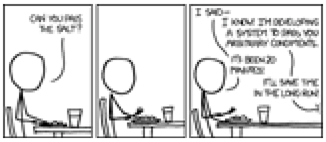
Lecture 15

Design Patterns and Principles: Part 2


CAN YOU PASS THE SALT?
I SAID—
I KNOW! I'M DEVELOPING A SYSTEM TO PASS YOU ARBITRARY CONDIMENTS.
IT'S BEEN 20 MINUTES!
IT'LL SAVE TIME IN THE LONG RUN!

From xkcd Webcomics

Overview

- Enums
- Factory Pattern
- Testing
- Interfaces v. Inheritance
- Method Overloading

Back to Our Snake Program

- Specifications
  - player moves snake via key input around board of squares with goal of eating pellets to increase score
  - snake can pivot left or right but not 180º
  - gain score by eating pellets – different colors yield different scores
- Represent snake as `ArrayList` of `BoardSquare`s and delegate to a wrapper `Snake` class
- Represent board as 2D array of `BoardSquare`s and delegate to a wrapper `Board` class
- Today, we'll cover details about snake movement and food

twinning! 👯‍♀️

Significant revisions to Snake code by former HTAs Adam, Brandon, and Naafi

Overview

- Enums
- Factory Pattern
- Testing
- Interfaces v. Inheritance
- Method Overloading

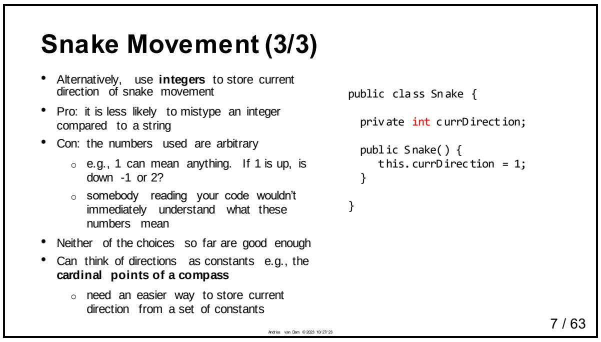
Snake Movement (1/3)

- Snake keeps moving in the same direction until a key is pressed, which triggers change in direction
- Direction in which the snake moves is a **property** or piece of **state**
- What have we learnt so far that we can use to represent a **property** or piece of **state** for a class?
  - instance variables!
- Need to indicate whether direction the snake is moving is up, down, left, or right
- What type should our instance variable be?

Snake Movement (2/3)

- Can use `String`s to store current direction of snake movement
- Pro: easy to read and understand
- Con: value of strings can be anything!
  - e.g., the north direction can be represented as “up”, “upward”, “UP”, “upside” and many more
  - can be confusing. It’s easy to mistype a string causing runtime bugs

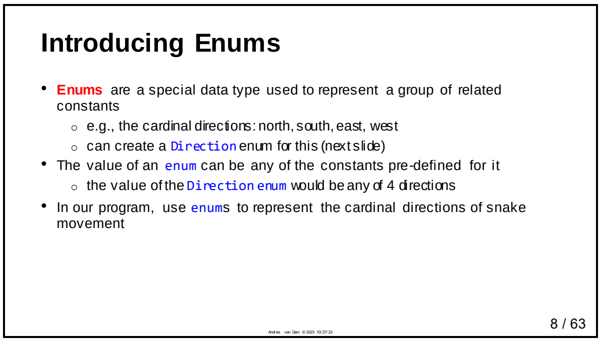
```
public class Snake {

  private String currDirection;

  public Snake() {
     this.currDirection = “up”;
  }

}
```



Snake Movement (3/3)

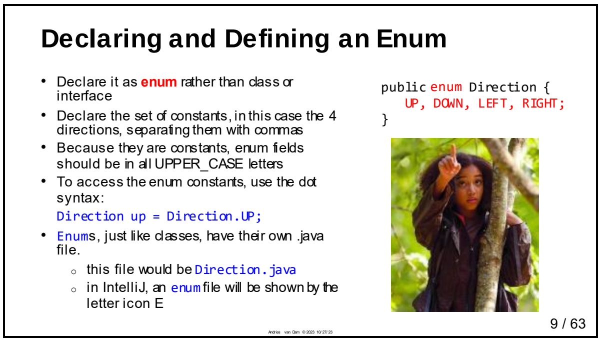
- Alternatively, use **integers** to store current direction of snake movement
- Pro: it is less likely to mistype an integer compared to a string
- Con: the numbers used are arbitrary
  - e.g., 1 can mean anything. If 1 is up, is down -1 or 2?
  - somebody reading your code wouldn't immediately understand what these numbers mean
- Neither of the choices so far are good enough
- Can think of directions as constants e.g., the **cardinal points of a compass**
  - need an easier way to store current direction from a set of constants

```
public class Snake {

  private int currDirection;

  public Snake() {
     this.currDirection = 1;
  }

}
```



Introducing Enums

- **Enums** are a special data type used to represent a group of related constants
  - e.g., the cardinal directions: north, south, east, west
  - can create a `Direction` enum for this (next slide)
- The value of an `enum` can be any of the constants pre-defined for it
  - the value of the `Direction enum` would be any of 4 directions
- In our program, use `enum`s to represent the cardinal directions of snake movement



Declaring and Defining an Enum

- Declare it as **enum** rather than class or interface
- Declare the set of constants, in this case the 4 directions, separating them with commas
- Because they are constants, enum fields should be in all UPPER_CASE letters
- To access the enum constants, use the dot syntax:
  `Direction up = Direction.UP;`
- `Enums`, just like classes, have their own .java file.
  - this file would be `Direction.java`
  - in IntelliJ, an `enum` file will be shown by the letter icon E

```
public enum Direction {
   UP, DOWN, LEFT, RIGHT;
}
```

Using Enums: Snake Movement (1/3)

- Can use a Direction enum in Snake to store direction of movement
  - notice currDirection's type is the enum Direction. Not String or int
  - currDirection is initialized to right
- Like any type in Java, enums can be used as parameters to methods
  - changeDirection sets current direction to whatever is passed in
- Notice how intuitive the value of currDirection is compared to when we used strings and integers!

```
public class Snake {

  private Direction currDirection;

  public Snake() {
     this.currDirection = Direction.RIGHT;
  }

  public void changeDirection(Direction newDir) {
     this.currDirection = newDir;
  }


}
```

TopHat Question

Given the enum below, which of the following is a correct way to initialize the paused variable?

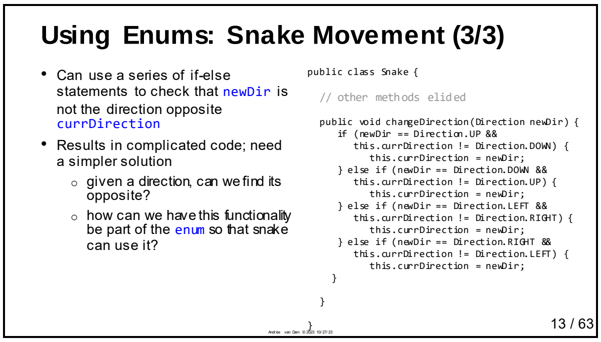
```
public enum Status {
  PAUSED, RUNNING, STOPPED;
}
```

```
A. Status paused = new Status(PAUSED);
B. Status paused = Status(PAUSED);
C. Status paused = Status.PAUSED();
D. Status paused = Status.PAUSED;
```

Using Enums: Snake Movement (2/3)

- Remember the handleKeyPress method from lab4 & Cartoon?
  - JavaFX provided it with arguments that corresponded to Left, Right, or Space keys
  - these KeyCodes were ENUMs!
- Again, use a switch and call changeDirection in each case, passing in the corresponding direction
- But wait! There's one specification with snake movement we've ignored
  - snake can pivot right or left, but not 180º
  - thus check new direction passed from key input is not the opposite of current direction

```
private void handleKeyPress(KeyCode code) {
 switch (code) {
    case UP:
          this.snake.changeDirection
          (Direction.UP);
          break;
    case DOWN:
          this.snake.changeDirection
          (Direction.DOWN);
          break;
    case LEFT:
          this.snake.changeDirection
          (Direction.LEFT);
          break;
     case RIGHT:
          this.snake.changeDirection
          (Direction.RIGHT);
          break;
     default:
          break;
}
```



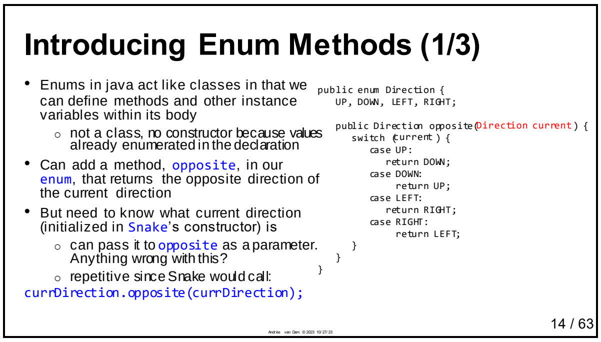
Using Enums: Snake Movement (3/3)

- Can use a series of if-else statements to check that newDir is not the direction opposite currDirection
- Results in complicated code; need a simpler solution
  - given a direction, can we find its opposite?
  - how can we have this functionality be part of the enum so that snake can use it?

```
public class Snake {

  // other methods elided

  public void changeDirection(Direction newDir) {
     if (newDir == Direction.UP &&
        this.currDirection != Direction.DOWN) {
           this.currDirection = newDir;
     } else if (newDir == Direction.DOWN &&
        this.currDirection != Direction.UP) {
           this.currDirection = newDir;
     } else if (newDir == Direction.LEFT &&
        this.currDirection != Direction.RIGHT) {
           this.currDirection = newDir;
     } else if (newDir == Direction.RIGHT &&
        this.currDirection != Direction.LEFT) {
           this.currDirection = newDir;
    }

  }

}
```

Andries van Dam © 2023 10/27/23

13 / 63



Introducing Enum Methods (1/3)

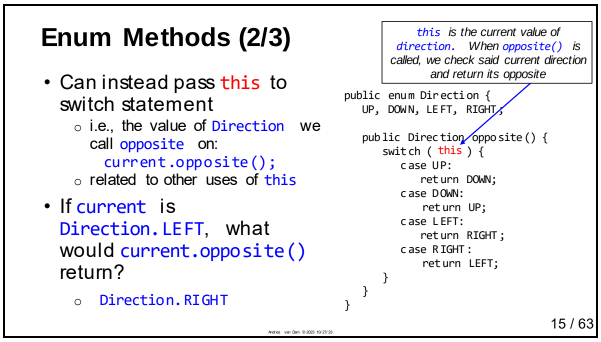
- Enums in java act like classes in that we can define methods and other instance variables within its body
  - not a class, no constructor because values already enumerated in the declaration
- Can add a method, opposite, in our enum, that returns the opposite direction of the current direction
- But need to know what current direction (initialized in Snake's constructor) is
  - can pass it to opposite as a parameter. Anything wrong with this?
  - repetitive since Snake would call:

currDirection.opposite(currDirection);

```
public enum Direction {
   UP, DOWN, LEFT, RIGHT;

   public Direction opposite(Direction current) {
      switch (current) {
         case UP:
            return DOWN;
         case DOWN:
              return UP;
         case LEFT:
            return RIGHT;
         case RIGHT:
              return LEFT;
      }
   }
}
```

Andries van Dam © 2023 10/27/23

14 / 63



Enum Methods (2/3)

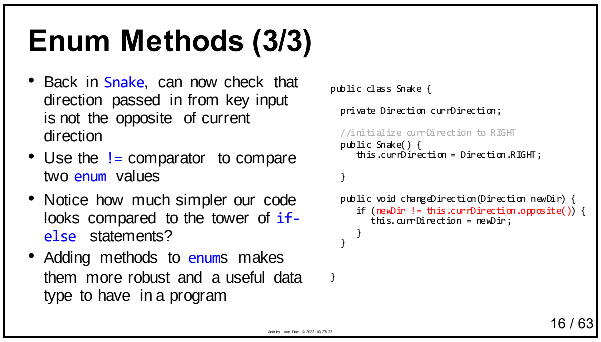
- Can instead pass this to switch statement
  - i.e., the value of Direction we call opposite on: current.opposite();
  - related to other uses of this
- If current is Direction.LEFT, what would current.opposite() return?
  - Direction.RIGHT

this is the current value of direction. When opposite() is called, we check said current direction and return its opposite

```
public enum Direction {
   UP, DOWN, LEFT, RIGHT;

   public Direction opposite() {
      switch ( this ) {
         case UP:
            return DOWN;
         case DOWN:
            return UP;
         case LEFT:
            return RIGHT;
         case RIGHT:
            return LEFT;
      }
   }
}
```

Andries van Dam © 2023 10/27/23

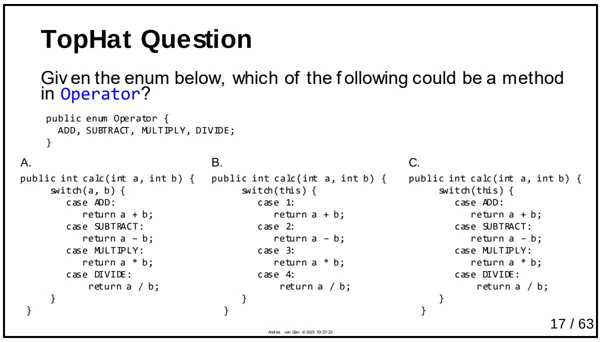
15 / 63



Enum Methods (3/3)

- Back in Snake, can now check that direction passed in from key input is not the opposite of current direction
- Use the != comparator to compare two enum values
- Notice how much simpler our code looks compared to the tower of if-else statements?
- Adding methods to enums makes them more robust and a useful data type to have in a program

```
public class Snake {

  private Direction currDirection;

  //initialize currDirection to RIGHT
  public Snake() {
     this.currDirection = Direction.RIGHT;

  }

  public void changeDirection(Direction newDir) {
     if (newDir != this.currDirection.opposite()) {
        this.currDirection = newDir;
     }
  }


}
```



TopHat Question

Given the enum below, which of the following could be a method in Operator?

```
public enum Operator {
  ADD, SUBTRACT, MULTIPLY, DIVIDE;
}
```

A.

```
public int calc(int a, int b) {
     switch(a, b) {
        case ADD:
           return a + b;
        case SUBTRACT:
           return a - b;
        case MULTIPLY:
           return a * b;
        case DIVIDE:
            return a / b;
     }
 }
```

B.

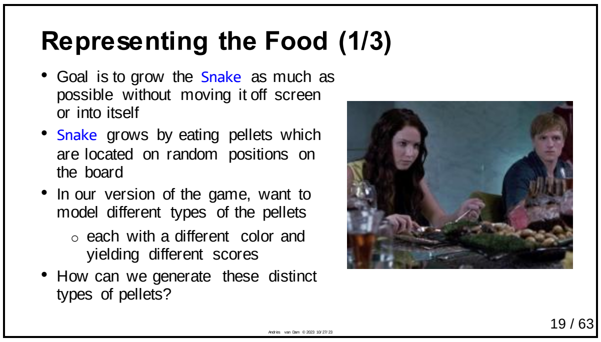
```
public int calc(int a, int b) {
     switch(this) {
        case 1:
           return a + b;
        case 2:
           return a - b;
        case 3:
           return a * b;
        case 4:
            return a / b;
     }
 }
```

C.

```
public int calc(int a, int b) {
     switch(this) {
        case ADD:
           return a + b;
        case SUBTRACT:
           return a - b;
        case MULTIPLY:
           return a * b;
        case DIVIDE:
            return a / b;
     }
 }
```

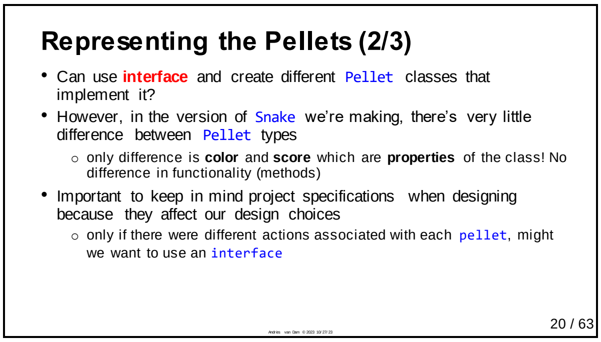
Overview

- Enums
- Factory Pattern
- Testing
- Interfaces v. Inheritance
- Method Overloading



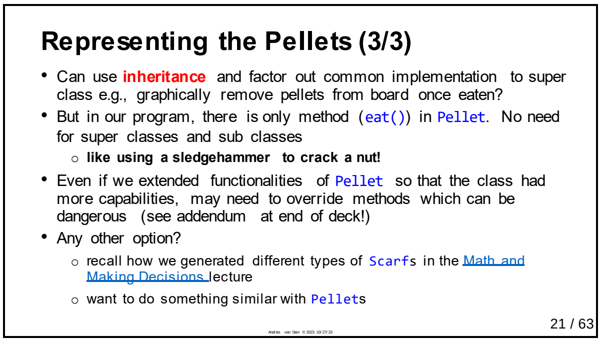
Representing the Food (1/3)

- Goal is to grow the `Snake` as much as possible without moving it off screen or into itself
- `Snake` grows by eating pellets which are located on random positions on the board
- In our version of the game, want to model different types of the pellets
  - each with a different color and yielding different scores
- How can we generate these distinct types of pellets?



Representing the Pellets (2/3)

- Can use **interface** and create different `Pellet` classes that implement it?
- However, in the version of `Snake` we're making, there's very little difference between `Pellet` types
  - only difference is **color** and **score** which are **properties** of the class! No difference in functionality (methods)
- Important to keep in mind project specifications when designing because they affect our design choices
  - only if there were different actions associated with each `pellet`, might we want to use an `interface`



Representing the Pellets (3/3)

- Can use **inheritance** and factor out common implementation to super class e.g., graphically remove pellets from board once eaten?
- But in our program, there is only method (`eat()`) in `Pellet`. No need for super classes and sub classes
  - **like using a sledgehammer to crack a nut!**
- Even if we extended functionalities of `Pellet` so that the class had more capabilities, may need to override methods which can be dangerous (see addendum at end of deck!)
- Any other option?
  - recall how we generated different types of `Scarf`s in the Math and Making Decisions lecture
  - want to do something similar with `Pellet`s

Factory Pattern (1/2)

- Can use **Factory** Pattern to create one `Pellet` class and specify parameters to its constructor that will configure its type, i.e., **score** and **color**
  - allows us to instantiate different types of `Pellet`s without caring about creation logic
  - a really useful pattern when creation logic is more complicated, e.g., if each type of `Pellet` had a different shape. Or even with **Tetris** pieces (coming up soon!)

Factory Pattern (2/2)

- Key features: a switch statement
  - in this case uses a random number generator
  - used on Fruit Ninja to generate fruits/bombs

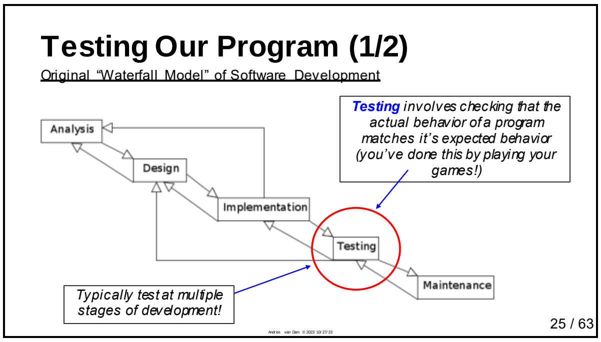
Pellet Constructor!

```
public Pellet(Pane gamePane, Color color, int score,
int row, int col)
```

```
public void spawnFood() {
    // gets random empty tile on board where food will be added
    BoardSquare tile = this.getRandomEmptyTile();
    Food food;
    int rand = (int) (Math.random() * 3)
    switch (rand) {
        case 0:
          food = new Pellet(this.gamePane, Color.RED, 10,
                        tile.getRow(), tile.getCol());
          break;
        case 1:
          food = new Pellet(this.gamePane, Color.BLUE, 30,
                        tile.getRow(), tile.getCol());
          break;
        default:
          food = new Pellet(this.gamePane, Color.GREEN, 50,
                      tile.getRow(), tile.getCol());
          break;
    }
    tile.addFood(food);
}
```

Overview

- Enums
- Factory Pattern
- Testing
- Interfaces v. Inheritance
- Method Overloading

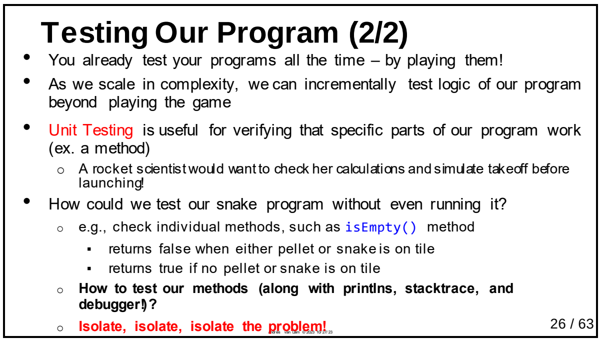


Testing Our Program (1/2)

Original "Waterfall Model" of Software Development

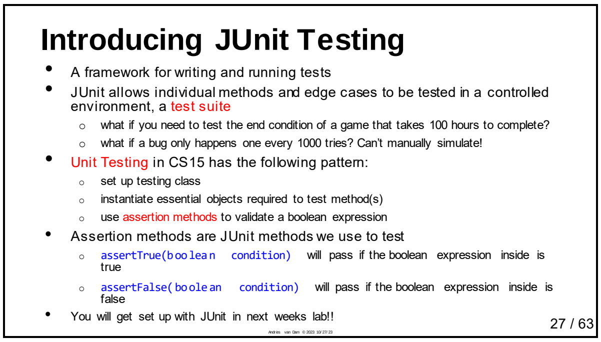
***Testing** involves checking that the actual behavior of a program matches it's expected behavior (you've done this by playing your games!)*

Typically test at multiple stages of development!



Testing Our Program (2/2)

- You already test your programs all the time – by playing them!
- As we scale in complexity, we can incrementally test logic of our program beyond playing the game
- Unit Testing is useful for verifying that specific parts of our program work (ex. a method)
  - A rocket scientist would want to check her calculations and simulate takeoff before launching!
- How could we test our snake program without even running it?
  - e.g., check individual methods, such as `isEmpty()` method
    - returns false when either pellet or snake is on tile
    - returns true if no pellet or snake is on tile
  - **How to test our methods (along with printlns, stacktrace, and debugger!)?**
  - **Isolate, isolate, isolate the problem!**



Introducing JUnit Testing

- A framework for writing and running tests
- JUnit allows individual methods and edge cases to be tested in a controlled environment, a test suite
  - what if you need to test the end condition of a game that takes 100 hours to complete?
  - what if a bug only happens one every 1000 tries? Can't manually simulate!
- Unit Testing in CS15 has the following pattern:
  - set up testing class
  - instantiate essential objects required to test method(s)
  - use assertion methods to validate a boolean expression
- Assertion methods are JUnit methods we use to test
  - `assertTrue(boolean condition)` will pass if the boolean expression inside is true
  - `assertFalse(boolean condition)` will pass if the boolean expression inside is false
- You will get set up with JUnit in next weeks lab!!

JUnit Testing: Naïve Example

- Trivial example: test the following code that adds two integers:
- What steps do we take to test?

```
public class Calculator {

   // constructor elided
   public int add(int x, int y){
         return x+y;
   }
}
```

@Test tells compiler this is a unit test

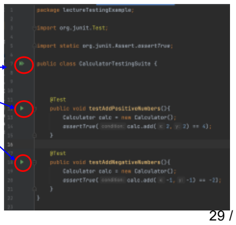
- 1) Set up testing class
- 2) Instantiate essential objects required to test method(s)
- 3) Use assertion functions to validate a boolean expression

```
public class CalculatorTestingSuite {

    @Test
    public void testAddNumbers(){
          Calculator calc = new Calculator();
          assertTrue(calc.add(2,2) == 4);

    }
}
```

How does IntelliJ help?

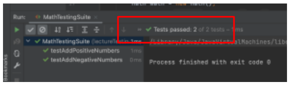
- Our test(s) from the last slide look like this in IntelliJ:

Can run individual tests, or the whole class (the "testing suite") with green play buttons



```
package lectureTestingExample;

import org.junit.Test;

import static org.junit.Assert.assertTrue;

public class CalculatorTestingSuite {



    @Test
    public void testAddPositiveNumbers(){
        Calculator calc = new Calculator();
        assertTrue( condition: calc.add( x: 2, y: 2) == 4);
    }

    @Test
    public void testAddNegativeNumbers(){
        Calculator calc = new Calculator();
        assertTrue( condition: calc.add( x: -1, y: -1) == -2);
    }
}
```

Pressing the top play button, gets us the following output in IntelliJ:



```
✓ Tests passed: 2 of 2 tests – 1ms
✓ MathTestingSuite (lectureTestin 1ms
    ✓ testAddPositiveNumbers 1ms
    ✓ testAddNegativeNumbers 0ms

/Library/Java/JavaVirtualMachines/lib

Process finished with exit code 0
```

JUnit Testing: Snake Example

How can we apply this framework to test our Snake code?

- Set up testing class
- Instantiate essential objects required to test method(s)
- Use assertion functions to validate boolean expression(s)

You will get practice writing tests like this in next weeks lab

- **Testing will be required for a mini-project alongside Tetris (after you learn more in lab!) but not Doodle Jump**
- You will learn a lot more about testing in CS200!! ☺

```
public class SnakeTestingSuite {

   @Test
    public void testTileUpdates(){

        Pane gamePane = new Pane();
        Board board = new Board(gamePane);
        Pellet pellet = new Pellet(gamePane,
          Color.RED, Constants.SCORE, 1, 1);
        BoardSquare tile = board.tileAt(1,1);

        tile.addPellet(pellet);
        assertFalse(board.tileAt(1,1).isEmpty());

        tile.addSnake(); //eats pellet, but adds snake
        assertFalse(board.tileAt(1,1).isEmpty());

        tile.reset(); // removes snake
        assertTrue(board.tileAt(1,1).isEmpty());
    }
}
```

Recap Snake Design Process

- Assignment specifications can be daunting
- Start at very high level: how to separate components of the program
  - which classes can I use to model different objects in my program?
  - what functionalities can I delegate to those classes?
  - how would those classes interact with each other?
  - how can you test these components?
  - is my design scalable?
  - repeat and revise!

Intermission

- Have seen how to design mock CS15 project from scratch
  - need to go through similar design discussions for the projects in the remainder of the semester
  - code for the different designs of Snake can be found on GitHub
- For remainder of lecture, will cover additional discussions around design that will be useful in the future

Overview

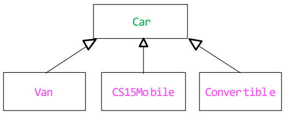
- Enums
- Factory Pattern
- Testing
- Interfacesv. Inheritance
- Method Overloading

Interfaces vs. Inheritance

- When deciding between interfaces and inheritance, need to consider trade-offs between the two
  - interfaces + composition/containment offer more flexibility compared to inheritance
    - ex. wrapper classes, like a "smart square"
  - can implement several interfaces but only extend one super-class
  - while inheritance allows sub-classes to inherit functionality from parent, there's risk of unintended consequences when overriding methods
- Note that while interface (coupled with composition) is often favored over inheritance, there are use cases which can really take advantage of inheritance, e.g., cars and animals

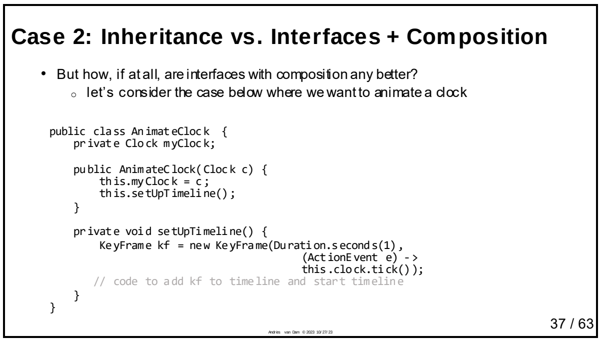
Case 1: Problems with Inheritance

- Let's return to our `Race` example from the Inheritance lecture
- `CS15Mobile`, `Van`, and `Convertible` have many identical capabilities and share a lot of the same components
  - start/stop engines
- We created a `Car` superclass
  - `Car` contains instances of `Engine`, `Brake`, etc.
  - `CS15Mobile`, `Van`, and `Convertible` extend from `Car`



Extending Our Design

- Assume now that we add an `ElectricCar` class to the program
  - but `ElectricCar` doesn't use the standard `Engine` inherited from `Car`
  - can `ElectricCar` just override `Car`'s methods that make use of `Engine`? Anything wrong with that?
    - can do this but could be dangerous (see appendix)
    - when you subclass `Car`, its `this.engine`, is hidden from you
      - a parent's private variables stay private
    - you inherit methods that use `this.engine`, but implementation is hidden
      - you do not know which methods use `this.engine`, let alone how they do that
    - and you still have the now useless `this.engine` via pseudo-inheritance



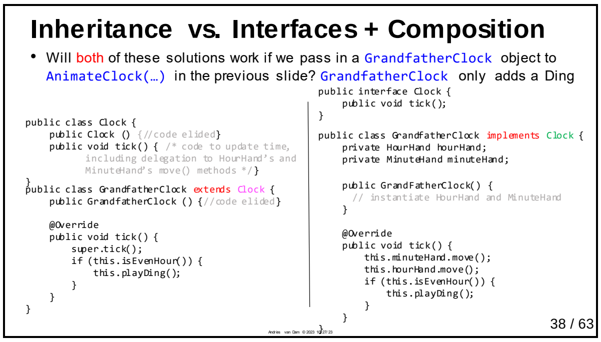
Case 2: Inheritance vs. Interfaces + Composition

- But how, if at all, are interfaces with composition any better?
  - let's consider the case below where we want to animate a clock

```
public class AnimateClock {
    private Clock myClock;

    public AnimateClock(Clock c) {
        this.myClock = c;
        this.setUpTimeline();
    }

    private void setUpTimeline() {
        KeyFrame kf = new KeyFrame(Duration.seconds(1),
                                   (ActionEvent e) ->
                                   this.clock.tick());
       // code to add kf to timeline and start timeline
    }
}
```

Andries van Dam © 2023 10/27/23

37 / 63



Inheritance vs. Interfaces + Composition

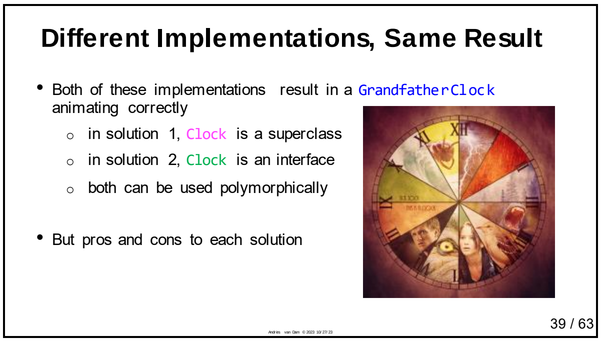
- Will both of these solutions work if we pass in a `GrandfatherClock` object to `AnimateClock(…)` in the previous slide? `GrandfatherClock` only adds a Ding

```
public class Clock {
    public Clock () {//code elided}
    public void tick() { /* code to update time,
          including delegation to HourHand's and
          MinuteHand's move() methods */}
}
public class GrandfatherClock extends Clock {
    public GrandfatherClock () {//code elided}

    @Override
    public void tick() {
        super.tick();
        if (this.isEvenHour()) {
            this.playDing();
        }
    }
}
```

```
public interface Clock {
    public void tick();
}

public class GrandfatherClock implements Clock {
    private HourHand hourHand;
    private MinuteHand minuteHand;

    public GrandFatherClock() {
      // instantiate HourHand and MinuteHand
    }

    @Override
    public void tick() {
        this.minuteHand.move();
        this.hourHand.move();
        if (this.isEvenHour()) {
            this.playDing();
        }
    }
}
```

Andries van Dam © 2023 10/27/23

38 / 63

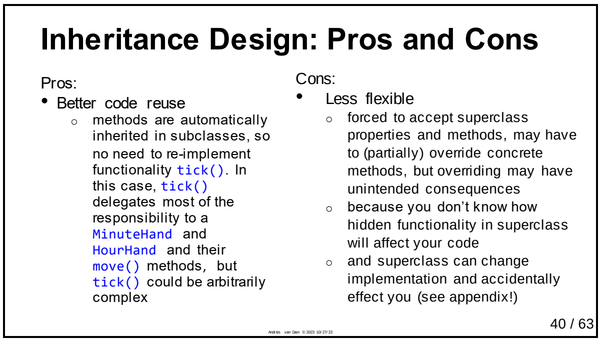


Different Implementations, Same Result

- Both of these implementations result in a `GrandfatherClock` animating correctly
  - in solution 1, `Clock` is a superclass
  - in solution 2, `Clock` is an interface
  - both can be used polymorphically
- But pros and cons to each solution

Andries van Dam © 2023 10/27/23

39 / 63



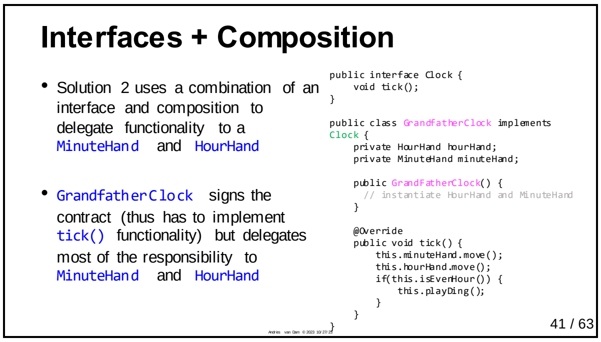
Inheritance Design: Pros and Cons

Pros:

- Better code reuse
  - methods are automatically inherited in subclasses, so no need to re-implement functionality `tick()`. In this case, `tick()` delegates most of the responsibility to a `MinuteHand` and `HourHand` and their `move()` methods, but `tick()` could be arbitrarily complex

Cons:

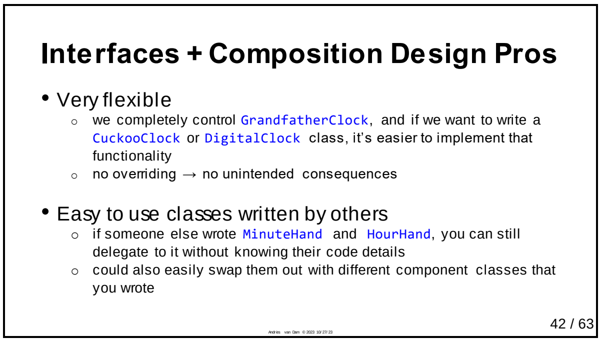
- Less flexible
  - forced to accept superclass properties and methods, may have to (partially) override concrete methods, but overriding may have unintended consequences
  - because you don't know how hidden functionality in superclass will affect your code
  - and superclass can change implementation and accidentally effect you (see appendix!)



Interfaces + Composition

- Solution 2 uses a combination of an interface and composition to delegate functionality to a `MinuteHand` and `HourHand`
- `GrandfatherClock` signs the contract (thus has to implement `tick()` functionality) but delegates most of the responsibility to `MinuteHand` and `HourHand`

```
public interface Clock {
    void tick();
}

public class GrandfatherClock implements
Clock {
    private HourHand hourHand;
    private MinuteHand minuteHand;

    public GrandFatherClock() {
      // instantiate HourHand and MinuteHand
    }

    @Override
    public void tick() {
        this.minuteHand.move();
        this.hourHand.move();
        if(this.isEvenHour()) {
            this.playDing();
        }
    }
}
```



Interfaces + Composition Design Pros

- Very flexible
  - we completely control `GrandfatherClock`, and if we want to write a `CuckooClock` or `DigitalClock` class, it's easier to implement that functionality
  - no overriding → no unintended consequences
- Easy to use classes written by others
  - if someone else wrote `MinuteHand` and `HourHand`, you can still delegate to it without knowing their code details
  - could also easily swap them out with different component classes that you wrote

Interfaces + Composition Design Cons

- Cons
  - both inheritance and interface use composition (i.e., delegate to other objects)
    - with inheritance you automatically get concrete methods from the superclass
    - when you use composition, you must invoke the methods you want on the objects to which you have delegated – thus more control but more responsibility

Case 3: Multiple Interfaces

- Have seen how interfaces provide us with more flexibility because no unintended consequences
- Interfaces offer us even more flexibility because can implement several interfaces
  - why is this useful?
- Imagine we're making a game with the following classes

`FlyingSuperhero`
- fly()
- saveLives()

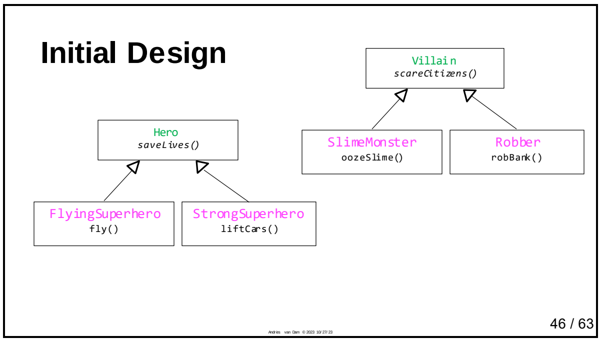
`StrongSuperhero`
- liftCars()
- saveLives()

`SlimeMonster`
- scareCitizens()
- oozeSlime()

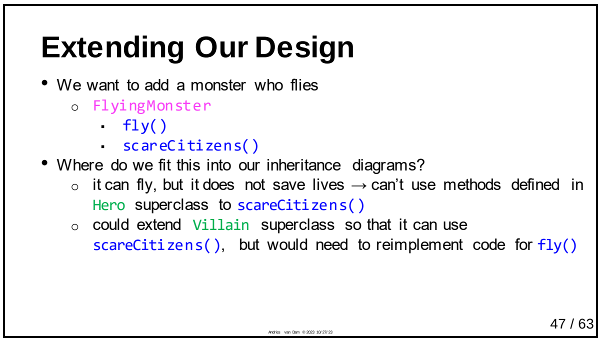
`Robber`
- scareCitizens()
- robBank()

Interfaces vs. Inheritance

- There are some similarities in implementation
  - `FlyingSuperhero` and `StrongSuperhero` both have a `saveLives()` method
  - `SlimeMonster` and `Robber` both have a `scareCitizen()` method
  - can abstract this up into superclasses!

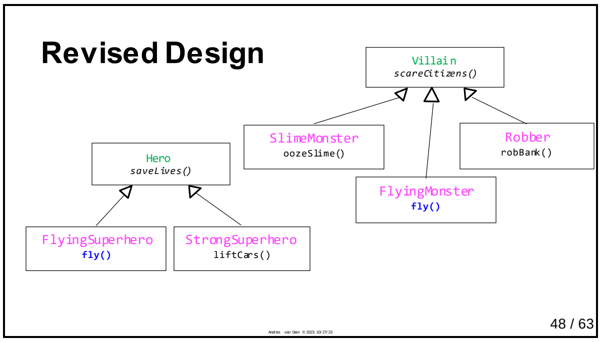


Initial Design



Extending Our Design

- We want to add a monster who flies
  - FlyingMonster
    - fly()
    - scareCitizens()
- Where do we fit this into our inheritance diagrams?
  - it can fly, but it does not save lives → can't use methods defined in Hero superclass to scareCitizens()
  - could extend Villain superclass so that it can use scareCitizens(), but would need to reimplement code for fly()

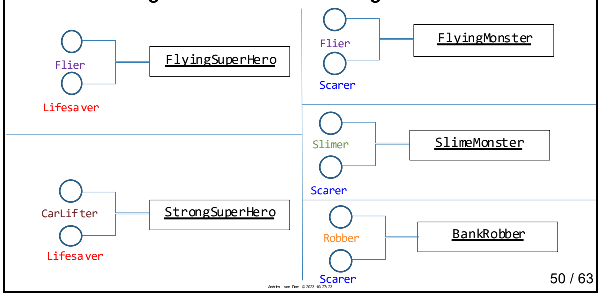


Revised Design

Can we do better?

- Separate classes by their capabilities
  - FlyingSuperhero: flier + lifesaver
  - StrongSuperhero: carlifter + lifesaver
  - SlimeMonster: slimer + scarer
  - FlyingMonster: flier + scarer
  - BankRobber: robber + scarer
- **Inheritance:** model classes based on what they are
- **Interface:** model classes based on what they do
  - in this case, prefer interface over force-fitting inheritance

Better Design: Mix and Match Using Interfaces



Interfaces and Our Design

- As you can see, there are a lot more classes in this design
  - however, we have extreme flexibility
    - could make a flying, strong, scary, bank robbing monster without changing or force-fitting our new class into the current design
    - although you still have to implement the methods of the interface in your new class

The Challenges of Design (1/2)

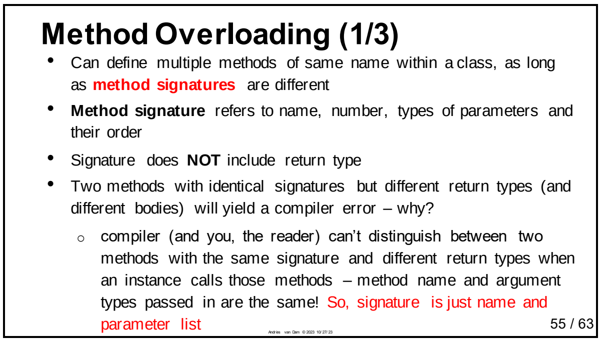
- Design a solution to a problem such that it solves the problem efficiently, but also makes it easy to extend the solution if additional functionality is required
  - only define the capabilities that you know you will need to solve the problem at hand
- Your job in creating an interface/superclass is precisely to figure out the right abstractions
  - decision making under uncertainty – you do the best you can. And frankly, opinions may differ on what is “the best solution”
  - experience (practice) really matters
- Extensibility is important, but only to a degree
  - you cannot design a program that solves every problem a user thinks of

The Challenges of Design (2/2)

- CS32 (Software Engineering) goes deeper into design decisions and tradeoffs, as well as software engineering tools
  - you can take it after you’ve completed CS0150 and CS0200!

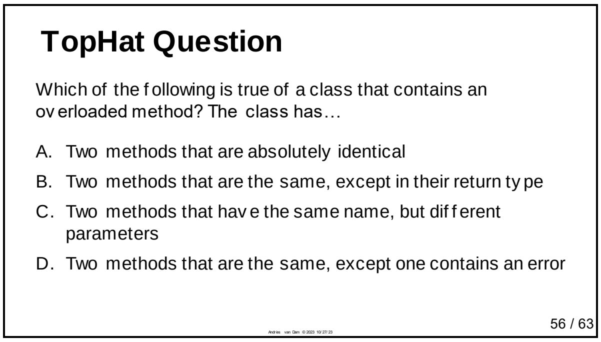
Overview

- Enums
- Factory Pattern
- Testing
- Interfacesv. Inheritance
- Method Overloading



Method Overloading (1/3)

- Can define multiple methods of same name within a class, as long as **method signatures** are different
- **Method signature** refers to name, number, types of parameters and their order
- Signature does **NOT** include return type
- Two methods with identical signatures but different return types (and different bodies) will yield a compiler error – why?
  - compiler (and you, the reader) can't distinguish between two methods with the same signature and different return types when an instance calls those methods – method name and argument types passed in are the same! So, signature is just name and parameter list



TopHat Question

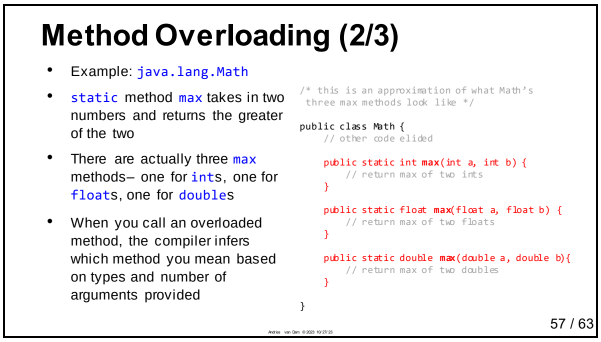
Which of the following is true of a class that contains an overloaded method? The class has…

A. Two methods that are absolutely identical

B. Two methods that are the same, except in their return type

C. Two methods that have the same name, but different parameters

D. Two methods that are the same, except one contains an error



Method Overloading (2/3)

- Example: `java.lang.Math`
- `static` method `max` takes in two numbers and returns the greater of the two
- There are actually three `max` methods– one for `int`s, one for `float`s, one for `double`s
- When you call an overloaded method, the compiler infers which method you mean based on types and number of arguments provided

```
/* this is an approximation of what Math's
 three max methods look like */

public class Math {
    // other code elided

    public static int max(int a, int b) {
        // return max of two ints
    }

    public static float max(float a, float b) {
        // return max of two floats
    }

    public static double max(double a, double b){
        // return max of two doubles
    }

}
```

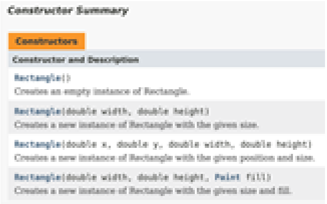
Method Overloading (3/3)

- Be careful not to confuse **overloading** and **overriding**!
  - **Overriding an inherited method in a subclass**: signatures and return types must be the same
  - **Overloading methods within the same class**: names are the same but the rest of the signatures (i.e., the parameters) must be different so the compiler can differentiate; the return types may also differ (see `max`)
- Using same signatures and return types in different classes is OK because the compiler can differentiate by class/type of instance on which the method is called

Method Overloading: Constructors

- Even constructors can be overloaded!
- Already seen this with JavaFX shapes
- Can instantiate a rectangle with any of the constructors!

```
Rectangle rect = new Rectangle ();
rect = new Rectangle (120, 360);
rect = new Rectangle (0, 0, 120, 120);
rect = new Rectangle (0, 0,
Color.BLUE);
```



Constructor Summary

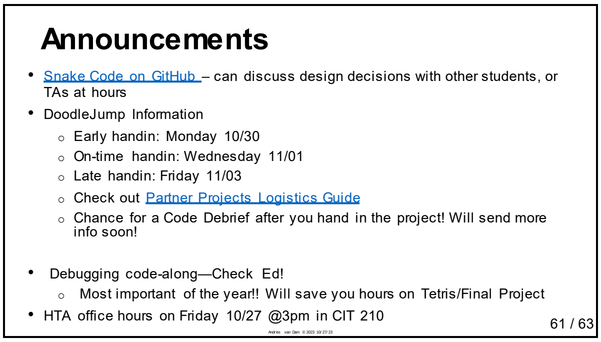
Constructors

Constructor and Description
`Rectangle()` Creates an empty instance of Rectangle.
`Rectangle(double width, double height)` Creates a new instance of Rectangle with the given size.
`Rectangle(double x, double y, double width, double height)` Creates a new instance of Rectangle with the given position and size.
`Rectangle(double width, double height, Paint fill)` Creates a new instance of Rectangle with the given size and fill.

Method Overloading: Example

- Can call an overloaded method on other overloaded methods

```
public class Halloween {

    public Halloween(HalloweenShop shop) {
        Hat hat = shop.getHat();
        this.wearCostume(hat);
    }

    public void wearCostume(Hat hat) {
        Gown gown = hat.getMatchingGown();
        this.wearCostume(hat, gown);
    }

    public void wearCostume(Hat hat, Gown gown) {
        //code to wearCostume elided
    }
    //other methods elided
}
```



Announcements

- Snake Code on GitHub – can discuss design decisions with other students, or TAs at hours
- DoodleJump Information
  - Early handin: Monday 10/30
  - On-time handin: Wednesday 11/01
  - Late handin: Friday 11/03
  - Check out Partner Projects Logistics Guide
  - Chance for a Code Debrief after you hand in the project! Will send more info soon!
- Debugging code-along—Check Ed!
  - Most important of the year!! Will save you hours on Tetris/Final Project
- HTA office hours on Friday 10/27 @3pm in CIT 210

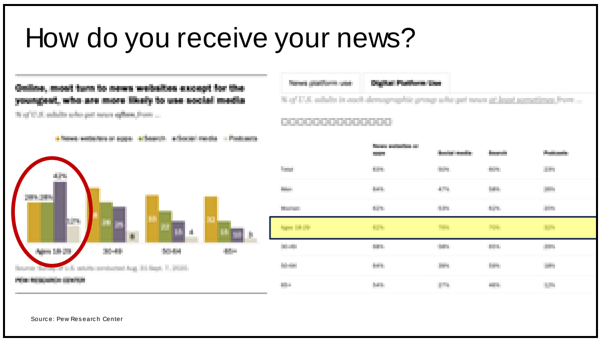
Andries van Dam © 2023 10/27/23

61 / 63

Socially Responsible Computing

Social Media & Misinformation

CS15 Fall 2023



How do you receive your news?

Online, most turn to news websites except for the youngest, who are more likely to use social media

% of U.S. adults who get news often from ...

Source: Survey of U.S. adults conducted Aug. 31-Sept. 7, 2020.

PEW RESEARCH CENTER

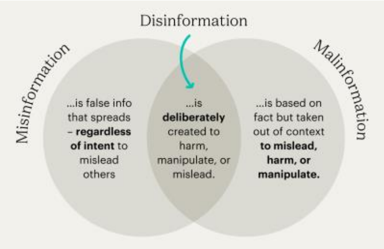
News platform use | Digital Platform Use

% of U.S. adults in each demographic group who get news at least sometimes from ...

	News websites or apps	Social media	Search	Podcasts
Total	[illegible]	[illegible]	[illegible]	[illegible]
Men	[illegible]	[illegible]	[illegible]	[illegible]
Women	[illegible]	[illegible]	[illegible]	[illegible]
Ages 18-29	[illegible]	[illegible]	[illegible]	[illegible]
30-49	[illegible]	[illegible]	[illegible]	[illegible]
50-64	[illegible]	[illegible]	[illegible]	[illegible]
65+	[illegible]	[illegible]	[illegible]	[illegible]

Source: Pew Research Center

Misinformation / Disinformation



Disinformation

Misinformation

Malinformation

...is false info that spreads – **regardless of intent** to mislead others

...is **deliberately** created to harm, manipulate, or mislead.

...is based on fact but taken out of context **to mislead, harm, or manipulate.**

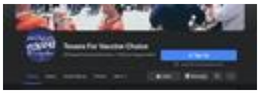
Image credit: WIT Schumann Library
Definitions coined by Prof. Claire Wardle, co-director of Brown's Information Futures Lab

Misinformation / Disinformation

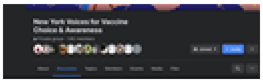
- **July 2021:** Biden: Facebook is 'killing people' because of vaccine hesitancy

  How much is FB to blame?

- **July 2023:** Louisiana judge rules that gov. agencies cannot communicate w/ social media platforms about deletion of posts



Texans For Vaccine Choice



New York Voices for Vaccine Choice & Awareness

Anti-vax Facebook groups

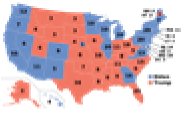
Source: NYTimes

Why is this content popular?

- Social network algorithms tend to reward extreme content!
- Shock → more engagement → more revenue
- Confirmation bias
- Filter bubble: when an internet user encounters only info/opinions that reinforce their own beliefs
  - AKA "echo chamber"
- Contrary evidence can harden a belief: "post-truth" world of alternative facts

Result: tribalism, divisiveness, polarization in the US, decline of civic responsibility

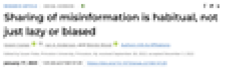
Filter bubbles. Photo Credit: Spread Privacy



Map of the 2020 electoral college. For the most part: coasts are blue, middle is red. Credit: Wikipedia

Social Media Can Reward Sharing Fake News

- In a study of 2,476 Facebook users, 30%+ of the false news shared was due to the 15% most habitual news sharers



Sharing of misinformation is habitual, not just lazy or biased

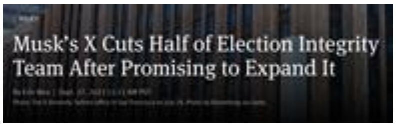
Proceedings of the National Academy of Sciences

- Social media has a rewards system (likes, etc.) that encourages users to keep posting attention-grabbing content — like a video game

X (formerly Twitter) Discussion

- **Jan 2021**: Trump permanently banned from Twitter & other platforms
- **Nov 2022**: Elon Musk ends Trump's ban after posting a poll asking if Trump should be allowed back

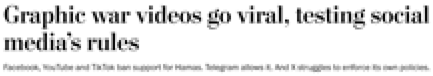
Source: NBC news



Musk's X Cuts Half of Election Integrity Team After Promising to Expand It

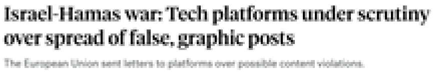
Source:
The Information (2023)

Moderating the Spread of Terrible News



Graphic war videos go viral, testing social media's rules

Facebook, YouTube and TikTok ban support for Hamas. Telegram allows it. And X struggles to enforce its own policies.



Israel-Hamas war: Tech platforms under scrutiny over spread of false, graphic posts

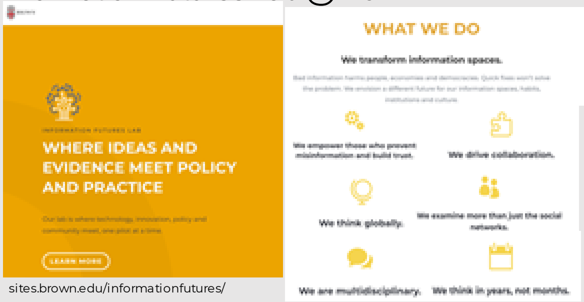
The European Union sent letters to platforms over possible content violations.

Sources: Washington Post, ABC

We can benefit from algorithmic detection and throttling + human content moderation…

but ultimately, harmful content isn't only a technical problem; it stems from the social problem of factions that want to spread mis- and dis-information.

Information Futures Lab @Brown



INFORMATION FUTURES LAB

WHERE IDEAS AND EVIDENCE MEET POLICY AND PRACTICE

Our lab is where technology, innovation, policy and community meet, one pilot at a time.

LEARN MORE

WHAT WE DO

We transform information spaces.

Bad information harms people, economies and democracies. Quick fixes won't solve the problem. We envision a different future for our information spaces, habits, institutions and culture.

We empower those who prevent misinformation and build trust.

We drive collaboration.

We think globally.

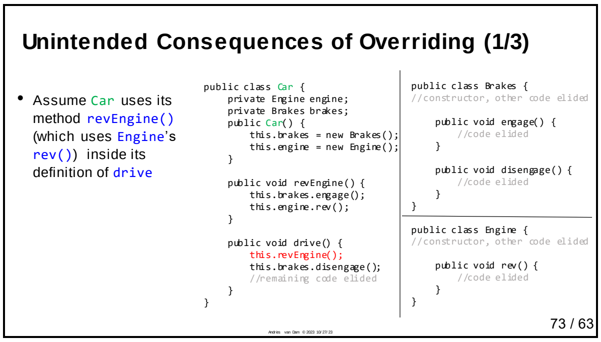
We examine more than just the social networks.

We are multidisciplinary.

We think in years, not months.

sites.brown.edu/informationfutures/

Appendix on Method Overriding!



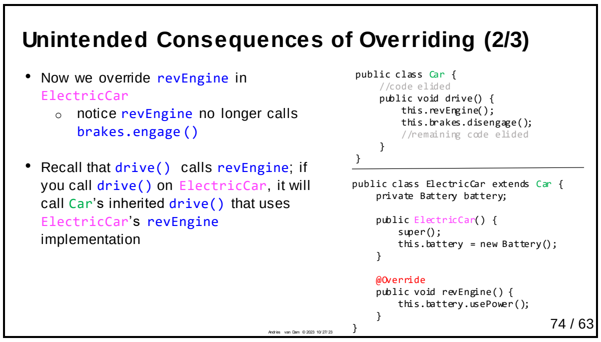
Unintended Consequences of Overriding (1/3)

- Assume Car uses its method revEngine() (which uses Engine's rev()) inside its definition of drive

```
public class Car {
    private Engine engine;
    private Brakes brakes;
    public Car() {
        this.brakes = new Brakes();
        this.engine = new Engine();
    }

    public void revEngine() {
        this.brakes.engage();
        this.engine.rev();
    }

    public void drive() {
        this.revEngine();
        this.brakes.disengage();
        //remaining code elided
    }
}
```

```
public class Brakes {
//constructor, other code elided

    public void engage() {
        //code elided
    }

    public void disengage() {
        //code elided
    }
}
```

```
public class Engine {
//constructor, other code elided

    public void rev() {
        //code elided
    }
}
```

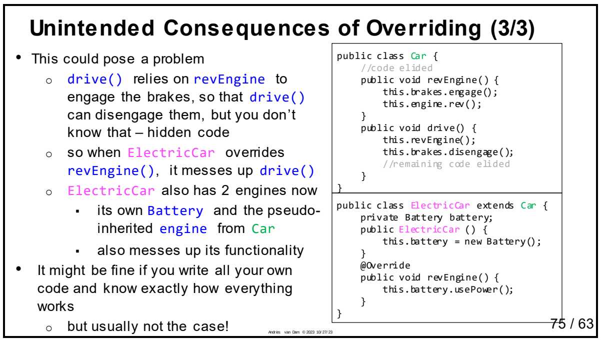


Unintended Consequences of Overriding (2/3)

- Now we override revEngine in ElectricCar
    - notice revEngine no longer calls brakes.engage()
- Recall that drive() calls revEngine; if you call drive() on ElectricCar, it will call Car's inherited drive() that uses ElectricCar's revEngine implementation

```
public class Car {
    //code elided
    public void drive() {
        this.revEngine();
        this.brakes.disengage();
        //remaining code elided
    }
}
```

```
public class ElectricCar extends Car {
    private Battery battery;

    public ElectricCar() {
        super();
        this.battery = new Battery();
    }

    @Override
    public void revEngine() {
        this.battery.usePower();
    }
}
```



Unintended Consequences of Overriding (3/3)

- This could pose a problem
    - drive() relies on revEngine to engage the brakes, so that drive() can disengage them, but you don't know that – hidden code
    - so when ElectricCar overrides revEngine(), it messes up drive()
    - ElectricCar also has 2 engines now
        - its own Battery and the pseudo-inherited engine from Car
        - also messes up its functionality
- It might be fine if you write all your own code and know exactly how everything works
    - but usually not the case!

```
public class Car {
    //code elided
    public void revEngine() {
        this.brakes.engage();
        this.engine.rev();
    }
    public void drive() {
        this.revEngine();
        this.brakes.disengage();
        //remaining code elided
    }
}
```

```
public class ElectricCar extends Car {
    private Battery battery;
    public ElectricCar () {
        this.battery = new Battery();
    }
    @Override
    public void revEngine() {
        this.battery.usePower();
    }
}
```