MS4S21 CW-1

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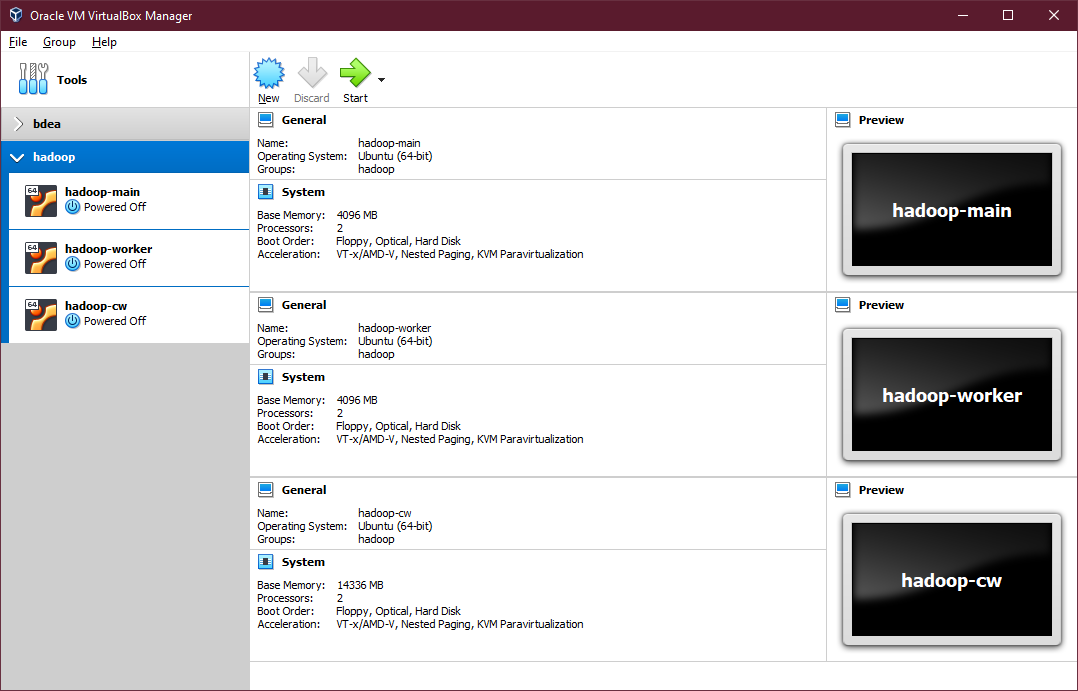
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# 1 – Experiment 1

This section will detail what was carried out for experiment 1, which was to create a Hadoop cluster using Ubuntu Virtual Machines (VMs) on our local machines. This will be done with [Oracles VirtualBox](#_x.1_-_VirtualBox) software. The main task was to replace the existing worker node with a new worker node with the following specifications:



(Figure 1 – Screenshot of the 3 node hadoop cluster)

Seeing as I ran into some issues with my existing cluster from the tutorials, I took a day to re-create the whole cluster again following the notes from the tutorials which I manipulated for myself. The next few steps will be the sequence of events which happened from start to finish, with a working 3 node cluster.

## - Hadoop-Main

After installing Ubuntu Desktop 20.04 Long Term Support ([Instruction Here](https://ubuntu.com/tutorials/install-ubuntu-desktop#1-overview)), I installed the updates and openssh-server so I could ssh into the main node from my computer using [Windows Terminal](#_x.2_-_Windows). This would allow me to copy and paste some of the commands I initially edited during the tutorials, to speed up my process of setting up the VMs.

### 1.1.1 – Set Hostname

I checked the hostname on the main node to make sure it was correctly assigned as: **hadoop-main**. This was done by editing the file with ***sudo nano /etc/hostname*** and deleting the hostname and changing it to **hadoop-main**.

### 1.1.2 – Set Hosts

Next was to assign the hosts correctly for the main node and the two worker nodes – I already knew I was going to set a static IP as it is good practice, so these were hard coded in a range which I knew was free on my local network. Setting the hosts file was done by typing into a terminal, **sudo nano /etc/hosts** and adding the following:

* 127.0.0.1 localhost
* #127.0.1.1 hadoop-xyz (this would be Virtual Machine hostname)
* 192.168.1.173 hadoop-main
* 192.168.1.174 hadoop-worker
* 192.168.1.175 hadoop-cw

### 1.1.3 – Download and Install Java

To install java on Linux, this can be done with the follow code: **sudo apt install openjdk-8-jdk** which is an open-source version of java freely distributed. Now that java is installed, the path needs to be assigned to the **~/.bashrc** file. This can be done with the following code: **sudo nano ~/.bashrc** and add the following code at the very bottom of the file:

* # JAVA
* export JAVA\_HOME=/usr/lib/jvm/java-8-openjdk-amd64/jre

and apply these changes with this: **source ~/.bashrc** – this is all that is currently needed for setting up java on Linux.

### 1.1.4 – Download and Install Hadoop

This next section will cover how to download and install Hadoop, which is required for our clusters, this code can be run from everywhere, but I usually change directory to downloads when downloading files. This can be done with:

* **cd Downloads/**
* **wget** [**https://archive.apache.org/dist/hadoop/common/hadoop-3.2.2/hadoop-3.2.2.tar.gz**](https://archive.apache.org/dist/hadoop/common/hadoop-3.2.2/hadoop-3.2.2.tar.gz)

Next will be to extract the archive which can be done with **tar -xvf hadoop-3.2.2.tar.gz** and should be moved to /usr/local/hadoop, this can be done with the following code: **sudo mv hadoop-3.2.2 /usr/local/hadoop** – now that we have moved the hadoop files to our local user files, we would need to add the path to **~/.bashrc** again. This can be done with: **sudo nano ~/.bashrc** and adding the 3 lines to the bottom of the file (under the Java entry)

* # HADOOP
* export PATH=$PATH:/usr/local/hadoop/bin:/usr/local/hadoop/sbin
* export CONF=/usr/local/hadoop/etc/hadoop

and applying the changes again with **source ~/.bashrc** – this will conclude this section.

### 1.1.5 – Cloning the VM

After getting this far and setting up a few basic things, the next step is to clone the VM. This can be done by right clicking the VM and clicking clone with these settings:

Graphical user interface, text, email

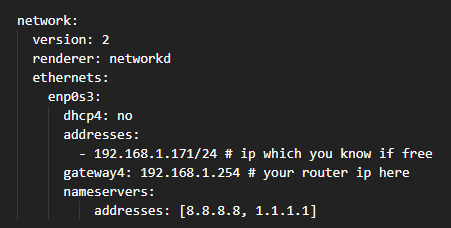
Description automatically generated

(Figure 2 – Screenshot of Cloning a VM)

And using the **Full Clone** option for the next setting – this will create (as the name suggests) a full clone of the VM but will generate a new mac address for the network adapter.

### 1.1.6 – Set Static IP

Now that the VM has been cloned, this is where I set a static IP for my VMs which I know are free on my local network. This can be done with the following code: **sudo nano /etc/netplan/01-network-manager-all.yaml** and pasting the following code:



(Figure 3 – Screenshot of how to set static IP)

### 1.1.7 – Generate SSH Keys

The next step will be to generate SSH keys from the main node to the two worker nodes, this is an easy task to do, but will need to be done after completing a few dependencies:

* [Changing the hostname of the 2 worker nodes](#_1.1.1_–_Set)
* [Setting static IPs for the 2 worker nodes](#_1.1.6_–_Set)

To generate your ssh keys from the main node, this can be done with: **ssh-keygen -t rsa** and accepting the default (which is not best practice, but this is only local). These keys would then need to be copied to the two worker nodes. This can be done with:

* **ssh-copy-id hadoop-cw@hadoop-main** # copy the key to main
* **ssh-copy-id hadoop-cw@hadoop-worker** # copy the key to worker 1
* **ssh-copy-id hadoop-cw@worker-cw** # copy the key to worker 2

These can be tested with all the machine running and typing from the main node: **ssh hadoop-cw@hadoop-worker** – you should be asked about accepting the connection and asked for the password. If successful you should see the terminal for **hadoop-cw@hadoop-worker**.

### 1.1.8 – Modifying Hadoop Files

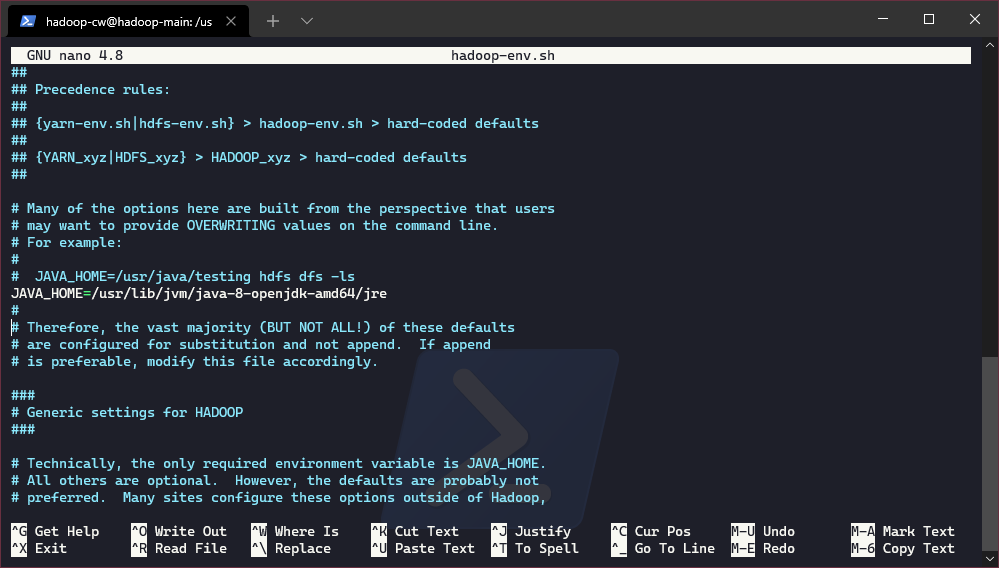
This step requires a few hadoop files to be modified, seeing as this will require going back and forth the path, we will create a command which will make changing directories much easier. This can be done by adding this code to the **~/.bashrc** file again, with: **sudo nano ~/.bashrc** and at the bottom of the file adding: **export CONF=usr/local/hadoop/etc/hadoop**, saving the changes and typing **source ~/.bashrc**. This will allow us to easily navigator to the hadoop folder with **cd $CONF/**.

#### 1.1.8.1 – hadoop-env.sh

Now this has been added, we need to change 4 files for the main node, these files are:

* hadoop-env.sh
* core-site.xml
* hdfs-site.xml
* workers

The first file will be changed with **sudo nano $CONF/hadoop-env.sh**, for this file we need to add the Java path which we created earlier. Within this file look for the java which is commented out and add our customised one like so:



(Figure 4 – hadoop-env.sh modified)

#### 1.1.8.2 – core-site.xml

Next we will need to change core-site.xml, this can be done with **sudo nano $CONF/core-site.xml**, within this file we want to add:

**<configuration>**

**<property>**

**<name>fs.defaultFS</name>**

**<value>hdfs://hadoop-main:9000</value>**

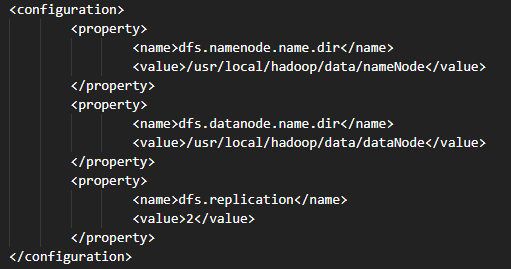
**</property>**

**</configuration>**

This is all for this file.

#### 1.1.8.3 – hdfs-site.xml

Next we will change hdfs-site.xml, this can be done with **sudo nano $CONF/hdfs-site.xml**, within this file we want to add:



(Figure 5 – hdfs-site.xml)

This is all we need for this file.

#### 1.1.8.4 – workers

The workers file is just there to list our worker nodes, for this we can access it with: **sudo nano workers**, within this file we want to add the two worker node hostnames, mine is as follows:

* hadoop-worker
* hadoop-cw

### 1.1.9 – Copy files to worker nodes

Now all these files have been modified, this is where we want to securely copy these files to our workers. This can be done with 2 lines of code:

* scp $CONF/\* hadoop-cw@bdea-worker:/usr/local/hadoop/etc/hadoop/
* scp $CONF/\* hadoop-cw@worker-cw:/usr/local/hadoop/etc/hadoop/

You should be presented with a success notification, and this concludes this section.

### 1.1.10 – Adding HADOOP to bashrc

To make sure we can call hadoop from everywhere on the machine, we want to add a few paths to bashrc. This can be done with **sudo nano ~/.bashrc** and within this file, again at the bottom add:

* export HADOOP\_HOME=/usr/local/hadoop
* export HADOOP\_COMMON\_HOME=$HADOOP\_HOME
* export HADOOP\_CONF\_DIR=$HADOOP\_HOME/etc/hadoop
* export HADOOP\_HDFS\_HOME=$HADOOP\_HOME
* export HADOOP\_MAPPED\_HOME=$HADOOP\_HOME

saving the changes and applying the changes with **source ~/.bashrc**. Now before moving on to running a map reduce task, there are a few more changes to add to the worker nodes.

## – Hadoop-Worker

To begin with our first worker, lets assigned a new hostname as it will be the same as the main node when we cloned the VM. Seeing as these instructions have already been described, I will just link to that section from [here](#_1.1.1_–_Set).

The next step is to make sure we have a static IP which we can use when connecting via ssh – again these steps have been mentioned so will be linked [here](#_1.1.6_–_Set).

Repeat these steps for the other worker and all should be good.

### – Modify files

This section will show the files which need to be modified to get the workers up and running, the only file which needs to be modified is yarn-site.xml. Just make sure this file has this in the file:

* **<configuration>**
  + **<property>**
    - **<name>yarn.resourcemanager.hostname</name>**
    - **<value>hadoop-main</value>**
  + **</property>**
* **</configuration>**

Now this file has been modified, we want to copy this file to the other worker node, both are all set up. This can be done with:

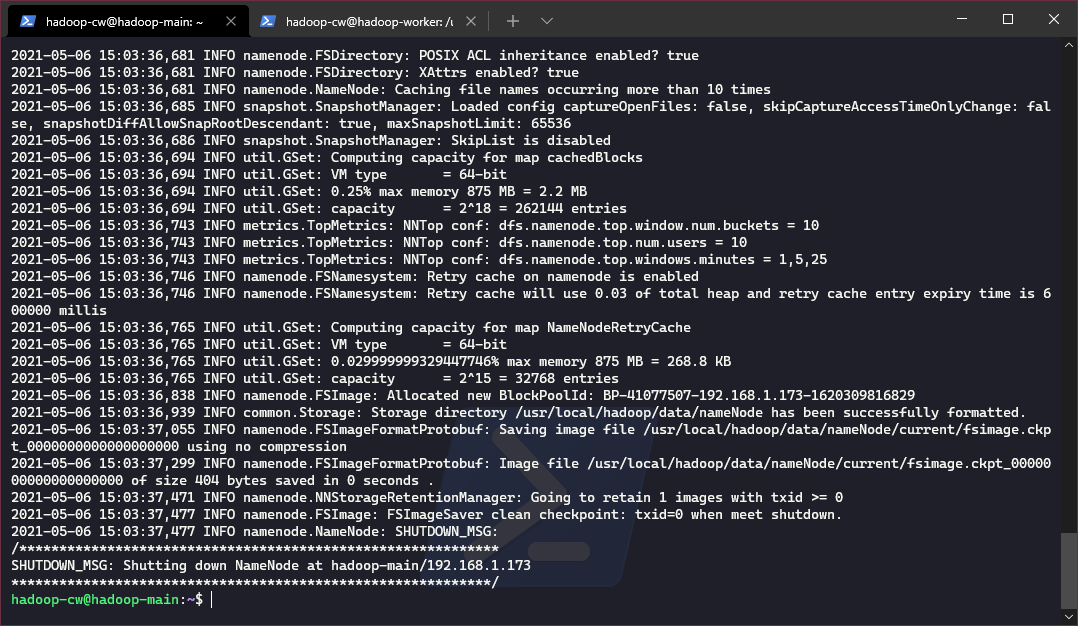
* **scp yarn-site.xml hadoop-cw@worker-cw:/usr/local/hadoop/etc/hadoop/**

After this, we are finished for the two workers and can begin to format and run a hdfs map reduce job.

## – Map Reduce

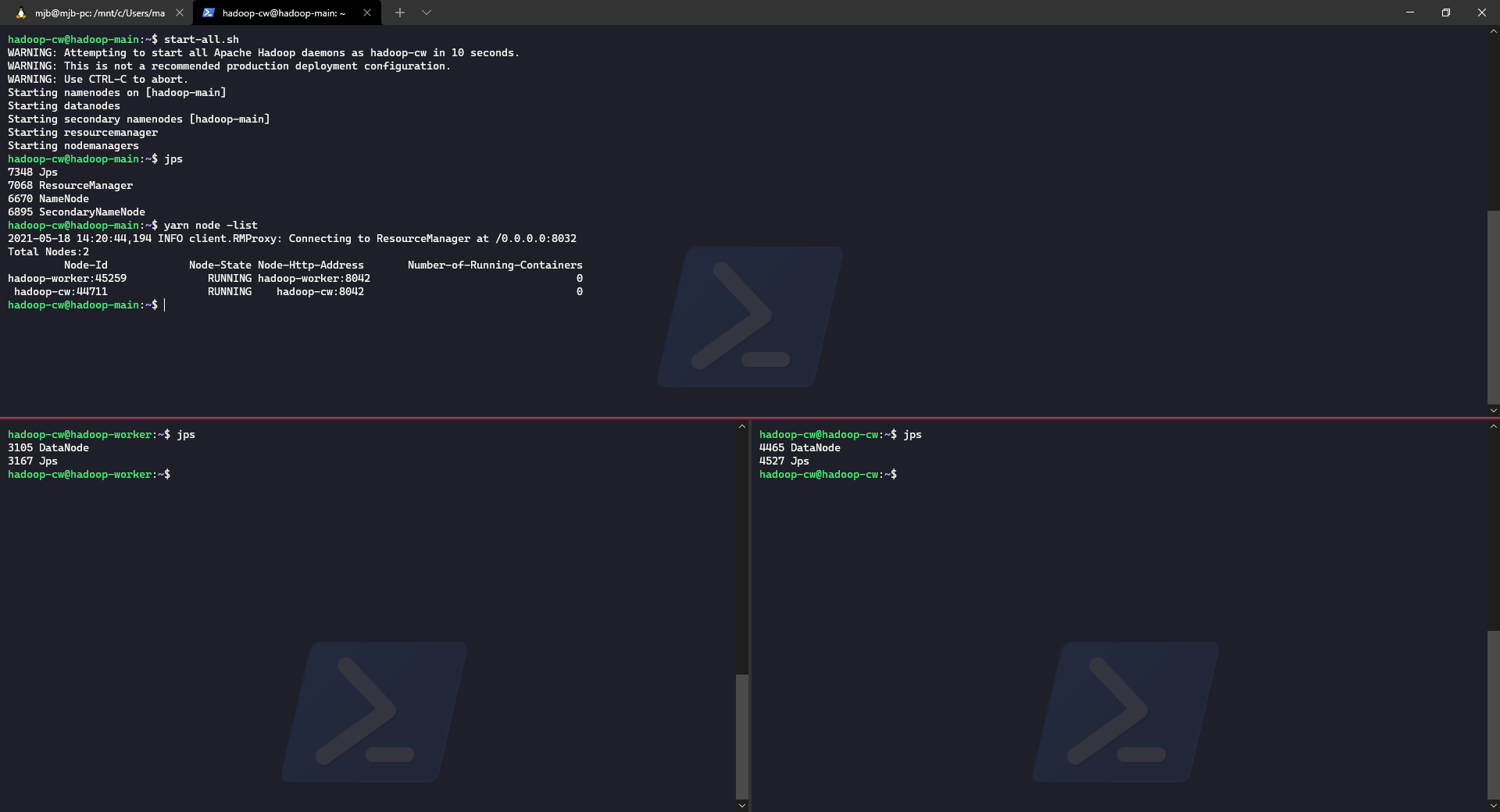
To begin with getting our cluster ready to carry out a map reduce job, there is still a few things left to do. The first is so format the main node which sets up the node and looks to see if the worker nodes are ready. This can be done with the following code, which can be executed from anywhere on the main node:

* **hadoop namenode -format**



(Figure 6 – Hadoop Main Format Response)

After running this command, we can start the distributed file system (dfs), this can be done with **start-dfs.sh** or **start-all.sh**. This will have an output as seen below:



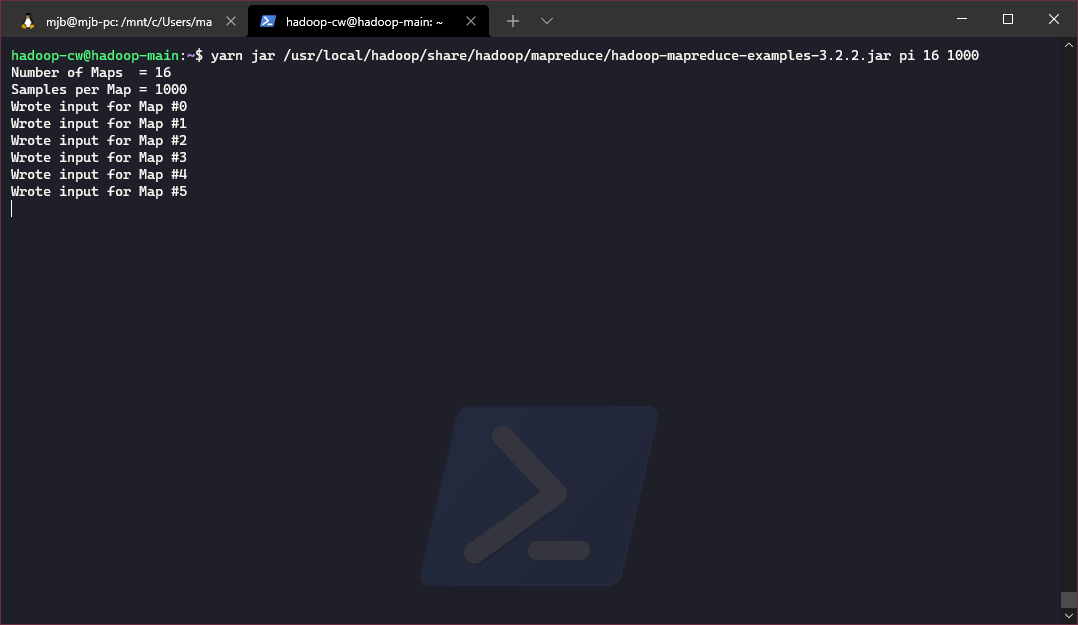
(Figure 7 – start-all.sh)

Now the cluster has been formatted and checked with **yarn node -list** (as seen above), this means our cluster is ready to run a map reduce job.

To run a map-reduce job, for this example lets run one of the built-in examples which is to estimate the value of pi. This can be done with the following code:

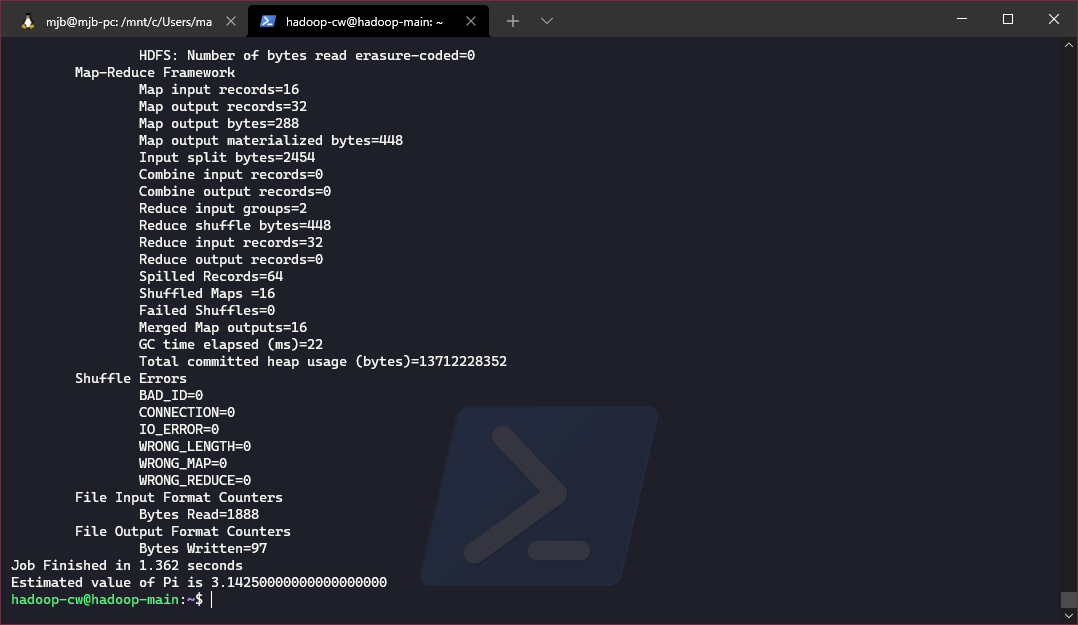
* **yarn jar /usr/local/hadoop/share/hadoop/mapreduce/hadoop-mapreduce-examples-3.2.2.jar pi 16 50000**

Where we are running a yarn jar file to estimate pi, with 16 map tasks and 50000 examples. Hopefully, you get no errors, and the output will look like the figure below.



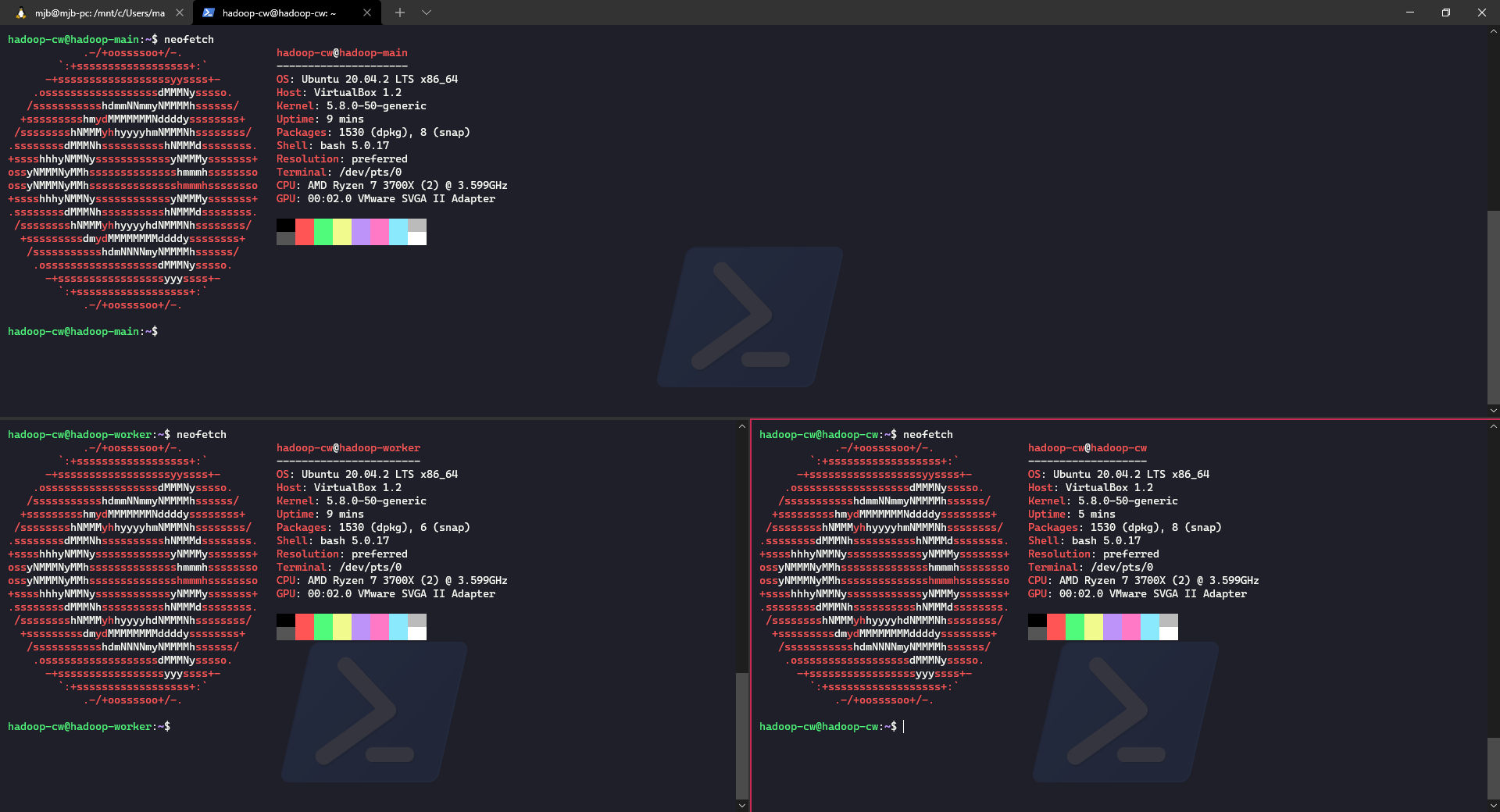
(Figure 8 – Map Reduce Job Running)

With the end looking like this:



(Figure 9 – Map Reduce Job Finished)

This concludes this section of the report which looks to set up a 3-node cluster and run a map reduce task. With the 3 nodes and their system resources found below:



(Figure 10 – 3 Node Cluster System Resources)

# – Experiment 2

This section of the report will go over how to stream tweets from the website [Twitter](https://twitter.com/) using their [API](developer.twitter.com) with a third-party API called [Tweepy](https://www.tweepy.org/). This will be done using a [Jupyter-Notebook](https://jupyter.org/) and python, which is being run from the package [Anaconda](https://www.anaconda.com/).

## 2.1 - Twitter Streamer

To start with this experiment, the first thing to do was to import two modules which are required for this task. This can be done with this:

|  |
| --- |
| **# install modules**  **import tweepy, json** |

Next is to set up the security keys from the twitter developer account:

|  |
| --- |
| **consumer\_key = 'y1Hz3CADNPj7fWOtkPfReA5Vbyzz'**  **consumer\_secret = 'sz3SszPNyJFA0URxqq8R76poS2q37pUbVwbj7Z0ARm68B5hQSRSzz'**  **Bearer\_Token = 'AAzAAAAAAAAAAAAAAAAAAANkfKQEAAAAApqxe6v7ejWpxazCs0S2YSJuiIJE%3DoDJ41CBVFbZQ0cZ4KftvIAMFLCWYn0Ih3SRzvF8reI74UdqNDxzz'**  **access\_token = '7z55358007-sDkidtK10EmFad6XaOFre7scKITWvoBMLkxkQ6KUzz'**  **access\_token\_secret = 'SzsYgAuAAFOl8m1zWWFSYJRdpL1L0u8KTZRDB2ZhbSsZZXzz'** |

***(This code has been modified so it will not work.)***

After setting these variables, we would need to set the authentication:

|  |
| --- |
| **# set authentication**  **auth = tweepy.OAuthHandler(consumer\_key, consumer\_secret)**  **auth.set\_access\_token(access\_token, access\_token\_secret)**  **api = tweepy.API(auth)** |

This is using tweepy to handle the authentication.

The next step is to create an instance of a file, which we will use to store the streamed tweets to.

|  |
| --- |
| **# open a file to append the streaming data**  **streamedTweets = open("streamed-tweets.csv", "w")**  **unfilteredTweets = open("unfiltered.csv", "w")** |

For this, I have set up two files which are as follows.

* streamed-tweets – this will only save certain properties from the twitter streamer.
* unfiltered – this will save everything that comes from the twitter streamer.

This next function is a big function which is used to connected to the streamer, check for errors and picks what data to keep from the streamer.

|  |
| --- |
| **class myStreamListener(*tweepy*.*StreamListener*):**  **def on\_connect(*self*):**  **# Called initially to connect to the Streaming API**  **print("You are now connected to the streaming API.")**    **def \_\_init\_\_(*self*, *api*=None):**  ***super*(myStreamListener, *self*).\_\_init\_\_()**    **def on\_error(*self*, *status\_code*):**  **if status == 420:**  **# Returning False on\_data method in case rate limit occurs.**  **return False**  **print(status)**  **# On error - if an error occurs, display the error / status code**  **print('An Error has occured: ' + repr(status\_code))**  **return False**  **def on\_data(*self*, *data*):**  **# Get all data from twitter as datajson**  **datajson = json.loads(data)**  **# dump all the data to see what we can use**  **json.dump(datajson, unfilteredTweets, *indent* = 6)**  **# select what we want to keep**  **createdAt = datajson['created\_at']**  **userName = datajson['user']['name']**  **tweetText = datajson['text']**  **userLoc = datajson['user']['location']**  **hashTags = datajson['entities']['hashtags']**  **userMentions = datajson['entities']['user\_mentions']**  **# get the data as a dictionary -**  **Dictionary = {1:createdAt, 2:userName, 3:tweetText,**  **4:userLoc, 5:hashTags, 6:userMentions}**  **# convert dict to json string**  **json\_string = json.dumps(Dictionary)**  **# write this converted string to csv & JSON**  **json.dump(json\_string, streamedTweets)** |

The ***on\_data***function is the part where we specify the data and what to save, for this I tried to take all the data as ***unfilteredTweets*** along with some filtered tweets. This was to check if working with one over the other would have been easier.

The next section is a big function which takes a few parameters which can be used against the rest of the streamer to filter down the stream. This can be done with things like locations, languages, hashtags and more. This can be done with the following code:

|  |
| --- |
| **def goGetTweets():**  **try:**  **# locations # uk**  **loCal = [-3.576205, 51.466683, -3.143618, 51.825436]**  **# languages**  **lanG = ['en']**  **# hashtags**  **hashT = ['#COVID19', '#CoronaVirus', '#UnitedKingdom', '#UK', '#India']**  **# set wait on rate limit**  **listener = myStreamListener(*api* = tweepy.API(*wait\_on\_rate\_limit* = True))**  **# init the streamer**  **streamer = tweepy.Stream(*auth*=auth, *listener* = listener)**  **# print tracking**  **print("Tracking location " + *str*('United Kingdom'))**  **# DOES THIS START OR STOP THE LOOP**  **streamer.filter(*locations*=loCal, *languages* = lanG, *track* = hashT)**  **except *KeyboardInterrupt*:**  **print("manually stopped at:", datetime.now())**  **finally:**  **print('Done.')**  **finalTime = datetime.now()**  **print(finalTime)**  **print("time ran out.")** |

The main parts of this code which is important is the locations which was set with [BBoxFinder](http://bboxfinder.com/), the languages which was easy enough to set and the hashtags which are the topics we are interested in tracking.

Next is setting the listening with the Tweepy API with wait on rate limit as this will make sure we do not go over our limit, setting the streamer with the authorisation and printing a string to let us know the app is tracking when it runs.

Next is the filter being applied to streamer before setting 2 excepts which will wait for a keyboard interrupt printing the time it stopped, and finally printing out done if the code runs to completion.

Before calling the function to start the stream, I tried to set up a condition which would run for x amount of time before finishing. I could not get this to work, but left the code in, here is the following code:

|  |
| --- |
| **####################################**  **## ALL OF THIS LOGIC DOESN'T WORK :(**  **####################################**  **# add some logic to see if it loops**  **from datetime import datetime, timedelta**  **# set start**  **startTimer = datetime.now()**  **# set end**  **endTimer = startTimer + timedelta(*seconds*=5)**  **print('START @',startTimer)**  **print('Should end at', endTimer)**  **# start loop**  **while datetime.now() < endTimer:**  **goGetTweets()**  **else:**  **finalTime = datetime.now()**  **print(finalTime)**  **print("time ran out.")**  **# close both csv files**  **streamedTweets.close()**  **unfilteredTweets.close()**  **# disconnect from streamer**  **#streamer.disconnect() # this kept throwing an error**  **print("Disconnecting from Streamer")** |

When running this code, I expected it to run for 5 seconds from when the command was run. However, this was not the case so instead I left it run for several hours before being hit with a connection issue. Although this code did run long enough to get two different types of csv’s saved – one which is unfiltered and in a JSON format, and the other which was a dictionary which contained only the entries which I wanted.

However, the second dataset which was a dictionary, seemed to all be within a single cell within Excel which I thought would have taken way too long to clean on submission day. Because of this I looked to the full JSON formatted file, which will be used in the next step.

## 2.2 – Data Pre-Processing

To begin with the data pre-processing, I started by creating a new notebook so I could keep things simple and clean. I then started by importing json, csv, pandas and importing the full ***unfiltered*** dataset which was dumped out from the last section.

|  |
| --- |
| **import json, csv**  **import pandas as pd** |
| **myFile = open('unfiltered.csv','r') # read the data**  **data = json.load(myFile)** |
| **print(data[1]) # print all the data for the first entry**  **print(data[1]['created\_at']) # print the create at for the first entry** |

There were some issues before getting the data to import correctly, when I was dumping out the data from section 2.1 the csv file which saved as a json format (indented) did not have commas between the curly brackets (**This = }{** ) which needed to be converted to (**This = },{**). This was difficult as the data was too big to replace all with Microsoft Excel (Obviously), it was also too big to clean with Microsoft Visual Studio Code (this was a surprise), but I was able to replace all with Notepad++ which really impressed me.

## 2.3 – DynamoDB

For this section we will create a database on DynamoDB which will have the layout for the data we want to keep and query.

|  |
| --- |
| TableName = 'twitter\_data',  Item = {  "created\_at": {  "S": " "  },  "user\_name": {  "S": " "  },  "tweet\_text": {  "S": " "  },  "user\_location": {  "N": ""  },  "hashtags": {  "S": ""  },  "user\_mentions": {  "S": ""  }  } |

# – Experiment 3

This section will go over the HiveQL queries specified in the brief.

* 1. The country which has authored the most tweets

Select \* from

* 1. The most frequent hashtag/word mentioned in experiment 2 found in tweets from each country
  2. The most frequent hashtag/word mentioned in experiment found in all tweets
  3. Total number of user mentions in tweets from each country
  4. Total number of user mentions in all tweets

# X – References

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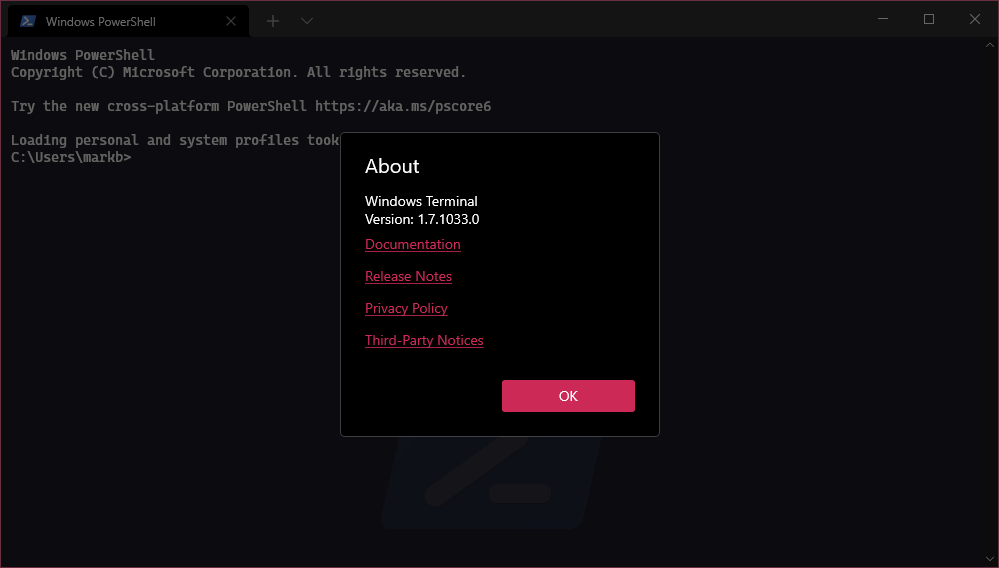
Microsoft Excel (2021) Available at: <https://www.microsoft.com/en-gb/microsoft-365/excel> (Accessed 23/04/2021)

# X - Software

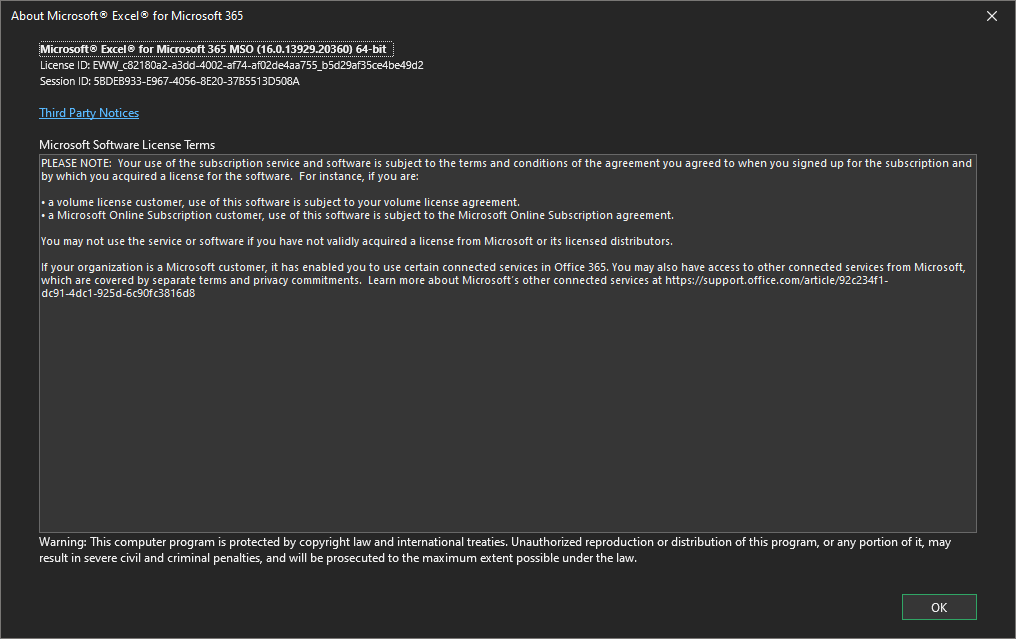
## x.1 - VirtualBox – Version 6.1.22 r144080 (Qt5.6.2)



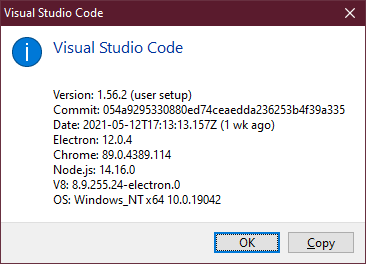
## x.2 - Windows Terminal - Version: 1.7.1033.0



## x.3 – Microsoft Excel – Version: 16.0.13929.20360



## X.4 – Microsoft Visual Studio Code – Version 1.56.2



## x.5 – Notepad++ - Version 7.9.5

