

**HOS 6932 Concepts of artificial intelligence for plant scientists**

Graduate Level – 1 credit hours

Fall 2023

**Instructor:** Dr. Charlie Messina  
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 Horticultural Sciences Department  
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**Location and time:** TBD Friday ~ 3.00-3.50 PM

**Office hours:** TBD Friday ~ 4.00-5.00 PM

**Prerequisite** Familiarity with AI and basic knowledge of plant breeding, quantitative genetics, mathematics, and statistics

**Course Description**

This course creates an intellectual container for students to experience the excitement, tensions, complexities, and contradictions we encounter today in artificial intelligence (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 modality of the course is structured around the discussions of current papers and books published on artificial intelligence and applications in science, engineering, and medicine.

**Intended Audience**

The course is designed for graduate students and advanced undergraduate students working in plant sciences (e.g., agronomy, horticulture, environmental horticulture, biology, and forestry) with emphasis on plant breeding. Students working in other disciplines are welcome to expand their awareness of methods and the integration of symbolic and sub-symbolic AI.

**Course 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. By the end of the semester students should be able to critically think about AI, explain the advantages and disadvantages of the different methods, and discuss these in context of system complexity.

**Evaluation**

| Points     | Type         | Criteria  |
|------------|--------------|---|
| 50         | Presentation | Quality of the presentation that introduces the paper to be discussed in class                |
| 50         | Engagement   | Quality of contributions to advance the collective understanding of the paper being discussed |
| <b>100</b> | <b>TOTAL</b> |   |

**Letter Grade**

A >90    B+ 85 to 90    B 80 to 84    C+ 75 to 79    C 70 to 74    D+ 65 to 69    D 60 to 64    E < 60

UF grading policies: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

**Evaluation Description**

Presentations: the student is expected to report the main points of one or more papers and/or book chapters in 15 minutes.

**Engagement:** instructors will grade the students based on the quality of their questions, comments and answers to questions raised by instructors and peer students. The student is expected to post questions and contribute to discussions in Canvas.

## Recommended Literature

- Azodi CB, Pardo J, VanBuren R, de los Campos G, Shiu S-H.** 2019. Transcriptome-Based Prediction of Complex Traits in Maize. *The Plant Cell* **32**, 139-151.
- Baker RE, Peña J-M, Jayamohan J, Jérusalem A.** 2018. Mechanistic models versus machine learning, a fight worth fighting for the biological community? *Biology Letters* **14**, 20170660.
- Chen D, Bai Y, Ament S, Zhao W, Guevarra D, Zhou L, Selman B, van Dover RB, Gregoire JM, Gomes CP.** 2021. Automating crystal-structure phase mapping by combining deep learning with constraint reasoning. *Nature Machine Intelligence* **3**, 812-822.
- Ching T, Himmelstein DS, Beaulieu-Jones BK, Kalinin AA, Do BT, Way GP, Ferrero E, Agapow P-M, Zietz M, Hoffman MM, Xie W, Rosen GL, et al.** 2018. Opportunities and obstacles for deep learning in biology and medicine. *Journal of The Royal Society Interface* **15**, 20170387.
- Ghahramani Z.** 2015. Probabilistic machine learning and artificial intelligence. *Nature* **521**, 452-459.
- Gustafson K.** 2016. The importance of imagination (or lack thereof) in artificial, human and quantum decision making. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* **374**, 20150097.
- Kauffman SA.** 2016. *Humanity in a creative universe*: Oxford University Press. Chapters 1-3.
- Krakauer DC.** 2019. *Worlds hidden in plain sight: the evolving idea of complexity at the Santa Fe institute 1984-2019*: Santa Fe Institute Press. Chapter 37
- Krenn M, Pollice R, Guo SY, Aldeghi M, Cervera-Lierta A, Friederich P, dos Passos Gomes G, Häse F, Jinich A, Nigam A, et al.** 2022. On scientific understanding with artificial intelligence. *Nature Reviews Physics* **4**, 761-769.
- Lappalainen T, MacArthur DG.** 2021. From variant to function in human disease genetics. *Science* **373**, 1464-1468.
- Larson, Erik.** 2021. *The myth of Artificial Intelligence*. Cambridge, Massachusetts: Harvard University Press. Chapters 8-12
- Martin AE, Baggio G.** 2020. Modelling meaning composition from formalism to mechanism. *Philosophical Transactions of the Royal Society B: Biological Sciences* **375**, 20190298.
- Mitchell M, Krakauer DC.** 2023. The debate over understanding in AI's large language models. *Proceedings of the National Academy of Sciences* **120**, e2215907120.
- Pezzulo G, Levin M.** 2016. Top-down models in biology: explanation and control of complex living systems above the molecular level. *Journal of The Royal Society Interface* **13**, 20160555.
- Roel-Touris J, Bonvin AMJJ.** 2020. Coarse-grained (hybrid) integrative modeling of biomolecular interactions. *Computational and Structural Biotechnology Journal* **18**, 1182-1190.
- Vasudevan RK, Ziatdinov M, Vlack L, Kalinin SV.** 2021. Off-the-shelf deep learning is not enough, and requires parsimony, Bayesianity, and causality. *npj Computational Materials* **7**, 16.
- Wang JP, Matthews ML, Williams CM, Shi R, Yang C, Tunlaya-Anukit S, Chen H-C, Li Q, Liu J, Lin C-Y, et al.** 2018. Improving wood properties for wood utilization through multi-omics integration in lignin biosynthesis. *Nature Communications* **9**, 1579.
- White CR, Alton LA, Bywater CL, Lombardi EJ, Marshall DJ.** 2022. Metabolic scaling is the product of life-history optimization. *Science* **377**, 834-839.

**Course Schedule and Topics**

| <b>Week of semester<br/>Month/day</b> | <b>General Topic Description &amp; Publication</b> |
|---------------------------------------|--|
| Wk 1<br>8/25                          | Introduction                                       |
| Wk 2<br>9/1                           | Student presentation                               |
| Wk 3<br>9/8                           | Student presentation                               |
| Wk 4<br>9/15                          | Student presentation                               |
| Wk 5<br>9/22                          | Student presentation                               |
| Wk 6<br>9/29                          | Student presentation                               |
| Wk 7<br>10/6                          | Homecoming   |
| Wk 8<br>10/13                         | Student presentation                               |
| Wk 9<br>10/20                         | Student presentation                               |
| Wk 10<br>10/27                        | Student presentation                               |
| Wk 11<br>11/3                         | Student presentation                               |
| Wk 12<br>11/10                        | Holiday (no class)                                 |
| Wk 12<br>11/18                        | Student presentation                               |
| Wk 14<br>11/24                        | Holiday (no class)                                 |
| Wk 15<br>12/1                         | Student presentation                               |
| Wk 16<br>12/8                         | Reading days                                       |

**Attendance and Make-Up Work**

“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/ugrad/current/regulations/info/attendance.aspx>”

**Online Course Evaluation Process**

“Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>”

**Academic Honesty**

“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 (<http://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.”

### **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.

### **Services for Students with Disabilities**

“Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, [www.dso.ufl.edu/drc/](http://www.dso.ufl.edu/drc/)) 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.”

### **Campus Helping Resources**

Health and Wellness:

U Matter, We Care: If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) or 352 392- 1575 so that a team member can reach out to the student.

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.

Sexual Assault Recovery Services (SARS) Student Health Care Center, 392-1161. University Police Department, 392-1111 (or 9-1-1 for emergencies). <http://www.police.ufl.edu/>