Integrating Landscape Change with Birds and Turtles

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Integrating our work

If we arrived here, it means we were successful in forecasting landscape changes, simulating turtle habitat suitability and bird abundance! Thank you all for your hard work on it. :)

So far, we have only worked with our own groups, so now we will hear a little bit about what other groups did.

Now we will see how we can integrate all this work and answer our burning scientific question: **are birds good umbrella species for turtles?**
Of course, we need to remember that this example is completely made up, so none of our conclusions here really apply to the real world. However, once we are finished you will have had a hands-on experience on how we can work collaboratively with predictive ecology and why this knowledge is important in whatever area you work on.

So let's get started!

1. Load libraries

As always, our first step is to load the necessary libraries. We will load a couple more libraries this time, so we can download the files straight from google drive and use some nice plotting tools.

```r
if (!require("Require")) {install.packages("Require"); require("Require")}
Require("sf")
Require("RCurl")
Require("googledrive")
```

If the dependencies were installed now (not just loaded), please restart your R session and re-run the script.

```r
Require("data.table")
Require("terra")
Require("reproducible")
Require("ggplot2")
Require("gridExtra")
```

The next thing we will do is to `source` all `functions` that will help us integrate all the work done by all three groups:

```r
source("landscapeSimulation.R")
source("turtleSimulation.R")
source("birdSimulation.R")
source("integratingSimulations.R")
```

Now we are ready to start with the integration!

First, we need to get all the data that was collected and generated by each one of the groups.

```
allData <- getAllData()
```

The **Landscape Simulation** group has generated changes in landscape through 100 years. These include forest growth, wildfire and human disturbance. Here we can see the initial landscape, and the landscape after 100 years:

```
initialLandscape <- getInitialLandscape()
finalLandscape <- allData$landscape
```

The **Species Abundance Simulation** group developed a model to predict bird abundance based on the landscape. The model can be seen here:

```
birdModel <- allData$birdResults
```

At last, the **Habitat Selection Simulation** group developed a habitat selection model to predict habitat suitability for turtles. Their results can be seen here, in a ranking of the different habitats:

```
habitats <- merge(availableHabitatsTurtles(), allData$turtleResults, by = "habitatType")
```

Now we will try to answer our question: are birds good umbrellas for turtles now and in the future?

The first step to answer this question is to map both bird abundance now and in the future using our generated landscape.

```
birdMaps <- generateBirdMaps(initialLandscape, finalLandscape, birdModel)
```

We then map turtle habitat suitability now and in the future also using our generated landscape.

```
turtleMaps <- generateTurtleMaps(initialLandscape, finalLandscape, habitats)
```

And then we look at all the maps we have created so far:

```
plotMaps(allMaps = c(initialLandscape, finalLandscape,
                     birdMaps$Now, birdMaps$Future,
                     turtleMaps$Now, turtleMaps$Future))
```

Now, to answer our question, we will do a correlation analysis between the two sets of maps. To do that, we can use the

```
answerToOurQuestion <- areBirdsGoodUmbrellaForTurtle(birdMaps, turtleMaps)
```

So, can we answer our question now? Are birds good umbrellas for turtles now? And how does this relationship changes in the future?

I hope you have enjoyed this exercise and now understands a little bit more about the importance of predictive ecology. Please do not hesitate in contacting me if you have doubts about the exercise, or the exchange we had during this course, and I look forward to seeing you in a not so distant future. :)

Cheers,

Tati

PS.: If you really enjoyed this exercise or want to try the exercises from other groups, but don't have any Lego's at hand, don't despair. I have prepared a script that you can run each step of the game with made up data, so you can understand each cog of this complex machine. You can run the full game from scratch running the script named `gameTestingScript.R`. Have fun!