

# ISC 4221: Discrete Algorithms for Science Applications

Fall 2021

## SYLLABUS

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<b>Instructor</b>	Bryan Quaipe 444, Dirac Science Library bquaipe@fsu.edu
<b>TA</b>	Kevin Ziegler 481C, Dirac Science Library kdz14@my.fsu.edu
<b>Class</b>	Lectures: TR: 9:20–10:10am
<b>Lab</b>	(Lab: M: 3:05–5:35pm)
<b>Office Hours</b>	Wednesdays 10:15am–11:15am (Quaipe) TBD (Kevin) Set up another time by emailing the professor or TA.
<b>Text Book</b>	There is no required text for this class. Completed notes will be provided after each lecture.
<b>Coding</b>	This class uses Matlab, which is available on SC computers. Matlab may be installed on your laptop here with your FSU account. Alternatively you may use Python or Julia. Please do not submit Jupyter Notebooks.
<b>Prerequisites</b>	MAC 2312 (Calculus II) ISC 3222 (Symbolic and Numerical Computations)
<b>Website</b>	FSU's Canvas Course Management Site.

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### Description

This course offers stochastic algorithms, linear programming, optimization techniques, clustering, and feature extraction presented in the context of science problems. The laboratory component includes algorithm implementation for simple problems in the sciences and applying visualization software to interpret results.

### Detailed Course Plan

The first class will be on August 23 (M), and the last class will be on December 3 (F). There is no class on September 6 (Labor Day), and November 24 and 26 (Thanksgiving). Barring unforeseeable events, we will have about 42 lecture days and 13 lab weeks.

Outline and sequence of topics is as follows:

1. *Algorithm Design and Analysis* [3]

overview, discrete versus continuous algorithms, canonical discrete problems (sort, search, graphs etc.); common strategies (brute force, greedy, divide and conquer etc.); comparing algorithms, computational cost.

2. *Random Processes* [6]

basic probability theory, random number generation, PDFs and CDFs, central limit theorem, Monte Carlo Method for integration and simulation.

3. *Graphs* [6]

representation, taxonomy (components, connectedness, paths), four computational problems and algorithms, traversing (depth-first search), shortest path (Dijkstra), minimum spanning tree (Kruskal).

4. *Data Mining* [5]

clustering and classification; clustering problems and algorithms (hierarchical,  $k$ -means, geometric), Lloyd's and McQueen's algorithms, CVT; decision trees for classification.

5. *Image Manipulation* [6]

representation, histograms, compression, contrast stretching and enhancement, denoising, blurring, edge and component detection.

6. *Computational Geometry* [5]

points and lines, triangles, triangulating polygons, convex hull, Delaunay triangulation, integrating functions on triangular domains.

7. *Discrete Optimization* [7]

linear programming, dynamic programming, simulated annealing; application to numerous problems including knapsack and TSP.

Note that this course plan is subject to change.

<b>Grading</b>	Assignments	15%	(approximately 4)
	Labs	30%	(approximately 7)
	Midterm	25%	(mid October)
	Final Exam	30%	(Monday, December 6, 7:30am-9:30am)

### Course Policies

- All lab and assignment submissions must include a **single pdf file** that serves as a report, and **well-documented computer code** that produces all results in the report. It is not the instructor's or TA's job to run your code in order to generate results and figures. These must be embedded in your report.
- Interruptions during class time are highly encouraged. If you do not understand a concept, there is a good chance that other students would benefit from further explanation.
- The complete notes will be posted on Canvas after class. However, listening to explanations that complement the notes is necessary to understand the course content. Therefore, it is in your best interest to attend every lecture possible. History has shown that students who "learn" the material by only reading the notes on their own time are less successful than those who also come to class and participate in the discussion.
- Unless otherwise directed, the only need for a computer, laptop, phone, or tablet during class is to follow notes or participate in a coding exercise. During class time, I ask that you do not check email, chat, text, etc. There is compelling evidence that such multitasking distracts both you and the instructor, and lowers student engagement and learning. Class discussions are less fruitful when only a handful of people participate.

- Labs will be handed out before lab time. The typical frequency will be a new lab every two weeks. Labs will focus on **computer exercises**. You are strongly encourage to attend the lab sessions where the course TA will be able to address your questions.
- Assignments will focus on **paper-and-pencil** calculations. The assignments are meant to reinforce material learnt in class.
- Unless discussed with the instructor before the deadline, late labs and assignments will be deducted 10% per day. Assignments later than five days will not be graded.
- I encourage you to work with others on both your labs and assignments. However, the final submission, including the code, must be unambiguously yours. Plagiarism will not be tolerated, will result in a 0, and will be reported.
- The midterm and final will be in-class.

### **University Attendance Policy**

Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

### **Academic Honor Policy**

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "...be honest and truthful and...[to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found here.)

### **Americans With Disabilities Act**

Students with disabilities needing academic accommodation should:

- register with and provide documentation to the Student Disability Resource Center; and
- bring a letter to the instructor indicating the need for accommodation and what type.

This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact the:

Student Disability Resource Center  
 874 Traditions Way  
 108 Student Services Building  
 Florida State University  
 Tallahassee, FL 32306-4167  
 (850) 644-9566 (voice)  
 (850) 644-8504 (TDD)  
 sdrcadmin.fsu.edu  
<http://www.disabilitycenter.fsu.edu>

### **Recording of Lectures**

Students may record class lectures delivered by the instructor that cover academic content. No recordings of other students, class participation, or discussion will be permitted. The recordings may not be published, which includes sharing, texting, and posting of any recordings of other students, without the specific permission of the student. More information can be found in House Bill 233 Intellectual and Viewpoint Diversity Act.

### **Free Tutoring from FSU**

For tutoring and writing help in any course at Florida State University, visit the Academic Center for Excellence (ACE) Tutoring Services' comprehensive list of tutoring options—see <http://ace.fsu.edu/tutoring> or contact [tutor@fsu.edu](mailto:tutor@fsu.edu) for more information. High-quality tutoring is available by appointment and on a walk-in basis. These services are offered by tutors trained to encourage the highest level of individual academic success while upholding personal academic integrity.

### **Syllabus Change Policy**

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.