Introduction to Formal Reasoning and Decision Making
Philosophy 109
Sections 01 and 03, Fall 2019

Instructor: Dr. Max Bialek   **Email:** mbialek@rutgers.edu
Lecture: MW 1:10–2:30pm (01) or 2:50–4:10 (03)   **Office Hours:** TBA
Location: CA-A1 (01) or FH-B1 (03)   **Office Hours Location:** Miller Hall 211 (map)

Course Description.   "Fundamentals of logical, probabilistic, and statistical thinking, as well as the basic principles of rational decision making. Reasoning through data (and rhetoric) encountered on a daily basis using elementary principles of deductive logic and inference."

Resolving differences of opinion isn't always impossible. Figuring out what you should believe isn't just a matter of checking what's true. Deciding what you should do doesn't have to be left up to your whim. Formal tools have been (and continue to be) developed that enable us to talk very precisely about the strength of arguments and of evidence, the rationality of beliefs we have, and the value of choices we make.

This course will introduce students to some of those formal tools and their applications to formal reasoning and decision making: Sentential Logic will be used as a model for expressing ourselves carefully and judging deductive arguments. Probability and Statistics serve as tools for making inductive inferences, evaluating evidence, and quantifying risk and uncertainty. Decision Theory and Game Theory will provide methods that employ those logical and probabilistic tools in order to help guide our decision making. For all of these, we will also discuss their peculiarities, limits to their application, and their potential for expansion and sophistication.

Core Curriculum Learning Goals.   Please note that this course satisfies the SAS Core Quantitative and Formal Reasoning learning goals

(QQ) Formulate, evaluate, and communicate conclusions and inferences from quantitative information.

(QR) Apply effective and efficient mathematical or other formal processes to reason and to solve problems.

This is a Philosophy course, so the qualitative conceptual foundations and implications of the mathematics discussed will constitute a significant portion of the course material on which you are evaluated. However, quantitative mathematical skills themselves will play no less of a role in the course material and evaluation. It is assumed that you have some basic mathematical skills (especially algebra and fractions), and success in this course depends heavily on the *kind* of thinking that one has to do in math classes.

Course Materials.   We will be working exclusively from notes provided by the instructor that will be posted to the course website.

Course Website. The course website is done through Canvas, and is available directly at [TBA]. It is expected that you turn on alerts for announcements made on the course site so that you can stay up-to-date on any changes to the course.

Accessibility and Accommodations. Any needed accommodations or issues that might affect your academic performance should be brought to the attention of the instructor as soon as possible. Consult with the instructor or any of the following offices for help or more information: Academic Advising, Health and Counseling, Office of Disability Services.

Student Conduct. You should make sure you are familiar with the rules regarding proper academic conduct as detailed at the Student Affairs' Academic Integrity website. Additional information regarding student conduct in general is available at the Office of Student Conduct website.

Course Requirements & Grading. The course is divided into three units—Logic, Probability, and Decisions—and eleven topics (four each in the first two units, and three in the third unit) that correspond with single chapters in the notes.

There will be 11 online discussion forums (one for each topic), each of which will require two substantial posts (original or in reply to others' posts). These will each be worth 1% of the final course grade, and the lowest scoring discussion will be dropped, for a total 10% of the course grade being based on discussion posts.

There will be 11 online quizzes (one for each topic), each worth 3% of the course grade. Each quiz may be taken twice, with the higher score being retained. The lowest of the 11 (retained) quiz grades will be dropped, for a total of 30% of the course grade.

Each of the three units of the course will end with an exam worth 20% of the course grade. A comprehensive final exam will be worth 20% of the course grade. The lowest exam grade will be dropped, for a total of 60% of the course grade coming from exams. This means that if you do poorly on an exam, you can make up for it with the final, or, if you are happy with your grade going into the final, you can skip it.

In short:

10% — 10 Discussion Posts at 1% each (best of 13)

30% — 10 Quizzes at 3% each (best of 11)

60% — 3 Exams at 20% each (best of 3 Unit Exams and 1 Comprehensive Final)

Note that this "best of" structure to the course's grading makes the last discussion posts, the last quiz, and the comprehensive final exam function as extra credit. Please do not ask for additional extra credit. Alternative assessments will be offered only as warranted by documented accessibility and accommodation requirements.

All grades will be given in numerical form. The course grade will be based on the weighted average described above, and the following scheme will be used to convert its numerical value to a letter grade:

$$A \geqslant 90 > B+ \geqslant 87 > B \geqslant 80 > C+ \geqslant 77 > C \geqslant 70 > D \geqslant 60 > F$$

Late Assignments. Late assignments may be submitted at any time prior to the relevant unit exam and half credit (the earned score divided by two, rounded down).

Attendance and Participation. Attendance is expected. Being present, engaged, and asking questions if you don't understand something is the most reliable way to succeed in this course. In-class time is, first and foremost, an opportunity for you to interact with the instructor so as to improve your understanding of the course content. Passively listening to a lecture is unlikely to help you any more than simply sitting at home and reading the notes. You, the instructor, and most of the rest of the class will have a better time and learn more when course content is discussed and not merely reported.

If you expect to miss any classes, please use the University's absence reporting website to indicate the date(s) and reason(s) for your absence.

Schedule. Below is a *tentative* schedule for the course. Check the course website announcements at least once a week for any possible changes.

Readings should be done *before* the class on which they are listed. A reading assignment of, for example, "Read *Notes*, Sections 2.0–2.4" means that you should read everything in Chapter 2 of the provided notes for the course from the unnumbered introductory section (the 2.0) *through* section 2.4, stopping when you arrive at 2.5.

Note that the online quizzes and discussion posts are not listed below. One of each will be due per chapter. Specific due dates will be listed online.

LOGIC

Sep 4 Introduction and Simple Sentences
Read *Notes*, Sections 1.0–1.5

Sep 9 Simple Sentences: Truth-Functional Operators
Read *Notes*, Sections 1.6–1.11

Sep 11 Complex Sentences: Well Formed Formulas
Read *Notes*, Sections 2.0–2.4

Sep 16 Complex Sentences: Truth Tables
Read *Notes*, Sections 2.5 and 2.6

Sep 18 Translations
Read *Notes*, Chapter 3

Sep 23 Translations (continued)

Sep 25 Arguments
Read *Notes*, Chapter 4

Sep 30 Arguments (continued)

Oct 2 *Exam 1* in class

PROBABILITY

Oct 7 Classical Probability: Games of Chance
Read *Notes*, Sections 5.0–5.4

Oct 9 Classical Probability: The Interpretation
Read *Notes*, Section 5.5

Oct 14 Axiomatic Probability
Read *Notes*, Chapter 6

Oct 16 Axiomatic Probability (continued)

Oct 21 Frequentism: χ^2 Testing
Read *Notes*, Sections 7.0–7.2

Oct 23 Frequentism: The Interpretation
Read *Notes*, Section 7.3

Oct 28 Bayesianism: The Interpretation
Read *Notes*, Sections 8.0–8.4

Oct 30 Bayesianism: Base Rate Neglect
Read *Notes*, Section 8.5

Nov 4 Review

Nov 6 *Exam 2* in class

DECISIONS

Nov 11 NO CLASS (make-up activity TBA)

Nov 13 Representing Decisions: Trees and Tables
Read *Notes*, Sections 9.0–8.2

Nov 18 Representing Decisions: Utilities
Read *Notes*, Section 9.3

Nov 20 NO CLASS (University on Friday schedule)

Nov 25 Decision Rules: Dominance and Maximin
Read *Notes*, Sections 10.0–10.3

Nov 27 Decision Rules: Minimax and Expected Utility
Read *Notes*, Sections 10.4–10.5

Dec 2 Games: Equilibrium Outcomes
Read *Notes*, Sections 11.0-11.2

Dec 4 Games: Coordination
Read *Notes*, Section 11.3

Dec 9 Review

Dec 11 *Exam 3* in class

FINAL EXAM TBA