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## CS 3304: Analysis of Algorithms

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### Syllabus

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**Prerequisites:** None.

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**Course Description:** This course builds on knowledge of elementary algorithm analysis gained in CS 3303: Data Structures, and introduces more advanced algorithms. Implementation strategies for algorithms including Brute Force, Branch and Bound, Divide and Conquer, Greedy, Linear Programming and Dynamic programming as well as techniques to analyze and evaluate the complexity of algorithms are taught. Finally the concepts of NP-complete, hard problems, impossible problems, and the halting problem will be explored.

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**Required Textbook and Materials:** UoPeople courses use open educational resources (OER) and other materials specifically donated to the University with free permissions for educational use. Therefore, students are not required to purchase any textbooks or sign up for any websites that have a cost associated with them. The main required textbooks for this course are listed below, and can be readily accessed using the provided links. There may be additional required/recommended readings, supplemental materials, or other resources and websites necessary for lessons; these will be provided for you in the course's General Information and Forums area, and throughout the term via the weekly course Unit areas and the Learning Guides.

- This course makes use of two main textbooks (below) and various other assigned readings. In some cases, the material presented in each textbook is redundant or repeated. However, both resources have been provided in this case because each textbook provides a unique perspective on the topic and those differences in perspective can be helpful in learning and understanding the material.
  - Schaffer, C.A. (2011). A Practical Introduction to Data Structures and Algorithms Analysis (3.1 ed.). Blacksburg, VA: Virginia Tech University, Department of Computer Science. Available at <http://people.cs.vt.edu/~shaffer/Book/C++3e20100119.pdf>
  - Dasgupta, S., Papadimitriou, C.H., & Vazirani, U.V. (2006). Algorithms. Berkeley, CA: University of California Berkeley, Computer Science Division. Available at <http://algorithms.wtf/algorithmics/lsi/upc.edu/docs/Dasgupta-Papadimitriou-Vazirani.pdf>
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**Software Requirements/Installation:** Analysis of algorithms is a course that is steeped in theory. The focus in this course is not on the development of programs but rather understanding basic computer science concepts and as such this course will not require a lot of development with a programming language. This course does, however, present the implementation of data structures and basic algorithms through the use of pseudo code and java code. Several examples of algorithms will be implemented using Java programming. Although you can use any java compiler and IDE to develop your code, a good option that does not require any local installation of software is the Cloud9 IDE (Integrated Development Environment) which can be accessed at (<https://c9.io>). Using Cloud9, your algorithms can be executed directly from a Java enabled browser (including Google Chrome, Windows Internet Explorer, and Mozilla Firefox).

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### Learning Objectives and Outcomes:

By the end of this course students will be able to:

1. Articulate the characteristics and design of fundamental patterns of algorithms
2. Implement algorithms using the Java programming language
3. Understand the characteristics of the different algorithm designs including:
  - Brute Force
  - Backtracking
  - Branch and Bound

- Greedy
  - Divide and Conquer
  - Linear Programming
  - Dynamic Programming
4. Asymptotically analyze algorithms
  5. Describe and discuss theoretical computer science concepts such as hard problems, NP completeness, and the halting problem.
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**Course Schedule and Topics:** This course will cover the following topics in eight learning sessions, with one Unit per week. The Final Exam will take place during Week/Unit 9 (UoPeople time).

**Week 1: Unit 1** - Review of Data Structures and Algorithms

**Week 2: Unit 2** - Divide and Conquer Algorithms

**Week 3: Unit 3** - Graphs (Part 1)

**Week 4: Unit 4** - Graphs (Part 2)

**Week 5: Unit 5** - Dynamic Programming

**Week 6: Unit 6** - Linear Programming and Reductions

**Week 7: Unit 7** - Limits to Computation (Part 1)

**Week 8: Unit 8** - Limits to Computation (Part 2)

**Week 9: Unit 9** - Review and Final Exam

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**Learning Guide:** The following is an outline of how this course will be conducted, with suggested best practices for students.

#### **Unit 1: Review of Data Structures and Algorithms**

- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Make entries to the Learning Journal
- Take the Self-Quiz

#### **Unit 2: Divide and Conquer Algorithms**

- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Complete and submit the Programming Assignment
- Make entries to the Learning Journal
- Take the Self-Quiz

#### **Unit 3: Graphs (Part 1)**

- Peer assess Unit 2 Programming Assignment
- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Complete and submit the Programming Assignment
- Make entries to the Learning Journal
- Take the Self-Quiz

#### **Unit 4: Graphs (Part 2)**

- Peer assess Unit 3 Programming Assignment
- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Complete and submit the Programming Assignment

- Make entries to the Learning Journal
- Take the Self-Quiz
- Take the Graded Quiz

#### **Unit 5: Dynamic Programming**

- Peer assess Unit 4 Programming Assignment
- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Complete and submit the Programming Assignment
- Make entries to the Learning Journal
- Take the Self-Quiz

#### **Unit 6: Linear Programming and Reductions**

- Peer assess Unit 5 Programming Assignment
- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Make entries to the Learning Journal
- Take the Graded Quiz
- Take the Self-Quiz

#### **Unit 7: Limits to Computation (Part 1)**

- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Make entries to the Learning Journal
- Take the Self-Quiz

#### **Unit 8: Limits to Computation (Part 2)**

- Read the Learning Guide and Reading Assignments
- Participate in the Discussion Assignment (post, comment, and rate in the Discussion Forum)
- Make entries to the Learning Journal
- Take the Self-Quiz
- Read the Unit 9 Learning Guide carefully for instructions on the Final Exam
- Take the Review Quiz
- Complete and submit the anonymous Course Evaluation

#### **Unit 9: Course Review and Final Exam**

- Read the Learning Guide and take the Review Quiz, if you haven't already done so
- Prepare for, take, and submit the Final Exam
- The Final Exam will take place during Week/Unit 9 (UoPeople time); exact dates, times, and other details will be provided accordingly by your instructor

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### **Course Requirements:**

#### **Programming Assignments & Assessment Forms**

This course will require each student to complete five Programming Assignments. These assignments are designed to help the student bridge the gap between theory and practice. Each of the five assignments will require that the student implement the topic being explored, either in terms of a design or a working algorithm developed in the java language. You are required to submit your assignments by the indicated deadlines and, in addition, to peer assess three (3) of your classmates' assignments according to the instructions found in the Assessment Form, which is provided to you during the following week. During this peer assessment period, you are expected to provide details in the feedback section of the Assessment Form, indicating why you awarded the grade that you did to your peer. Failure to submit Written Assignments and/or Assessment Forms may result in failure of the course.

#### **Discussion Assignments & Response Posts/Ratings**

Some units in this course require that you complete a Discussion Assignment. You are required to develop and post a substantive response to the Discussion Assignment in the Discussion Forum. A substantive response is one that fully answers the question that has been posed by the instructor. In addition, you must extend the discussion by responding to at least three (3) of your peers' postings in the Discussion Forum

and by rating their posts. Instructions for proper posting and rating are provided inside the Discussion Forum for each week. Discussion Forums are only active for each current and relevant learning week, so it is not possible to contribute to the forum once the learning week has come to an end. Failure to participate in the Discussion Assignment by posting in the Discussion Forum and responding to peers as required may result in failure of the course.

**Learning Journal**

Your instructor may choose to assign specific topics and/or relevant questions as a weekly Learning Journal entry for you to complete, but you are still encouraged to also use it to document your activities, record questions/problems you may have encountered, reflect on the learning process, and draft answers for other course assignments. The Learning Journal must be updated on a weekly basis, because its entries will be assessed by your instructor directly as a part of your final grade. The Learning Journal will only be seen by your instructor.

**Quizzes**

This course will contain three types of quizzes – the Self-Quiz, the Graded Quiz, and the Review Quiz. These quizzes may contain multiple choice, true/false, or short answer questions. The results of the Self-Quiz will not count towards your final grade. However, it is highly recommended that you complete the Self-Quiz to ensure that you have adequately understood the course materials. Along with the Reading Assignments, the results of the Self-Quiz should be used as part of an iterative learning process, to thoroughly cover and test your understanding of course material. You should use the results of your Self-Quiz as a guide to go back and review relevant sections of the Reading Assignments. Likewise, the Review Quiz will not count towards your final grade, but should also be used to assist you in a comprehensive review and full understanding of all course material, in preparation for your Final Exam. Lastly, the results of the Graded Quiz will count towards your final grade.

**Final Exam**

The Final Exam will take place during the Thursday and Sunday of Week/Unit 9, following the completion of eight units of work. The format of the Final Exam is similar to that of the quizzes, and may contain a combination of different question types. You will have one attempt to take the exam, and it will be graded electronically. Specific instructions on how to prepare for and take the Final Exam will be provided during Week 8 (located inside the Unit 9 Learning Guide). Final Exams must be taken without the use of course learning materials (both those inside and outside the course). If particular materials are allowed for use during the exam, these will be noted in the exam’s instructions.

**Course Forum**

The Course Forum is the place to raise issues and questions relating to the course. It is regularly monitored by the instructors, and is a good place to meet fellow students taking the same course. While it is not required to participate in the Course Forum, it is highly recommended.

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**Course Policies:**

**Grading Components and Weights**

Each graded component of the course will contribute some percentage to the final grading scale, as indicated here:

|                        |             |
|------------------------|-------------|
| Learning Journals      | 10%         |
| Discussion Assignments | 20%         |
| Assignments            | 20%         |
| Two Graded Quizzes     | 20%         |
| Final Exam             | 30%         |
| <b>TOTAL</b>           | <b>100%</b> |

**Grading Scale**

This course will follow the standard 100-point grading scale defined by the University of the People, as indicated here:

| Letter Grade | Grade Scale | Grade Points |
|--------------|-------------|--------------|
| A+           | 98-100      | 4.00         |
| A            | 93-97       | 4.00         |
| A-           | 90-92       | 3.67         |
| B+           | 88-89       | 3.33         |
| B            | 83-87       | 3.00         |
| B-           | 80-82       | 2.67         |
| C+           | 78-79       | 2.33         |
| C            | 73-77       | 2.00         |
| C-           | 70-72       | 1.67         |

|    |          |      |
|----|----------|------|
| D+ | 68-69    | 1.33 |
| D  | 63-67    | 1.00 |
| D- | 60-62    | 0.67 |
| F  | Under 60 | 0.00 |

### **Grade Appeal**

If you believe that the final grade you received for a course is erroneous, unjust, or unfair, please contact your course instructor. This must be done within seven days of the posted final grade. For more information on this topic, please review the Grade Appeal Procedure in the University Catalog.

### **Participation**

Non-participation is characterized by lack of any assignment submissions, inadequate contributions to the Discussion Forums, and/or lack of peer feedback to Discussion/Written Assignments. Also, please note the following important points about course participation:

- Assignments must be submitted on or before the specified deadline. A course timeline is provided in the course schedule, and the instructor will specify deadlines for each assignment.
- Any student showing non-participation for two weeks (consecutive or non-consecutive) is likely to automatically fail the course.
- Occasionally there may be a legitimate reason for submitting an assignment late. Most of the time, late assignments will not be accepted and there will be no make-up assignments.
- All students are obligated to inform their instructor in advance of any known absences which may result in their non-participation.

### **Academic Honesty and Integrity**

When you submit any work that requires research and writing, it is essential to cite and reference all source material. Failure to properly acknowledge your sources is known as "plagiarism" – which is effectively passing off an individual's words or ideas as your own. University of the People adheres to a strict policy of academic honesty and integrity. Failure to comply with these guidelines may result in sanctions by the University, including dismissal from the University or course failure. For more information on this topic, please review the Academic Integrity Policy in the University Catalog.

Unless otherwise stated, any materials cited in this course should be referenced using the style guidelines established by the American Psychological Association (APA). The APA format is widely used in colleges and universities across the world and is one of several style and citation formats required for publication in professional and academic journals. Purdue University's Online Writing LAB (OWL) is a free website that provides excellent information and resources for understanding and using the APA format and style. The OWL website can be accessed here: [https://owl.purdue.edu/owl/purdue\\_owl.html](https://owl.purdue.edu/owl/purdue_owl.html)

### **Code of Conduct**

University of the People expects that students conduct themselves in a respectful, collaborative, and honest manner at all times. Harassment, threatening behavior, or deliberate embarrassment of others will not be permitted. Any conduct that interferes with the quality of the educational experience is not allowed and may result in disciplinary action, such as course failure, probation, suspension, or dismissal. For more information on this topic, please review the Code of Conduct Policy in the University Catalog.

### **Submitting Assignments**

Please note that accepted formats for assignments are Microsoft compatible format, PDF, or any other file format that is clearly specified in the course and activity instructions. These files should not be password-protected. Additionally, unless otherwise stated in assignment instructions, screenshots of computer coding, mathematical formulas or images with sentence structures (typed or in handwriting) are not allowed when you submit your assignments in this course.