

INTRODUCTION TO DIGITAL IMAGE PROCESSING

ASSIGNMENT 1

Due date: Wednesday, October 14, 2020 by 11:55 pm

Total marks: 5

Late penalty: 0.5 marks per day overdue. Late assignments will not be accepted after 11:55 pm on Friday, October 16, 2020, and a mark of zero will be given.

All assignments will be done in **groups of 3**, and the same final mark for the assignment will be assigned to all group members. Currently, you have all been **randomly** placed in groups of 3; please see Appendix A on how to check which group you are in. You are required to keep the same group for each subsequent assignment. The rationale for creating groups is to encourage you to meet others (at least virtually) and work together. Groups are required to interact with each other using Zoom or any other web conferencing tool of your choice. In the extreme case where a partnership is not working, please contact Dr. Ladak to change groups; my preference is that you work with the partners assigned to you even if you don't know them – it is a good way to meet new people. In exceptional cases (e.g., you are working in a time zone that is very different from the rest of the class), you may work alone if you wish; please contact Dr. Ladak to arrange this.

Note: An institutional version of Zoom is available to Western students that does not have some of the limitations of the free version. Instructions on using the institutional version can be found in Appendix B.

If you are an **auditor**, you have not been assigned to a group and are not required to submit the assignment; you may do it on your own and check the results when solutions are posted online.

Instructions for submitting answers are given with each question below. Note that I allow you to keep resubmitting until the deadline. Only the last submission is available to the TAs for marking. I recommend that all group members agree to a submission before uploading it. Only one person in the group needs to submit on behalf of the entire group.

CONVENTIONS

Fixed-point font (*Courier*) is used to denote MATLAB commands, variables and filenames.

OBJECTIVES

1. To virtually meet others in the class to foster collaboration.
2. To gain experience with writing functions in MATLAB using programming statements (`function`, `for`, etc).
3. To help you become familiar with MATLAB's help facilities.

PROBLEMS

Write a MATLAB function that accepts a `uint8` image matrix called `im` and a $1 \times N$ vector `v` of strictly increasing gray-level values; N is the length of vector `v`. This function should return as output a $1 \times (N-1)$ row vector, `y`, where $y(i)$ is the total number of pixels in `im` that satisfy $v(i) \leq im < v(i+1)$. The function header should be:

```
function y = countGL_(im, v)
```

where # is your group number. For instance, if you are part of AssignmentGroup-1, your filename would be `countGL_1.m`. If you are part of AssignmentGroup-27, your filename would be `countGL_27.m`.

You may only use the following MATLAB keywords, functions and operators:

```
for ... end, sum, &, >=, <, length, if...end, function, size, zeros
```

You are not required to use all the above. You can also use any other operator found by typing:

```
help ops
```

You are not allowed to use the `imhist` function.

The rationale for these restrictions is to require use of C-like programming statements and basic MATLAB operators that do not rely on any specific toolbox.

For all assignments, you may assume that the user has entered the correct number and types of inputs to the function since we are focusing on image processing instead of input parsing.

All code and answers requested below must be submitted using OWL. For the first assignment, I will demonstrate this in class, but I have included instructions here and will do so for every assignment. To provide answers via OWL:

1. One group member should log into OWL and access the course web site.
2. From the left-hand side, select the “Assignments” tab.
3. From the page that comes up, select “Assignment 1”.
4. You will now reach the submission page for Assignment 1. Follow the instructions below for each part to submit answers.

- (a) [3.5 marks] Save the function in a file called `countGL_#.m` where # is your group number. For instance, if you are part of AssignmentGroup-1, your filename would be `countGL_1.m`. If you are part of AssignmentGroup-27, your filename would be `countGL_27.m`. **NOTE: Use the exact filename and function name as specified above. Uppercase/lowercase is important. Your function should be commented.**

When you are on the submission page in OWL for Assignment 1, scroll to the bottom and attach your M-file. Also, cut and paste this code into the text box taking care to label this as part (a).

- (b) [0.5 marks] Generate a test image using the following set of MATLAB commands:

```
>> row = uint8(0:255);  
>> im = repmat(row, 100, 1);
```

Now, create a stem plot of the number of pixels at each graylevel 0, 1, ..., 255 in `im` by typing the following:

```
>> stem( 0:255, countGL_#(im, 0:256))  
>> set(gca, 'xlim', [0, 255], 'ylim', [0, 150])  
>> title('Assignment 1', 'fontsize', 16)  
>> xlabel('Gray level')  
>> ylabel('No. Pixels')
```

Note: In the first command (i.e., `stem`) the # symbol will be replaced with your actual group number.

What you have generated is the gray-level histogram of an image with “bin size” of 1. Histograms will be discussed in class after we finish our discussion of MATLAB.

Once you generate the stem plot, you should save the display by selecting “File” in the figure window and then “Save As...”. In the dialog box that comes up, select “TIFF image (*.tif)” as the output type and for

“File name”, enter “1b_#” without quotes where # is your group number. This will save the figure in the file called “1b_.tif”. **Attach it in OWL as you did the M-file.**

- (c) **[0.5 marks]** What would you type at the MATLAB prompt to find the total number of pixels in the test image `im` from Part (b) using the function `countGL_#?` **Enter your answer in the text box on the assignment submission page, taking care to label this as part (c).**
- (d) **[0.5 marks]** **Finally, in the text box on the assignment submission page, enter the name of each group member.** (This is to check that you at least know your groups members names.)

MATLAB RESOURCES

All MATLAB guides can be found at:

<http://www.mathworks.com/access/helpdesk/help/helpdesk.shtml>

which can also be accessed by typing `doc` at the MATLAB prompt. For information on the image processing toolbox, select the link labelled “Image Processing Toolbox”.

APPENDIX A: Checking Assignment Group Membership

Below are instructions for checking your group membership.

Step 1: Log into OWL and click on Site Info.

Step 2: Click on the section near the bottom of the page that is labelled Groups you are a member of.

Step 3: Your group’s name should come up. You should note the group number as you will need it for the assignment. If you click on the link labeled “Membership”, you will see other members of the group.

APPENDIX B: Using Zoom as a Western Student

The following instructions outline one procedure to install Zoom on your personal computer, sign in using Western University's institutional license, and schedule/create meetings for your assignment group. These instructions assume that Zoom is not yet installed on your personal computer.

Step 1: Navigate to the following webpage provided by Western Technology Services (https://wts.uwo.ca/zoom/getting_started.html).

Step 2: As illustrated in Figure 1, click the link contained within the tab 'Install Zoom on your desktop or mobile device' to begin downloading Zoom on your computer.

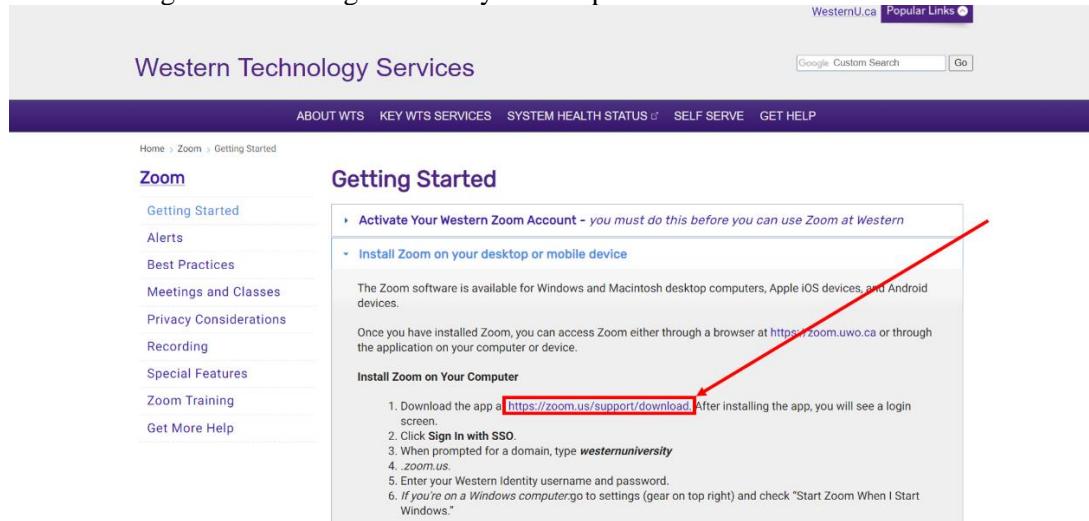


Figure 1. Link to download Zoom on Western Technology Services website. Note: when clicking the link outlined in red, the download of Zoom should begin automatically; if it does not, follow the instructions on the webpage to begin the download.

Step 3: Open the downloaded file 'ZoomInstaller' to install Zoom on your computer. If you are using a web browser such as Google Chrome or Microsoft Edge, the downloaded file will appear automatically in the web browser as illustrated in Figure 2. If you are using a different web browser or if you would like to open the file at a later time, you can access it in the 'Downloads' folder of your computer's drive.

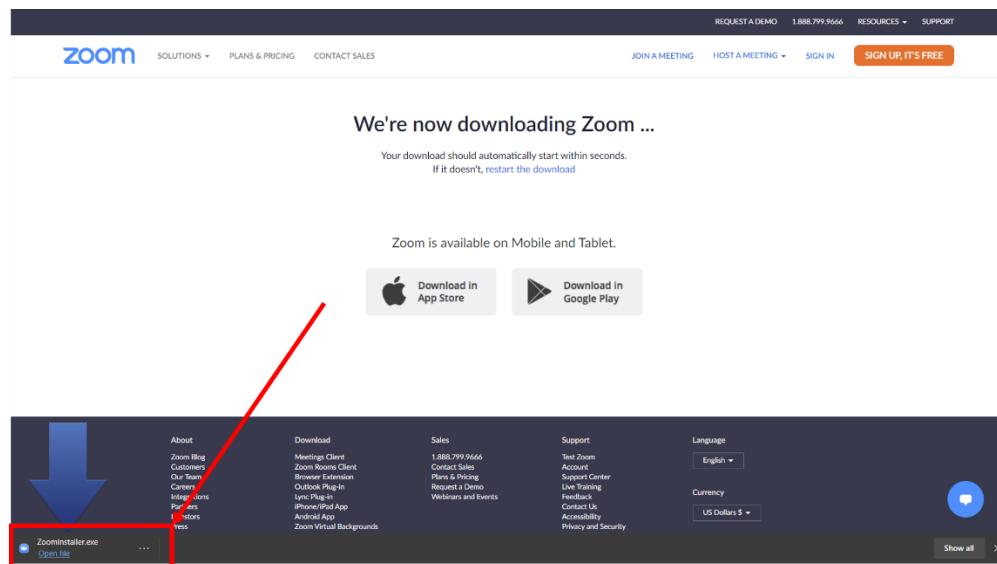


Figure 2. Open the 'ZoomInstaller' file upon downloading to finish the installation of Zoom on your computer.

Step 4: Open the installed Zoom application on your computer. Once the Zoom application opens, click the ‘Sign In’ button. On the following screen, click ‘Sign in with SSO’ (as illustrated in Figure 3), to sign in using Western University’s institutional license.

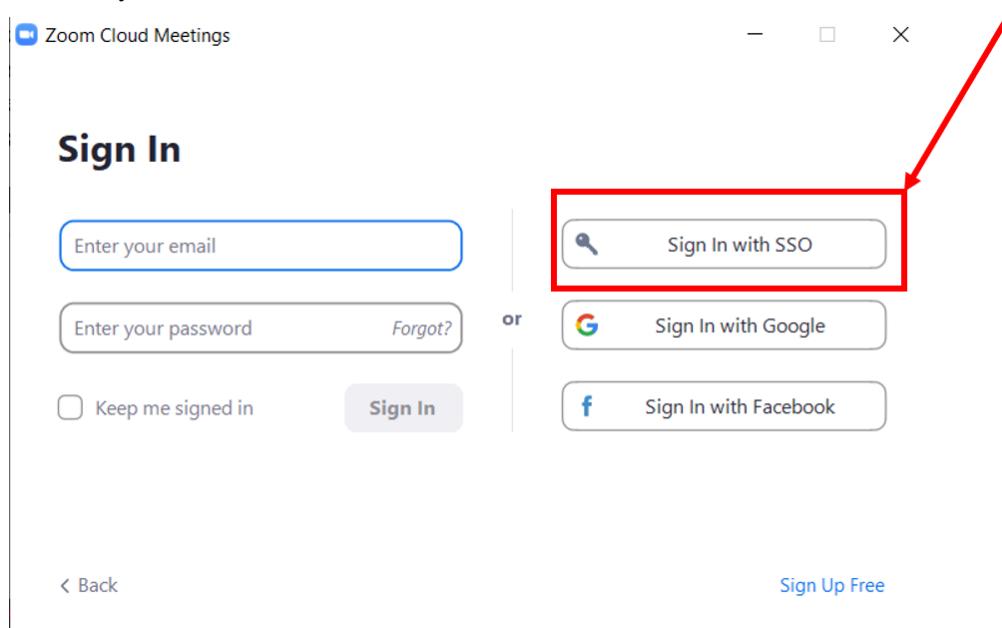


Figure 3. Click ‘Sign In with SSO’ to sign in using Western’s institutional license.

Step 5: As illustrated in Figure 4, type ‘westernuniversity’ in the field that says, “Enter your company domain”. After clicking ‘Continue’, you will be taken to a Western University web page where you are prompted to enter your username and password (the same username and password used in OWL) to sign into Zoom using the Western University license. After confirming your Western University username and password, Zoom will launch, and you will be signed in.

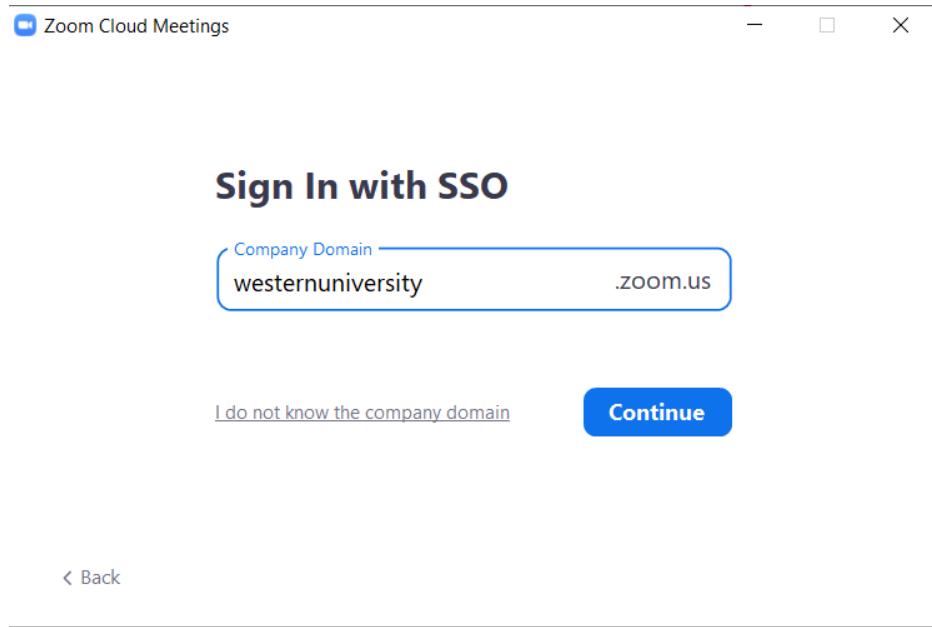


Figure 4. Type ‘westernuniversity’ and click ‘Continue’ to sign in to Zoom using the Western University license.

Step 6: Now that you are signed in, you can schedule/create and join Zoom meetings. To schedule a Zoom meeting, click the ‘Schedule’ button after the Zoom application launches, as illustrated in Figure 5. You will then be brought to a page which will allow you to set the details of your meeting.

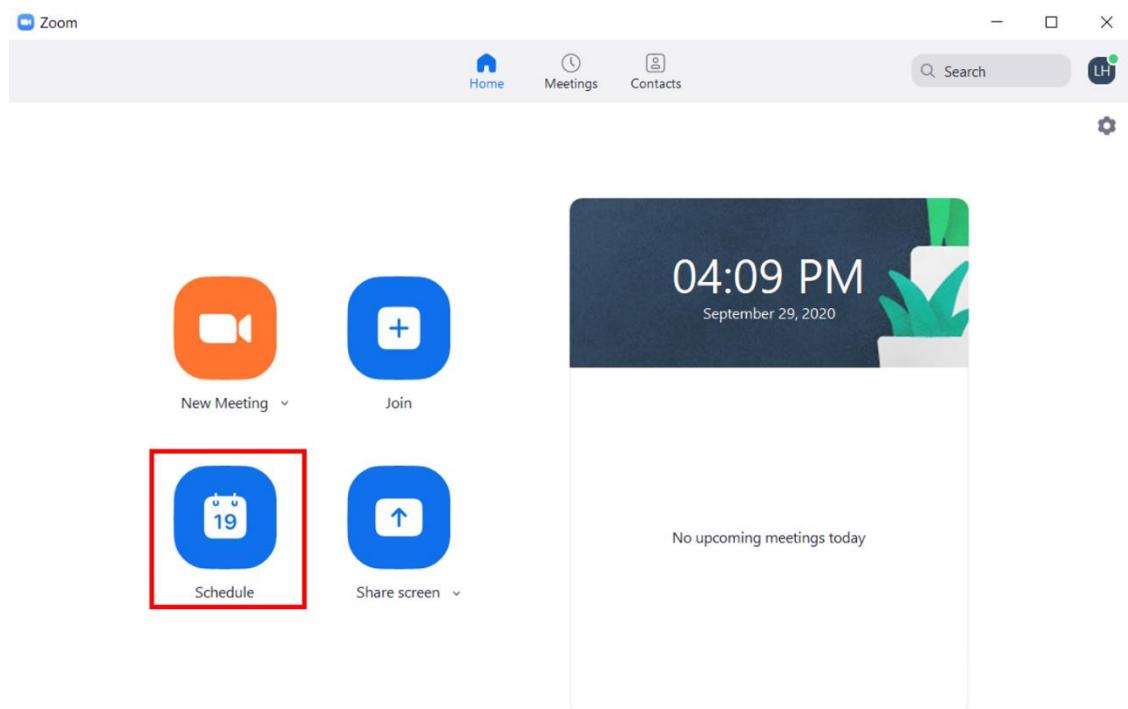


Figure 5. Scheduling/creating a new Zoom meeting.

Step 7: If you click ‘Other Calendar’ under the ‘Calendar’ section, followed by ‘Save’, the Zoom meeting details will be displayed in Zoom for you to share with your group. Alternatively, you can select a calendar service such as ‘Outlook’ to import your meeting details.