PSYCH 413: Design and Analysis in Experimental Psychology
850 — Fall 2026

Instructor Information

Name: Dr. Jeffrey M. Pisklak (he/him)
Office: BS-P535
Email: pisklak@ualberta.ca
Office Hours: TBA

Class Information

Class Dates: January 5 - April 10
Lecture Days and Times: Tuesday and Thursday 09:30 - 10:59 (80-min via Zoom)
Lab Days and Times: Tuesday and Thursday 11:00 - 12:20 (80-min via Zoom)
Classroom: Online synchronous lecture and lab via Zoom.
Course Website: https://jpisklak.github.io/courses/PSYCH_413_wi2026/index.html

Teaching Assistant

Teaching Assistant: Angely Claire Suerte
Email: suerte@ualberta.ca

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1 Territorial Acknowledgement

The University of Alberta, its buildings, laboratories, and research stations are primarily located on the territory of the Néhiyaw (Cree), Niitsitapi (Blackfoot), Métis, Nakoda (Stoney), Dene, Haudenosaunee (Iroquois) and Anishinaabe (Ojibway/Saulteaux), lands that are now known as part of Treaties 6, 7 and 8 and homeland of the Métis. The University of Alberta respects the sovereignty, lands, histories, languages, knowledge systems, and cultures of all First Nations, Métis, and Inuit nations whose cultures continue to influence our vibrant community.

2 Course Calendar Description

Provides the background necessary to design and analyze data in any area of experimental psychology and prepares students to conduct original research. Topics include sampling distributions and hypothesis testing; issues in and analysis of between-subjects, within-subjects, and mixed designs; trend analysis; planned and post hoc comparisons; fixed and random effects factors; and efficiency and power of various experimental designs.

Prerequisites

PSYCH 212, PSYCH 213 or STAT 151 or 161, and PSYCH 313 or STAT 252 or permission of the department. [Faculty of Science]

3 Course Philosophy & Goals

This course provides an overview to the statistical methodologies that support a wide range of experimental designs in Psychology. Particular emphasis is placed on understanding the underlying principles and assumptions of these methods, alongside guidance on best practices in modern research—such as the use of robust measures of central tendency. The course also introduces students to statistical computing using the R programming language, a key tool in contemporary scientific research across disciplines. This programming-based approach not only equips students with practical skills but also reflects a commitment to ethical, transparent research practices. In keeping with the ideals of Open Science, the course avoids reliance on costly proprietary software or restrictive file formats, ensuring accessibility and reproducibility.

3.1 By the end of this course, you should . . .

- **Overcome statistical anxiety:** Develop confidence in working with data and understand how to leverage R as a user-friendly and powerful tool.
- **Master data handling:** Learn to manage, organize, and summarize large and diverse datasets effectively.
- **Understand behavioural research:** Appreciate core principles of data analysis and how they are applied to study human and animal behavior.
- **Design effective studies:** Gain the ability to create experiments and studies that are coherent, analyzable, and methodologically sound.
- **Build analytical foundations:** Acquire foundational skills to approach more advanced statistical methods in psychology and related fields.
- **Embrace robust science:** Appreciate the utility of robust statistical methods and lament at their lack of inclusion in a lot of modern research.
- **Enhance computer literacy:** Improve your ability to use computational tools to solve real-world problems.
- **Feel confident learning new statistical concepts:** Feel more confident that you have the tools and background to learn new statistical concepts when the need arises.
- **Worship at the altar of R:** Give in to the majesty that is open-access statistical computing — an essential element of all modern research.

4 Course Objectives/Outcomes

This course is organized into topics, each with a general learning outcome supported by specific learning outcomes. These can be found in the syllabus Appendix located at the end of this document. In addition, the Appendix also lists what portions of the textbook are required reading for students.

5 OMG! Why does this course use R?!

(My friend didn't have to learn that in their stats course!)

The decision to use R (a programming language) in a Psychology focused course may seem strange, but there are many compelling reasons to learn it in place of the kinds of proprietary software (e.g., SPSS) that have been traditionally employed (and justifiably disliked by students) in these types of courses.

- **Free and Open Source:** R is open-source software, meaning students can not only access it for free, there is a wealth of complementary open-source packages freely available for specialized analyses and tasks.

- **Versatility in Data Analysis:** R is a powerful tool and was literally developed for conducting statistical analysis, data visualization, and data manipulation. It is used widely across academia and various other fields such as business, healthcare, and government.
- **Strong Community Support:** R has a large and active community that contributes to a vast array of impressive packages, tools, and resources. This means students can easily source help, tutorials, and code examples for almost any task.
- **Reproducible Research:** Aligned with open-science principles, R is built for reproducible research—a crucial aspect in both academic and professional environments. It enables students to create scripts that can be easily shared, reviewed, and rerun, ensuring their work is transparent, accurate, and reliable.
- **Integration with Other Tools:** R can easily integrate with other software and programming languages, such as Python, SQL, HTML, $\LaTeX$, and even (ugh) Excel. This makes it a valuable tool for working in diverse computational environments.
- **Growing Demand in the Job Market:** R is highly valued in the job market, especially in data science, analytics, and research roles. Learning R can open up numerous career opportunities for students.
- **Advanced Statistical Capabilities:** Many of R's packages make it easy to apply best practices in statistics (e.g., the use of robust methodologies) and can readily employ newer and more complex types of analyses.
- **Enhanced Data Visualization:** R offers powerful and intuitive packages like ggplot2 for sophisticated and customizable data visualizations, helping students communicate their findings effectively.
- **Learning Curve and Educational Value:** While R has a learning curve, it is no steeper than expensive proprietary point and click programs like SPSS. Moreover, working with R teaches valuable problem-solving and programming skills that generalize to (and thus are an excellent first step towards learning) other programming languages.

6 Math, Stats, and Programming Help

Learning is an active process, and seeking help when you need it is an important part of that process. Many resources are available to support you, but it is up to you to take the initiative to seek them out. Your primary point of contact is the instructor. If you are facing challenges, do not hesitate to attend office hours or send an email. It is important to address any issues, whether course-related or not, *as soon as they arise*. If you cannot attend office hours, reach out via email to arrange an alternative meeting time.

> The course content builds on itself. Concepts introduced early form the foundation for later material, so unresolved difficulties can accumulate and become harder to address over time. By seeking clarification promptly, you help prevent small gaps from becoming major obstacles to your progress.

With respect to R programming specifically, the most time efficient way to seek help is to email the instructor with a brief description of the problem you are having and ensure that you have shared a copy of your R code (i.e., the .IPYNB file). This will allow the instructor to quickly run and spot issues with the code.

7 Minimum Technology Requirements

This course introduces students to both statistics and statistical computing using the R programming language for statistical computing. To successfully participate in this course, it is recommended that students have, at a minimum, access to a computer with an internet connection that can support the tools and technologies the University uses to deliver content, engage with instructors, teaching assistants, fellow students, and facilitate assessments. Student access of the UofA library computer laboratories is more than sufficient in this respect. For more details about technology access through the UofA libraries visit:

https://www.library.ualberta.ca/services/technology

For an optimal learning experience, please review the University's minimum technology specifications.

Please note that while tablets and Chromebooks can be used, they are not recommended, as they may impose limitations that make completing course tasks more challenging.

If students have questions or concerns about these requirements, they should reach out to the instructor at the start of the term. Not addressing these issues promptly may result in a zero for assessments requiring the specified technology.

8 Recommended Course Materials

1. **Textbook: Discovering Statistics Using R by Andy Field**

   - A second edition of the book is pending for March but not yet available (so it may be difficult to find hard copies of the first edition).
   - This book walks through many of the statistical methods we will discuss in class in a clear manner and works as an excellent reference that will serve you well throughout your university career. It covers many topics we will not have the time to cover. The book is also a hilarious read. A couple of the R functions at the start of the book are a bit outdated, though that shouldn't impact its usefulness to you.
   - Note that the UofA library has many different introductory stats textbooks which are probably as good as this one in terms of the statistical information provided. Do not feel as though purchasing this book is a requirement for the course. Students often ask for a recommended textbook so they have easy access to supplementary explanations. There is no ideal book for this course, but if I have to recommend one to you, "Discovering Statistics" is the one I would. Other helpful statistics and R resources can be found on the course webpage "Useful Student Links" section.

2. **Textbook: R for Data Science (2e) by Hadley Wickham, Mine Çetinkaya-Rundel, & Garrett Grolemund**

   - Free (open source) eBook version available at https://r4ds.hadley.nz/
   - A useful textbook for learning R and the tidyverse specifically. It's also free.

9 Tentative Lecture Schedule

See the current Calendar for the Academic Schedule, Dates, and Deadlines, which include the Registration Add/Drop deadline and Withdrawal date: https://calendar.ualberta.ca/content.php?catoid=56&navoid=17524

Week	Dates	Topic
1	Jan 05 - 09	- Getting Started with R
2	Jan 12 - 16	- Getting Started with R - *Add/drop deadline (Fri)*
3	Jan 19 - 23	- Summarizing and Evaluating Distributions
4	Jan 26 - 30	- Summarizing and Evaluating Distributions - Sampling Distributions
5	Feb 02 - 06	- Single Sample Design - Comparing Two Independent Group Means
6	Feb 09 - 13	- Comparing Two Dependent Group Means

7	Feb 16 - 20	- *Reading Week*
8	Feb 23 - 27	- **Midterm Exam (Tues - No Lecture)** - Simple Linear Modelling
9	Mar 02 - 06	- Plotting Assignment Instructions - Extending Simple Linear Models
10	Mar 09 - 13	- Extending Simple Linear Models
11	Mar 16 - 20	*Reading Week*
12	Mar 23 - 27	- Comparing More than Two Independent Group Means (Along a Single Factor)
13	Mar 30 - Apr 03	**Plotting Assignment Due (Fri by Midnight)** - Multi-Group Designs: Comparing More than Two Independent Group Means Along Two Factors
14	Apr 06 - 10	- Comparing More than Two *Dependent* Group Means Along a Single Factor - Inference with Categorical Variables (Time Permitting)
	Apr 17	**Final Exam at 17:30**

Notes:

- Schedule is (very) tentative; topics and order may change.
- A listing of the topics and their associated learning outcomes can be found in the Appendix at the end of this document.
- Exams cover all material up to the exam date (unless noted otherwise in class).
- Students must confirm final exam date and time on BearTracks once posted.

It is the student's responsibility to stay up to date with lectures to ensure they do not miss important announcements about upcoming assessments, deadlines, and schedule changes.

9.1 Midterm and Final Exam Conflicts with Regularly Scheduled Classes

Time conflicts between regularly scheduled class periods (as listed on BearTracks) and term exams from other courses will not be accommodated. If a term exam from another course overlaps with a scheduled class time, it is the student's responsibility to contact the instructor of the intruding course to request an accommodation. As noted in the University Calendar:

> "...Students have the right to attend regularly scheduled class activities. Therefore, if a student has a conflict between a regularly scheduled class and a scheduled term examination, the instructor of the class in which there was a scheduled term examination will be required to make an accommodation for the student."

10 Grade Evaluation

10.1 Minimum Criteria for a Passing Grade (D or higher)

To earn a passing grade in the course, students must satisfy both of the following requirements below. These criteria establish a fixed baseline of performance; meeting them does not guarantee a specific letter grade, but ensures that they will not receive an F.

1. Exam performance requirement

The weighted mean raw percentage score across the midterm and final exams must be ≥ 30%, calculated as:

$$\text{Pass} = \frac{(\text{Midterm\%} \times 30\%) + (\text{Final\%} \times 38\%)}{30\% + 38\%} \geq 30\% \tag{1}$$

The exam weights (30% midterm, 38% final) are taken from Table 3.

Note: Any weight adjustments applied elsewhere in the course (e.g., transfers from other assignments) do not change the calculation in Equation 1; passing requires meeting the threshold based on the original exam weights.

2. Homework completion and performance requirement

Students must complete at least 60% of homework assignments and obtain a weighted mean raw percentage score ≥ 50% across those completed assignments.

These requirements ensure that students demonstrate a minimum level of engagement and understanding in both cumulative exams and ongoing coursework before a passing grade can be assigned.

10.2 How Course Performance Is Evaluated

Meeting the minimum passing criteria stated above (see section 10.1) reflects the minimum achievement of the core learning outcomes. Grades above that threshold are assigned based on performance of a robust, difficulty-adjusted scale designed to correspond more faithfully and reliably to the University's letter-grade descriptors than traditional percentage cutoffs can.

Each assessment's raw percentage score is rescaled to a common standard that establishes a consistent centre and spread across assessments. This has the benefit of adjusting for differences in assessment difficulty and variability so that, when combined into a total score, each course component contributes fairly to the final grade (i.e., students are not penalized for overly difficult assessments nor rewarded for easy ones) and produces values that can be mapped, *a priori*, to the University's letter-grade descriptors in a principled way.

This process does not impose quotas, force a curve, or normalize scores to a fixed distribution; it is a method of scale alignment, not norm-referencing.

10.2.1 How raw percentages are rescaled

A student's raw score on each assessment (e.g., midterm, homework assignments, etc.) is converted to a standardized score using Equation 2:

$$\text{Standardized Score} = \frac{\text{Raw Score} - \text{Median}}{\text{MADN}} \tag{2}$$

“Raw Score” indicates a student’s raw percent score on an assessment (e.g., the midterm). The “Median” and ”MADN” summarize the statistical centre (i.e. average) and spread respectively for that assessment. Students may be less familiar with the notion of spread, but it matters because it shows how tightly or loosely scores are grouped around the average. This is information that helps interpret what a raw score really means.

On this scale, 0 represents the class average. Positive values indicate above-average performance, with scores near or above +1 reflecting clearly strong results. Negative values indicate below-average performance, with scores near or below –1 reflecting clearly weaker results. How these scores map to letter grades specifically can be seen in Table 2.

The standardized scores for each assessment are then combined as outlined in section 10.2.2 below.

Additional info for those interested:

- Students do not need to calculate their own standing in the course. Each student will have access to a personal gradebook page that displays their raw percentage score for every assessment, the corresponding weight, and the class median and MADN (which indicate overall performance and spread, respectively). Standardized scores for each assessment and for the total course grade will also be provided, along with visual summaries of the class distribution to help contextualize results in a “non-numeric” way.
- The median and MADN are used because they retain accuracy even in the presence of outliers or skewed distributions. MADN refers to the ”normalized median absolute deviation” and is a *robust* measure of spread analogous to the standard deviation (and is the focus of one of the topics in the course).
- Conceptually, the transformation applied by Equation 2 is analogous to a common z-score, but replaces the mean and standard deviation with the median and MADN. This makes the re-scaling robust under skewed or irregular distributions.
- Applying Equation 2, the class median (i.e., average) of an assessment becomes fixed at 0, which is set to correspond to a B letter grade in this class (see Table 2). Anchoring the standardized median at B matches the University’s formal meaning of the letter’s broader category (i.e., “good” performance) and aligns typical achievement in this course with University norms for a fourth-year offering.
- Unsubmitted course-work (i.e., non-submissions) are not included in the determination of the median and MADN, since the lack of an attempt provides no information about the difficulty of the assessment.

10.2.2 Combining assessments

The standardized scores of all the assessments are combined using a weighted mean (weights are listed in Table 3) to produce an overall course total. Because applying different weights to components may shift the centre and spread of the combined scores away from 0 and 1 respectively, this total is also converted to a standardized score (see Equation 2) so that the class median is again anchored at 0 with the same spread convention. This final step ensures that a student’s overall score remains directly interpretable using the letter-grade boundaries in Table 2.

Because a weighted mean is sensitive to extreme values, standardized assessment scores are capped at ± 3.5 to ensure that no single assessment overwhelms the final grade. The value ± 3.5 corresponds to the range within which virtually all standardized scores fall under typical performance variation (i.e., beyond this point differences are no longer educationally meaningful), providing a clear limit on both unusually high and unusually low results. Unexcused non-submission is recorded as a zero and, after standardization, receives the lowest capped score.

If a student withdraws from the course, performance on assessments completed prior to withdrawal continues to inform the statistical calibration of those assessments (e.g., median and MADN), as it reflects completed work and assessment difficulty. After withdrawal, the student is removed from subsequent assessments and course-total calculations.

10.2.3 Assigning letter grades

Final letter grades are determined by comparing the overall course total described above (see section 10.2.2) to a fixed set of grade boundaries (see Table 2). These boundaries were established in advance, informed by historical student performance, instructor judgment, and the realities of aggregating values with comparable centres and spreads. They **do not** and **cannot** enforce a predetermined distribution of grades. Each student's grade depends only on their own performance relative to the class median and spread, not on how many classmates fall into each category.

Standardized Score (x)	Descriptor	Grade Points	Letter Grade
$1.15 \le x < \infty$	Excellent	4.0	A+
$0.974 \le x < 1.15$		4.0	A
$0.739 \le x < 0.974$		3.7	A–
$0.332 \le x < 0.739$	Good	3.3	B+
$-0.088 \le x < 0.332$		3.0	B
$-0.454 \le x < -0.088$		2.7	B–
$-0.806 \le x < -0.454$	Satisfactory	2.3	C+
$-1.175 \le x < -0.806$		2.0	C
$-1.598 \le x < -1.175$		1.7	C–
$-2.17 \le x < -1.598$	Poor	1.3	D+
$-\infty \le x < -2.17$	Minimal Pass	1.0	D
NA (see section 10.1)	Failure	0.0	F

Table 2: Letter Grade Boundaries. Each grade covers scores from its listed lower limit up to (but not including) the upper limit. Table values are displayed rounded to three decimal places. Actual cutoffs are more precise.

This table contains an approximate guideline for the course; however, the instructor reserves the right to adjust this table to correspond to University-suggested ranges and assign appropriate grades based on relative performance.

Grades are unofficial until approved by the Department and/or Faculty offering the course.

🤔 FAQ about Grade Evaluation

- **Q: Why don't you just use the percentage scores like most classes?**

  A: Raw percentages can be misleading because the same number can reflect very different levels of performance depending on the difficulty of the assessment. For example, 60% might be excellent on a challenging exam, whereas 85% might be average on an easier one.

  Assigning letter grades directly from raw percentages requires the instructor to accurately anticipate the centre (average) and spread (variability) of each assessment, as well as how those distributions will combine when course components are aggregated. Outside of a course that is taught and assessed in exactly the same way every term, making these predictions with meaningful precision is extremely difficult. As a result, most instructors rely on traditional percentage cutoffs (e.g., 90% = A) as a practical convention rather than the outcome of a carefully calibrated, course-specific grading model. This means that raw percentage scales can drift unpredictably from one assessment to the next, and from one course offering to the next, making their letter-grade interpretations inconsistent. An A in one course (or section) can therefore represent a very different level of difficulty, effort, or demonstrated learning than an A in another.

  Standardization avoids these problems. After standardization, the scale is consistent and interpretable across all assessments:

  - 0 always represents the class median (i.e., average performance)
  - Positive values reflect above-median performance (around +1 = clearly strong performance).

- Negative values reflect below-median performance (around –1 = clearly weaker performance)

This approach prevents a hard exam or assignment from dragging down the entire class and stops an easy one from inflating grades. i.e., the meaning of a score stays tied to performance, not difficulty.

From the instructor's perspective, standardization also supports principled and transparent grade boundaries. Because each assessment is on a common scale with a known centre and spread, combining components yields overall scores with predictable structure (even though the distribution of letter grades is not predetermined). This makes grade boundaries easier to set and interpret and helps align final grades more closely with their intended meaning.

- **Q: I don't understand any of this! Can you just give a simple example of why you believe standardization is beneficial?**

  A: Yes. Imagine two quizzes worth the same weight in the course. One turns out to be very difficult, with a class average of 55%; the other is much easier, with a class average of 85%.

  If we used raw percentages directly, a score of 72% on the difficult quiz would appear worse than a score of 80% on the easy quiz, even though earning 72% on a hard assessment likely reflects stronger understanding than earning 80% on an easy one. Standardization corrects for this mismatch by placing both results on a common scale that reflects how each score compares to the class.

  After standardization, the two results become directly comparable:

  - The 72% score would appear above the standardized centre (0), indicating stronger performance.
  - The 80% score would fall below the standardized centre (0), indicating weaker performance relative to peers.

  This makes averaging across assessments more meaningful because you are combining values expressed on the same scale, not raw percentages influenced by how forgiving or demanding a particular assessment happened to be.

- **Q: Is this the same as "grading on a curve"?**

  A: No. While both standardization and curving involve thinking about how student scores relate to the rest of the class, they are fundamentally different. Grading on a curve typically ranks students by performance and then assigns a fixed number of each letter grade (e.g., only the top 2.5% receive an A+), regardless of how well the class actually performed. This creates a zero-sum allocation: for one student to move up, another must move down, and the amount of each letter is capped in advance. Instructors using this approach impose a curve on the grade distribution rather than allowing the grade distribution to reflect the class's actual performance.

  In contrast to that, this course does not use quotas or predetermined distributions. Instead, standardized scoring helps ensure fairness across assessments, and the actual number of A's, B's, C's, etc. *emerges* from how the class performs, not from an imposed formula — fully in line with University policy prohibiting mandatory curves. See University of Alberta Assessment and Grading Policy.

- **Q: Is this grading system competitive?**

  A: Only in a limited and generally healthy sense. Standardized scores are interpreted relative to the class median, so your performance is understood in relation to the class rather than in isolation. In that way, there is a mild competitive element: performing well relative to the class raises your standardized score, and performing below the class median lowers it.

  However, this does not mean that grades are capped or that students are ranked against one another. There are no quotas, no predetermined number of high grades, and no requirement that some students must receive lower grades for others to receive higher ones. If many students perform strongly, many students can earn strong grades.

  Put simply: your performance is interpreted in the context of the class, but your success does not come directly at someone else's expense.

- **Q: Can everyone get an A?**

  A: Not realistically. An A or A+ is meant to signal *extra*ordinary performance — achievement that clearly stands out from the rest of the class. If everyone earned the same top grade, then by definition no one's performance would be extraordinary (it would be ordinary), and the grade would lose its meaning. Because scores are standardized around the class median, only those who perform well above that benchmark end up in the A range. In practice, this means that while many students can do well, top grades remain a mark of truly exceptional achievement.

- **Q: If the median is always 0 (B), does that mean half the class will fail?**

  A: No. The median is simply a sensible anchor point for the scale. Students above 0 are above average and may receive grades ranging from B to A+; students below 0 are below average but may still earn passing grades (C's and D's). In most classes, the majority of students pass. The exact distribution of grades depends on how the whole class performs, not on a fixed quota.

- **Q: Does this system disadvantage strong students?**

  A: No. Standardization preserves performance differences: students who perform well compared to their peers will always receive higher standardized scores and thus higher letter grades.

- **Q: What does it mean that the grading method is "robust"?**

  A: In statistics, "robust" means that the method is not thrown off by unusual values or outliers. For example, if one student happens to score extremely low or extremely high, a robust method won't let that single score shift the whole class's average or spread. That's why this system uses the median (the middle score) instead of the mean (the arithmetic average), and the MADN (a spread measure based on the median) instead of the standard deviation. These choices make the standardized scale more stable and fair, especially in classes where exams or assignments occasionally produce extreme results.

- **Q: How can I estimate my standing during the term?**

  A: After an assessment has been marked, you will receive both your raw score and your standardized score on your personal gradebook page. The standardized score is the one that counts toward your final grade. By comparing your standardized score to the published letter grade boundaries in Table 2, you can track your progress throughout the term. Additional stats and graphs will be provided as well to give you a sense of your standing as well.

- **Q: Can you show how to convert a raw score to a standardized score?**

  A: Yes. The standardized score is calculated in a way similar to a z-score, but it uses the class median and the normalized median absolute deviation (MADN). The formula is:

  $$s = \frac{x - m}{\text{MADN}}$$

  where x is the raw score of an assessment (e.g., the midterm), m is it's class median, and MADN is a measure of its spread.

  1. Suppose a student gets a raw score of $x = 88$%.
  2. Suppose the class median on an assignment is $m = 79$%.
  3. Suppose MADN $= 11.9$%, we therefore compute:

  $$s = \frac{88 - 79}{11.9} \approx 0.76$$

  So in this example, a raw percent score of 88% converts to a standardized score of about 0.76. This value indicates performance well above the class average (0), and it would then be compared to the fixed letter grade boundaries in Table 2, which shows this is an A- level of performance.

- **Q: What if I have questions or concerns about the grading system?**

  A: If you have questions, uncertainties, or well-reasoned concerns about how grading works in this course, I strongly encourage you to talk with me (your instructor) about them. The grading system is designed to be principled, transparent, and fair, but it is also unfamiliar to many students at first. Conversations are often helpful for clarifying how standardized scores are interpreted, how different components contribute to the final grade, and how this approach differs from traditional percentage cutoffs.

10.3 Components of Course Grade

Assessment	Weight	Date Provided	Date Due
Attendance (all)	2%	NA	NA
Homework Assignments (all)	24%	Fridays by 17:00	Fridays by 23:59
Plotting Assignment	6%	Mar 3^{rd} at 23:59	April 3^{rd} by 23:59
Midterm	30%	Feb 24^{th} at 09:30	Feb 25^{th} by 09:30
Final Exam*	38%	April 17^{th} at 17:30	April 18^{th} by 17:30

Table 3: Assignment and Exam Weightings and Due Dates

- *Students must verify this date on BearTracks when the Final Exam Schedule is posted.
- Unless otherwise specified by the instructor, exams will cover all content completed up to the date of the exam.
- Deadlines marked as "by" a specific time mean that submissions must be completed before that time. Any submission made *at* the specified time or *after* it will be considered late.
- The relative weight of individual homework assignments may vary based on the estimated workload involved.

10.4 Re-examination

There is no possibility of a re-examination in this course.

11 Format of Assessments

11.1 Attendance

To support your learning and help you succeed in this course, all lectures will be recorded and (barring any technical issues or forgetfulness on the part of the instructor) made available on the course website. These recordings are intended as a supplement to your in-class experience. i.e., they are intended for reviewing complex material, improving your notes, or catching up if you miss a class due to unforeseen circumstances. However, the availability of recordings should not be seen as a substitute for regular attendance. Because the course moves quickly, students who rely solely on recordings and fall into the habit of procrastination are likely to fall behind.

To encourage consistent engagement, attendance will be monitored at *random* points throughout the term. Each attendance check contributes to your overall attendance mark. If, for example, you attend 10 out of 13 checks, your attendance score would be approximately 77%. That said, you are allowed up to **three free passes**. i.e., these missed checks will not count against you. Any absences beyond that will reduce your attendance score accordingly.

Students with specialized, ongoing commitments (e.g., work obligations during lecture hours) may appeal to have the full attendance component reallocated to the final exam. Such appeals must be made as soon as the commitment is known, and approval is at the discretion of the instructor.

Attendance checks will begin following Winter Term Add/Drop Deadline on January 16th.

11.2 Format of Weekly Homework Assignments

Homework assignments will be posted each Friday by 17:00 (often earlier) in the homework section of the course website. These will consist of take-home questions and datasets designed to reinforce key concepts from lectures. Completed assignments must be submitted via the Canvas portal (linked on the course website) by 23:59 the following Friday.

Individual questions within each assignment may carry different weights, reflecting their ability to differentiate levels of student understanding. Similarly, the weight of each assignment toward your final grade may vary depending on the scope and workload involved. Collectively, homework accounts for 24% of your overall course grade.

Mastering statistics requires consistent, hands-on engagement. These assignments are your primary opportunity to apply what you've learned, diagnose areas needing improvement, and stay aligned with the pace of the course. Regular completion is not only recommended, it is essential for success.

11.2.1 Late Penalties

Be aware that there are no late penalties for assignments in this course. Failing to submit before a due date will result in a mark of 0. For details surrounding missed deadlines, see section 13 of the syllabus.

> The homework assignments are intentionally designed to be relatively easy so that students can practice applying the material and build confidence through repeated success. They carry marks so students have a clear incentive to complete them regularly. Consistent practice is essential for mastering the skills covered in the course. Because of this design, high (raw) homework scores are expected from most students and should not be interpreted as evidence of exceptional or "A" level performance. Rather, strong homework results indicate typical, competent engagement with the material, which is exactly their purpose.

11.3 Format of Exams

Both the midterm and the final will consist of take-home questions and data provided to students via the exam section of the course website. Questions will be made available to the student at the appointed exam time listed in Table 3. Students will be permitted 24 hours to complete and submit the exam. Exams should be submitted via the Canvas link provided on the course website, in a similar manner to that of homework assignments. Questions may carry different weights based on their significance in evaluating student performance within the course.

The take-home nature of the exams does not permit collaboration with other students. You are expected to produce your own code and results. Violation of this will constitute a form of academic misconduct.

Should technical issues arise with Canvas, the student's computer, or their internet access, it is recommended that students *share* their completed exam (using Google Colaboratory's share function) with the instructor along with a detailed explanation and corroborating photo or video evidence of the issue (as taken with a cell phone). In these instances, late penalties incurred will be at the discretion of the instructor.

Unless specified otherwise by the instructor, the exams will cover all content completed up to the date of the exam.

11.3.1 Representative Evaluative Material

Homework assignments offer the most accurate preview of the question formats and material that students can expect on both the midterm and final exam. However, two sets of sample exams designed to reflect the style and format of actual exam questions on the midterm and final, will be provided on the course website. Please note that while the sample exams may be a helpful tool, they should not replace thorough studying.

12 Statement of Expectations for the use of Artificial Intelligence (AI)

In this course, the use of AI tools (e.g., GPT-5, DALL-E, Stable Diffusion) is permitted, provided it is **ethical, transparent, and responsible**. If AI has contributed in a *significant* way to your submitted work—such as drafting text, generating substantial code, or outlining a problem solution—you must acknowledge that contribution. Minor or incidental uses (e.g., asking for a syntax reminder, checking a small calculation) do not require formal citation, but you are still responsible for the accuracy and integrity of the result. For guidance on formal citation when needed, see the U of A Library's page on How to Cite AI.

Using AI to gain an unfair advantage undermines both your learning and the integrity of the academic community, and may violate U of A policy. See Section 3, Student Academic Integrity Policy Appendix A: Academic Misconduct.

Be appreciative of the fact that, while AI is a powerful and highly useful tool, it does have many limitations. It may not always fully "understand" context or nuance, often follows the most popular practices (as opposed to the best practices) and all its outputs should be critically reviewed to ensure accuracy and relevance to the task at hand. This means that, while AI can enhance our capabilities, it should be used judiciously to maintain the integrity and quality of a persons academic work. Please note that students will be held responsible for any confusing, erroneous, false, offensive, plagiarised, or unethical content provided by AI within their work, so exercise caution and diligence in its use.

12.1 Using AI in This Course: Guidelines and Best Practices

AI can support and enhance your learning if used wisely. It should **complement** your own thinking, not replace it.

The Wrong Way to Use AI

Relying on AI solely to "get the answer" for coding, math problems, or other assignments will:

- Create gaps in your understanding, making future learning harder.
- Leave you unprepared for exams or other assessments where AI is not permitted.
- Prevent you from spotting or correcting AI-generated mistakes.
- Constitute a form of academic misconduct.

Your focus should be on ***learning***, not just earning a grade.

The Right Way to Use AI

AI works best as a tutor or guide. For example:

> *"Can you explain how to create a dataframe in R?"*

Such targeted questions can clarify concepts, reinforce understanding, and help you develop problem-solving skills.

Use AI to deepen your engagement with the material. The more you practice independently, the more confident you will be when it matters.

AI use is permitted in this course, but with important conditions: all submitted work must reflect your own understanding and abilities. Occasional, well-judged use of AI to support your learning is fine; relying on it to produce your work is not. If it appears that AI has completed most or all of a submission, marks may be reduced, potentially to zero. If you believe this determination is incorrect, you may request a reassessment by meeting with the instructor or marker ***in person*** *to demonstrate your grasp of the material. This ensures you can explain and apply the concepts independently.*

13 Policies for Missed Term Work

Failure to submit homework assignments or other course projects through the designated channels by the specified due dates will result in a grade of 0. However, students unable to complete these tasks due to incapacitating illness, severe domestic circumstances, or other compelling reasons may apply for an excused absence. To apply for an excused absence, a student must contact the instructor in a timely manner (see section 13.1 and 13.2 below). IF an excused absence is granted, then the weight of the assessment will be transferred to the final exam. Should a shift in weighting to the final exam increase its weight to $\geq$ 40%, this does not change the original 'syllabus weight', meaning the student does not now qualify for possible re-examination. This also means that the cumulative weight of the assessment will be lower than the percentage stated in Table 3 above.

Please be aware that transferring the weight of missed work to the final exam might disqualify a student from being eligible for a deferred final examination if they have not completed at least 50% of the term's coursework.

In all cases, instructors may request adequate documentation to substantiate the reason for the absence, at their discretion. Deferral of term work is a privilege and not a right; there is no guarantee that a deferral will be granted. Misrepresentation of Facts to gain a deferral is a serious breach of the Student Academic Integrity Policy.

Deferral of term work/tests is under the discretion of the instructor; however, deferral of a final exam is determined at the Faculty level. A student must apply to their home Faculty for a deferral of a final exam, not the Faculty the course is listed in (see section 17).

13.1 Exemption Requests Relating to Non-technical Issues

Baring extreme circumstances (e.g., unexpected hospitalization or immediate death in the family), requests for exemptions related to known chronic or prolonged conditions and events (e.g., mourning, recuperation, general illness, etc.) must be submitted to the instructor at least **24 hours** before the specified due date for consideration. i.e., students are expected to be proactive about notifying the instructor in a timely manner when the circumstances allow it.

With rare exception, requesting exemptions moments before or after a deadline is unacceptable behaviour. People are rarely so incapacitated that they cannot send an email.

It is important to note that it is neither within the purview nor the responsibility of the instructor to verify or handle claims related to enduring physical or psychological medical conditions (e.g., ADHD, clinical anxiety or depression, etc.). Students seeking accommodations for such reasons must do so through appropriate university channels (i.e., Academic Success Centre).

13.2 Exemption Requests Relating to Technical issues

If students experience technical issues in the process of submitting an assignment, they are expected to document the issue by taking an appropriate video or photo with their phone or computer. Do not expect clemency for technical issues without providing at least this. They must ensure that the photo or video provides reasonable evidence of the date and time in addition to the technical issue.

A generous time frame is allotted for assignment submissions. Exemption requests related to technical issues made within the last 12 hours before a deadline will not be deemed reasonable, regardless of circumstances such as internet outages, computer crashes, or hardware failure. Assignments are expected to be completed in a timely fashion with due precautions taken, such as file backups.

> *Procrastination and last-minute completion carry inherent risks, for which responsibility rests with the student.*

14 Missed Midterm

Students are required to complete the midterm exam as scheduled. If a student is unable to complete the midterm for any reason, they need to notify the instructor within ± 48 hours of the exam deadline. If an exemption is granted then the weight of the assessment will be transferred to the final exam.

As with term work, the instructor may request adequate documentation to substantiate the reason for the absence, at their discretion. Deferral of term work is a privilege and not a right; there is no guarantee that a deferral will be granted. Misrepresentation of Facts to gain a deferral is a serious breach of the Student Academic Integrity Policy.

15 Missed Term Work or Final Exam Due to Non-medical Protected Grounds (e.g., religious beliefs)

When a term assessment or final exam presents a conflict based on non-medical protected grounds, students can register with the Academic Success Centre for accommodations via their Register for Accommodations website. Students can review their eligibility and choose the registration process specific for **Accommodations Based on Non-medical Protected Grounds**.

It is imperative that students review the dates of all course assessments upon receipt of the course syllabus, and register **AS SOON AS POSSIBLE** to ensure the timely application of the accommodation. Students who register later in the term may experience unavoidable delays in the processing of the registration, which can affect the accommodation.

16 Re-evaluation of Term Work

Students who wish to request a re-evaluation of their graded term work must do so in a timely manner (e.g., within a week) after the grade has been posted and *before* final course grades are submitted.

Requests must include a clear and specific justification. Re-evaluations will only be considered if the rationale provided is deemed reasonable by the marker. General requests for "another look" without a substantive explanation will not be granted.

17 Deferred Final Examination

A student who cannot write the final examination due to incapacitating illness, severe domestic affliction, or other compelling reasons can apply for a deferred final examination. Such an application must be made to the student's home Faculty Office within two working days of the missed exam and must be supported by appropriate documentation or a Statutory Declaration (see calendar on Attendance). Deferred examinations are a privilege and not a right; there is no guarantee that a deferred examination will be granted. The Faculty may deny deferral requests in cases where less than 50% of term work has been completed. Misrepresentation of facts to gain a deferred examination is a serious breach of the Student Academic Integrity Policy.

18 Respect Policy

18.1 I Respect Your Time:

- *Preparedness:* I will come to each class prepared to help you understand the course material and prepare you for quizzes and exams.
- *Communication:* Communication is key. If something is unclear or you are facing challenges, please let me know. I cannot assist you if I am unaware of your concerns.
- *Support:* I am here to help you succeed. This is your time, so please communicate how I can best support your learning.
- *Flexibility:* If there is something you would like me to do differently, please share your feedback. I am open to working with you to make this class the best it can be.

18.2 Respect My Time:

- *Punctuality:* Be on time to class. Arriving late disrupts the learning process for everyone.
- *Attention:* Pay attention when I am speaking to you. Your focus is essential for your success.
- *Preparation:* Come to class prepared by completing the required work and utilizing office hours when you need additional help.

18.3 Respect Each Other:

- *Minimize Disruptions:* Do not be disruptive in class. If you need to take a call or send a text, please step outside to do so.
- *Embrace Mistakes:* Allow one another to make mistakes—this is a vital part of the learning process.
- *Respectful Communication:* Use respectful language when speaking with one another, both in and out of class.

19 Student Responsibilities

19.1 Guidelines for Respectful Engagement

Students from many different backgrounds participate in courses at the University of Alberta. Sexist, racist, homophobic comments and other inflammatory remarks are not conducive to learning in our courses, and are absolutely not permitted. All participants are governed by the Student Academic Integrity Policy. Be mindful when discussions involve controversial topics or issues, and consider the possibility that members of our community have themselves experienced some of these issues and/or very different realities because of these issues. Participate in a respectful and considerate manner.

If you are witness to or the target of abusive or offensive behaviour in any course, please inform your instructor immediately. You may also contact the Psychology Undergraduate/Graduate Advisor, Associate Chair Undergraduate, Academic Director of Graduate Studies, or Chair.

19.2 Academic Integrity and Student Conduct

The University of Alberta is committed to the highest standards of academic integrity and honesty, as well as maintaining a learning environment that fosters the safety, security, and inherent dignity of each member of the community, ensuring students conduct themselves accordingly. Students are expected to be familiar with the standards of academic honesty and appropriate student conduct, and to uphold the policies of the University in this respect.

Students are particularly urged to familiarize themselves with the provisions of the Student Academic Integrity Policy and the Student Conduct Policy, and avoid any behaviour that could potentially result in suspicions of academic misconduct (e.g., cheating, plagiarism, misrepresentation of facts, participation in an offence) and non-academic misconduct (e.g., discrimination, harassment, physical assault). Academic and non-academic misconduct are taken very seriously and can result in suspension or expulsion from the University.

All students are expected to consult the Academic Integrity website for clarification on the various academic offences. All forms of academic dishonesty are unacceptable at the University. Unfamiliarity of the rules, procrastination or personal pressures are not acceptable excuses for committing an offence. Listen to your instructor, be a good person, ask for help when you need it, and do your own work – this will lead you toward a path to success. Any academic integrity concern in this course will be reported to the College.

Suspected cases of non-academic misconduct will be reported to the Office of Student Success and Experience. The College, the Faculty, and the Dean of Students are committed to student rights and responsibilities, and adhere to due process and administrative fairness, as outlined in the Student Academic Integrity Policy and the Student Conduct Policy. Please refer to the policy websites for details on inappropriate behaviours and possible sanctions.

The College of Natural and Applied Sciences (CNAS) has created an Academic Integrity for CNAS Students website. To access this website, students must be signed in to their UAlberta account. Website content includes the importance of academic integrity, examples of academic misconduct and possible sanctions, and the academic misconduct and appeal process. Students can also access this material as an online, self-directed Canvas course and complete assessments to test their knowledge.

"Integrity is doing the right thing, even when no one is watching" – C.S. Lewis

19.3 Inappropriate Collaboration:

Students need to be able to recognize when they have crossed the line between appropriate collaboration and inappropriate collaboration. If students are unsure, they need to ask instructors to clarify what is allowed and what is not allowed. Here are some tips to avoid copying on assessments:

- Do not write down something that you cannot explain to your instructor.
- When you are helping other students, avoid showing them your work directly. Instead, explain your solution verbally. Allowing your work to be copied is also considered inappropriate collaboration.
- It is also possible that verbally discussing the solution in too much detail may result in written responses that are too similar. Try to keep discussions at a general or higher level.
- If you find yourself reading another student's solution, do not write anything down. Once you understand how to solve the problem, remove the other person's work from your sight and then write up the solution to the question yourself. Looking back and forth between someone else's work and your own work is almost certainly copying and considered inappropriate collaboration.
- If the instructor or TA writes down part of a solution in order to help explain it to you or the class, you cannot copy it and hand it in for credit. Treat it the same way you would treat another student's work with respect to copying, that is, remove the explanation from your sight and then write up the solution yourself.

- There is often more than one way to solve a problem. Choose the method that makes the most sense to you rather than the method that other students happen to use. If none of the ideas in your solution are your own, there is a good chance it will be flagged as copying.

19.4 Contract Cheating and Misuse of University Academic Materials or Other Assets

Contract cheating describes the form of academic dishonesty where students get academic work completed on their behalf, which they submit for academic credit as if they had created it themselves. Contract cheating may or may not involve the payment of a fee to a third party, who then creates the work for the student.

Examples include:

- Getting someone to write an essay or research paper for you.
- Getting someone to complete your assignment or exam for you.
- Posting an essay, assignment, or exam question to a tutorial or study website; the question is answered by a "content expert", then you copy it and submit it as your own answer.
- Posting your solutions to a tutorial/study website, public server, or group chat and/or copying solutions that were posted to a tutorial/study website, public server, or group chat.
- Sharing your login credentials to the course management system (e.g., Canvas) and allowing someone else to complete your assignment or exam remotely.
- Using an artificial intelligence bot or text generator tool to complete your essay, research paper, assignment, or exam solutions for you (without the instructor's permission).
- Using an online grammar checker to "fix" your essay, research paper, assignment, or exam solutions for you (without the instructor's permission).
- Contract cheating companies thrive on making students believe that they cannot succeed without their help; they attempt to convince students that cheating is the only way to succeed.

Uploading the instructor's teaching materials (e.g., course outlines, lecture slides, assignment, or exam questions, etc.) to tutorial, study, or note-sharing websites or public servers is a copyright infringement and constitutes the misuse of University academic materials or other assets. Receiving assignment solutions or answers to exam questions from an unauthorized source puts you at risk of receiving inaccurate information.

20 University Policy

20.1 Withdrawals

See the University Calendar for the relevant add/drop deadlines for each term.

20.2 Course Outlines

Policy about course outlines can be found in the Academic Regulations, Evaluation Procedures and Grading section of the University Calendar.

20.3 Student Academic Integrity

The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Academic Integrity Policy and the Student Conduct Policy (on the University of Alberta Policies and Procedures Online (UAPPOL) website) and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

20.4 Recordings

Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content authors.

20.5 Accommodations for Students

In accordance with the University of Alberta's Accommodation Policy and Discrimination and Harassment Policy, accommodation support is available to eligible students who encounter limitations or restrictions to their ability to perform the daily activities necessary to pursue studies at a post-secondary level due to medical conditions and/or non-medical protected grounds. Accommodations are coordinated through the Academic Success Centre, and students can learn more about eligibility on the Register for Accommodations website.

It is recommended that students apply **AS SOON AS POSSIBLE** in order to ensure sufficient time to complete accommodation registration and coordination. Students are advised to review and adhere to published deadlines for accommodation approval and for specific accommodation requests (e.g., exam registration submission deadlines). Students who request accommodations less than a month in advance of the academic term for which they require accommodations may experience unavoidable delays or consequences in their academic programs, and may need to consider alternative academic schedules.

21 Student Supports

21.1 The Student Service Centre

The Student Service Centre provides students with information and access to services to support academic, financial, mental, and physical well-being. Information about various student resources, including academic, financial, and health and wellness, can also be found on the Campus Life website.

21.2 Academic Success Centre

The Academic Success Centre provides professional academic support to help students strengthen their academic skills and achieve their academic goals. Individual advising, appointments, and group workshops are available year round in the areas of Accessibility, Communication, Learning, and Writing Resources. Modest fees may apply for some services.

21.3 Writing Services

Writing Services offers free one-on-one writing support to students, faculty, and staff. Students can request a consultation for a writing project at any stage of development. Instructors can request class visits and presentations.

21.4 First Peoples' House

First Peoples' House provides an environment of empowerment for First Nations, Métis, and Inuit learners to achieve personal and academic growth.

21.5 Student Self-Care Guide

This Self-Care Guide, originally designed by the Faculty of Native Studies, has broader application for use during students' learning. It provides some ideas and strategies to consider that can help navigate emotionally challenging or triggering material.

21.6 Feeling Stressed, Anxious, or Upset?

It's normal for us to have different mental health experiences throughout the year. Know that there are people who want to help. You can reach out to your friends and access a variety of supports available on and off campus at the Need Help Now webpage or by calling the 24-hour Distress Line: 780-482-4357 (HELP). The Health and Wellness Support for Students website also contains mental and physical health resources, which are offered on-campus and in the community.

22 Learning and Working Environment

The Department of Psychology, Faculty of Arts, and Faculty of Science are committed to ensuring that all students, faculty, and staff are able to work and study in an environment that is safe and free from discrimination, harassment, and violence of any kind. It does not tolerate behaviour that undermines that environment. This includes virtual environments and platforms.

The Department of Psychology believes that organizational diversity and excellence go hand-in-hand. We are committed to identifying our limitations as a department in terms of equity, diversity, and inclusion and making actionable changes to overcome these limitations. We want all our constituents to feel welcome, safe, and valued in the core activities of teaching, research, and administration. Please visit our Commitment to EDI and Indigenization in Psychology website for more information.

If you are experiencing harassment, discrimination, fraud, theft or any other issue and would like to get confidential advice, please contact any of these campus services:

- Office of Safe Disclosure & Human Rights: A safe, neutral and confidential space to disclose concerns about how the University of Alberta policies, procedures or ethical standards are being applied. They provide strategic advice and referral on matters such as discrimination, harassment, duty to accommodate and wrong-doings. Disclosures can be made in person or online using the Online Reporting Tool.
- University of Alberta Protective Services: Peace officers dedicated to ensuring the safety and security of U of A campuses and community. Staff or students can contact UAPS to make a report if they feel unsafe, threatened, or targeted on campus or by another member of the university community.
- Office of the Student Ombuds: A confidential and free service that strives to ensure that university processes related to students operate as fairly as possible. They offer information, advice, and support to students, faculty, and staff as they deal with academic, discipline, interpersonal, and financial issues related to student programs.
- Office of Student Success and Experience: They can assist students in navigating services to ensure they receive appropriate and timely resources. For students who are unsure of the support they may need, are concerned about how to access services on campus, or feel like they may need interim support while they wait to access a service, this office is there to help.

22.1 Course Outlines

Policy about course outlines can be found in the Academic Regulations, Evaluation Procedures and Grading section of the University Calendar.

23 Document Information

This syllabus was Compiled with LuaLaTeX (LuaTeX 1.21.0) on 2026-01-03 at 17:24:14

23.1 Typos and Errors

Any typographical errors in this syllabus are subject to change and will be announced in class and/or posted on the course website. The date of final examinations is set by the Registrar and takes precedence over the final examination date reported in the syllabus.

23.2 Copyright

Appendix: Course Topics and Learning Outcomes

This course is organized into topical units, each with a general learning outcome supported by specific outcomes. Specific outcomes articulate what students are expected to learn and be able to demonstrate upon successful completion of the course.

T1 - Getting Started with R (via Google Colab)

General Outcome: Students will develop foundational fluency with R within a cloud-based environment called Google Colab, enabling them to write, execute, and interpret basic R code to support data-driven coursework.

Specific Outcomes: By the end of this topic, students will be able to:

- Navigate and run R code in a Google Colab notebook environment.
- Create and manipulate basic R objects, including vectors, variables, and data frames.
- Use core tools for inspecting and analyzing data sets, including functions (e.g., `length()`, `sum()`, `round()`) and subsetting/indexing operations (e.g., `x[1:3]`).
- Install and load R packages required for data analysis workflows.
- Construct basic data visualizations with `ggplot2` and modify key aesthetics (e.g., axes labels, colour, and theme elements) to enhance interpretability.

T2 - Summarizing and Evaluating Distributions: Classical and Robust Approaches

General Outcome: Students will learn to summarize, visualize, and evaluate univariate data using classical and robust descriptive statistics. They will develop competency in identifying distributional structure, assessing model assumptions, and selecting appropriate summary measures based on empirical characteristics of the data.

Specific Outcomes: By the end of this topic, students will be able to:

Terminology, Data Handling, and Visualization

- Define and interpret common statistical notation and terminology used in descriptive analysis (e.g., summation notation; samples vs. population).
- Import external data files (e.g., `.csv`) into R and verify successful data loading.
- Explain what a comma-separated values (CSV) file is and generate one using common spreadsheet software.
- Visualize distributions using histograms to explore modality, symmetry, and outliers.

Central Tendency and Spread

- Compute and interpret classical measures of central tendency (mean, median, mode) using R, and explain their merits, limitations, and sensitivity to skew and extreme values.
- Quantify spread using range and interquartile range (IQR).
- Define quartiles, quantiles, and percentiles, and describe how quartiles and percentiles represent specific cases of quantiles used to summarize distributional position.
- Construct and interpret boxplots to identify distributional features including median shifts, spread differences, and potential outliers.

Distributional Structure and Standardization

- Describe and identify key features of the normal distribution, including symmetry, unimodality, and empirical rule conventions.
- Use standardization and linear transformations (e.g., z-scores, scaling, shifting) to re-express variables and explain how these transformations affect measures of centre and spread.
- Assess the degree to which a variable approximates normality using visual diagnostics (e.g., QQ-plots, density plots, histograms).

Transformations and Assumption Checks

- Assess the degree to which a variable approximates normality using visual diagnostics (e.g., QQ-plots, density plots, histograms) and explain the limitations of each relative to each other.
- Describe why test-based assumption checks (e.g., Shapiro–Wilk) may be misleading in small or large samples.

- Identify when non-linear transformations (e.g., log, square-root) may improve interpretability or reduce skewness, and apply such transformations in R.
- Describe the limitations of non-linear transformations and justify when alternative strategies (e.g., robust statistics) provide more defensible summaries than transforming the data.

Robust Summaries and Outlier Evaluation

- Compute and interpret robust measures of centre (trimmed mean) and spread (Winsorized standard deviation, median absolute deviation).
- Explain why robust statistics may outperform classical statistics when distributions are skewed or contain extreme observations.
- Apply robust outlier detection approaches and articulate key concepts like masking and the finite sample breakdown point.
- Evaluate when removing outliers is appropriate and when it risks discarding meaningful variation or biasing results.

Critical Interpretation and Decision-Making

- Compare classical and robust summaries for the same dataset and justify which measures more accurately characterize the underlying distribution.
- Select and defend appropriate descriptive statistics based on distributional characteristics.

T3 - Sampling Distributions: Foundations of Statistical Inference

General Outcome: Students will develop foundational inferential reasoning skills by understanding how sampling distributions link observed data to population claims. They will learn the conceptual basis of confidence intervals, p-values, and hypothesis testing, enabling them to interpret inferential results and evaluate the strength of evidence without relying on procedural formula-memorization.

Specific Outcomes: By the end of this topic, students will be able to:

Sampling Distributions and the Role of Chance

- Explain how sampling variability arises and why repeated sampling produces a distribution of sample statistics.
- Describe how sampling distributions connect observed data to population-level inferences.
- State the key implications of the Central Limit Theorem (CLT) and explain how it motivates normal approximations for sampling distributions under broad conditions.
- Distinguish between normal and t-distributions conceptually, and explain when each provides a more appropriate model for sampling variability.

Evaluating Evidence and Uncertainty

- Describe the logic of hypothesis testing as a framework for evaluating competing claims about population parameters.
- Interpret p-values as measures of extremity under a specified null model.
- Explain the logic of confidence intervals as a range of plausible population values derived from sampling variability, and interpret confidence intervals in applied contexts.

T4 - Single Sample Design

General Outcome: Students will learn to evaluate whether observed sample means provide meaningful evidence about population values using classical and robust one-sample inference. They will develop the ability to interpret test statistics, effect sizes, and power in context, and justify when robust approaches offer more defensible conclusions than classical methods.

Specific Outcomes: By the end of this topic, students will be able to:

Classical One-Sample Testing Framework

- Explain the logic of the one-sample t-test and how sample variability, sample size, and hypothesized population values jointly determine the test statistic.
- Distinguish between two-tailed and one-tailed hypothesis tests, and justify when directional tests are conceptually appropriate rather than merely convenient.

- Calculate a (one and two tailed) one-sample t-test, goth by hand and in R, assessing significance on the basis of both confidence intervals and p-values.
- Define and interpret common standardized effect sizes (Cohen's d, Hedges' g), and explain how they complement significance tests.
- Explain how statistical power reflects the probability of detecting meaningful population differences and how sample size, variability, and effect size jointly influence a study's power.

Robust Testing and Distributional Sensitivity

- Describe why classical one-sample t-tests may be sensitive to non-normality or extreme values, and identify when robust inference provides a defensible alternative.
- Conduct and interpret a one-sample trimmed mean t-test.

T5 - Two-Group Designs: Comparing Two Independent Group Means

General Outcome: Students will learn to compare independent group means using classical and robust inferential methods. They will develop the ability to compute and interpret effect sizes, visualize group differences, and determine when robust alternatives provide more defensible conclusions than classical approaches.

Specific Outcomes: By the end of this topic, students will be able to:

Classical Two-Sample Inference

- Explain the logic of the two-sample t-test for independent groups.
- Explain why the variance sum law underpins the two-sample t-test.
- Describe the circumstances under which variances need to be pooled.
- Conduct and interpret classical two-sample t-tests in R, assessing appropriate assumptions.
- Compute and interpret standardized mean-difference effect sizes (Cohen's d, Hedges' g) for two independent groups, and explain how effect size complements hypothesis testing.

Visualization & Interpretation

- Distinguish between wide and tidy data formats and convert paired data between formats to support analysis and visualization in R.
- Leverage R's tidyverse tools and piping syntax to efficiently compute custom summary statistics that support visualization and interpretation of group differences.
- Plot and visually summarize group differences using R (e.g., barplots with confidence intervals), and interpret visual patterns alongside inferential outcomes.

Robust Alternatives and Distributional Sensitivity

- Describe how violations of equal-variance and normality assumptions affect classical two-sample inference and justify when robust approaches provide more reliable conclusions.
- Conduct and interpret Welch's two-sample t-test by hand and in R, emphasizing its advantages when group variances differ.
- Conduct and interpret a trimmed (Yuen's) two-sample t-test by hand and in R, and justify when its robustness to distributional irregularities makes it preferable to classical methods.

T6 - Two-Group Designs: Comparing Two Dependent Group Means

General Outcome: Students will learn to evaluate mean differences in paired or dependent data using classical inference, effect size estimation, and visualization. They will develop the ability to interpret results in the context of repeated measurements or matched observations, and articulate how paired designs influence variability, statistical power, and substantive interpretation.

Specific Outcomes: By the end of this topic, students will be able to:

Classical Paired Inference

- Explain how paired or dependent data arise (e.g., pre–post measurements, matched participants) and why analysing paired differences can reduce error variance relative to independent-samples designs.
- Describe how pairing influences statistical power and interpretability of mean differences.

- Conduct and interpret a paired t-test by hand and within R.
- Explain how paired t-tests can be understood as one-sample t-tests on within-subject difference scores.
- Compute and interpret standardized effect sizes (e.g., Cohen's d, Hedges' g) for paired data, and explain how effect sizes complement significance testing in dependent designs.
- Explain benefits and limitations of paired designs relative to independent designs.

Visualization and Interpretation of Paired Differences

- Plot and visually summarize group differences for paired two-group designs using R (e.g., barplots with confidence intervals), and interpret visual patterns alongside inferential outcomes.

T7 - Linear Modelling - Simple Linear Regression and Correlation

General Outcome: Linear modelling is a foundational tool in Psychology and across the sciences because it provides a principled way to describe, quantify, and evaluate relationships between variables, and it forms the conceptual basis for procedures such as ANOVA as implemented in modern statistical software. Students will learn to model, quantify, and interpret simple linear relationships between two variables using correlation and ordinary least squares (OLS) regression. They will develop the ability to estimate and visualize regression lines, understand the meaning of model parameters, evaluate model fit, and interpret inferential statistics while recognizing when assumptions or outliers limit defensible conclusions.

Specific Outcomes: By the end of this topic, students will be able to:

Relationship Structure and Visualization

- Describe how scatter plots reveal the form, direction, and strength of relationships and complement the use of linear models.
- Plot a fitted linear model over observed data and interpret visual patterns in relation to model parameters and residual variability.
- Compute and interpret the Pearson correlation coefficient as an index of the direction and strength of linear relationships, with an emphasis on how the mathematics logically generates this index.
- Conduct and interpret a test of statistical significance for the correlation coefficient.

Ordinary Least-Squares Linear Modelling

- Explain the rationale of least-squares regression as a method that minimizes the sum of squared residuals to estimate model parameters.
- Compute the intercept and slope directly from the observed data.
- Visualize a regression line implied by estimated parameters, and relate the fitted line to observed data.

Inference and Evaluation of the Model

- Conduct hypothesis tests for regression coefficients and articulate how these tests evaluate whether observed linear trends likely reflect non-zero population relationships.
- Compute and interpret R^2 as a measure of accounted-for variance.
- Assess OLS regression assumptions: linearity, independence, homoscedasticity, and approximate normality of residuals.
- Identify influential observations and outliers using visual and numerical diagnostics, and explain how they can distort the model's ability to characterize and (by extension) predict the data.
- Explain when excluding outliers is defensible.

T8 - Extending Simple Linear Models - Multiple Regression, Model Comparison, and Robust Estimation

General Outcome: Students will extend their understanding of linear modelling to situations involving multiple predictors, learning how multivariable regression enables the evaluation of unique and combined predictor contributions. They will develop the ability to specify and interpret multiple regression models, incorporate categorical variables through coding schemes, compare competing models, and assess assumptions and robustness. Students will also learn to apply robust regression methods in the presence of outliers and/or distributional irregularities.

Specific Outcomes: By the end of this topic, students will be able to:

Model Structure and Interpretation of Coefficients

- Specify and fit multiple linear regression models in R using continuous and categorical predictors, and interpret output in the context of substantive research questions.
- Interpret regression coefficients as estimates of partial effects, articulating how each predictor is evaluated while controlling for other predictors in the model.
- Explain how categorical predictors are incorporated into regression using coding schemes (e.g., dummy or treatment coding), and interpret model output in terms of group differences.

Assumptions and Diagnostics

- Explain how anticipated effect sizes, desired power, and model complexity inform a priori sample size calculations for regression, and justify sample size choices in terms of planned evidential goals.
- Evaluate regression assumptions in the context of multiple predictors.
- Use visual and numerical diagnostics to identify influential points, multicollinearity, autocorrelation.

Model Comparison and Evidence Evaluation

- Compare competing hierarchical regression models using appropriate statistical tools (e.g., F-tests, Bayes factors).
- Describe how adding or removing predictors affects explained variance (R^2 and adjusted R^2), parsimony, and interpretability.

Robust Estimation

- Explain how robust regression methods (e.g., M-estimation and iteratively reweighted least squares) reduce the influence of outliers and heavy-tailed distributions.
- Conduct and interpret robust regression in R and justify when robust approaches provide more defensible estimates than classical least squares.
- Compare conclusions from classical and robust regression models and articulate how differences reflect underlying data characteristics rather than procedural choices alone.

T9 - Multi-Group Designs: Comparing More than Two *Independent* Group Means (Along a Single Factor)

General Outcome: Students will learn to evaluate mean differences across multiple independent groups using one-way ANOVA framed as a general linear model (GLM). They will develop the ability to specify and interpret ANOVA models in R, understand how Fisher's variance-ratio logic applies to GLMs, set contrasts, and generate post-hoc comparisons to address focused questions about group differences. Students will also learn to compute and interpret effect sizes, diagnose assumption violations, and estimate sample size requirements to support defensible inferential conclusions.

Specific Outcomes: By the end of this topic, students will be able to:

Conceptual Foundations

- Explain how one-way independent ANOVA can be expressed as a linear model and articulate parallels to regression when predictors are categorical.
- Interpret the variance-ratio logic of ANOVA (i.e., Fisher's model) and describe how the omnibus F-test is determined and why it is equivalent to a regression model's F-test of β coefficients.

Model Specification, Estimation, and Assumptions

- Specify and fit one-way independent ANOVA models in R and interpret model summaries.
- Evaluate ANOVA assumptions and describe how assumption violations.

Contrasts and Planned Comparisons

- Explain the rationale for planned contrasts and articulate how they target theoretically motivated group comparisons.
- Specify and interpret planned contrasts in R and justify when planned comparisons are preferable to omnibus testing.

Trend Analysis and Polynomial Contrasts

- Apply and interpret polynomial contrasts (e.g., linear, quadratic) to evaluate ordered patterns among group means.
- Visualize polynomial contrast trends using model-based fitted values.

Post-Hoc Comparisons

- Conduct and interpret post-hoc comparisons to evaluate group differences following a significant omnibus test, and articulate the role of multiple-comparison adjustments in maintaining defensible inference.
- Distinguish between planned contrasts and post-hoc comparisons and justify when each approach is appropriate for different research goals.

Effect Size Estimation

- Compute and interpret ANOVA effect sizes for omnibus tests as well as planned contrasts.
- Explain how effect sizes relate to variance explained (i.e., $R^2 = \eta^2$) and compare effect size measures across ANOVA and regression frameworks.

T10 - Multi-Group Designs: Comparing More than Two *Independent* Group Means Along Two Factors

General Outcome: Students will learn to evaluate mean differences across combinations of factors using two-way independent factorial ANOVA framed as a general linear model. They will develop the ability to specify and interpret factorial models in R and apply variance-ratio logic to assess main effects and interactions. Students will also learn when different sums-of-squares types are appropriate, and how planned contrasts and simple effects analyses address focused questions about factor combinations.

Specific Outcomes: By the end of this topic, students will be able to:

Model Structure and Interpretation

- Visualize factorial designs through the use of interaction plots displaying relevant summary and inferential statistics.
- Explain how factorial ANOVA extends the linear model to include multiple factors and their interaction, and interpret interaction terms.
- Describe how the ANOVA model partitions variability across multiple factors.
- Fit two-way independent factorial ANOVA models in R using categorical predictors, and interpret model output in terms of main effects and interactions.
- Distinguish between Type I, Type II, and Type III sums of squares and explain how each partitions variance under different modelling assumptions.
- Explain the principle of marginality and describe why interaction terms should not be interpreted without considering the corresponding main effects in factorial models and how this relates to sum of square types.

Contrasts and Focused Comparisons

- Explain the rationale for planned contrasts in factorial designs and articulate how they address targeted research questions involving combinations of factor levels.
- Conduct and interpret planned contrasts within factorial ANOVA using appropriate coding schemes.
- Conduct and interpret simple-effects analyses in the presence of significant interactions, and explain how simple-effects clarify the patterns that interactions imply.

Effect Size, Power, and Sample Size

- Justify sample-size targets in terms of meaningful effect magnitudes rather than simply maximizing power, explaining how aligning evidential goals with theory supports defensible conclusions.
- Explain the problems associated with excessively high or excessively low levels of statistical power.
- Estimate the required sample size for a factorial ANOVA using anticipated effect sizes, desired power, and factor structure (e.g., number of levels per factor).
- Distinguish between pre-registered planned contrasts and exploratory post-hoc comparisons, and justify how pre-registration clarifies evidential claims associated with each.

T11 - Multi-Group Designs: Comparing More than Two *Dependent* Group Means Along a Single Factor

General Outcome: Students will learn to evaluate mean differences across repeated measurements using one-way repeated measures ANOVA. They will develop the ability to specify and interpret repeated-measures models in R, understand how within-subject dependency affects variance structure and inference, and recognize the assumptions and limitations of classical approaches based on sphericity. Students will also gain foundational insight into how mixed-effects models provide a flexible extension that directly models dependency rather than correcting for it post hoc.

Specific Outcomes: By the end of this topic, students will be able to:

Classical Repeated Measures ANOVA

- Specify and fit one-way repeated measures ANOVA models in R and interpret output.
- Explain the sphericity assumption and describe how violations affect inferential conclusions.
- Apply sphericity corrections (e.g., Greenhouse–Geisser).

Introduction to Mixed-Effects Modelling

- Interpret random intercepts as a way to model individual baseline differences and describe how this captures subject-level dependency in a principled way.
- Explain why mixed-effects models relax sphericity assumptions.
- Set contrasts that reflect theoretically motivated hypotheses in repeated-measures designs and distinguish these planned comparisons from exploratory post-hoc tests following omnibus results.
- Compute and interpret repeated-measures effect sizes, and explain how effect-size measures generalize across classical and mixed-model contexts.

T12 - Inference with Categorical Variables

(Time-Permitting)

General Outcome: Understand how to use chi-square tests to evaluate whether observed categorical patterns differ from expectations based on chance or independence.

Specific Outcomes: By the end of this topic, students will be able to:

- Distinguish between research questions involving categorical variables that call for a chi-square goodness-of-fit test versus a chi-square test of independence.
- Formulate null and alternative hypotheses for chi-square tests and explain how expected frequencies represent the patterns predicted by chance or independence.
- Conduct chi-square goodness-of-fit and tests of independence by hand and using R.
- Evaluate whether the assumptions of chi-square tests are reasonably met (e.g., expected cell counts, independence of observations) and describe how violations may affect interpretation or require alternative approaches.
- Quantify and interpret effect sizes for categorical associations using odds and odds ratios.