

SOFTWARE DESIGN AND TESTING

LABORATORY

LAB-02/03: JAVA / GRADLE

1. Create Project

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

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

4. Importing *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.gradle 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:

- Create a new class called `Game`.
- 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.
- Create two new methods in this class: a private `draw()` method and public `run()` method.
- Copy the code that paints the screen (those three last lines) to the `draw()` method.
- Make the `run()` method call the `draw()` method.
- 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 de 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("#FFF  
F33"));  
    graphics.enableModifiers(SGR.BOLD);  
    graphics.putString(new TerminalPosition(position.getX(),  
position.getY()), "X");  
}
```

Note 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;
```

Note 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 Heroes 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 terminate 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. Some 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.

