CS1021 Lab #0
Getting Started with ARM Assembly Language Programming Tools

29 September 2017

Submit your solution to this lab using Blackboard no later than 23:59pm on Monday 2nd October 2017.

Working in Pairs

The lab exercises for CS1021 require you to work in pairs.

- You should use one workstation and choose one person to type.
- Switch roles each week.
- Submit **one solution per pair** using Blackboard.
- Both of you must maintain your own copy of everything that you work on and submit.
- Full marks will only be awarded to students that have attended both of the lab sessions allocated to each lab exercise, regardless of your pair's attendance. Half marks will be given to students attending one of the two lab sessions without being formally excused. Zero marks will be awarded if both labs are missed.

General Tips Before Starting

1. You are required to keep your own copy of all the coursework you submit.
2. You should use your network file store (U: Drive) or a USB memory stick to store your CS1021 lab exercises, assignments and other programs.
3. Do not store your projects on the local hard disk of lab computers. They will probably not be there when you return.
4. Maintain a backup copy of all of your coursework.
5. Dropbox (`http://www.dropbox.com`) is a good way to backup your important coursework files and get access to them at home.
6. Create a course folder (e.g. "CS1021Projects") and use this to store each of your projects in its own folder.

Using the Keil µVision IDE

1. Log in to the computer using the username and password you were given.

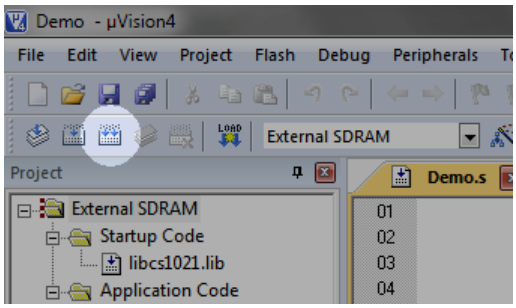
2. Create a folder for your CS1021 projects on your network file store or on a USB stick. Call it "CS1021Projects".

3. Download `libcs1021.zip` from the CS1021 Blackboard site (`http://mymodule.tcd.ie`) and extract the zip file to your "CS1021Projects" folder (Right Click, Extract All on Windows). You should now have a single 'libcs1021' folder containing a single file, If this is not the case correct the directory structure to remove unnecessary folders.

4. Download the Demo µVision project from Blackboard (called `Program.1.1.Demo`) and again extract the zip file to your "CS1021Projects" folder.

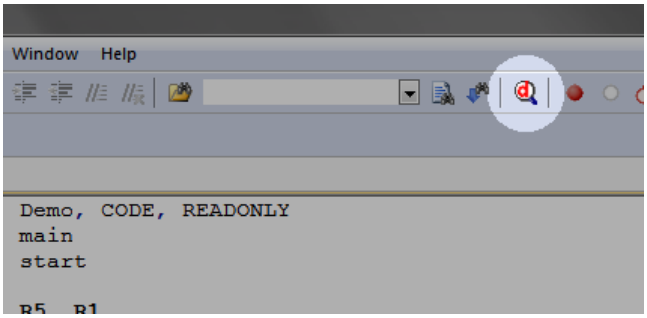
5. In the `Program.1.1.Demo` folder, double click the `Demo.uvproj` file to open the Demo project in µVision. (It may appear as simply "Demo" and the file type will be µVision4 Project.)

6. Click the "Rebuild all target files" icon or select "Rebuild all target files" from the "Project" menu.



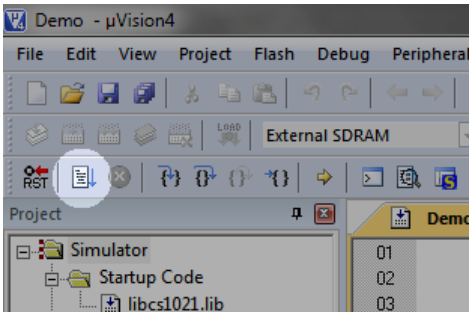
   Some text should appear at the bottom of the screen, ending in "0 Error(s), 0 Warning(s)".

7. Execute the Demo program by clicking the "Start/Stop Debug Session" icon or selecting "Start/Stop Debug Session" from the "Debug" menu.

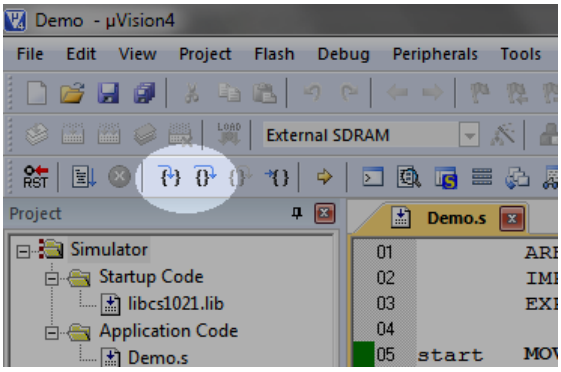


   You should see a window containing an ARM Assembly Language program with a yellow arrow beside the line containing the word "start". The yellow arrow is the Program Counter (PC) and shows the next instruction to be executed. The processor is "halted" waiting for you to start the program.

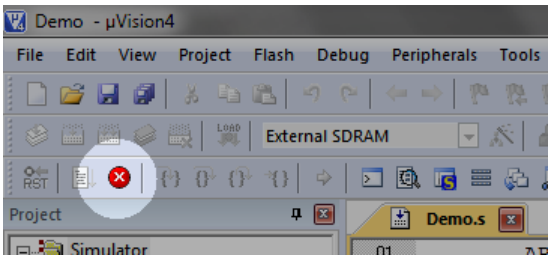
8. Run the program by clicking the "Run" icon or selecting "Run" from the "Debug" menu.



Alternatively, you can step through the program one instruction at a time by clicking the "Step" or "Step Over" icons or selecting "Step" or "Step Over" from the "Debug" menu.



You can halt the program by clicking the "Stop" icon or selecting "Stop" from the "Debug" menu.



You can stop the Debug session by clicking "Start/Stop Debug Session" again or by clicking the "Start/Stop Debug Session" icon.

Full documentation for the µVision IDE is available on-line from Keil:

`http://www.keil.com/support/man/docs/uv4/`

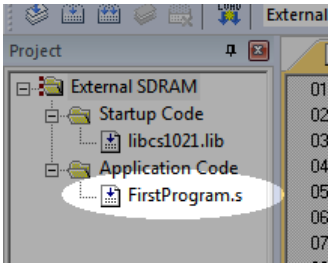
Writing your first program

Follow the steps below to write and execute your own program.

1. Download the FirstProgram µVision project from the CS1021 Blackboard site and extract the zip file to your "CS1021Projects" folder. You should have a new folder called `Lab.1.1.FirstProgram` containing an empty µVision4 project.

2. Open the project in the µVision IDE by double-clicking the `FirstProgram.uvproj` file.

3. In the µVision IDE, in the "Project" window on the left-hand side, you should see a list of files. Double-click the `FirstProgram.s` file to open and edit it.



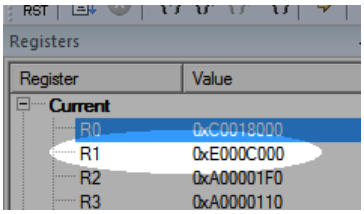
4. Beginning on the line immediately after `start`, type in the following program. Do not enter the line numbers (1, 2, 3, etc.). Insert a tab at the start of each line (i.e. before typing "MOV" or "ADD") using the TAB key.

```
1       MOV     R0, R1
2       ADD     R0, R0, R0
3       ADD     R0, R0, R0
4       ADD     R0, R0, R0
```

5. Save your changes to the file.

6. Rebuild the project and execute it using the same sequence of steps that you used to build and execute the Demo program above.

7. Before running the program, you need to give the program some input. The only input required is the value in `R1`. Click on the value shown beside `R1` in the "Registers" window and press the F2 key to edit the value. Enter the value '1' and press the RETURN key.



8. Run the program by clicking the run icon, as described above for the Demo program.

9. Stop the program by clicking the red "halt" icon. What value do you observe in `R0`? What does the program do?

10. Try stepping through the program line by line, watch the values in R0 and R1 change.

11. **To verify that you can submit assignments using the CS1021 Blackboard site, use the site to upload your FirstProgram.s file as your solution to Lab #0.** You should upload FirstProgram.s only. Do not upload any other files and do not place the .s file in a compressed archive (.zip file). You should upload your solution by **23:59 on Monday 2 October 2017**.