HOS6932 AI Concepts for Plant Science

Spring 2026
Fridays, 3:00-4:50 PM
Hybrid (Synchronous Zoom & In-Person, Classroom 1306 Fifield Hall), 2 credits

Instructor: Dr. Carlos D. Messina

2215 Fifield Hall

352-273-4862

cmessina@ufl.edu

Office hours: TBD

Teaching Assistants: Melanie Cabrera & Salvador A. Cuadros Cerpa

UF/IFAS Crop Transformation Center office

melanie.cabrera@ufl.edu, salvador.cuadros@ufl.edu

Office hours: TBD

Course Description

This 2-credit graduate course creates an intellectual container for students to experience the excitement, tensions, complexities, and contradictions we encounter today in AI, and to discover the need for transdisciplinary science if we are to realize the potential of AI to transform agricultural systems and thus create societal value. The course introduces core concepts of crop modeling and artificial intelligence (AI) and teaches how to think with models. The modality of the course is structured around the discussions of seminal papers in artificial intelligence and applications in science and engineering, and the development of predictive models.

Course Learning Objectives

The course goal is to create awareness of the opportunities and limitations of contemporary AI that stems from natural systems complexity and thus motivate the students to seek transdisciplinary approaches to advance AI in science and engineering.

i. **Frame problems in plant science as models and prediction tasks**
Students will formulate crop improvement and plant science questions in terms of G×E×M systems, clearly defining inputs, outputs, and assumptions.

ii. Select methods appropriate to research goals
Students will be able to describe symbolic, sub-symbolic and integrated AI, explain the advantages and disadvantages of the different methods, and discuss these in context of system complexity. They will be able to make informed decisions about choosing methodologies considering their limitations, purpose of the research and the development of technologies.

iii. **Develop and interpret mechanistic crop models**
Students will represent plant and crop systems, implement minimal crop models in R/Python,

use models to predict emergent phenotypes, adaptation, and genotype x environment interactions

iv. **Develop and evaluate AI/ML methods with plant data**
Students will use basic AI/ML approaches (linear/regularized regression, classification, tree-based ensembles) with appropriate metrics and cross-validation schemes to build predictive models for applications in crop improvement.

v. **Integrate CGM and AI tools and communicate results**
Students will design small CGM–AI workflows and effectively communicate methods, assumptions, and implications of model results to plant scientists and other stakeholders.

Course Prerequisites

Students enrolling in this course are expected to have:

- Graduate-level background in plant science, agronomy, horticultural sciences, plant breeding, or a closely related field (or instructor approval).
- Basic familiarity with statistics and linear models (e.g., understanding of regression, variance, and hypothesis testing).
- Exposure to R or Python, or a willingness to learn basic scripting (if needed) during the course.

The following are recommended but not required**:** prior coursework or experience in quantitative genetics**,** linear algebra, calculus, modeling**,** or numerical methods.

Textbooks, Learning Materials, and Supply Fees

No purchase of textbooks or other materials is required for this course. All essential readings will be provided through Canvas or available electronically via the UF Libraries. We will primarily use **free, open-source software**, including:

- **R** and/or **Python** for modeling and data analysis.

Selected readings will be drawn from sources such as:

- Deisenroth, M. P., Faisal, A. A., & Ong, C. S. (2020). *Mathematics for Machine Learning*. Cambridge University Press.
- May, R. M. (1976). “Simple mathematical models with very complicated dynamics.”
- Chen, R. T. Q., Rubanova, Y., Bettencourt, J., & Duvenaud, D. K. (2018). “Neural Ordinary Differential Equations.”
- Städter, P., Schälte, Y., Schmiester, L., & Hasenauer, J. (2021). “Benchmarking of numerical integration methods for ODE models of biological systems.”
- Choat, B., Jansen, S., Brodribb, T. J., Cochard, H., Delzon, S., Bhaskar, R., … Zanne, A. E. (2012). “Global convergence in the vulnerability of forests to drought.”
- Messina, C. D. “Towards a general framework for AI-enabled prediction in crop improvement.”
- Messina, C. D., & Cooper, M. “Incorporating genetics into crop models to identify new phenotypes adapted to climate change.”
- Haefner, J. W. *Modeling Biological Systems: Principles and Application.*
- Wallach et al. 2019. Working with Dynamic Crop Models, 3rd edition. Academic Press

- Scott Page. 2018. The model thinker. Basic Book, New York.

Technical Support

UF Computing Help Desk & Ticket Number: All technical issues require a UF Helpdesk Ticket Number. The UF Helpdesk is available 24 hours a day, 7 days a week. https://helpdesk.ufl.edu/ | 352-392-4357

Weekly Course Schedule

Week	Topic	Assessment	Due Dates
January 16	Why AI and modeling in Plant Sciences? Model thinker perspective. Course overview		
January 23	Framing questions in plant sciences through a systems-thinking lens: define system boundaries, identify key components and interactions, choose an appropriate level of detail, and visually represent the system		
January 30	Introduction to the core processes and equations I: Phenology and growth dynamical models	Project Part 1 Assigned	February 27
February 6	Introduction to the core processes and equations II: water and nitrogen dynamical models		
February 13	Implementing a simple crop model in R/Python: basics of numerical integration and implications for identifiability and model complexity.		
February 20	How to interpret and use CGM outputs in plant science and crop improvement: target populations of environments concept, emergent phenotypes, genotype x environment x management interactions		
February 27	Basics of AI/ML for plant data: framing prediction problems, data structures and evaluation metrics RMSE, r, R^2.	Project Part 2 Assigned	March 20
March 6	AI algorithms		
March 13	Many model diversity theorem		
March 20	No class—Spring Break		
March 27	Fusing symbolic and subsymbolic AI: Crop growth model-genomic prediction (CGM-GP) case study	Project Part 3 Assigned	April 17
April 3	Working with CGM-GP		
April 10	Project Studio: CGM–AI Workflow Troubleshooting & Feedback		
April 17	Students will present their final project in class		

Grading Policy

Course grading is consistent with UF grading policies.

Course Grading Structure

Assignment Type	Point Value	Percent of Final Grade
Project Part 1	40	20%
Project Part 2	50	25%

Assignment Type	Point Value	Percent of Final Grade
Project Part 3	70	35%
Class participation	20	10%
Final Presentation	20	10%
Total	200	100%

Grading Scale

Grade	Points	Percentage
A	180-200	90-100%
B	160-179	80-89%
C	140-159	70-79%
D	120-139	60-69%
F	<120	<60%

Academic Policies and Resources

Academic policies for this course are consistent with university policies. See https://syllabus.ufl.edu/syllabus-policy/uf-syllabus-policy-links/

Campus Health and Wellness Resources

Visit https://one.uf.edu/whole-gator/topics for resources that are designed to help you thrive physically, mentally, and emotionally at UF.

Please contact UMatterWeCare for additional and immediate support.

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.

Privacy and Accessibility Policies

- Instructure (Canvas)
  - Instructure Privacy Policy
  - Instructure Accessibility
- Zoom
  - Zoom Privacy Policy
  - Zoom Accessibility

Additional information

[Optional: Instructors may choose to clarify in their syllabus their teaching philosophy, expectations for classroom behavior, utilization of e-learning, grading rubrics, and other information that will help students succeed in the course.]