An Introduction to Algorithms

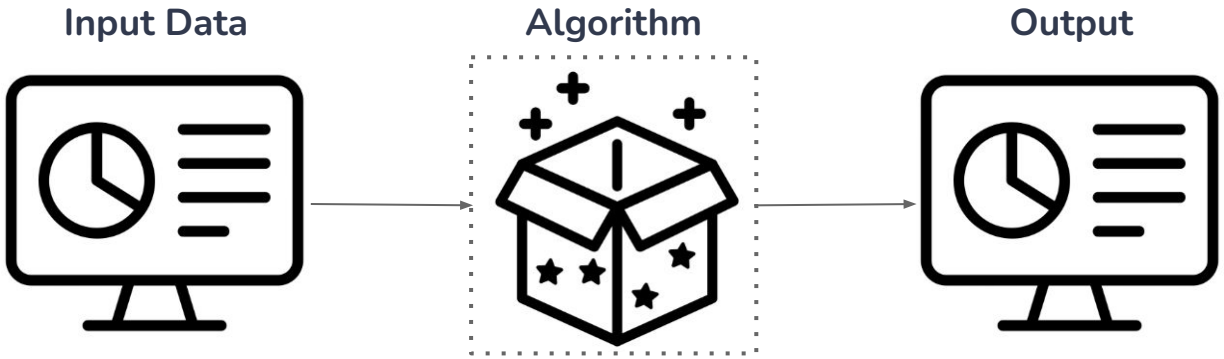
CS/MCS 401: Computer Algorithms 1
Lecture 1
Professor: Jonathan Liu

Sit next to someone! If you don't now, you'll have to move later.

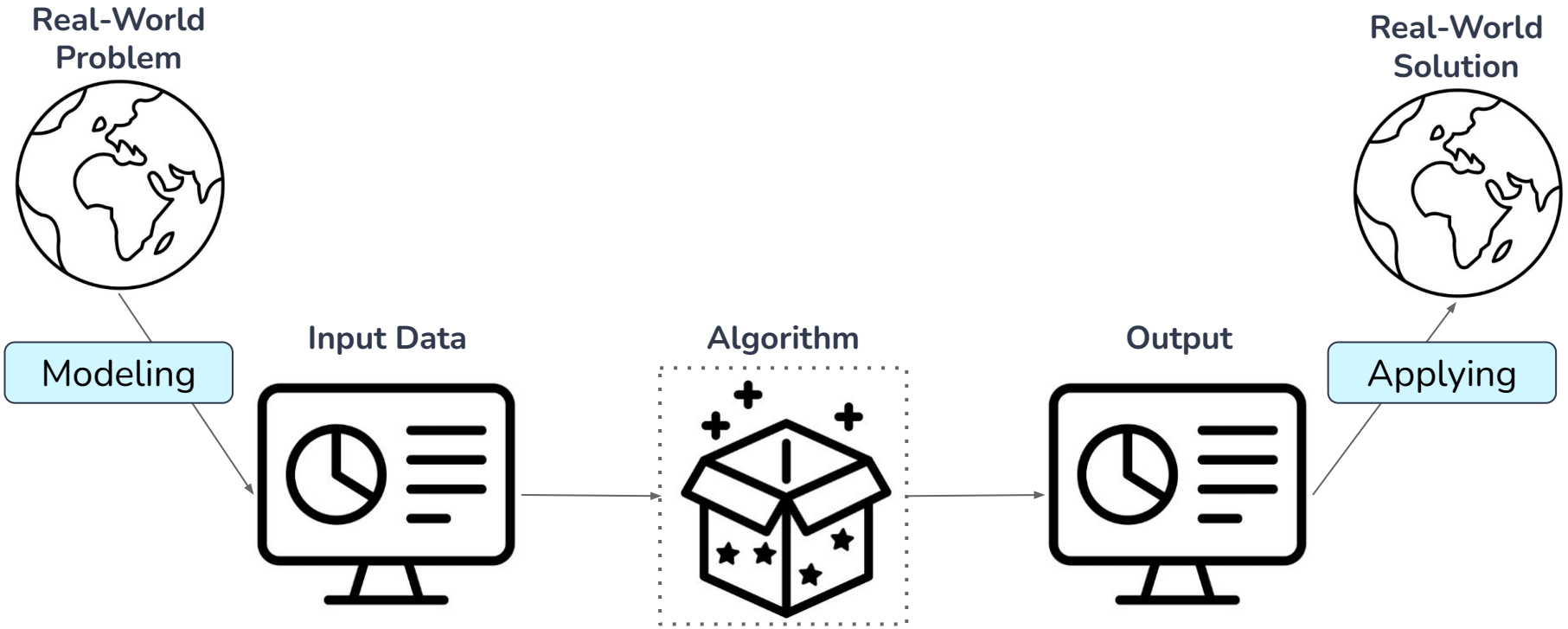
Introduce yourself!
Icebreaker: What are you looking forward to this semester?

What are we doing in this class?

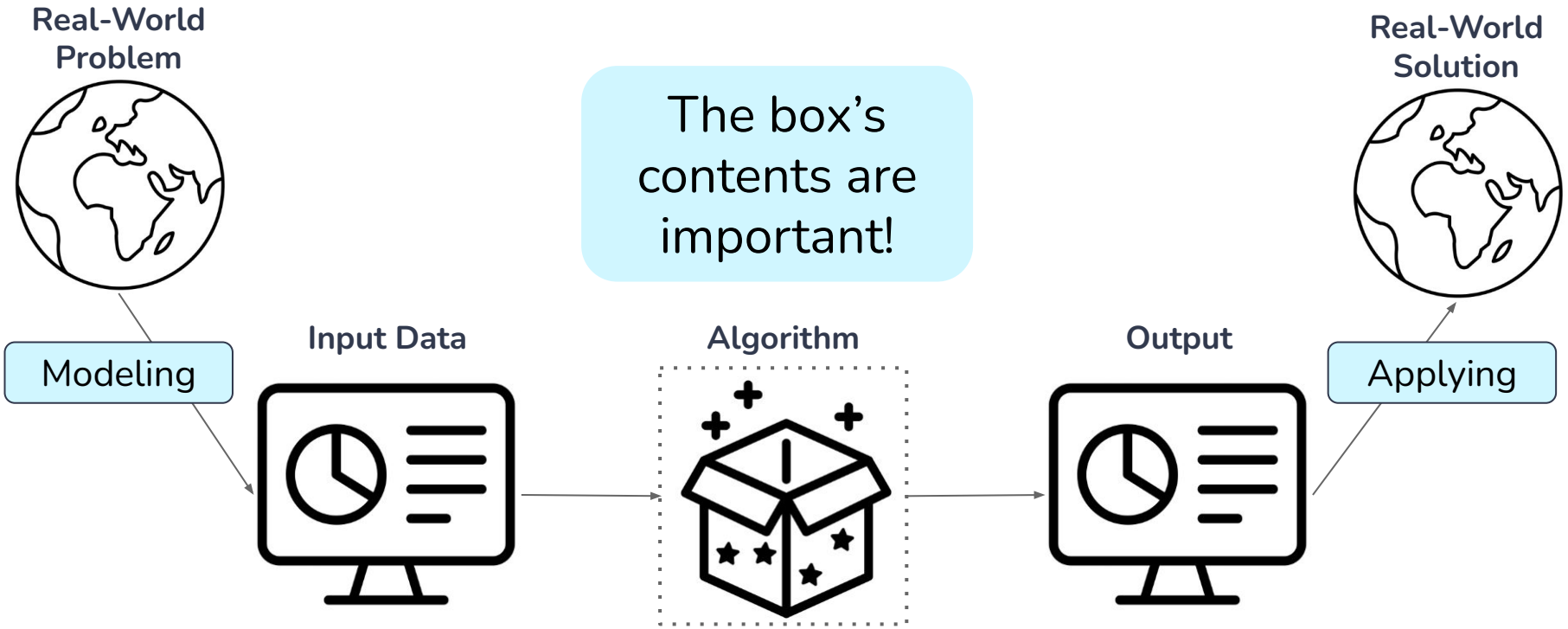
Algorithms as Solving Real World Problems



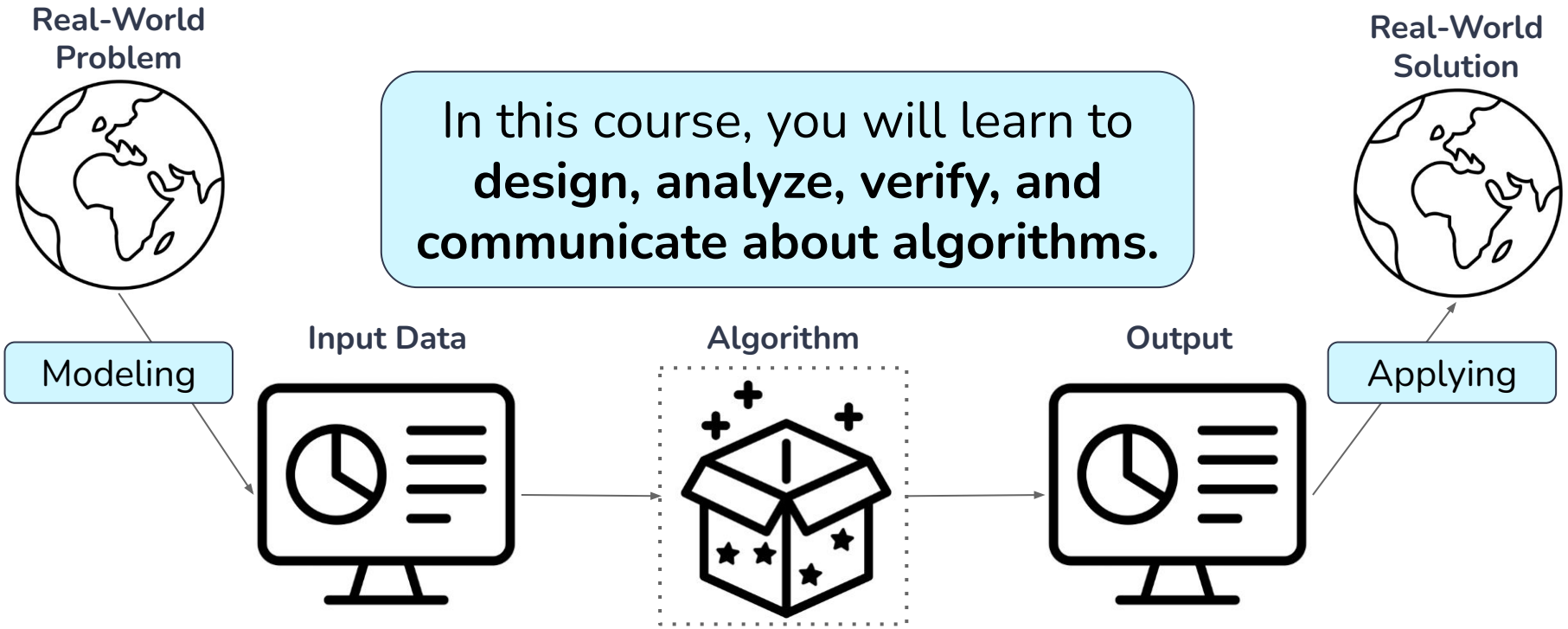
Algorithms as Solving Real World Problems



Algorithms as Solving Real World Problems



Algorithms as Solving Real World Problems



10 Example “Real-World” Problems

And by “real-world,” I mean your ice cream shop.

Problem 1: Truck Balancing

You have many cartons of ice cream, each of which has a different weight. You have two trucks, and you want to put the same weight of ice cream on each truck.

Problem Modeling

What is the input data?

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Problem Modeling

What is the input data?

An array of weights.

What is the output data?

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Problem Modeling

What is the input data?

An array of weights.

What is the output data?

Two arrays whose sums are as close to one another as possible.

Problem 1: Truck Balancing

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Problem Modeling

Input: An array of weights.
Output: Two arrays whose sums are as close to one another as possible.

Question:

If you have 100 cartons, how many different configurations are there?

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Problem Modeling

Input: An array of weights.
Output: Two arrays whose sums are as close to one another as possible.

Question:

If you have 100 cartons, how many different configurations are there?

Approximately 2^100. For the fastest supercomputer in the world, it'd take at least 40000 years to try them all.

Problem 1: Truck Balancing

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Problem Modeling

Input: An array of weights.
Output: Two arrays whose sums are as close to one another as possible.

Applying

What have we lost by modeling it this way?

Problem 2: Opening Hours

You've run the numbers, and you know the profits your ice cream shop will gain being open at each hour of the day. Some are positive, and some are negative. Your shop needs to be open for consecutive hours, and at least 4 hours per day. Find the set of hours that you should be open.

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An array of profits, one entry per hour.

What is the output data?

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Problem Modeling

What is the input data?

An array of profits, one entry per hour.

What is the output data?

The hours you should be open to maximize profit.

Problem 3: One-Way Roads

You're driving an ice cream truck, trying to get to your next stop. Ice Cream Trucks have the privilege of going the wrong way on a one-way street, but you don't want to use that too often. Find the shortest path that goes the wrong way on at most two one-way streets.

Problem Modeling

What is the input data?

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Problem Modeling

What is the input data?
A graph with some one-way streets.

What is the output data?

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Problem Modeling

What is the input data?
A graph with some one-way streets.

What is the output data?
The shortest path that uses at most two one-way streets.

Problem 4: Employee Coverage

Your ice cream shop has a number of applicants, each of whom can work for a different set of hours. Find the minimum number of employees you need to hire in order to ensure that, every hour you're open, there's someone who can work at that time.

Problem Modeling

What is the input data?

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Your ice cream shop has a number of applicants, each of whom can work for a different set of hours. Find the minimum number of employees you need to hire in order to ensure that, every hour you're open, there's someone who can work at that time.

Problem Modeling

What is the input data?

One time interval per applicant

What is the output data?

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Your ice cream shop has a number of applicants, each of whom can work for a different set of hours. Find the minimum number of employees you need to hire in order to ensure that, every hour you're open, there's someone who can work at that time.

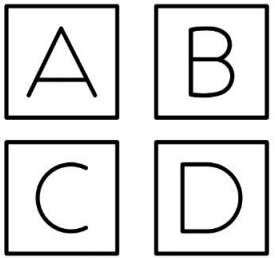
Problem Modeling

What is the input data?
One time interval per applicant

What is the output data?
The minimum number of applicants to hire to ensure that every open hour can be covered.

Problem 5: Sign Editing

You need to update your block-letter storefront sign with your new promotion. Every letter added or removed takes some time. Find the minimum number of additions and removals that need to be made to update the sign.



Problem Modeling

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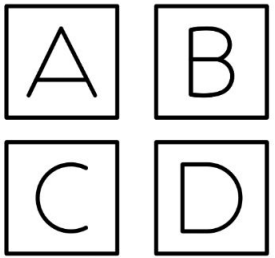

Problem Modeling

What is the input data?
The current message and the desired new message.

What is the output data?

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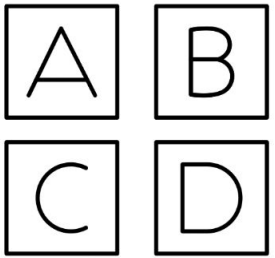


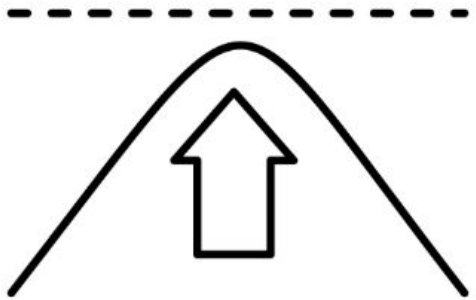
Problem Modeling

What is the input data?
The current message and the desired new message.

What is the output data?
The minimum number of additions and removals needed to update the sign.

Problem 6: Peak-Finding

You want to find one of your ice cream shop's best days to figure out what went well. You have a list of your profits for each day. Find a day where profits peaked: where they were lower both the day before and the day after.



Problem Modeling

What is the input data?

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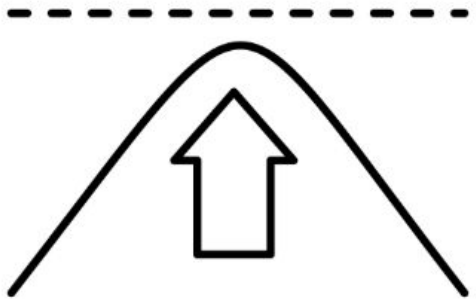

Problem Modeling

What is the input data?

An array of your profits for each day.

What is the output data?

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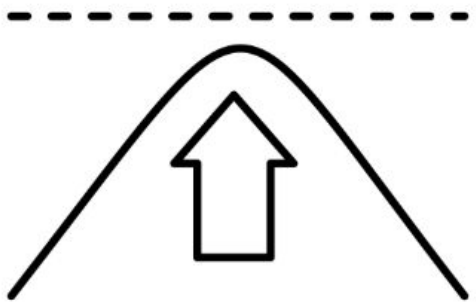


Problem Modeling

What is the input data?

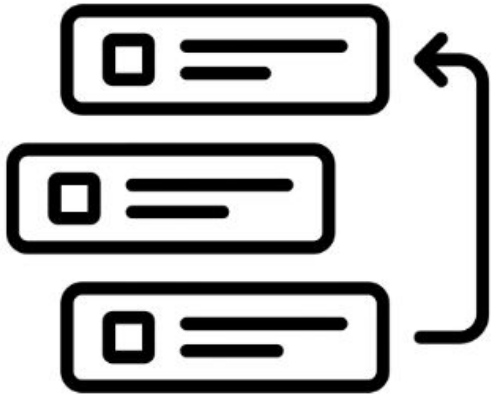
An array of your profits for each day.

What is the output data?

The index of any day where profits peaked.

Problem 7: Order Ordering

Your ice cream shop suddenly got a bunch of online orders at once. The orders take different amounts of time to make and have different requested pickups times. Unfortunately, because there are so many orders, some people will have to pick up later than they hoped. Find the order in which you should make the orders to minimize the total delay.



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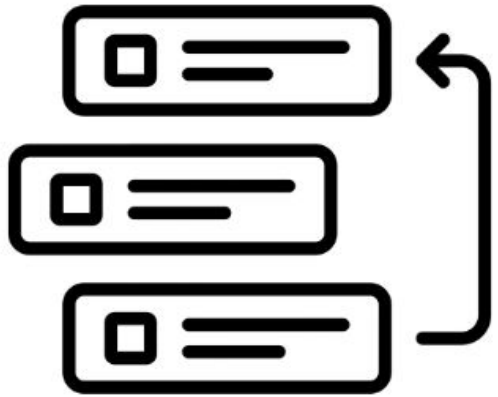

Problem Modeling

What is the input data?
Two arrays: one array of the time to make each order, and one array of each order's pickup time.

What is the output data?

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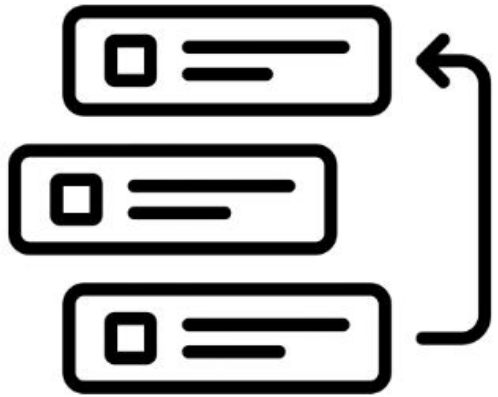


Problem Modeling

What is the input data?
Two arrays: one array of the time to make each order, and one array of each order's pickup time.

What is the output data?
A list of orders in the order they should be made.

Problem 8: Shop Tour

You want to drive around and visit every ice cream shop you own, but you'll feel silly if your path passes a store multiple times. Find a path that visits every store once, but re-visits stores as few times as possible.

Problem Modeling

What is the input data?

What is the output data?

Problem 8: Shop Tour

You want to drive around and visit every ice cream shop you own, but you'll feel silly if your path passes a store multiple times. Find a path that visits every store once, but re-visits stores as few times as possible.

Problem Modeling

What is the input data?
A graph with every ice cream shop.

What is the output data?
A path that visits every store at least once but re-visits stores as few times as possible.

Problem 9: Closest Shops

Times are tough, so you need to close a shop. Find the two shops that are closest to one another so that one can be removed. You only know each shop's coordinates, and you're calculating distance directly, not by driving distance.

Problem Modeling

Problem 9: Closest Shops

Times are tough, so you need to close a shop. Find the two shops that are closest to one another so that one can be removed. You only know each shop's coordinates, and you're calculating distance directly, not by driving distance.

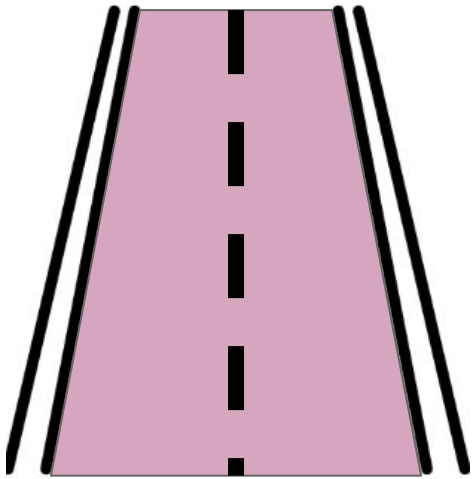
Problem Modeling

What is the input data?
A list of every shop’s coordinates.

What is the output data?
The two closest shops.

Problem 10: Pink Roads

You're doing a city-wide promotion where you want to paint some roads pink so that anyone following the roads can get to your shop. You want to figure out the minimum amount of paint you need to do so.



Problem Modeling

What is the input data?
A graph of the city's roads, where each road is weighted by the road's area, and the vertex where your shop is.

What is the output data?
The roads you need to paint to ensure that their area is minimized but every vertex can get to your shop.

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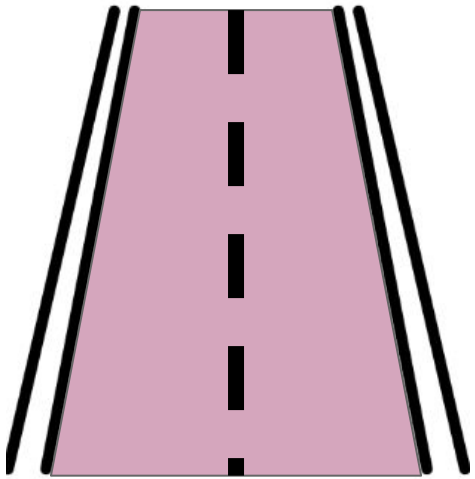


Problem Modeling

What is the input data?
A graph of the city's roads, where each road is weighted by the road's area, and the vertex where your shop is.

What is the output data?
The roads you need to paint to ensure that their area is minimized but every vertex can get to your shop.

Your Task: Part 1

This course is divided into 6 units.

Unit 1: Intro

Units 2-5: 4 Different approaches/paradigms for solving problems

Unit 6: Problems that are too difficult to solve

Of these 10 problems, two belong to each unit from 2-6 (which means two problems are too difficult to solve efficiently!)

Your task is to pair them up by which ones you think belong in the same unit.

Note: This task will be on your final exam! For now, just try your best.

Make your pairings, then go to gradescope.com and submit your pairings in the Lecture 1 Activity.

Your Task: Part 2

Find a partner and compare your work with them!

On Gradescope, you'll find a few questions to guide you.

This is your participation credit for the day! You'll get the credit as long as your answers were reasonable – they definitely don't need to be correct.

Course Guidelines

I am committed to your success in this course.

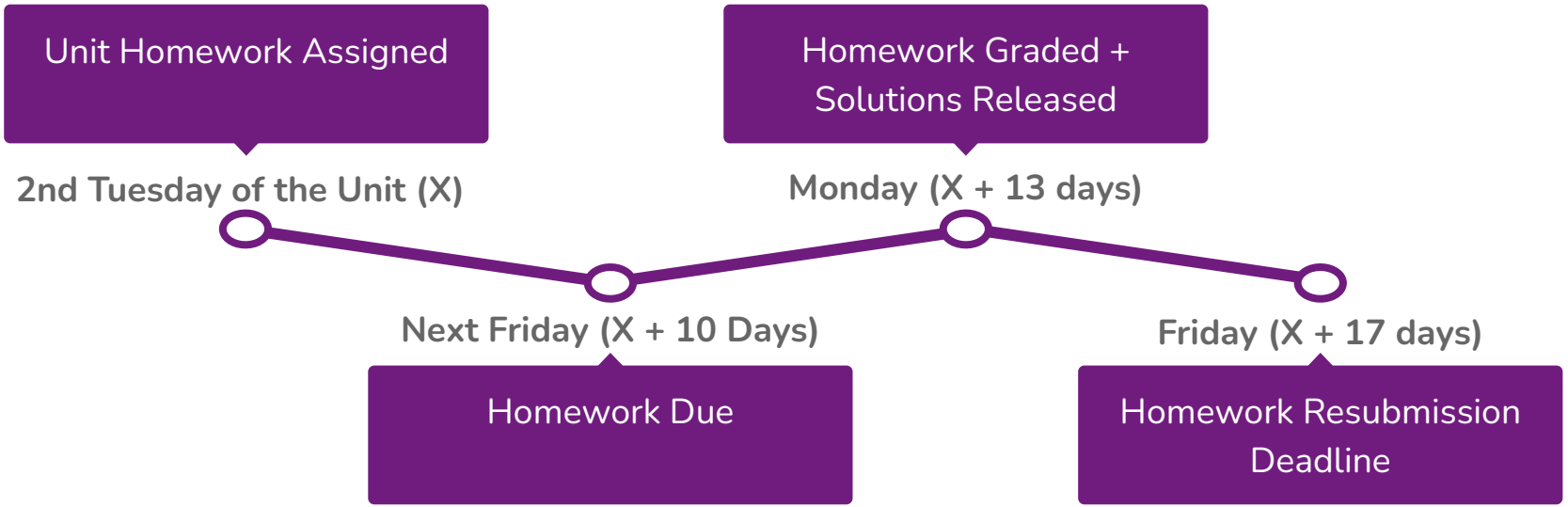
Don’t be a bad person.

Don’t suffer in silence!

Syllabus/Logistics

Homework Overview

Reminder: Homework is your chance to practice!



GenAI+Homework Policy

Official Policy

GenAI is permitted for use while doing homework, but you should treat it like a peer: ask it for help but write your own solutions, indicate that you used it, and make sure you understand the topic because you won't be able to use GenAI on exams.

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Unofficial Policy

Please ask a human for help first!

This can be me (on Piazza or in Office Hours), it can be a classmate, it can be a friend, or it can be one of UIC's free tutoring resources.

Course Logistics/Announcements

Course Staff:
Me (jonliu@uic.edu)

Office Hours (CDRLC 3450):

- Wednesdays 1:30-2:30pm
- Thursdays, 3:30-5:00pm

Send me an email if you want to meet outside of these times!

Homework 0 will be released tonight on Gradescope.

- Syllabus Questions
- GenAI Contract

Textbooks