Simulating Bird Abundance

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The present game-exercise intends to give you a hands-on experience on how ecological modelers use data, statistics, and probability to forecast changes in our planet. To play the game, you were previously divided in three groups:
1. the **Turtle** group
2. the **Bird** group, and
3. the **Tree** group.

If you are reading this, you belong to the Bird group, which we will rename to ***Species Abundance Simulation*** group. Fancier, right? :)

You will be responsible for simulating abundance of birds across the landscape and, ultimately, forecasting how their populations will change through time based on landscape changes.

You have received a small Lego set, which you can use to simulate the the population size of your birds. This Lego set brings the aerial view of your landscape and you can see the animal's habitat.

Getting started

Before you start, you will need to install two libraries to help with the simulations. The first library is called `Require`, and is an R package (or library) dedicated to improve code reproducibility on the setup side. The second library we will need is called `data.table`, which improves efficiency of data manipulation.

```
if (!require("Require")) {install.packages("Require"); require("Require")}
Require("data.table")
Require("raster")
Require("googledrive")
```

The next thing we will do is to `source` all `functions` that will help us simulate the movement of the turtle. These functions are described in the file `turtleSimulation.R`, which is a typical coding file for the R environment. Functions are the basis for programming. They are generally generic commands to explain to the software what to do. If you are interested, you can read more about:

R and functions, in this great and simple tutorial from Norm Matloff: https://github.com/matloff/fasteR and in a cool YouTube video from R Programming https://www.youtube.com/watch?v=BvKETZ6kr9Q
data.table and efficient data manipulation in this tutorial: https://www.machinelearningplus.com/data-manipulation/datatable-in-r-complete-guide/
RMarkdown and other awesome packages from Yihui Xie here: https://bookdown.org/yihui/rmarkdown/ and https://bookdown.org/yihui/rmarkdown-cookbook/
RStudio in a fun and easy way: https://moderndive.netlify.app/1-getting-started.html

The present `birdSimulation.Rmd`, on the other hand, is a mixed-file that allows for both documentation (normal text) and code to be written. When the file is done, this document can be `rendered` into a PDF with a really neat format, which you can also see in the folder, as `birdSimulation.pdf`.

Functions' Sourcing

To `source` (or in other words, *read*) the functions we will using, we can use a function in R called `source()` (I agree, not too creative, but easy to remember). To run the line below, you can press the little green arrow on the right side of the `code chunck`, where the instructions for R to source the file with functions are written.

```
source("birdSimulation.R")
```

If everything goes according to the plan, you should have seen in the `Console` below this window the following sentence:

```
All functions were correctly sourced! You are ready to start.
```

Now the real fun begins!

Defining bird abundance

The bird will move randomly across the landscape and depending on the proportion of different habitats, you will count how many birds are in that area. In general, birds like following available habitats, in this order of preference:

A. Recently burned patch (light yellow) B. Young forest (light green) C. Human disturbed patch (grey or black) D. Middle-aged forest (middle green) E. Old forest (dark green) F. Water (light blue)

To define the abundance of birds, we will go through three phases: *finding area*, *defining habitat proportions*, and *counting birds*.

Finding Area The first thing to do is to place the bird in a random area. Try to avoid the exact areas it has been previously.

Defining Habitat Proportions Once you have placed the bird place the Lego square around it, trying your best to keep the bird in the middle. Now you will count the number of patches (Lego heads) of each habitat and take notes of it. All you have to do is count how many of each habitat you have within the square where the bird is. If a given habitat is not inside the square, give it a zero.

The function below shows you all the habitat types available. Please use the codes provided to record your collected data (i.e., the letters, not habitat description).

```
availableHabitats()
```

You should repeat this cycle of placing the bird and counting the habitat patches for at least 15 rounds. Once you have compiled all the data, you should enter the results on the table which has already been prepared for you. This table can be found in the `data` folder of the `predictiveEcologyInAction` directory. The table to fill in is called `birdHabitat.csv`. The sheet contains pre-filled habitat type' columns. Just place the number of patches you counted in each habitat per round.

Counting birds Each row in the Excel file should represent habitat counts for the habitats of each round. Once you have enter the total patches of each habitat for at least 15 rounds on the Excel table, save it (don't change the name or format!), you will read the table and enter the data into a function that will tell you how many birds were observed in each round.

To load the table, you can use the function below:

```r
birdsTable <- loadBirdsTable()
```

And to calculate the number of observed birds, you can use the function below:

```r
calculateObservations(birdsTable)
```

Now you can complete the table with the observations. To do that, fill the column **counts**, on the table (`G`) with the values presented by the function above and save the table.

> It is *VERY IMPORTANT* that you do not change the file name or type, as the code was built to read `.csv` files, not normal Excel `.xlsx` files.

Fitting a bird abundance model

Once you have finished your 15 rounds and filled the table with the observed number of birds using the `calculateObservations(birdsTable)`, you will move to building a model to be able to forecast how many birds are now and will be in the future landscapes. This is a complicated statistical procedure under the hood of a very simple code, as shown below.

The first step will be to import the table you created in Excel:

```r
birdDataset <- fread("data/birdHabitat.csv")
```

After importing the data, we will then fit a generalized linear model, which uses the Poisson distribution because we are dealing with counts (but don't worry about it too much, this is just information for those who are stats lovers!). As birds are not in the water (habitat `F`), we exclude it from our model:

```r
birdModel <- glm(formula = counts ~ A + B + C + D + E,
                 family = "poisson", data = birdDataset)
birdModel
```

Once we have our bird model, we will save it and upload the saved object so we can explore it further with the others.

```r
saveAndSendResults(birdModel)
```

If you never used `googledrive` in R, you will probably have some setup to do. But don't worry! Follow the instructions in the screen and it should work.

If you see the message: `Results uploaded!`, you have finished the exercise!

Congratulations! Now you know how many birds you have depending on the proportion of different landscape types. We need, however, to know how the landscape will look like in the future. And then see what the turtle's group has to do with it!

Once all groups are done, we will integrate all projects and answer our research question. :)

Playing further on

If you enjoyed the simulations and would like to play further on, just restart the game by: 1. Deleting the information you entered on the table `birdHabitat.csv` in the `data` folder in the `predictiveEcologyInAction` directory as well as the file `birdResults.rds`;
2. Place the bird randomly on the board;
3. Re-run the present script from the beginning.

I hope you had some fun, but most of all, could grasp the general mechanisms behind how we model animal abundance in function of landscape.