**Requirements:** For each homework assignment you must create and submit a homework lab notebook. The notebook must include your name, the course (CPSC 324), and the assignment number (HW-6). Your notebook must be organized by step (see below), with each step number clearly marked (e.g., **Step 1**, **Step 2**, and so on). You may create your lab notebook in any editor/tool you like (e.g., google docs, microsoft word, latex, etc.), however, you must submit your notebook as a single PDF file named `hw6-lab-notebook.pdf`. Specific information to add to your notebook will be asked for in each step of the instructions. Additional details are provided below. Your notebook and any additional work (e.g., program files) must be submitted on or before the due date using the homework GitHub classroom repository provided via Piazza.

**Instructions:** Do the following steps and add the information requested to your lab notebook. Your lab notebook should be organized and well formatted. *Note:* You can (and should) look through the Google Cloud Skills Labs (part of some steps below) prior to starting them, which can help you get a sense for what the tasks are and each lab’s scope. You can also go back over the lab as well after you complete them and/or do them multiple times as needed (but watch out for those that require credits).

**STEP 1 (Pub/Sub I):** Within Google Cloud Skills Boost, complete the **Pub/Sub: Qwik Start - Console** lab. This is a free lab. Note the following concerning the lab before you begin.

- First, watch this video for a brief introduction to Pub/Sub: [Cloud Pub/Sub Overview](#).
- Next, watch this video for additional concepts used in Pub/Sub as well as use cases: [What is Cloud Pub/Sub?](#)

As you do the lab, add the following to your lab notebook for this step.

- Add a screen shot of the “Hello World” message that was generated in the console.
- Send another message “Go Zags!” and show the result of pulling it from the console again. This is just repeating the steps of the lab again.

**STEP 2 (Pub/Sub II):** Within Google Cloud Skills Boost, complete the **Pub/Sub: Qwik Start - Command Line** lab. This is a free lab. As you do the lab, add the following to your lab notebook for this step.

- Write down each of the CLI commands you used for the lab and what their purpose is.
- Write down the order that the four messages were pulled in.
• Before stopping the lab, play around with pub/sub by sending a seven or so messages and then pulling them using different values of limit (smaller than the number of messages you sent). Write down the results.

STEP 3 (Pub/Sub III): Within Google Cloud Skills Boost, complete the Pub/Sub: Qwik Start - Python lab. This lab requires 1 credit. As you do the lab, add the following to your lab notebook for this step.

• In step 4, you create a topic using the publisher.py script, which calls the create_topic function. Write down the code for this function and explain how you think it works.

• In step 4, you also list the topics. Find the corresponding function in publisher.py, write down the code for the function, and explain how you think it works.

• In step 5, you create a subscription using subscriber.py. Find the corresponding function in subscriber.py, write down the code for the function, and explain how you think it works.

• Step 7, you pull messages using subscriber.py. Find the corresponding function, write down the code for it, and explain how you think it works.

STEP 4 (Pub/Sub IV): Within Google Cloud Skills Boost, complete the Pub/Sub Lite: Qwik Start lab. This lab requires 1 credit. As you do the lab, add the following to your lab notebook for this step.

• Show the result of running both Python files you created. Note I had to wait a bit for the messages to be available before receiving them, and then the script waited a bit before stopping.

• Try calling send_messages.py a few times (five or so). Then call receive_messages.py again.

• Write down what the main difference is between Pub/Sub lite and the “normal” Pub/Sub.

STEP 5 (Cloud Scheduler I): Within Google Cloud Skills Boost, complete the Cloud Scheduler: Qwik Start lab. This lab requires 1 credit. As you do the lab, add the following to your lab notebook for this step.

• Enter in a message that says hello but with your name (instead of cron).
• Paste a screen shot showing that your scheduler service is working and sending messages.

STEP 6 (Dataflow I): Within Google Cloud Skills Boost, complete the **Dataflow: Qwik Start - Templates** lab. This lab requires 1 credit. As you do the lab, add the following to your lab notebook for this step.

• This is a fairly high-level lab, where the main task is to reuse an existing dataflow template. For this lab, write down the `gcloud` commands you used to deploy the dataflow job, and include a screen shot showing that the final query worked.

STEP 7 (Dataflow II): Within Google Cloud Skills Boost, complete the **Dataflow: Qwik Start - Python** lab. This lab requires 1 credit. As you do the lab, add the following to your lab notebook for this step.

• In task 3, for the last step, look through the output messages for `JOB_MESSAGE_DETAILED`. Some of the message should be familiar (based on the dataflow paper from the reading). Write down some of the messages that are interesting and/or familiar to you.

• Take a screenshot of the job (diagram) in the dataflow console (make sure it is in the “graph view”). Note that in the dataflow console, I had to click “refresh” to see the job running.

• Take a screen shot of the directories and subdirectories that were placed within the bucket after the job completed (the last part of Step 4).

STEP 8 (Dataflow III): Within Google Cloud Skills Boost, complete the **ETL Processing on Google Cloud Using Dataflow and BigQuery (Python)**. This lab requires 5 credits. As you do the lab, add the following to your lab notebook for this step.

• Write down what files were copied to the bucket in task 4. Include what the headers are for these files (i.e., what attributes do they have).

• For task 8, write down the following code snippets from the file without the corresponding comments:
  
  - How is the pipeline `p` initialized?
  - What is the first step of the pipeline? What does it do?
  - What is the second step of the pipeline?
  - What is the third step of the pipeline?
• In task 9, take a screen shot of the “job graph” as it is running. You should browse around the interface to see additional views (e.g., execution details, etc.).

• Write down how the pipeline in task 11 is different from the task 8.

• Write down the steps of the pipeline in task 13. Note that this pipeline involves a few more steps than the previous one.

• Include a screen shot of the “job graph” for task 14. Relate this back to the pipeline description you have for task 13. Be sure to expand the “Join Data” box.

• Write down the steps of the pipeline in task 15. Note that this pipeline is also different than the previous ones.

• Include a screen shot of the “job graph” for task 16. Relate this back to the pipeline description you have for task 14. Be sure to expand the “Join Data with sideInput” box.

**STEP 9 (Dataflow V):** Within Google Cloud Skills Boost, complete the Stream Processing with Cloud Pub/Sub and Dataflow: Qwik Start lab. This lab requires 1 credit. Note the following.

• Be sure to remember (copy) your project id, bucket, and region. Note that I was successful running the lab in us-west1.

• Make sure you select Python as the language at the end of step 1.

• At the end of Step 1, be sure to run each Python command individually (docker, git, cd, pip).

• When you start the pipeline in Task 3, be sure to fill in the missing project, bucket, and region info.

• Because you are creating a stream-based dataflow pipeline, it will never end (so you don’t want to wait for it to stop). You should give it some time, however, to generate files (10 minutes or so).

As you do the lab, add the following to your lab notebook for this step.

• Paste a screen shot of the dataflow graph once it is created with the Window into task expanded.

• Paste a screen shot of the files generated at the end of Task 4
**STEP 10 (VertexAI Pipelines):** Within Google Cloud Skills Boost, complete the **Vertex Pipelines: Qwik Start** lab. This lab requires 5 credits. As you do the lab, add the following to your lab notebook for this step.

- Describe in your own words what each of the three pipeline components do in Task 3.
- Describe the pipeline you built in Task 3 (Step 3), i.e., how are the three components combined to form the pipeline.
- Paste a screen shot of your pipeline running (before it completes).
- Paste a screen shot of your running pipeline from Task 4. Be sure to expand the condition deploy model step to include the details in your screen shot.
- Briefly describe what the pipeline in Task 4 is doing including what the purpose of each individual component is.

**STEP 11 (Tensorflow I):** Within Google Cloud Skills Boost, complete the **TensorFlow: Qwik Start** lab. This lab requires 1 credit. As you do the lab, add the following to your lab notebook for this step.

- Play around (as mentioned in the lab) with a few different (smaller) epoch values.
- Show the result (screen shot) of a couple examples.
- Paste the final script into your notebook.

**STEP 12 (Tensorflow II):** Within Google Cloud Skills Boost, complete the **Introduction to Computer Vision with TensorFlow** lab. This lab requires 1 credit. As you do the lab, add the following to your lab notebook for this step.

- Describe the structure of the network you defined at the end of Task 5.
- Paste a screen shot of your model evaluation at the end of Task 7.
- Paste a screen shot of the evaluation results for the model you ran with more “neurons” in Exercise 1 of the Explore task.
- Paste a screen shot of the evaluation results for the model you ran with more dense layers in the Exercise 2 of the Explore task.
- Paste a screen shot of the evaluation results for the model you ran without normalization in the Exercise 3 of the Explore task.
**STEP 13 and 14 (Tensorflow III):** Pick *two* of the following TensorFlow labs and complete them.

- **Introduction to Convolutions with TensorFlow**, 5 credits
- **Classify Images with TensorFlow Convolutional Neural Networks**, 5 credits
- **Identify Horses or Humans with TensorFlow and Vertex AI**, 5 credits
- **Identify Damaged Car Parts with Vertex AutoML Vision**, 5 credits
- **TFX on Google Cloud Vertex AI Pipelines**, 5 credits

Write down the following in your lab notebook for this step.

- In your own words, what was the purpose of each lab?
- What was the outcome of each lab?
- What did you learn by doing the lab?