

# STAT 5412

## Biostats 1: Linear Models

Instructor: Justin French

August 15, 2023

RAS 128

10:00 AM - 11:50 AM, M,W,F

**Email (preferred):** [justin.french@sulross.edu](mailto:justin.french@sulross.edu)

**Phone:** (432) 837-8505

**Office Hours:** Fridays, 1:00 PM to 4:00 PM, or by appointment.

### 1 Course Overview

This class introduces the basic concepts, mathematics, and applications of modern statistical methods. We will begin with simple foundations of measurement theory, and steadily build towards framing ecological hypotheses as statistical models. Then we will learn to assess the performance of those models and explore the limitations of simplistic assumptions. We will also touch on the foibles of statistics past, contextualize the long history of statistical impropriety in ecology, and work towards a general statistical literacy throughout the course. By the end of this course you will be able to:

1. Summarize the expected value and uncertainty in your data.
2. Pose a hypothesis in terms of a statistical model.
3. Fit linear models to real data.
4. Interpret the estimated parameters of your models.
5. Assess the performance of fitted models.

### 2 Required Texts

Fieberg, J. 2022. Statistics for Ecologists. An open-source online textbook.  
<https://fw8051statistics4ecologists.netlify.app/>

### 3 General Assignments

I will assign exercises each week to reinforce the material. All work in this class will be done in R, which is a free statistical analysis package (and so much more, as you will see). It is best that you install both R and R Studio, which is a convenient interface. They are available for free download at:

- **R:** <https://cloud.r-project.org/>

- **R Studio:** <https://rstudio.com/products/rstudio/download/>

All assignments integrate written work and statistical results, so we will utilize a typesetting program called  $\text{\LaTeX}$  within R Studio to do all assignments. The easiest and most reliable way to get started with  $\text{\LaTeX}$  in R Studio is called TinyTex, which can be installed following the procedures shown here: [https://www.youtube.com/watch?v\u003dF\\_KI4SLuBs&ab\\_channel\u003dAmeliaMcNamara](https://www.youtube.com/watch?v\u003dF_KI4SLuBs&ab_channel\u003dAmeliaMcNamara)

## 4 Grading Policy

Grades are based on weekly assignments, 1 exam, and the semester project. Each of these categories contribute contribute 33.3% of your final grade.

Letter grades follow:  $100 > A \geq 90 > B \geq 80 > C \geq 70 > D \geq 60 > F$ . There is no curve.

## 5 Attendance

Showing up is the only way to get the material you need. If you don't come to class, your grade will reflect it with no penalty needed from me. In the event of an excused absence, make arrangements with me to get over material ahead of time.

## 6 Academic Dishonesty

Academic dishonesty includes copying, sharing, or obtaining information from an unauthorized source, attempting to take credit for the intellectual work of another person, falsifying information, and giving or receiving information about a test, quiz, or assignment to other students. Any student involved in academic dishonesty will receive no credit (0) for work done and/or may be penalized in accordance with published University Rules.

## 7 Counseling and Accessibility Services

Sul Ross State University is committed to equal access in compliance with the Americans with Disabilities Act of 1973. It is the student's responsibility to initiate a request for accessibility services. Students seeking accessibility services must contact Mary Schwartz, M. Ed., L.P.C., in Counseling and Accessibility Services, Ferguson Hall, Room 112. The mailing address is P.O. Box C-122, Sul Ross State University, Alpine, Texas 79832. Telephone: 432-837-8691. E-mail: [mschwartz@sulross.edu](mailto:m Schwartz@sulross.edu).

## 8 Course Schedule (Tentative)

- Module 1: Basic Concepts
  - **Week 1 (8/28-9/1):** Course Intro and Fundamentals
    - \* Lecture 1: What is statistics anyway?
    - \* Lecture 2: What are (parametric) statistics?
    - \* Lecture 3: A brief introduction to R
    - \* Reading:
    - \* Exercise: A pRimer
  - **Week 2 (9/4-9/8):** The very basics
    - \* Lecture 1: Off for Labor Day
    - \* Lecture 2: Scales of measurement, Central tendency, and variability: what do we expect?
    - \* Lecture 3: Frequency to probability, discrete and continuous events
    - \* Reading:
    - \* Exercise: Continua, Categories, and Interpreting Probabilities
  - **Week 3 (9/11-9/15):** Uncertainty and the Reduction Thereof
    - \* Lecture 1: Understanding the normal distribution
    - \* Lecture 2: Conditioning the normal distribution
    - \* Lecture 3: Conditioning the normal distribution con't.
    - \* Reading:
    - \* Exercise: What is Normal?
  - **Week 4 (9/18-9/22):** The problem of sampling
    - \* Lecture 1: Limited information and levels of uncertainty
    - \* Lecture 2: Distributions... distributions everywhere!
    - \* Lecture 3: Sampling and simulation
    - \* Reading:
    - \* Exercise: Understanding sampling by simulation
  - **Week 5 (9/25-9/29):** Estimating parameters and their uncertainty
    - \* Lecture 1: A little Least-Squares
    - \* Lecture 2: Distributions... distributions everywhere!
    - \* Lecture 3: Confidence intervals
    - \* Reading:
    - \* Exercise:

- **Week 6 (10/2-10/6):** What if variable things are related?
  - \* Lecture 1: Joint distributions and their interpretation
  - \* Lecture 2: Handy parameters of a BVN, Least-Squares shortcuts, and non-parametric analogs
  - \* Lecture 3: Exam Day!!!
  - \* Reading:
  - \* Exercise:
  
- Module 2: Getting to the good stuff: Simple Linear Models
  - **Week 7 (10/9-10/13):** Cause, effect, and covariates.
    - \* Lecture 1: The basic linear model
    - \* Lecture 2: Conditional parameters as hypotheses
    - \* Lecture 3: Discrete and continuous covariates
    - \* Reading:
    - \* Exercise: Conceptualizing your hypothesis/model
  
  - **Week 8 (10/16-10/20):** Parameter estimates with a covariate
    - \* Lecture 1: Least squares again
    - \* Lecture 2: Considering the sampling problem
    - \* Lecture 3: Confidence intervals of estimates
    - \* **Reading:**
    - \* Exercise: The math of fitting simple models
  
  - **Week 9 (10/23-10/27):** Is my little model any good?
    - \* Lecture 1: Diagnostics, test statistics, and  $p$ -values
    - \* Lecture 2: Simple models mean simplistic assumptions
    - \* Lecture 3: Outliers and other anomalies
    - \* **Reading:**
    - \* Exercise:
  
  - **Week 10 (10/30-11/3):** A little more complexity
    - \* Lecture 1: Interpreting models with multiple covariates
    - \* Lecture 2: Fitting and assessing such models
    - \* Lecture 3: Additional assumptions
    - \* **Reading:**
    - \* Exercise:

- **Week 11 (11/6-11/10):** Yet a little more complexity
  - \* **Reading:**
  - \* Lecture 1: Introduction to interaction terms
  - \* Lecture 2: Interpreting interaction terms 1
  - \* Lecture 3: Interpreting interaction terms 2
  - \* **Reading:**
  - \* Exercise:
  
- **Week 12 (11/13-11/17):**Sampling designs and linear models
  - \* **Reading:**
  - \* Lecture 1: Randomized Block Design
  - \* Lecture 2: Structured Sampling
  - \* Lecture 3: Correlative Studies
  - \* **Reading:**
  - \* Exercise:
  
- **Week 13 (11/20-11/24):** Contextualizing the Past
  - \* **Reading:**
  - \* Lecture 1: Significance Testing: A problematic fairy tale
  - \* Lecture 2: Thanksgiving Break
  - \* Lecture 3: Thanksgiving Break

- **Week 14 (11/27-12/1):** Data Transformation Do's and Don'ts
  - \* **Reading:**
  - \* Lecture 1: Transforming to “achieve” normality
  - \* Lecture 2: Log-normal models for population growth
  - \* Lecture 3: Transforming covariates
  - \* Exercise:
  
- **Week 15 (12/4-12/8):** Introducing the General Linear Model!
  - \* Lecture 1: What you've done: The gLM
  - \* Lecture 2: What's to come: the GLM
  - \* Lecture 3: None - Finals Begin
  
- **Week 16 (12/11-12/15):** Final Exam Week
  - \* Final Exam (per SRSU schedule)