COMP2001 – Artificial Intelligence Methods Lab 0: Introduction

The purpose of this introductory lab is to get set up Java, Eclipse IDE, and the COMP2001 Framework which is used in the subsequent labs. The first six labs (0-5) are designed to give you an understanding of, and give you practical skills of, designing and implementing low-level operators, heuristics, and meta-heuristics for solving combinatorial optimisation problems and experimental practices. These learning outcomes will be the focus of the in-lab assessment.

1 Learning Outcomes

1. To understand how a Java Project can be set up using Eclipse with external libraries.
2. To gain an understanding through experimentation of how pseudorandom generators work.
3. To gain an insight into the COMP2001 Framework's API.

2 Objectives

This introductory lab session is aimed at familiarising yourselves with the framework and tools which will be used for the following labs. It is important that you take part in and complete the lab exercises as these will lead to a better understanding of the content which will be needed for the project.

In this exercise, there will be a "tutorial" covering the software framework which will be used for the labs, as well as instructions for how to set up the programming environment.

2.1 Tutorial

- Introduction to the COMP2001Framework and API
- Setting up Eclipse/Java
- Implementation of a simple random walk algorithm

2.2 Exercises

The following are the exercises that you will be expected to complete during the lab session.

- Setting up/installing Java and Eclipse
- Setting up the COMP2001framework with Eclipse
- Running of a simple example

Note that the "tutorial" is conducted as a set of walk-though exercises in conjunction with an API specification which can be found on Moodle.

3 File Downloads

The following files are available on Moodle and should be downloaded for this lab session:

- COMP2001 Framework JARs.zip –the JAR files required for labs $0 \rightarrow 5$.
- COMP2001 Framework API.pdf – a document detailing the API with examples.
- COMP2001 Lab 0 Exercise Sheet.pdf – this document.
- Lab 00 Source Files.zip – An archive of all source files required for **this** lab session.

4 Tutorial / Lab Exercises

4.1 Setting up/Installing Java and Eclipse

Depending on whether you plan on using the machines in A32, the computer science remote desktop, or your own machine, you should follow different steps:

- Machines in A32 – Eclipse and Java are already set up!
- CS Remote Desktop – follow the instructions in section 4.1.1.
- Your own machine – follow the instructions in section 4.1.2.

4.1.1 Setting up Eclipse on the CS Remote Desktop

One you have connected to the CS remote desktop, there are a few things that you need to set up before you can start using Eclipse to complete the exercises.

- Set up OneDrive (to keep your files backed up)
- Install Eclipse (using a script)

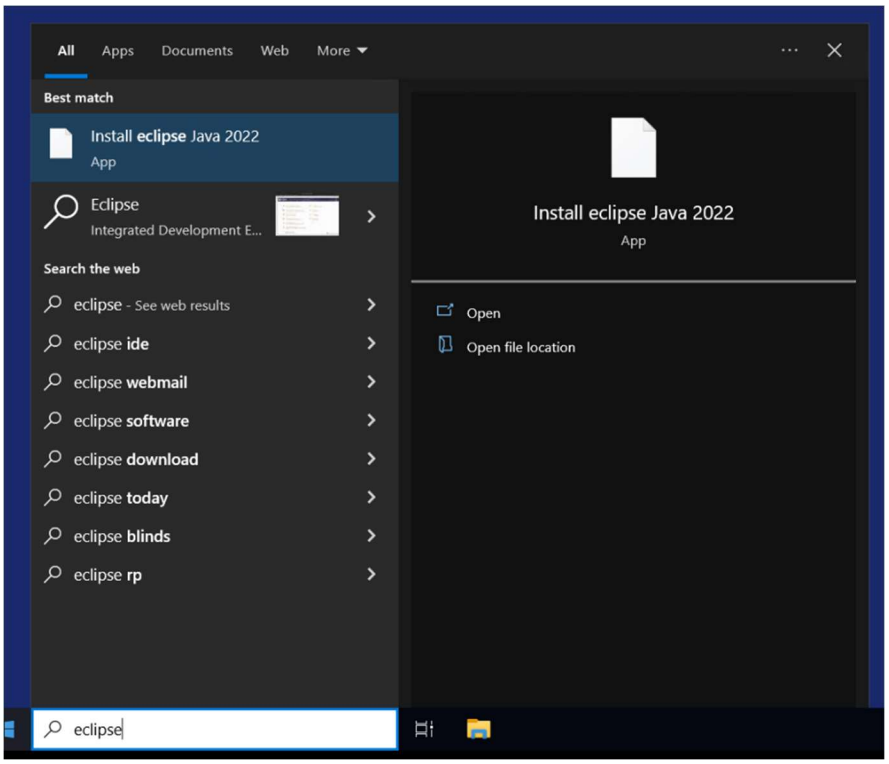
OneDrive

Search for and run OneDrive, you should be prompted to sign-in. Sign in with your university credentials and your OneDrive and files should now be synchronised.

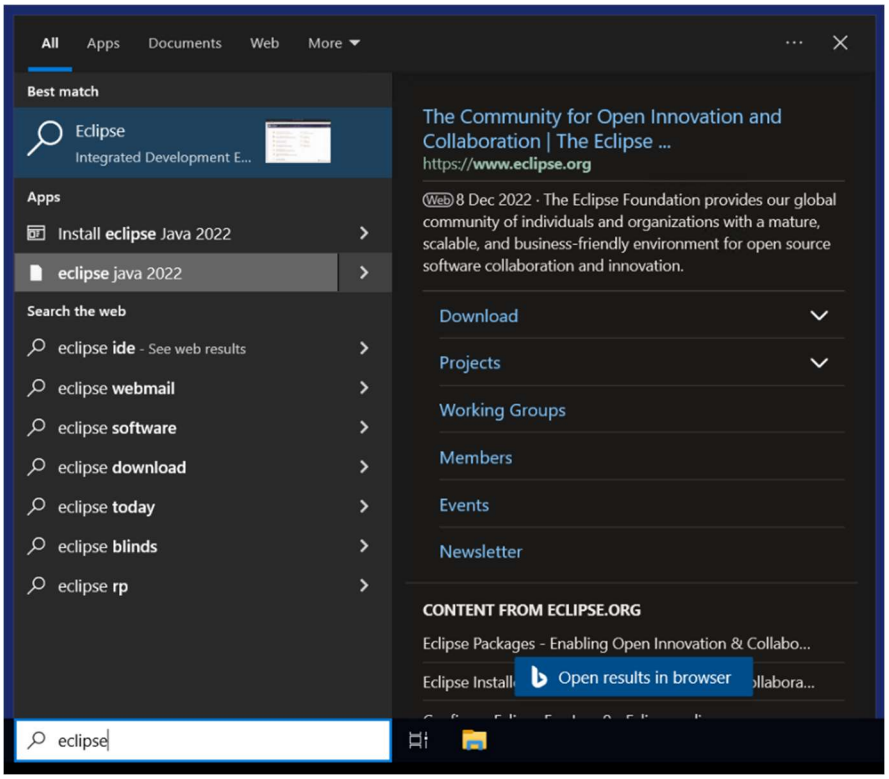
OneDrive usually gets placed into the directory "`C:/Users/[USERNAME]/OneDrive - The University of Nottingham`".

Installing Eclipse

Eclipse is already downloaded onto the CS remote desktop but not installed by default. There is a script which will install it for us, but we must locate and run it first. Search for "eclipse" and locate "Install eclipse Java 2022". Run the script and Eclipse will be set up for you.

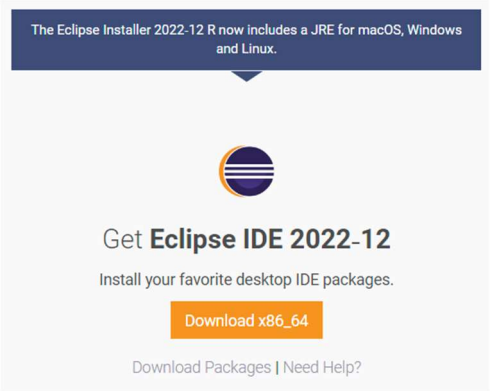


After the script has finished, search for eclipse again but this time look for “eclipse java 2022”. This is how you can run Eclipse on the CS remote desktop. You should now skip to the section [Configuring Eclipse for COMP2001] where we will set up Eclipse ready for the COMP2001 exercises.



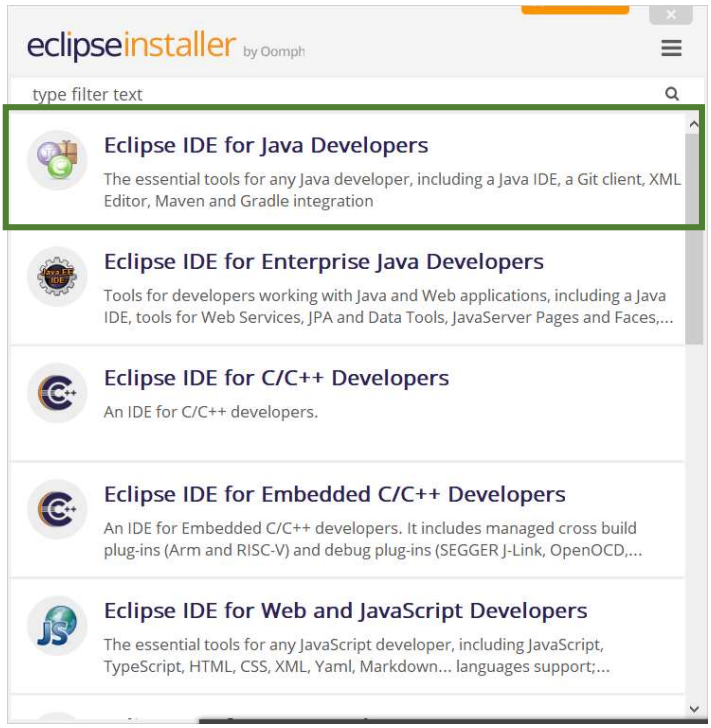
4.1.2 Installing Java and Setting Up Eclipse on Your Own Machine

Before completing any exercises, you will need to make sure you have both Java and Eclipse installed. Eclipse now bundles a suitable Java Runtime Environment (JRE) as part of its download and installation process. You can download these from https://www.eclipse.org/downloads/.



Click on the orange download button (screenshot updated 28/04/2023) which will take you to the download specific to your operating system and click download to download the installer.

Once that has downloaded, run the installer and choose “Eclipse IDE for Java Developers”:



In the next step, you will be prompted to choose a JRE. If the installer detects a compatible version of Java already installed, then they will appear as local paths, otherwise, you can choose to download the JRE, we recommend you select JRE 19.0.1 but if you have any other JRE installed not older than JRE 17 then you can opt to use that instead.

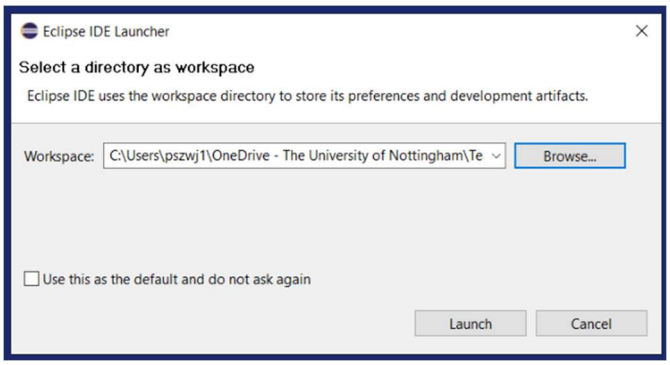
Select "INSTALL" and the installer will download the selected JRE (or link to an existing install) and install the Eclipse IDE. Once the installation is complete, close the window (rather than choosing launch) so you can follow the instructions in the next section.

4.2 Configuring Eclipse for COMP2001

4.2.1 Eclipse Workspace

Now that Eclipse is installed, run it from the start menu by searching for "Eclipse"; if you cannot find it, the default installation path on Windows is "`C:/Users/[USERNAME]/eclipse/java-2022-12/eclipse/eclipse.exe`".

You should see a splash screen followed by this pop-up dialog. When we use the Eclipse IDE, the environment configuration, projects, your code, and other information is saved in the selected "workspace". It is therefore essential that you choose a folder which is backed up (such as OneDrive) so that you do not lose your work.

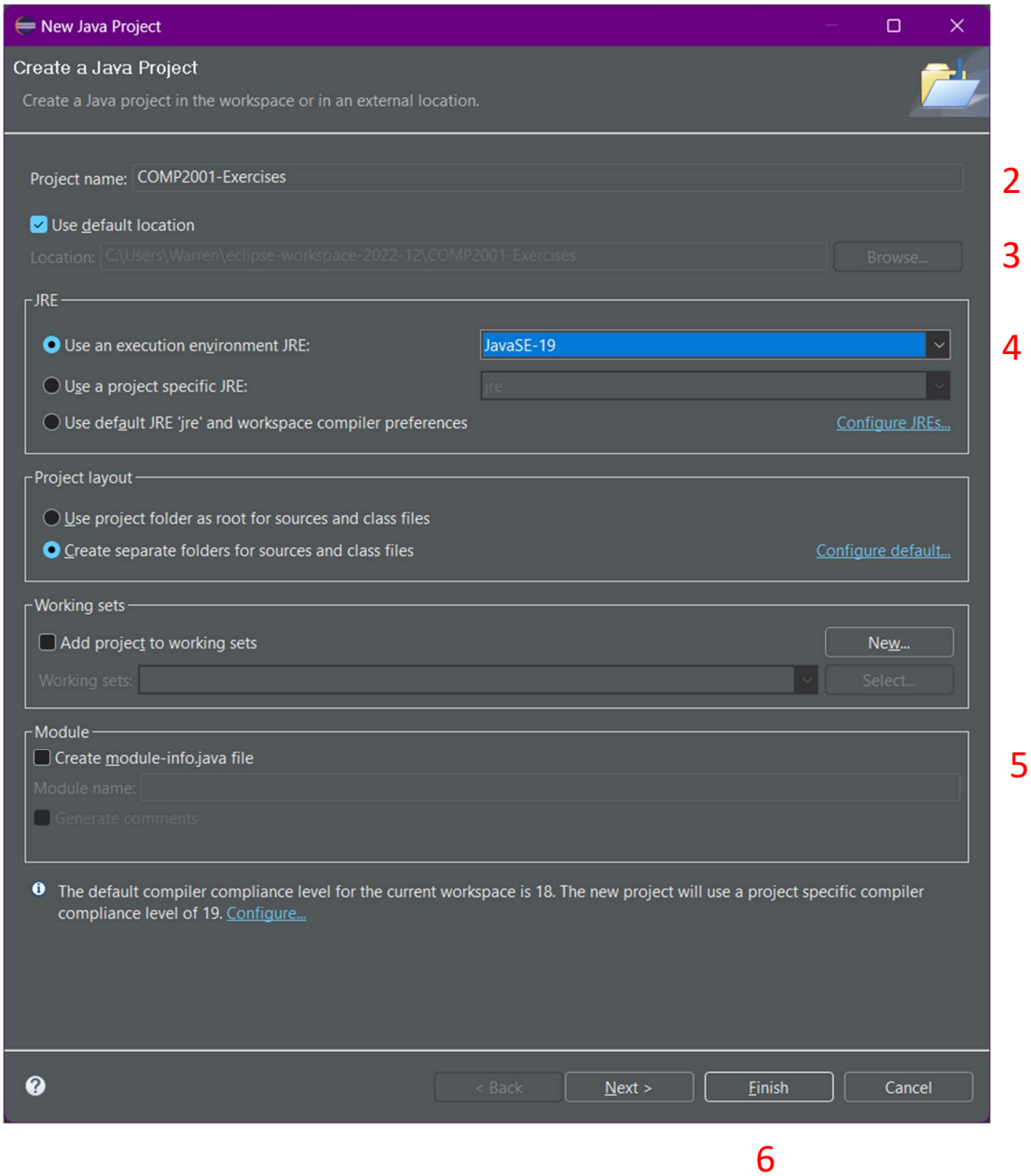


4.2.2 Setting up a new project with the COMP2001 Framework

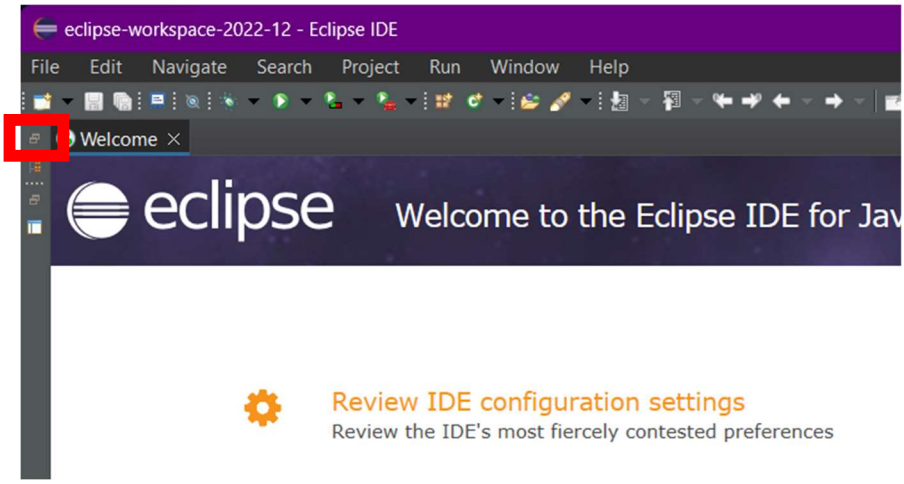
An archive including a **jar** file of the COMP2001 Framework can be found on the Moodle webpage for COMP2001 under the section **Lab 0**. Within this archive, you will also be able to find an example program which you will use to run the random walk example. This serves to check that everything is set up correctly.

To set up the framework in Eclipse, you will need to create a new project, import the necessary libraries, and finally import any Classes which are provided to you.

1. From the menu, choose `File > New > Java Project`.
2. Give the project a name, for example `COMP2001-Exercises`.
3. Note that the default save location is in your workspace which should already be configured in the previous steps to be in a location that is backed up.
4. Ensure that in the JRE configuration you are using **Java version 11** or higher. The default JRE 19 should be selected by default (unless you are reusing an existing installation).
5. Under "Module" **deselect** "Create module-info.java file"
6. Click `Finish`.



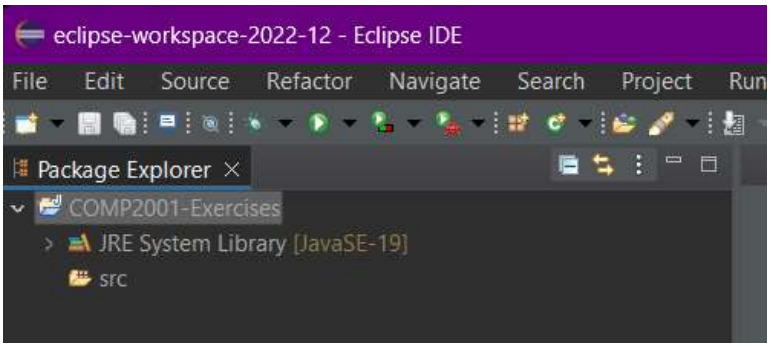
The project has now been created, but you may not see anything different. If this is the case, expand the file explorer by pressing this button and close the “Welcome” tab.



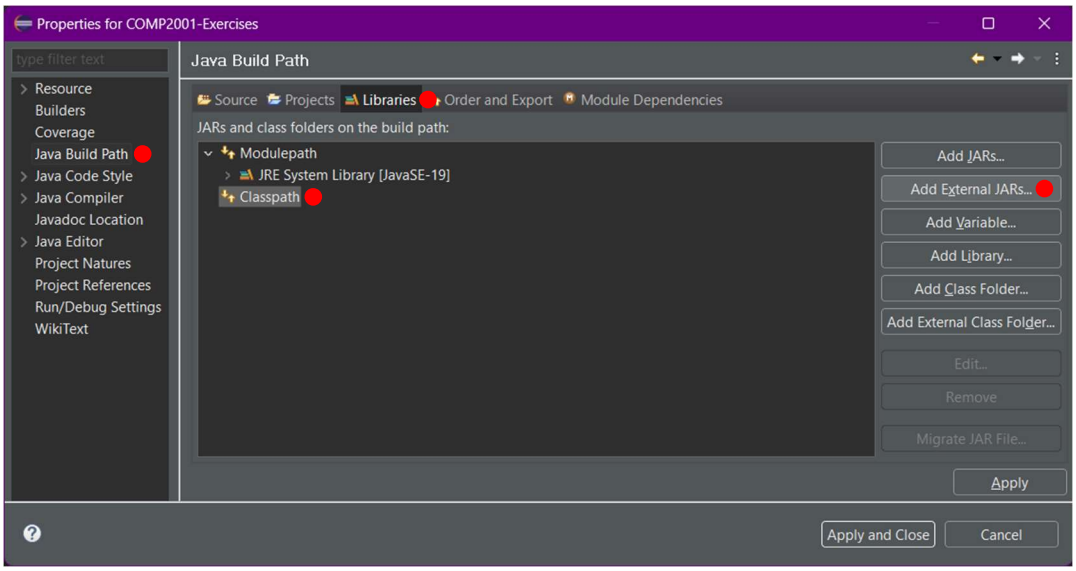
4.2.3 Configuring Eclipse to Include the COMP2001 Framework Library

To include external libraries (jar files), you need to import them into the Eclipse project as follows:

1. Right click on the COMP2001-Exercises project in the **Package Explorer**.

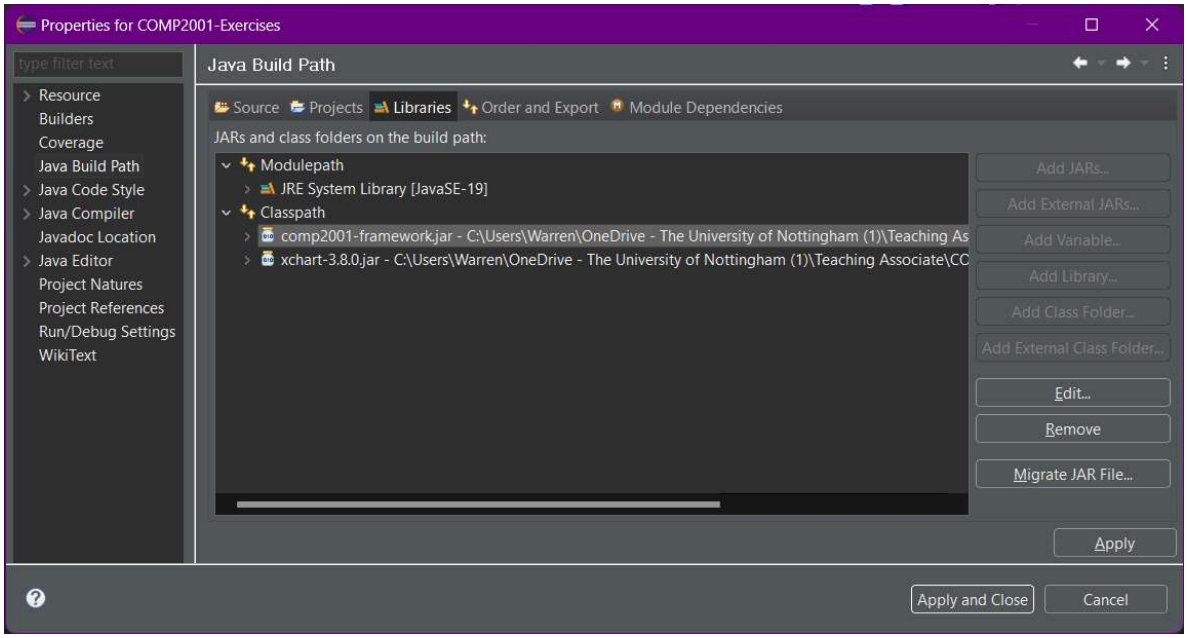


2. Select `Properties > Java Build Path`.
3. Open the `Libraries` tab.
4. Click on `Classpath` and select `Add External JARs`.



5. Navigate to the COMP2001 framework jar file (`comp2001-framework.jar`), select, and choose open.
6. Repeat this for the `xchart` library (`xchart-3.8.0.jar`).
7. Press "`Apply and Close`" to finish.

> Note – libraries should be added to the Classpath, **not** the Modulepath.



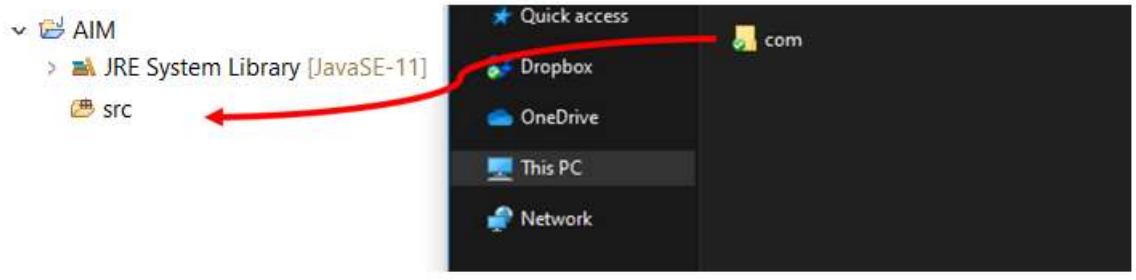
4.2.4 Importing any Classes (java source code files)

After downloading any files required for each lab, the easiest way is to simply drag these files into the IDE.

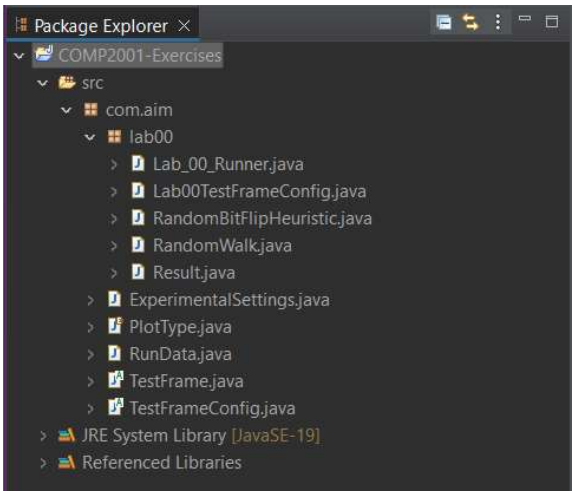
1. Locate the files in your file explorer.
2. Locate the directory "com".
3. Drag them into "src" `package` located in the `Package Explorer`.
4. Choose **Copy files and folders** in the popup window.
5. Then press OK.

For this lab, you will copy some experiment framework files, as well as a simple RandomWalk example heuristic. Extract the source files and open the "src" folder. Now drag-and-drop the "com" folder onto the "(default package)". Choose "Copy files and folders" and select "OK".

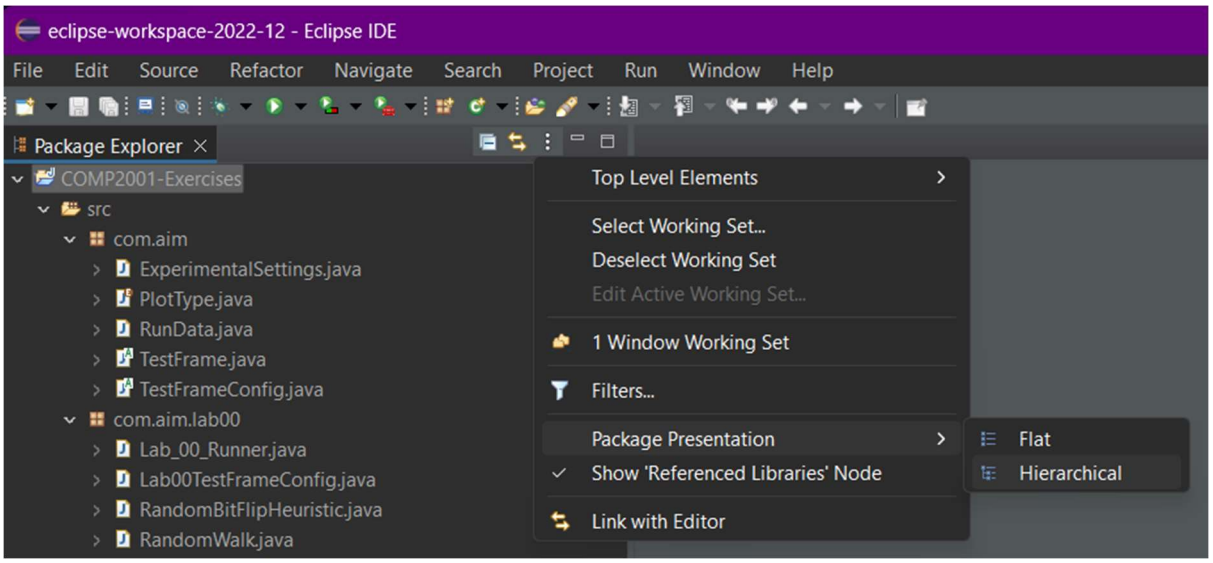
The package explorer should initially look like this:



Assuming that the Package Presentation is chosen as “Hierarchical”, this should result in the following structure:



If your view is different, you can change to the hierarchical view by clicking on the three dots next to the package explorer, go to package presentation, and select “Hierarchical”.



If you do not see the source files, you should click on the arrows next to the packages “com.aim” and “com.aim.lab00” to expand them.

5 Exercise – Pseudo-random Number Generators

5.1 Background

Random Walk is a very basic search algorithm that randomly performs a search over the space of solutions. In this specific case of solving a binary encoded MAX-SAT problem, random walk iteratively applies a random bit flip operator until the computational time budget has expired.

The code for Random Walk has already been implemented for you and included in the lab 0 source files. Similarly, the relevant data structures and operators are implemented for the maximum

satisfiability problem (SAT) and when Random Walk is run, it is applied to a chosen SAT problem instance.

Experimental seeds are used in experimental designs to allow the results of experiments to be *reproducible* while at the same time allowing random/stochastic elements to be used, created by pseudorandom generators, within a program to produce *random* events. These random events are important as they allow a random sample of the search space to be taken. At the same time, these seeds ensure that such random sequences are repeatable (given the same seed). The experimental seed for lab 0 can be found in the lab runner file "`Lab00TestFrameConfig.java`".

```
public class Lab00TestFrameConfig extends TestFrameConfig {

    /**
     * The experimental seed, set as the date this lab was released.
     */
    private static final long[] m_seeds = { 30012023l, 30012023l, 30012023l };
```

5.2 EXERCISE

You should now try playing around with changing the length of the seeds array and its values and observe the effects.

The minimum you should try is:

1. Using the seed 30012023 for a single trial.
2. Using the seed 30012023 for multiple trials.
3. Using different seed values, either on their own or as seeds for multiple trials.

Included in the archive for this lab are three classes, `Lab_00_Runner.java`, `RandomBitFlipHeuristic.java`, and `RandomWalk.java`. These are nested inside a series of folders (`com > aim > lab00`). **With the `Lab_00_Runner` Class opened in the main window, press the run button to run the experiments with the seeds set in Lab00TestFrameConfig.** This appears as a green circle with a play button/triangle inside.

If you get some funny Java error with java.lang.Object and you are using the CS remote desktop, closing and re-opening Eclipse usually solves this!

You should discuss your findings with your peers in the COMP2001 Moodle discussion forum "Lab Support and Discussions" (https://moodle.nottingham.ac.uk/mod/forum/view.php?id=6544312). You should create a new topic (or respond to an existing topic from your peers) with the subject "Lab#0: …" to show that the topic relates to Lab 0, and you can give it a relevant title in place of the …. Your message could be something like below:

> Lab 0 Exercise:
> What: I tried using 3 different seeds - <copy paste the seeds>
> Observation: …
> Why: I think X happened because Y.

6 COMP2001 FRAMEWORK API

The API specification can be found on the Moodle webpage for COMP2001. You are encouraged to read through this document as it is designed to help with the exercises and coursework. The document explains the MAX-SAT problem which is the topic of the first six (0-5) lab exercises and will help you with the assessed in-lab test.

7 OUTCOMES

4. You should have a reasonable insight into the COMP2001 Framework's API.
5. You should have set up and be able to use the COMP2001 Framework which will be used in future lab exercises.
6. Understand how pseudorandom generators work.

8 NEXT WEEK'S EXERCISE

Next week, you will be given an opportunity to implement some local search heuristics for the MAX-SAT problem and gain an insight into the strengths and weaknesses of different heuristics.