APSTA-GE-2094
Modern Approaches in Measurement
APSY-GE 2025
Psychological Measurement

Klint Kanopka, Ph.D. (he/him)
Assistant Professor of Applied Statistics

Spring 2024-2025

1 Course Description

The course provides students with the software skills and theoretical knowledge required to apply latent construct measurement techniques in R. The course assumes a working knowledge of R, linear regression, and basic probability. Continuous and categorical latent variables, dimensionality reduction, clustering, finite mixture, and diagnostic classification models are covered. The course focuses on cross-sectional applications of measurement techniques, with examples drawn from education, psychology, and social science.

2 Student Learning Outcomes

During the course of this class:

1. Students will identify and define continuous and categorical latent constructs.
2. Students will relate unsupervised learning techniques and measurement models.
3. Students will compare and contrast competing measurement models.
4. Students will select, apply, and evaluate measurement models to analyze real data.

3 Course Logistics

3.1 Teaching Team

- **Klint Kanopka** - Instructor
  - klint.kanopka@nyu.edu
  - Office Hours: W 2p-3p @ Kimball, Rm 205W
- **Victoria Zhang** - Grader
  - xz2661@nyu.edu

3.2 Meeting Times and Locations

In-person lecture attendance is required, but lectures will be recorded for reference.

- **Lecture:** F 1.55p-4.55p @ Silver, Rm 208

3.3 Required and Recommended Reading

- *Elements of Statistical Learning* [1] covers the unsupervised machine learning core and estimation.
  https://hastie.su.domains/ElemStatLearn/
- *Handbook of Modern Item Response Theory* [3] covers a wide variety of item response models.
  https://link.springer.com/book/10.1007/978-1-4757-2691-6. You may need to be on NYU servers or using a VPN.

3.4 Prerequisites

Students should be experienced with the `R` Programming Language [2], probability, regression, and data visualization. Additional experience in survey methodology and unsupervised machine learning is helpful but not required.

4 Grading

This is a three-credit course. Table 1 contains the proportion of the final grade coming from each assignment category. Table 2 contains the transformation from the weighted proportion of earned points to letter grades.

4.1 Problem Sets

The course contains eight equally-weighted problem sets (PS0-PS7). PS0 is a one-week assignment. PS2-PS6 are two-week assignments. PS7 is longer, due during finals week, and closer to a "project."

Category	p
Problem Sets	0.9
Participation (Lecture)	0.1

Table 1: Final grade weighting scheme

	G^-	G	G^+
A	$[.895, .945)$	$[.945, 1]$	—
B	$[.795, .825)$	$[.825, .865)$	$[.865, .895)$
C	$[.695, .825)$	$[.725, .765)$	$[.765, .795)$
D	$[.600, .640)$	$[.640, .670)$	$[.670, .695)$
F	—	$[0, .600)$	—

Table 2: Grading Scale

4.1.1 Submission Guidelines

All assignments are to be submitted on Brightspace using Quarto (preferred) or Rmarkdown and adhere to the following conventions:

1. **Submit assignments by the deadline.** Assignment deadlines are typically Fridays at 11.59p. Late assignments will receive a 10% penalty per day.

2. **Name your files correctly.** For each homework assignment, name your files using the convention: `LastName_FirstInitial_HW#.ext`

3. **Put your name and the assignment in the text of the file.** These should occupy the author and title fields, respectively.

4. **Submit both a source file and a knitted file.** Source files have the extension `.qmd` or `.Rmd`. Files should be knitted to `.pdf`. As an example for the first homework, I would submit two files:

   - `Kanopka_K_HW1.qmd`
   - `Kanopka_K_HW1.pdf`

5. **Your source file should run without modification.** If you load a file, please use relative paths. Do not load libraries unless explicitly requested in an assignment.

6. **Do not use `install.packages()` calls in your assignments.** Please install packages locally and then load them in your assignment source code.

4.2 Participation

Participation is a subjective assessment of "are you doing class." If I remember who you are, see you in class, and you're reasonably engaged in the stuff we

do, you'll get full credit. This is a very small portion of your overall grade and meant to boost scores that fall near the grade thresholds.

5 Course Policies

5.1 Academic Integrity

I take academic integrity incredibly seriously. Please review NYU Steinhardt's Academic Policies and Procedures for more information on specific policies, the disciplinary process, and sanctions.

5.2 Collaboration

I **strongly** encourage students to form study groups. Students may discuss and work on problem sets in groups. Each student must (1) report at the top of each question what other students they consulted with, (2) write their code and solution independently, and (3) understand their work well enough in order to reconstruct it entirely on their own.

5.3 AI Tool Policy

All assignments should be your own original work. The use of generative AI tools in this course is explicitly not allowed. Not all AI tools are generative (and thus banned), however. Here are some guiding examples to consider when using various AI-based tools. If you have a question about a specific tool or use case, please reach out to me.

Examples of AI that are okay to use in the course include:

- Grammar and spelling checkers (e.g., Grammarly)
- Transcription or translation tools (e.g., OtterAI)
- Generative AI tools that help you troubleshoot and understand code you have written

Examples of AI that are **not** okay to use in this course:

- Generative AI tools that analyze data for you (e.g., Chartify, Rows.ai)
- Generative AI tools that write your code for you (e.g., Copilot)
- Generative AI tools that construct text responses to questions from assignments for you (e.g., ChatGPT)

5.4 Students with Disabilities

New York University is committed to providing equal educational opportunity and participation for all students, and academic accommodations are available for qualified students who disclose their disability to the Moses Center. Students requesting academic accommodations are advised to reach out to the Moses Center for Student Accessibility as early as possible in the semester for assistance

- Teleophone: 212-998-4980
- Email: mosescsa@nyu.edu
- Web: `http://www.nyu.edu/csd`

5.5 Mental Health Statement

If you are experiencing undue personal and/or academic stress during the semester that may be interfering with your ability to perform academically, the NYU Wellness Exchange (212-443-9999) offers a range of services to assist and support you. I am available to speak with you about stresses related to your work in my course, and I can assist you in connecting with the Wellness Exchange. Additionally, if you anticipate any challenges with completing the assignments, readings, exams and other work required in this course, I encourage you to register with the Moses Center (212 998 4980) in advance so that you may be granted the proper academic accommodations.

5.6 Inclusion

NYU values an inclusive and equitable environment for all our students. I hope to foster a sense of community in this class and consider it a place where individuals of all backgrounds, beliefs, ethnicities, national origins, gender identities, sexual orientations, religious and political affiliations, and abilities will be treated with respect. I intend that all students' learning needs be addressed in and out of class and that the diversity students bring to this class be viewed as a resource and strength. Please feel free to speak with me if this standard is not being upheld.

6 Course Calendar

Table 3 contains topics, assignments, and deadlines. Note that this is subject to change.

Week	Lecture	Assignments
1	Topics: • What is measurement? • Continuous Latent Variables • Latent Variable Estimation • Optimization Preparation: • TBD	Released: • HW0
2	Topics: • Principal Component Analysis • Factor Structure in Item Responses • Exploratory Factor Analysis • Multidimensionality Preparation: • TBD	Released: • HW1 Due: • HW0
3	Topics: • Classical Test Theory • Item Response Theory • Instrument Design and Validation • Rasch Models for Dichotomous Responses Preparation: • TBD	

4	Topics: • Two and Three Parameter Item Response Models • Multidimensional Item Response Theory • Explanatory Item Response Models Preparation: • TBD	Released: • HW2 Due: • HW1
5	Topics: • Polytomous Item Response Models Preparation: • TBD	
6	Topics: • Getting creative about "item responses" • Ideal Point Models • Elo Systems Preparation: • TBD	Released: • HW3 Due: • HW2
7	Topics: • Text as Data • Topic Modeling • Automatic Scoring Preparation: • TBD	

8	Topics: • Categorical Latent Variables • Cluster Analysis • k-Means, Agglomerative, and Divisive Clustering Preparation: • TBD	Released: • HW4 Due: • HW3
9	Topics: • "Soft" and Probabilistic Clustering • Mixture Models Preparation: • TBD	
10	Topics: • Latent Class Analysis Preparation: • TBD	Released: • HW5 Due: • HW4
11	Topics: • Cognitive Diagnostic Models Preparation: • TBD	
12	Topics: • Process Data • Response Time • Drift-Diffusion Models Preparation: • TBD	Released: • HW6 Due: • HW5

13	Topics: • Mixture Item Response Models • Hidden Markov Models Preparation: • TBD	
14	Topics: • Bayesian Networks • Measurement Models in Causal Inference Preparation: • TBD	Due: • HW6

Table 3: Course Calendar

References

[1] T. Hastie, R. Tibshirani, J. H. Friedman, and J. H. Friedman. *The elements of statistical learning: data mining, inference, and prediction*, volume 2. Springer, 2009.

[2] R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2018. URL `https://www.R-project.org/`.

[3] W. J. van der Linden and R. K. Hambleton. *Handbook of modern item response theory*. Springer Science & Business Media, 2013.