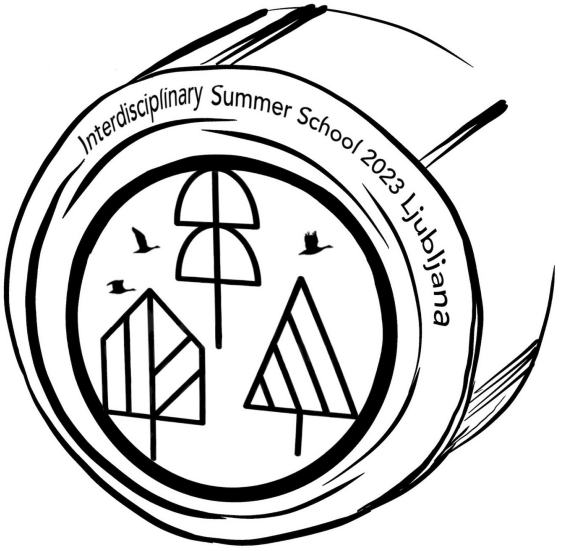

Forest Modeling Exercise

Step by step instructions

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Repository available in GitHub

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1 General

This document is the step by step guide. You will now find a set of instructions for your group.

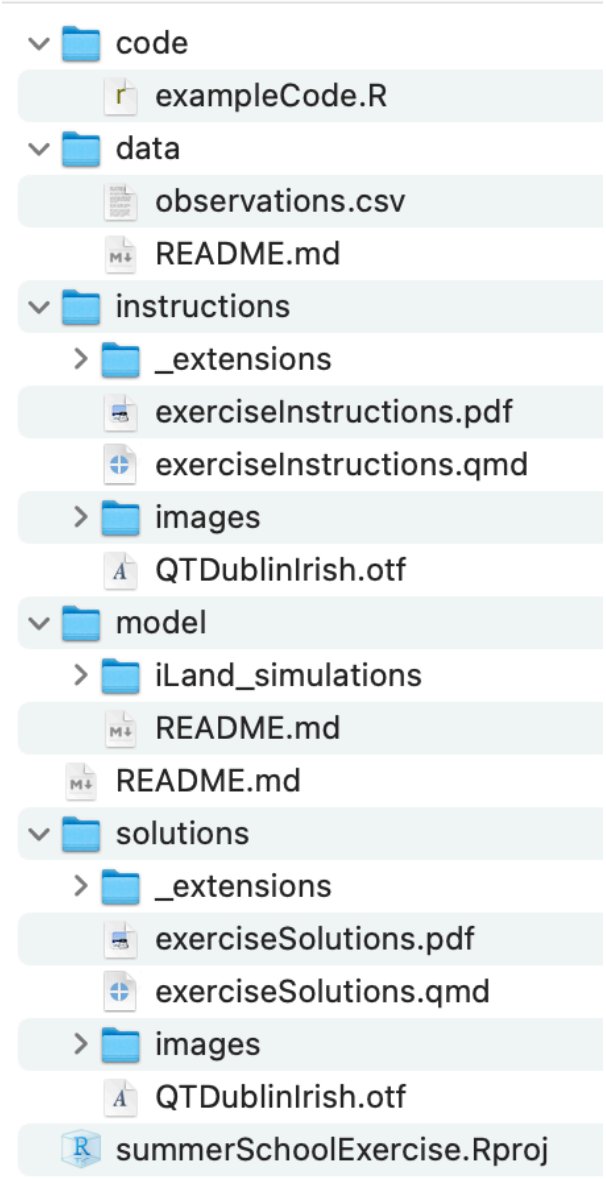
To do this exercise you first need to download the project folder. You can download the complete project folder from this link:

https://drive.google.com/drive/u/0/folders/1IXfJNIXw32lp1q4AmEZzt0nqgE3HDRIx.

In this project folder you will find the following folders and files:

- `summerSchoolExercise.Rproj`: this is the project file that you should open. This file contains various project options and is used as a shortcut for opening the project directly from the file system.
- `code`: where you should save the R scripts.
- `data`: this folder contains the data used in the empirical modeling.
- `instructions`: where you can find the pdf and qmd with the step by step instructions for the exercises without the solutions, and all the extensions and images needed to compile the document.
- `model`: where you will find the folder `iLand_simulations` with all the files needed to run the process based exercise
- `solutions`: where you can find this document in pdf and in the qmd and all the extensions and images needed to compile the document

Our recommendation is that you follow this folder structure and that you use the `summerSchoolExercise.Rproj` to open Rstudio. If you decide to organize things in a different way then you will have to change all the relative paths in the codes provided in the solutions documentation. The folder you have downloaded should look like this:



This project is also available in a github repository. You can clone the project in here:

https://github.com/oldiya/summerSchoolExercise

Please notice that in the github project the data file `data/observations.csv` and the folder `model/iLand_simulations` are missing and have to be downloaded separately (read the README.md files in these folders to learn how to download them).

Please, also be aware of data and model policy, you can read it following this link.

2 GROUP1

2.1 Tasks

The group should answer 4 questions during the exercises (A-D). Questions A-B addressing process-based modeling for Plot1, C-D addressing empirical modeling for Bryophyte species using GLMs. You should form four sub-groups of 3-4 people inside the group to address each of the questions.

2.2 Subgroup A [Process Based]

2.2.1 Question to address

How are biodiversity indices changing in time and across the simulated scenario(s) on Plot 1?

2.2.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work
b. Load the output files into R and read in the *tree* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Study the output table and do some visualizations, e.g. plot the trees by locations in year=0 and year=100 coloring by species and making different size of circles based on dbh and compare reference and scenario runs [for help click here]
d. Plot the time development of some variables (e.g. average dbh of the trees) and compare reference and scenario runs [for help click here]

e. Study how tree species biodiversity changed over time during your simulations and compare reference and scenario runs. You can use species diversity index (for help click here), and also some structural diversity indices for which you can get familiar with Francesco's R package "treespat" (for help click here). You can find more information about this R package following this link.

2.3 Subgroup B [Process Based]

2.3.1 Question to address

How are the species distribution and total living biomass Carbon content changing in time on Plot 1? Compare 0 year and 100 year status in the reference case and in the case of your scenario(s).

2.3.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work.
b. Load the output files into R and read in the *landscape* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Visualize model results for both reference and scenarios run(s) using the species specific outputs, for example total_carbon_kg (carbon content of living compartments) and count_ha (number of trees). You can also plot e.g. mean dbh change per species, or anything that you think is interesting. [for help click here]
d. Calculate the carbon content of living compartments of the trees in year=0 and year=100 and compare them between different model runs! [for help click here]
e. Study the species composition change based on carbon content, or volume. Which species remained there, disappeared of increased on decreased their proportions [for help click here]

2.4 Subgroup C [Empirical]

2.4.1 Question to address

Does a more diverse forest in structure and composition have more Bryophyte species?

2.4.2 Step by step guide

1. Learn what are Bryophytes, you can find a short description here
2. Get familiar with what Generalized Linear Models (GLMs) are, you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here
4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a GLM model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here including two models alternatives
6. Explore the model. If you do not know how to do this, you can find some instructions in here. You can also try to understand the explanatory power of your model following these insturctions and look at the model assumptions following these instructions

2.5 Subgroup D [Empirical]

2.5.1 Question to address

Is the number of Bryophyte species affected by forest management type and the forest structural diversity?

2.5.2 Step by step guide

1. Learn what Bryophytes are, you can find a short description here
2. Get familiar with what Generalized Linear Models (GLMs) are, you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here

4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a GLM model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here including two models alternatives
6. Explore the model. If you do not know how to do this, you can find some instructions in here. You can also try to understand the explanatory power of your model following these insturctions and look at the model assumptions following these insturctions

3 GROUP2

3.1 Tasks

The group should answer 4 questions during the exercises (A-D). Questions A-B addressing process-based modeling for Plot2, C-D addressing empirical modeling for bird species using GLMs. You should form four sub-groups of 3-4 people inside the group to address each of the questions.

3.2 Subgroup A [Process Based]

3.2.1 Question to address

How are biodiversity indices changing in time and across the simulated scenario(s) on Plot 2?

3.2.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work
b. Load the output files into R and read in the *tree* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Study the output table and do some visualizations, e.g. plot the trees by locations in year=0 and year=100 coloring by species and making different size of circles based on dbh and compare reference and scenario runs [for help click here]
d. Plot the time development of some variables (e.g. average dbh of the trees) and compare reference and scenario runs [for help click here]

e. Study how biodiversity changed over time during your simulations and compare reference and scenario runs. You can use species diversity index (for help click here), and also some structural diversity indices for which you can get familiar with Francesco's R package "treespat" (for help click here) You can find R package documentation in the *documents* folder

3.3 Subgroup B [Process Based]

3.3.1 Question to address

How are the species distribution and total living biomass C content changing in time on Plot 2? Compare 0 year and 100 year status in the reference case and in the case of your scenario(s).

3.3.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work.
b. Load the output files into R and read in the *landscape* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Visualize model results for both reference and scenarios run(s) using the species specific outputs, for example total_carbon_kg (carbon content of living compartments) and count_ha (number of trees). You can also plot e.g. mean dbh change per species, or anything that you think is interesting. [for help click here]
d. Calculate the carbon content of living compartments of the trees in year=0 and year=100 and compare them between different model runs [for help click here]
e. Study the species composition change based on carbon content, or volume. Which species remained there, disappeared of increased on decreased their proportions [for help click here]

3.4 Subgroup C [Empirical]

3.4.1 Question to address

Does a more diverse forest in structure and composition have more bird species?

3.4.2 Step by step guide

1. I think you already know what birds are but if you do not, please find out now.
2. Get familiar with what Generalized Linear Models (GLMs) are, you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here
4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a GLM model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here including two models alternatives
6. Explore the model. If you do not know how to do this, you can find some instructions in here. You can also try to understand the explanatory power of your model following these insturctions and look at the model assumptions following these insturctions

3.5 Subgroup D [Empirical]

3.5.1 Question to address

Is the number of bird species affected by forest management type and the forest structural diversity?

3.5.2 Step by step guide

1. I think you already know what birds are but if you do not, please find out now.
2. Get familiar with what Generalized Linear Models (GLMs) are, you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here

4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a GLM model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here including two models alternatives
6. Explore the model. If you do not know how to do this, you can find some instructions in here. You can also try to understand the explanatory power of your model following these insturctions and look at the model assumptions following these insturctions

4 GROUP3

4.1 Tasks

The group should answer 4 questions during the exercises (A-D). Questions A-B addressing Plot 3, C-D addressing empirical modeling for the presence of the Great spotted woodpecker using Boosted Regression Trees. You should form four sub-groups of 3-4 people inside the group to address each of the questions.

4.2 Subgroup A [Process Based]

4.2.1 Question to address

How are biodiversity indices changing in time and across the simulated scenario(s) on Plot 3?

4.2.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work
b. Load the output files into R and read in the *tree* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Study the output table and do some visualizations, e.g. plot the trees by locations in year=0 and year=100 coloring by species and making different size of circles based on dbh and compare reference and scenario runs [for help click here]
d. Plot the time development of some variables (e.g. average dbh of the trees) and compare reference and scenario runs [for help click here]

e. Study how biodiversity changed over time during your simulations and compare reference and scenario runs. You can use species diversity index (for help click here), and also some structural diversity indices for which you can get familiar with Francesco's R package "treespat" (for help click here) You can find R package documentation in the *documents* folder

4.3 Subgroup B [Process Based]

4.3.1 Question to address

How are the species distribution and total living biomass C content changing in time on Plot 3? Compare 0 year and 100 year status in the reference case and in the case of your scenario(s).

4.3.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work.
b. Load the output files into R and read in the *landscape* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Visualize model results for both reference and scenarios run(s) using the species specific outputs, for example total_carbon_kg (carbon content of living compartments) and count_ha (number of trees). You can also plot e.g. mean dbh change per species, or anything that you think is interesting. [for help click here]
d. Calculate the carbon content of living compartments of the trees in year=0 and year=100 and compare them between different model runs! [for help click here]
e. Study the species composition change based on carbon content, or volume. Which species remained there, disappeared of increased on decreased their proportions [for help click here]

4.4 Subgroup C [Empirical]

4.4.1 Question to address

Is the presence of the Great spotted woodpecker affected by forest density?

4.4.2 Step by step guide

1. You can learn a bit about the Great spotted woodpecker in here
2. Get familiar with what Boosted Regression Trees (Boosted Regression Treess), you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here
4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a Boosted Regression Trees model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here. Please read this section carefully, you will have to manipulate the data in order to have enough observations. This is all explained in the link.
6. Explore the model behaviour. If you do not know how to do this, you can find some instructions in here.
7. Explore the model output. If you do not know how to do this, you can find some instructions in here.

4.5 Subgroup D [Empirical]

4.5.1 Question to address

Is the presence of the Great spotted woodpecker affected by forest diversity?

4.5.2 Step by step guide

1. You can learn a bit about the Great spotted woodpecker in here
2. Get familiar with what Boosted Regression Trees (Boosted Regression Treess), you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here

4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a Boosted Regression Trees model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here. Please read this section carefully, you will have to manipulate the data in order to have enough observations. This is all explained in the link.
6. Explore the model behaviour. If you do not know how to do this, you can find some instructions in here.
7. Explore the model output. If you do not know how to do this, you can find some instructions in here.

5 GROUP4

5.1 Tasks

The group should answer 4 questions during the exercises (A-D). Questions A-B addressing Plot 4, C-D addressing empirical modeling for the presence of the Eurasian treecreeper using Boosted Regression Trees. You should form four sub-groups of 3-4 people inside the group to address each of the questions.

5.2 Subgroup A [Process Based]

5.2.1 Question to address

How are biodiversity indices changing in time and across the simulated scenario(s) on Plot 4?

5.2.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work
b. Load the output files into R and read in the *tree* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Study the output table and do some visualizations, e.g. plot the trees by locations in year=0 and year=100 coloring by species and making different size of circles based on dbh and compare reference and scenario runs [for help click here]
d. Plot the time development of some variables (e.g. average dbh of the trees) and compare reference and scenario runs [for help click here]

e. Study how biodiversity changed over time during your simulations and compare reference and scenario runs. You can use species diversity index (for help click here), and also some structural diversity indices for which you can get familiar with Francesco's R package "treespat" (for help click here) You can find R package documentation in the *documents* folder

5.3 Subgroup B [Process Based]

5.3.1 Question to address

How are the species distribution and total living biomass C content changing in time on Plot 4? Compare 0 year and 100 year status in the reference case and in the case of your scenario(s).

5.3.2 Step by step guide

1. Get familiar with the model [click here]
2. Start with the exercise [click here]
3. Get familiar with the input files [click here]
4. Read information on model settings to consider [click here]
5. Run the model for the reference case [click here]
6. Create and run alternative scenario [click here]
7. Process model outputs [click here]:

a. Open R project file and open a new script and save it into your "code" folder, here you can start to work.
b. Load the output files into R and read in the *landscape* output table from the sqlite files both for reference simulations and scenario run(s) [for help click here]
c. Visualize model results for both reference and scenarios run(s) using the species specific outputs, for example total_carbon_kg (carbon content of living compartments) and count_ha (number of trees). You can also plot e.g. mean dbh change per species, or anything that you think is interesting. [for help click here]
d. Calculate the carbon content of living compartments of the trees in year=0 and year=100 and compare them between different model runs [for help click here]
e. Study the species composition change based on carbon content, or volume. Which species remained there, disappeared of increased on decreased their proportions [for help click here]

5.4 Subgroup C [Empirical]

5.4.1 Question to address

Is the presence of the Eurasian treecreeper affected by forest density?

5.4.2 Step by step guide

1. You can learn a bit about the Great spotted woodpecker in here
2. Get familiar with what Boosted Regression Trees (Boosted Regression Treess), you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here
4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a Boosted Regression Trees model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here. Please read this section carefully, you will have to manipulate the data in order to have enough observations. This is all explained in the link.
6. Explore the model behavior. If you do not know how to do this, you can find some instructions in here.
7. Explore the model output. If you do not know how to do this, you can find some instructions in here.

5.5 Subgroup D [Empirical]

5.5.1 Question to address

Is the presence of the Eurasian treecreeper affected by forest management?

5.5.2 Step by step guide

1. You can learn a bit about the Great spotted woodpecker in here
2. Get familiar with what Boosted Regression Trees (Boosted Regression Treess), you can find a short description here
3. Get familiar with the observed data available under the folder `data`. If you do not know how to do this, you can find some instructions in here

4. Select a response variable to answer your question. Select also explanatory variables that you think will help you to answer your question. If you do not know how to do this, you can find some instructions in here
5. Create a Boosted Regression Trees model in R using the selected response variable and explanatory variables. If you do not know how to do this, you can find some instructions in here. Please read this section carefully, you will have to manipulate the data in order to have enough observations. This is all explained in the link.
6. Explore the model behavior. If you do not know how to do this, you can find some instructions in here.
7. Explore the model output. If you do not know how to do this, you can find some instructions in here.