**Comp Sci XXX – Introduction to Programming in Rust**

Welcome to Comp Sci 380 – Design & Analysis of Algorithms. Algorithms are the “Heart of Computer Science”. In CS 380, you will learn advanced techniques for designing algorithms that will allow you to tackle a wide range of the toughest problems in Computer Science. You will also learn how to analyze both the time and space complexity of algorithms so that you can make wise choices among alternative algorithms. We will conclude the course by looking at advanced issues in computational complexity (how inherently hard particular problems are to solve), parallel algorithms, and some advanced topics. Algorithms are not a “spectator sport”. One needs to engage and wrestle with them to truly understand and appreciate their power as well as to be able to create and apply them to solve problems. Thus, CS 380 is designed to be very hands-on and mentally-engaging. Your active participation will be essential to success in this course.

**Course Documents:**

Blackboard: <https://usafa.blackboard.com/>

**Course Text:**

Foundations of Algorithms, 5th Ed., Neapolitan, Jones & Bartlett Publishers, 2015

**Instructor Contact Information:**

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**Course Description:**

Comp Sci 380. Design and Analysis of Algorithms. 3(1). Advanced design and analysis of algorithms used in modern computing systems. Topics include analysis of algorithms, basic data structures, advanced abstract data types, recursion, computability and complexity. Problem solving and analytical skills are improved by examining the application of problem solving strategies to several problem domains with an emphasis on the impact of design decisions on algorithm performance. Concepts are reinforced by several programming exercises. Final exam. Prereq: Comp Sci 220 and (Math 340 or Math 474). Sem hrs: 3 Spring .

**Course Objectives:**

1. Analyze worst case and average case asymptotic running times of algorithms applying the results to selection of the most appropriate algorithm for specific applications.
2. Apply various algorithm design strategies including divide-and-conquer, greedy, backtracking, dynamic programming, and branch-and-bound.
3. Communicate the results of technical and ethical analysis to a general audience.
4. Analyze a technical scenario or argument for ethical considerations and conclusions.
5. Apply fundamentals of recursion and mathematical induction to the design and analysis of algorithms.
6. Classify a problem according to its complexity class (e.g., P, NP, NP-Complete, NP-Hard, and undecidable).
7. Describe the basic concepts, techniques, and strategies for parallel algorithm development and analysis.

**Course Policies:**

* Assignments are due at the start of class.
* Meeting deadlines is important; please do not submit late work without prior coordination.
* Except for extraordinary circumstances, **uncoordinated late work will be penalized at a rate of 25% for each 24-hour period past the on-time turn-in date and time**. The late penalty is a *cap* on the maximum grade that may be awarded for the late work.
* Focus is the key to efficiency and effectiveness; please dedicate class time to lesson activities; working on other pursuits during class is not acceptable.
* In order to motivate and track your engagement during lessons, 100 points (10% of course grade) is devoted to Lesson Participation. This includes being engaged and responsive in class as well as working through Lesson Exercises.
* Written communications and ethical reasoning comprise primary sub-goals of CS 380. We address these with two ethics papers as well as some lesson time. Please take these seriously.
* Grade lines will be as follows: A at 92%, A- at 90%, B+ at 88%, B at 82%, B- at 80%, C+ at 78%, C at 72%, C- at 70%, D at 60%
* We reserve the right to award bonus points for exceptional efforts.

**Graded Events**

|  |  |  |
| --- | --- | --- |
| Event Type | Number | Points |
| Homework | 8 (4) | 300 (150) |
| Graded Reviews | 4 (1) | 400 (100) |
| Ethics Papers | 1 | 50 |
| Final Exam | 1 | 250 |

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**Expectations**

* You have successfully made it through at least two years at the Academy. Soon you will be an officer in the United States Air Force shortly. I expect a level of professionalism and commitment commensurate with status and position that you have thus far earned.
* Come prepared for each and every class.
* Actively engage in class activities and discussions.
* Work well ahead of due dates.
* Complete each assignment neatly and professionally; sloppy work will likely receive zero credit.
* Seek assistance whenever needed; I am fully committed to helping you succeed!

**CS XXX – Introduction To Programming in Rust – Spring 2024**

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| **Lsn** | **Date** | **Reading** | **Topic** | **Assignments** |
| **1** | 1/8-9 | 1.1 - 1.2 | Introduction to Algorithms |  |
| **2** | 1/10-11 | 1.3 | Analysis of Algorithms |  |
| **3** | 1/12, 16 | 1.4 - 1.5 | Order of Magnitude Complexity |  |
| **4** | 1/17-18 | A.1–4 | Limit Theorem, Math Review |  |
| **5** | 1/19, 22 | B.1, B.3 | Recurrence Equations - Induction, Substitution |  |
| **6** | 1/23-24 | B.2.1 | Recurrence Equations - Linear, Homogeneous | HW1 (25 pts, Lsns 1-4) |
| **7** | 1/25-26 | B.2.2 | [Recurrence Equations - Linear, Non-Homogeneous](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn09) |  |
| **8** | 1/29-30 | B.4 | [Recurrence Equations - Master Theorem](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn10) |  |
| **9** | 1/31, 2/1 | 2.1 - 2.2 | [Divide-and-Conquer](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn11) - Coins Problem, Merge Sort | HW2 (25 pts, Lsns 5-8) |
| **10** | 2/2, 5 | 2.3 | [Divide-and-Conquer](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn12) - Trominos |  |
| **11** | 2/6-7 | 2.4 | [Divide-and-Conquer](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn13) - Analysis and Thresholds |  |
| **12** | 2/8-9 | 3.1 - 3.2 | [Dynamic Programming](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn15) - Binomial Coefficients |  |
| **13** | 2/12-13 | 3.3 | [Dynamic Programming](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn17) - Floyd’s Algorithm | HW3 (50 pts, Lsns 9-11) |
| **14** | 2/14-15 | [**Graded Review #1 (Lessons 1-11)**](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn16) | | |
| **15** | 2/16, 20 | 3.4 | [Dynamic Programming](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn18) – Chained Matrix Multiply |  |
| **16** | 2/21-22 | 3.5 | [Dynamic Programming](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn19) - Optimal Binary Trees |  |
| **17** | 2/26-27 | 3.6 | [Dynamic Programming](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn20) - Traveling Salesman Problem |  |
| **18** | 2/28-29 | 4.1 | [Greedy Method](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn21) - Spanning Trees | HW4 (50 pts, Lsns 12-17) |
| **19** | 3/1, 4 | 4.2 | [Greedy Method](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn21) - Dijkstra’s Single Source Shorts Paths |  |
| **20** | 3/5-6 | 4.4 | [Greedy Method](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn21) - Huffman Codes |  |
| **21** | 3/7-8 | 4.5 | Greedy vs. Dynamic Programming & 0-1 Knapsack |  |
| **22** | 3/11-12 | 5.1 - 5.2 | [Backtracking](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn25) - N Queens | HW5 (50 pts, Lsns 18-21) |
| **23** | 3/13-14 | [**Graded Review #2 (Lessons 12-21)**](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn16) | | |
| **24** | 3/18-19 | 5.5 | [Backtracking](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn26) - Graph Coloring |  |
| **25** | 3/20-21 | 5.6 | [Backtracking](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn27) - Hamiltonian Circuits |  |
| **26** | 3/22-4/1 | 5.7 | [Backtracking](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn27) - 0-1 Knapsack |  |
| **Spring Break (23-31 March)** | | | | |
| **27** | 4/2-3 | 6.1 | [Branch-and-Bound](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn30) - 0-1 Knapsack Problem |  |
| **28** | 4/4-5 | 6.2 | [Branch-and-Bound](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn31) - Traveling Salesman Problem |  |
| **29** | 4/8-9 | 7.1, 7.8 | [Computational Complexity](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn32) | HW6 (50 pts, Lsns 22-28) |
| [**30**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Lesson%20Materials\Lsn35-MS-Access-Demo.accdb) | 4/10-11 | [**Graded Review #3 (Lessons 22-28)**](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn16) | | |
| [**31**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Assignments\Demo.php) | 4/12, 15 | 9.1 - 9.3 | [Computational Complexity - Intro to NP](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn34) |  |
| [**32**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Assignments\Demo.php) | 4/16-17 | 9.4 | [Computational Complexity - NP-Complete](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn35) |  |
| [**33**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Lessons\Lsn30-Indexing.docx) | 4/18-19 |  | [Computational Complexity - NP-Complete](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn35) Reductions |  |
| [**34**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Lessons\Lsn31-Transaction-Processing.docx) | 4/22-23 |  | Ethics Lesson - Traveling Salesman - The Movie |  |
| [**35**](http://www.w3schools.com/php/php_mysql_delete.asp) | 4/24-25 | 12.1 | [Parallel Algorithms](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn38) - Models and Interconnections | HW7 (25 pts, Lsn 29-33) |
| [**36**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Assignments\CS364_PEX3_S11_Part1.docx) | 4/29-30 |  | [Parallel Algorithms](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn39) – Task Graphs, Map/Reduce | Ethics Essay (50 pts) |
| [**37**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Lesson%20Materials\Lsn35-MS-Access-Demo.accdb) | 5/1-2 | 12.2 | [Parallel Algorithms](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn39) - PRAM CRCW |  |
| [**38**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Assignments\CS364_PEX3_S11_Part1.docx) | 5/3-6 |  | DNA Storage & Computing, Quantum Computing | HW8 (25 pts, Lsns 35-37) |
| [**39**](file:///\\eim.usafa.edu@SSL\DavWWWRoot\academics\compsci\cs364\Shared%20Documents\Lesson%20Materials\Lsn35-MS-Access-Demo.accdb) | 5/7-8 | [**Graded Review #4 (Lessons 29-37)**](https://eis.usafa.edu/academics/compsci/CS380/Shared%20Documents/Lsn16) | | |
| **40** | 5/9-10 |  | Course Review and Critiques, Final Exam Prep |  |
| **Final Exams**  **Details to Follow** | | | | |

**Last Updated: 12/5/2023**