

HORT 522 - Data Analysis in Systems Biology

Systems Biology is an interdisciplinary approach that models complex biological molecular interactions. There are two approaches to Systems Biology: bottom-up and top-down. Bottom-up approaches build models that describe interactions between basic molecular units. Top-down approaches build models that describe higher-level system-wide interactions. Both approaches inform the other through new knowledge and hypotheses. This course provides an overview of top-down systems-biology models that include gene co-expression, regulatory, protein-protein interaction, and metabolic networks. The course includes interdisciplinary concepts from network science with a focus on large-scale data analysis needed to build top-down models. A semester-long project directs students to construct a genome-wide gene co-expression network from transcriptomic data (RNA-seq) for an organism and biological function of interest to them.

Course Logistics

Course Title	<i>Data Analysis in Systems Biology</i>
Course Number	HORT 522
Semester	Fall 2023
Credits	3
Meeting Hours	Tues/Thurs 9:10-10:25
Meeting Location	Pullman: CUE #114 Other Locations: by Zoom video conference

Recommend Preparation: Introductory coursework covering topics of general statistics, genomics, and protein structure and function.

Requirement: A laptop with a minimal operating system version of Windows 8, MacOS 10.13, or Ubuntu/RedHat/CentOS 6+ Linux. A laptop is required for connections to remote computational machines and for word processing.

Instructors

Stephen Ficklin, Ph.D.

Interim Chair, Dept. of Horticulture & Interim Director, Integrated Plant Sciences degree program.
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Office Phone	509-335-4295
Office Hours	3-5 pm Tuesdays from Aug 29 th – Dec 12 th .

Huiting Zhang, Ph.D.

Postdoctoral Researcher, Dept. of Horticulture.

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Office Hours	3-5 pm Tuesdays from Aug 29 th – Dec 12 th .

Office Hours:

Office hours will be conducted in the offices of Dr. Zhang or Ficklin and attended either by Dr. Ficklin or Dr. Zhang:

<https://wsu.zoom.us/j/95530128159?pwd=cnFXSEJGUE1kc29NeENDdVZpVERNQOT09&from=addon>

Meeting ID: 955 3012 8159

Passcode: 918926

Learning Materials

Required Text

1. Albert-László Barabási. *Network Science*. Free online edition: <http://networksciencebook.com/>
2. During the course additional reading assignments will be provided from journal articles and online tutorials.

Canvas: Assignments, projects, articles, links, and lecture slides will be posted to Canvas. Due dates for assignment will be available via Canvas.

Student Learning Outcomes

Students are expected to grow knowledge and skills in the following ways:

1. Develop skills in scientific writing and presentation.
2. Gain or review knowledge underlying omics-based systems: genomics, transcriptomics, proteomics, metabolomics.
3. Develop skill in the UNIX command line, high-performance computing and command-line data wrangling that support bioinformatics.
4. Gain knowledge and practice employing graph theory, community detection, and network analysis.
5. Gain knowledge in the use, construction, advantages, and limitations of top-down molecular networks: gene co-expression (GCN), gene regulatory (GRN), top-down metabolic networks, and protein-protein interaction networks (PPI).

Expectations for Student Effort

For each hour of lecture equivalent, students should expect to have a *minimum* of two hours of work outside class. This includes reading, studying, or working on projects. Please see the instructor if your efforts require more or less than this. It is important that the course meets learning expectations for the topic but also not to be over burdensome.

Class Timeline

This course is meant to be flexible and adjust to the learning needs of students. Changes to the following schedule may occur. If changes do occur an updated course schedule will be provided. In the table below SLO indicates student learning outcomes from the weekly topics and activities as numbered in the “Student Learning Outcomes” section above.

Week	Days	Topics	Start On	Turn In	SLO	Inst
1	Aug 22 Aug 24	Course Introduction Semester project Scientific writing Hypothesis generation	Activities 1 & 2 Reading 1, 2, 3, 4 Writing 1	Activity 1 Reading 1 & 2 (Thursday)	1	SF
2	Aug 29 Aug 31	Genomics & Transcriptomics	Project Step 1 Activities 3 & 4	Reading 3 & 4	2	HZ
<i>Monday, Sept 4: Labor Day holiday</i>						
3	Sep 5 Sep 7	Using High-Performance Computing	Reading 5 Writing 2	Activity 2, 3, & 4 Writing 1	2	HZ
4	Sep 12 Sep 14	Basics of Modeling Graph Theory	Project Step 2	Project Step 1 Reading 5	3	SF
5	Sep 19 Sep 21	Project Phase 1 Presentation Outline Presentations & Review	Reading 6	Presentation 1 Writing 2	1	
6	Sep 26 Sep 28	Communities Visualization	Reading 7 Writing 3 Activity 5	Reading 6 Writing 3	4	SF
7	Oct 3 Oct 5	Visualization Command-line Data Wrangling	Presentation 2 Project Step 3	Reading 7 Activity 5 Project Step 2	4	SF
8	Oct 10 Oct 12	Command-line Data Wrangling Functional Enrichment Analysis	Reading 8 Activity 6		4	SF
9	Oct 17 Oct 19	Gene Co-expression Networks	Reading 9 Writing 4	Reading 8 Activity 6	3,4	SF
10	Oct 24 Oct 26	WGCNA Demo Gene Regulatory Networks		Reading 9 Writing 4	5	SF
11	Oct 31 Nov 2	Gene Regulatory Networks Inferelator Demo	Project Step 4 Writing 5 Reading 10, 11	Project Step 3	5	SF HZ
12	Nov 7 Nov 9	Protein-Protein Interaction	Reading 12, 13	Reading 10, 11	2, 5	HZ SF
13	Nov 14 Nov 16	Protein-Protein Interaction Metabolomics	Project Step 5	Project Step 4 Reading 12 Writing 5	2, 5	HZ
<i>Nov 22-26 Fall Break – No Classes</i>						

14	Nov 28 Nov 30	Metabolomics	Writing 6	Project Step 5 Reading 13 Writing 6	2, 5	HZ
15	Dec 5 Dec 7	Final Project Presentations		Presentation 2	1, 3, 4, 5	
<i>Dec 11 – Dec 15: Finals Week</i>				Writing 7		

Assignments, Assessments & Grading Policy

Project: This course requires a single course-long project divided into 5 steps. Each step builds on the previous, thus each step must be completed before proceeding to the next. Each student will choose the species and biological process to study for the project, thus each student's project results will be different. This may result in unexpected complications depending on the availability and types of data, and some projects may have no meaningful results. Additionally, we will be working on computing resources which can be temperamental. Therefore, project objectives may be adjusted during the course if needed, and due dates may be relaxed to respond to unexpected delays.

Writing: Scientific writing both for scientific manuscripts and grant proposals is an important skill for any scientist. This course will require students to write a multi-page grant proposal about the semester-long project that includes background information, a hypothesis, materials and methods, preliminary results, and impact statements. The writing will proceed throughout the semester with opportunities for peer-review and multiple opportunities for revision. The final written document is due at the end of the semester.

Presentations: Two presentations are required. The first will present the student's project and corresponding written proposal outline to the class. The second will present final project results to the class.

Other Assignments: Out of class reading and other activities are assigned each week. Often students have a full week to complete these exercises. Due dates for these assignments are listed on Canvas.

Exams: This course has no exams.

Grading Policy: All students begin the course with an A. Every item assigned has the potential to decrease the grade by 10 points. For items with points removed, students can correct it and resubmit at any time. If it meets expectations all lost points can be recovered. Failure to turn in any item results in a loss of 10 points (e.g., 100 drops to 90 grade points).

Grading Scale:

Grade	Points	Grade	Points
A	93+	C	70-73.9
A-	90-92.9	C-	66-69.9
B+	86-89.9	D+	62-65.9
B	82-85.9	D	58-61.9
B-	78-81.9	F	0-57.9
C+	74-77.9		

Mid-Term Grade: The mid-term grade will be composed of all points subtracted and not yet recovered.

Incomplete Grade Policy (Academic Rule 90h): Incompletes are granted only with permission of the instructor and are subject to the following guidelines:

1. Students must request an incomplete in writing or by e-mail from the instructor before the end of the semester.
2. The request must be signed and dated by the student (or identified by student's e-mail address) and must explain the reasons behind the request for the incomplete.
3. To be considered for an incomplete, there are two main conditions:
 - a. A student must complete a minimum amount of the assigned course work. Specifically, a student must complete 75 percent of the course work.
 - b. A student must have a mathematical possibility of passing the class. A passing grade is 60 percent or above for the entire course.
4. If extraordinary circumstances (e.g., family emergency, serious illness) are involved and are documented to the instructor's satisfaction, the professor/ instructor retains the discretion to grant an incomplete even if the minimum conditions outlined in item 3 above are not met. If an incomplete is granted, the standard WSU policy applies (i.e., ALL work must be completed within one full year from the end of the enrollment semester at issue, unless a shorter time is specified by the instructor. Otherwise, an automatic grade of "F," or failing, will be entered on the student's transcript).

Rounding of Grades: Grades will be rounded to the nearest whole number grade (e.g., 89.2 becomes 89 and 89.5 becomes 90).

Attendance and Make-up Policy

Attendance: Attendance of this class is highly encouraged for student success. Absences because of illness, personal and/or family crises, mandated court appearances, university-approved events, or similar reasons will be accommodated if such absences are not excessive, and notification is provided to the instructor in advance. Excused absences should be arranged prior to any known or planned event. Required University activities will be excused absences if an official Class Absence Request form signed by the sponsoring faculty or organization is given to the instructor before the event.

Make-up exams: This course has no exams.

Make-up presentations: Two days are provided for student project presentations for both the initial and final presentations. To maintain the course schedule, make-up project presentations will not be allowed in class. A student can submit a late presentation as a recording. It will only receive an instructor review to respect the time of other students.

Make-up written assignments: All written assignments except those that require peer-review can be submitted late without penalty. However, late written assignments that do require peer-review will only receive an instructor review to respect the time of other students.

Make-up reading and activities: Students are allowed to submit late reading and activity assignments at any time prior to the last week of class for full points or for recovered points on resubmissions. The exception is for peer-reviewed items. No late assignments will be accepted after Friday Dec 15th.

Academic Integrity Policy:

You are responsible for reading WSU's [Academic Integrity Policy](#), which is based on [Washington State law](#). If you cheat in your work in this class, you will:

1. Fail the assignment or project.
2. Be reported to the Center for Community Standards.
3. Have the right to appeal my decision.
4. Not be able to drop the course or withdraw from the course until the appeals process is finished.

If you have any questions about what you can and cannot do in this course, ask the instructors.

If you want to ask for a change in the instructor's decision about academic integrity, use the form at the Center for Community Standards website. You must submit this request within 21 calendar days of the decision.

Online Collaboration

The essence of education is exposure to diverse viewpoints. You will meet students with vastly different opinions and backgrounds. When you don't agree with their views, pause a moment. Weigh their words. You're encouraged to disagree with the substance of others' ideas and opinions but do so with an active sense of respect for one another, and without losing focus on the topic at hand. Personal attacks, inflammatory statements, flaming, trolling, and disruption of the discussion do not have a place in academic discourse.

Online postings must comply with University policy on the use of computing resources, including those regarding harassment and discrimination, as well as conform to the Standards of Conduct for Students. Students are encouraged to review the Standards, particularly WAC 504-26-218, 504-26-220, and 504-26-222. Visit the University Website specific to your campus of enrollment for more information.

Copyright

Any course-related materials, presentations, lectures, etc. are the instructor's intellectual property and may be protected by copyright. The use of university electronic resources for commercial purposes, including advertising to other students to buy notes, is a violation of WSU's computer abuses and theft policy (WAC 504-26-218).

WSU's AWARE Network:

As a student you have many responsibilities and obligations. One of the most important obligations that you may have is to your friends and peers at WSU. If you feel as if one of your friends or peers is struggling with academics because of physical or mental health, please inform me and/or appropriate university personnel. For more information refer to <http://aware.wsu.edu/>.

University Syllabus

Students are responsible for reading and understanding all university-wide policies and resources pertaining to all courses (for instance: accommodations, care resources, policies on discrimination or harassment), which can be found in the university syllabus. <https://syllabus.wsu.edu/university-syllabus/>