CSCI332:

Basie Data Structures and Algorithms

Course Intro, Syllabus, and Logistics

Reese Pearsall Spring 2025

https://www.cs.montana.edu/pearsall/classes/spring2025/232/main.html



To start things off, we are going to take a brief look at some of problems we are going to tackle in CSCI 232

We are going to find a **cave** and go **treasure hunting**



(x,y)

Given *n* cave entrances, where each cave entrance has an x,y coordinate, find the pair of caves with the smallest distance between them

> (You can assume no caves have the same x or y values)





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Algorithm?







(You can assume no caves have the same x or y values)

Algorithm ? $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$



	C1	C2	С3	•••	С9
C1	/	D(1,2)	D(1,3)	•••	D(1,9)
C2	D(2,1)	/	D(2,3)	•••	D(2,9)
С3	D(3,1)	D(3,2)	/	•••	D(3,9)
•••	•••	•••	•••	•••	
С9	D(9,1)	D(9,2)	D(9,3)	•••	/



(x,y)



	C1	C2	С3	•••	С9
C1	/	D(1,2)	D(1,3)	•••	D(1,9)
C2	D(2,1)	/	D(2,3)		D(2,9)
С3	D(3,1)	D(3,2)	/	•••	D(3,9)
•••					
С9	D(9,1)	D(9,2)	D(9,3)	•••	/

Basic solution:

- 1. Compute distance for each pair
- 2. Select smallest







	C1	C2	С3	•••	С9
C1	/	D(1,2)	D(1,3)	•••	D(1,9)
C2	D(2,1)	/	D(2,3)	•••	D(2,9)
C3	D(3,1)	D(3,2)	/	•••	D(3,9)
C9	D(9,1)	D(9,2)	D(9,3)	•••	/

Basic solution:

- 1. Compute distance for each pair
- 2. Select smallest

Running time = ?





	C1	C2	С3	•••	С9
C1	/	D(1,2)	D(1,3)	•••	D(1,9)
C2	D(2,1)	/	D(2,3)	•••	D(2,9)
C3	D(3,1)	D(3,2)	/	•••	D(3,9)
				•••	••••
C9	D(9,1)	D(9,2)	D(9,3)	•••	/

Basic solution:

- 1. Compute distance for each pair
- 2. Select smallest

Running time = ?

Running time = $O(n^2)$

n = # of caves







Now things get a bit messier. Our table is going to much larger, and will take more time to compute





Algorithms

Remember, we are concerned with our algorithm performs **as some input** *n* **grows**











There are several ways to get there!





There are several ways to get there!

Cost: 23 (3 + 7 + 5 + 8)





There are several ways to get there!

```
Cost: 19 (2 + 14 + 3)
```





There are several ways to get there!

What is the shortest path from start to finish?





There are several ways to get there!

What is the shortest path from start to finish?

Brute Force?





There are several ways to get there!

What is the shortest path from start to finish?

Brute Force?

Brute forcing every possible path is **not feasible** (ie exponential or factorial time) It is ok for this map, but we want our approach to work on every possible map











How should they explore this cave? What are the different ways they could explore it?



We have now reached the cave, but the cave consists of many complex tunnels

How should they

ways they could

explore it?



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Explore each level before going to the next layer below



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How should they explore this cave?

What are the different ways they could explore it?



<u> 济济济</u>





Go as far as you can before you backtrack



Carp Carp Carp



Go as far as you can before you backtrack

This may be the better approach if we <u>know</u> the thing we are looking for is <u>deep</u> in the cave



We have now reached the cave, but the cave consists of many complex tunnels

济济济





Explore each level before going to the next layer below

Go as far as you can before you backtrack



We have now reached the cave, but the cave consists of many complex tunnels





Tree Traversal Methods

Explore each level before going to the next layer below

Go as far as you can before you backtrack





We have reached the treasure room, but there is much more treasure than our backpack can fit

We must pick what treasure we want to take !





Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack









Goal: Steal items such that we **maximize the value** of items being stole, while **not overfilling our backpack**





Our backpack can only fill 10 pounds









Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack





Our backpack can only fill 10 pounds









Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack





Our backpack can only fill 10 pounds





Stuff our backpack with the most expensive items until we can't fit anymore





We are going to steal some items fand put them into our backpack

Each item has a weight, and a value

Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack



Algorithm?

Stuff our backpack with the most expensive items until we can't fit anymore





Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack







Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack



Is this the **optimal** solution?

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We are going to steal some items fand put them into our backpack Each item has a weight, and a value

Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack

Is this the **optimal** solution?

Value: Weight:

Our backpack can only fill 10 pounds





We are going to steal some items fand put them into our backpack Each item has a weight, and a value

Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack





Our backpack can only fill 10 pounds Is this the **optimal** solution?

Value: 55 Weight: 10





We are going to steal some items fand put them into our backpack

Each item has a weight, and a value

Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack







We are going to steal some items fand put them into our backpack Each item has a weight, and a value

Goal: Steal items such that we maximize the value of items being stole, while not overfilling our backpack



Our backpack can only fill 10 pounds

Optimization



Suppose we want to keep a record of which person has which treasures, ie a ledger





Suppose we want to keep a record of which person has which treasures, ie a ledger





CSCI 232





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• Code (a lot) (in Java)





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 Learn about more data structures we can use in our programs (and tradeoffs)





• Code (a lot) (in Java)

 Learn about more data structures we can use in our programs (and tradeoffs)

 Learn about more strategies/types of algorithms to solve problems





• Code (a lot) (in Java)

• Learn about more **data structures** we can use in our programs (and tradeoffs)

- Learn about more strategies/types of algorithms to solve problems
- Be able to formally detail the performance of an algorithm and identify factors limiting that performance









Pros	Cons
 Cheap Precise No Training Availability 	SlowLabor
FastLabor	ExpensiveTraining
 Really good at digging 	 Takes up a lot of garage space

Each tool has their pros, cons, and **tradeoffs**



Pros	Cons	
CheapPreciseNo TrainingAvailability	SlowLabor	Best tool for the job? Digging a Well for water
FastLabor	ExpensiveTraining	
 Really good at digging 	 Takes up a lot of garage space 	





What do you need to dig a hole?







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We can't use the best tool for the job unless we know <u>how to use</u> that tool



CSCI 232- Data Structures and Algorithms

- "Tools"
- Arrays
- Linked Lists
- Stacks/Queues
- Hash Tables
- Trees
- Graphs

"Use of tools"

- Sorting
- Searching
- Routing
- Optimization

A data structure is a mechanism for storing and organizing data

An **algorithm** is a series of instructions to be followed to solve some problem



This class is **critical**

- Learn important set of tools to solve problems
- Become autonomous programmers, no more hand holding
- All other CS classes build on this*
- Job interview questions use stuff from this class
- I want this class to challenge you !







Reese Pearsall (pierce-all)

Third year Instructor @MSU **B.S & M.S @ MSU**

Interests

- Cybersecurity •
- Malware analysis and • detection
- Cybercrime •
- **Computer Science** Education

Hometown

Teaching

- **CSCI 132**
- **CSCI 232**
- **ESOF 422**

Favorite Fast Food

- Blaze Pizza •
- **McDonalds** •

Experience

- Software Engineer and Tester, Techlink (Bozeman)
- Software Engineer, United States Air Force (Hill AFB, Utah)
- Cybersecurity Software Engineer, Hoplite Industries (Bozeman)
- Graduate Researcher, MSU (Bozeman)

Outside of academia

Video games, New England Patriots, Fantasy Football, TikTok (rip), Dr Pepper, Memes, The Bachelor, Naps

You can just call me "Reese" 🙂

Billings, MT











How it feels to have class canceled because the professor is experiencing ahorrible event



There may be a time I have to cancel class due to feeling unwell

I will always announce ahead of time if a class is cancelled (email, D2L announcement, Discord)





Contact

Email: reese.pearsall@montana.edu (I will respond as soon as I can)

Office Hours: Tuesday, Wednesday and Friday 12:00 PM – 1:00 PM

Office: Barnard Hall 361



I am also very responsive on Discord! (@reese_p)



College Student @CollegeStudent 2+

Emailing professors be like

Me: *polite greeting, multiple paragraphs, perfect grammar*

Professor: "sure" -sent from my iPhone 2:55 PM · 15 Oct 16

16K RETWEETS 31.5K LIKES









Course Logistics (Lecture)

<u>Class Meetings</u> TR: 10:50 AM – 12:05 PM Barnard Hall 103

- All lectures will be recorded and posted on the course website (coming to class is still a good idea)
- We will be doing lots of live coding during lecture, so it might be helpful if you bring your own laptop to class (if you would like to code along)

• Please be respectful and considerate of your classmates siting around you



when I go to uni on 2h of sleep and the professor doesnt take attendance





Course Logistics (Lab)

Section 003- Fridays 10:00 - 11:50 AM
Section 004- Fridays 12:00 - 2:00 PM
Section 005- Fridays 2:10 - 4:00 PM

Locations: Roberts 111

- You can go to lab and get help from your TA and lab assistants
- Lab attendance is optional
- Lab assignments will be posted a few days before Fridays and can be completed from home.
- You can attend a different lab section earlier/later in the day if you would like





Course Logistics

You will be visiting this website a lot... be sure to bookmark it!

https://www.cs.montana.edu/pearsall/classes/spring2025/232/main.html

CSCI 232: Data Structures and Algorithms 📃				Discord server!				
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Tuesday January 14th	<u>Syllabus</u> + Course Intro			Please Fill out the Cou	Ress Ressall 10/00/2023 54 PM ggwp Glad you enjoyed it		nickname to your nan	ne el Moiyad A. (466). Ind over metter. 1 Simpson (347 47
Thursday January 16th	Java Review			+ 0-536-556-556-5735+ # announcements	(the class; not the exam) Try not to stress too much about it. Rememebe	r that there will be a good chunk of extra credit getting added to everyone's exam scores 😔 Bucenier 13		😪 Andrew Fallin (476)
Friday January 17th	NO LAB (Get IDE Installed)			# 366-general 부 windows-compiling # oue-compiling	Prad D 15/15/2022 818/94 the research project still hasn't been graded rig just making sure hele			Angelo P
Tuesday January 21st	Stacks, Queues, Linked Lists			- CSO-475- COMPUTER-SECURITY + # announcements # 476-general & @	correct:) bould be graded sometime in the next few day			e Armand carrantetee
Thursday January 23rd	Trees			- csci-to2-toC-bath-streucture+ # announcements # 132-general	Reese Pearsall Yesterday at 600 PM			baljeet
Friday January 24th	Lab 1 (Java)			- CSC-446-METWORKS + # announcements ## 466-mercent	https://www.cs.montana.edu/pearsall/classes/			Boomer
Tuesday January 28th	Trees			+ voig provident # # find-u-partner - csc+-4-0-spen-internet.c-pt+	Jeremy H. Tuey et TAD AH @Reese Pearsall Will this class be available ful @ Avereny H. @Reese Pearsall Will this class be available @ Avereny H. @Reese Pearsall Will this class be available			Brooks Palin CELETE FROM uners WHERE Brook Lahnen (145, 35
Thursday January 30th	Tree Traversal			## announcements ## 443-gammal ## find-a-partner-if-you	Yepi All the lectures will be recorded again. Eve 1 so you can do this class 100% from home if you	n better, however, is that there won't be an in-person final this semester 😳 really want to (although I still highly encourage you to go to lectures)		Byron Norman
Friday January 31st	Lab 2 (Trees)			- csc- to-400-0474-01000100 - +		n bann Than an Bhuann ta Addaeach Feill badd anna rean ann an brithnigd		A <i>a a a b b b b b b b b b b</i>
Tuesday February 4th	Binary Search Trees					Get 232	notifications	
						by typing] !join-232	

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Vou alao will pood to join our

Course Questionnaire

Please take some time this week to fill out the course questionnaire ③

Spring 2025- CSCI 232 Course Questionnaire

This information will help me get to know you better and your experience with various tools and topics

Sign in to Google to save your progress. Learn more

* Indicates required question

What is your email address? (I will use this email if I need to contact you) *

Your answer

Please tell me your FIRST name as it appears in MSU's system *

Your answer

Please tell me your LAST name as it appears in MSU'S system *

Your answer

What is your PREFERRED name (your name as you like to be called) *



Prerequisites

- CSCI 132- Basic Data Structures and Algorithms (Required)
- CSCI 246- Discrete Structures (Recommended)

You will be totally fine if you have taken CSCI 246

Before taking this class, you should feel comfortable basic Java programming, be comfortable using the following data structures: arrays, linked lists, stacks, queues, be comfortable with basic recursion, and how to analyze an algorithm using big-O notation

(If you are not familiar with any of this stuff, you should take some time to review it this week. My CSCI 132 course is available and may be helpful)



Textbook

•(Optional) Algorithms (4th Edition) by Sedgewick and Wayne.



Can you guys please recommend books that made you cry?





Books > Computers & Technology > Programming



Algorithm	s <mark>(</mark> 4th E	dition) 4th Edition	
by Robert Sedgewick	c (Author), Kevi	n Wayne (Author)	
4.7 ★★★★☆ ~	795 ratings	4.4 on Goodreads 1,748 ratings	

This fourth edition of Robert Sedgewick and Kevin Wayne's Algorithms is the leading textbook on algorithms today and is widely used in colleges and universities worldwide. This book surveys the most important computer algorithms currently in use and provides a full treatment of data structures and algorithms for sorting, searching, graph processing, and string processing--including fifty algorithms every programmer should know. In this edition, new Java implementations are written in an accessible modular programming style, where all of the code is exposed to the reader and ready to use.

The algorithms in this book represent a body of knowledge developed over the last 50 years that has become indispensable, not just for professional programmers and computer science students but for any student with interests in science, mathematics, and engineering, not to mention students who use computation in the liberal arts.

The companion web site, algs4.cs.princeton.edu, contains

- An online synopsis
- Full Java implementations

✓ Read more

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Data Structures and Algorithms in Java (2nd Edition) 2nd Edition by Robert Lafore ~ (Author) 會會會會會 → 114 customer reviews



unfortunately, a very relatable meme

This textbook is **not** required (but it does have tons of great stuff!!)



- 35% Labs (10 @ ~3.5% each)
- 45% Programs (5 @ 9% each)
- 20% Quizzes (3 @ 6.67% each)



Labs (35%)

- Shorter, weekly assignments.
- Can generally be finished within 1-2.5 hours
- Due on Friday nights @ 11:59 PM
- I will post the labs a few days ahead of time
- You are usually given starting code
- You should be able to finish within your 2hr lab time
- Individual submissions



Programs (45%)

- Longer, more complicated programming assignments
- Will likely take 2+ hours to complete
- You will always have 2-3 weeks to complete them
- Write code from scratch
- Much higher stakes, make sure you give yourself plenty of time to complete them
- You can get help from your TA during lab time, or office hours, or from Reese, or on Discord
- You are allowed to work with 1 partner



Quizzes (20%)

- There will be three quizzes this semester (Friday 2/28, 3/28, 4/25)
- They are taken online through Brightspace/D2L (autograded)
- Conceptual questions
- → Multiple Choice
- → True False
- → Matching



- You **must** take the quiz in Roberts Hall 111 (You can bring your laptop). You **must** attend the lab section that you are registered for.
- The TAs will be keeping track of who has come/left Roberts 111
 → If you take the quiz from home, you quiz grade will face a harsh penalty



Grading Deductions/Late assignments

- If you submit late, but you are within < 24 of the original. You will face a -25% penalty
- If you submit late, but you are within < 48 of the original. You will face a -50% penalty

Any assignment submitted 48+ hours after the deadline will **not** be accepted

You must submit code that **compiles**. Code that does not compile will receive an automatic 0%.

If your code compiles and runs, but doesn't work, or has **runtime errors** later on, that is ok.

Your TA or I should not need to fix your code in order for it to compile and run





LeetCode

We will be looking at and solving **LeetCode** problems throughout the semester.

LeetCode is a website that helps people enhance their coding skills and prepare them for coding interviews.

LeetCode is a great way to get better at programming, and many of the *thousands* of coding problems are very related to CSCI 232 !

If you create a LeetCode account and solve at least 2 problems, you will earn 1% added to your final grade!

Exact submission details tbd


Grading Scale

- 93+: A
- 90+: A-
- 87+: B+
- 83+: B
- 80+: B-
- 77+: C+
- 73+: C
- 70+: C-
- 67+: D+
- 63: D
- 60: D-

At the end of the semester, if you are

- within 1% of the next letter grade, I will
- bump you up
- I will not curve exams or final grades
- unless it is needed



in college you gotta get over L's real quick because the next one is due at 11:59



IDE

You will need to download an IDE that you can write Java programs in

- Eclipse (I will use this one)
- Netbeans
- IntelliJ





Academic Misconduct



You are **not** allowed to submit something that is not your own, and you are **not** allowed to steal solutions from another person and modify it

I have a Chegg and Course Hero membership. **Don't try it**

Do not use any tools or Al that will write code for you Using small snippets of code from the internet is acceptable *(but should not be needed).* If you do use a small snippet of code from the internet, you should leave a reference as a comment in your code



Collaboration Policy

All labs will be individual submissions. For programs, you are allowed to work with **one** partner.

When it comes to labs, you may

- Share ideas with other students in the class.
- Work together on labs in the same physical location.
- Help other students troubleshoot problems.
- Give hints or provide textbook page numbers/slide numbers to students seeking help

You may NOT

- Share your code and solutions directly with other students.
- Submit solutions that you did not write.
- Modify another student's solution and claim it as your own.
- · Share your report or solutions directly on Discord



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Additional MSU Resources:

https://www.cs.montana.edu/pearsall/classes/msu_resources.html

Diversity Statement

Montana State University's campuses are committed to providing an environment that emphasizes the dignity and worth of every member of its community and that is free from harassment and discrimination based upon race, color, religion, national origin, creed, service in the uniformed services (as defined in state and federal law), veteran's status, sex, age, political ideas, marital or family status, pregnancy, physical or mental disability, genetic information, gender identity, gender expression, or sexual orientation. Such an environment is necessary to a healthy learning, working, and living atmosphere because discrimination and harassment undermine human dignity and the positive connection among all people at our University. Acts of discrimination, harassment, sexual misconduct, dating violence, domestic violence, stalking, and retaliation will be addressed consistent with this policy.

Inclusivity Statement

I support an inclusive learning environment where diversity and individual differences are understood, respected, appreciated, and recognized as a source of strength. We expect that students, faculty, administrators and staff at MSU will respect differences and demonstrate diligence in understanding how other peoples' perspectives, behaviors, and worldviews may be different from their own.

Counseling

In addition to eating right, taking breaks when you need them, and getting enough sleep, you may benefit from talking to a professional counselor if you think stress could be impacting your health. Here is a blurb and some links from MSU's Counseling & Psychological Services: MSU strives to create a culture of support and recognizes that your mental health and wellness are equally as important as your physical health. We want you to know that it's OK if you experience difficulty, and there are several resources on campus to help you succeed emotionally, personally, and academically:

- Counseling & Psychological Services: montana.edu/counseling
- Health Advancement: montana.edu/oha
- Insight Program (Substance Use): montana.edu/oha/insight
- Suicide Prevention: montana.edu/suicide-prevention
- · Medical Services: montana.edu/health/medical.html
- WellTrack: montana.welltrack.com/register

Civil Rights

There should be no discrimination or harassment for anyone at MSU. If you notice anything that seems to violate that principle, the Office of Institutional Equity can help. As an employee of MSU, I am a mandatory reporter, which means if I learn of any discrimination or harassment at MSU, I am obligated by my contract to report it.

Hamilton Hall, Offices 114, 116, and 118



"Not everyone can become a great artist, but a great artist can come from anywhere"



How to do well in this class

- Get help when you need it
- Lock in
- Get started on assignments early (especially programs)!
- Come to class and office hours

• Take care of yourself



♦ eve ♦ @impossiblyeve · 1h
professors say s like "u can't write this the night before" and then i do it anyway





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How to do well in this class

- Get help when you need it
- Lock in
- Get started on assignments early (especially programs)!
- Come to class and office hours

- Take care of yourself
- Try to have fun

I am here for you, and I am willing to do whatever it takes to help you succeed!



	+ eve +
	profess
	anyway

we @impossiblyeve · 1h fessors say s like "u can't write this the night before" and then i do it way

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Questions?

Meatball wishes you good luck on this upcoming semester

