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RESEARCH ARTICLE

STUDYING THE UNDERLAYING DYNAMICS OF ANIMAL MIGRATION USING MACHINE LEARNING TECHNIQUES

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Abstract

In this research, we have studied the dynamics of migration of The Lesser Black-Backed Gull. To study and analyse the data we have used machine learning techniques like Hidden Markov Models. The paper provides a detailed analysis of the migratory patterns of the bird. Through this research we aim to provide a detailed study on the bird and predict its location through machine learning models.

Introduction:-

The lesser black-backed gull (Larus fuscus) is a large gull that breeds on the Atlantic coasts of Europe. It is migratory, wintering from the British Isles south to West Africa. Even on the west coast, this species has become an annual winter visitor in California with birds

Figure 1:- The Lesser Black-Backed Gull (larus fuscus).(https://www.sdakotabirds.com/species/lesser_black_backed_gull_info.htm) reported around most of the state each winter.

The lesser black-backed gull measures 51–64 cm (20–25 in), 124–150 cm (49–59 in) across the wings, and weighs 452–1,100 g (0.996–2.425 lb), with the nominate race averaging slightly smaller than the other two subspecies Males, at an average weight of 824 g (1.817 lb), are slightly larger than females, at an average of 708 g

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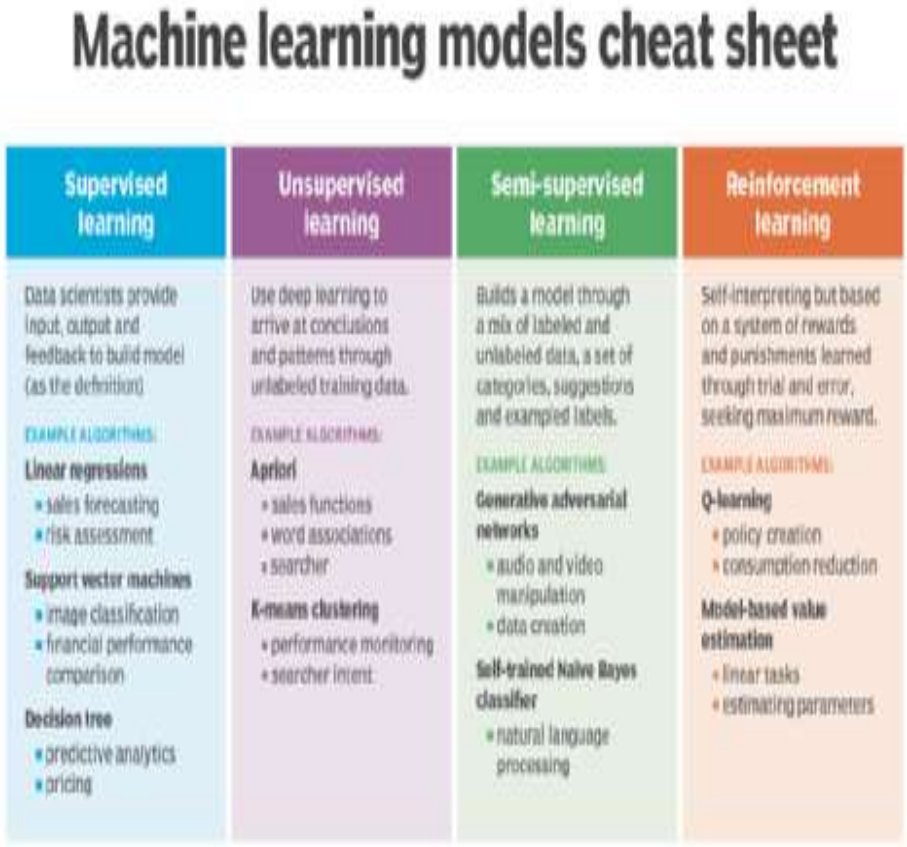
(1.561 lb). Among standard measurements, the wing chord is 38 to 45 cm (15 to 18 in), the bill is 4.2 to 5.8 cm (1.7 to 2.3 in), and the tarsus is 5.2 to 6.9 cm (2.0 to 2.7 in)

In this research, we consider the following research question: "In this research, we will apply machine learning techniques, such as Hidden Markov Models, to learn the underlying dynamics of animal migration." Our hypothesis is that, we can make a Hidden Markov model such that it can predict the location of an animal based on the prior data that has been provided to it.



In the following sections of the paper you will see: a) the review on previous studies in the same field , b) the procedure that was followed, c) the results that were obtained and d) the meaning of the results found and discuss what studies scientists can conduct in the future.

Related Work

Introduction

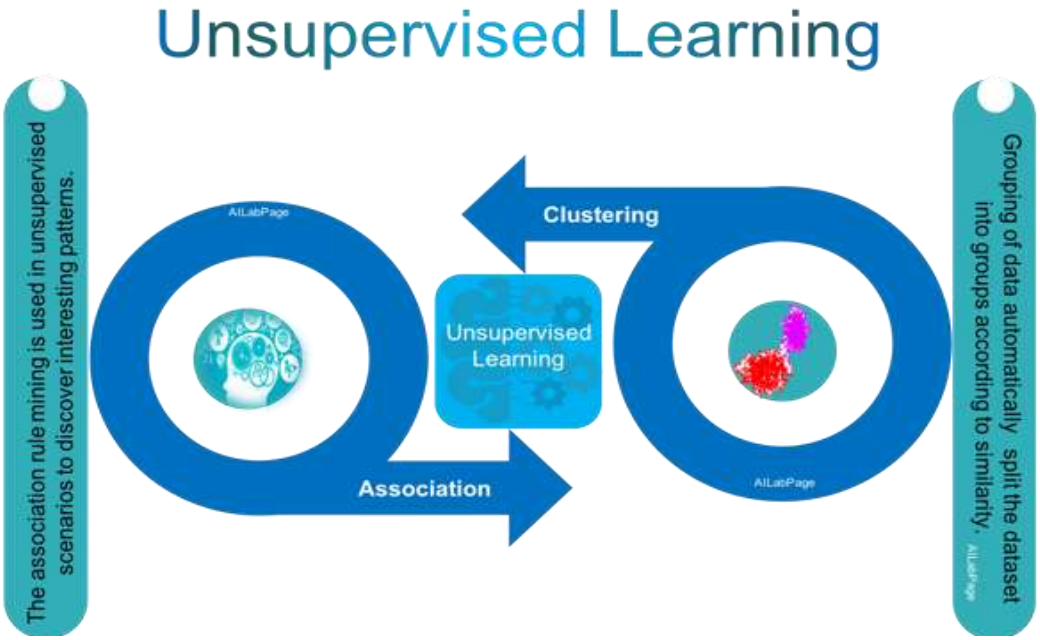
Machine learning is the field of study that gives computers the capability to learn without being programmed. It is a subset of Artificial Intelligence (AI) which focuses on using statistical techniques to build intelligent computers which learn from available datasets.

Machine learning is important because it gives enterprises a view of trends in customer behavior and business operational patterns, as well as supports the development of new products. Many of today's leading companies, such as Facebook, Google and Uber, make machine learning a central part of their operations. Machine learning has become a significant competitive differentiator for many companies.

Machine learning can broadly be categorised into 4 sections: a) Supervised Learning, b) Unsupervised Learning, c) Semi-supervised Learning and d) Reinforcement Learning. In this research we will be using Unsupervised machine learning to study the Lesser Black-Backed Gull.Figure-2 Provides the differences between the ML categories.

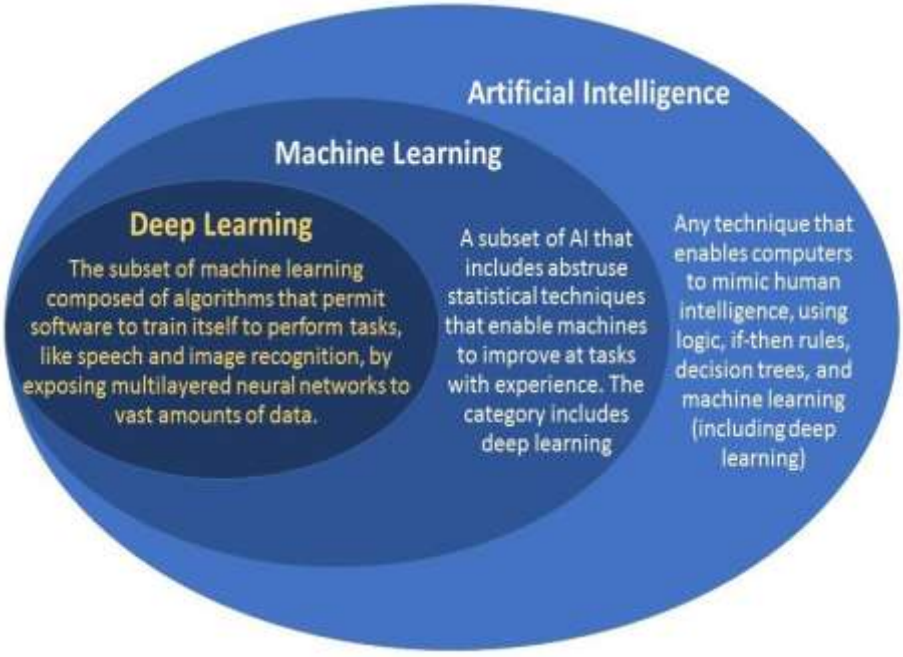
Previous Work

Figure 3:- How does unsupervised learning work.



Over the past years many research papers have been centred around machine learning and using it to study the migratory patterns and behaviours of various animals and birds. A lot of researchers have devised methods of using both supervised and unsupervised learning to track animals.

Figure 4:- Provides detailed explanation on what is Machine and Deep learning.



Along the same line of research a paper by T. Guilford and J. Meade illustrated one of the first attempt to use analytical techniques originally developed within machine learning to identify behaviour remotely using a combination of immersion and spatio-temporal data from miniature geolocation technology. Spatio-temporal data is a database that manages both space and time information. Some common examples include tracking of moving objects.

Another important paper in the field of machine learning is a paper by Dhanushi A. Wijeyakulasuriya. In this study the authors present a general framework for predicting animal movement using machine learning and deep learning in a combination of two steps: first predictingmovement behavioural states and second predicting the animal's velocity.The authors have also used both Machine Learning and Deep Learning sparingly to model movement behaviour or predict locations. This work provides a unified approach of combining both aspects within a general framework.

One more paper that was of great help was written by Raymond H.G. (Migration strategy of a flight generalist, the Lesser Black-backed Gull (Larus fuscus)) provided a detailed description the the lesser black-backed gull (Larus fuscus). The paper explained the migration strategies that the gull uses, its flexible travel behaviour and also gave a detailed account on how the author used GPS-based satellite telemetryto track the lesser black-backed gull. GPS telemetry is a process which combines the technology of both the GPS receiver and satellite transmitter in one device to collect data on animals with a limited range. It is basically wireless transmission of data from the satellite to the GPS receiver.

History Of Wildlife Tracking

Before the development of machine learning animal tracking was done through Genetic Markers and GPS locating. The main difficulty that was faced by researchers was that they had to manually record the data at the exact time according to their research.

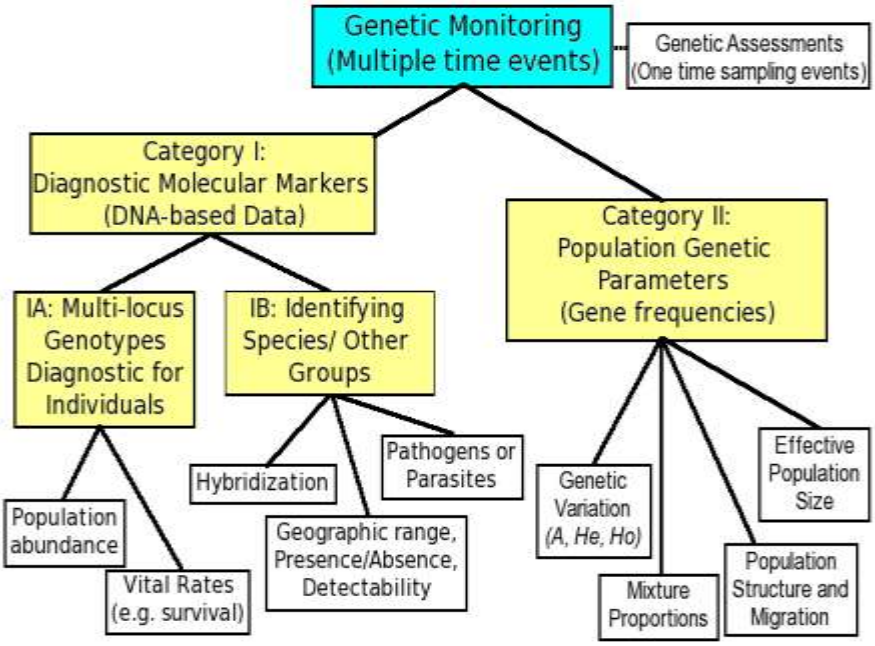


Figure 5:- The process of genetic marking and monitoring.

A paper by Michael K. Schwartz explains how Genetic monitoring is a promising tool for conservation and management of animals and also provides the limitations and difficulties that they faced while tracking animals through genetic markers.

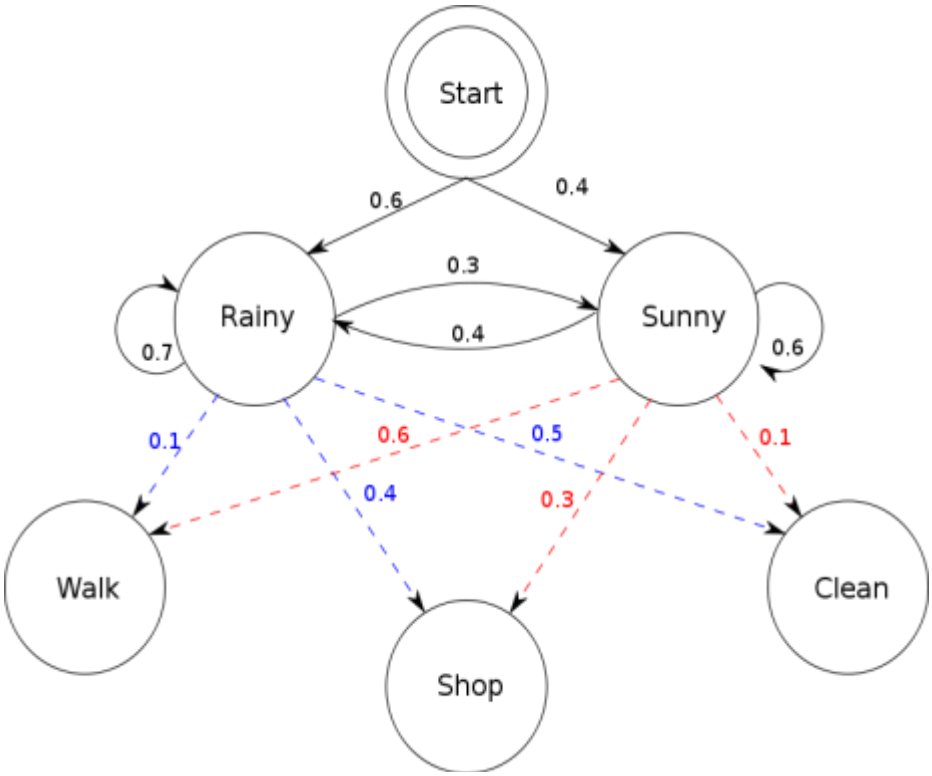
Experiment

Experiment Design

We present the research based on an existing dataset. The dataset is provided to us through a public sight kaggle. The aim of our research is to study this data thoroughly and analyse it. Furthermore make a Hidden Markov Model that can analyse this Data and predict the locations of the bird.

The dataset had recorded the locations of the Lesser Black- Backed Gull GPS live-tracking. More than 15 different birds were tagged and monitoredGenerally GPS tracking is done by tagging animals with GPS tags and then monitoring and noting down the locations. The location were recorded from 25th May 2009- 27th August 2015. The locations of the Lesser Black-Backed Gull were recorded at 4 time intervals which were 5am, 8 am then 2pm and finally at 8pm consecutively for 6 years.

Apparatus



To start the research we browsed through numerous datasets that provided the longitudinal and latitudinal locations of the animal so that we could analyse the data and feed it into our Hidden Markov Model. The final Dataset was procured from kaggle and it contained the latitudinal and longitudinal locations, the marker ID and how was the location recorded.

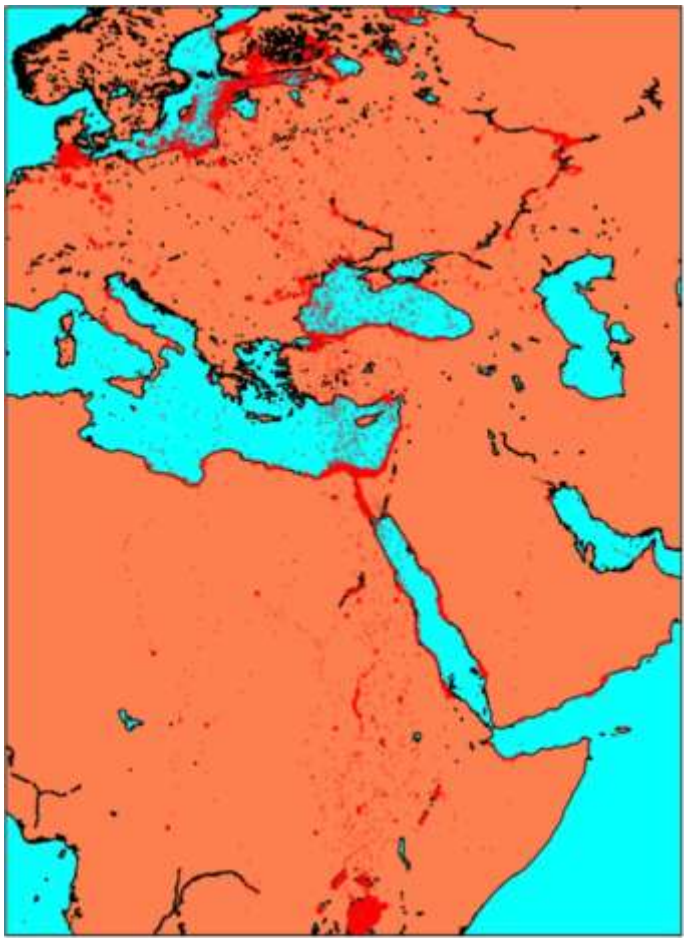
We used Google Collab toanalyse the data and produce statistical graphs of the Dataset.Collab was chosen as we could work on the same file together and share and improve the code which we were making for the model.

The baseline model that we had set was a model which could tell the distance which the Gull had travelled based on the recorded dataset.

Procedure

For each of theGull, we created distance graphs, boxplots etc. The first Model that we made was a model that had to predict weather a given day would be rainy or sunny based on same data that we had provided to it. The model provided calculated the probability of both and provided the results based on whichever outcome have the higher possibility.Figure-6 Structural design of the hidden markov model

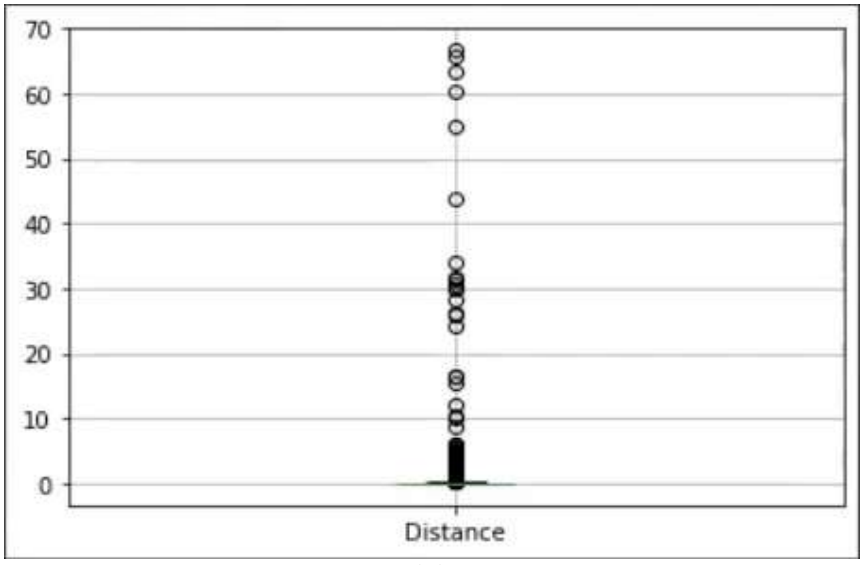
The baseline model predicted the distance between 2 sets of latitudes and longitudes that were taken from the dataset itself. This provided us with the distance that the gull had travelled through in a given timeframe.



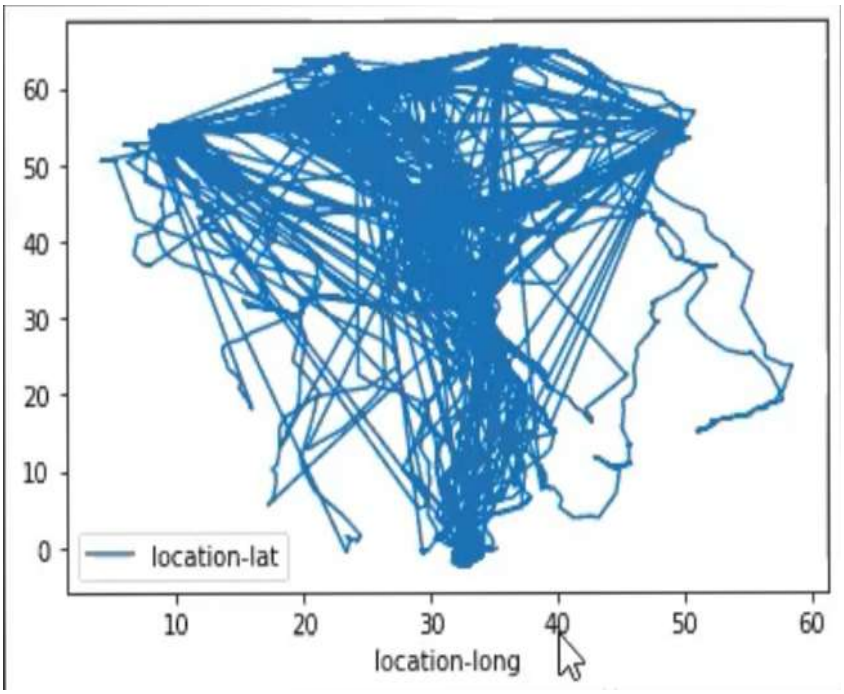
(A)

FIGURE- 7

A. Marks (in red) the locations of the Lesser Black-Backed Gull
B. (Boxplot) Depicts the distances travelled by the gulls.
C. Provides a graph depicting the longitudinal and latitudinal locations of the gulls.



(B)



(C)

Results:-

Findings

Based on the model they travelled huge distances during the day and nights as well. Even though the locations that the model had predicted showed errors, when they were compared to the actual; locations the conclusion that was drawn was that the Lesser Black-backed Gullswere extremely mobile.

On analysing the travels according to moths the result was that during the breeding period (April-June) some of the gulls would travel extensively but only for short distances. One of the main reasons could be extensive foraging. However during the other time period the Lesser Black-Backed gull would travel long distances especially during the migratory months (winter months).

Limitations Of The Research

1. **Error in the location prediction**- the model that was made predicted the latitude and longitude based on previous data but had errors when compared to the actual location.
2. **Limited to only latitudinal and longitudinal location-** the model can only read longitudinal and latitudinal points it can not predict the location based on any other figures.

Conclusion+ Future Work:-

The aim of this research was to study the migratory patterns of animals and predict their locations. Which could further help in locating, monitoring and conserving wildlife.

A lot of work can still be done in the field as there are so many ways in which we can study the underlaying dynamics of migration of animals and not all of them have been explored thoroughly.

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