Introduction to Theoretical Ecology

Instructor: Po-Ju Ke Teaching Assistant: Gen-Chang Hsu

2021 Fall at National Taiwan Univeristy

Contents

Course Description

Overview

The development of theory plays an important role in advancing ecology as a scientific field. This three-unit course is for students at the graduate or advanced undergraduate level. The course will cover classic theoretical topics in ecology, starting from single-species dynamics and gradually build up to multi-species models. The course will primarily focus on population and community ecology, but we will also briefly discuss models in epidemiology and ecosystem ecology. Emphasis will be on theoretical concepts and corresponding mathematical approaches.

This course is designed as a two-hour lecture followed by a one-hour hands-on practice module. In the lecture, we will analyze dynamical models and derive general theories in ecology. In the hands-on practice section, we will use a combination of analytical problem sets, interactive applications, and numerical simulations to gain a general understanding of the dynamics and behavior of different models.

Objectives

By the end of the course, students are expected to be familiar with the basic building blocks of ecological models and would be able to formulate and analyze simple models of their own. The hands-on practice component should allow students to link their ecological intuition with the underlying mathematical model, helping them to better understand the primary literature of theoretical ecology.

Requirements

Students are expected to have a basic understanding of **Calculus** (e.g., freshman introductory course) and **Ecology**.

Format

Tuesday 1:20 pm ~ 4:20 pm at Room 204, Gongtong Lecture Building

- Main lecture (two hours): theories and models (blackboard writing)

- Hands-on practice (one hour): programming and simulation (using R) + discussion

Grading

The final grade consists of:

(1) Assignment problem sets (60%)
(2) Midterm exam (15%)
(3) Final exam (15%)
(4) Course participation (10%)

Course materials

We will be using a combination of textbooks and literature articles on theoretical ecology in this course. Textbook chapters and additional reading materials will be provided (see **Syllabus** for more details).

Below are the textbook references:

- Case, Ted J. *An illustrated guide to theoretical ecology.* Oxford University Press, 2000.
- Gotelli, Nicholas J. *A primer of ecology* 4^{th} *edition.* Sinauer Associates, 2008.
- Pastor, John. *Mathematical ecology of populations and ecosystems.* John Wiley & Sons, 2011.
- Otto, Sarah P. and Troy Day. *A biologist's guide to mathematical modeling in ecology and evolution.* Princeton University Press, 2011.

Contacts

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Syllabus

Date	Lecture topic	Lab	Reading
Week 1 <span style='vertical-align:-30 28-Sept-2021	Introduction: what is theoretical ecology?		
Week 2 <span style='vertical-align:-30 05-Oct-2021	Exponential and geometric population growth	Modeling population growth	Gotelli [Ch.1] Case [Ch.1]

Week 1

Figure with label and caption

```
par(mar = c(4, 4, .1, .1))
plot(pressure, type = 'b', pch = 19)
```

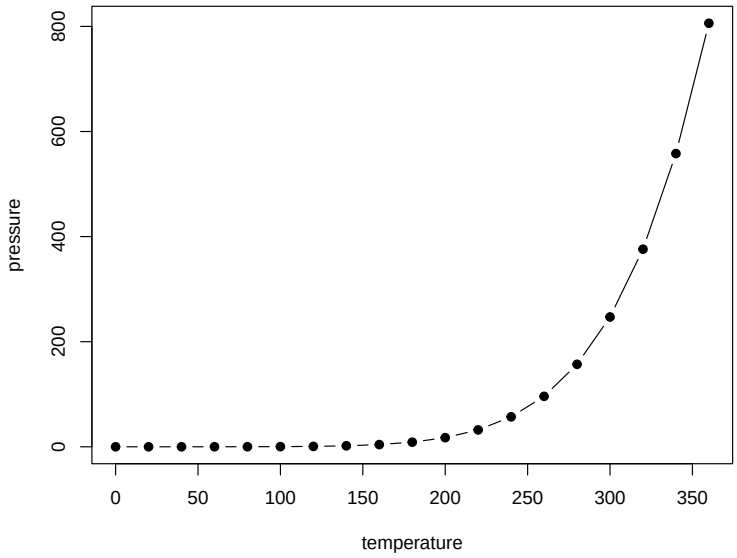

Figure 1: Here is a nice figure!

External image with label and caption

```
knitr::include_graphics("knit-logo.png")
```

Table with label and caption

Figure 2: Here is a nice figure!

```
knitr::kable(
  head(iris, 20), caption = 'Here is a nice table!',
  booktabs = TRUE
)
```

Internal Link to anchor

Equations

$f(k) = \binom{n}{k} p^k (1-p)^{n-k}$

$$f(k) = \binom{n}{k} p^k (1-p)^{n-k}$$

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

$$f\left(k\right) = \binom{n}{k} p^k \left(1-p\right)^{n-k} \tag{1}$$

$$\frac{d}{dx}\left(\int_{a}^{x} f(u)\,du\right) = f(x)$$

Text references

Table 1: Here is a nice table!

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5.0	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3.0	1.4	0.1	setosa
4.3	3.0	1.1	0.1	setosa
5.8	4.0	1.2	0.2	setosa
5.7	4.4	1.5	0.4	setosa
5.4	3.9	1.3	0.4	setosa
5.1	3.5	1.4	0.3	setosa
5.7	3.8	1.7	0.3	setosa
5.1	3.8	1.5	0.3	setosa

```
plot(cars)  # a scatterplot
```

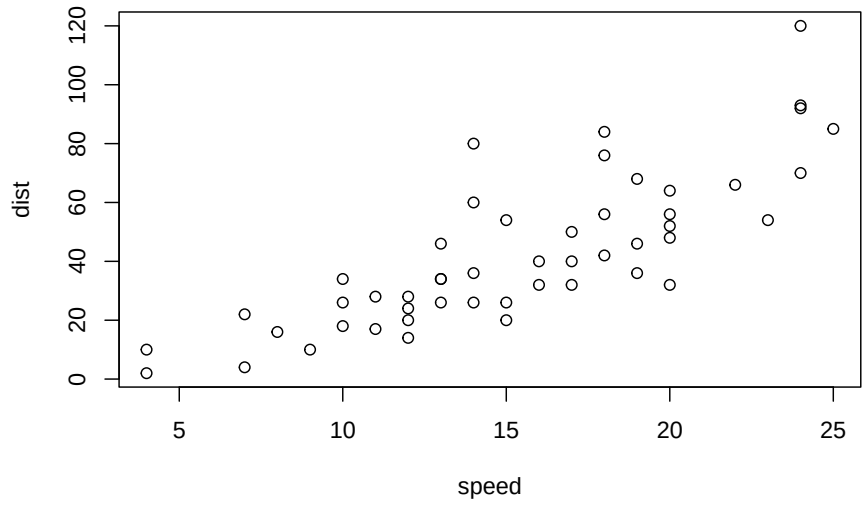

Figure 3: A scatterplot of the data `cars` using **base** R graphics.

see this!!!

Week 2

```
plot(cars)  # a scatterplot
```

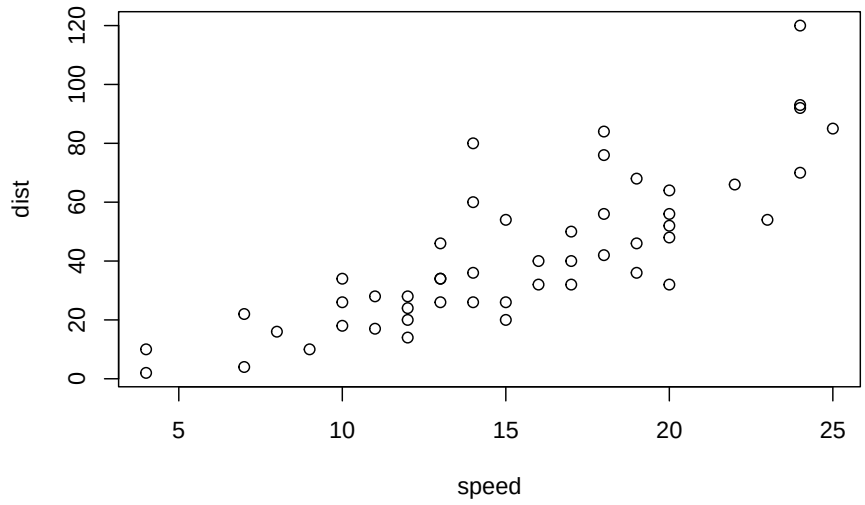

Figure 4: A scatterplot of the data `cars` using **base** R graphics.

[Course information]

[non-English books][Course information]

non-English books2

Figure 1

Cross-reference

Reference a figure by its code chunk label with the `fig:` prefix, e.g., see Figure 1. Similarly, you can reference tables generated from `knitr::kable()`, e.g., see Table 1.

see R Core Team (2021) for details

also Xie (2021) for details

Bibliography

R Core Team (2021). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.

Xie, Y. (2021). *bookdown: Authoring Books and Technical Documents with R Markdown*. R package version 0.23.