# IDS 2935 Can Big Data Save the Earth?

**Quest 2**

# I. Course Information

Spring 2021

Meeting Day/Time: T3, R3, F3

Location: MAT0118 (T, R), MAT0112 (F), online

Primary General Education Designation: Biological Sciences

Secondary General Education Designation (if seeking): No Secondary Designation

Writing Designation (if seeking): No writing designation

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

## Instructor

Geraldine Klarenberg – gklarenberg@ufl.edu (preferred, or messages via Canvas)

Office location: 340 McCarty Hall C

Office hours: Tuesday 1-2 pm (or by appointment Tuesday 2-4 pm: https://calendly.com/gklarenberg/can-big-data-save-the-earth)

Phone: (352) 273-0792 (office – limited access currently)

## Course Description

There is more pressure than ever before on our environmental resources: sometimes we find solutions, but sometimes we also generate unintended consequences. At the same time, technological advances are generating ever more amounts of data - also environmental data. Remote sensing, satellite technology, sensor technology, telemetry and data storage ensure that we have biological data over various time and space scales. The challenge arises how we use this data to do good; increase our understanding, find solutions, and avoid unintended consequences. This course addresses the question: can big data save the earth? We will explore complexity in biological and socio-ecological systems, the nature of causality, models and their relation to sustainability and natural resources management. We will connect data science and its tools to biology and ecosystems through project-based enquiry, by exploring and using real-life data sets, asking big questions and answering them.

## General Education designation and statement

Biological science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the life sciences. Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes that govern biological systems. Students will formulate empirically-testable hypotheses derived from the study of living things,

apply logical reasoning skills through scientific criticism and argument, and apply techniques of discovery and critical thinking to evaluate outcomes of experiments.

## Required & Recommended Course Materials (to purchase/rent)

All textbooks and articles used in this course are available online, for free. Select textbook chapters will be made available on Canvas.

Main textbook (select chapters used):

Grolemund, G & Wickham, H (2017). *R for Data Science*. O'Reilly. https://r4ds.had.co.nz/

Additional textbooks (select chapters used when necessary):

Phillips, N D (2018). *YaRrr! The Pirate's Guide to R*. https://bookdown.org/ndphillips/YaRrr/

Wickham, H (2018). *The tidyverse style guide*. https://style.tidyverse.org/

Other materials

Pearl, J & Mackanzie, D (2018). The Book of Why: the New Science of Cause and Effect. Basic Books, New York, USA.

Thurner, S, Hanel, R & Klimek, P (2018). Introduction to the Theory of Complex Systems. Oxford University Press, Oxford, UK.

TEDx video "Complexity is not complicated" (https://www.youtube.com/watch?v=VYVGPTauG5g)

Fleming, L, Tempini, N, Gordon-Brown, H, Nichols, G, Sarran, C, Vineis, P, Leonardi, G, Golding, B, Haines, A, Kessel, A, Murray, V, Depledge, M, & Leonelli, S (2017, July 27). Big Data in Environment and Human Health. *Oxford Research Encyclopedia of Environmental Science*. https://doi.org/10.1093/acrefore/9780199389414.013.541

Video "Big Data for Climate Change and Disaster Resilience: Two Experts on their Work", DfID (https://datapopalliance.org/big-data-for-climate-change-and-disaster-resilience-two-experts-on-their-work/)

Video "Monitoring Forests in Near Real Time" (https://www.youtube.com/watch?v=lTG-0brb98I)

* Rossi, F., Breidenbach, J., Puliti, S.; Astrup, R., Talbot, B. (2019). Assessing Harvested Sites in a Forested Boreal Mountain Catchment through Global Forest Watch. *Remote Sens.* 2019, 11, 543.

* Pittman, J.R., Hatzell, H.H., and Oaksford E.T. (1997). Spring contributions to water quantity and nitrate loads in the Suwannee River during base flow in July 1995. *USGS Water-Resources Investigations Report 97-4152*.

* Bergquist, D.C., Heuberger, D., Sturmer, L.N., Baker, S.M. (2008). Continuous water quality monitoring for the hard clam industry in Florida, USA. *Environ Monit Assess* 148: 409–419. DOI 10.1007/s10661-008-0171-3.

* Provisional readings. Final selection of readings dependent on demos in week 3.

* Kucera, Thomas E, and Reginald H Barrett. 2011. “A History of Camera Trapping.” In *Camera Traps in Animal Ecology: Methods and Analyses*, edited by Allan F O’Connell, James D Nichols, and K Ullas Karanth, 9–26. Camera Traps in Animal Ecology: Methods and Analyses. Tokyo: Springer Japan.

* Nichols, James D, Allan F O’Connell and K Ullas Karanth. 2011. “Camera Traps in Animal Ecology and Conservation: What’s Next?.” In *Camera Traps in Animal Ecology: Methods and Analyses*, edited by Allan F O’Connell, James D Nichols, and K Ullas Karanth, 9–26. Camera Traps in Animal Ecology: Methods and Analyses. Tokyo: Springer Japan.

* Wanik, D.W., J.R. Parent, E.N. Anagnostou and B.M. Hartman (2017). Using vegetation management and LiDAR-derived tree height data to improve outage predictions for electric utilities. *Electric Power Systems Research*. 146: 236-245.

Episode of Vox: Coding, Explained (on Netflix)

Broman, KW & Woo, KH (2018) Data Organization in Spreadsheets, The American Statistician, 72:1, 2-10, DOI: 10.1080/00031305.2017.1375989

Wilson, G, Aruliah ,DA, Brown, CT, Chue Hong, NP, Davis, M, Guy, RT, et al. (2014) Best Practices for Scientific Computing. PLoS Biol 12(1): e1001745. https://doi.org/10.1371/journal.pbio.1001745

Wilson, G, Bryan, J, Cranston, K, Kitzes, J, Nederbragt, L, Teal, TK (2017) Good enough practices in scientific computing. PLoS Comput Biol 13(6): e1005510. https://doi.org/10.1371/journal.pcbi.1005510

Video: “What is a Climate Model?” https://www.youtube.com/watch?v=bkcrH9tYv8g

Online article “Satellite data record shows climate change’s impact on fires“, NASA (https://climate.nasa.gov/news/2912/satellite-data-record-shows-climate-changes-impact-on-fires/)

Zook M, Barocas S, Boyd D, Crawford K, Keller E, Gangadharan SP, et al. (2017) Ten simple rules for responsible big data research. PLoS Comput Biol 13(3): e1005399. https://doi.org/10.1371/journal.pcbi.1005399

Online article: ”Big data case study: big data and conservation biology” (https://www.onlineethics.org/40548.aspx)

Materials and Supplies Fees: n/a

* Provisional readings. Final selection of readings dependent on demos in week 3.

# II. Coursework & Schedule

## 1. List of Graded Work[1]

| Assignment | Description | Requirements | Points[2] |
|---|---|---|---|
| Reflection essay 1 | Reflection on the nature of complexity, consequences for natural resources management and socio-ecological systems. | 500-750 words | 10 |
| Reflection essay 2 | Reflection on the usefulness of models. | 500-750 words | 10 |
| Reflection essay 3 | Reflection on current and future data production, dangers and opportunities. | 500-750 words | 10 |
| Coding tutorials | Coding tutorials on the basics of data management, organization and analysis (5; week 4 through 8) | Annotated, working code | 10 each |
| Project | Conceptual framework of the question and pathway to answering it | Visual representation + 200 words max | 10 |
| Project | Project materials: organized data and code | Scripts, spreadsheets | 20 |
| Project | One-pager with project description (what, why, how, results) | ~500 words | 20 |
| Project | Presentation | Powerpoint / Prezi | 20 |
| **TOTAL** | | | **150** |

[1] Additional short quizzes or tasks can be assigned at the discretion of the instructor. These will be announced at least 2 weeks in advance

[2] Grading rubrics are available for assessment criteria and point allocation

## 2. Weekly Course Schedule

| Week/ Date | Activity | Topic/Assignment (Question/Subject) | | Assigned Work Due |
|---|---|---|---|---|
| *NOTE: this course meets 3 times a week. Generally, the first class (Tuesday) will consists of a lecture and discussions. The two classes later in the week (Thursday and Friday) will focus on hands-on work. Later in the semester though, it will occur that all three meeting times are used for coding and group work. During the group work, progress has to be submitted, but this is not graded.* | | | | |
| **Week 1**<br>Jan 11-17 | Topic | **Complexity in nature and society** | | |
| | Summary | - What is complexity – chaos and emergence<br>- Unintended consequences / unpredictability<br>- Issues of scale<br>- Determinism vs stochastic<br>- Linked to environmental problems, specifically socio-environmental problems | | |
| | Readings/Works | Introduction "Mind over Data" from The Book of Why (Pearl and Mackenzie, 2018)<br>Chapter 1 "Introduction to Complex Systems" from Introduction to the Theory of Complex Systems (Thurner et al., 2018)<br>TEDx video "Complexity is not complicated" (https://www.youtube.com/watch?v=VYVGPTauG5g) | 22 pages<br>26 pages<br>16 mins | |
| | Assignment | Reflection essay 1 on complexity and causality, determinism and stochasticity – specifically in relation to socio-ecological systems | | Wed wk 2 |
| | | | | |
| **Week 2** | Topic | **What is big data in ecosystem sciences and how are they used?** | | |
| | Summary | - Satellite data / remote sensing / LiDAR<br>- Automatic instrumentation: weather, water flow/quality, flux towers<br>- Camera traps, acoustic detection systems (bats, birds)<br>- Eddy flux towers and other forestry-related data<br>- Associated with all this; telemetry | | |
| | Readings/Works | Article: Fleming, L., Tempini, N., Gordon-Brown, H., Nichols, G., Sarran, C., Vineis, P., Leonardi, G., Golding, B., Haines, A., Kessel, A., Murray, V., | 25 pages | |

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| | | Depledge, M., & Leonelli, S. (2017, July 27). Big Data in Environment and Human Health. *Oxford Research Encyclopedia of Environmental Science*.<br>Video "Big Data for Climate Change and Disaster Resilience: Two Experts on their Work", DfID (https://datapopalliance.org/big-data-for-climate-change-and-disaster-resilience-two-experts-on-their-work/)<br>Video "Monitoring Forests in Near Real Time" (https://www.youtube.com/watch?v=lTG-0brb98I) | 5 mins<br>2:30 mins | |
| | Assignment | Explore some of the presented data sources, such as USGS, NOAA websites (and other ecological projects), find a project or research article that shows practical applications of big data. Present it and its importance through an online tool (tool tbd) | | Wed wk 3 |
| | | | | |
| **Week 3** | Topic | **Big data in real life** | | |
| | Summary | Demos from practitioners, showing measuring equipment and software<br>- Tower/forestry data from NEON (Batelle staff)<br>- Camera traps (UF faculty/students) / acoustic detection systems (Normandeau)<br>- Water quality monitoring (SRWMD, SJRWMD)<br>- Drones, LiDAR (Geomatics, SFRC) | | |
| | Readings/Works | TBD in detail (depending on demos): reading related to case studies, e.g.<br>*Tracking deforestation*: Rossi, F., Breidenbach, J., Puliti, S.; Astrup, R., Talbot, B. (2019). Assessing Harvested Sites in a Forested Boreal Mountain Catchment through Global Forest Watch. *Remote Sens.* 2019, 11, 543.<br>*Water quality monitoring*: Pittman, J.R., Hatzell, H.H., and Oaksford E.T. (1997). Spring contributions to water quantity and nitrate loads in the Suwannee River during base flow in July 1995. *USGS Water-Resources Investigations Report 97-4152*.<br>Bergquist, D.C., Heuberger, D., Sturmer, L.N., Baker, S.M. (2008). Continuous water quality monitoring for the hard clam industry in Florida, USA. *Environ Monit Assess* 148: 409–419. DOI 10.1007/s10661-008-0171-3.<br>*Camera traps*: Kucera, Thomas E, and Reginald H Barrett. 2011. "A History of Camera Trapping." In *Camera Traps in Animal Ecology: Methods and Analyses*, edited by Allan F O'Connell, James D Nichols, and K Ullas Karanth, | Approx. 35-40 pages max | |

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| | | 9–26. Camera Traps in Animal Ecology: Methods and Analyses. Tokyo: Springer Japan.<br>Nichols, James D, Allan F O'Connell and K Ullas Karanth. 2011. "Camera Traps in Animal Ecology and Conservation: What's Next?." In *Camera Traps in Animal Ecology: Methods and Analyses*, edited by Allan F O'Connell, James D Nichols, and K Ullas Karanth, 9–26. Camera Traps in Animal Ecology: Methods and Analyses. Tokyo: Springer Japan.<br>Weather/LiDAR: Wanik, D.W., J.R. Parent, E.N. Anagnostou and B.M. Hartman (2017). Using vegetation management and LiDAR-derived tree height data to improve outage predictions for electric utilities. *Electric Power Systems Research*. 146: 236-245. | | |
| | Assignment | N/A | | |
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| **Week 4** | Topic | **Organize, manage, analyze: tools to deal with data** | | |
| | Summary | - Programming / coding: advantages of scripts and reproducible research<br>- Overview of statistics / math requirements (brief)<br>- Software: R Programming language | | |
| | Readings/Works | Episode of Vox: "Explained: Coding", on Netflix (alternative: clips from code.org)<br>Article: Karl W. Broman & Kara H. Woo (2018) Data Organization in Spreadsheets, The American Statistician, 72:1, 2-10, DOI: 10.1080/00031305.2017.1375989<br>Section I from "R for Data Science" (Wickham, 2017):<br>- Chapter 2 Introduction<br>- Chapter 3 Data visualization<br>- Chapter 4 Workflow: basics | 25 mins<br>10 pages<br>2.5 pages*<br>12 pages*<br>9 pages* | |
| | Assignment | Tutorial with introduction to Excel (if necessary)<br>Good practice in using spreadsheets<br>Introduction to R tutorial | | Wed wk 5 |
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| **Week 5** | Topic | **Organize, manage, analyze: tools to deal with data (ctd)** | | |

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| | Summary | - Programming fundamentals<br>- Introduction to R<br>- Focus on reproducibility | | |
| | Readings/Works | Articles:<br>Wilson G, Aruliah DA, Brown CT, Chue Hong NP, Davis M, Guy RT, et al. (2014) Best Practices for Scientific Computing. PLoS Biol 12(1): e1001745. https://doi.org/10.1371/journal.pbio.1001745<br>Wilson G, Bryan J, Cranston K, Kitzes J, Nederbragt L, Teal TK (2017) Good enough practices in scientific computing. PLoS Comput Biol 13(6): e1005510. https://doi.org/10.1371/journal.pcbi.1005510<br>Section I from "R for Data Science" (Wickham, 2017):<br>- Chapter 5: Data transformation<br>- Chapter 6 Workflow: scripts<br>- Chapter 7 Exploratory Data Analysis<br>- Chapter 8 Workflow: projects | 7 pages<br>20 pages<br>17 pages*<br>5 pages*<br>10 pages*<br>2.5 pages* | |
| | Assignment | Tutorials on programming and introduction to R | | Wed wk 6 |
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| **Week 6** | Topic | **Organize, manage, analyze: tools to deal with data (ctd)**<br>Sub-topic: what are supercomputers and how to use them? | | |
| | Summary | Continuation with:<br>- Programming fundamentals<br>- Introduction to R; packages for data science<br>- Focus on reproducibility and big data<br>In addition:<br>- What are supercomputers and why do we use them?<br>- Introduction to Hipergator and CyVerse<br>- Visit Hipergator / guest lecture from Hipergator staff | | |
| | Readings/Works | Section II from "R for Data Science" (Wickham, 2017):<br>- Chapter 9 Introduction<br>- Chapter 10 Tibbles<br>- Chapter 11 Data import<br>- Chapter 12 Tidy data | 0.5 page*<br>3 pages*<br>10 pages*<br>11 pages* | |

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| | Assignment | Tutorials on programming and introduction to R | Wed wk 7 |
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| **Week 7** | Topic | **Big questions and big data in ecosystem science** | |
| | Summary | What are the kinds of questions people are asking? How can more data help? Exploration of NEON data themes, with examples of questions related to them and connected to resource management:<br>- Atmosphere<br>- Organisms, populations and communities<br>- Biogeochemistry<br>- Ecohydrology<br>- Land cover and processes | |
| | Readings/Works | Get started with NEON Data: https://www.neonscience.org/get-started-neon-series<br>- Introduction to NEON<br>- Download and explore NEON data<br>- Use the 'neonUtilities' package to access NEON data<br>Section III from "R for Data Science" (Wickham, 2017):<br>- Chapter 17 Introduction 1.5 pages*<br>- Chapter 18 Pipes 4 pages*<br>- Chapter 19 Functions 10 pages* | |
| | Assignment | Make groups, decide on a NEON site and an area of interest. For their project, students can choose *any* NEON site.<br>Tutorials on programming and introduction to R | Wed wk 8 |
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| **Week 8** | Topic | **Exploration of real-life data: NEON data**<br>Project work: conceptual framework for analysis | |
| | Summary | - Engage more with the NEON data, look at the sites, what data is available, what kind of question would you want to answer.<br>- Continue exploring NEON data using R, use NEON packages for downloading and organizing data | |

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| | Readings/Works | Get started with NEON Data: https://www.neonscience.org/get-started-neon-series<br>- Work with NEON's plant phenology data<br>- Work with NEON's single-aspirated air temperature data<br>- Plot continuous and discrete data together<br>Section II from "R for Data Science" (Wickham, 2017):<br>- Chapter 20 vectors<br>- Chapter 21 Iteration | 9 pages*<br>13 pages* | |
| | Assignment | Project work: developing questions. Make a conceptual diagram / visual representation of the question to answer, which data is needed, types of analyses? | | Wed wk 10 |
| | | | | |
| **Week 10** | Topic | **What are models? Usefulness and application of models**<br>Project work: data and organization | | |
| | Summary | - What is a model<br>- Purpose<br>- Usefulness; how to interpret models<br>- Connecting data analysis/models with resource management | | |
| | Readings/Works | Video: "What is a Climate Model?" https://www.youtube.com/watch?v=bkcrH9tYv8g<br>Online article "Satellite data record shows climate change's impact on fires", NASA (https://climate.nasa.gov/news/2912/satellite-data-record-shows-climate-changes-impact-on-fires/)<br>Section IV from "R for Data Science" (Wickham, 2017):<br>- Chapter 22 Introduction<br>- Chapter 23 Model basics<br>- Chapter 24 Model building<br>- Chapter 25 Many models | 9 mins<br>3-4 pages<br>1.5 pages*<br>12 pages*<br>7 pages*<br>11 pages* | |
| | Assignment | Essay 2: contemplate the usefulness of computer models, the development of models over time, how they are used nowadays, and the dangers/risks of using and interpreting models.<br>Continue with project: download data and organize – submit progress/draft | | Wed wk 11 |
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| **Week 11** | Topic | **How to communication and visualize results and analyses effectively**<br>Project work: data wrangling | | |
| | Summary | Effective visualization<br>- Basics of effective visualization<br>- Grammar of graphics<br>- Tools in R for data visualization | | |
| | Readings/Works | Section V from "R for Data Science" (Wickham, 2017):<br>- Chapter 28 Graphics for communication | 9 pages* | |
| | Assignment | Continue with project; wrangle data – submit progress | | Wed wk 12 |
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| **Week 12** | Topic | **Project work: data wrangling and analysis** | | |
| | Summary | Continue hands-on work on group project | | |
| | Readings/Works | Depending on focus of groups and questions being asked | | |
| | Assignment | Continue with project; wrangle data and analyze – submit progress | | Wed wk 13 |
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| **Week 13** | Topic | **Where will the data revolution take us?**<br>Project work: analysis | | |
| | Summary | Specifically related to natural resources management;<br>- What is the future of data collection and analysis?<br>- Ethics associated with (big) data and analyses | | |
| | Readings/Works | Article: Zook M, Barocas S, boyd d, Crawford K, Keller E, Gangadharan SP, et al. (2017) Ten simple rules for responsible big data research. PLoS Comput Biol 13(3): e1005399. https://doi.org/10.1371/journal.pcbi.1005399<br>Online article: "Big data case study: big data and conservation biology (https://www.onlineethics.org/40548.aspx) | 10 pages<br>7 pages | |
| | Assignment | Essay 3: reflection on current and future data production, dangers and opportunities; consider ethics of data collection, use, analysis and publication/dissemination.<br>Continue with project; analyze – submit progress | | Wed wk 14 |
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| **Week 14** | Topic | **Project work: analysis and visualization** | |
| | Summary | Continue hands-on work on group project | |
| | Readings/Works | Depending on focus of groups and questions being asked | |
| | Assignment | Continue with project; analyze and visualize – submit progress | Wed wk 15 |
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| **Week 15** | Topic | **Presentations of project work** | |
| | Summary | Work on presentation and one page summary (in plain English, as if for a resource management agency)<br>One page summary contains: what, why, how, result of the project (in plain English, as if for a resource management agency) | |
| | Readings/Works | N/A | |
| | Assignment | Group presentations, peer review others' presentation | Before reading days |
| | | | |
| | Final project | Data, code, one page summary, presentation | Penultimate week |

* Since these are online books, number of pages is estimated based on word count, and taking 500 words/page (hence excluding figures).

# 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 taken daily and recorded in the Canvas gradebook. You are allowed four "personal days" for the semester, after which each absence that does not meet university criteria for "excused" will result in a two-point deduction from your final grade.

Participation: Consistent informed, thoughtful, and considerate class participation is expected.

NOTE: If you have personal issues that prohibit you from joining freely in class discussion, e.g., shyness, language barriers, etc., see the instructor as soon as possible to discuss alternative modes of participation.

## 4. Grading Scale

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

| | | | | |
|---|---|---|---|---|
| A | 94 – 100% of possible points | | C | 74 – 76% |
| A- | 90 – 93% | | C- | 70 – 73% |
| B+ | 87 – 89% | | D+ | 67 – 69% |
| B | 84 – 86% | | D | 64 – 66% |
| B- | 80 – 83% | | D- | 60 – 63% |
| C+ | 77 – 79% | | E | <60 |

# IV. Quest Learning Experiences

## 5. Details of Experiential Learning Component

Students will work with real-life datasets from the National Ecological Observatory Network (NEON), a nationwide monitoring network. One of the NEON sites is Ordway-Swisher Biological Station, just outside Gainesville. NEON staff will show and demonstrate some of the equipment used to capture atmospheric, mammal and vegetation data to give students in-depth understanding of the data that has been collected.

Using tutorials, class exercises and a learner-centered approach, the majority of classes will be hands-on project work. The focus will be on developing an ecosystem question driven by data availability and student interest, and use programming tools (the R language) to wrangle and analyze data to provide answers. This inquiry-based project work is done in teams to provide students a realistic data science project experience, and practice effective communication.

## 6. Details of Self-Reflection Component

The course requires students to reflect on the concept of complexity and causality, as well as determinism and stochasticity (focusing on biological and socio-economic systems) at the beginning of the semester. Students are asked to contemplate whether determinism is true or not, and what it means for human agency in either case. These philosophical questions have strong connections with mathematics and physical sciences, especially in the realm of modeling processes – but also with our own personal views on free will and agency, and the effects of actions on each other and the environment.

Then, after being introduced to data, tools and computer models, students contemplate the usefulness of computer models related to biological and environmental systems. They are expected to reflect on the development of models over time, how they are used nowadays, and the dangers of models. This exercise aims to have students engage critically with the concept of predictive and explanatory science and data analysis.

Towards the end of the semester, students are asked to question the use and abuse of data in our current and future society. They should articulate their thoughts about current and future developments around data production and the effect on our world. This should focus specifically on biological and environmental data. Aside from practical considerations, this exercise addresses issues of ethics in data science.

# V. General Education and Quest Objectives & SLOs

Biological Sciences in GenEd courses: Biological science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the life sciences. Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes that govern biological systems. Students will formulate empirically-testable hypotheses derived from the study of living things, apply logical reasoning skills through scientific criticism and argument, and apply techniques of discovery and critical thinking to evaluate outcomes of experiments.

## 7. Biological Sciences + Quest 2 + Course Objectives

| **Biological 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…) |
|---|---|---|---|
| Biological science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the life 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. | … explore the use of data over time, the emergence of systems thinking, complexity and data science. They will contemplate and address philosophical questions around these issues, such as (causal) determinism, stochasticity of systems and agency (in biological and environmental sciences). | … examining complexity and systems literature, explore various existing data sets and computer models. Students will work with data hands-on, and will write a reflection on complexity and determinism in relation to data science and models (essay 1). |
| Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes | Present different social and/or biophysical science methods and theories and consider how their biases and influences shape pressing questions about the | … present the different ways in which data and models are used for predictive and explanatory purposes, reflect on their underlying assumptions and thus usefulness. | … explore a variety of models, discuss their uses and have students reflect on the use of models |

| **Biological 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…) |
|---|---|---|---|
| that govern biological systems. | human condition and/or the state of our planet. | | |
| Students will formulate empirically-testable hypotheses derived from the study of living things, 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. | … apply coding and other software tools to analyze biological and environmental data relevant to the questions students pose (based on data availability and students' interests), associated with ecosystems. | … having students work in teams to develop questions and pathways to answering these. They will learn about tools they can employ and develop workflows and apply tools. They will submit a conceptual framework before starting analyses. |
| Biological science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the life sciences. | 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. | … explore the role of big data and data science in providing explanations or solutions for pressing issues affecting ecosystems and society | … having students work with data and tools, and having students develop questions related to ecosystems and natural systems that they consider relevant |
| | Explore or directly reference social and/or biophysical science resources outside the classroom and explain how engagement with those resources complements classroom work. | … put students in touch with people working on biological and environmental data collection and analyses, and it will give students hands-on experience in coding and analyzing real-life datasets. | … demonstrations and guest lectures, and an inquiry-based project that requires the using of online databases and coding tools. |

## 8. Biological Sciences + Quest 2 + Course SLOs

| | **Biological Sciences SLOs ➔**<br>**Students will be able to…** | **Quest 2 SLOs ➔**<br>**Students will be able to…** | **This Course's SLOs ➔**<br>**Students will be able to…** | **Assessment**<br>**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 role of big data, data science, analyses and models in understanding and predicting biological and ecosystem issues such as biodiversity loss and deforestation. | Class participation, reflection essays 1 and 3. |
| **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** available real-life large-scale biological (NEON) data in relation to the question asked by students / student groups. | Class participation, reflection essay 2, project results (conceptual framework, one page summary, presentation). |

| | Biological Sciences SLOs ➔<br>Students will be able to… | Quest 2 SLOs ➔<br>Students will be able to… | This Course's SLOs ➔<br>Students will be able to… | Assessment<br>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. | **Develop** a one page (plain English) summary of a data analysis project; the question, approach and results. **Present** a visual overview (presentation) of the project, as a group. | Project results (one page summary, presentation) |
| Connection | N/A | **Connect course content** with critical reflection on their intellectual, personal, and professional development at UF and beyond. | **Reflect** on the knowledge gained from the course on the role of data in society and in environmental sciences, and **connect** it to their thoughts about the future of our planet and its environment, and the role of data and humans in it. | Essay 3 |

# VI. Required Policies

## 10. Students Requiring Accommodation

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the Disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

## 11. 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/.

## 12. 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.

## 13. Software Use:

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

## 14. Campus Helping Resources

Students experiencing crises or personal problems that interfere with their general wellbeing are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

• University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575, www.counseling.ufl.edu (Counseling Services, Groups and Workshops, Outreach and Consultation, Self-Help Library, Wellness Coaching)

• U Matter We Care, www.umatter.ufl.edu/

Other resources:

• Career Connections Center, First Floor JWRU, 392-1601, https://career.ufl.edu/.

Student Complaints:

• Residential Course: https://sccr.dso.ufl.edu/policies/student-honor-code-studentconduct-code/.

• Online Course: http://www.distance.ufl.edu/student-complaint-process

## 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.