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The Data Mining Application to Classifying the Protected Herpetofauna in Indonesia by Using Naïve Bayes Method

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Abstract— *Herpetofauna is a combination of the amphibian class and the reptile class. Indonesia has a total of 409 amphibians and 755 reptiles. This makes Indonesia ranked 7th in the number of amphibian species in the world and 4th in the number of reptiles in the world. But herpetofauna is still poorly understood by many people. The large number of protected animal species in Indonesia requires a deeper classification, especially for the herpetofauna group. Data mining techniques that can be used are classification techniques. This technique can help to identify which types of animals are included as herpetofauna. The algorithm that will be used in this research is the Naive Bayes Algorithm. In this research, a calculation was carried out using the Naïve Bayes Algorithm model by taking a tested dataset by using the Orange application. The data used refers to the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.20 / MENLHK / SETJEN / KUM.1 / 6/2018 concerning the Types of Protected Plants and Animals. The results of the trial will showed that many herpetofauna are protected in Indonesia. The results showed that out of 792 protected animal species, 38 protected animal species were included in the herpetofauna class. For the Receiver Operating Characteristics (ROC) curve of the target, the Area Under Curve (AUC) is below number 1. The classification results by using the Naïve Bayes method showed an accuracy of 97.3%.*

Keywords— *Data Mining, classification, Herpetofauna, Naïve Bayes.*

I. INTRODUCTION

Indonesia is a megacenter of biodiversity due to a quite a high diversity of animal species includs wild animals and plants. Indonesia has 300,000 animal species or 17% of the world's animals or 350,000 animals. This also includes the types of amphibians and reptiles commonly known as the herpetofauna group. Herpetofauna is a combination of the amphibian class and the reptile class. Indonesia has a total of 409 amphibians and 755 reptiles. Meanwhile, according to (Nathan Rusli, 2018: 1-2) reptiles and amphibians (herpetofauna) are one of the wildlife groups that are currently not well known by the public. Public knowledge of herpetofauna is very different from that of mammals and aves, which have been the main focus of conservation efforts in Indonesia. In various regions in Indonesia, residents capture and trade various species of herpetofauna not only for meat and for traditional medicine, but also as exotic pets. Species regulated in CITES or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (international trade conventions for flora and wildlife species) are basically grouped into large sections called appendices.

Research conducted (Bhuvaneswari and Dhulipala, 2013) states that animal classification is the arrangement of objects, ideas, or information into groups, whose members have one or more of the same characteristics. Classification makes things easier to find, identify and learn. The use of data mining techniques for classification can be applied such as research carried out (Alharbi, Alharbi, and Kamioka, 2019), predatory animals present a great danger to people who camp or live outdoors and they also threaten livestock Researchers classify predatory animals by focusing on animal faces based specifically on the eyes and ears. The dataset is divided into two parts. The first dataset is training data which contains 150 information images, 75 for predators and 75 for pets. The second dataset is for testing, and contains 50 information 25 images for both predatory animals and domesticated animals. This technique can also be used to help identify the type of herpetofauna whether it is a protected species or not. From all data on protected animals in Indonesia, it will be processed to become some data containing a list of protected herpetofauna in Indonesia. By the implementation of data mining, the presentation of information about protected herpetofauna types will be faster and easier.

The naïve bayes method is used to classify herpetofauna so that the types and species of herpetofauna are known so that as soon as possible data collection and handling of the herpetofauna can be identified. The application of this naïve Bayes method will later be able to help conservation officers who do not necessarily have the skills to handle herpetofauna in order to classify protected herpetofauna species. For this reason, it is necessary to classify herpetofauna in order to overcome the problem of the absence of data on the number of populations in the wild as a basis for legal trading based on conservation provisions.

II. THEOROTICAL BASIC

A. Herpetfauna

Herpetofauna comes from the word "herpeton", which is a group of reptiles with amphibians and reptiles. Based on their similar habitat, both ectothermal vertebrates, and similar observation methods, amphibians and reptiles are currently included in the same field of herpetology. Even though amphibians and reptiles belong to one field of research, they are still different organisms.

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Reptiles have an outer skin (integument) covered with impermeable scales, which allows them not to depend completely on water. In contrast, amphibians have skin that is so permeable that they have to rely completely on water.

Most amphibians and reptiles have their own zone of optimum temperature. Although amphibians and reptiles are known as poikilothermic, they actually still have physiological control over their body temperature. The body temperature of amphibians and reptiles is not completely dependent on external heat sources. External temperature fluctuations greatly affect the activity of poikilothermic animals. Reptiles must modify their activities and behavior to accommodate changes in environmental temperature. They must seek protection during over heating to prevent hyperthermia and extreme cold to prevent hypothermia (Paul and Hogan, 2008)

B. *Data Mining*

Data mining is a technique of extracting information from large amounts of data so that it can be obtained from information that is useful for those in need. According to another definition, the meaning of data mining is hidden knowledge in a large database to find a pattern which is then carried out by the extraction process so that useful information can be obtained for users in the database (Hand, Mannila, and Smyth, 2003).

Data mining according to David Hand, Heikki Mannila, and Padhraic Smyth from MIT is an analysis of data (usually large data) to find clear relationships and conclude that they were not previously known in a way that is currently understood and useful for the owner of the data.

From the above definition, it can be concluded that data mining is a process of analysis by mining, extracting, gathering information from large databases and then processing it to get patterns in the database so that useful information is obtained to help humans identify a problem.

C. *Naïve Bayes*

The Naïve Bayes classification works on a probability theory which views all features of various data as evidence in probability. Based on this, it can be seen as follows:

a. Naïve Bayes works robustly with isolated data which is usually data with different characteristics (outliner) besides that the Bayes method can also handle incorrect attribute values by ignoring training data during the process of model building and prediction.

b. Be able to deal with attributes that are not relevant

c. Attributes that have a correlation can degrade the performance of the Naïve Bayes classification because the assumption of attribute independence is gone (Mawarni, 2016).

III. Research Method

At this stage, the method that will be used in the research process will be described systematically so that the research carried out is well directed.

A. *The Understanding of Business*

For the problems that arise, when identifying the type of herpetofauna, there are many similarities between the types in the dataset being studied. The target of the dataset is to distinguish whether these protected animal species are herpetofauna or not.

B. *The understanding of Data*

At this stage, it is the data collection process which is carried out as a reference in conducting research. The following are the stages of data collection.

1. Observation

The documentation method is carried out by studying the documents related to the data required in this research. The documentation needed in this research can be in the form of a guidebook, scientific journals, textbooks, and a regulation of the Minister of Environment and Forestry. Dataset. Secondary data will be processed using Microsoft Excel with the .csv file format. The dataset used is named according to the attribute which contains the information where in the dataset there is 1 collection (table). In the table there are 8 fields (columns), namely Scientific Name, Indonesian Name, Family, Subfilum, Class, Blood, Breeding, and Herpetofauna. The data has 3 types, namely text data, categorical data, and numeric data.

2. Dataset

The dataset used in this research is secondary data on protected animals, based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.20 / MENLHK / SETJEN / KUM.1 / 6/2018 concerning Protected Plant and Animal Types.

C. *Data Preparation*

The animal dataset is then processed using Microsoft Excel with the .csv file format with a size of 65 KB. The dataset used is named according to the attribute which contains the information where in the dataset there is 1 collection (table). In the table there are fields (columns), namely Scientific Name, Indonesian Name, Family, Subfilum, Class, Blood, Breeding, and Herpetofauna.

D. *Modeling*

The modeling stage is the initial stage after the dataset is determined. At this stage, the dataset will be checked and cleaned so that the features that are tested are only those that are relevant for research. The tested dataset consists of 7 attributes with 2 targets, namely "Yes" Herpetofauna and "No" Herpetofauna.

1. Data Cleaning

Data cleaning is used to clean irrelevant data, remove blank data, duplicate data and noise data. In this research, data was deleted if data on animal names that had more than one type of name were found, which were related to the data needed in this research.

2. Categorization

Setelah dilakukan proses data cleaning langkah selanjutnya yaitu After the data cleaning process is carried out, the next step is the process of categorizing or grouping values based on each attribute. The result of categorization is that the target of the dataset is “Yes” and “No” Herpetofauna.

Each attribute also has its own data type. Also explained the meaning of each attribute used in the dataset.

E. Evaluation

After the data preparation process was carried out on the test dataset, the next step was testing the dataset with a classification model. In this test using the naïve Bayes method to determine the results then the results are seen how much accuracy in classifying protected herpetofauna. The accuracy results will also be tested by calculating the confusion matrix and Receiver Operating Characterictic (ROC) curves. Then the accuracy results will be compared with the accuracy results from the orange application.

F. Spread

The results of this research are in the form of an analysis that leads to the Decision Support System (DSS), which is expected to be used by officers of the Natural Resources Conservation Agency (BKSDA) in increasing efficiency and speed in decision making. BKSDA officers can more easily classify protected herpetofauna because the data used are not only sourced from internal data belonging to the Ministry of Environment and Forestry (KLHK) but also added with external data from guidebooks, scientific journals and textbooks. The results of this research can also be used as reference material for further research.

IV. Result and Discussion

The amount of data used was 792 data. The data is divided into 2 types based on the output. The first is the one with "No" output totaling 754 data. The second is the one that has a "Yes" output totaling 38 data. The data will be used to calculate the information from each class. From the 792 data used, it is divided into training data and testing data. The percentage of training data is 95% of the total data. Meanwhile the percentage of data testing is 5% of the total data.

A. Calculate the Number of Class Targets

The results of the 38 "Yes" targets are the results belonging to the herpetofauna group. The 754 “No” target results are those that do not belong to the herpetofauna group. Here is the calculation:

a. Target No / Amount of Data
= 754 / 792
= 0.95202

b. Target Yes / Amount of Data
= 38/792
= 0.04797

B. Calculate the Accuracy of Each Attribute

Each attribute in each dataset will be calculated for accuracy manually. The results obtained will later be used to calculate the final probability equation being tested. To find out the amount of data predicted "Yes" can use the error rate formula as follows:

$$\text{Akurasi} = \frac{\textit{Jumlah data yang diprediksi benar}}{\textit{Jumlah prediksi yang dilakukan}} = \frac{c+d}{a+b+c+d+e}$$

Meanwhile, to find out the amount of data predicted "No" can use the error rate formulation as follows:

$$\text{Akurasi} = \frac{\textit{Jumlah data yang diprediksi salah}}{\textit{Jumlah prediksi yang dilakukan}} = \frac{a+b}{a+b+c+d+e}$$

In table I below is the accuracy result of data with type category in each class. These attributes consist of Subphylum, Animal Class, Blood, and Breeding. The data has attributes with category types and is qualitative

TABLE I. The Accuracy result to Each Attribute

Subfilum	Including Herpetofauna		Accuracy	
	No	Yes	No	Yes
Vertebrate	719	38	0,9535	1
Avertebrate	35	0	0,0464	0
Animal class	Including Herpetofauna		Accuracy	
	No	Yes	No	Yes
Mamalia	137	0	0,1816	0
Aves	562	0	0,7453	0
Amfibi	0	1	0	0,0263
Reptile	0	37	0	0,9736
Fish	20	0	0,0265	0
Insect	26	0	0,0344	0
Crustacea	1	0	0,0013	0
Mollusca	5	0	0,0066	0
Xiphorusa	3	0	0,0039	0
Blood	Including Herpetofauna		Accuracy	
	No	Yes	No	Yes
Homoiterm	699	0	0,9270	0
Poikolterm	55	38	0,0729	1
Breeding	Including Herpetofauna		Accuracy	
	No	Yes	No	Yes
Vivipar	136	0	0,1803	0
Ovipar	610	38	0,8090	1
Ovovivipar	8	0	0,0106	0

Meanwhile, the quantitative attributes of the calculations were performed using Microsoft Excel to calculate the mean and standard deviation. The attributes of Indonesian Name and Family are changed to numeric data type. Table II is the result of Indonesian names and table III is the result of Family, here are the results of the calculation:

TABLE II. The Accuracy result of Indonesia name

Indonesia Name	Herpetofauna class	
	No	Yes
Mean Value	718.5	380.272
Deviation Standart	222.434	11.1131

TABLE III. The Accuracy result of Famili

Famili	Herpetofauna class	
	No	Yes
Mean Value	57.2785	105.132
Deviation Standart	30.8387	2.74277

After obtaining the mean and standard deviation of the quantitative attributes, the next step is to calculate the probability value using the sample data to be tested using the Naïve Bayes Algorithm model. Samples of testing data used were each attribute, namely the name of Indonesia with green pythons, family pythonidae, with vertebrate subphylum, reptile class, poikolterm blood, and oviparous breeding. Then to perform continuous data classification calculations on quantitative attributes can be done using the Gaussian formula.

$$P(Y|X) = \frac{1}{\sqrt{2\pi(\sigma ij)^2}} exp^{-\frac{(Yi-\mu ij)^2}{2\sigma ij^2}}$$

TABLE IV. The result of Quantitative Attribute

Attribute	Accuracy	
	Yes	No
Chondropython viridis / Green Python = 729	4.2203	0.0256
Pythonidae = 110	0.0660	0.0642
Vertebrate	1	0,9535
Reptile	0,9736	0
Poikolterm	1	0,0729
Ovipar	1	0,8090

The results of table IV show that the accuracy of "Yes" is greater, which means that the type of green python is included in the pythonidae family, with vertebrate subphylum, reptile class, has poikolterm blood, and reproduces by oviparous. These results indicate that green pythons belong to the herpetofauna group.

Then after obtaining the results of the accuracy of both the category type attribute (qualitative) and the categorical type (quantitative) the next step is to calculate the final accuracy equation tested. Here's the calculation:

Calculate for class = "Yes"

$=P(Yes|F_1, F_2, F_3, F_4, F_5, F_6) = P(Ya) \times \prod_i^{13} P(Fi)$

=P(Yes)*P(Indonesianame=GreenPython|Yes)*P(Famili=Pythonidae|Yes)*P(Subfilum=Vertebrate|Yes)*P(Class=Reptile|Yes)*P(Blood=Poikolterm|Yes)*P(Breeding=Ovipar|Yes)

=0.0068*4.2203*0.0660*1*0.1340*1*1

$= 2.538054658 \times 10^{-04}$

Calculate for class = "No"

$=P(Ya|F_1, F_2, F_3, F_4, F_5, F_6) = P(No) \times \prod_i^{13} P(Fi)$

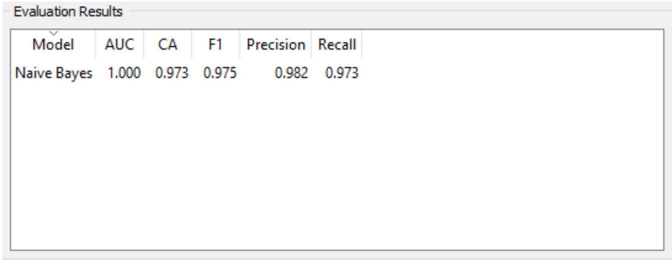
=P(No)*P(IndonesiaName=GreenPython|No)*P(Famili=Pythonidae|No)*P(Subfilum=Vertebrate|No)*P(Class=Reptile|No)*P(Blood=Poikolterm|No)*P(Breeding=Ovipar|No)

=0.1360*0.0256*0.0642*0,9535*0*0,0729*0,8090

= 0

Based on the results of the final classification that has been tested, the value of all attributes for the class Result = Yes> Result = No. Then it can be determined for the data sample solution tested is included in the classification Result = "Yes". It is proven that the data results are in accordance with the test results.

After testing and modeling using orange data mining tools with the Naïve Bayes algorithm, the following results are produced:


Evaluation Results

Model	AUC	CA	F1	Precision	Recall
Naive Bayes	1.000	0.973	0.975	0.982	0.973

Fig. 1. The result of Naïve Bayes Test & Score

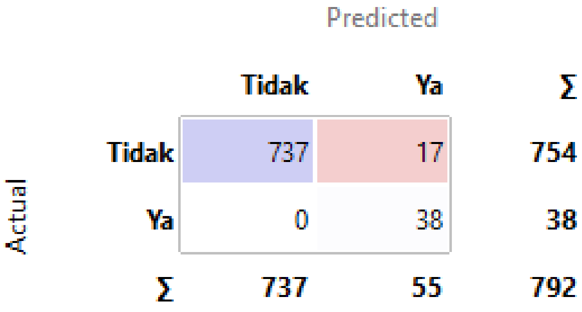


Fig. 2. The result of Confussion Matrix

The results obtained from the configuration matrix will be measured for accuracy to get the best accuracy value. Later these results will be compared with the accuracy results from the orange application. Here is the calculation:

TP : 38
FP : 0
TN : 737
FN : 17

$$Presisi = \left(\frac{TP}{(TP+FP)}\right) * 100\ \%$$

Precision (Result = No) =

$$\frac{38}{38+0} = \frac{38}{38} = 1 = 100\%$$

Precision (Result = No) =

$$\frac{737}{737+17} = \frac{737}{754} = 0.9774 = 97{,}74\%$$

$$Recall = \left(\frac{TP}{(TP+FN)}\right) * 100\ \%$$

Recall (Result = No) =

$$\frac{38}{38+17} = \frac{38}{55} = 0.6909 = 69.09\%$$

Recall (Result = Yes) =

$$\frac{737}{737+0} = \frac{737}{737} = 1 = 100\%$$

$$Akurasi = \left(\frac{TP+TN}{(TP+TN+FP+FN)}\right) * 100\ \%$$

Accuracy =

$$\frac{737+38}{737+38+0+17} = \frac{775}{792} = 0.9785 = 97{,}85\%$$

From the results of calculations that have been done, it shows that the results of manual accuracy from the Naïve Bayes Algorithm have an accuracy of 97.85%. The results of the accuracy with tests carried out on the orange data mining tools were 97.3%.

For the Receiver Operating Characteristic (ROC) curves of the "Yes' and" No "targets, the results of the Area Under Curve (AUC) are at point 1. The Receiver Operating Characteristic (ROC) curve area is between 0 and 1, and AUC = 1 means a perfect prediction model. So the closer the Area Under Curve (AUC) is to 1. the better the results are. These results produce a class that is included as Excellent Classification.

The classification results using the naïve Bayes method showed an accuracy of 97.3%. Of the 792 protected animal species, 38 protected animal species are categorized as herpetofauna. So what is included in the herpetofauna group are vertebrate animals with the class of reptiles and amphibians.

Herpetofauna have poikolterm blood (cold blooded) and reproduce by ovipar (laying eggs). The types of animals are: red frogs, soa umbrellas, pig-nosed turtles, long-necked Papuan turtles, Bromo turtles, green turtles, hawksbill turtles, lekang turtles, flat turtles, irian crocodiles, estuarine crocodiles, crocodiles siamese, sinyulong crocodiles, leatherback turtles, biuku, beluku, clothes, Borneo monitor lizards, timor pythons, green pythons, bodo pythons, pythons, brown tires, star pigs, rote lizards, aru lizards, waigeo lizards, maluku monitor lizards, monitor lizards Komodo dragons, proud lizard, gray lizard, brown lizard, green lizard, misool lizard, dwarf lizard, timor lizard, and togian lizard.

V. CONLUSION

A. Conclusion

Based on the results of research and testing of protected animal datasets, it can be concluded that:

1. The naïve Bayes method can be used to classify the protected herpetofauna species by classifying them based on the Indonesian name, family, subphylum, class, blood, and breed of each animal. Types of animals that are included in the herpetofauna class are vertebrate subphylum with reptile and amphibian classes, have poikolterm blood (cold blooded) and reproduce by oviparous (laying eggs).
2. Protected animals that are included in the herpetofauna group, namely the red frog, soa umbrella, pig-nosed turtles, rote turtles, long-necked Papuan turtles, Bromo turtles, green turtles, hawksbill turtles, cocktails, flat turtles , crocodile irian, estuarine crocodile, siamese crocodile, sinyulong crocodile, leatherback turtle, biuku, beluku, shirt, Kalimantan monitor lizard, timor python, green python, python bodo, python, brown tire, starfish lizard, rote lizard, aru lizard , the waigeo lizard, the lizard Maluku, the komodo lizard, the proud lizard, the gray lizard, the brown lizard, the green lizard, the misool lizard, the dwarf lizard, the timor lizard, and the togian lizard.
3. The naïve Bayes algorithm produces an accuracy value of 97.3% or shows that out of 792 protected animal species, 38 protected animal species are included in the herpetofauna class and 754 protected animal species that are not included in the herpetofauna class. These results are in accordance with the number of herpetofauna contained in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.20 / MENLHK / SETJEN / KUM.1 / 6/2018 concerning Types of Protected Plants and Animals.
4. The Receiver Operating Characterictic (ROC) curves of the “Yes” and “No” targets all show that the Area under Curve (AUC) results are at point 1. So the closer the Area under Curve (AUC) is from point 1, the better the results. These results produce a class that includes Excellent Classification.

B. Suggestion

The suggestions that the authors can give regarding research on the classification of protected herpetofauna are:

1. Can add herpetofauna data from other sources such as Visual Guidebooks and Field Identification. 107+ Indonesian Snakes. Indonesia Nature and Wildlife Publication written by Marlon R in 2014.
2. The element of classification measurement among herpetofauna species can be expanded again by adding the Latin name attributes and animal physical characteristics such as body size, body color, tail shape and head shape.
3. This research can be developed by comparing the classification results of protected herpsancaetofauna using the decision tree method.

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