absences. They divide the data into 70% training sets and 30% testing sets using the bootstrap approach, then they repeat the process five times to build more accurate models.

The results indicate that some endemic birds will lose an average of 73% of their suitable areas by 2050. Moreover, at least some of these bird species will have either less than 10% or even no suitable areas for their occurrence in all scenarios analyzed. Since they are highly dependent on forest habitats, these species are already undergoing strong reductions in their habitat because of the high rates of deforestation.

In "Migration and stopover in a small pelagic seabird, the Manx shearwater *Puffinus puffinus*: insights from machine learning" [2] they used a Bayesian analysis adapted from machine learning techniques to identify distinct behavioural categories inherent in the patterns within the immersion records, and used this to shed light on the birds' behaviour at different stages of the migratory cycle: during summer feeding, winter feeding, migration and egg-laying. In particular, they identify what appear to be migratory stopover periods that we hypothesize may function in the same way as stopovers in terrestrial migrants for refuelling. We believe that this and similar machine learning techniques may have considerable usage in helping to extract more information from extant and future birds tracking datasets.

Conclusion

Rapid climatic change is already causing bird species to adapt by changing their ranges, phenology, and population dynamics. Because of these changes and interactions between climate change and other global changes, many bird species that are currently common will probably become endangered, and many species that are already endangered may face extinction. It may be early to predict which species will succeed, struggle to survive or even become extinct in the coming years however, some species might be at an advantage: Birds that breed following unpredictable availability of food, like red crossbills or zebra finches, and non-migratory birds and short-distance migrants may prove to be the most resilient as future climates develop and communities become reorganized. Birds living in the most extreme environments on Earth (deserts, high altitudes and high latitudes) are already near the limits of their tolerance of stress and may fail to cope with additional complications. The purpose of this paper was to review the challenges faced by birds due to climate change, how it affects their growth, migration, breeding, etc. and how machine learning models can have considerable usage in helping to find out the problems affected by birds due to climate change.

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