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CSc – 180

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Project 1 – Expert Systems / Fuzzy Logic

I. Introduction and Background

This project is called the “Northern California Bird of Prey FuzzyCLIPS Identifier.” The purpose of this project was to create a system with which the user could input information regarding a bird that they had collected, and which they thought may be a bird of prey in the region of Northern California. The program would take the information and generate a list of most likely birds based on the criteria of the program. For the sake of limiting the scope of the project, only a select number of California’s Birds of Prey were implemented into this assignment.

II. Knowledge Engineering

My Expert is Nate Johnson, my co-worker at Covered California. He has been an avid birder for decades and spends most weekends hiking or spending time outdoors, always with a camera or a pair of binoculars nearby for sighting birds. Nate does not identify all birds but has some specialization with song birds and birds of prey. He can go into a wooded area and identify birds just by listening to the sound of their cry. He is also able to identify birds by their flight patterns. He uses books from the Audubon society as well as the Merlin Bird ID application from Cornell Labs to confirm his identifications.

I sat down with Nate at work and discussed his methods for bird identification multiple times for a total of approximately 3 hours. Nate described to me the basic format that almost all bird identification uses at a basic level. The first step is to determine the general size of the bird, second is to identify the location at which you spotted the bird, third is to determine the season in which you saw the bird, and fourth is to identify primary and secondary colors of the bird. With this information, you are on the right path to identify your bird. Sometimes, this is all you need but often you may have to use other pieces of information to help you identify as well. Other identifiers include bird song, flight pattern, and nest location and material. Nate often identifies birds of prey in the California area through identifying size, then color, and then flight pattern.

I decided to simplify the California bird of prey identification in a few ways. Firstly, I based my program on the main criteria that were outlined to me as crucial to bird identification; that is, location, bird size, and coloration. Second, I wanted to limit the number of birds for which I would be programming data on as the list of birds can be incredibly expansive. Those birds include the Bald Eagle, Golden Eagle, White Tailed Kite, California Condor, Peregrine Falcon, Swainson’s Hawk, Spotted Owl, Great Gray Owl, Osprey, Merlin, Red Tailed Hawk, and Prairie Falcon. These birds represent a wide range of size, color, and terrain in which they live, as well as being the most unique and intriguing birds of prey that California has to offer.

Third, I omitted some identifiers from the program entirely. Those identifiers would include bird song, flight pattern, nest conditions, and season. Bird song, flight pattern, and nest condition are all hard to quantify in a program and are highly subjective to the person who is doing the bird identifying, and, seeing as all these birds are in California all year, there is no need to include season in the program.

III. Expert System Design

I decided that the best method to represent my experts bird identification method would be through a type of elimination process. Instead of using a tree structure to represent the process, which would require every branch of the tree to ask the same questions as the others, when a question was asked, the answer would be used to identify all of the birds that fit the criteria and any others would not be selected. The first question that is asked is “What is the size of the bird?” The next question is “What is the terrain in which you saw your bird?” The third is “What is the primary color of your bird?” The last question is “What is the secondary color of your bird?” After all questions are asked, the program then runs through all birds and identifies which ones fit the criteria that the user input.

There are three rules that are used to obtain information that are not part of the fuzzy logic component. The first is rule p1, and this rule asks the user to input the terrain in which they spotted the bird and lists the outputs that the program is expecting to receive. Those inputs would be ‘Lake’, ‘River’, ‘Coast’, ‘Grasslands’, ‘Marsh’, ‘Mountain’, ‘City’, and ‘Forest.’ The second asks the user to enter the primary color of the bird that they are trying to identify and lists the colors that the program expects to receive. Those inputs would be ‘Brown’, ‘White’, ‘Black’, and ‘Gray.’ The third asks the user to enter the secondary color of the bird, if there is a secondary color, and lists the answers that the program expects to be entered. Those inputs would be ‘Brown’, ‘White’, ‘Gray’, and ‘None.’ After this point, the rules are all used to determine on a bird by bird basis if the current rule matches the information entered by the user and if that bird can be listed. The different identifiers for each bird are listed in fig. 1 below. The bird traits for which there are listed multiple options, the code has been designed with ‘OR’ operators to accept both options.

Birds	Wingspan	length	Color	Location	size
Bald Eagle	204cm	71-96cm	Dark Brown	lakes, rivers, coasts, marshes	lrg
Golden Eagle	185-220cm	70-84cm	Brown	mountains, open country	lrg
White Tailed Kite	99-110cm	32-38cm	White	grasslands, marshes	sml
California Condor	277cm	117-134cm	Black and White	beaches, mountains	lrg
Peregrine Falcon	100-110cm	36-49cm	grey and white	cities, cliffs, tall structures, everywhere	sml
Swainson’s Hawk	150cm	48-56cm	black	open country	sml, med

Spotted Owl	101cm	47-48cm	Dark Brown	mature forests	sml
Great Gray Owl	137-157cm	61-84cm	light brown, gray	dense evergreen forests	med, lrg
Osprey	150-180cm	54-58cm	brown and white	bodies of water	med
Merlin	53-68cm	24-30cm	gray, brown	cities, forests, rivers	sml
Red tailed hawk	114-133cm	45-65cm	brown	open country	sml, med
Prairie falcon	90-113cm	37-47cm	brown	open country	sml

Fig. 1 – Bird Identification Traits

The fuzzy logic component of my code is the first set of rules that are in my program. This section of the code accounts for the ‘wingspan’ and ‘length’ traits that are used to help identify the ‘size’ of the bird. The first is a template for identifying whether the bird’s wingspan is small, medium, or large. An example of the code for this can be found below in figure 2, and the subsequent diagram that this code represents can be seen in figure 3. The first template accounts for the wingspan of the bird and expects inputs ranging from 50 cm to 250 cm. The second template accounts for the bird’s length, which is the measure from beak tip to tail, and expects inputs ranging from 30 cm to 90 cm. This is templates diagram is shown in figure 4 down below. The third template accounts for the result of the two factors of wingspan and length and returns a number between -1 and 1. This diagram is shown down below in figure 5. The fuzzy set works to determine whether the users input of the wingspan is small (Sml), medium (Med), or large (Lrg), and then determine whether the size is short (Srt), middle (Mid), or tall (Tal). These values are plugged into the FAM, shown in figure 6 below, where a resulting number is determined between -1 and 1. If the wingspan result in anything less than -0.5, then the bird is considered small (SM), between -0.5 and 0.5 is considered medium (MD), and above 0.5 is considered large (LG).

```
(deftemplate Wingspan
  50 250 wingcm
  ((Sml (75 1) (150 0))
   (Med (75 0) (150 1) (225 0))
   (Lrg (150 0) (225 1))))
```

Fig. 2 – Wingspan Code

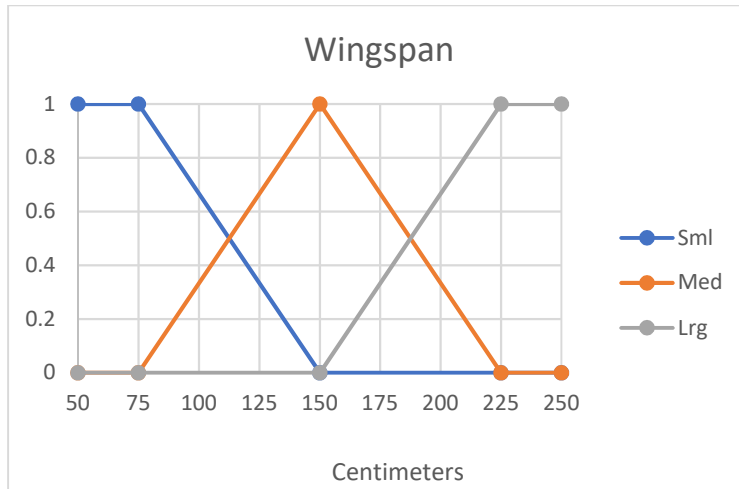


Fig. 3 – Wingspan Fuzzy Set

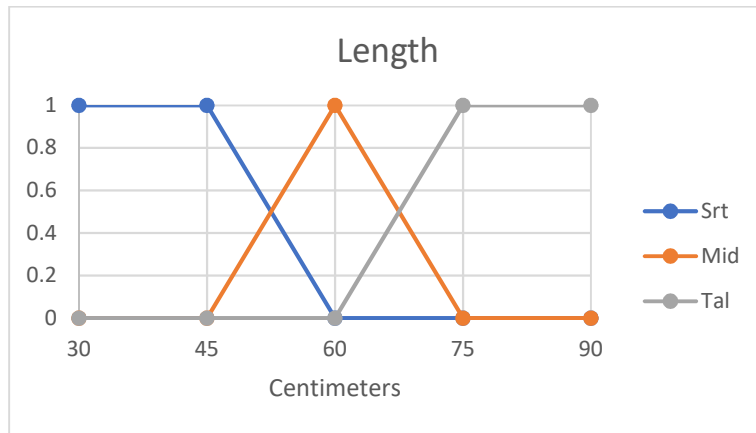


fig. 4 – Length Fuzzy Set

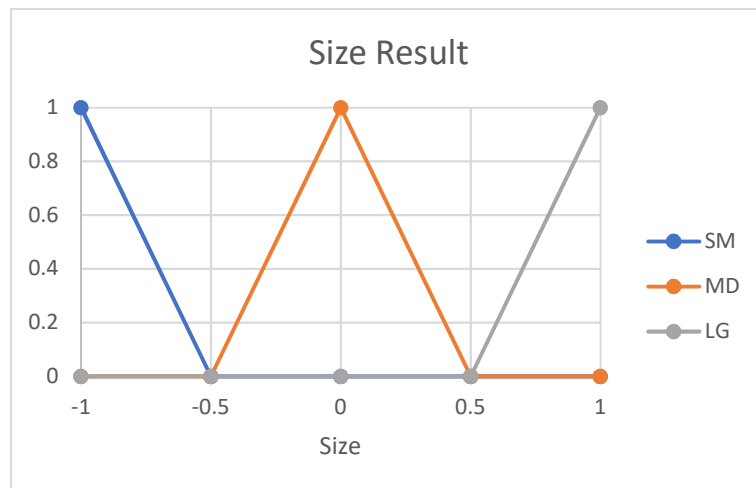


fig. 5 – Size Fuzzy Set

		Length		
		Srt	Med	Tal
Wingspan	Sml	SM	SM	MD
	Med	SM	MD	LG
	Lrg	MD	LG	LG

fig. 6 – FAM

Example Scenarios:

- Wingspan: 150 cm
- Length: 60 cm
- Result: 0

This is an example of the true medium scenario. This would result in the identified bird being declared a medium size because result is between -0.5 and 0.5

- Wingspan: 90 cm
- Length: 50 cm
- Result: -0.678

In this example, the identified bird would be considered small because the Wingspan and Length resulted in a value that is below -0.5

IV. Conclusion

My system works very well for what it was designed to do. It was designed simply with a lot of constraints on what could have become very complex components to ensure I was able to complete it properly. The information I used to identify the birds is direct from Cornell Lab, so it is realistic to life in terms of accuracy of bird traits. If you had the time and resources to identify accurately a bird of prey wingspan and beak tip-to-tail length, then you would only need to identify the terrain of your surroundings and the bird's colors to have a fairly accurate chance at using this program to identify the correct bird.

There are no known bugs in the system currently. The birds have been tested so the range of their sizes input and result in the correct size identifiers.

The flaw with my code is its limitations. Nature has an incredible amount of variation and there was never going to be enough time to create a comprehensive code that would work to identify all the birds of prey that could be in California. My program does not account for extreme variations in size, such as juvenile birds or sexual dimorphism between male and female pairs that can make them vary wildly in size, nor does it account for strange color combinations in birds, or for birds of prey that may only travel in to California. If any of those were to be the case, you would either receive no result or an incorrect result. That is why the code does not guarantee a correct bird identification. I specifically stated that the birds listed after inputting all values, one of them may be the correct bird.

Appendix A

To install this code, ensure you have FuzzyCLIPS installed on your computer. Download the zip file and extract Bird.clp to a location on your computer. It can be extracted to the documents or desktop folder, but wherever it is put, keep track of that location. Open up FuzzyCLIPS and press ctrl – L to load a program. Search for the folder holding Bird.clp and double click to open the code. In FuzzyCLIPS, type in ‘(reset)’ and then ‘(run)’ to begin running the program.

Appendix B

The program will prompt you to begin entering data once it has started running. It will first ask for the wingspan of your bird, then for the length of the bird, then the terrain you spotted the bird in, then finally it will ask for the primary and secondary colors of the bird. If there is not a secondary color, then ‘None’ can be inputted as this is a valid input. After these values have been input, the program will tell you that it is going to print out a list of birds that you may have seen. This list is not entirely comprehensive and multiple birds may appear on the list. It is up to the user to then continue on to other resources to finalize the identification of any birds accurately. If no birds appear on the list, then that means that the bird that you are trying to identify is either not represented by this program, is not a bird of prey, or is an outlier bird that is not usually present in California.

References

Knopf, Alfred A. *The Audubon Society Field Guide to North American Birds: Eastern Region*. Knopf, 1977.

Nate Johnson, Information Technology Specialist II at Covered California who has over a decade of experience as a birder.

Cornell University. "Cornell Lab of Ornithology Home Page." *Tag and Marking Information*, 2019, www.birds.cornell.edu/.

Cornell Lab. *Merlin Bird ID*. Version 1.5.1, Cornell University, 2019. *Google Play Store*