

Knowledge and the Universe

A Quest 2 Syllabus

Primary General Education Designation: Physical Sciences

Secondary General Education Designation: International

I. Course Information

Quest 2 IDS2935

Fall 2022

Meeting Day/Time: M/W/F 10:40 a.m. – 11:30 a.m.

Location: LAR 0310 (In person)

General Education Designation: Physical Sciences, International

A minimum grade of C is required for general education credit

Instructor

Paul Torrey – paul.torrey@ufl.edu

Office location: 310 Bryant Space Sciences

Office hours: M/W 11:45 – 12:45 (i.e. right after class) and by appointment

Office hours location: All office hours will be held via in person meeting by default, but zoom participation can be arranged by request.

Phone: (352) 294-1846

Teaching Assistant

Dhruv Zimmerman – d.zimmerman@ufl.edu

Office location: 319A Bryant Space Sciences

Office hours: T 10-11 AM; Th 2-3 PM and by appointment

Office hours location: All office hours will be held via in person meeting by default, but zoom participation can be arranged by request.

Course Description

How can different people can view the same evidence yet form or retain different conclusions? This course introduces students to the concept of inference: the process by which we convert information presented to us into new conclusions or new 'knowledge'. This course asks students to apply inference not just in a scientific context, but also to pressing societal issues. The units of this course are structured with a repeating cycle of science, history, analysis, and application. Each unit focuses first on a seminal debate/mystery in the history of astronomy (e.g. is the Earth flat? does the Earth orbit the Sun? is the Universe expanding or static?), followed by examination of a current, pressing societal issue (Are

vaccines harmful? Is the climate changing and are humans responsible? Is my Facebook feed a valid source of information?). These seemingly disparate topics will be intimately linked by addressing the question: How do we know what we know? How do we, as scientists and members of society, process information in order to draw conclusions (i.e. to determine what we 'know'). While it may seem absurd now, there was a time when much of society believed the Sun orbited the Earth. For the historical astronomy examples explored in the course, we will discuss the experiments and data that were available, the ambient culture that influenced decision making, and other relevant factors that would have been considered by the scientists in their conclusion drawing process. Similarly, for the current societal issues, we will introduce relevant evidence and scientific principles to understand each issue. In both cases, our primary focus will be on understanding how different people can view the same evidence yet form or retain different conclusions.

This course explores the advancement of knowledge broadly in terms of Bayesian analysis. In this framework, observations from real world experiments (i.e. imperfect experiments with error bars and noise) are balanced with prior assumptions or knowledge (e.g. I think this data is better fit with a line than a parabola, I don't trust this instruments measurements, I don't trust this person's opinion/memory, etc.). Each historical unit is coupled to extensive discussions of examples in which this kind of thinking applies in the actual day-to-day lives of the students. This course will encourage students to explicitly examine how the combination of observed facts and their own 'prior knowledge' can lead rational people to draw different conclusions from the same set of observations. We will use classroom discussions among the whole class – and among breakout groups -- on a weekly basis to explore these ideas. This course will solidify these concepts for students to the point where they will automatically think about priors and likelihoods when determining how they come to accept facts as truth.

By using an inference or Bayesian-based approach to view the development of knowledge, we obtain a unique window into understanding how people from other countries, cultures, religions, or upbringings may develop varied beliefs or knowledge despite living in an increasingly connected world. Throughout the semester, we will continuously look at examples of pressing societal issues (Climate change, anti-vaccination, and disinformation campaigns in particular), the specific 'priors' that surround decision making and knowledge development for these topics, and isolate how priors can vary between or within different societies or sub-groups within a society. Students will be asked to not only continuously confront their own priors, but also to attempt to understand the origin of priors that conflict with their own. We will use examples of pressing societal issues to promote students understanding the origin of varied beliefs or knowledge in order to provide them with the tools needed to effectively engage with politically, culturally, or socioeconomically diverse groups.

Recommended Course Materials (to purchase/rent)

- *The Essential Cosmic Perspective*, Bennett, Donahue, Schneider & Voit (ISBN:978-0134446431)

A note about this text: In past years, this text was required for the course. However, feedback has indicated that many students found it unnecessary to their learning experience. More specifically, we will cover all key concepts from this text in pre-recorded lectures, which will be available throughout the entire semester on our course website. For students with particularly strong math/science/physics backgrounds – or for students who learn efficiently from those lectures alone -- you may not find this textbook to be necessary. Thus, following the feedback from previous years, the textbook is not required. However, this textbook contains more detailed explanations of the astrophysical concepts

that will be important for problem set assignments. Thus, for students who may have less strong math/science/physics backgrounds – or for students who find reading to be a more effective learning modality compared against recorded lecture – may find it helpful to use this book.

Other Assigned Reading (Links provided through Canvas):

- Original Ptolemy Almagest excerpt:
 - <https://bertie.ccsu.edu/naturesci/cosmology/ptolemy.html>
- Original Copernicus Commentary:
 - <http://copernicus.torun.pl/en/archives/astronomical/1/?view=transkrypcja&lang=en>
- 'Introduction to Inference'
 - Course notes, provided by the Instructor via Canvas.
- Lord Kelvin on the sun:
 - http://www-history.mcs.st-andrews.ac.uk/Extras/Kelvin_sun_1.html
- The age of the earth (Excerpt from Comte de Buffon)
- The age of the Earth in the twelfth Century: a problem (mostly) solved
- How to think like an Epidemiologist
 - <https://www.nytimes.com/2020/08/04/science/coronavirus-bayes-statistics-math.html>
- The Anti-vaccination Movement: A Regression in Modern Medicine
 - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6122668/pdf/cureus-0010-0000002919.pdf>
- Excerpts from the “The Great Debate”:
 - https://apod.nasa.gov/diamond_jubilee/1920/cs_nrc.html

Supplemental Reading (Not Required):

- The Sun in the Church: Cathedrals as Solar Observatories (Heilbron)

Statement on Experiential Learning and Learning Labs

As a Quest-2 class, a key element is the application of experiential learning. In the case of this class, this means participating in Astronomical learning labs where you will look through telescopes at objects in the sky, record your observations, and submit a report on what conclusions those observations let you draw. **Astronomical observations are subject to availability of clear observing conditions!** Thus, while we can try to plan out our experiential learning lab schedule, our actual ability to observe on a given night will not be known until the day of the planned event, and sometimes only within an hour or two of the start time. Additionally, we will be using a shared space for these labs (the UF Campus Teaching Observatory). This means that we only currently have labs scheduled through the first several weeks of the semester, but additional dates will be announced as the semester proceeds.

You will have to carry out three assignments (three labs) during this semester. To carry out these Experiential Learning Labs, you will need to visit the Campus Teaching Observatory (CTO), at least two, but likely three times.

The currently known list of dates available for students to carry out their experiential learning assignments are:

- 9/2 – 8-10 PM
- 9/6 – 8-10 PM
- 9/13 – 8-10 PM

Additionally, if we are not able to secure sufficient time during the week for the experiential learning, you may choose to attend a Public Observing Night. Public Observing Nights are scheduled for the following dates:

- 9/30 – 8-10 PM
- 10/14 – 8-10 PM
- 10/21 – 8-10 PM
- 10/28 – 8-10 PM
- 11/4 – 8-10 PM
- 11/18 – 8-10 PM
- 12/2 – 8-10 PM

Statement on Materials and Supplies Fees

N/A

II. Coursework & Schedule

1. List of Graded Work

Work	Description	Word Count	Points
Problem Sets	Problem sets (7 in number; see weekly schedule for details) including simple physical calculations, brief reading analysis, and discussion preparation. One problem set will be assigned with each Astronomy Topic covered. Problem sets will assess student comprehension of the physical concepts covered in the course. Problem sets will be graded for accuracy.	N/A	30
Class Prep Quizzes	Comprehension Quizzes will be assigned to ensure students have completed the assigned reading and/or lecture prior to coming to class . This is essential to facilitating classroom discussion. Quizzes will be available via Canvas and have a strictly enforced deadline prior to the class/week when the material is to be discussed. Quizzes will be graded for accuracy.	N/A	15
Experiential Learning Labs	Lab assignments to be carried out requiring students to make measurements toward questioning or confirming the underpinnings of astronomical knowledge. Lab reports will be graded for accuracy and clarity.	N/A	10
Societal Parallel writing assignments	Identification of societal parallels, along with an essay explaining how it relates to the subject of the unit. Essays will be graded based on (i) completion, (ii) accurate application of course material to the writing subject, (iii) logical consistency of any arguments presented, and (iv) grammatical and spelling accuracy.	500	20
Final Presentations	Group presentations addressing historical examples where humans acted irrationally based on either misinformation, limited scientific knowledge, dogmatism, or similar.	N/A	15

Attendance	Class attendance will be taken at the discretion of the instructor including by checking presence via participation of in class-based Surveys. Attendance points will be awarded to students present in class. Scores will be recorded in Canvas.	N/A	10
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As a general matter:

- Most assignments are already available with due dates on Canvas so that students can plan accordingly for their semester. Due dates may be postponed owing to the class delays (e.g., owing to unanticipated class cancellations), but will not be advanced.
- All assignments (homework, writing, and experiential learning labs) are due at 5 p.m. on the assigned due date. Students must submit completed assignments via Canvas in the format specified in the assignment. Late assignments will generally not be accepted unless a documented reason is provided that qualifies under UF's approved/excused absences.
- It is the student's responsibility to ensure that any submitted assignments are legible (i.e. can be easily read and graded), contain the correct information (i.e. that you don't submit last week's HW assignment for this week), and that the submitted files are not corrupted (i.e. that the file can be opened by the grader). **Failure to submit the correct document in a readable form will be treated as equivalent to not submitting the document.**
- The course Canvas site will make clear all assignment dates and deadlines. Any questions about deadlines should be directed to the Instructor, ideally through the course Discussion pages.

2. Weekly Course Schedule

Week/ Date	Topic (Question/Subject)	Physical Sciences + Q2 Method/Concept/Practice at Work	Homework: Reading & Activities for Before Class	Assigned Work Due
Week 1 (8/24 – 8/31)	Why do planets appear to ‘wander’ relative to the ‘fixed’ stars?	Ptolemy, Copernicus, Kepler, Galileo, & Occam’s razor: modelling the solar system. Students will learn the mechanics of planetary orbits. We will discuss the methods and data that ancient astronomers used to identify the motion of planets. We will discuss relevant societal factors (e.g. religious/dogmatic influence) that contributed to solar system model formation.	1) Watch pre-recorded lectures via Canvas. 2) Do pre-class quizzes 3) First Problem Set Assigned	Pre-class Quizzes.
Week 2 (9/2-9/9)	How do scientists decide what to believe?	Introduction to inference. We will introduce the concept of inference and explore examples where students intuitively accept or reject testimony/evidence (e.g. when judging the validity of an alleged UFO photo). We will use these examples to build a simple and intuitive framework for Bayesian analysis and to introduce the critical Bayesian concept of a ‘prior’. Class discussions will be used to discuss further examples of priors in daily life, highlighting all the other names we might refer to them as (expectations, intuition, common knowledge, etc.). We will discuss the historical example of the relationship between the religious/dogmatic beliefs and Astronomy to reflect on the ways in which cultural beliefs influence the development of an individual’s priors.	1) Watch pre-recorded lectures via Canvas. 2) Read ‘Introduction to Inference’ lectures notes provided via Canvas. 3) Do pre-class quizzes 4) First Writing Assignment assigned.	Pre-class Quizzes. First Problem Set Due
9/5	Holiday – No Class	Holiday – No Class	Holiday – No Class	
Week 3 (9/12-9/16)	What is the source of the sun’s energy?	Energy in physics. Students will learn the concepts of energy and power in the context of our Sun. We will discuss modern and ancient methods to measure the Sun’s power output, but highlight the difficulty in observing where this power comes from. We will discuss different options for powering the sun including	1) Watch pre-recorded lectures via Canvas. 2) Read: Lord Kelvin on the sun (provided through Canvas) 3) Do pre-class quizzes	Pre-class Quizzes.

Week/ Date	Topic (Question/Subject)	Physical Sciences + Q2 Method/Concept/Practice at Work	Homework: Reading & Activities for Before Class	Assigned Work Due
		chemical burning, gravitational contraction, and nuclear fusion. We will examine the historical evolution in our understanding of the Sun’s power, and its coevolution with the available body of physical knowledge. Class discussions will prepare students for their experiential learning experiment, and discuss difficulties <i>inferring knowledge</i> about something we cannot directly see or touch.	4) Second Problem Set Assigned	First Writing Assignment Due.
Week 4 (9/19-9/23)	Public Knowledge about Public Health	The Anti-vaccination Movement. We will discuss the origins, some initial studies, and retracted conclusions which have formed the basis of the modern anti-vaccination movement. We will specifically re-address “how do scientists decide what to believe” and generalize this to “how do humans decide what to believe”. We encounter here an example where two different people in modern society can apparently live in the same area, read the same news, see the same evidence, and yet come to different conclusions? We will discuss how this can happen specifically using a Bayesian framework coupled to highly variable priors tied to each individual. Course meeting discussions will focus discussion on the distinction (or lack thereof) between how scientists and members of society draw conclusions when faced with evidence that contradicts their expectations. We will discuss how the anti-vaccination movement has manifested in different countries and different cultures. Regardless of our ability to understand and accept varied priors, we will use an inference-based framework as a way to understand how different individuals can arrive at different conclusions with the same evidence.	1) Do assigned readings 2) Watch video lectures. 3) Do pre-class quizzes 3) Second Writing Assignment assigned	Pre-class quizzes. Second Problem Set Due

Week/ Date	Topic (Question/Subject)	Physical Sciences + Q2 Method/Concept/Practice at Work	Homework: Reading & Activities for Before Class	Assigned Work Due
Week 5 (9/26–9/30)	Earth's Origins Note: Prof. Torrey is Travelling. Classes will proceed as usual.	The formation of the Solar System and Age of the Earth. How old is the Earth, and how do we know this to be true? Students will learn the concepts of radioactive decay which will be used to introduce mathematical modeling. We will discuss evolution in the “best” estimate of the Earth’s age and use this to introduce the concepts of precision vs. accuracy in measurements. Course discussions will further cover the concepts of radioactive decay and modelling of the Earth’s age. As we discuss the formation of the Earth, so too will we discuss the formation of the Solar System.	1) Watch pre-recorded lectures via Canvas. 2) Read: The age of the earth (Comte de Buffon) 3) Do pre-class quizzes 4) Third Problem Set Assigned	Pre-class quizzes. Second Writing Assignment Due.
Week 6 (10/3-10/7)	The Milky Way and A Universe of Galaxies Note: Prof. Torrey is Travelling. Classes will proceed as usual.	Our galactic home in the Universe. The Universe is massive. It is filled with galaxies in all directions each with millions or billions of stars, and we have not detected an edge. Students will learn about our understanding of the structure of the Universe as well as the evidence we used to infer this structure. We will discuss the famous <i>Curtis/Shapley debate</i> , Edwin Hubble’s observations, and the expansion of the Universe. Breakout discussions will explore the similarities, differences, and distinctions between the Great Debate about the Universe’s expansion and Climate Change.	1) Watch pre-recorded lectures via Canvas. 2) Read: Excerpts from the “The Great Debate” 3) Do pre-class quizzes 4) Fourth Problem Set Assigned	Pre-class quizzes. Third Problem Set Due
Week 7 (10/10-10/14)	Climate Change	The History of, Evidence for, and Debate about Climate Change. We will define climate change and discuss the evidence and experiments that have been used to establish its existence. We will contrast the near uniform consensus in the scientific community with the ongoing debate in the public domain. We will explore real data to identify ways one can influence conclusions by applying very specific assumptions (e.g. smoothing the data over very specific timescales, placing emphasis	1) Do assigned readings 2) Watch Recording of Senate Hearing on Climate Change 3) Third Writing Assignment assigned	Pre-class quizzes. Fourth Problem Set Due.

Week/ Date	Topic (Question/Subject)	Physical Sciences + Q2 Method/Concept/Practice at Work	Homework: Reading & Activities for Before Class	Assigned Work Due
		<p>on – or specifically neglecting -- individual datapoints). Breakout sections will discuss how the perceived validity of very specific assumptions can vary based on an individual's priors. We will look at polling data from different countries to identify the popularity of action on climate change, and review articles and arguments that have been presented from both sides. We will discuss instances of 'selective neglect' of evidence, and how such actions can be understood with priors.</p>		
<p>Week 8 (10/17- 10/21)</p>	<p>The Birth, Size, and Expansion of the Universe</p>	<p>An Expanding Universe? Students will learn about the current favored model for the Universe. Students will see Edwin Hubble's original dataset that he used to propose an expanding Universe. We will debate how confident Hubble should have been in his conclusion of an Expanding Universe. We will explore the implications of an expanding Universe (specifically, the Big Bang, size, and fate).</p>	<p>1) Watch pre-recorded lectures via Canvas. 2) Read: Einstein's blunder 3) Do pre-class quizzes 4) Fifth Problem Set Assigned</p>	<p>Pre-class quizzes. Third Writing Assignment Due</p>
<p>Week 9 (10/24-- 10/28)</p>	<p>The Anti-masking Movement</p>	<p>How do priors influence opinions on public health issues? We will return to our discussion of the anti-vaccination movement, this time with a focus on Covid-19 and pro-mask/anti-mask sentiment. We will discuss factors that influence the formation of an individual's priors, the rigidity of priors (e.g. I never trust this news source), and the flexibility of priors (i.e. can we change ours?). Class discussions will explore situations where individuals can seem unchanged by new evidence. The question will be asked and discussed: Are decision makers who are uninfluenced by new evidence acting rationally/logically? We will use this discussion to re-emphasize the relationship and distinction between evidence and priors. Moreover, we will discuss how</p>	<p>1) Do assigned readings 2) Fourth Writing Assignment assigned</p>	<p>Pre-class quizzes. Fifth Problem Set due.</p>

Week/ Date	Topic (Question/Subject)	Physical Sciences + Q2 Method/Concept/Practice at Work	Homework: Reading & Activities for Before Class	Assigned Work Due
		internationally varied societal priors/beliefs can translate into varied medical or public health norms.		
Week 10 (10/31-11/4)	Dark Matter, Dark Energy, & the Fate of the Universe	Our Cosmic Pie of Ignorance. We now have abundant evidence to conclude that the dominant composition of the Universe is Dark Matter and Dark Energy. These are ‘substances’ that (to this point) we cannot touch or directly probe. Instead, despite making up 95% of our Universe’s composition, we only know of their existence through inference. We will discuss the transformative study that revealed the existence of dark energy. We will scrutinize the data and examine how scientists were able to draw this bold conclusion. Class discussions will focus on the essential role that detailed statistical analysis played in allowing scientists to be certain in this conclusion and relate this back to the main theme of the class.	1) Watch pre-recorded lectures via Canvas. 2) Do pre-class quizzes 3) Sixth Problem Set Assigned	Pre-class quizzes. Fourth Writing Assignment Due
Week 11 (11/7-11/11)	Fact checking scientific topics in Modern News	“The Public” rarely gets direct access to the scientists or scientific communities that have been directly researching a topic. Instead, they are more likely to get access to a curated news feed (social media, or professionally curated), containing articles by journalists, who likely read a press-release, skimmed journal articles, and may have interviewed relevant scientists. This process, which is akin to the childhood game of telephone, can work very efficiently, or not. Either way, we (all of us, whether we like it or not) use a filter when determining which information sources to trust, and how much to trust them. We will discuss both the process of bringing scientific topics into the media, as well as how priors influence the way we (the public) digest this media.	1) Do assigned readings 2) Fifth Writing Assignment assigned	Pre-class quizzes. Sixth Problem Set Due

Week/ Date	Topic (Question/Subject)	Physical Sciences + Q2 Method/Concept/Practice at Work	Homework: Reading & Activities for Before Class	Assigned Work Due
11/11	Holiday – No Class	Holiday – No Class	Holiday – No Class	
Week 12 (11/14- 11/18)	Are we alone in the Universe?	Exoplanets and Aliens. Recent history remembers a time when it was not known if planets existed around other stars. The past two decades have seen an explosion in our knowledge about the existence, statistics, and characteristics of exoplanets. Students will learn the physics behind exoplanet detection and characterization. We will explore the data that led to early exoplanet discoveries, confront uncertainties/noise in the data, and evaluate the certainty in these detections. Breakout sessions will explore the uncertainty of early exoplanet discoveries, the process of acceptance of these discoveries, and how this changed scientific priors on the question “do exoplanets exist?”.	1) Watch pre-recorded lectures via Canvas. 2) Do pre-class quizzes 3) No New Problem Set Assigned	Pre-class quizzes. Fifth Writing Assignment Due
Week 13 (11/21 & 11/23)	No Structured Classes	Optional Gatherings for Final Presentation Prep		
Weeks 14 & 15 (11/28-12/2) (12/5-12/7)	Final Presentations	Students will present their Final Presentations.		Final Reports Due

III. Grading

3. Statement on Attendance and Participation

Attendance and Participation:

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

- Attendance will be regularly taken by the instructor. One (1) point of credit will be given to each student who is present when attendance is taken. Any absences that do not meet University criteria for 'excused' will result in a student not receiving credit for that day. Any student who attends class but does not participate in a graded attendance event (e.g., a Canvas survey does not work for them for technical reasons) must present themselves to the instructor *immediately* following lecture to receive attendance credit. All students will have their lowest 3 attendance scores dropped at the end of the semester (i.e. students are allowed three absences for the semester without any required justification or penalty).

4. Grading Scale

For information on how UF assigns grade points, visit: <https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/>

A	90 – 100% of possible points		C	70 – 73%
A-	87 – 89%		C-	67 – 69%
B+	84 – 86%		D+	64 – 66%
B	80 – 83%		D	60 – 63%
B-	77 – 79%		D-	57 – 59%
C+	74 – 76%		F	<56

A minimum grade of **C** is required for a general education credit.

IV. Quest Learning Experiences

5. Course Delivery and Engagement

Number of Seats Anticipated: 76 students
Delivery Method: In person, LAR 0310, Synchronous

This course will be an in-person class with a heavy emphasis on interactive discussion.

In this course, we will explore ideas like what role prior knowledge and experience (i.e. priors) plays in determining what a person chooses to believe. For example, we will explore why students may likely believe me when I assert that “I rode my bike to work today” but will likely not believe me when I assert “I rode my dragon to work today.” (The answer is they have ‘strong priors’ that dragons don’t exist.) We will use this basic concept to discuss examples through history where strong priors influenced or impacted the advancement of astronomy (e.g., Why did it take so long for ancient civilizations to accept that the Sun – and not the Earth – was the center of the solar system? Because they had strong priors – partially grounded in Religion or dogma – that Earth must be at the center.) We will then apply these same concepts to current events and societal issues (e.g., How can groups of voters fixate on the same problem [e.g., a faltering economy] but have vehement disagreements about the solutions? How can groups of voters see the same data [e.g., rising ocean temperature measurements] but disagree about the implications?). The goal of this class is not to determine right-from-wrong, nor fact-from-fiction, but rather to shed light on the process through which humans assemble knowledge as modeled within a Bayesian framework.

To promote class-meeting discussion and interaction, reading assignments and lecture material will be assigned via Canvas in advance. Students will be required to complete these assignments in advance of class, which will allow us to focus our class meeting times on answering questions, doing practice problems, and engaging in debate.

6. Details of Experiential Learning Component

This course focuses around having students question the origins of knowledge. As such, the course includes three experiential learning labs where students carry out experiments that simultaneously demonstrate the underpinnings of astronomical knowledge while allowing students to assess the level of the certainty that should be associated with the conclusions from those experiments.

The three experiential learning components include:

- 1) A Modern Day Galileo: Students will observe object in the solar system and galaxy that allowed Galileo to conclude that the cosmos are not “perfect”.
- 2) Weighing Jupiter: Students will use multiple observations of Jupiter including the positions of its moons to “weigh” Jupiter.
- 3) Experiment meets reality: Students will design an observing session using computer software to target objects of interest to them, and then try to observe these systems at the Observatory.

Each of these labs will require students to carry out an experiment and provide a written summary of conclusions. In particular, students will be asked analyze the certainty of the conclusions of these experiments and how any conclusions might be influenced by assumptions made during the experiment.

7. Details of Self-Reflection Component

Students will carry out self-reflection through their written assignments which will require they consider how course concepts apply to the modern world and their everyday lives. Within our society, groups of people can hear the same testimony, face the same set of observations, or experience the same situation, yet come away with inconsistent opinions. We will discuss how humans come to conclusions

– broadly defined – through a combination of observations/information convolved with their prior knowledge or assumptions. We will ask students to reflect on how this fact-vetting framework applies to their everyday life.

8. What is the essential/pressing question your course explores?

How do we know what we know? How do you determine to believe (or not) what a person tells you? How can a group of people hear the same testimony, face the same set of observations, or experience the same situation, yet come away with inconsistent opinions or conclusions?

Scientists draw conclusions by carrying out experiments that shed light on unknowns. Astronomers in particular advance knowledge using observations of distant objects to infer physical knowledge. Yet, there are a number of examples in history where the scientific community was slow to develop consensus. We will use a series of historical examples to explore how scientists confront observations with priors in order to develop conclusions.

While our course will focus on the advancement of knowledge in Astronomy. We will continuously focus on how the scientific knowledge building process applies to students in their everyday life. Humans develop opinions and vet facts based on a number of factors (e.g. reliability of source, existence of conflicting opinions, prior subject knowledge). This course will ask students to explore how they process knowledge, a concept that applies to students' everyday life. We will ask students to confront how they draw conclusions and determine fact. We will focus less on determining what the 'right' conclusion is, but instead emphasize and make explicit the process that leads humans to draw conclusions.

III. General Education and Quest Objectives & SLOs

9. This Course’s Objectives—Gen Ed Primary Area and Quest

Physical Sciences Objectives →	Quest 2 Objectives →	This Course’s Objectives → (This course will....)	Objectives will be Accomplished By: (This course will accomplish the objective in the box at left by...)
Physical science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the physical sciences.	Address in relevant ways the history, key themes, principles, terminologies, theories, or methodologies of the various social or biophysical science disciplines that enable us to address pressing questions and challenges about human society and/or the state of our planet.	... expose students to the basic principles of astronomy fact-gathering and research. Astronomy is unique in that the object studied can be seen only at a distance, and often with limited direct observability. The limited availability of observational information impacts the conclusion drawing process (inference).	... examining through 7 distinct Units historical examples within Astronomy where great advancements were made. We will discuss what observations were made and how that led scientists to draw the conclusions that they did.
Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes that govern physical systems.	Present different social and/or biophysical science methods and theories and consider how their biases and influences shape pressing questions about the human condition and/or the state of our planet.	... deeply and continuously immerse students in the practice and discipline of probabilistic inference and Bayesian analysis: the subtle but critical underpinnings of the conclusion drawing process at the core of the Scientific Method.	... examining through 7 distinct Units which explore historical examples within Astronomy where great advancements were made. In each case, advancement required not only evidence, but also confronting established (incorrect) common knowledge.

Physical Sciences Objectives →	Quest 2 Objectives →	This Course's Objectives → (This course will...)	Objectives will be Accomplished By: (This course will accomplish the objective in the box at left by...)
Students will formulate empirically-testable hypotheses derived from the study of physical processes, apply logical reasoning skills through scientific criticism and argument, and apply techniques of discovery and critical thinking to evaluate outcomes of experiments.	Enable students to analyze and evaluate (in writing and other forms of communication appropriate to the social and/or biophysical sciences) qualitative or quantitative data relevant to pressing questions concerning human society and/or the state of our planet.	... use astronomy as a means for studying how observations can lead to new knowledge.	... using two lab modules where students will gather or use data (e.g., on the Sun's temperature or the expansion of the Universe). Students will critically analyze the experiment design, data, and conclusions.
	Analyze critically the role social and/or the biophysical sciences play in the lives of individuals and societies and the role they might play in students' undergraduate degree programs.	... examine how the <i>exact same</i> critical thinking and conclusion drawing process used in the Scientific Method can apply to the actual day-to-day lives of the students.	... examine historical examples where groups of highly educated scientists with expert knowledge examined the same evidence and drew varied conclusions. We will examine why that happened, and how that applies to students' everyday lives.
	Explore or directly reference social and/or biophysical science resources outside the classroom and explain how engagement with those resources complements classroom work.	... have students gather real astronomy data to confirm/explore/validate/understand the origins of observational facts asserted in lecture.	... have students construct their own experiments and/or data processing to gather insight on the underpinnings of modern astronomy knowledge.

10. This Course's Student Learning Outcomes (SLOs)—Gen Ed Primary Area and Quest

	Physical Sciences SLOs → Students will be able to...	Quest 2 SLOs → Students will be able to...	This Course's SLOs → Students will be able to...	Assessment Student competencies will be assessed through...
Content	Identify, describe, and explain the basic concepts, theories and terminology of natural science and the scientific method; the major scientific discoveries and the impacts on society and the environment; and the relevant processes that govern biological and physical systems.	Identify, describe, and explain the cross-disciplinary dimensions of a pressing societal issue or challenge as represented by the social sciences and/or biophysical sciences incorporated into the course.	Identify, describe, and explain the physical principles that underly our current model for the cosmos as well as how scientists process evidence to come to conclusions and link this to how individuals and groups of people come to make decisions and form opinions while taking into account the influence of the priors that those individuals and groups possess.	Bi-weekly writing assignments, problem sets, and experiential learning labs.
Critical Thinking	Formulate empirically-testable hypotheses derived from the study of physical processes or living things; apply logical reasoning skills effectively through scientific criticism and argument; and apply techniques of discovery and critical thinking effectively to solve scientific problems and to evaluate outcomes.	Critically analyze quantitative or qualitative data appropriate for informing an approach, policy, or praxis that addresses some dimension of an important societal issue or challenge.	Analyze and evaluate the role that priors play in setting opinions and beliefs so that students can critically analyze and more deeply understand what drives knowledge and opinion formation.	Bi-weekly writing assignments, problem sets, and experiential learning labs.

	Physical Sciences SLOs → Students will be able to...	Quest 2 SLOs → Students will be able to...	This Course's SLOs → Students will be able to...	Assessment Student competencies will be assessed through...
Communication	Communicate scientific knowledge, thoughts, and reasoning clearly and effectively.	Develop and present , in terms accessible to an educated public, clear and effective responses to proposed approaches, policies, or practices that address important societal issues or challenges.	... write, present, and debate the basics of a quantitative formulation of the scientific method known as probabilistic inference.	... biweekly written assignments requiring clear communication and thoughtful reasoning as well as final presentations.
Connection	N/A	Connect course content with critical reflection on their intellectual, personal, and professional development at UF and beyond.	... apply the same thought patterns that govern in the scientific process to societal contexts in situations as wide-ranging as medical diagnoses, social media discourse, journalism, politics, and religion.	... biweekly written assignments that require drawing parallels from the scientific process discussed in class to the real world.

10a. This Course's Objectives and Student Learning Outcomes (SLOs)—Gen Ed Secondary Area

International Objectives (for N co-designation)

International Objectives →	This Course's Objectives → (This course will....)	Objectives will be Accomplished By: (This course will accomplish the objective in the box at left by...)
International courses promote the development of students' global and intercultural awareness.	... use the advancement of science (astronomy) to probe the underpinnings of how humans vet knowledge which naturally includes intercultural awareness.	... use a Bayesian framework to probe how and why a person's upbringing and background can impact their views-on and perception-of the word.
Students examine the cultural, economic, geographic, historical, political, and/or social experiences and processes that characterize the contemporary world, and thereby comprehend the trends, challenges, and opportunities that affect communities around the world.	... discuss how past experiences, education, and biases shape the 'priors' that any and all people bring to decision making processes. Emphasis will be placed on how variations in international or cultural norms impact individual prior development, and therefore knowledge development.	... discuss specific examples of when astronomy was misled by 'common knowledge' or dogmatic ideas, and how/why this happened (e.g. the slow advancement of the Copernican model, the poor estimations of the Age of the Earth).
Students analyze and reflect on the ways in which cultural, economic, political, and/or social systems and beliefs mediate their own and other people's understanding of an increasingly connected world.	... explore the role that priors (i.e. the past experiences, education, and biases) play in determining how a person makes decisions and reaches conclusions. Emphasis will be placed on understanding how an internationally connected community with access to the same information can remain in tension when drawing conclusions about important societal issues (vaccine safety, climate change, and disinformation campaigns will be used as specific examples).	... exploring how scientists/astronomers draw varied conclusions based on the same data owing to their varied strongly held beliefs, past research history, and/or preferences (e.g., Einstein's unfounded insertion of a cosmological constant). A mirrored process will be used to explore the role of priors when examining climate change data, interpreting vaccine safety studies, or vetting social media information sources.

International Student Learning Outcomes (for N co-designation)

	International SLOs → Students will be able to...	Course SLOs → Students will be able to...	Assessment Student competencies will be assessed through...
Content	Identify, describe, and explain the historical, cultural, economic, political, and/or social experiences and processes that characterize the contemporary world.	... understand how groups of people can come to varied conclusions even when faced with the same evidence or testimony.	... societal parallel writing assignments where students will discuss how both scientists and all humans draw conclusions drawn through a combination of accepted evidence and priors, which can vary dramatically based on background, upbringing, and subject education.
Critical Thinking	Analyze and reflect on the ways in which cultural, economic, political, and/or social systems and beliefs mediate understandings of an increasingly connected contemporary world.	... navigate the data-flooded world of the internet and social media using the same tools of inference to employ critical thinking in everyday life.	... societal parallel writing assignments where students link the 'knowledge building' process we discuss in astronomy to the 'fact vetting' process that all humans carry out continuously.

IV. Required Policies

11. Students Requiring Accommodation

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://disability.ufl.edu/>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

12. UF Evaluations Process

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

13. University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code.” On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

14. Counseling and Wellness Center

Contact information for the Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc/Default.aspx>, 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

15. The Writing Studio

The writing studio is committed to helping University of Florida students meet their academic and professional goals by becoming better writers. Visit the writing studio online at <http://writing.ufl.edu/writing-studio/> or in 2215 Turlington Hall for one-on-one consultations and workshops.

15. In Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

15. Known Class Cancellations and Prof. Travel

We will follow the University’s academic calendar, and do not currently anticipate any class cancellations.

Prof. Torrey will be traveling 9/19 – 9/28 & on 10/14. Class sessions during that time will be covered by either the TA or another UF professor.