Independent Study | in Idaho

STAT 427: R Programming

Providing independent study opportunities for more than 40 years.

Course Guide

Independent Study in Idaho

Self-paced study. Anytime. Anywhere!

STAT 427
R Programming
University of Idaho
3 Credits

Prepared by:
Dr. Brian Dennis
Professor, Department of Statistical Sciences
University of Idaho

Table of Contents

Stat 427 R Programming 3 Semester-Hour Credits: UI

Welcome!

Whether you are a new or returning student, welcome to the Independent Study in Idaho (ISI) program. Below, you will find information pertinent to your course including the course description, course materials, course objectives, as well as information about assignments, exams, and grading. If you have any questions or concerns, please contact the ISI office for clarification before beginning your course.

Policies and Procedures

Refer to the ISI website at **www.uidaho.edu/isi** and select *Students* for the most current policies and procedures, including information on setting up accounts, student confidentiality, exams, proctors, transcripts, course exchanges, refunds, academic integrity, library resources, and disability support and other services.

Course Description

This course is an introduction to the R computer language for scientific graphics, statistical analysis, simulation, and mathematical modeling. Topics include assignment statements, scripts, objects, functions, data management and manipulation, loops and logical structures, vector and matrix calculations, contemporary graphical displays, probability and simulation, dynamic models, numerical optimization, and standard methods of statistical analysis.

Credit not awarded for Stat 424 after Stat 419.

Prerequisite: Stat 251 (3 credits), or Stat 301 (3 credits), or Stat 416 (3 credits) or any equivalent undergraduate introductory statistics course.

15 graded assignments,1 project paper, 0 (Zero) proctored exams
Available online only.

Students may submit up to two assignments per week; however, **assignments and exams must be submitted consecutively, in the order outlined in the course.**

ALL assignments plus project paper must be submitted to receive a final passing grade for the course.

Course Materials

Required Course Materials

- Dennis, B. 2013. *The R Student Companion.* CRC Press, Boca Raton, Florida USA. ISBN: 978-1-4398-7540-7.
- Wickham, H. 2016. *ggplot2: Elegant Graphics for Data Analysis, Second Edition*. Springer, Switzerland. ISBN: 978-3-319-24275-0.
- The student will need regular access to a semi-contemporary laptop or desktop computer (Windows, Mac, or Linux) on which a semi-recent version of R is installed and running.

Course Delivery

All ISI courses are delivered through BbLearn, an online management system that hosts the course lessons and assignments and other items that are essential to the course. Upon registration, the student will receive a *Registration Confirmation Email* with information on how to access ISI courses online.

Course Introduction

R is a computer programming language and package for scientific graphs, calculations, statistical analysis, and mathematical modeling. It was written by scientists, for scientists to use in their work. It is easy to use yet is extraordinarily powerful. R is spreading rapidly throughout the science and technology world (see the article in the New York Times Jan 7 2009 linked in Lesson 1), and it is setting the standards for graphical data displays in science publications.

R is free. It is an open-source product that is easy to install on most computers. It is available for Windows or Mac machines, as well as for Linux/Unix machines. One simply downloads and installs it from the R website (http://www.r-project.org/). At present, there are no R versions for chromebooks or tablets (although there are websites with R servers on which one can run small R programs).

While students in all STEM fields will benefit from knowing R, STEM teachers especially will find that R opens up many possibilities for making science and math exciting for students. Calculating in R is intuitive and fun. Fantastic, publication-quality graphs of data, equations, or both can be produced with little effort. Every high school or college course currently relying on graphing calculators or spreadsheet programs would benefit from using R instead.

I believe R will revolutionize the teaching of introductory college and high school courses in science and mathematics ("science" interpreted broadly to include research-based social sciences, and "mathematics" interpreted broadly to include statistics). This course is intended to get that revolution started! Indeed, R is easy and fun enough to use in middle school and even elementary school.

This course provides an introduction to programming and analysis with R. The material in the course blends programming concepts, scientific graphs, mathematical ideas, and statistical methods toward solving real scientific problems. Applications are drawn from many areas of science. The science and math content are middle- and high-school level, but the approaches are commensurate with daily tasks of researchers all over the world. The skills acquired in this course will carry over into future college courses and professional work and will help to gold-plate any professional resume.

The course is an active course! Readings are not meant to be read; they are meant to be *done*! You should progress through each lesson with a computer at hand, typing/running every R command and evaluating the result.

There are no tests (life will test you plenty on these topics!). Instead, there are work-at-home computational assignments accompanying each lesson as well as a final project paper.

Course Objectives

Learning outcomes:

- Students completing this course will be able to solve most statistical analysis problems appearing in standard undergraduate statistics textbooks with the R software.
- Using the R software, students will be able to prepare excellent publication-quality graphical displays of data as well as undertake substantial scientific calculations and simulations in support of scientific work.
- Students will be able to understand and use basic computer programming concepts such as assignment statements, scripts, logic and control, loops, data management and manipulation, objects.

Lessons

Overview

Each numbered lesson includes a reading and a computational/written assignment. The assignments consist of computational tasks to be performed with R that illustrate, develop, or extend the lesson. You should hand in, via Bblearn, the R code you used for the assignment, the output of the code, as well as typed written responses to any questions posed in the assignment. The assignment portions should be assembled and submitted to Bblearn in the form of a either an MS-Word file (docx or doc file), a pdf file, or an html file. Each lesson is the rough equivalent of 1 week of material in the on-campus semester version of the course (usually 3 class meetings per week, plus homework time), use this fact to scale your personal pacing.

The course project can take many forms, including a data analysis that heavily relies on R (with a report that focuses on the results of the analysis), or a project that explores an unfamiliar aspect of R not covered in the course, such as a contributed function for a specialized analysis or some more advanced programming feature (with a mostly expository report). More details can be found in the Final Project Information section.

The course will require considerable independent study in the form of learning by reading and doing, without the benefit of lectures. However, I welcome questions! I can usually get to answering questions within 24 hours, unless I am traveling away from computers.

Each lesson includes the following components:

- lesson objectives
- reading assignment(s)
- written computational assignment to be submitted

Study Hints:

- Keep a copy of every assignment submitted.
- Complete all reading assignments.
- Set a schedule allowing for course completion one month before your personal deadline. An *Assignment Submission Log* is provided for this purpose.
- Web pages and URL links in the World Wide Web are continuously changing. Contact your instructor if you find a broken Web page or URL.
- The concepts in the course are cumulative; each successive lesson builds on previous lessons.
- This is a course for beginners at computing; concepts will likely be new and unfamiliar. You can expect frustration at first, but you also can expect your learning to snowball as we go!

Refer to the ***Course Rules*** in BbLearn for further details on assignment requirements and submission.

Grading

The course grade will be based upon the following considerations:

Assignments	Points	Percentage
Each assignment	10	5
Total	150	75

Project	Points	Percentage
Project	50	25
Total	50	25

A = 90% to 100%
B = 80% to 89%
C = 70% to 79%
D = 60% to 69%
F = 59% or less

The final course grade is issued after all assignments and the project paper have been graded.

Acts of academic dishonesty, including cheating or plagiarism, are considered a very serious transgression and may result in a grade of F for the course.

About the Course Developer

Your course developer and instructor is Brian Dennis, a professor at the University of Idaho with a joint appointment in the Department of Fish and Wildlife Sciences and the Department of Statistical Science. Dr. Dennis has a master's degree in statistics and a Ph.D. in ecology, both degrees from Pennsylvania State University. His research interests include mathematical modeling, biometrics, statistical ecology, stochastic processes, and computer simulation, especially toward solving pressing problems in ecology and natural resource management. He has authored or co-authored more than 100 scientific publications, including papers in Science, Nature, Proceedings of the National Academy of Science USA, Proceedings of the Royal Society, Biometrics, Ecology Letters, Ecology, and Ecological Monographs. More information here:
https://www.uidaho.edu/cnr/faculty/dennis

Contacting Your Instructor

Instructor contact information is posted on your BbLearn site under *Course Rules.*

Assignment Submission Log Template

Lesson	Projected Date for Completion	Date Submitted	Grade Received	Cumulative Point Totals
1				
2				
3				
4				
5				
6				
7				
Begin discussion of ideas for your project with the instructor around midway through course or earlier. Conduct project, document results, outline report, draft report, revise report, simultaneously with subsequent lessons.				
8				
9				
10				
11				
12				
13				
14				
15				
Be putting final touches on project paper, with time to spare. Submit final project report.				
Project Report				

Lesson 1
About R, and Getting Started in R

Lesson Objectives

In Lesson 1, you will:

- Learn the origins of R and gain an overview of its capabilities.
- Understand arithmetic calculations, assignment statements, variable names, vectors, vector arithmetic, and simple graphs (equation, scatterplot).

Reading Assignment

- New York Times article, *"Data analysts captivated by R's power"* Jan 7 2009:
- http://webpages.uidaho.edu/~brian/R_NYT_article.pdf
- Presentation about R: http://webpages.uidaho.edu/~brian/what_is_R.pdf
- *The R Student Companion* (abbreviated hereafter as *RSC*): Preface, and Chapter 1.

Reading notes:

There is a typo near the bottom of RSC p. 11. The R statement given by "k=b*m/(a+m)" should be "k=a*m/(b+m)" (a and b are interchanged).

Important Terms

Arithmetic symbols	Order of operations	Variable names
Assignment statements	Vectors	Simple graphs with plot()
Adding to plots with point()	R console	

Written Assignment

Before beginning the first written assignment, refer to the **Lessons** section above for your instructor's assignment requirements. If emailing assignments to your instructor, please copy the ISI office at *indepst@uidaho.edu.*

Assignment for Lesson 1:

- Do Computational Challenges 1.1 & 1.2 (*RSC* pp 14-15), and your choice of 1 additional CC in the set.
- Copy/paste your R commands & the resulting output from the console into a word processor document. Submit the document to BbLearn in the form of a Word file (doc or docx), pdf file, or html file.