

Syllabus for TC 310 – Modes of Reasoning: Applied Logic and Reasoning through Programming and Data Analysis

Taught by Dr. Paul Navrátil, Ph.D.

Homepage: <https://utexas.instructure.com/courses/1276152>

Spring 2020 unique # 41690

Classroom: TTh 09:30 – 11:00 RLP 1.402

Office Hours: TTh 11:00 – 12:00 POB 2.404a (Vislab); by appointment; or on Slack (see below)

This course carries a Quantitative Reasoning (QR) flag, see

<https://ugs.utexas.edu/flags/students/about/quantitative-reasoning>

Course Description

Computers and digital technology are endemic to everyday life, impacting the ways we communicate, the ways we learn, and the ways we work. These sophisticated machines, and the software that operates them, have radically altered many aspects of life from even just the turn of the century. Yet, at their core, these machines operate using a relatively small vocabulary of basic instructions, from which amazing complexity is produced.

This course introduces logic and reasoning through computer programming, with an examination of the reasoning power and potential of machines themselves. It is meant to form a foundation for continued learning and practical use through your college career and beyond. During this course, you will learn how to think about logic problems, particularly as they apply to our increasingly digital world. Along the way, you will also encounter the basic principles used to provide instructions to a computer, and you will learn to apply them to solve problems, assist your research and help present your findings. You will be able to generalize the concepts from this class to your work as you progress through Plan II (and any other major(s) you might pursue!) and into your post-collegiate life *wherever it might take you*.

Required and Optional Texts

We will use readings from these three books to motivate our exploration and discussion of applied logic. Please acquire them (legally ☺). They are all worth owning and can be found for reasonable prices online. Silver and Mitchell are both available in digital formats as well.

- *Gödel, Escher, Bach: An Eternal Golden Braid*. Douglas Hofstadter.
- *The Signal and the Noise: Why So Many Predictions Fail – but Some Don't*. Nate Silver.
- *Artificial Intelligence: A Guide for Thinking Humans*. Melanie Mitchell.

The two books below are optional. There are many Python guides on the web, and this course assumes no prior knowledge, so the Python guide is not strictly necessary. However, if having a tactile reference and guide is helpful to your journey, this is a good one. *On Writing Well* is an excellent guide to improving your writing, for this course and beyond. I wish I had read it as an

undergraduate, and I am offering you the opportunity to benefit from my hindsight ☺. It is not strictly required either, but it is worth owning and re-reading occasionally as you advance in your career. Both of these are also available at reasonable prices online and in digital formats.

- *Introducing Python: Modern Computing in Simple Packages (2nd Edition)*. Bill Lubanovic.
- *On Writing Well: The Classic Guide to Writing Nonfiction*. William Zinsser.

Additional Resources

We will use UT's Canvas website for most class-related functions. The direct link is here:

<https://utexas.instructure.com/courses/1276152>

We will also use several popular software development technologies to give you experience with them, and to enable you to claim familiarity with them for future opportunities.

- We have a Slack workspace for the class: <https://planiilogic.slack.com/>
Slack is an instant messaging service popular in the tech industry (and increasingly elsewhere). It provides direct messaging as well as channels, group chats, and more. It will be the most effective means of contacting me for questions, and I hope it will also provide a productive forum for discussion outside of class. If you join the Slack workspace, you agree to abide by the Student Rights & Responsibilities there as well.
- We will use Jupyter Notebooks for our Python environment: <https://jupyter.org/>
No need to install this, we will use web-hosted environments that should be accessible from any modern web browser.
- The assignments for this course will be posted at my GitHub site here: <https://github.com/pnav/planiilogic>

Course Requirements:

Your grade in this course will be determined by a combination of short programming assignments, a longer course project, and class participation:

- **Short Assignments:** The best way to learn anything is to do it. In that spirit, these short assignments will ask you to exercise logic, reasoning and programming concepts from class. There will be eight short assignments over the Fundamentals and Algorithms sections of the course. These will be used to reinforce material covered in class and to build your comfort and familiarity with covered concepts.
- **Course Project:** The final course section will apply your skills to perform data analysis and deep learning techniques on real-world data. The project will be broken into parts to assist you in maintaining development momentum and to address any challenges early in the process. In addition to the project code, you will submit a 3-5 page summary of your work and findings and present a lightning talk (5-8 minutes) to class.
- **Class Participation:** Class will cover logic, reasoning and programming concepts through examples and analysis, and it will be an opportunity to address any questions or issues that arise. You will be expected to actively participate in discussion and in-class activities to aid your classmates (and your instructor!) in achieving a better understanding of the material.

Grading Policies

The course is arranged such that you have opportunities for feedback early and often so that we can quickly assess areas of strength and improvement, both for individuals and the class collectively, and we can intervene as needed. The contribution of each assignment and course project is relatively small by design, such that a poor result on any one assignment does not lead to a poor result overall. Your overall grade in the class will be determined according to the chart below. I reserve the right to apply a curve to the overall grade distribution solely for the benefit of the students (i.e. curve grades up not down). I will determine whether a curve should be applied, and how much, based on the overall distribution of student grades.

- Short Assignments: 8 @ 5% each (40% total)
- Course Project: (50% total)
 - Project Plan: 10% (meeting 5%, proposal 5%)
 - Milestone 1: 10%
 - Milestone 2: 15%
 - Final Project: 15% (overall 5%, paper 5%, talk 5%)
- Class Participation: 10%

Grade	Cutoff
A	94%
A-	90%
B+	87%
B	84%
B-	80%
C+	77%
C	74%
C-	70%
D	65%
F	<65%

Assignments are due at 11:59pm Central Time the day marked “due” in the Class Schedule. Generally, assignments will be submitted via upload to UT Box with a supplied link. The timestamp on the upload will be used to determine timeliness. Late assignments will be penalized 1% per hour late or portion thereof (e.g. 1.5 hours late = 2%) unless prior arrangements have been made.

Class Schedule (subject to revision based on class progress)

	Topic	Readings (pages) due by listed class	Assignments due by “due” class
Class 1 1/21/20	Planet Jupyter (Notebook): Course Introduction & Overview		Assignment 0 out
Class 2 1/23/20	Abstraction: if it’s not one thing, it’s anything, but maybe an int, a float, or a string	GEB: Introduction (25) GEB: Three-Part Invention (4) SN: Introduction (18) AI: Prologue (14)	Assignment 0 due Assignment 1 out
Class 3 1/28/20	Propositional Logic: IFs ORs ANDs NOTs and forming formal thoughts	GEB: Chapter 1 (10) GEB: Two-Part Invention (3) GEB: Chapter 2 (15)	

		GEB: Sonata for Unaccompanied Achilles (3) GEB: Chapter 3 (11) GEB: Contracrostipunctus (7)	
Class 4 1/30/20	Control Flow: Strange Loops indeed, or how one line is worth a thousand iterations	GEB: Chapter 4 (21) GEB: Little Harmonic Labyrinth (24) GEB: Chapter 5 (26) GEB: Canon by Intervallic Augmentation (5)	Assignment 1 due Assignment 2 out
Class 5 2/4/20	Structures: Data, data, everywhere, but make sure you think!	GEB: Chapter 6 (19) GEB: Chromatic Fantasy, and Feud (4) GEB: Chapter 7 (18) GEB: Crab Canon (5)	
TWELFTH CLASS DAY			
Class 6 2/6/20	Functions: Many hands make light work, or how to build tools for success	GEB: Chapter 8 (27) GEB: A Mu Offering (15) GEB: Chapter 9 (29)	Assignment 2 due Assignment 3 out
Class 7 2/11/20	Libraries: Tom Sawyer was right!	SN: Chapter 1 (28) SN: Chapter 2 (27)	
Class 8 2/13/20	Data ETL: <i>Ceci n'est pas une database</i>	SN: Chapter 3 (34) SN: Chapter 4 (34)	Assignment 3 due Assignment 4 out
Class 9 2/18/20	Data Analysis: The alchemy of insight	SN: Chapter 5 (34) SN: Chapter 6 (28)	
Class 10 2/20/20	Modeling: Learning from our past (data)	SN: Chapter 7 (28) SN: Chapter 8 (30)	Assignment 4 due Assignment 5 out
Class 11 2/25/20	Applying Models: Games	SN: Chapter 9 (32) SN: Chapter 10 (35)	
Class 12 2/27/20	Applying Models: Finance	SN: Chapter 11 (41)	Assignment 5 due Assignment 6 out
Class 13 3/3/20	Applying Models: Science	SN: Chapter 12 (42)	
Class 14 3/5/20	Applying Models: Learning	SN: Chapter 13 (34) SN: Conclusion (9)	Assignment 6 due Assignment 7 out
Class 15 3/10/20	Anatomy of a Neural Net	AI: Chapter 1 (18) AI: Chapter 2 (8) GEB: Prelude (10) GEB: Chapter 10 (26) GEB: Ant Fugue (26)	
Class 16 3/12/20	The AI Promise and Thoughts on Thoughts	AI: Chapter 3 (24) GEB: Chapter 11 (29)	Assignment 7 due

		GEB: English French German Suite (3)	
SPRING BREAK (3/16 – 3/20)			
Class 17 3/24/20	What Can a Neural Net Do, and Can We Know What It's Doing?	AI: Chapter 4 (14) AI: Chapter 5 (15) GEB: Chapter 12 (22) GEB: Aria with Diverse Variations (15)	Schedule project scoping meeting
Class 18 3/26/20	We Have Seen the Data and It Is Us: What outputs might tell us about our inputs	AI: Chapter 6 (21) AI: Chapter 7 (16)	
Class 19 3/31/20	Gaming Revisited: Implications of Mechanical Might	AI: Chapter 8 (12) AI: Chapter 9 (20) AI: Chapter 10 (12)	
Class 20 4/2/20	Demonstrating Incompleteness	GEB: Chapter 13 (25) GEB: Air on G's String (7) GEB: Chapter 14 (23) GEB: Birthday Cantatata... (4)	Project Proposal due
Class 21 4/7/20	Are You Speaking My Language? Thinking, speaking, and computer translation	AI: Chapter 11 (20) AI: Chapter 12 (16) GEB: Chapter 15 (15) GEB: Edifying Thoughts of a Tobacco Smoker (15)	
Class 22 4/9/20	But Does It Really Understand?	AI: Chapter 13 (22) AI: Chapter 14 (12)	
Class 23 4/14/20	Implications for Ourselves	GEB: Chapter 16 (54) GEB: The Magnificrab, Indeed (10)	Milestone 1 due
Class 24 4/16/20	Actual Knowing, and Will We Know It?	AI: Chapter 15 (19) GEB: Chapter 17 (27) GEB: SHRDLU, Toy of Man's Designing (8)	
Class 25 4/21/20	AI Retrospective	GEB: Chapter 18 (39) GEB: Contrafactus (8)	
Class 26 4/23/20	AI Prospectus (1979)	GEB: Chapter 19 (40) GEB: Sloth Canon (3)	Milestone 2 due
Class 27 4/28/20	AI Prospectus (2019)	AI: Chapter 16 (15)	
Class 28 4/30/20	Parting Future Thoughts	GEB: Chapter 20 (36) GEB: Six-Part Ricercar	
Class 29 5/5/20	Final Project Lightning Talks		Final Paper and Code due
Class 30 5/7/20	Final Project Lightning Talks		
NO FINAL – ENJOY YOUR SUMMER – KEEP IN TOUCH			

Student Rights & Responsibilities

- You have a right to a learning environment that supports mental and physical wellness.
- You have a right to respect.
- You have a right to be assessed and graded fairly.
- You have a right to freedom of opinion and expression.
- You have a right to privacy and confidentiality.
- You have a right to meaningful and equal participation, to self-organize groups to improve your learning environment.
- You have a right to learn in an environment that is welcoming to all people. No student shall be isolated, excluded or diminished in any way.

With these rights come responsibilities:

- You are responsible for taking care of yourself, managing your time, and communicating with the teaching team and with others if things start to feel out of control or overwhelming.
- You are responsible for acting in a way that is worthy of respect and always respectful of others.
- Your experience with this course is directly related to the quality of the energy that you bring to it, and your energy shapes the quality of your peers' experiences.
- You are responsible for creating an inclusive environment and for speaking up when someone is excluded.
- You are responsible for holding yourself accountable to these standards, holding each other to these standards, and holding the teaching team accountable as well.

Absences

Excused Absence: The only absences that will be considered excused are for religious holidays or extenuating circumstances due to an emergency. If you plan to miss class due to observance of a religious holiday, please let me know at least two weeks in advance. You will not be penalized for this absence, although you will still be responsible for any work you will miss on that day if applicable. Check with me for details or arrangements.

If you have to be absent, use your resources wisely. Ask other classmates in person or on Slack to get a run-down and notes on any lessons you miss. If you find there are topics that we covered while you were gone that raise questions, you may come by during office hours or schedule a meeting to discuss. Email specific questions you have in advance so that we can make the most of our time. "What did I miss?" is not specific enough.

Personal Pronoun Use (She / He / They / Ze / Etc)

Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name, unless they have added a "preferred name" with the Gender and

Sexuality Center (<http://diversity.utexas.edu/genderandsexuality/publications-and-resources/>). I will gladly honor your request to address you by a name that is different from what appears on the official roster, and by the gender pronouns you use (she/he/they/ze, etc). Please advise me of any changes early in the semester so that I may make appropriate updates to my records.

University Resources for Students

Services for Students with Disabilities

This class respects and welcomes students of all backgrounds, identities, and abilities. If there are circumstances that make our learning environment and activities difficult, if you have medical information that you need to share with me, or if you need specific arrangements in case the building needs to be evacuated, please let me know. I am committed to creating an effective learning environment for all students, but I can only do so if you discuss your needs with me as early as possible. I promise to maintain the confidentiality of these discussions. Any student with a documented disability who requires academic accommodations should contact Services for Students with Disabilities at 471-6259 (voice) or 512-410-6644 (Video Phone) as soon as possible to request an official letter outlining authorized accommodations. For more information, visit <http://ddce.utexas.edu/disability/about/>.

Counseling and Mental Health Center

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

<http://www.cmhc.utexas.edu/individualcounseling.html>

The Sanger Learning Center

Did you know that more than one-third of UT undergraduate students use the Sanger Learning Center each year to improve their academic performance? All students are welcome to take advantage of Sanger Center's classes and workshops, private learning specialist appointments, peer academic coaching, and tutoring for more than 70 courses in 15 different subject areas. For more information, please visit <http://www.utexas.edu/ugs/slc> or call 512-471-3614.

Undergraduate Writing Center: <http://uwc.utexas.edu/>

Libraries: <http://www.lib.utexas.edu/>

ITS: <http://www.utexas.edu/its/>

Student Emergency Services: <http://deanofstudents.utexas.edu/emergency/>

BeVocal

BeVocal is a university-wide initiative to promote the idea that individual Longhorns have the power to prevent high-risk behavior and harm. At UT Austin all Longhorns have the power to intervene and reduce harm. To learn more about BeVocal and how you can help to build a culture of care on campus, go to: <http://wellnessnetwork.utexas.edu/BeVocal>.

Important Safety Information

If you have concerns about the safety or behavior of fellow students, TAs or Professors, call BCAL (the Behavior Concerns Advice Line): 512-232-5050. Your call can be anonymous. If something doesn't feel right – it probably isn't. Trust your instincts and share your concerns.

The following recommendations regarding emergency evacuation from the Office of Campus Safety and Security, 512-471-5767, <http://www.utexas.edu/safety/> Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.

- Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
- In the event of an evacuation, follow the instruction of faculty or class instructors. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- Link to information regarding emergency evacuation routes and emergency procedures can be found at: <http://www.utexas.edu/emergency>

Title IX Reporting

Title IX is a federal law that protects against sex and gender-based discrimination, sexual harassment, sexual assault, sexual misconduct, dating/domestic violence and stalking at federally funded educational institutions. UT Austin is committed to fostering a learning and working environment free from discrimination in all its forms. When sexual misconduct occurs in our community, the university can:

1. Intervene to prevent harmful behavior from continuing or escalating.
2. Provide support and remedies to students and employees who have experienced harm or have become involved in a Title IX investigation.
3. Investigate and discipline violations of the university's relevant policies.

Faculty members and certain staff members are considered “Responsible Employees” or “Mandatory Reporters,” which means that they are required to report violations of Title IX to the Title IX Coordinator. I am a Responsible Employee and must report any Title IX related incidents that are disclosed in writing, discussion, or one-on-one. Before talking with me, or with any faculty or staff member about a Title IX related incident, be sure to ask whether they are a responsible employee. If you want to speak with someone for support or remedies without making an official report to the university, email advocate@austin.utexas.edu. For more information about reporting options and resources, visit titleix.utexas.edu or contact the Title IX Office at titleix@austin.utexas.edu.

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University Policies

Academic Integrity

Each student in the course is expected to abide by the University of Texas Honor Code: “As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity.” Plagiarism is taken very seriously at UT. Therefore, if you use words or ideas that are not your own (or that you have used in previous class), you must cite your sources. Otherwise you will be guilty of plagiarism and subject to academic disciplinary action, including failure of the course. You are responsible for understanding UT’s Academic Honesty and the University Honor Code which can be found at the following web address: http://deanofstudents.utexas.edu/sjs/acint_student.php

Q Drop Policy

If you want to drop a class after the 12th class day, you’ll need to execute a Q drop before the Q-drop deadline, which typically occurs near the middle of the semester. Under Texas law, you are only allowed six Q drops while you are in college at any public Texas institution. For more information, see: <http://www.utexas.edu/ugs/csacc/academic/adddrop/qdrop>

Instructor Biography

Dr. Paul A. Navrátil is an expert in high-performance visualization technologies, accelerator-based computing and advanced rendering techniques at the Texas Advanced Computing Center (TACC) at The University of Texas at Austin. His research interests include efficient algorithms for large-scale parallel visualization and data analytics (VDA) and innovative design for large-scale VDA systems, with particular focus on in-situ, high-fidelity visualization techniques. My recent work includes software-defined visualization capabilities, particularly the NSF-funded GraviT project that enables large-scale distributed-memory ray tracing. This work enables photo-realistic rendering of the largest datasets produced on supercomputers today. He is Director of Visualization at TACC and leads TACC's programs for large-scale visualization and human-data interaction. Dr. Navrátil's work has been featured in numerous venues, both nationally and internationally, including the New York Times, Discover, and PBS News Hour. He holds BS, MS and Ph.D. degrees in Computer Science and a BA in Plan II Honors from the University of Texas at Austin. When not helping power discoveries that change the world (TACC's motto), Paul enjoys the Austin outdoors, spending time with his wife and their menagerie, maintaining his martial arts practice, and trying to lower his golf handicap.