CMPSC 310
Artificial Intelligence
Fall 2018
Janyl Jumadinova

Lab 3
17 September, 2017
Due: 24 September by 2:30 pm
This is a group lab, please work in teams of 2-3.

Objectives

To continue experimenting with an agent-based modeling tool called, NetLogo, to design agent-based models. To learn how a Bayesian inferencing can be implemented in NetLogo. To add extra features to the community model that is provided to you. Finally, to present the extended model and to reflect on it in writing while also commenting on the applications of Bayesian inferencing.

Reading Assignment

To help you understand the probability, Bayesian theorem and inferencing, you should also read Sections 8.1-8.4 in the FCA book.

Also, as you write your reflection, please refer to the relevant "GitHub Guides", available at https://guides.github.com/, that explain how to use many of the features that GitHub provides.

Bayesian Inference

Bayesian inference is a method of obtaining more accurate predictions from your data. It is based on the ideas of Thomas Bayes, an English statistician, philosopher and Presbyterian minister, who is known for his now famous Bayes Theorem in its raw form, which has since been applied to the problem of inference, the technical term for educated guessing. Bayesian inference is extremely powerful for modeling any random variable, for example a demographic statistic, a business key performance indicator, or the part of speech of a word.

Bayesian inferencing approach to modeling uncertainty is especially useful when:

- the data is limited,
- there may be an issue with overfitting,
- there is a reason to believe that some facts are more likely than others, but that information is not contained in the data used in the model,
- there is an interest in knowing exactly how likely certain facts are, as opposed to just picking the most likely fact.

Bayesian inferencing is derived from the Bayes' theorem, which provides an expression for the conditional probability of event A given B, calculated as:

$P(A|B) = \frac{P(A)P(B|A)}{P(B)}$

In Bayesian inferencing, we think of A as some proposition about the world (also known as a prior), and B as some data or evidence. For example, A represents the proposition that it rained today, and B represents the evidence that the sidewalk outside is wet. Then, $p(rain|wet)$ asks, "What is the probability that it rained given that it is wet outside?" In Bayesian inference, the initial beliefs are represented by the prior distribution $p(rain)$, and the final beliefs are represented by the posterior distribution $p(rain|wet)$.

A posterior probability is the probability of the events outcome given the data (observation). A prior probability is the probability of the events outcome before you collect the data (make observations).

Accepting GitHub Classroom Assignment

Since this is your first team-based assignment we will be using a group assignment functionality of GitHub Classroom. For group assignments only one person will be creating the team while the other team members will join that team.

The selected person of the team should go into the #labs channel in our Slack team and find the announcement that provides a link for it. Copy this link and paste it into your web browser. Now, you should accept the laboratory assignment and create a new team with a unique and descriptive team name (under "Or Create a new team").

Now the other members of the team can click on the assignment link and select their team from the list under "Join an Existing Team". When other team members join their group in GitHub Classroom, a team is created in our GitHub organization. Teams have pretty cool functionality, including threaded comments and emoji support. Every team member will be able to push and pull to their team's repository. Your team's project manager should be the one to resolve any conflicts or merge pull requests.

Unless you provide the instructor with documentation of the extenuating circumstances that you are facing, not working in a team and not accepting the assignment means that you automatically receive a failing grade for it.

Netlogo Models of Bayesian Inference

In the lab repository you will find two Netlogo models demonstrating Bayesian inference that were obtained from the Netlogo community. The first model, Bayes1D, illustrates how Bayesian inferencing can be in a world of predator and prey in a static one-dimensional environment. In this model the state of the world is the distance between the predator to the prey, and Bayesian inference is used to calculate the posterior probability by presenting the changes of three distribution models: uniform, normal, and dirac-delta. This model has a sensor in the upper left corner that flashes (representing a neuron) each time something is detected by the predator and a line is placed on the moving bar in the middle of the display every time that there is something detected. The average of the posterior probability and its standard deviation is given as an output.

The second model, Spatial, is similar to the first model, as it uses Bayesian inference to learn about the world. The state of the world in this model is the location of a prey (small red circle) with respect to a predator (large red circle). The model calculates the probability that the prey is close

to one of the sensors when it takes random samples beginning at the black circle and examining the surrounding patches. As the model narrows in the possible location of the prey it alters the color of the patches around the prey.

Extensions to the Model

Your team should select one of the given Netlogo models and try the items specified in the "THINGS TO TRY" section under the "Info" tab. You should study the documentation, interface and the code of the selected model. Your first task is to understand the implementation of the model. Then, you are invited to make the a number of enhancements to the selected model outlined below. The goal of your enhancements to the model is to make it more user friendly to the future AI enthusiasts who study Bayesian theorem and inference via usage of this model.

1. Make changes to the model:
    - Add at least two more features to the interface (e.g., add additional parameters that can be modified, add/change prior distribution to be used, etc.).
    - Change or enhance the visual output of the model.
2. Add/modify the documentation under the "Info" tab appropriately.
3. Document the program appropriately. To demonstrate your understanding of the original model, you should add comments to all significant portions (e.g., functions) in the program.

Required Deliverables

This assignment invites you to submit electronic versions of the following deliverables through your GitHub repository.

- Written reflection report in the document `writing/reflection.md` found in the lab 3 repository that contains the detailed description of your modifications and your motivation for them with the goal of helping people learn Bayesian inference in mind. Please remember that your reflection is a Markdown file that must adhere to the standards. Your reflection document should also include a screenshot of the "Interface" tab of your model. See https://guides.github.com/features/mastering-markdown/ for an example of incorporating an image into a Markdown document.
- A properly documented and styled Netlogo model containing all of your enhancements.
- A two minute pitch of your extended model. The winning team will "win" an opportunity to submit it to the Netlogo Community. In this "sales" pitch your team should identify all of the features of your extended model that make it worth of Netlogo community contribution. You will give your short presentation/demonstration during the lab on September 24 and we will vote on the most worthy model(s), which I will then invite to submit to the Netlogo's community models (after it has been graded).