# Toolkit for network analysis

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			Thursday	Friday	Т	Fuesday	Wednesday	Thursday	Friday	] [	Tuesday	Wednesday	Thursday	Friday	Т	uesday	Wednesday	Thursday
			March 13	March 14	Ν	March 18	March 19	March 20	March 21		March 25	March 26	March 27	March 28	A	April 1	April 2	April 3
From	То																	
10:15	12:00	CTURE	Outline and Intro	Food webs			Mutualistic networks	Null models	Spatial networks			Network robustness	Genetic networks	Ecological dynamics in networks			Evolutionary dynamics in networks	Exam
	Speaker	LE C	Bascompte	Bascompte			Bascompte	Bascompte	Román			Gonçalves	Román	Bhandary			Cosmo	Pedraz
12:00	13:00		Lunch			Lunch	Lunch	Lunch	Lunch		Lunch	Lunch	Lunch	Lunch			Lunch	Luncł
	Lead	ш	Pedraza	Pedraza		Knop	Cosmo	Pedraza	Bhandary			Gonçalves	Román	Bhandary			Cosmo	
13:00	17:00	EXERCISI	Toolkit for network analysis	Measuring modularity		Sampling an ecological network	Measuring nestedness	Null models	Spatial networks		Open time	Measuring network robustness	Analyzing genetic networks	Models of ecological dynamics in networks		Open time	Models of evolutionary dynamics in networks	

## Course structure



# Plan for today

- i. Rules of the game
- assignments
- iii. Introduction to today's exercise: Toolkit for network analysis

### ii. Introduction to the Course website, RStudio Server, and submitting

# Rules of the game

- exam (up to 2 points).
- iii. Each exercise sessions (afternoons) will be graded on a scale from 1 to 6 by the instructor responsible for that session.
- code runs without errors on the server (more on this later).
- 13:00.

i. Your grade will be determined by the exercise sessions (up to 3 points) and by the final

ii. The exam consists of a multiple-choice test on the topics of the morning lectures.

iv. You are expected to complete the exercise assignments directly on the RStudio Server, after having logged in with their personal credentials. Please make sure that you're

v. Each afternoon assignment must be submitted on OLAT by midday of the next day (more on this later). An exception is the exercise session Sampling an ecological network, for which the assignment should be handed in by Saturday, April 5th at

## Course Website

### The rules of the game, schedule, slides, and afternoon exercises can be found in the course website:

### https://ieubascomptelab01.uzh.ch/bio365-fs25/index.html

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Ecological Networks 2025	=	Q	A	ß	i
Preface					
Learning goals of the course					
Lecture plan			F	<b>-</b> S2	5 EEE
Working settings					
Assessment			c	coordii	nators: J. Ba
General readings			6	)thar l	octurors: S
Acknowledgements					ecturers. 0.
1 Toolkit for network analysis					
<b>1.1</b> Downloading data from the web			F	Pre	face
1.2 Build and visualise networks					
1.3 Exercise			N n	letworl nultiple	ks are usefu e elements. <sup>-</sup>
2 Measuring modularity			tł	ne com	nmunity leve
2.1 Networks and modularity by hand			tr	rophic	cascades, c
<b>2.2</b> Computing modularity in R			C tł	ommu neories	nity. Networ
3 Sampling an ecological network			a	mong	seemingly d
			С	onstra	ints on their



### E321 Ecological Networks

ascompte & F. Pedraza

Bhandary, L. Cosmo, F. Gonçalves, E. Knop, M. Román

In descriptors of ecological systems that put the emphasis on the interactions between They provide a conceptual framework to assess the consequences of perturbations at el. This may serve to assess relevant questions such as how overfishing can cause or how the disruption of mutualisms may reduce the pollination service within a rks are also a means to introduce heterogeneity into our previously homogeneous tions, diseases, and societies. Finally, networks have allowed us to find generalities different systems that, despite their disparate nature, may experience similar r architecture in order to be functional.

Each chapter in the website corresponds to an afternoon's v practical exercise.

The website will be continuously updated as the course progresses to make all exercises available.

Solutions to the exercises will be added as a final subsection to each exercise, after the submission deadline.

### **Course Website: Practical exercises**

### $\bullet \bullet \bullet \bullet$ $\blacksquare \lor \cdot \cdot \cdot \cdot$ ieubascomptelab01.uzh.ch/bio365-fs25/index.html Ecological Networks 2025 E Q A 🖸 i Preface Learning goals of the course **FS25 EEE321 Ecological Networks** Lecture plan Working settings Coordinators: J. Bascompte & F. Pedraza Assessment General readings Other lecturers: S. Bhandary, L. Cosmo, F. Gonçalves, E. Knop, M. Román Acknowledgements **1** Toolkit for network analysis **Preface** 1.1 Downloading data from the web ... **1.2** Build and visualise networks Networks are useful descriptors of ecological systems that put the emphasis 1.3 Exercise multiple elements. They provide a conceptual framework to assess the conser the community level. This may serve to assess relevant questions such as how **2** Measuring modularity trophic cascades, or how the disruption of mutualisms may reduce the pollina 2.1 Networks and modularity by hand community. Networks are also a means to introduce heterogeneity into our pro-2.2 Computing modularity in R theories of populations, diseases, and societies. Finally, networks have allowe



### Chapter 1 Toolkit for network analysis

### Fernando Pedraza

session 13/03/2025

An ecological network is a data set describing a group of species and their reciprocal interaction. Typically, this data is collected by ecologists in the field trough observations. Often, ecologists share their data sets to the wider scientific community. This valuable information then sparks additional research.

Some research groups have gathered network data sets from different publications and compiled them into public databases to facilitate access to the scientific community. Two of such examples are Mangal and Web of life.

In this session you will learn how to download datasets from the Web of life database of experimental ecological networks. You will also learn how to plot the networks and convert them into several formats that are suitable for further analysis.

### **Downloading data from the web of life** 1.1

Web of life is a database of ecological networks developed and maintained by the Bascompte lab. You can find more information on the project in this paper or in this user's manual.

## **Course Website: Practical exercises**

The practical exercises aim to develop concepts introduced during the morning lectures and are designed to be selfcontained.

They demonstrate how to perform network analyses using R.

We ask you to develop your own R script where you replicate the analyses using different parameters, data, etc.





### The RStudio Server can be accessed here:

### <u>https://ieubascomptelab01.uzh.ch/rstudio/auth-sign-in</u>



### VPN and have your user credentials (sent to you via email).

## Course Website: RStudio Server

ieubascomptelab01.uzh.ch/rstudio/auth-sign-in	5 <b>a</b>
Sign in to RStudio	
lisername.	
Password:	
Stay signed in when browser closes	
You will automatically be signed out after 60 minutes of inactivity.	
Sign in	

Note that to connect to the server you will need to be connected to the UZH/ETH



The R script and files you create to solve the assignments should be uploaded to OLAT in the corresponding assignment folder.

You should make sure that your scripts run without errors on the server, so that we can mark them.

## Submitting assignments

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→) Course access (Block Cour								
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Important course informat	03_13_toolkit_network_analysis							
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03_14_modularity	■ 03_18_sampling_an_ecological_network							
03_18_sampling	03_19_measuring_nestedness							



# Toolkit for network analysis

The main goal for today's exercise is for you to learn:

- How to download networks from the Web of Life using R.
- How to construct a network in R.
- How to visualise a network in R.

### You can access the web of life data base at: https://www.web-of-life.es/



**b**ascompte lab



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# Web of Life



# Network terminology

### Network





# Types of networks

### **Unipartite Network**



All nodes are of the same type

**Bipartite Network** 



Nodes can be classified into two distinct groups





Links have different strengths

**Directed Bipartite Network** 



Links have direction

## Ways of representing a network



	Adjacency matrix							Incidence matrix			
	A1	A2	P1	P2	Р3	P4					
A1	0	0	1	1	1	0			A1	A2	
A2	0	0	0	1	1	1		P1	1	0	
P1	1	0	0	0	0	0		P2	1	1	
P2	1	1	0	0	0	0		P3	1	1	
P3	1	1	0	0	0	0		P4	0	1	
P4	0	1	0	0	0	0					

matrix/array

matrix/array



## Example workflow

### i. Connect to the Web of Life database

ii. Download data for a network



iii. Convert the data into a network

Edge list

**Bipartite Network** 



dataframe

