
JAVA

EXERCISES

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JAVA / GRADLE

1. CREATE PROJECT

1. Open **IDEA IntelliJ** and create a new project but this time choose **Gradle** as your project type and make sure that **Java** is selected in the additional libraries and frameworks.

2. **Gradle**  is a build automation tool that simplifies all build tasks, from dependency management to the actual building, running, testing and publishing.

3. To use **Gradle** we need to choose (1) a name (e.g., **hero**), (2) an appropriate **location**, and, on the **Artifact Coordinates** section, choose (3) a **GroupId** (uniquely identifies your project across all projects and should follow the Java packages convention — e.g., **com.yourusername.hero**), (4) an **ArtifactId** (a lowercase name representing your project — e.g., **hero**), and (5) a **Version** (**1.0-SNAPSHOT** is fine for now).

4. Click “**Finish**”.

2. CREATE REPOSITORY

You should commit each step of these exercises to Git.

Start by creating a new **private** Git repository on **GitHub** called **hero** and then open a **command line** window.

```
cd directory/of/my/project/hero  
git init
```

Add your **GitHub** repository as a remote for this project (don't forget to replace *yourusername* with your actual *username*):

```
git remote add origin git@github.com:yourusername/hero.git
```

Using **IntelliJ**, create a **".gitignore"** file on your project root with the following contents:

```
.idea/  
.gradle/  
out/  
build/  
*.iml
```

Verify that these are the only files that will be added to your repository using "**git status**".

```
.gitignore  
build.gradle  
gradle/  
gradlew  
gradlew.bat  
settings.gradle
```

Stage and commit all changes:

```
git add -A  
git commit -a -m "Initial version"
```

Push and **track** your **master** branch so that you only have to do "**git push**" next time you want to push to your remote repository.

```
git push -u origin master
```

From now on, **commit** each one of the following steps into your repository.

3. BUILDING AND RUNNING

One of the features of **Gradle** is that it allows us to **build** and **run** our applications from the **command line** very easily. Try building your application by doing:

```
$ ./gradlew build # or gradlew.bat build if you're using windows  
BUILD SUCCESSFUL in 0s  
1 actionable task: 1 executed
```

You should now have a new directory called **build** having a new **.jar** file. **Jar** files are how Java applications are **distributed**.

Now lets create an "**Application**" class, within the **src/main/java** directory, so we can try running using **Gradle**:

```
public class Application {  
    public static void main(String[] args) {  
        System.out.println("Hello World!");  
    }  
}
```

To run our code we first need to make a few changes to the **build.gradle** file (this file controls every gradle aspect of our project).

In the **plugins** section add a new plugin called '**application**':

```
plugins {  
    id 'java'  
    id 'application'  
}
```

And then we configure the plugin:

```
application {  
    mainClass.set("Application")  
}
```

Whenever we change any **Gradle** file, we need to import those changes. **IntelliJ** should be asking you if you want to import these last changes. Choose "**Enable Auto-Import**" so you don't have to deal with this anymore.

Now, try running your application using:

```
./gradlew run
```

Notice that gradle knows that to "**run**" your application it needs to "**build**" it first. That's just another neat **Gradle** feature.

4. IMPORT LANTERNA

Another feature of **Gradle** is the ability to easily **manage dependencies**.

In this project we'll be using [Lanterna](#), a Java library for creating text-based GUIs. You can find the line you have to add in order to include this library [here](#) (I just googled "lantern gradle"). Just choose the latest version (probably 3.1.1) and then choose Gradle. You are looking for something like this:

```
implementation group: 'com.googlecode.lanterna', name: 'lanterna',  
version: '3.1.1'
```

Add it to your **build.grade** dependencies section:

```
dependencies {  
    implementation group: 'com.googlecode.lanterna', name: 'lanterna',  
    version: '3.1.1'  
}
```

After changing your `build.gradle` you have to ask IntelliJ to **load** any changes. This can be done in several ways: using the shortcut **Ctrl+Shift+O**, clicking the cute elephant with a blue **reload icon**, opening the **Gradle tab** on the right and clicking the **reload icon**, and you can even set *IntelliJ* to **reload automatically** everytime this file changes by clicking the **wrench icon** (🔧) and configuring "*Auto Reload Settings*".

Note: Reloading *Gradle* can take some time...

Now we can use **Lanterna** in our project.

5. USING LANTERNA

Lanterna can utilize many types of terminals for different OSs. The **DefaultTerminalFactory** class creates one based on **Swing** (a GUI widget toolkit for Java) that should work anywhere. Let's use that one for now.

During these exercises don't forget to try the power of the **Alt+Enter** shortcut. This shortcut will try to automatically fix problems, offer suggestions and auto-complete code.

The **Screen** class simplifies the usage of **Lantern** terminals by allowing developers to add characters to a back panel and then swaping it with the current panel in one go. The following code initializes a **Lanterna Terminal** and a **Screen**:

```
Terminal terminal = new DefaultTerminalFactory().createTerminal();
Screen screen = new TerminalScreen(terminal);

screen.setCursorPosition(null);    // we don't need a cursor
screen.startScreen();            // screens must be started
screen.doResizeIfNecessary();    // resize screen if necessary
```

Start by replacing your `main(String[])` method with this code.

Both the `createTerminal() method` and the `TerminalScreen constructor` can throw a `IOException` so we have to wrap this code inside a `try-catch` block:

```

try {
    Terminal terminal = new DefaultTerminalFactory().createTerminal();
    Screen screen = new TerminalScreen(terminal);

    screen.setCursorPosition(null);      // we don't need a cursor
    screen.startScreen();                // screens must be started
    screen.doResizeIfNecessary();        // resize screen if necessary
} catch (IOException e) {
    e.printStackTrace();
}

```

If you want to set the **terminal size** to a certain number of columns and rows, you need to **configure** the **terminal factory** first:

```

TerminalSize terminalSize = new TerminalSize(40, 20);
DefaultTerminalFactory terminalFactory = new DefaultTerminalFactory()
    .setInitialTerminalSize(terminalSize);
Terminal terminal = terminalFactory.createTerminal();

```

Adding a character to our screen is just a matter of calling the **setCharacter(x, y, char)** method, but before we see any changes we must call the **refresh()** method, and if we want to clear the current screen we must call the **clear()** method first:

```

screen.clear();
screen.setCharacter(10, 10, TextCharacter.fromCharacter('X')[0]);
screen.refresh();

```

These three methods are the basis of drawing using **Lanterna**. Everytime we want to update our screen, we call **clear** first, we then **set** all the characters at their current positions and then we **refresh** the screen.

Add these **three lines** to your **main(String[])** method and try running your project. And don't forget to **commit** and **push**...

6. CREATING THE GAME

Until this moment we have been writing all our code inside a **static** method (the **main** method of the **Application** class). That's not very **object-oriented**... Let's change that:

1. Create a new class called **Game**.

2. Copy the code that **initializes** the *terminal* and *screen* to the default constructor of this new class. This time make the **screen** variable a **class field**.

3. Create two new methods in this class: a *private* **draw()** method and *public* **run()** method.

4. Copy the code that paints the screen (those three last lines) to the **draw()** method.

5. Make the **run()** method call the **draw()** method.

6. Clear the original **main(String[])** method, and inside it create a new **Game** object and call the **run()** method on it.

Important: There are several **Lanterna** methods that throw **IOException** exceptions. When developing your code, you have to decide if your class should be **responsible** for handling each particular exception or if it should **pass it** to the calling method by **declaring** that it **throws** that **kind** of exception. Catching an exception should only be done if your method knows how to handle it properly.

For example, if you don't want your **draw()** method to catch and handle any **IOException** then just throw the exception like this:

```
private void draw() throws IOException {  
    // ...  
}
```

Take a moment to understand **how** exceptions work and **how** you should **handle** them. Ask your **teacher** if you need help with that.

Don't forget to **commit** and **push** your work regularly.

7. READING KEYSTROKES

Add two new fields to the Game class:

```
private int x = 10;  
private int y = 10;
```

And now, instead of drawing an '**X**' in position **(10, 10)**, let's draw it in position **(x, y)**:

```
screen.setCharacter(x, y, TextCharacter.fromCharacter('X')[0]);
```

The screen **readInput()** method waits for a **key stroke** pausing until it gets one:

```
KeyStroke key = screen.readInput();
```

Create a private **processKey(KeyStroke)** method. This method should receive a **KeyStroke** and print it:

```
private void processKey(KeyStroke key) {  
    System.out.println(key);  
}
```

In your **run()** method: 1) call the **draw()** method, 2) **read a key stroke** and 3) **send it to the processKey(KeyStroke) method**.

Run your code and try **pressing some key** (e.g. **the arrow up key**) and you should get the following result in the **console**:

```
KeyStroke{keytype=ArrowUp}
```

As you can see, **Lanterna** detected that you pressed the **ArrowUp** key and returned a **KeyStroke** containing that information. You can now test the key within the **processKey()** method:

```
if (key.getKeyType() == KeyType.ArrowUp)
// ...
```

If the pressed key is a normal character key, then **KeyType** will be **Character** and you can check **which character** was pressed like this:

```
if (key.getKeyType() == KeyType.Character && key.getCharacter() == 'q')
// ...
```

1. Change the **processKey(KeyStroke)** code so that depending on the arrow key pressed (**up, right, down, left**) the variables **x** and **y** change accordingly (e.g. if the **ArrowLeft** key is pressed, then **x** should be **decremented by 1**). **Note:** Try using a **switch**-clause instead of a bunch of **if**-clauses; remember that **Alt+Enter** is your friend if you need help.

2. Wrap all method calls in the body of the **run()** method with an **infinite** while loop, so that you can also detect subsequent key presses and not just one.

3. After reading the key, verify if it is '**q**', if it is then close the **Screen**. If it is **KeyType.EOF** (**end of file** because the window was closed), then **break** from the loop.

Test your code. You should now have a **moving X char**. Welcome our **Hero!**

Make sure that, when you close the terminal window, if you're running from **IntelliJ**, the following is printed in the console: "**Process finished with exit code 0**".

If it isn't, then your process is still running and there is **something wrong** with your code. To stop your process, press the stop button in the top bar of **IntelliJ**.

8. THE HERO CLASS

Create a new class for our hero called, well, **Hero**.

Add some fields **x** and **y** to our hero and initialize them in the constructor so that you can create a new Hero like this:

```
Hero hero = new Hero(10, 10);
```

Make sure you have **setters and getters** for the **x** and **y** fields (use **Alt+Enter** to create them).

In our **Game** class, replace the **x** and **y** fields by a new **hero** field and initialize it in the constructor:

```
hero = new Hero(10, 10);
```

Change whatever code you need in the **Game** class, to use the newly created **Hero** class. Also replace incrementing and decrementing the **x** and **y** fields with calls to new **moveUp()**, **moveRight()**, **moveDown()** and **moveLeft()** methods in the **Hero** class.

Don't forget that a **real hero** should know how to **draw** himself:

```
public class Game {  
    // ...  
    private void draw() throws IOException {  
        screen.clear();  
        hero.draw(screen);  
        screen.refresh();  
    }  
    // ...  
}
```

9. POSITION

Create a new class called **Position**. This class will have two fields **x** and **y**. Generate getters and setters for both these fields.

Replace the **x** and **y** fields in the **Hero** class with a new **position** field. So, instead of:

```
public class Hero {  
    private int x;  
    private int y;  
    //...
```

We will have:

```
public class Hero {  
    private Position position;  
    //...
```

Replace all getters and setters for the **old** fields for **new** getters and setters for the **Position** class.

Change the **moveX()** methods so that instead of moving the hero they return a new desired position leaving the actual moving to be done by the game. For example:

```
public Position moveUp() {  
    return new Position(position.getX(), position.getY() - 1);  
}
```

In the **Game** class, change the calls like this one:

```
if (key.getKeyType() == KeyType.ArrowUp) hero.moveUp();
```

To something like:

```
if (key.getKeyType() == KeyType.ArrowUp) moveHero(hero.moveUp());
```

Where **moveHero(Position)** is just a method that moves the hero to the new position:

```
private void moveHero(Position position) {  
    hero.setPosition(position);  
}
```

This way we can later control if the hero can actually move to that new position.

10. ENTER THE ARENA

Create a new **Arena** class with **width** and **height** fields. Also add a **constructor** receiving these same parameters. This is where our **Hero** will live. So we have to **move** him **there**.

This means that our game will now have an **Arena** and that our **Arena** will have an **Hero**. All calls to the **Hero** class should now be done by means of the **Arena** class:

```
private void processKey(KeyStroke key) {  
    arena.processKey(key);  
}  
  
private void draw() throws IOException {  
    screen.clear();  
    arena.draw(screen);  
    screen.refresh();  
}
```

Now that we have an **Arena** we can constrain the **Hero** to be inside it. Let's make our **moveHero(Position)** method verify if the hero can move there first:

```
public void moveHero(Position position) {  
    if (canHeroMove(position))  
        hero.setPosition(position);  
}
```

Make the **canHeroMove(Position)** return **true** if the position is **inside** the **Arena** (using the **width** and **height** fields) and **false** otherwise.

11. PAINT THE FLOOR

Let's now paint the **Arena** floor in a nice color.

TextGraphics is an auxiliary class that can be constructed from the **Screen** class that can do more **complex** character manipulations (like drawing **lines** and **rectangles**). To obtain a **TextGraphics** object just do:

```
TextGraphics graphics = screen.newTextGraphics();
```

We can set the background color of the **TextGraphics** object and draw a rectangle like this:

```
graphics.setBackgroundColor(TextColor.Factory.fromString("#336699"));
graphics.fillRect(new TerminalPosition(0, 0), new TerminalSize(width,
height), ' ');
```

Use this new knowledge to **paint** the **Arena** floor any **color** you like.

To make things easier, we should create the **TextGraphics** object when we draw the **Game** and pass it to the **draw** methods from the **Hero** and **Arena** classes instead of passing the **Screen**. This way, the **Arena** and **Hero** classes will have a more useful tool to draw themselves.

```
private void draw() throws IOException {
    screen.clear();
    arena.draw(screen.newTextGraphics());
    screen.refresh();
}
```

Let's go ahead and also change our **Hero** color. And, what the heck, let's make him **BOLD** — he's a hero after all.

```
public void draw(TextGraphics graphics) {
    graphics.setForegroundColor(TextColor.Factory.fromString("#FFFF33"));
    graphics.enableModifiers(SGR.BOLD);
    graphics.putString(new TerminalPosition(position.getX(),
```

```
position.getY()), "X");  
}
```

Notice that, the way we have **organized** our code, it is **very easy** to make our game **bigger** just by changing these **two lines** in the **draw** methods in the **Arena** and **Hero** class:

```
graphics.fillRect(new TerminalPosition(0, 0), new TerminalSize(width  
* 2, height * 2), ' ');
```

```
graphics.putString(new TerminalPosition(position.getX() * 2,  
position.getY() * 2), "\\\\";  
graphics.putString(new TerminalPosition(position.getX() * 2,  
position.getY() * 2 + 1), "\\\\");
```

But let's **leave it smaller** for now...

12. WALLS

Create a **new** class called **Wall**. This class is going to be very **similar** to the **Hero** class but it won't be able to **move** and will be drawn with a **different character or color**.

Instead of having only one **Wall** in our **Arena**, we are going to want to have many. Let's try using an **ArrayList** to store all these walls. We start by declaring a new **walls** field in our **Arena**:

```
private List<Wall> walls;
```

Notice that we used **List** instead of **ArrayList**. **List** is the **interface** that all lists implement and **ArrayList** is a concrete instantiation of a class.

This is the "Return the most specific type, accept the most generic type" principle.

To create the `walls`, let's use a new `method`. Call it inside the `Arena` constructor:

```
this.walls = createWalls();
```

And then define it like this:

```
private List<Wall> createWalls() {
    List<Wall> walls = new ArrayList<>();

    for (int c = 0; c < width; c++) {
        walls.add(new Wall(c, 0));
        walls.add(new Wall(c, height - 1));
    }

    for (int r = 1; r < height - 1; r++) {
        walls.add(new Wall(0, r));
        walls.add(new Wall(width - 1, r));
    }

    return walls;
}
```

Don't forget the walls when drawing the arena:

```
for (Wall wall : walls)
    wall.draw(graphics);
```

Last thing we need to do is to modify the `canHeroMove(Position)` methods so that the hero does not go `inside walls`. Do that **yourself!**

13. BETTER COLLISION DETECTION

In the last step you ended by **verifying** if the `Hero` entered a `Wall`. You **probably** did something like this:

```
if (wall.getPosition().getX() == position.getX() &&
    wall.getPosition().getY() == position.getY())
// ...
```

Wouldn't it be **much nicer** if you could just do:

```
if (wall.getPosition().equals(position))
// ...
```

The **equals(Object)** method is a method declared by the **Object** class that any class can **override**. The original method only checks if both objects are the same but we want something a little bit more **sophisticated**. Normally it is done like this:

```
@Override
public boolean equals(Object o) {
    if (this == o) return true;

    if (o == null) return false;

    if (getClass() != o.getClass()) return false;

    Position p = (Position) o;
    return x == p.getX() && y == p.getY();
}
```

This is still **not** incredibly **efficient**. Every time the **Hero** moves, we must go through **every Wall** to see if the **Wall** is in his way. But let's leave it like that for now...

14. WALLS AND HEROS HAVE SO MUCH IN COMMON

As we've seen in a previous step:

"A Wall is basically a Hero that cannot move" — Someone, 2019.

Create an **abstract class** called **Element** that is a **generalization** of these two **classes**. This new class should have a **constructor**, methods to deal with its **position** and an abstract **draw** method. Make both classes, **Hero** and **Wall**, **extend** this class.

15. COINS

Create a new **Element** class called **Coin** just like we did with the **Wall**. Coins should just have a different way of drawing themselves.

But let's place our coins in random places:

```
private List<Coin> createCoins() {  
    Random random = new Random();  
    ArrayList<Coin> coins = new ArrayList<>();  
    for (int i = 0; i < 5; i++)  
        coins.add(new Coin(random.nextInt(width - 2) + 1,  
random.nextInt(height - 2) + 1));  
    return coins;  
}
```

Don't forget the coins when drawing the arena:

Extra: Make sure no **Coin** is on top of another or on top of the **Hero**.

When the hero moves, verify if he landed on a coin. If he did, remove that coin from the list of coins. Do this inside a new method called **retrieveCoins()**.

You should modify a **List** (or any other data structure for that matter) at the **same time** you are **looping** over it. In this case we can just break from the loop as soon as we remove a coin but in other situations you have to devise a better strategy.

16. MONSTERS

Create a new **Monster** class that extends the **Element**. As with other **Element** classes, a **Monster** also is drawn in some different way. It should also have a method called **move()**

that returns a position adjacent to his own position.

Every time you process a key, all monsters move one position. Do this inside a new method called `moveMonsters()`.

Every time the **Hero** touches a **Monster** the game should close and a message should be printed to the console. Do this inside a method called `verifyMonsterCollisions()`. Note: You might need to do it twice...

Don't forget to draw the monsters...

17. MORE STUFF

Other things you can do **at home**:

- Organize the code into **packages**.
- The hero could have some **energy** that would be drained as he touches monsters instead of dying immediately.
- There could be more **types of monsters** with different **moving techniques**.
- The map of the arena could be **stored in a file** and read when the game starts.
- Have different **rooms** each with **its own map**, number of **coins**, number of **monsters** and **doors** to go from one room to the other.
- Doors could only **show** after **all coins** have been collected.
- Keep the player's **score**.
- Show **messages** in the game screen when the player **loses** or **beats** the game.
- Allow the player to **restart** the game after losing.