



IUPUI

**SCHOOL OF INFORMATICS  
AND COMPUTING**

**DEPARTMENT OF BIOHEALTH INFORMATICS**  
Indiana University–Purdue University  
Indianapolis

**INFO B536 (& B436)**

**Computational Methods for Biomedical Informatics**

**Department of BioHealth Informatics**

**Indiana University School of Informatics and Computing, IUPUI**

**Fall 2021**

*Credit Hours:* 3

*Time:* Tuesday 3:00–5:40 pm

*Location:* IT 271

*First Class:* August 24, 2021

*Instructor:* Amir Manzour, Ph.D., Assistant Professor

*Office Hours:* Mondays 3:00 – 4:00 pm by Appointment

Zoom meeting ID: 730 117 6460 Password: **135791**

<https://iu.zoom.us/j/7301176460?pwd=MDZYV3NxVWN0UmRBWVR2bWRFZVdIQOT09> ([Links to an external site.](#))

*Office:* IT 479

535 W. Michigan Street, Indianapolis, IN 46202

*Phone:* (317) 278-4108 (Office)

*Email:* amanzour@iu.edu

*Website:* <https://soic.iupui.edu/people/amir-manzour/>

**COURSE DESCRIPTION**

This course covers the applications of algorithm design, algorithm analysis, and complexity analysis in biomedical informatics.

**EXTENDED COURSE DESCRIPTION**

Biomedical informatics focuses on using computational methods to acquire, organize, and analyze biomedical data. This course introduces various algorithm design techniques, such as exhaustive search, greedy search, divide-and-conquer, dynamic programming, graph-based algorithms, and randomized algorithms, as well as various biomedical problems, such as sequence alignment, genome arrangement, motif finding, and peptide identifications. These problems are used as examples to demonstrate how to use computational methods to solve a biomedical problem by mathematical modelling and algorithm design. In addition, this course covers algorithm analysis and complexity analysis, which are essential for understanding pros and cons of computational methods and for theoretically investigating their efficiency and

performance.

## REFERENCE BOOKS

Most teaching contents are covered by lecture slides. Please refer to the class topics below for details about the contents in the lectures. Students are encouraged to get a copy of the following reference books.

Title: An Introduction to Bioinformatics Algorithms  
Authors: Neil C. Jones and Pavel A. Pevzner  
Edition: 1 edition (August 6, 2004)  
Publisher: The MIT Press  
ISBN: ISBN-10: 0262101068 ISBN-13: 978-0262101066

Title: Computational Molecular Biology: An Algorithmic Approach  
Author: Pavel A. Pevzner  
Edition: 2<sup>nd</sup> edition (July 1, 2004)  
Publisher: A Bradford Book  
ISBN: ISBN-10: 0262161974 ISBN-13: 978-0262161978

## GENERAL GUIDELINE TO THE SYLLABUS

Students are responsible for familiarizing themselves with the syllabus. The instructor is responsible for being responsive to the diverse needs of the enrolled students and for making necessary modifications to this syllabus, which is to be treated as a living document.

### Principles of Graduate and Professional Learning (PGPL)

- |  |                          |
|--|--------------------------|
| 1. Knowledge and skills mastery        | <i>Major emphasis</i>    |
| 2. Critical thinking and good judgment | <i>Moderate emphasis</i> |
| 3. Effective communication             | <i>Some emphasis</i>     |
| 4. Ethical behavior                    |                          |

### Core Competencies:

The following biomedical informatics core competencies are covered in the course:

1. **Fundamental knowledge:** Understand and apply concepts in discrete mathematics, data structures, and computational complexity in biomedical informatics.
2. **Application of computing knowledge to biomedical problems:** Understand and apply computational methods to solve various problems in biomedical informatics.
3. **Mathematical Modelling:** Analyze biomedical problems and build models that clearly describe mathematical representation and optimization objectives, which are used for computational method design.
4. **Design, implement, and evaluate computer systems:** Understand the tradeoffs of choices of computer methods and demonstrate an ability to design and implement efficient methods, and assess their performance.
5. **Problem solving skills:** Use instances to examine properties of computational problems and to find solutions, and iteratively improve existing methods.

## Teaching and Learning Methods

Project-based learning (PBL), Team-based learning, Lecture by instructor with slides.

### LEARNING OUTCOMES:

Upon completion of this course, students will	RBT	PGPL	Core comp.	Assessment
1. Evaluate common problems in biomedical informatics, such as sequence alignment, genome arrangement, and peptide identification	5	1	1, 2	Assignments, exams
2. Analyze time and space complexity and other theoretical concepts used in algorithm analysis and complexity analysis	4	1	1	Assignments, exams
3. Apply abstract data structures to solve problems in biomedical informatics	3	1, 2	1	Assignments, project, exams
4. Compare the pros and cons of computational methods for a biomedical problem and choose appropriate methods	4, 5	1, 2	1, 2	Assignments, project, exams
5. Evaluate the similarity between new problems and existing problems and adapt computational methods designed for existing problems to new problems	5, 6	1, 2	2, 3, 4	Assignments, project, exams
6. Design computational methods using a greedy, brute-force, divide-and-conquer, or dynamic programming approach	6	2	4, 5	Assignments, project
7. Evaluate biomedical problems using example-based problem-solving skills and iterative refinement skills	5	2	4, 5	Assignments, project
8. Design and perform experiments for evaluating computational methods and publically present experimental results	3, 6	1, 2, 3	2, 4, 5	Project

RBT: Revised Bloom's Taxonomy; PGPL: Principles of Graduate and Professional Learning

## TENTATIVE SCHEDULE

	Date	Class topic	Percentage
Lecture 1	Aug 24	Introduction	8%
Lecture 2	Aug 31	Greedy methods	8%
Lecture 3	Sep 7	Brute force methods	8%
Lecture 4	Sep 14	Sequence motif search	8%
Lecture 5	Sep 21	Dynamic programming algorithms	8%
Lecture 6	Sept 28	Gene prediction	8%
Lecture 7	Oct 5	Multiple sequence alignment	8%
Mid term exam	Oct 12		
Lecture 8	Oct 19	Divide and conquer algorithms	8%
Lecture 9	Oct 26	Graph algorithms	8%
Lecture 10	Nov 2	Combinatorial pattern matching	8%
Lecture 11	Nov 9	Mass spectrometry	8%
Lecture 12	Nov 16	Randomized algorithms	8%
Review	Nov 30		
Final exam	Dec 7		
Project presentation	Dec 14		

## CLASS TOPICS:

### Lecture 1 Introduction

### Lecture 2 Greedy methods

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 5 Greedy algorithms
- Pevzner (2004) *Computational Molecular Biology: An algorithmic Approach*
  - Chapter 10 Genome rearrangement

### Lecture 3 Brute force methods

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 4 Exhaustive search (4.1-4.4)
- Pevzner (2004) *Computational Molecular Biology: An algorithmic Approach*
  - Chapter 2 Restriction mapping

### Lecture 4 Sequence motif search

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 4 Exhaustive search (4.5-4.9)

### **Lecture 5 Dynamic programming algorithms in sequence alignment**

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 6 Dynamic programming algorithms
- Pevzner (2004) *Computational Molecular Biology: An algorithmic Approach*
  - Chapter 6 Sequence comparison

### **Lecture 6 Gene prediction**

- Pevzner (2004) *Computational Molecular Biology: An algorithmic Approach*
  - Chapter 9 Gene prediction

### **Lecture 7 Multiple sequence alignment**

- Pevzner (2004) *Computational Molecular Biology: An algorithmic Approach*
  - Chapter 7 Multiple sequence alignment

### **Lecture 8 Divide and conquer algorithms in sequence alignment**

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 7 Divide-and-conquer algorithms

### **Lecture 9 Graph algorithms in DNA sequencing**

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 8 Graph algorithms

### **Lecture 10 Combinatorial pattern matching**

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 9 Combinatorial pattern matching

### **Lecture 11 Mass spectrometry**

- Pevzner (2004) *Computational Molecular Biology: An algorithmic Approach*
  - Chapter 11 Computational proteomics

### **Lecture 12 Randomized algorithms in motif finding**

- Jones and Pevzner (2004) *An Introduction to Bioinformatics Algorithms*
  - Chapter 12 Randomized algorithms

## **ASSIGNMENTS, PROJECT and EXAMS:**

Four home assignments will be given to assess learning and apprehension. Homework assignments will be available on Canvas and students will have two weeks to complete each assignment. Scores and model answers will be available on Canvas.

Students will complete a project about comparing and evaluating computational methods for biomedical data analysis. Students will work in a group of 2-3 students. Each group will find a biomedical data analysis problem, understand various computational methods, design and perform experiments for method comparison and evaluation. and submit analysis reports. Each group will submit a methodology report in the 9<sup>th</sup> week and a final report in the 16<sup>th</sup> week, and give a 20-minute oral presentation in the 16<sup>th</sup> week. Project reports and project presentations will be graded as a group. Project reports will be evaluated on research objective setting, research redesign, technical complexity, implementation, and experimental results; project presentations

will be evaluated on presentation clarity and slides organization. The weights of the methodology report, the final report, and the presentation will be 8%, 10%, and 7%, respectively.

A mid-term exam and a final exam will be given to assess student learning outcomes. The mid-term exam will be in the 8<sup>th</sup> week and the final exam will be in the 15<sup>th</sup> week. Both will be 2-hours closed book exams. An unexcused absence from an exam will receive a zero. Illness or a death in the immediate family is usually the only acceptable excuse for absence. A makeup exam with 10% penalty will be given to students that miss an exam with an acceptable excuse.

### **COURSE GRADE BREAKDOWN**

- Homework 25%
- Exams 50%
  - Mid-term exam 20%
  - Final exam 30%
- Project 25%
  - Methodology report 8%
  - Final report 10%
  - Project presentation 7%

### **Grading Scale:**

A+	97 – 100	Outstanding achievement, given at the instructor’s discretion
A	93 – 100	Excellent achievement
A–	90 – 092.99	Very good performance and quality of work
B+	87 – 089.99	Good performance and quality of work
B	83 – 086.99	Modestly acceptable performance and quality of work
B–	80 – 082.99	Marginal acceptable performance and quality of work
C+	77 – 079.99	Unacceptable work (Core course must be repeated for credit)
C	73 – 076.99	Unacceptable work (Core course must be repeated for credit)
C–	70 – 072.99	Unacceptable work (Course must be repeated for credit)
D+	67 – 069.99	Unacceptable work (Course must be repeated for credit)
D	63 – 066.99	Unacceptable work (Course must be repeated for credit)
D–	60 – 062.99	Unacceptable work (Course must be repeated for credit)
F	Below 60	Unacceptable work (Course must be repeated for credit)

No grade below B– will count toward major requirements.

### **Administrative Withdrawal [University Policy]**

- a. A basic requirement of this course is that you will conscientiously complete all required course activities and/or assignments. Keep in touch with the instructor if you are unable to attend, participate, or complete an assignment on time.
- b. If you miss more than half of the required activities within the first 25% of the course

without contacting the instructor, you may be administratively withdrawn from this course by the instructor. For example: *This course meets once per week; thus if you miss more than two classes in the first four weeks*, you may be withdrawn by the instructor.

Administrative withdrawal may have academic, financial, and financial aid implications. Administrative withdrawal will take place after the full refund period, and if you are administratively withdrawn from the course you will not be eligible for a tuition refund.

- c. If you have questions about the administrative withdrawal policy at any point during the semester, please contact the instructor. See campus policy in detail here:  
<http://registrar.iupui.edu/withdrawal-policy.html>

## ASSIGNMENT DEADLINES

### 1. Late Assignments

You are responsible for completing each deliverable (e.g., assignment, project reports) by its deadline and submitting it by the specified method. Deadlines are outlined in supplementary documents accessible through Canvas. 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. You are allowed one excused or unexcused late submission for homework assignments in 24 hours after the deadline. The second late submission for homework assignments and all late submissions for project reports will receive a zero.

### 2. Team Responsibility

If a late assignment is due to the action of one team member, the entire team will reap the negative results. For this reason, it is imperative that team members establish a self-monitoring system that includes regular communication via email, text or phone. If a team has a team member who is not acting responsibly, the team may petition the instructor for a solution.

## 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](mailto: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 make a request in writing by the end of the 2nd week of the semester to the course instructor and should use the [Request for Course Accommodation Due to Religious Observance Form](#). 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:** Indiana University prohibits discrimination on the basis of sex or gender in its educational programs and activities. IU policies on sex misconduct can be found at the following link: <http://policies.iu.edu/policies/categories/administration-operations/equal-opportunity/sexual-misconduct.shtml>. 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.