LEC 02

CSE 123

Polymorphism; Abstract Classes

Questions during Class?
Raise hand or send here

sli.do #cse123

BEFORE WE START

Talk to your neighbors:

Coffee or tea? Or something else?

Respond on sli.do!

Instructor: Miya Natsuhara

TAs:

Arohan	Shiven	Yuntong	Anya
Sreshta	Vrinda	Amiya	Anisha
Rushil	Gavin	Sahana	Trien
Sean B	Shreya	Anirudh	Neal
Chloe	Jonah	Rohan	Evan
Jenny	Renee	Crystal	Rena
Nate	Chris	Eeshani	
Saachi	Ishita	Prakshi	
Hawa	Kuhu	Aidan	
Maggie	Kavya	Cora	
Sean E	Misha	Nhan	

Music: CSE 123 26sp Lecture Tunes

Announcements

- Creative Project 0 due tonight, Wednesday, April 8 at 11:59pm!
  - See generic Creative Project rubric posted on website
- Programming Assignment 0 will be released tomorrow, Thursday, April 9 and is due Wednesday, April 15
  - Focused on inheritance and abstract classes
- Recruiting students for a research study about the self-placement
  - See Ed post #71 for details

Lecture Outline: Polymorphism

- **Polymorphism** 
- Compiler vs. Runtime Errors
- Abstract Classes
- Academic Honesty Policy

Declared Type and Actual Type

```
DeclaredType varName = new ActualType(…);
```

`ActualType` must be a subclass of (or same as) `DeclaredType`

Example 1

```
Animal rufus = new Dog("Rufus");
```

Declared Type: Animal
Actual Type: Dog

Can call methods that makes sense for EVERY Animal
If Dog overrides a method, uses the Dog version

Example 2

```
Dog rufus = new Dog(”Rufus");
```

Declared Type: Dog
Actual Type: Dog

Can call methods that makes sense for EVERY Dog
If Dog overrides a method, uses the Dog version

Lecture Outline: Compile vs. Runtime Errors

- Polymorphism
- **Compiler vs. Runtime Errors**
- Abstract Classes
- Academic Honesty Policy

Compiler vs. Runtime Errors

- `DeclaredType x = new ActualType()`
  - At compile time, Java only knows `DeclaredType`
  - Compiler error: trying to call a method that isn't present

```
Animal a = new Dog();
a.bark();                    // No bark() -> CE
```

  - Can cast to change the `DeclaredType` of an object

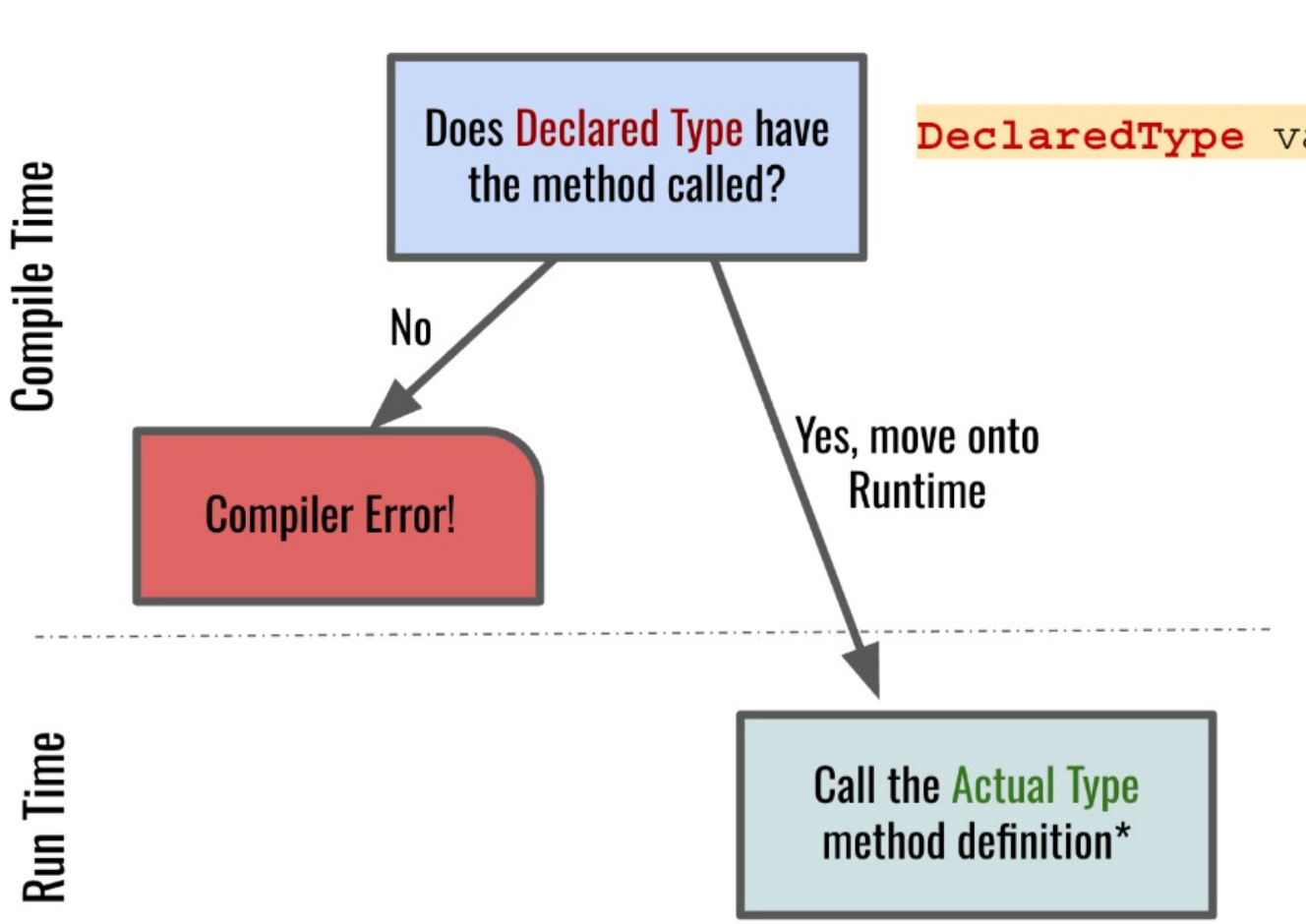
```
Dog d = (Dog) a;
d.bark();                    // No more CE
```

  - Runtime error: attempting cast to type that is not a superclass of actual type

```
Animal a = new Fish();
Dog d = (Dog) a;             // Can't cast -> RE
d.bark();
```

  - Order matters! Compilation before runtime

Compiler vs. Runtime Errors: Method Calls



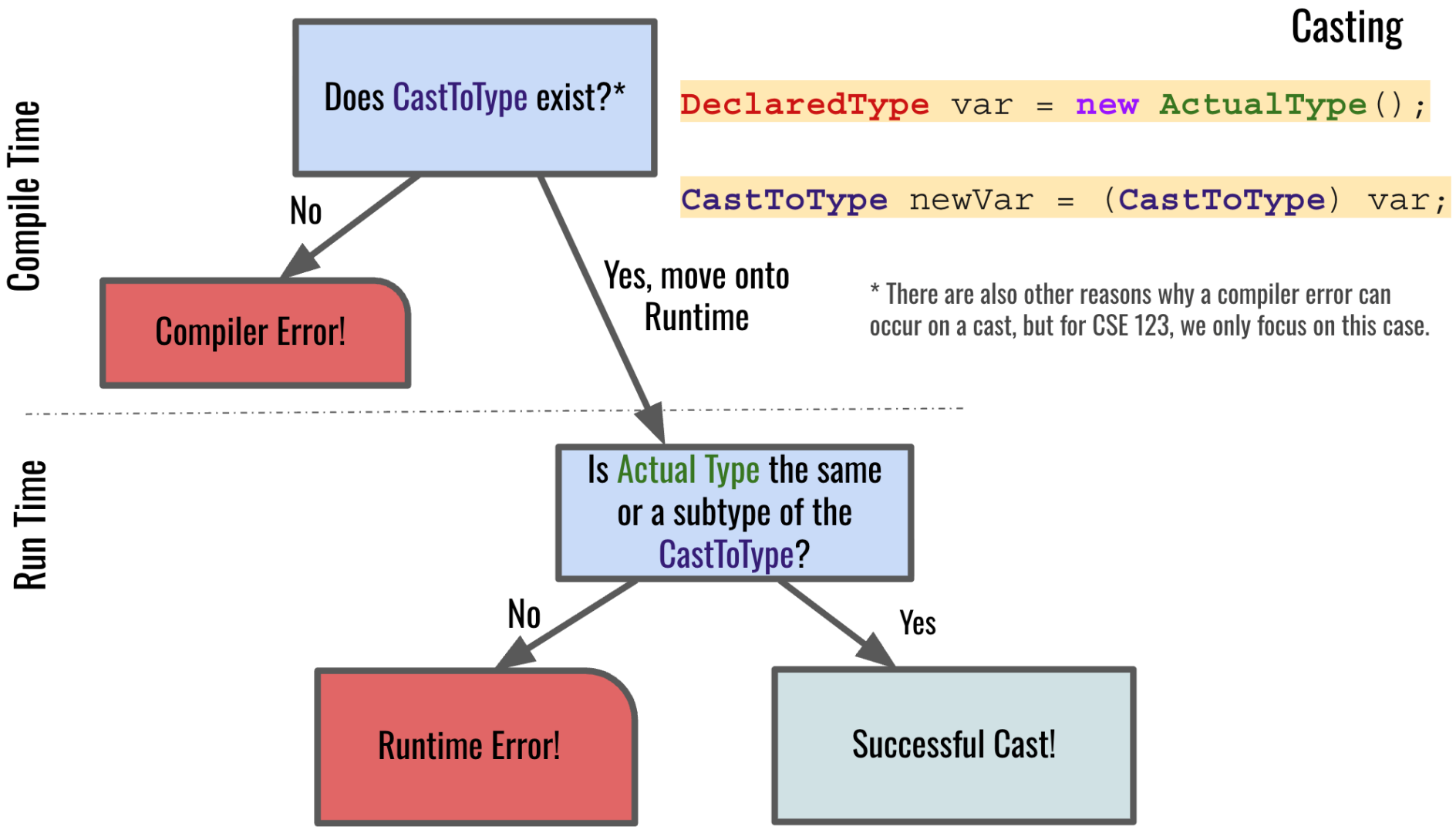
Method Calls

```
DeclaredType var = new ActualType();
```

```
Ex. var.method()
```

* Start at the Actual Type at run time. If it doesn't exist in Actual Type, trace up the inheritance tree to find the nearest inherited method definition

Compiler vs. Runtime Errors: Casting



Practice : Think

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What is the result of the following code?

```
Teacher socrates = new Teacher("Socrates", 2400);
System.out.println(socrates.getEmployeeName());
System.out.println(socrates.getYearsExperience());
```

A. Compiler Error

B. Runtime Error

C. No error– runs to completion

Practice : Pair

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What is the result of the following code?

```
Teacher socrates = new Teacher("Socrates", 2400);
System.out.println(socrates.getEmployeeName());
System.out.println(socrates.getYearsExperience());
```

A. Compiler Error

B. Runtime Error

C. No error– runs to completion

Practice : Think

sli.do #cse123

What is the result of the following code?

```
Employee anthony = new Chef("Anthony Bourdain");
System.out.println(anthony.getEmployeeName());
anthony.cookFood("shrimp");
```

A. Compiler Error

B. Runtime Error

C. No error– runs to completion

Practice : Pair

sli.do #cse123

What is the result of the following code?

```
Employee anthony = new Chef("Anthony Bourdain");
System.out.println(anthony.getEmployeeName());
anthony.cookFood("shrimp");
```

A. Compiler Error

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Practice : Think

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What is the result of the following code?

```
Employee anthony = new Chef("Anthony Bourdain");
System.out.println(anthony.getEmployeeName());
Chef c = (Chef) anthony;
c.cookFood("shrimp");
```

A. Compiler Error

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Practice : Pair

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What is the result of the following code?

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Practice : Think

sli.do #cse123

What is the result of the following code?

```
Employee anthony = new Chef("Anthony Bourdain");
System.out.println(anthony.getEmployeeName());
Teacher t = (Teacher) anthony;
t.getYearsExperience();
```

A. Compiler Error

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Practice : Pair

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What is the result of the following code?

```
Employee anthony = new Chef("Anthony Bourdain");
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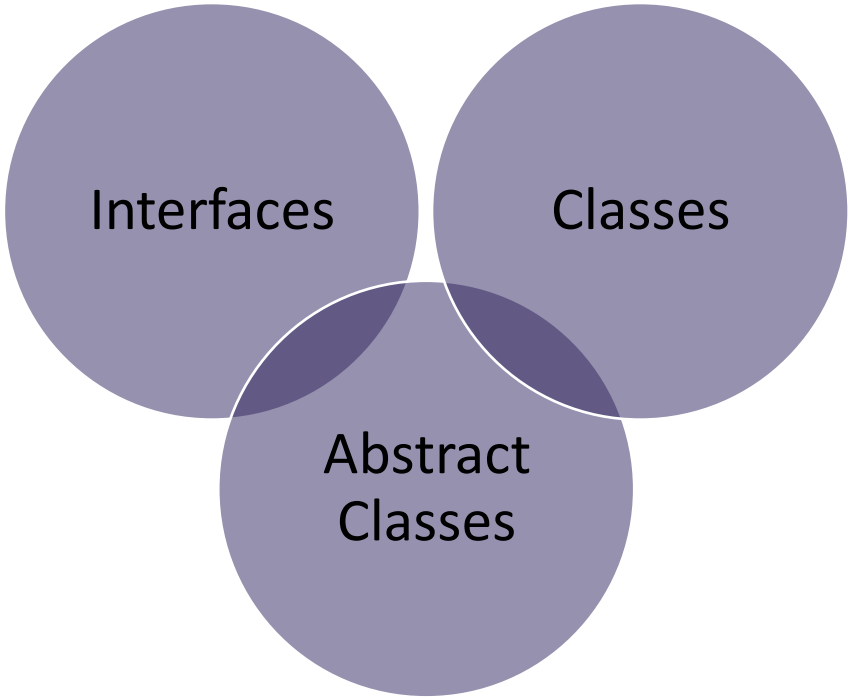
Lecture Outline: Abstract Classes

- Polymorphism
- Compiler vs. Runtime Errors
- **Abstract Classes**
- Academic Honesty Policy

Abstract Classes

- Mixture of `Interfaces` and `Classes`
  - `Interface` similarities:
    - Can contain (`abstract`) method declarations
    - Can't be instantiated
  - `Class` similarities:
    - Can contain method implementations
    - Can have fields
    - Can have constructors



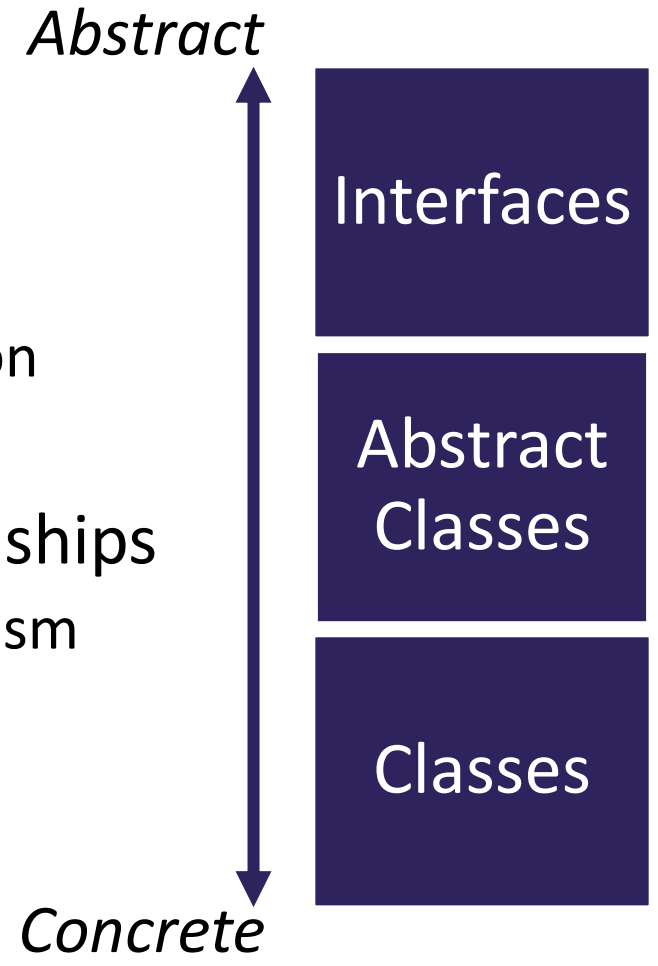
- Is there identical / nearly similar behavior between classes that shouldn't inherit from one another?

Shape Example: Tasks

- Add an abstract `getName` method to the `Shape`.
  - Add implementations of `getName` to `Square` and `Circle` that return "Square" and "Circle".
- Add a method `isEmpty` to `Shape` that tells you whether the shape is empty (has zero area) or not.
  - Hint: you will need to call `getArea`, but we've included a slight trap related to `getArea` in the starter code!
- Implementing `isEmpty` by calling `getArea` works fine as is, but suppose we wanted to implement it in `Circle` directly. How could we do this just by looking at the fields of the `Circle`? Implement it this way by overriding `isEmpty` in `Circle`.
- Override `toString` in `Shape` to return a similar message to what the `Client` prints in the starter code:
  - Hint: your `toString` can call abstract methods!
- Rewrite the `Client` class to use the new `toString` on shapes.

Advanced OOP Summary

- Allow us to define differing levels of abstraction
  - Interfaces = high-level specification
    - What behavior should this type of class have
  - Abstract classes = shared behavior + high-level specification
  - Classes = individual behavior implementation
- Inheritance allows us to share code via “is-a” relationships
  - Reduce redundancy / repeated code & enable polymorphism
    - Still might not be the “best” decision!
  - Interfaces extend other interfaces
  - (abstract) classes extend other (abstract) classes



- You’re now capable of designing some pretty complex systems!

Design in the "real world"

- In this course, we'll always give you expected behavior of the classes you write
  - Often not the case when programming for real
  - Clients don't really know what they want (but programmers don't either)

- My advice:
  - Clarify assumptions before making them (do I really want this functionality?)
  - **There's no one right answer**
    - Weigh the options, make a decision, and provide explanation
    - Iterative development: make mistakes and learn from them
    - Be receptive to feedback and be willing to change your mind

Interface vs. Implementation

- Interface: what something *should* do
- Implementation: *how* something is done
- These are different!
- Big theme of CSE 123:

    choose between different implementations of same interface

Lecture Outline: Academic Honesty Policy

- Polymorphism
- Compiler vs. Runtime Errors
- Abstract Classes
- **Academic Honesty Policy**

Academic Honesty Policy

- When we assess your work in this class, we need to know that it's *yours*.
- Unless otherwise specified, **all graded work must be completed individually and without touching AI tools.**

Some specific rules to highlight:

- do not share your own solution code or view solution code from any source – including but not limited to other students, tutors, or the internet
- do not use AI tools (e.g. ChatGPT, Claude) to create or modify graded work

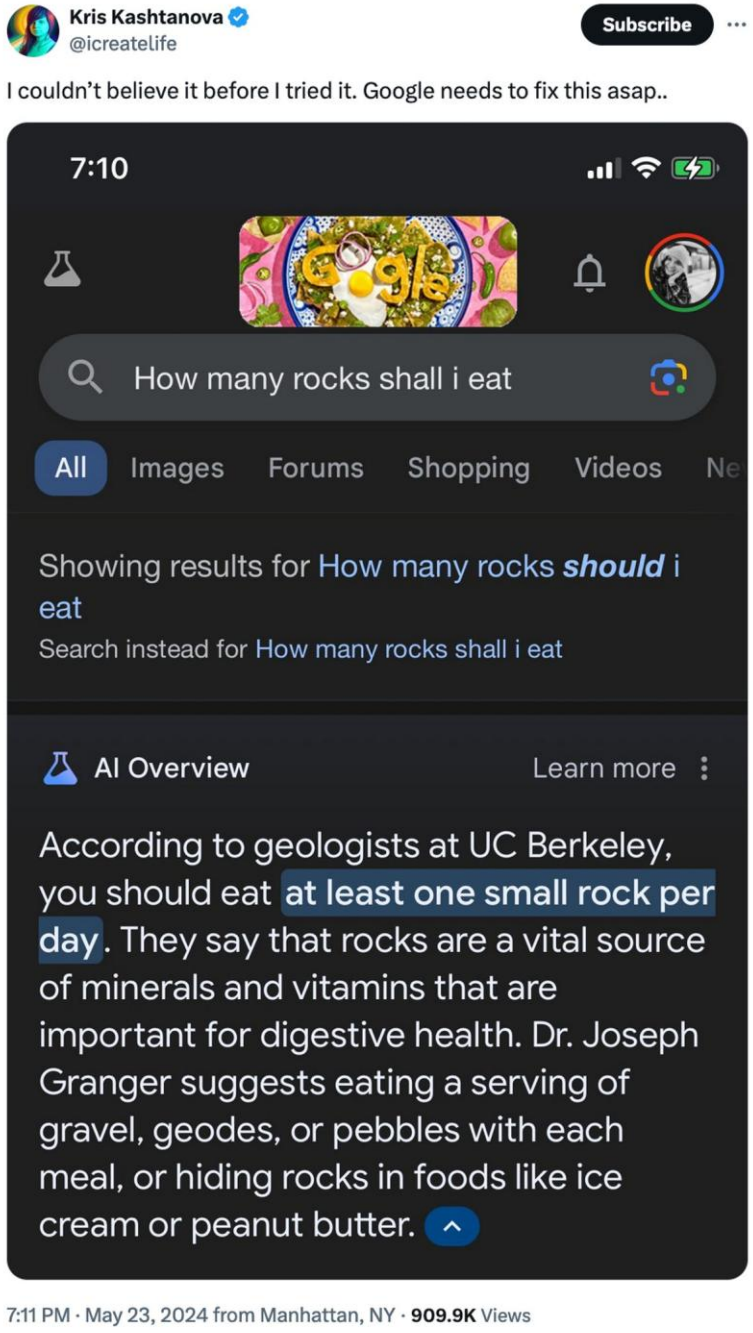
See the syllabus for more details (this is *very* important to understand).

AI and CSE 123: Our Philosophy

Computing applications enabled by **artificial intelligence (AI)** are increasingly common and more widely used for a variety of tasks.

It is becoming more difficult to teach an introductory computing course without acknowledging the **existence of AI tools**.

But as relatively new programmers, **you still need to learn and practice effectively using core programming 'building blocks'**.



Courtesy "Glue in Pizza? Eat Rocks? Google's AI Search Is Mocked for Bizarre Answers" by Ian Sherr for CNET. May 24, 2024

CSE 123 AI Policy

No part of any graded work may touch an AI tool.

You may not copy and paste any work generated by AI into any graded submission, nor may you copy and paste any work from or for a graded assignment into an AI tool. All other uses of AI on graded work must be cited.

cs.uw.edu/123/syllabus/#using-ai-in-cse-123

CSE 123 AI Policy: Examples

No part of any graded work may touch an AI tool.

You may not copy and paste any work generated by AI into any graded submission, nor may you copy and paste any work from or for a graded assignment into an AI tool. All other uses of AI on graded work must be cited.

ALLOWED

- Asking AI to **explain an error message**
- Asking AI to **explain the functionality of non-graded code** snippets
- Asking AI to **suggest additional information** or resources

PROHIBITED

- **Generating code, comments, reflections**
- Using AI to **'solve' an assignment**
- Using AI to **write, modify, or extend** reflections, code, comments, etc.

cs.uw.edu/123/syllabus/#using-ai-in-cse-123