**Australian Shelduck**

**Observation:**

key insights:

* **Wing Length**: It's mentioned that wing length can be used to sex almost every individual of the Australian Shelduck. This suggests that there are distinct differences in wing size between males and females.
* **Juvenile Tail Feathers**: A large proportion of immature ducks retain juvenile tail feathers, which are suggesting of first-year birds when present.
* **Juvenile Wing Feathers**: For the Australian Shelduck, retained juvenile wing feathers are reliable and easily detected ageing characters.
* **Body Plumage**: Body plumage recording is necessary, especially for species difficult to sex visually when only wings are available.

**Use-flow Diagram:**

1. **Start:**
   * The user opens the app and selects the option to identify the Australian Shelduck.
2. **Confirmation:**
   * The user confirms they want to choose this bird based on its description.
3. Choice Determination:
   * The user confirms they want to choose ageing or sexing for the given bird.
4. **Questions for Age Determination:**
   * Question 1: How likely are you to observe juvenile tail feathers on the Australian Shelduck? Please rate the likelihood based on your observation - 1 (Very Unlikely) to 5 (Very Likely).
     + 1
     + 2
     + 3
     + 4
     + 5
   * Question 2: What is the likelihood that the bird has juvenile wing feathers? Please rate the likelihood based on your observation - 1 (Very Unlikely) to 5 (Very Likely)
     + 1
     + 2
     + 3
     + 4
     + 5
   * Question 3: Please rate the maturity of the bird's body plumage. Please rate the likelihood based on your observation - 1 (Very Unlikely) to 5 (Very Likely)
     + 1
     + 2
     + 3
     + 4
     + 5
5. **Sex Determination Questions:**
   * Question 4: Measure and enter the wing length of the shelduck.
     + If greater than 355 mm, determine as male and proceed to next questions, ignore other answers.
     + If less than 354 mm, determine as female and proceed to next questions, ignore other answers.
     + If between 354 mm and 355 mm, proceed to next questions**.**

The specific values (354 mm and 355 mm) suggest that there is an overlapping range where the wing lengths of males and females are close enough that they might be ambiguous. In such cases, additional characteristics (like plumage) are used to make a more accurate determination.

* + **Plumage Questions**
    - Question 5: Observe the eye-ring.
    - Question 6: Look at the white feathering at the bill base.
    - Question 7: Examine the breast and mantle colour.
    - Question 8: Inspect the white collar around the hindneck.
    - Based on answers, apply logic to determine sex.

1. **Results:**
   * The app presents the final determination age or sex.
2. **End:**
   * The user is given the option to start over or exit the app.

**Questions for Determining Age**

1. **Retained Juvenile Tail Feathers**: (**Weight: 35%)**
   * How likely are you to observe juvenile tail feathers on the Australian Shelduck? Please rate the likelihood based on your observation - 1 (Very Unlikely) to 5 (Very Likely).
     + 1
     + 2
     + 3
     + 4
     + 5
2. **Retained Juvenile Wing Feathers**: (**Weight: 35%)**
   * What is the likelihood that the bird has juvenile wing feathers? Please rate the likelihood based on your observation - 1 (Very Unlikely) to 5 (Very Likely)
     + 1
     + 2
     + 3
     + 4
     + 5
3. **Maturity of Body Plumage**: (**Weight: 30%)**
   * Please rate the maturity of the bird's body plumage. Please rate the likelihood based on your observation - 1 (Very Unlikely) to 5 (Very Likely).
     + 1
     + 2
     + 3
     + 4
     + 5

**Questions for Determining Sex**

1. **Wing Length Measurement**: (**Weight: 20%)**
   * "What is the wing length of the shelduck? Please select the range that applies."
     + Options: [Less than 354mm / 354-355 mm / More than 355 mm]
2. **Plumage Characteristics**:
   * **White Eye-Ring Presence**: (**Weight: 20%)**
     + "Observe the shelduck's eye-ring. How would you describe it?"

Options: Conspicuous and Broad / Absent or Inconspicuous

* + **White Feathering at Bill Base**: (**Weight: 20%)**
    - "Look at the base of the shelduck's bill. Do you see a broad ring of white feathering?"

Options: Yes / No

* + **Breast and Mantle Colour**: (**Weight: 20%)**
    - "Examine the colour of the shelduck's breast and mantle. Which description fits best?"

Options: Chestnut / Cinnamon or Yellowish-Rufous

* + **White Collar Completeness**: (**Weight: 20%)**
    - "Inspect the white collar around the hindneck. Is it complete or incomplete?"

Options: Complete and Broad / Incomplete

**Logic Interpretation Ageing:**

**1. Predefined Condition:**

If the rating for juvenileTailFeathers is 5, then the probability for juvenile is 100% and the probabilities for immature and adult are both 0%, unless the rating for bodyPlumage is also 5, in which case the probabilities for juvenile and adult are both 50% and the probability for immature is 0%, or the rating for bodyPlumage is 1, in which case the probabilities for juvenile and immature are both 50% and the probability for adult is 0%. If the rating for juvenileTailFeathers is not 5, then the probability for juvenile is 0% and the probabilities for immature and adult depend on the rating for bodyPlumage: if it is 5, then the probability for adult is 100% and the probability for immature is 0%; if it is 1, then the probability for immature is 100% and the probability for adult is 0%.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| juvenileTailFeathers | bodyPlumage | juvenile | immature | adult |
| 5 | 5 | 50% | 0% | 50% |
| 5 | 1 | 50% | 50% | 0% |
| 5 | 2, 3, 4 | 100% | 0% | 0% |
| 1, 2, 3, 4 | 5 | 0% | 0% | 100% |
| 1, 2, 3, 4 | 1 | 0% | 100% | 0% |

**2. Probabilistic Model Algorithm:**

**Step 1: Define Contribution of Each Scale Point to Age Categories**

For each question (Juvenile Tail Feathers, Juvenile Wing Feathers, Body Plumage Maturity), define how each response (1 to 5) contributes to the probability of each age category.

Example Contribution Definition:

1. **Juvenile Tail Feathers Contribution**:
   * Scale 1 (Very Unlikely): Juvenile +5%, Immature +20%, Adult +15%
   * Scale 2 (Unlikely): Juvenile +10%, Immature +25%, Adult +10%
   * Scale 3 (Neutral): Juvenile +15%, Immature +20%, Adult +10%
   * Scale 4 (Likely): Juvenile +25%, Immature +10%, Adult +5%
   * Scale 5 (Very Likely): Juvenile +30%, Immature +5%, Adult +0%
2. **Juvenile Wing Feathers Contribution**:
   * Scale 1 (Very Unlikely): Juvenile +5%, Immature +15%, Adult +20%
   * Scale 2 (Unlikely): Juvenile +10%, Immature +20%, Adult +15%
   * Scale 3 (Neutral): Juvenile +15%, Immature +20%, Adult +10%
   * Scale 4 (Likely): Juvenile +20%, Immature +15%, Adult +5%
   * Scale 5 (Very Likely): Juvenile +25%, Immature +10%, Adult +0%
3. **Body Plumage Maturity Contribution**:
   * Scale 1 (Very Unlikely): Juvenile +20%, Immature +30%, Adult +0%
   * Scale 2 (Unlikely): Juvenile +15%, Immature +25%, Adult +5%
   * Scale 3 (Neutral): Juvenile +5%, Immature +15%, Adult +40%
   * Scale 4 (Likely): Juvenile +0%, Immature +5%, Adult +65%
   * Scale 5 (Very Likely): Juvenile +0%, Immature +0%, Adult +80%

**Step 2: Collect User Responses**

Ask the user to rate each characteristic on a scale of 1 to 5.

**Step 3: Calculate Scores for Each Age Category**

Based on user responses, calculate the score for each age category by adding up the contributions from each characteristic's rating.

Example Calculation:

Suppose the user rates:

* Juvenile Tail Feathers: 2 (Unlikely)
* Juvenile Wing Feathers: 3 (Neutral)
* Body Plumage Maturity: 4 (Likely)

The scores would be:

* **Juvenile**: (Tail Feathers 2) + (Wing Feathers 3) + (Body Plumage 4)
* **Immature**: (Tail Feathers 2) + (Wing Feathers 3) + (Body Plumage 4)
* **Adult**: (Tail Feathers 2) + (Wing Feathers 3) + (Body Plumage 4)

**Step 4: Normalize Scores to Probabilities**

Normalize these scores so that the total across all age categories equals 100%.

**Step 5: Present Probabilities**

Display the normalized scores as probabilities for each age category.

**3. How were the Weights determined?**

The process of determining these weights involves a combination of logical reasoning, and the need for a balanced approach to age determination in birds. Here's a breakdown of how these weights were conceptualized:

1. **Ornithological Principles**: Understanding the development stages of birds is crucial. For example, juvenile feathers are key indicators of a bird's age. This knowledge guides the weighting.
2. **Characteristic Reliability**: Some characteristics are more reliable indicators of age than others. After discussion, it was concluded that Tail feathers, for instance, are often considered more definitive in determining a bird's juvenile status than wing feathers. Hence, the weights reflect the varying reliability of these characteristics.
3. **User Input Interpretation**: The scale (1 to 5) is designed to capture the user's certainty about each characteristic. Higher ratings indicate a stronger presence or likelihood of a feature. The weights translate this certainty into a probabilistic assessment.
4. **Balance and Nuance**: The weights are adjusted to ensure a balanced contribution from each characteristic. This is important to avoid overemphasis on a single trait.
5. **Iterative Refinement**: The initial weights are hypotheses based on the above factors. An iterative approach as that of CRISP DM Process was taken into consideration, where logical consistency guide adjustments.
6. **Scenario Testing**: Hypothetical scenarios (like the ones provided below) were used to test the weights. The outcomes are evaluated for their logical consistency with what is known about bird age characteristics. Adjustments are made to ensure the results align with reasonable expectations.
7. **Normalization Requirement**: Finally, the need for the probabilities across all age categories to sum to 100% is a guiding principle in determining how weights are distributed across the scale.

**4. Real-Time Example:**

**Scenario Ratings**

* Juvenile Tail Feathers: 4 (Likely)
* Juvenile Wing Feathers: 3 (Neutral)
* Body Plumage Maturity: 2 (Unlikely)

**Step-by-Step Calculation**

1. Apply Contributions Based on Ratings

* **Juvenile Tail Feathers (Rating 4 - Likely)**:
  + Juvenile: +25%
  + Immature: +10%
  + Adult: +5%
* **Juvenile Wing Feathers (Rating 3 - Neutral)**:
  + Juvenile: +15%
  + Immature: +15%
  + Adult: +10%
* **Body Plumage Maturity (Rating 2 - Unlikely)**:
  + Juvenile: +15%
  + Immature: +25%
  + Adult: +5%

**Weighted Contributions:**

* **Juvenile Tail Feathers (Weight 0.35)**:
  + Juvenile: 25% \* 0.35 = 8.75%
  + Immature: 10% \* 0.35 = 3.5%
  + Adult: 5% \* 0.35 = 1.75%
* **Juvenile Wing Feathers (Weight 0.35)**:
  + Juvenile: 15% \* 0.35 = 5.25%
  + Immature: 20% \* 0.35 = 7%
  + Adult: 10% \* 0.35 = 3.5%
* **Body Plumage Maturity (Weight 0.30)**:
  + Juvenile: 15% \* 0.30 = 4.5%
  + Immature: 25% \* 0.30 = 7.5%
  + Adult: 5% \* 0.30 = 1.5%

2. Sum the Contributions for Each Age Category

* **Total Juvenile Probability**:
  + 8.75% (Tail) + 5.25% (Wing) + 4.5% (Body) = 18.5%
* **Total Immature Probability**:
  + 3.5% (Tail) + 7% (Wing) + 7.5% (Body) = 18%
* **Total Adult Probability**:
  + 1.75% (Tail) + 3.5% (Wing) + 1.5% (Body) = 6.75%

3. Normalize (If Necessary)

The total of all probabilities sums up to 125% (55% Juvenile + 50% Immature + 20% Adult). Normalization is needed.

4. Normalize the Probabilities

Normalize these scores so that the total across all age categories equals 100%.

Total Probability Sum = 18.5% + 18% + 6.75% = 43.25%

* **Normalized Juvenile Probability**:
  + (18.5 / 43.25) \* 100 ≈ 42.79%
* **Normalized Immature Probability**:
  + (18 / 43.25) \* 100 ≈ 41.61%
* **Normalized Adult Probability**:
  + (6.75 / 43.25) \* 100 ≈ 15.60%

5. Output Probabilities

The final probabilities are:

* Juvenile: ≈ 42.79%
* Immature: ≈ 41.61%
* Adult: ≈ 15.60%

**Logic Interpretation Sexing:**

**1. Questions and Outcomes for Plumage Characteristics**

1. **White Eye-Ring**:
   * **Male**: Absent or inconspicuous.
   * **Female**: Conspicuous and broad.
2. **White Feathering at Bill Base**:
   * **Male**: Absent (with the exception that some males may have this feature).
   * **Female**: Present.
3. **Breast and Mantle Colour**:
   * **Male**: Cinnamon or yellowish-rufous.
   * **Female**: Chestnut.
4. **White Collar Completeness**:
   * **Male**: Complete and broad around the hindneck.
   * **Female**: Incomplete around the hindneck.

**Questions and Outcomes for Wing Length**

1. **Wing Length**:
   * **Male**: Greater than 355 mm.
   * **Female**: Less than 354 mm.
   * **Indeterminate**: Between 354 mm and 355 mm, where plumage characteristics should be used to assist in sexing the bird.

**2. Weight Assignment (Hypothetical)**

1. Wing Length: 40% - This is usually a very reliable indicator if the bird falls clearly into male or female wing length ranges.
2. White Eye-Ring: 20% - This characteristic is visually distinctive and usually correlates well with gender.
3. White Feathering at Bill Base: 15% - While significant, there is some ambiguity due to the presence of this trait in a minority of males.
4. Breast and Mantle Colour: 15% - Colour can be subjective and lighting conditions may affect perception, so it's reliable but not as much as wing length.
5. White Collar Completeness: 10% - This may be less prominent because of variability and observer interpretation.

**3. Formulas:**

totalScore = maleScore + femaleScore;

maleProbability = (maleScore / totalScore) \* 100;

femaleProbability = (femaleScore / totalScore) \* 100;