STAT 527 — Introduction to Statistical Computing

CRN (modality): 31407 (asynchronous online)

Credit Hours: 3

Instructor   Vinayak Rao
Office: MATH 212
webpage: varao.github.io
Office Hours: TBA
E-mail: varao@purdue.edu

Course Website: Brightspace is our course management system, and you can access the course material here. It is strongly suggested that you explore and become familiar not only with the site navigation, but with content and resources available for this course. For example, you will find your course content and student resources in the left-hand course menu. To begin your course, please read the items on the *Content* carefully. The *Content* serves as your central resource linking you to important course deadlines, help files, and instructions for how to get started.

Software We will be studying and using the `R` programming language. Students must have access to a computer with `R` and `RStudio` installed, and have the necessary permissions to install R packages as needed.

Accessibility `R` programming forms a significant component of this course, and some of the lecture material and assignments may present challenges to individuals with additional accessibility requirements. If you anticipate or experience any problems, please contact the instructor as soon as possible to make any necessary accommodations.

Discussions: Brightspace Discussions/Piazza

Required Textbooks:

N. Matloff (2011). *The Art of R Programming: A Tour of Statistical Software Design.* No Starch Press. (Available through Purdue Libraries)

H. Wickham, M. Çetinkaya-Rundel and G. Grolemund (2021). *R for Data Science (2nd edition)* O'Reilly Media. (Available online here: http://r4ds.hadley.nz)

G. James, D. Witten, T. Hastie, and R. Tibshirani (2021). *An Introduction to Statistical Learning: with Applications in R (2nd edition).* Springer Texts in Statistics. Springer New York. (Available online here: https://www.statlearning.com/)

Course Description:

This course provides a thorough introduction to the R programming language, and its use for statistical computing and data science. The course will first look at the fundamentals of R, including different data-structures, control-flow, and the basic vocabulary. An emphasis will be placed on learning idiomatic and efficient R, covering ideas such as recycling, vectorization and functional programming. The course will then look at principles and tools for tasks like organizing data ('tidy data'), manipulating data ('data carpentry'), querying data (through topics like regular expressions) as well as visualizing data (including interactive visualizations). The material and

the homework will encourage development of modular reusable code and reproducible research through ideas such as object-oriented programming and dynamic documents in R Markdown. The last part of the course will study statistical procedures such as least-squares regression, optimization, Monte Carlo sampling and Markov chain Monte Carlo. The course will also involve a final project that allows students to collaborate together and put these ideas into practice.

Course Outcomes

- Utilize dynamic documents and RMarkdown for reproducible research
- Acquire hands-on experience with the elements and structure of the R programming language, including
  1. identifying what data structures are appropriate for a particular task, and how to create and manipulate such data structures,
  2. structuring R code into loops, functions and classes to avoid repetition and facilitate reuse of code blocks.
- Acquire a fluency for idiomatic R programming including vectorization, recycling
- Develop familiary with R packages for data visualization (`ggplot, plotly`), data tidying (`tidyverse`) and model fitting (`lm`)
- Acquire hands-on experience of statistical issues like regularization, bias-variance trade-offs, model selection and cross validation
- Analyze text data in R through regular expressions
- Optimize functions in R through the `optim` function, and the algorithms that underly it.
- Use Monte Carlo and Markov chain Monte Carlo methods to solve analytically intractable statistical problems.

Course Work and Requirements:

	Percentage of Grade
Homework	40%
Midterm 1	20%
Midterm 2	20%
Project	20%

- *Homework* will generally be posted on a Thursday, and due two weeks later. There will be about 7 homework assignments accounting for 40% of your course grade. The lowest homework score will be dropped. R Markdown should be used for homework submission. A short tutorial can be found here: `http://tinyurl.com/gqyoaxm`.
- *Group projects* will be due at the end of the semester. Specific details on the project will be given in a separate handout.

Course Policies

Grading: Grades for this course will be curved, however a good performance will earn you a good grade (so, while it is important not to fall behind your colleagues, there is no competition for a fixed number of A's).

Communication

Miscellaneous basic policy questions: Examples:

- When is the midterm?
- How do assignment due dates work?

Re-read this syllabus and the course website first to be sure it's not already there. If not, post to Brightspace Discussions so that all students can benefit from this additional information.

Help with assignments or course topics: Brightspace Discussions should be the first place you turn to for assistance: if you face a problem, then the odds are than someone else is encountering the same problem. Furthermore, someone else might answer your question before an instructor/TA. If the matter should be private from other students (e.g. something about your code, or a question about your grade), then create a private post. Additionally, office hours are available for direct assistance. If you learned something in the office hour that might help other students - please post it back to Brightspace Discussions for other students if appropriate.

Confidential issues: Do not hesitate to email me directly about more serious/confidential issues at `varao@purdue.edu`

Addressing Questions via E-mail: Your first resource for asking questions should be the class Brightspace Discussions page, where you are likely to get the fastest response, and so other students can benefit from having questions answered. We will prioritize Brightspace Discussions over email, but please do not expect instantaneous answers, or even answers within 24 hours (e.g. by posting right before deadlines). If your question involves debugging code, please be sure to include a minimal working example of your code to the instructors. If your question involves details of your solution, you can post it as a private question. Please do not be offended if the instructor or a TA edits your question (often this is to make a good private question available to other students).

If you send an email to us that would be better suited as a Brightspace Discussions post - do not be offended if we ask you to repost there so we can answer it for the good of all.

Netiquette When interaction online via email or the discussion boards, you are encouraged to comment, question, or critique ideas, but you should not attack other individuals. Consider that sarcasm and humor can be misconstrued in online interactionsand generate unintended disruptions. Please read the Netiquette rules for this course:

- Do not dominate any discussion. Give other students the opportunity to join in the discussion.
- Do not use offensive language. Present ideas appropriately.

- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular and/or slang language. This could possibly lead to misinterpretation.
- Keep an open-mind and be willing to express even your minority opinion.
- Think and edit before you push the "Send" button.
- Do not hesitate to ask for feedback.

Missing Work

Late Policy Homework and Projects are to be submitted by the due date listed in the assignment. *Seven extension days can be applied any time to homeworks/projects, with no explanation needed.* Its use must be stated explicitly at the time of submission at the start of the homework or project. These cannot be rearranged after they are applied to a submission, and cannot be used after the final day of classes. If circumstances arise where you know meeting a deadline will be impossible due to previously unforeseen circumstances you must contact a TA as soon as you can BEFORE the deadline, present the rationale for the extension, and a proposed timeline. Additional extensions will be granted only due to serious and documented medical or family emergencies. *Other than this, no late submissions will be accepted.*

Incompletes: Incompletes will only be given under emergency circumstances, e.g., a serious auto accident, death of family member, etc. (see the grief absence policy for further information). Incompletes will not be given to students failing the course.

Evaluation: Student feedback is essential for any course to be successful. Feedback questionnaires will be included in each assignment. These evaluations should be taken seriously, and will be addressed directly by the instructor.

Re-grading: All grade disputes are to be made on paper, and submitted *directly* to Professor Rao. Discussions or arguments for re-grades will *not* be done in person. A student has until one week after receiving his/her grade to dispute the grade (in writing). Handling re-grades in this manner eliminates the "end of the semester" digging for points.

When disputing a grade, you should state the question, the dispute, and the number of points you feel you should have received for the question. If you do not state the number of points you think are reasonable for the re-grade, zero points will be give as the re-grade. Please note that when you ask for a question to be re-graded, the entire assignment may be re-graded, and there is a possibility of losing points.

Dropping the Course: The instructors reserve the right to *not* sign anyone out of the course once the deadline for dropping without the instructors signature has passed. Please take care to pay attention to these dates.

Grief Absence Policy for Students: Purdue University recognizes that a time of bereavement is very difficult for a student. The University therefore provides the following rights to students facing the loss of a family member through the Grief Absence Policy for Students (GAPS). Students will be excused for funeral leave and given the opportunity to earn equivalent credit and to demonstrate evidence of meeting the

learning outcomes for missed assignments or assessments in the event of the death of a member of the student's family.

Counseling and Psychological Services Information: Purdue University is committed to advancing the mental health and well-being of its students. If you find yourself beginning to feel some stress, anxiety, and/or feeling slightly overwhelmed, try Well-Track. Sign in and find information and tools at your fingertips, available to you at any time. If you need support and information about options and resources, please see the Office of the Dean of Students for drop-in hours (Monday - Friday, 8:00 AM - 5:00 PM). If you or someone you know is feeling depressed and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765) 494-6995, and www.purdue.edu/caps during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

University Emergency Information: In the event of a major campus emergency or temporary suspension of classes, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructors' control. You can get information about changes in this course by means of the course web page, or contacting the instructors via e-mail or phone. You are expected to read your Purdue e-mail on a frequent basis.

Violent Behavior Policy: Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent behavior impedes such goals. Therefore, violent behavior is prohibited in or on any University Facility or while participating in any university activity.

Academic Dishonesty: Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972].

Academic integrity is one of the highest values that Purdue University holds. You are encouraged to alert university officials to potential breeches of this value by either e-mailing integrity@purdue.edu, calling 765-494-8778, or contacting the Office of the Dean of Students (www.purdue.edu/odos). While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern. Bonus points will be given to students who report instances of cheating.

Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the Office of Student Rights and Respon-

sibilities (OSRR, www.purdue.edu/odos/osrr) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a failing or zero grade for that particular assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered. Use of instructor solution manuals or related resources will not be tolerated.

Use of Copyrighted Materials: Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by the instructors are protected by copyright unless the instructors have stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Notes taken in class are, however, generally considered to be "derivative works" of the instructors' presentations and materials, and they are thus subject to the instructors' copyright in such presentations and materials. No individual is permitted to sell or otherwise barter notes, either to other students or to any commercial concern, for a course without the express written permission of the course instructor. To obtain permission to sell or barter notes, the individual wishing to sell or barter the notes must be registered in the course or must be an approved visitor to the class. Course instructors may choose to grant or not grant such permission at their own discretion, and may require a review of the notes prior to their being sold or bartered. If they do grant such permission, they may revoke it at any time, if they so choose.

Students with Disabilities: Purdue University is required to respond to the needs of the students with disabilities as outlined in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 through the provision of auxiliary aids and services that allow a student with a disability to fully access and participate in the programs, services, and activities at Purdue University.

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic behaviors based on disability, you are welcome to let the instructors know so that they can discuss options. You are also encouraged to contact the disability resource center at drc@purdue.edu or by phone 765-494-1247. If you have a disability that requires special academic accommodation, please make an appointment to speak with the instructors within the first three (3) weeks of the semester in order to discuss any adjustments. It is important to talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center (www.purdue.edu/drc) of an impairment/condition that may require accommodations and/or classroom modifications.

Nondiscrimination: Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture di-

versity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue University's nondiscrimination policy can be found at www.purdue.edu/purdue/ea_eou_statement.php.

Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Executive Memorandum No. D-1, which provides specific contractual rights and remedies. Any student who believes they have been discriminated against may visit www.purdue.edu/report-hate to submit a complaint to the Office of Institutional Equity. Information may be reported anonymously.

Protect Purdue The Protect Purdue Plan, which includes the Protect Purdue Pledge, is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include:staying home and contacting the Protect Purdue Health Center (496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask in classrooms and campus building, at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace prior to and after use, maintaining appropriate social distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to,during and after class, and following all safety directions from the instructor. Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university. Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not wearing a mask) may leave the room without consequence. The student is encouraged to report the behavior to and discuss next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights.

Disclaimer

This syllabus is subject to change.