

On-campus Students:

Time TBD

Room TBD

Distance Ed Students:

Access lecture video recordings through Content page of D2L

Prof. Matthias Poloczek

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Office Hours:

TBD

Course Description:

Recent advances in computational and information technology allow the collection and evaluation of vast volumes of data. This explosion in information has amplified the need to understand the value of information and how to use available information to make better decisions that in turn affect the environment.

For example, consider the following questions:

- How should a firm optimally experiment among different website designs before deciding on a single one, with the goal to maximize user traffic or revenue?
- How should a company choose its bid for mining rights if it has access to exclusive probing data, in order to maximize its profit?
- How should a buyer interpret online feedback and ratings before deciding on which product to buy?
- How should a doctor decide which medical tests to perform on a patient to deliver the most effective care?

The course will cover information valuation, decision-making, and information economics in non-strategic and strategic settings.

Course Prerequisite(s):

This course is intended for a wide audience interested in machine learning and optimization. Learners from Industrial Engineering, Systems Engineering, Engineering Management, other fields of engineering (e.g., ECE, AME, BME), applied math and computer science are very welcome.

Undergraduate students:

SIE 305 (Introduction to Engineering Probability and Statistics) or equivalent, or instructor's consent. Note that the success of machine learning relies on mathematical models fitted to data and the development of algorithmic techniques. Thus, you should be comfortable with basic distributions (normal, binomial, beta etc.), (conditional) probability and expectation, and discrete and continuous random variables.

If you are an undergraduate student in the UA College of Engineering, you must be granted *advanced standing* to enroll in this course. For advanced standing of undergraduate students, please visit the webpage for detail information to obtain the advanced standing: <http://sie.engr.arizona.edu/advanced-standing>.

Graduate students:

You should be comfortable with basic distributions (normal, binomial, beta etc.), (conditional) probability and expectation, and discrete and continuous random variables.

All students:

You should be comfortable with coding small programs for activities and will be required to complete a larger program for the project. While Python (version 2 or 3, for example with [Anaconda](#), [scipy.stats](#), and [matplotlib](#)) is recommended, the choice of the programming language is yours. The instructor cannot provide individual assistance (e.g., “debugging”). We will use the D2L forum to facilitate solving coding issues collaboratively. Please e-mail the instructor if you are concerned about having appropriate prerequisites.

Instructor and Contact Information:

Prof. Dr. Matthias Poloczek poloczek@email.arizona.edu
Office Hours: TBA, or by appointment

Teaching Assistant: TBA

Course Format and Teaching Methods:

This course is based on lectures, homework sets, and group projects. This class will use web-based D2L (Desire to Learn) as the only means of distributing class materials including assignments. All assignments and submissions will be uploaded by the student into Assignment Submission Folders on D2L before the appropriate due dates. For each set you will be given a *grace period* of 24 hours, unless stated otherwise. Later submissions will not be graded. Exceptions from this rule will be made only if there is a convincing, properly documented reason. Your grades for this course will also be available on D2L. You will need a UANet ID to access D2L at the following site: <http://d2l.arizona.edu/>. You are expected to check D2L frequently for class information.

For distance learning students, you will find your team mates remotely and meet online for your projects (Instructor will provide you detail instruction about that in the recorded lecture). If you are not able to form team remotely, you are allowed to carry out the project individually based on recorded lectures accessible through D2L.

Course Topics:

- Review of relevant concepts from probability theory and Bayesian statistics
- Learning from experimental observations: conjugacy, the beta-binomial model, the normal-normal model, recursive updates for the posterior distribution
- Information: Information structures and partition model, signal technology, noisy signals
- The Value of Information (VoI): the Elementary Game, optimal actions and strategies, Bayesian decision theory, applications in engineering and finance
- Efficient computation of an optimal strategy
- Optimal information acquisition
- Sequential decision-making under uncertainty
- Learning from others: information in common multi-agent settings, cascades

- Information in strategic settings: auctions, underbidding, truthfulness, winner's curse

This list is tentative. The instructor reserves the right to make modifications if appropriate.

Expected Learning Outcomes:

Upon completion of this course **Undergraduate and Graduate** students will be able to

- Describe uncertainties that arise when acting in an environment whose state is not known and can only be observed with noise.
- Model learning processes of agents.
- Formulate the interplay of learning objectives and other objectives such as the maximization of revenue *via* dynamic programming.
- Understand how decisions of multiple agents are affected by the private and/or public information.
- Be aware of pitfalls in strategic settings, e.g., leading to “herding” behavior, and strategies to avoid them.

In addition, **Graduate** students will be able to derive an optimal policy for an adaptive decision process.

Absences and Class Participation Policy:

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at: <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored. See: <https://deanofstudents.arizona.edu/absences>

Participating in the course and attending lectures and other course events are vital to the learning process. Students are responsible for all materials covered during class. As such, attendance is strongly recommended. Occasionally, attendance may be required for special events such as Project Presentations. Students who miss class due to illness or emergency are required to bring documentation from their health-care provider or other relevant, professional third parties. Failure to submit third-party documentation will result in unexcused absences.

Class Guidelines:

All students:

- Check D2L regularly.
- Turn-in assignments by due date/time (allow for D2L “glitches”).
- Treat instructors, speakers and peers with respect.
- Always behave in an ethical manner.
- Students are encouraged to use laptops for note taking and other class activities.
- Make sure that you are subscribed to the respective forum at D2L: after clicking on ‘Discussions’ in D2L, click the arrow next to the forum name to subscribe to the whole forum.

On-campus students:

- Arrive on-time, turn off cell phones, beepers, social networks, etc.
- Attend class regularly and participate in class discussions and activities.

Distance Ed students:

- View lectures in a timely manner, preferably within 48 hours of the lecture date.
- In some cases, Content will be developed “For Distance Ed Students Only”. Pay careful attention to all communications.

Grad students:

- In some cases, Content will be developed “For Grad Students Only”. Pay careful attention to all communications.

Course Communication:

D2L will be used for normal course communication. Both D2L and UA e-mail will be used for any critical items.

Do not inquire about projects and assignments *via email*. To assert that every student has access to the same information, such questions will only be answered in class or in our D2L forum.

This policy does not apply to personal or sensitive matters, e.g., special needs.

Required Text:

Students will not be required to purchase a text book. The main book for this course is *Information Economics* by Urs Birchler and Monika Bütler, 2007, ISBN 978-0415373456. It is available as **ebook** via the UA library.

Other recommended books include

- *Networks, Crowds, and Markets* by David Easley & Jon Kleinberg, 2010, ISBN 978-0521195331. The authors have made a PDF available at <https://www.cs.cornell.edu/home/kleinber/networks-book/networks-book.pdf>
- *Probability Theory: The Logic of Science* by E. T. Jaynes, 2003, ISBN 978-0521592710.

Further references will be provided in class and on the course website.

Required Materials:

Computer with internet access and your choice of programming tools.

Required Extracurricular Activities:

None

Assignments and Examinations:

We will calculate your final grade based on the final score based on the following table:

	Undergraduate Students	Graduate Students
Homework (equally weighted)	20%	20%
Exam	35%	35%
Project	40%	-
Project including advanced task	-	40%
Participation	5%	5%

Project: There will be two projects in the second half of the semester. Projects involve working in groups of two to three students over a period of four to six weeks, and will require students to hand in a report detailing their approach and solutions. The work will involve mathematical analysis using methods from the course, an implementation of the solution, and a project report. For project reports, I suggest an interactive document (*e.g.*, Jupyter, Matlab, Mathematica) which states the problem and results, and has interactive demonstrations of your work. (A static document is also accepted without penalty.) Graduate students will have an additional assignment that involves advanced methodology.

Exam: The exam will be a 45 minutes in-class exam held around the middle of the semester. The date and location will be announced on D2L. The exam will be closed book and closed notes.

Homework problems: For each set you will be given a *grace period* of 24 hours. Later submissions will not be graded. Exceptions from this rule will be made only if there is a convincing, properly documented reason.

Participation: Participations points are given for active participation in class and for assisting other students in the online forum (but not for raising questions). Active participation in class is not applicable for remote students.

Students may discuss the homework, readings and project with other current students of the class, but showing each other written solutions is not acceptable. Each student must write their submissions independently and individually. (Sharing write-ups, or submitting copies will be considered a violation of the code of academic integrity, and appropriate actions will be taken.) For group assignments, students only need to hand in a single submission per group that lists the names and UANet IDs of all students involved in the preparation and their individual contributions.

If there is a dispute about grading, you may turn in the entire assignment for a re-grade within a week of the work being returned, with a short explanation of the error. All of the work, not just the disputed question, will be regraded.

Grading Scale and Policies:

Final Grades for this course will be computed as follows:

≥ 90%	A
≥ 80%	B
≥ 70%	C
≥ 60%	D
<60%	E

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at <http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

Honors Credit:

Honors Credit will not be available at this time.

Scheduled Topics/Activities:

All assignments will be announced on D2L with their respective due dates.

All homework/projects/presentations and papers are to be submitted by the due date/time to the D2L Assignment Submission Folder unless otherwise specified. All D2L activities, including Discussions, Surveys and Quizzes, must be complete by the due date/time. No late work is accepted except where a grace period is given. No extra credit is available.

Additional Policies on Exams:

If you cannot attend an exam due to a significant reason, you have to inform the instructor by the third week of the semester (except in severe, unforeseeable events). To prevent any possibility of cheating, it is not possible to let a student take a regularly-scheduled exam at any other time. Additionally, there will be no alternative written exam option for any student, because there would be no way to curve it. Consequently, if you miss a written exam, you will be required to take an oral exam. Do not inquire about contents of exams *via* email. To assert that every student has access to the same information, such questions will only be answered in class or in our D2L forum. This policy does not apply to personal or sensitive matters, e.g., special needs.

Classroom Behavior Policy:

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

Accessibility and Accommodations:

At the University of Arizona we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, you are welcome to let me know so that we can discuss options. You are also encouraged to contact Disability Resources (520-621-3268) to explore reasonable accommodation.

If our class meets at a campus location: Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog. See: <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism, available at <http://www.library.arizona.edu/help/tutorials/plagiarism/index.html>.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

UA Nondiscrimination and Anti-Harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students:

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>

Student Assistance and Advocacy information is available at <http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>

Confidentiality of Student Records

All student records are held in strict confidence. Additional information can be found at <http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa>

Final Exam Regulations and Final Exam Schedule

Final Exam Regulations: <https://www.registrar.arizona.edu/courses/final-examination-regulations-and-information>,

Final Exam Schedule: <http://www.registrar.arizona.edu/schedules/finals.htm>

Subject to Change Statement:

Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.

This syllabus is tentative and the instructor reserves the right to make modifications if appropriate.

M. Poloczek, April 19, 2018