



IUPUI

**SCHOOL OF INFORMATICS  
AND COMPUTING**

**DEPARTMENT OF BIOHEALTH INFORMATICS**

Indiana University–Purdue University  
Indianapolis

**INFO B446  
Computational System Biology**

**Spring 2018**

*Section No.:* *Credit Hours:* 3  
*Day/Time:* Mondays, 3–5:40 pm  
*Location:* WK 321, Walker Plaza Building  
719 Indiana Avenue, Indianapolis, IN 46202 [\[map\]](#)  
May have guest lectures, not necessarily in the same room and time  
*First Class:*  
*Website:* Distribution of homework assignments and class notes via Canvas,  
including syllabus, outline of lectures, course calendar, suggested readings,  
final projects, and presentation schedules.  
*Instructor:* Jingwen Yan, Ph.D., Assistant Professor, BioHealth Informatics  
*Office Hours:* Tuesdays and Thursdays, 11 am–12 pm or by Appointment  
*Office:* WK 311, Walker Plaza Building  
719 Indiana Avenue, Indianapolis, IN 46202 [\[map\]](#)  
*Phone:* (317) 278-1692 (Office)  
*Email:* [jingyan@iupui.edu](mailto:jingyan@iupui.edu)  
*Prerequisites:* Biostatistics and [INFO B473](#) (or basic knowledge of programming, R, and  
Unix system management)

**COURSE DESCRIPTION**

This course covers basic system biology and network analysis concepts and provides hands-on experience analyzing biological data. It equips students with in-demand network analytics skills to select, prepare, analyze, interpret, evaluate, and present biological data for improving outcomes in translational bioinformatics research and applications.

**EXTENDED COURSE DESCRIPTION**

The analysis of biological networks is very complex because it involves interdisciplinary integration of knowledge such as biology, biochemistry, statistics and computer science. Handling, understanding and extracting knowledge from biological data requires the application of different system biology principles. The course aims to equip students with highly demanded network analytics skills to select, prepare, analyze, interpret, evaluate, and present data for the purposes of improving outcomes. This course introduces the basic network analysis methods and provides hands-on experience of working with real biological

data. This course will teach students how to apply the different system biology approaches to understand biological data.

*Prerequisites:* Knowledge of molecular biology is expected, although several of the required concepts will be taught throughout the course. Programming skills are expected and are a prerequisite for this course. Knowledge of biostatistics is recommended before taking this course.

*Course structure:* The instructor introduces various types of various biological datasets, network analysis approaches, and their applications commonly used for analyzing them. The students will work on a project, either individually or in a team, using system biology approaches on a translational bioinformatics problem, and submits a project report, which is also presented orally.

**Software used:**

R and Python or Perl

**Teaching and Learning Methods:**

Class lectures and lab sessions

**Assessment methods:**

Homework, midterm, project, presentation

**Required Readings:**

*An Introduction to Systems Biology: Design Principles of Biological Circuits* (1<sup>st</sup> ed.)  
by Uri Alon  
Publisher: Chapman & Hall/CRC  
July 9, 2006  
ISBN-13: 978-1584886426  
ISBN-10: 1584886420

**Recommended Readings:**

*Computational Systems Biology of Cancer* (1<sup>st</sup> ed.)  
by Emmanuel Barillot and Laurence Calzone  
Publisher: Chapman & Hall/CRC  
August 25, 2012  
ISBN-13: 978-1439831441  
ISBN-10: 1439831440

### Student Learning Outcomes:

Upon completion of this course, students will	RBT	PUL	Assessment
1. Understanding the concepts and different types of networks in biological data.	2	2, 3	A1
2. Apply and conceptualize graph theories for biological data.	3	1B	A1
3. Differentiate randomized networks and scale free networks.	4	1B	A1–4
4. Organize, explore, and visualize biological data using networks.	4	1B	A5
5. Evaluate the results of applying different system biology approaches over biological data.	5	2, 1B	A4 M1
6. Evaluate system biology projects with respect to ethical considerations.	5	6	A6
7. Write a report and give an oral presentation grounded in an appropriate review of the literature.	6	1C 2	F P

RBT: Revised Bloom's Taxonomy; A: Assignment; M: Midterm; F: Final Project; P: Presentation

### Principles of Undergraduate Learning (PUL):

Learning outcomes are assessed in the following areas:

- |   |                   |
|---|-------------------|
| 1A. Core communication: written, oral and visual skills |                   |
| 1B. Core communication: quantitative skills             | Major emphasis    |
| 1C. Core communication: information resources skills    |                   |
| 2. Critical thinking                                    | Moderate emphasis |
| 3. Integration and application of knowledge             |                   |
| 4. Intellectual depth, breadth, and adaptiveness        |                   |
| 5. Understanding society and culture                    |                   |
| 6. Values and ethics                                    |                   |

### Assessments:

A1–6	<i>Assignments</i> (× 6)	50%
M1	<i>Midterm exam</i> (× 1)	20%
F	<i>Final Project</i> (× 1)	20%
P	<i>Presentation</i> (× 1)	10%

### Grading Information:

- *Participation*: One point shall be deducted for each absence of the class from the final score. At most 5 points will be deducted for absences.
- *Homework/Assignment*: At least one assignment each on using types of sequencing datasets (available from canvas website). Strictly no copying of code from others and all the code should be functional to be awarded any grade.
- *Project*: Will comprise of a project for which you can work in groups of up to 2 students. Presentation of the project would be towards the end of the semester and will be evaluated as a group.

**Final project and presentation:**

Tackle a research problem, perform a literature review to identify relevant papers, present the papers, demonstrate the project, and write-up a short report; work individually or in pairs

**Grading Scale:**

A+	97–100%	Professional level work, showing highest level of achievement
A	93–96.99%	Extraordinarily high achievement, quality of work; shows command of the subject matter
A–	90–92.99%	Excellent and thorough knowledge of the subject matter
B+	87–89.99%	Above average understanding of material and quality of work
B	83–86.99%	Mastery and fulfillment of all course requirements; good, acceptable work
B–	80–82.99%	Satisfactory quality of work
C+	77–79.99%	Modestly acceptable performance and quality of work
C	73–76.99%	Minimally acceptable performance and quality of work
C–	70–72.99%	Unacceptable work (Core course must be repeated for credit)
D+	67–69.99%	Unacceptable work (Course must be repeated for credit)
D	63–66.99%	Unacceptable work
D–	60–62.99%	Unacceptable work
F	Below 60	Unacceptable work

No credit is granted for a grade below C.

**TENTATIVE WEEKLY SCHEDULE**

<b>Week</b>	<b>Topics Covered</b>	<b>Assignments</b>
1	Introduction to Course and introduction to system biology	A1: working on transcription network and gene regulations
2	The basic concepts of transcription network; the dynamics and response time of simple gene regulation.	
3	Patterns, Randomized Networks and Network Motifs; Negative Auto-Regulation and positive auto-regulation and cell-cell variability.	A2: Autoregulation is a Network Motif with position and negative autoregulation.
4	Graph theory; Subgraph in Random Networks; The Feedforward Loop (FFL); The Incoherent FFL; Convergent Evolution of FFLs	A3: application of FFL for the biological data analysis.
5	Temporal program and the global structure of transcription networks, including Generation of Temporal Expression Programs with the Single-Input Module (SIM) Network Motif;	
6	Network Motifs in Developmental Transcription Networks, including the positive feedback loops and bistability and the information Processing Using Multi-Layer Perceptrons	A4: Analyze biological data using transcription network with different network motifs.
7	Midterm Exam	Midterm Exam
8	The robustness principle with bacterial chemotaxis; Two models for exact adaptation; Individuality and Robustness in Bacterial Chemotaxis	
9	Robust patterning in development with morphogen gradients and to increased robustness by self-enhanced morphogen degradation	A5: Robust patterning in development with morphogen gradients and morphogen degradation;
10	SPRING BREAK	
11	Kinetic proofreading of the genetic code and molecular recognition	
12	Optimal gene circuit design; Cost and benefit analysis of gene circuits; Optimal regulation in variable environments	A6: kinetic proofreading of the genetic code and optimal gene circuit design.
13	Rules for gene regulation based on minimal error load and genes with multiple regulators	Project outline due
14	Apply computational system biology for course project.	
15	Apply computational system biology for course project.	Project report due
16	Final project presentation	Project PPT due

## **EXPECTATIONS, GUIDELINES, AND POLICIES**

### **Attendance:**

A basic requirement of this course is that you will participate in all class meetings, whether online or face-to-face, and conscientiously complete all required course activities and assignments. Class attendance is required for classroom-based courses. It entails being present and attentive for the entire class period. Attendance shall be taken in every class. If you do not sign the attendance sheet while in class, you shall be marked absent. Signing the attendance sheet for another student is prohibited. The instructor is required to submit to the Registrar a record of student attendance, and action shall be taken if the record conveys a trend of absenteeism.

Only the following are acceptable excuses for absences: death in the immediate family (e.g. mother, father, spouse, child, or sibling), hospitalization or serious illness; jury duty; court ordered summons; religious holiday; university/school coordinated athletic or scholastic activities; an unanticipated event that would cause attendance to result in substantial hardship to one's self or immediate family. Absences must be explained with the submission of appropriate documentation to the satisfaction of the instructor, who will decide whether missed work may be made up. Absences that do not satisfy the above criteria are considered unexcused. To protect your privacy, doctor's excuses should exclude the nature of the condition and focus instead on how the condition impacts your attendance and academic performance.

Missing class reduces your grade through the following grade reduction policy: You are allowed two excused or unexcused absences. Each additional absence, unless excused, results in a 5% reduction in your final course grade. More than six absences result in an F in the course. Missing class may also reduce your grade by eliminating opportunities for class participation. For all absences, the student is responsible for all covered materials and assignments.

### **Incomplete:**

The instructor may assign an Incomplete (I) grade only if at least 75% of the required coursework has been completed at passing quality and holding you to previously established time limits would result in unjust hardship to you. All unfinished work must be completed by the date set by the instructor. Left unchanged, an Incomplete automatically becomes an F after one year. <http://registrar.iupui.edu/incomp.html>

### **Deliverables:**

You are responsible for completing each deliverable (e.g., assignment, quiz) by its deadline and submitting it by the specified method. Deadlines are outlined in the syllabus or in supplementary documents accessible through OnCourse. Should you miss a class, you are still responsible for completing the deliverable and for finding out what was covered in class, including any new or modified deliverable. In fairness to the instructor and students who completed their work on time, a grade on a deliverable shall be reduced 10%, if it is submitted late and a further 10% for each 24-hour period it is submitted after the deadline.

## **CODE OF CONDUCT**

All students should aspire to the highest standards of academic integrity. Using another student's work on an assignment, cheating on a test, not quoting or citing references correctly, or any other form of dishonesty or plagiarism shall result in a grade of zero on the item and possibly an F in the course. Incidences of academic misconduct shall be referred to the Department Chair and repeated violations shall result in dismissal from the program.

All students are responsible for reading, understanding, and applying the *Code of Student Rights, Responsibilities and Conduct* and in particular the section on academic misconduct. Refer to *The Code > Responsibilities > Academic Misconduct* at <http://www.indiana.edu/~code/>. All students must also successfully complete the Indiana University Department of Education "How to Recognize Plagiarism" Tutorial and Test. <https://www.indiana.edu/~istd> You must document the difference between your writing and that of others. Use quotation marks in addition to a citation, page number, and reference whenever writing someone else's words (e.g., following the *Publication Manual of the American Psychological Association*). To detect plagiarism instructors apply a range of methods, including Turnitin.com. <http://www.ulib.iupui.edu/libinfo/turnitin>

### **Academic Misconduct:**

1. **Cheating:** Cheating is considered to be an attempt to use or provide unauthorized assistance, materials, information, or study aids in any form and in any academic exercise or environment.
  - a. A student must not use external assistance on any "in-class" or "take-home" examination, unless the instructor specifically has authorized external assistance. This prohibition includes, but is not limited to, the use of tutors, books, notes, calculators, computers, and wireless communication devices.
  - b. A student must not use another person as a substitute in the taking of an examination or quiz, nor allow other persons to conduct research or to prepare work, without advanced authorization from the instructor to whom the work is being submitted.
  - c. A student must not use materials from a commercial term paper company, files of papers prepared by other persons, or submit documents found on the Internet.
  - d. A student must not collaborate with other persons on a particular project and submit a copy of a written report that is represented explicitly or implicitly as the student's individual work.
  - e. A student must not use any unauthorized assistance in a laboratory, at a computer terminal, or on fieldwork.
  - f. A student must not steal examinations or other course materials, including but not limited to, physical copies and photographic or electronic images.
  - g. A student must not submit substantial portions of the same academic work for credit or honors more than once without permission of the instructor or program to whom the work is being submitted.
  - h. A student must not, without authorization, alter a grade or score in any way, nor alter answers on a returned exam or assignment for credit.
2. **Fabrication:** A student must not falsify or invent any information or data in an academic exercise including, but not limited to, records or reports, laboratory results, and citation

to the sources of information.

3. **Plagiarism:** Plagiarism is defined as presenting someone else's work, including the work of other students, as one's own. Any ideas or materials taken from another source for either written or oral use must be fully acknowledged, unless the information is common knowledge. What is considered "common knowledge" may differ from course to course.
  - a. A student must not adopt or reproduce ideas, opinions, theories, formulas, graphics, or pictures of another person without acknowledgment.
  - b. A student must give credit to the originality of others and acknowledge indebtedness whenever:
    1. directly quoting another person's actual words, whether oral or written;
    2. using another person's ideas, opinions, or theories;
    3. paraphrasing the words, ideas, opinions, or theories of others, whether oral or written;
    4. borrowing facts, statistics, or illustrative material; or
    5. offering materials assembled or collected by others in the form of projects or collections without acknowledgment
4. **Interference:** A student must not steal, change, destroy, or impede another student's work, nor should the student unjustly attempt, through a bribe, a promise of favors or threats, to affect any student's grade or the evaluation of academic performance. Impeding another student's work includes, but is not limited to, the theft, defacement, or mutilation of resources so as to deprive others of the information they contain.
5. **Violation of Course Rules:** A student must not violate course rules established by a department, the course syllabus, verbal or written instructions, or the course materials that are rationally related to the content of the course or to the enhancement of the learning process in the course.
6. **Facilitating Academic Dishonesty:** A student must not intentionally or knowingly help or attempt to help another student to commit an act of academic misconduct, nor allow another student to use his or her work or resources to commit an act of misconduct.

## **OTHER POLICIES**

1. **Administrative withdrawal:** Students must participate in all class discussions and conscientiously complete all required course activities and/or assignments. If a student is unable to attend, participate in, or complete an assignment on time, the student must inform the instructor. If a student misses more than half of the required activities within the first 25% of the course without contacting the instructor, the student may be administratively withdrawn from this course. Administrative withdrawal may have academic, financial, and financial aid implications. Administrative withdrawal occurs after the full refund period, and a student who has been administratively withdrawn is ineligible for a tuition refund.
2. **Civility:** To maintain an effective and inclusive learning environment, it is important to be an attentive and respectful participant in lectures, discussions, group work, and other

classroom exercises. Thus, unnecessary disruptions should be avoided, such as ringing cell phones, engagement in private conversations, and other unrelated activities. Cell phones, media players, or any noisy devices should be turned off during a class. Texting, web surfing, and posting to social media are generally not permitted. Laptop use may be permitted if it is used for taking notes or conducting class activities. Students should check with the instructor about permissible devices in class. IUPUI nurtures and promotes “a campus climate that seeks, values, and cultivates diversity in all of its forms and that provides conditions necessary for all campus community members to feel welcomed, supported, included, and valued” (IUPUI Strategic Initiative 9). IUPUI prohibits “discrimination against anyone for reasons of race, color, religion, national origin, sex, sexual orientation, marital status, age, disability, or veteran status” (Office of Equal Opportunity). Profanity or derogatory comments about the instructor, fellow students, invited speakers or other classroom visitors, or any members of the campus community shall not be tolerated. A violation of this rule shall result in a warning and, if the offense continues, possible disciplinary action.

3. **Communication:** For classroom-based courses, the instructor or teaching assistant should respond to emails by the end of the next class or, for online courses, within two Indiana University working days, which excludes weekends and holidays. The instructor should provide weekly office hours or accept appointments for face-to-face, telephone, or teleconferenced meetings, and announce periods of extended absence in advance.
4. **Counseling and Psychological Services (CAPS):** Students seeking counseling or other psychological services should contact the CAPS office at 274-2548 or capsindy@iupui.edu. For more information visit <http://life.iupui.edu/caps/>.
5. **Course evaluations:** Course evaluations provide vital information for improving the quality of courses and programs. Students are urged to complete one course and instructor evaluation for each section in which they are enrolled at the School of Informatics and Computing with the following exceptions: (a) The student has withdrawn from the course; (b) fewer than five students are enrolled in the section (in which case maintaining anonymity is difficult); and (c) the section is a laboratory that must be taken with a course having a different section number. Course evaluations are completed at <https://soic.iupui.edu/app/course-eval/>. Course evaluations are typically open from the eleventh week. Course evaluations are anonymous, which means that no one can view the name of the student completing the evaluation. In addition, no one can view the evaluation itself until after the instructor has submitted the final grades. In small sections, demographic information should be left blank, if it could be used to identify the student.
6. **Disabilities policy:** All qualified students enrolled in this course are entitled to reasonable accommodations for a disability. Notify the instructor during the first week of class of accommodations needed. Students requiring accommodations register with Adaptive Educational Services (AES) and complete the appropriate AES-issued before receiving accommodations. The AES office is located at UC 100, Taylor Hall (Email: [aes@iupui.edu](mailto:aes@iupui.edu), Tel. 317 274-3241). For more information visit <http://aes.iupui.edu>.
7. **Email:** Indiana University uses your IU email account as an official means of communication, and students should check it daily. Although you may have your IU

email forwarded to an outside email account, please email faculty and staff from your IU email account.

8. **Emergency preparedness:** Know what to do in an emergency so that you can protect yourself and others. For more information, visit the emergency management website at <http://protect.iu.edu/emergency>.
9. **IUPUI course policies:** A number of campus policies governing IUPUI courses may be found at the following link: [http://registrar.iupui.edu/course\\_policies.html](http://registrar.iupui.edu/course_policies.html)
10. **No class attendance without enrollment.** Only those who are officially enrolled in this course may attend class unless enrolled as an auditor or making up an Incomplete by prior arrangement with the instructor. This policy does not apply to those assisting a student with a documented disability, serving in an instructional role, or administrative personnel. <http://registrar.iupui.edu/official-enrollment-class-attendance.html> Children may *not* attend class with their parents, guardians, or childcare providers.
11. **Religious holidays:** Students seeking accommodation for religious observances must submit a request form to the course instructor by the end of the second week of the semester. For information visit <http://registrar.iupui.edu/religious.html>.
12. **Right to revise:** The instructor reserves the right to make changes to this syllabus as necessary and, in such an event, will notify students of the changes immediately.
13. **Sexual misconduct:** IU does not tolerate sexual harassment or violence. For more information and resources, visit <http://stopsexualviolence.iu.edu/>.
14. **Student advocate:** The Student Advocate assists students with personal, financial, and academic issues. The Student Advocate is in the Campus Center, Suite 350, and may also be contacted at 317 274-4431 or [studvoc@iupui.edu](mailto:studvoc@iupui.edu). For more information visit <http://studentaffairs.iupui.edu/advocate>.

## MISSION STATEMENT

The Mission of IUPUI is to provide for its constituents excellence in

- Teaching and Learning;
- Research, Scholarship, and Creative Activity; and
- Civic Engagement.

With each of these core activities characterized by

- Collaboration within and across disciplines and with the community;
- A commitment to ensuring diversity; and
- Pursuit of best practices.

IUPUI's mission is derived from and aligned with the principal components—Communities of Learning, Responsibilities of Excellence, Accountability and Best Practices—of Indiana University's Strategic Directions Charter.

## STATEMENT OF VALUES

IUPUI values the commitment of students to learning; of faculty to the highest standards of teaching, scholarship, and service; and of staff to the highest standards of service. IUPUI recognizes students as partners in learning. IUPUI values the opportunities afforded by its

location in Indiana's capital city and is committed to serving the needs of its community. Thus, IUPUI students, faculty, and staff are involved in the community, both to provide educational programs and patient care and to apply learning to community needs through service. As a leader in fostering collaborative relationships, IUPUI values collegiality, cooperation, creativity, innovation, and entrepreneurship as well as honesty, integrity, and support for open inquiry and dissemination of findings. IUPUI is committed to the personal and professional development of its students, faculty, and staff and to continuous improvement of its programs and services.