Assignment 2 – Road Rage

School of Engineering and Technology, University of Washington Tacoma
TCSS 305 Programming Practicum, Winter 2026

Due Date

Sunday, 8 February 2026, 23:59:59

Description

This assignment builds your understanding of **inheritance, polymorphism, interfaces, and abstract classes**. You will build a simulator of city streets, traffic lights, and vehicles.

Your task is to write classes that model various vehicles in the city. You'll start by implementing three vehicle classes independently, then **discover the duplication** and extract common code into an abstract parent class. This "feel the pain first" approach helps you understand *why* inheritance exists—not just how to use it.

A complete graphical user interface (GUI) is provided—you focus solely on the vehicle logic.

Learning Objectives

By completing this assignment, you will:

- Implement classes that fulfill an interface contract
- Discover code duplication across similar classes
- Extract common code into an abstract parent class (refactoring)
- Design an inheritance hierarchy using abstract classes
- Apply polymorphism to create vehicles with varied behaviors
- Write unit tests for classes with random behavior
- Use encapsulation to protect internal state

Before You Begin

Ensure you have completed:

- JDK 25 installed and configured
- IntelliJ IDEA installed with Checkstyle plugin
- Completed Assignments 1a, 1b, and 1c

Project Setup

This project uses **GitHub Classroom** to distribute starter code and collect submissions.

Accept the Assignment

GitHub Classroom

https://classroom.github.com/a/1YPl4V-A

1. Click the GitHub Classroom assignment link provided by your instructor.
2. **First time only:** Select your name from the course roster to link your UW identity to your GitHub username.
3. Click **Accept this assignment**. GitHub creates a personal repository for you.
4. Copy the repository URL from the green **Code** button.

Clone the Repository in IntelliJ

1. Open IntelliJ IDEA.
2. **File** → **New** → **Project from Version Control** (or **Get from VCS** on Welcome screen)
3. Paste the repository URL and choose a location.
4. Click **Clone**, then **Trust Project** when prompted.

Project Structure

The starter code includes a complete GUI, supporting classes, and **stubs** for three vehicle classes.

```
TCSS305-a2/
├── src/
│   └── edu/uw/tcss/
│       ├── app/
│       │   └── RoadRageMain.java            (main class - provided)
│       ├── io/
│       │   └── FileLoader.java             (file loading - provided)
│       ├── logic/
│       │   ├── CollisionComparators.java   (collision strategies - provided)
│       │   ├── Direction.java              (enum - provided)
│       │   ├── Light.java                  (enum - provided)
│       │   ├── RoadRage.java               (simulation engine - provided)
│       │   ├── RoadRageEvent.java          (sealed interface - provided)
│       │   └── Terrain.java                (enum - provided)
│       ├── model/
│       │   ├── Vehicle.java                (interface - provided)
│       │   ├── Truck.java                  (stub - implement this first)
│       │   ├── Car.java                    (stub - implement this second)
│       │   ├── Bicycle.java                (stub - implement this third)
│       │   ├── AbstractVehicle.java        (create this - extract common
code)
│       │   ├── Taxi.java                   (create from scratch)
│       │   ├── Atv.java                    (create from scratch)
│       │   └── Human.java                  (create from scratch)
│       └── view/                           (GUI - provided, do not modify)
├── test/
│   └── edu/uw/tcss/model/
│       ├── TruckTest.java                  (partial - complete this)
│       ├── CarTest.java                    (partial - complete this)
│       ├── BicycleTest.java                (partial - complete this)
│       ├── TaxiTest.java                   (create this)
│       ├── AtvTest.java                    (create this)
│       └── HumanTest.java                  (create this)
├── icons/                                  (vehicle sprites - provided)
├── maps/                                   (map files - provided)
│   └── city_map1.txt                       (default map)
├── config/                                 (configuration files)
│   └── vehicles.txt                        (vehicle configuration - see
below)
├── executive-summary.md                    (document your submission)
└── README.md                               (project readme - provided)
```

Vehicle Configuration (`config/vehicles.txt`)

The GUI loads vehicles from `config/vehicles.txt`. This file controls which vehicles appear in the simulation:

```
# Phase 1: Implement these first (stubs provided)
Truck
Car
Bicycle

# Phase 2: Add these after creating AbstractVehicle
#Taxi
```

```
#Atv
#Human
```

Lines starting with `#` are comments (ignored). As you implement each vehicle:

1. Start with Truck, Car, and Bicycle (already uncommented)
2. After creating AbstractVehicle and refactoring, uncomment Taxi, Atv, and Human as you implement them

Warning

If you uncomment a vehicle that doesn't exist or has compile errors, the GUI will display an error message with the class name. Check your spelling and package location.

The `Vehicle` Interface

Every vehicle class must implement the `Vehicle` interface. The provided stubs already declare `implements Vehicle`—your job is to implement each method.

Vehicle Interface

The `Vehicle` interface defines the contract for all vehicles in the simulation.

```
Direction chooseDirection(Map<Direction, Terrain> theNeighbors)
```

Returns the direction this vehicle would like to move, given the neighboring terrain. The map keys are `Direction` values; the map values are `Terrain` types.

```
boolean canPass(Terrain theTerrain, Light theLight)
```

Returns whether this vehicle can pass through the given terrain when lights are in the given state.

```
void collide()
```

Called when this vehicle **loses** a collision. The vehicle should update its own state (e.g., become disabled). The GUI determines collision winners using mass—you just handle what happens when your vehicle loses.

```
int getMass()
```

Returns this vehicle's mass. Heavier vehicles win collisions (by default). Each vehicle type has a specific mass value—see the vehicle descriptions below.

```
String getImageFileName()
```

Returns the image filename for the GUI to display. The filename must include the vehicle's current direction for enabled vehicles.

- **Enabled:** `{classname}_{direction}.png` (e.g., `"taxi_north.png"`, `"human_west.png"`)
- **Disabled:** `{classname}_disabled.png` (e.g., `"taxi_disabled.png"`, `"human_disabled.png"`)

```
int getDisabledDuration()
```

Returns the number of updates this vehicle stays disabled after a collision.

```
Direction getDirection()
```

Returns the direction this vehicle is currently facing.

```
int getX()
```

Returns the x-coordinate of this vehicle.

```
int getY()
```

Returns the y-coordinate of this vehicle.

```
boolean isEnabled()
```

Returns whether this vehicle is currently enabled (able to move).

```
void poke()
```

Called by the GUI once per update on disabled vehicles. Allows disabled vehicles to track their recovery countdown and become enabled when ready. When becoming enabled again, set direction to a random direction using `Direction.random()`.

```
void reset()
```

Resets this vehicle to its initial state (position and direction from construction).

```
void setDirection(Direction theDir)
```

Sets this vehicle's direction. Called by the GUI controller.

```
void setX(int theX)
```

Sets this vehicle's x-coordinate. Called by the GUI controller.

```
void setY(int theY)
```

Sets this vehicle's y-coordinate. Called by the GUI controller.

Provided Enumeration Types

The following enums are provided in the `logic` package:

```
public enum Direction {
    NORTH, WEST, SOUTH, EAST;

    public static Direction random()     // returns a random direction
    public Direction left()              // returns direction 90° counter-
clockwise
    public Direction right()             // returns direction 90° clockwise
```

```
    public Direction reverse()          // returns the opposite direction
}

public enum Light { GREEN, YELLOW, RED }

public enum Terrain { GRASS, STREET, LIGHT, WALL, TRAIL, CROSSWALK }
```

Understanding Enums

New to Java enums or need a refresher? See the Java Enums guide to learn how to use Direction, Light, and Terrain effectively in your vehicle implementations.

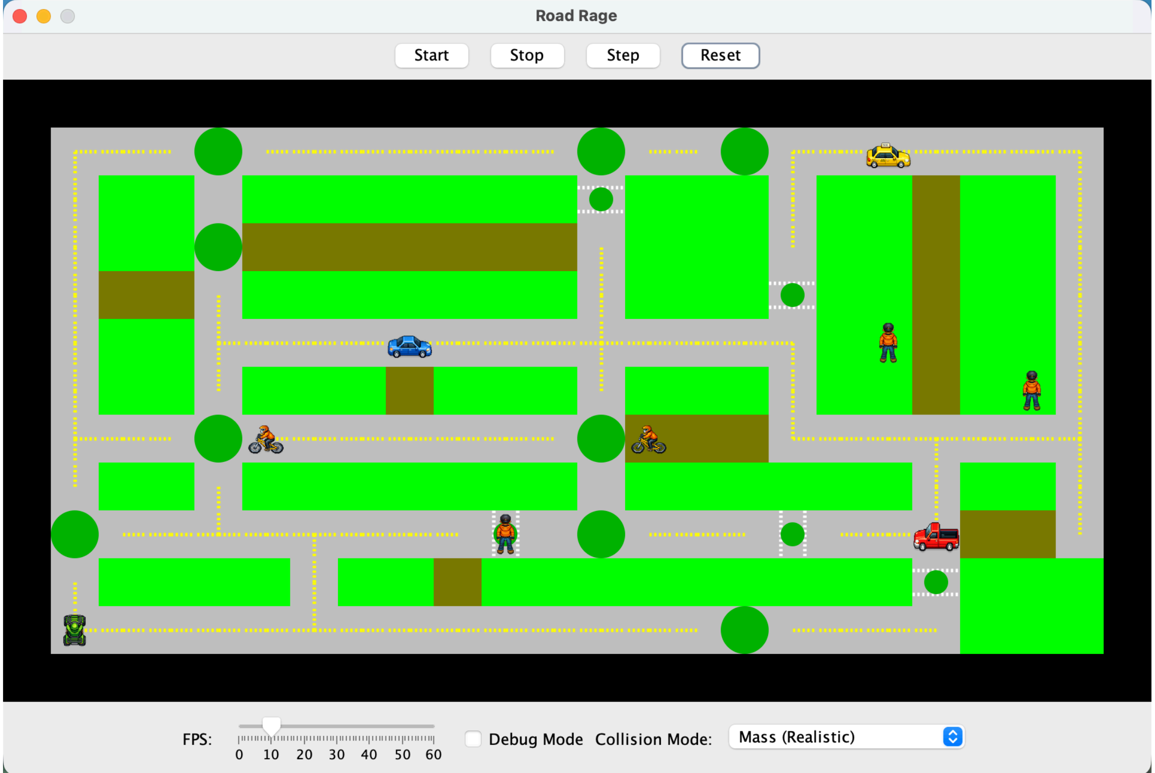
The GUI and Provided Packages

The starter code is organized into packages with specific responsibilities:

Package	Responsibility
`io`	File I/O — loads map files and vehicle configuration
`logic`	Game processing — movement, collisions, traffic light cycling
`view`	Rendering and controls — what you see in the GUI

You write code in the `model` package. The other packages interact with your vehicles through the `Vehicle` interface.

GUI Features



- **Controls:** Start/Stop animation, Step (single frame), Reset
- **Speed Slider:** Controls animation rate
- **Collision Mode:** Dropdown to select collision strategy (Mass is default)
- **Debug Mode:** Shows (x, y) coordinates and `toString()` output for each vehicle

Customizing the Map

Want to test with a different map? Look at `io/FileLoader.java` — you can change the map filename constant to load a different map file from the `maps/` directory. See the Creating Custom Maps guide to learn the map file format and create your own test scenarios.

How the Simulation Works

The `logic` package runs the simulation. Here's the actual `advance()` method (simplified):

```
@Override
public void advance() {
    for (final Vehicle v : myVehicles) {
        final Map<Direction, Terrain> neighbors = generateNeighbors(v);

        // move the vehicle
        if (v.isEnabled()) {
            final Direction newDirection = v.chooseDirection(neighbors);
            v.setDirection(newDirection);
```

```
            // move one square in current direction, if it's okay to do so
            if (v.canPass(neighbors.get(newDirection), myLight)) {
                v.setX(v.getX() + newDirection.dx());
                v.setY(v.getY() + newDirection.dy());
            }
        } else {
            // become one move closer to revival
            v.poke();
        }

        // look for collisions
        for (final Vehicle other : myVehicles) {
            if (v == other) { // don't collide with self
                continue;
            }

            if (v.getX() == other.getX() && v.getY() == other.getY()) {
                // resolve collision using the current Comparator
                resolveCollision(v, other);
            }
        }
    }
    // ... system-level steps: advance timestep, change lights, notify
observers
}
```

Note: The actual method includes additional system-level steps (advancing the timestep, cycling traffic lights, notifying observers) that are omitted here since they don't involve your vehicle classes.

What this code does:

- For each vehicle, generate a map of neighboring terrain
- If the vehicle is enabled: choose a direction, set it, then check if the vehicle can pass into that terrain given the current light. If yes, move forward.
- If the vehicle is disabled: call `poke()` to count down toward recovery
- After moving, check for collisions with other vehicles at the same position (both vehicles must be enabled for a collision to occur)
- Resolve collisions using the selected collision comparator

Two-Step Movement

Movement happens in two steps. First, the vehicle picks a direction based on neighboring terrain, ignoring lights. Then it checks if the light allows entry. A vehicle stopped at a red light waits in place and does not re-route around the light. Pay close attention to Truck rules. It may look like Trucks don't follow this pattern, but they do.

Polymorphism in Action

Notice how the loop iterates over `List<Vehicle>`. Each vehicle responds differently to `chooseDirection()` and `canPass()` based on its type — a Truck behaves differently than a Bicycle, even though both implement `Vehicle`. This is **polymorphism**: the same method call produces different behavior depending on the actual object type.

Understanding Polymorphism

Want to understand this concept deeply? See the Polymorphism guide to learn how polymorphism works and why it's essential for extensible code.

Collision Resolution

When two vehicles occupy the same position, a collision occurs. By default, the vehicle with **higher mass wins**. The losing vehicle's `collide()` method is called, which should disable it.

The GUI provides a **Collision Mode** selector (next to Debug Mode) that changes how collisions are resolved:

- **Mass (Realistic)** — Higher mass wins (default)
- **Random (Chaos)** — Winner chosen randomly
- **Inverted Mass (Underdog)** — Lower mass wins

Each vehicle has a **mass** value (see property tables in requirements). The mass determines collision outcomes:

- Higher mass → wins collisions (in default mode)
- Lower mass → becomes disabled when colliding with a heavier vehicle
- Equal mass → one vehicle chosen randomly (50/50)

The disabled duration determines how many updates a vehicle stays disabled before becoming enabled again. During this time, `poke()` is called each update to count down the recovery.

Understanding Comparators

Curious how collision modes work? The system uses `Comparator` to determine winners. See the Comparable and Comparator guide to understand ordering and comparison strategies.

> **Optional: Exploring the Codebase**
>
> Want to see how the starter code uses professional design patterns? The Exploring the Road Rage Codebase guide reveals the Strategy, Factory, Observer, and Sealed Types patterns hidden in the provided code.

Requirements

This assignment is structured to help you **discover** why inheritance is useful. You'll implement three vehicles independently, notice the duplication, then refactor.

> **Gen AI & Learning: Why Manual Implementation Matters**
>
> AI tools can generate boilerplate code quickly, but understanding inheritance hierarchies requires you to make design decisions: What belongs in the parent class? What's unique to each child? By implementing three classes first and *feeling* the duplication, you'll build intuition that helps you evaluate AI-generated code later. When AI suggests an inheritance structure, you'll know whether it makes sense.

Requirement 1: Truck

Implement the `Truck` class by completing the provided stub. The stub already implements `Vehicle`—you need to add fields, constructor logic, and method implementations.

Property	Value
Constructor	`public Truck(int theX, int theY, Direction theDir)`
Mass	100

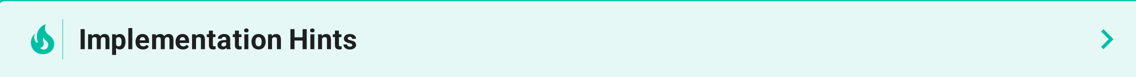
Property	Value
Disabled Duration	5
Images	`truck_{direction}.png` (enabled), `truck_disabled.png` (disabled)

Constructor Signature Required

The constructor signature `(int theX, int theY, Direction theDir)` is required. The file loading system depends on this exact signature—do not change it.

Movement behavior:

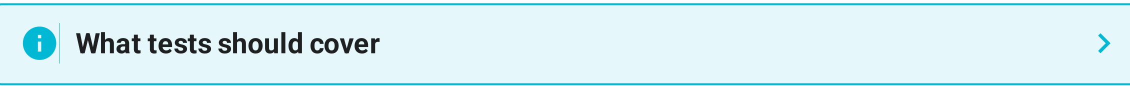
- Travels only on streets, traffic lights, and crosswalks. All other terrain is impassable.
- Randomly selects straight, left, or right from valid directions
- If all three directions are impassable, reverses
- Drives through **all** traffic lights without stopping
- Stops for **red** crosswalk lights; drives through yellow or green crosswalk lights



Testing: The starter includes `TruckTest.java` with partial tests demonstrating how to test random behavior. Study these tests, then complete the test class.

Testing Random Behavior

Testing methods with randomness requires special techniques. See the Testing Complex Logic guide for strategies used in the provided tests.



Requirement 2: Car

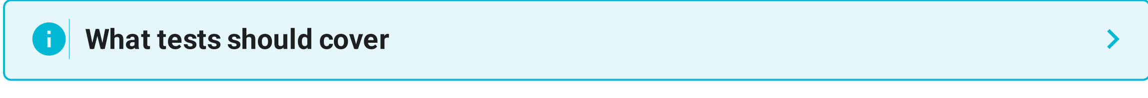
Implement the `Car` class by completing the provided stub.

Property	Value
Constructor	`public Car(int theX, int theY, Direction theDir)`
Mass	50
Disabled Duration	15
Images	`car_{direction}.png` (enabled), `car_disabled.png` (disabled)

Movement behavior:

- Travels only on streets, traffic lights, and crosswalks. All other terrain is impassable.
- Prefers straight; if impassable, tries left; if impassable, tries right; last resort: reverses
- Stops for **red** traffic lights (stays still, does not turn to avoid)
- Ignores yellow and green traffic lights
- Stops for **red and yellow** crosswalk lights; drives through green crosswalk lights

Testing: The starter includes `CarTest.java` with partial tests demonstrating how to test directional preference and traffic light behavior. Complete the test class.



Requirement 3: Bicycle

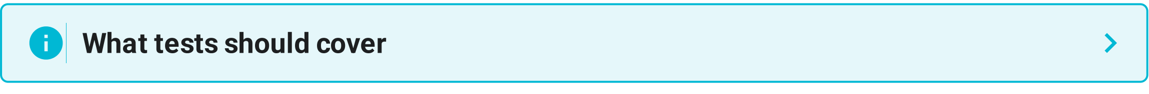
Implement the `Bicycle` class by completing the provided stub.

Property	Value
Constructor	`public Bicycle(int theX, int theY, Direction theDir)`
Mass	20
Disabled Duration	35
Images	`bicycle_{direction}.png` (enabled), `bicycle_disabled.png` (disabled)

Movement behavior:

- Travels on streets, traffic lights, crosswalks, and trails. All other terrain is impassable.
- **Prefers trails.** Trail-seeking priority:
  a. If trail is straight ahead → go straight
  b. If trail is to the left (but not straight) → turn left
  c. If trail is to the right (but not straight or left) → turn right
- If no trail in S/L/R directions: prefers straight; if impassable, tries left; if impassable, tries right; last resort: reverses
- **Note:** Will not reverse just to face a trail behind it — once it leaves a trail, it continues forward
- **Stops for yellow and red** traffic lights and crosswalk lights
- Ignores green traffic lights and green crosswalk lights

Testing: The starter includes `BicycleTest.java` with partial tests demonstrating how to test terrain-seeking behavior. Complete the test class.



Requirement 4: AbstractVehicle

Stop and look at your Truck, Car, and Bicycle classes. How much code is duplicated? Fields? Constructor logic? Getter/setter implementations? The `getImageFileName()` method? The `reset()` method?

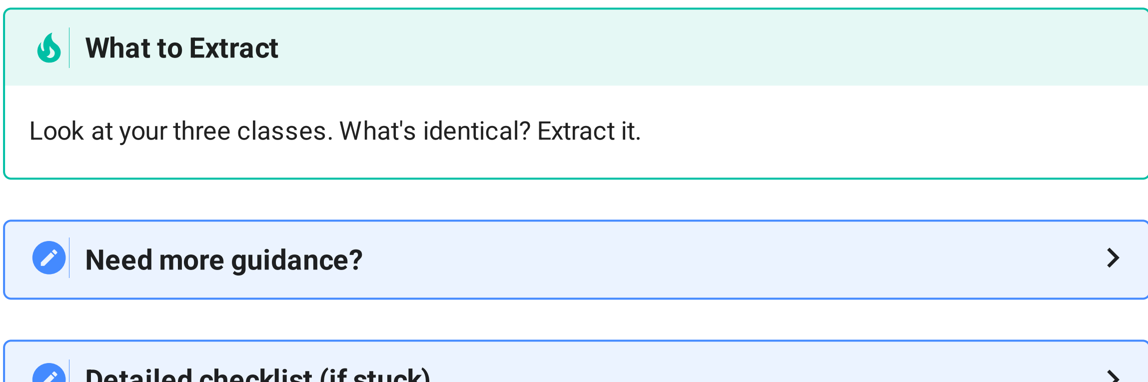
Create an `AbstractVehicle` class that extracts this common code. Then refactor Truck, Car, and Bicycle to extend it.

Requirements:

- `AbstractVehicle` must be abstract and implement `Vehicle`
- Contains all common instance fields shared by vehicle types
- Has a protected constructor that initializes these fields
- All instance fields must be `private`
- Implements all methods that are identical (or nearly identical) across vehicles
- Child classes implement only `canPass()` and `chooseDirection()` (their unique behavior)

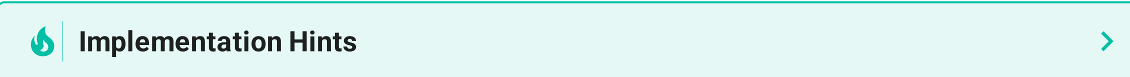
After refactoring:

- Your existing tests should still pass! Inherited methods work the same way.
- Run all your Truck, Car, and Bicycle tests to verify.



Additional constraints:

- You may NOT add new public or package-level methods to `AbstractVehicle` (except `toString()`)
- You may add `protected` non-abstract methods if your design calls for them
- All instance fields must remain `private` — use protected methods to provide access if needed
- Do NOT hardcode child class names in AbstractVehicle (e.g., no `if (this instanceof Truck)`)



Design Decision: Should `reset()` be `final`?

About your tests

Your Truck, Car, and Bicycle tests should still pass after refactoring—inherited methods work the same way. In a professional codebase, you might refactor tests to match the new class structure, but that's optional here.

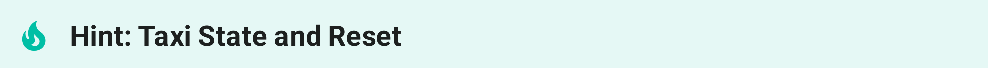
Requirement 5: Taxi

Create a new `Taxi` class from scratch. You may extend `AbstractVehicle` directly, or extend another vehicle class if you can reuse significant functionality.

Property	Value
Constructor	`public Taxi(int theX, int theY, Direction theDir)`
Mass	50
Disabled Duration	15
Images	`taxi_{direction}.png` (enabled), `taxi_disabled.png` (disabled)

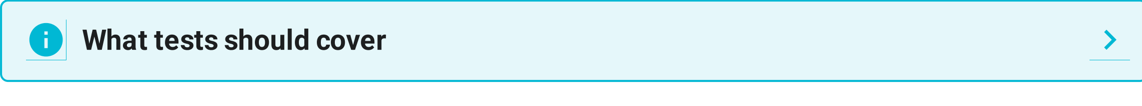
Movement behavior:

- Travels only on streets, traffic lights, and crosswalks. All other terrain is impassable.
- Prefers straight; if impassable, tries left; if impassable, tries right; last resort: reverses
- Stops for **red** traffic lights (does not turn to avoid)
- Ignores yellow and green traffic lights
- Stops for **red** crosswalk lights for **3 clock cycles or until the crosswalk light turns green**, whichever comes first
- Drives through yellow or green crosswalk lights



Hint: Taxi State and Reset

Testing: Create `TaxiTest.java` and write tests. Pay special attention to testing the 3-cycle crosswalk waiting behavior.



What tests should cover

Important

After implementing Taxi, uncomment `Taxi` in `config/vehicles.txt` to see it in the simulation.

Requirement 6: ATV

Create a new `Atv` class from scratch. You may extend `AbstractVehicle` directly, or extend another vehicle class if you can reuse significant functionality.

Property	Value
Constructor	`public Atv(int theX, int theY, Direction theDir)`
Mass	40
Disabled Duration	25
Images	`atv_{direction}.png` (enabled), `atv_disabled.png` (disabled)

Movement behavior:

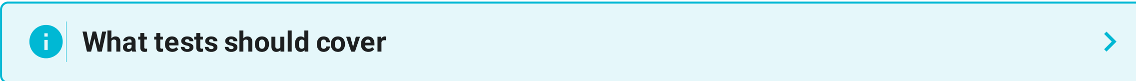
- Travels on **any terrain except walls**. Walls are impassable.
- Randomly selects straight, left, or right from valid directions
- Ignores **all** traffic lights and crosswalk lights

- **Edge case:** If all three directions (S/L/R) are walls, reverses. This is the only situation where ATV reverses.

In Provided Maps

In all provided maps, an ATV should never stop or reverse. These edge cases only occur in custom maps where the ATV is surrounded by walls.

Testing: Create `AtvTest.java` and write tests. Use the randomness testing patterns you learned from `TruckTest.java`.



What tests should cover

Important

After implementing Atv, uncomment `Atv` in `config/vehicles.txt` to see it in the simulation.

Requirement 7: Human

Create a new `Human` class from scratch. You may extend `AbstractVehicle` directly, or extend another vehicle class if you can reuse significant functionality.

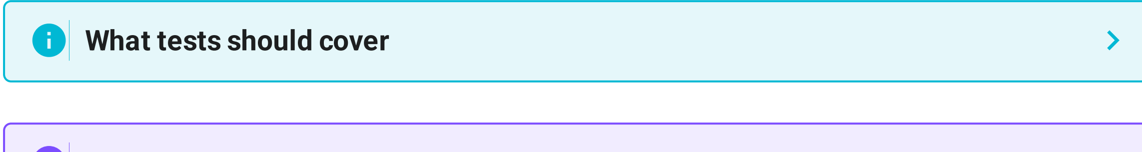
Property	Value
Constructor	`public Human(int theX, int theY, Direction theDir)`
Mass	10
Disabled Duration	45

Property	Value
Images	`human_{direction}.png` (enabled), `human_disabled.png` (disabled)

Movement behavior:

- Travels on **grass and crosswalks only**. All other terrain is impassable.
- Randomly selects straight, left, or right from valid directions
- If all three directions are impassable, reverses
- **Crosswalk-seeking:** If adjacent to a crosswalk in S/L/R directions, turns to face it. Will NOT reverse just to face a crosswalk behind (prevents back-and-forth oscillation). However, if the only valid terrain is behind, Human reverses as a last resort.
- **Waits for green crosswalk lights** — will not enter a crosswalk on green
- Crosses through yellow and red crosswalk lights

Testing: Create `HumanTest.java` and write tests. Use the terrain-seeking patterns you learned from `BicycleTest.java`.

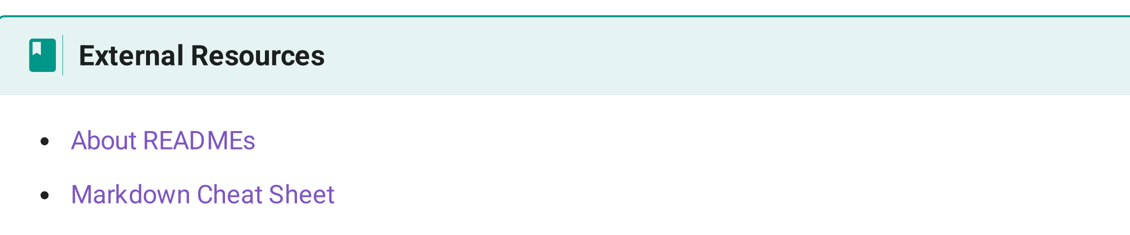


Important

After implementing Human, uncomment `Human` in `config/vehicles.txt` to see it in the simulation.

Requirement 8: Executive Summary

Edit `executive-summary.md` to personalize it for your submission. Remove all placeholder text in square brackets and replace with your own details.



Guide Reference

The following guides support this assignment. See the A2 Guides page for when to read each one.

Guide	Description
Java Enums	Understanding Direction, Light, and Terrain enums
Polymorphism	How the simulation uses polymorphism — same method call, different behavior
Comparable and Comparator	Collision resolution and ordering strategies
Testing Complex Logic	Testing random behavior, directional preferences, and terrain-seeking logic
Creating Custom Maps	**(Reference)** Map file format for testing custom configurations
Exploring the Road Rage Codebase	**(Optional)** Deep-dive into design patterns in the starter code

---

Submission and Grading

Important

Start early—inheritance design requires careful planning.

Please see the rubric in Canvas for a breakdown of the grade for this assignment.

Git Workflow Required

For this assignment, you must work on a **development branch** and submit via **pull request**.

Submitting Your Work

1. **Ensure all your work is committed** to your `dev` branch

2. **Push your dev branch** to GitHub:

   In IntelliJ: Click **Git → Push**, then click **Push**

   Or from the terminal:

   ```
   git push -u origin dev
   ```

3. **Create a Pull Request** on GitHub:
   - Go to your repository on GitHub.com
   - Click **Pull requests → New pull request**
   - Set base: `main` and compare: `dev`
   - Add a descriptive title and summary of your changes
   - Click **Create pull request**
4. **Merge the pull request** to main
5. **Verify:** Visit your repository on GitHub.com and confirm your changes appear on the `main` branch

Note: You can commit and push multiple times. Only your final state of `main` at the deadline will be graded.