INFO B646 Computational Systems Biology

Indiana University School of Informatics and Computing, Indianapolis
Spring 2014

Section No.: 15732
Credit Hours: 3
Time: Mondays 3–5:40 pm
Location: IT 357
Indianapolis, IN 46202
First Class: January 20th, 2014
Website: https://oncourse.iu.edu/portal/site/SP14-IN-INFO-B646-15732

Instructor: Jake Chen, Ph.D. (Minnesota) in Comp. Sci. & Eng., Associate Professor
Office Hours: Mondays, 5:40 pm–7 pm after class.
Or by appointment in advance.
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Phone: (317) 278-7604 (Office)
Email: jakechen@iupui.edu
Website: http://bio.informatics.iupui.edu/CV/

TA: Recep Vatansever (by courtesy)
Office Hours: by Appointment
Email: rvatanse@iupui.edu

Prerequisites: None (Not an extension of any undergraduate or graduate course)

EXTENDED COURSE DESCRIPTION

The past two decades have witnessed rapid development of genomics, proteomics, biotechnology, and translational medical sciences. The advances in these disciplines enabled the interrogation of living organisms at various levels, leading to the rapid accumulation of large-scale biological data. Systems biology emerges from the study of biological systems holistically, emphasizing the study of interconnections between genes, proteins, RNAs, environmental stimuli, pharmaceutical compounds, and various cell types instead of treating each component in isolation. Systems biology has become an essential tool to unraveling complexity in life and has promised to have many application potentials in drug discovery, environmental sciences, agriculture, and genomics medicine.

In this course we will study current research topics in systems biology. We will survey a wide range of topics that may cover:

- Basic concepts of computational systems biology
- Network biology concepts
- Network motifs
- Knowledge representation in systems biology
• Gene regulatory networks and dynamic modeling of gene expressions
• Biochemical networks structures and stochastic modeling of biochemical reactions
• Robustness modeling/adaptation of networks
• Pathway modeling and reverse engineering
• Genetic circuit design and synthetic biology

After successfully completing the course, students are expected to have a good understanding of the basic concepts, challenges, current research topics, and trends in selected topics of computational systems biology.

REFERENCE BOOKS
The papers will be used primarily to cover the broad spectrum of topics in computational systems biology. They will be posted on course web site.

Additional reading materials (kept up to date each year) will be shared through oncourse prior to each class meeting.

1. Systems Biology: A Textbook
   • By Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, Ralf Herwig
   • Updated 592-page textbook
   • Wiley-VCH, 1st edition (August 2009)

2. Systems Biology: Properties of Reconstructed Networks
   • By Bernhard O. Palsson
   • One of the first book on the topic
   • Cambridge University Press; 1st edition (January 2006)

3. An Introduction to Systems Biology: Design Principles of Biological Circuits
   • by Uri Alon
   • Widely read and distributed in the systems biology research community
   • Chapman & Hall, 1st edition (July 2006)

COURSE FORMAT
The instruction style will be primarily based on a mixture of lectures and student reading and presentations of systems biology related research publications. Some guest lectures may also be used. In the classroom, students will learn basic concepts and participate in in-depth classroom discussions of the course content. Outside of the classroom, students will practical systems biology data analysis skills through guided reading and class projects.
The emphasis of in-class learning will be to introduce fundamental concepts. It is crucial that students seek and perform readings related to classroom topics before and after the class proactively. To learn basic computational systems biology concepts and theories, students are expected to read current literatures as the primary textbook, write critical reviews, prepare presentations based on understanding from reading, participate in in-class discussions, and write reports to enhance comprehension of various topics. To learn how to develop systems biology analysis skills, students are expected to perform class projects. In particular, we expect the following for each student:

- Read weekly assigned papers on the topic before coming the class
- Write weekly literature review and critically evaluate published work
- Perform peer-review by giving candidate comments during in-class discussions
- Integrate reading, presenting, discussion, writing, and thinking into a coherent learning framework for advanced graduate research study.

PRINCIPLES OF GRADUATE AND PROFESSIONAL LEARNING

Learning outcomes are assessed in the following areas:
- Knowledge and skills mastery (K&S)
- Critical thinking and good judgment (CT)
- Effective communication (EC)
- Ethical behavior (EB)

GRADING CATEGORIES

A total of 100 points are available for distribution into the following tabulated main scoring subject areas:

<table>
<thead>
<tr>
<th>Scoring Subject Area</th>
<th>Points</th>
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<tbody>
<tr>
<td>Class Preparation</td>
<td>15</td>
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<tr>
<td>Research Paper Presentation</td>
<td>10</td>
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<tr>
<td>Reading Reports</td>
<td>16</td>
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<td>Critiques</td>
<td>24</td>
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<td>Data Analysis Project</td>
<td>35</td>
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<td>Proposal Presentation</td>
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<td>Progress Report #1</td>
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<td>Progress Report #2</td>
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<td>Final Presentation</td>
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<td>Final Report</td>
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1. **In-class Participations 15 pts**
- Each week, a student is elected to be the class monitor. The class monitor will hand out a signup sheet and record participation scores. As long as the sheet is submitted in time to the TA, the class monitor will earn 1 full pt for the week.
• Each student coming to a class will automatically earn 0.5 pt.
• Students who show good preparation and good constructive discussions as determined by the monitor and reviewed by the professor may get up to 1 additional pts for each class. No more than 1/2 of the class each time may get the full 1.5 pts to avoid grade inflation.

2. Research Paper Presentation 10 pts
• Identify a technical paper within computational systems biology published in the past three years (since 2011) to present. The student should discuss the feasibility of the paper with the professor at least 2 weeks in advance. The professor may choose to assign a paper for the student to present instead. The final selected paper pdf should be posted by the student to Oncourse wiki class page no later than 7 days in advance to avoid a late penalty of 20%.
• While presenting the paper, make sure to
  o Read both the paper and supplemental material in depth
  o Read portions of related papers to understand key details missing in the paper presented
  o Use background material from online sources to help class achieve better understanding
• Each presentation, with Q&A, will be approximately 60min. A thorough presentation of the research context, problem statement, computational technique in detail, data sets used, evaluation methods, and assessment of the strengths/weaknesses should be thoroughly presented. After incorporating all the feedback from class and clarify ambiguities, the final presentation file should be uploaded to the course site through TA within 3 days of completing the presentation in class. The grading will be performed according to the following weight:
  o Significance of the paper chosen 10%
  o Presentation clarity, style, timing 40%
  o Preparation and ability to address questions 25%
  o Submission of revised ppt 25%

3. Reading reports 16 pts
• (2pts each) Provide at least 8 research paper reading report before each class. The report should be no more than 2 pages long and should be written in the student’s own languages. The reports should be submitted to the student’s dropbox folder and be named as Reading Report #1, #2, #3, …
• Make sure to address following questions in the report:
  o What biological problems are the authors trying to address?
  o What are the past work performed?
o Are there new concepts raised? If so, what are they?
  o What are the core computational techniques used in the paper?
  o What data sets did the authors use?
  o Are there obvious weaknesses?
  o Write down a list of questions that you are unable to find answers for in
    this paper to pose to the class.

4. **Written Critiques 24 pts**
   • *(4pts each)* Choose up to 6 papers and write a 5-page comprehensive written
critique after a paper has been presented in class.
   • The written critique may be developed from the reading report. The critiques
should be submitted to the student’s dropbox folder and be named as **Written
Critique #1, #2, #3, …**
   • The written critique should additionally focus on the following aspect of the
research paper:
     o A comprehensive review of the innovations of the work
     o A comprehensive review of the significance of the work
     o A detailed assessment of weaknesses and strengths of the computational
techniques used
     o Summary of additional critiques raised in class.
     o Additional studies that extend the work, or validate/disprove the work
      (optional).

5. **Systems Biology Analysis Project and Presentation 35 pts**
   • Throughout the semester, each team of students is expected to develop a systems
biology project that address a new and challenging biomedical research problem.
   • You need to form a team of 1-2 players. You will be evaluated and ultimately
graded under these general principles:
     o Does the project involve critical application of systems biology?
     o Is the analysis approach sound? Does it use systems biology concepts or
       key techniques?
     o Is the research data set derived from credible, up-to-date resource? Does it
       use network biology or network medicine data?
     o Is the analysis helping biology or bioinformatics users addressing an
       important biological question?
     o Is the writing and presentation of your work clear and detailed?
   • Deliverables are the following:
     a. **Project site**: wiki page to host project related documentations and discussions
        whenever applicable
     b. **Project Proposal**: 6-pages
c. **Progress report #1 and #2**: Limit to 20min with Q&A. Report should be no more than 10 pages.

d. **Final project presentation**: Limit to 25min with Q&A

e. **Final report and package**: include the following components
   - Final report (up to 15-page limit)
   - Revised presentation slides
   - A signed cover letter showing what’s learned and statement indicating contribution of each participation. Also add a statement that “we grant all permissions for future students to use the code/data generated to continue the project whenever applicable”.
   - All software codes used to generate the analysis.
   - The entire raw and processed data should be thoroughly described and uploaded.

**FINAL GRADES**

The final grades will be based on summed points by referring to the following grading conversion table as closely as possible:

<table>
<thead>
<tr>
<th>Grade Category</th>
<th>Grade</th>
<th>Score Requirement</th>
<th>Relative Class Rank Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outstanding achievement</td>
<td>A+</td>
<td>&gt;93</td>
<td>Top 10%</td>
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<tr>
<td>Excellent achievement</td>
<td>A</td>
<td>[88, 93)</td>
<td>Top 20%</td>
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<tr>
<td>Very good work</td>
<td>A−</td>
<td>[84, 88)</td>
<td>Top 30%</td>
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<tr>
<td>Good work</td>
<td>B+</td>
<td>[80, 84)</td>
<td>Median</td>
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<td>Satisfactory</td>
<td>B</td>
<td>[76, 80)</td>
<td>Lower 40%</td>
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<tr>
<td>Marginal (Pass)</td>
<td>B−</td>
<td>[72, 76)</td>
<td>Lower 25%</td>
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<tr>
<td>Unacceptable work (Must be repeated)</td>
<td>C−, C, C+</td>
<td>[60, 72)</td>
<td>Lower 10%</td>
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<tr>
<td>Fail</td>
<td>F</td>
<td>0–59</td>
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</table>

* Students achieving the relative class rank as shown on the table are guaranteed the minimal corresponding grade, regardless of actual score obtained.

**SUBMISSION POLICY**

1. **Due Time**

<table>
<thead>
<tr>
<th>Submission Category</th>
<th>Default Due Time</th>
<th>Submission Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Participation Signup Sheet &amp; Scorecard</td>
<td>Within 24 hrs of the class</td>
<td>Email scanned version both to TA &amp; Professor</td>
</tr>
<tr>
<td>Reading Reports</td>
<td>At 11:59 pm each Sunday before class</td>
<td>Upload to dropbox through Oncourse</td>
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</tbody>
</table>
### Written Critiques
At 11:59 pm each Friday after class
Upload to dropbox through Oncourse

<table>
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<tr>
<th>All Project Documents</th>
<th>At 11:59 pm of Due Date announced</th>
<th>Upload through Oncourse</th>
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</table>

### 2. Late Submission Policy:

Note: Whenever applicable, the timestamp of the file submitted will be used to determine whether the submission is on time or late.

Within 48 hours of the deadline: 50% penalty
Beyond 48 hours of the deadline: 0 pts

### IMPORTANT DATES

1/20  First day of class
2/17  Project proposal presentation
3/17  Progress Report #1 due (Spring Break)
4/14  Progress Report #2 due
5/5   Student project final presentation

[Calendar Image]

**January**

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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.

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.
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.

7. **WARNING**: Any academic misconduct will be treated very seriously. The work will be scored 0 pts and the incident shall be reported to the School. So please do not violate the rules!

**OTHER POLICIES**

1. **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)

2. **Classroom 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. Texting, surfing the Internet, and posting to Facebook or Twitter during class are generally not permitted. 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. **Bringing children to class**: To ensure an effective learning environment, children are not permitted to attend class with their parents, guardians, or childcare providers.

4. **Disabilities Policy**: In compliance with the Americans with Disabilities Act (ADA), all qualified students enrolled in this course are entitled to reasonable
accommodations. Please notify the instructor during the first week of class of accommodations needed for the course. Students requiring accommodations because of a disability must 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, Tel. 317 274-3241). Visit http://aes.iupui.edu for more information.

5. **Administrative Withdrawal:** A basic requirement of this course is that students 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, it is the student’s responsibility to 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 will take place after the full refund period, and a student who has been administratively withdrawn from a course is ineligible for a tuition refund. Contact the instructor with questions concerning administrative withdrawal.

6. **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