FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE
Programming Exercise 4: Probability 19th January, 2023
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Problem 3: Hidden Markov Model

Problem Description

Wildlife protection is one of the most discussed topics today. A better understanding of population dynamics is necessary to infer the causes of changes in population size, such as environmental change and management actions. Typically, investigations are conducted using a periodic capture-recapture method. Based on observation sequences, important factors such as survival probability across different ages, life-stage transition probability, and age-specific appearance features can be estimated.

Figure 1: Credit: `https://aldf.org`

In this programming exercise, we aim to infer a manatee's life cycle from an observation sequence using a pre-trained Hidden Markov Model. Specifically, we want to determine the amount of time an individual has spent in different life stages, and when it is most likely to die, using observable indicators of age, such as body size, as our observations. Part of the parameters of the HMM are adapted from a recent paper[1]. (Note: *Reading or understanding the referenced paper is not necessary to complete the exercise.*)

Our HMM has 6 hidden states, namely the age classes of a manatee: "**baby**", "**child**", "**adolescent**", "**adult**", "**elderly**", and "**death**". They are indexed by **0**, **1**, **2**, **3**, **4**, and **5**, respectively. The observation will be the current body size of the individual, namely "**not observed**", "**small**", "**medium**", and "**large**".

For more detailed information, see the provided jupyter notebook ***HMM.ipynb****.*

Programming Framework

For this programming exercise, a *Jupyter Notebook* will be used. To model the problem, you should be familiar with Python. The main function of the template is in the **HMM.ipynb** file, which is also the only file you have to work on.

The following steps are required to correctly set up the environment for the programming exercise and submission:

1. **Installation of AIMA**: Work through AIMA installation instructions on Moodle[1]. (Using Docker is recommended for beginners.)
2. **ARTEMIS**: Log into ARTEMIS with your TUM credentials. Find the exercise *Probability* and follow the installation and submission instructions.

Submissions will close on **17th February at 23:59**. Your solution will be graded by ARTEMIS. There will be feedback on formatting errors and rightly implemented HMM. Nonetheless, it is very important to follow the instructions exactly!

ATTENTION

- The exercise is passed if all evaluations on Artemis are passed.
- **Do NOT** rename the submitted file or the function name. If you do you will fail!
- **Do NOT** import any additional modules for your solutions. If you do you will fail!
- Like the rest of the programming exercises, this is an individual project and work **must** be your own. We will use a plagiarism detection tool and any copied code will cancel all bonus points from programming exercises for both the copier and the copied person!

References

[1] Gowan, T. A., Tringali, M. D., Hostetler, J. A., Martin, J., Ward-Geiger, L. I., and Johnson, J. M.. 2021. A hidden Markov model for estimating age-specific survival when age and size are uncertain. Ecology 102(8):e03426. 10.1002/ecy.3426

[1] https://www.moodle.tum.de/mod/page/view.php?id=2323882