SREYAS INSTITUTE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, Affiliated to JNTUH)

2-50/5, SyNo.107, Tattiannaram(V), G.S.I Bandlaguda, Nagole, Hyderabad – 500 068

DEPARTMENT OF CSE-DATA SCIENCE

BIG DATA ANALYTICS
LAB MANUAL
III-B Tech – II Semester [Branch: CSE-DS(R18)]

SREYAS INSTITUTE OF ENGINEERING AND TECHNOLOGY

Besides InduAranya, Nagole, Hyderabad.

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G.S.I. Bandlaguda, Nagole, Hyderabad - 500068

CERTIFICATE

LAB NAME	**:**	**BIG DATA ANALYTICTS LAB**
BRANCH	**:**	**CSE-DS**
YEAR & SEM	**:**	**III – II**
REGULATION	**:**	**R18**

SREYAS INSTITUTE OF ENGINEERING & TECHNOLOGY
(Approved by AICTE, New Delhi & Affiliated to JNTUH)
Thatti Annaram(v), Bandlaguda, Nagole, Hyderabad - 500068.

DEPARTMENT OF CSE-DATA SCIENCE

VISION & MISSION OF INSTITUTION

VISION

To be a centre of excellence in technical education to empower the young talent through quality education and innovative engineering for well being of the society

MISSION

1. Provide quality education with innovative methodology and intellectual human capital.
2. Provide conducive environment for research and developmental activities.
3. Inculcate holistic approach towards nature, society and human ethics with lifelong learning attitude.

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DEPARTMENT OF CSE-DATA SCIENCE

VISION & MISSION OF DEPARTMENT

Vision

To excel in computer science engineering education with best learning practices, research and professional ethics.

Mission

1. To offer technical education with innovative teaching, good infrastructure and qualified human resources.
2. Accomplish a process to advance knowledge in the subject and promote academic and research environment.
3. To impart moral and ethical values and interpersonal skills to the students.

Program Educational Objectives

Computer Science & Engineering (CSE) is one of the most prominent technical fields in Engineering. The curriculum offers courses with various areas of emphasis on theory, design and experimental work. Subject matter ranges from basics of Computers & Programming Languages to Compiler Design and Cloud Computing. It maintains strong tie-ups with industry and is dedicated to preparing students for a career in Web Technologies, Object Oriented Analysis and Design, Networking & Security, Databases, Data Mining & Data Warehousing and Software Testing.

PROGRAM OUTCOMES(POs)

Engineering Graduates will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

13. Proficiency on the contemporary skills towards development of innovative apps and firmware products.
14. Capabilities to participate in the construction of software systems of varying complexity.

DEPARTMENT OF CSE-DATA SCIENCE

III Year B.Tech CSE-DS- II Sem

BIG DATA ANALYTICTS LAB INSTRUCTIONS TO THE STUDENTS

Things to Do:

1) Students should come in formal dresses.
2) Students must wear their id cards.
3) They have to be in the lab before 10 minutes.
4) They should come up with the observation and the record.
5) Observation should get corrected with the concerned faculty.
6) The programs corrected by the faculty have to copy to record.
7) They should maintain silence in the lab.

Things not to do:

1) Students should not bring any electronic gadgets into the lab.
2) They should not come late.
3) You should not create any disturbances to others.

HOD Lab Incharge

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

III Year B.Tech.CSE. II – Sem **L T P C**

CourseCode: **0 0 2 1**

BIG DATA ANALYTICTS LAB MANUAL

Course Objectives

1. The purpose of this course is to provide the students with the knowledge of Big data Analytics principles and techniques.
2. This course is also designed to give an exposure of the frontiers of Big data Analytics

Course Outcomes

1.Use Excel as an Analytical tool and visualization tool.
2. Ability to program using HADOOP and Map reduce.
3. Ability to perform data analytics using ML in R.
4. Use cassandra to perform social media analytics.

List of Experiments

1. Implement a simple map-reduce job that builds an inverted index on the set of input documents (Hadoop)
2. Process big data in HBase
3. Store and retrieve data in Pig
4. Perform Social media analysis using cassandra
5. Buyer event analytics using Cassandra on suitable product sales data.
6. Using Power Pivot (Excel) Perform the following on any dataset

a) Big Data Analytics
b) Big Data Charting

7. Use R-Project to carry out statistical analysis of big data
8. Use R-Project for data visualization of social media data

TEXT BOOKS:

1.Big Data Analytics, Seema Acharya, Subhashini Chellappan, Wiley 2015.
2. Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business, Michael Minelli, Michehe Chambers, 1st Edition, Ambiga Dhiraj, Wiely CIO Series, 2013.
3. Hadoop: The Definitive Guide, Tom White, 3rd Edition, O"Reilly Media, 2012.
4. Big Data Analytics: Disruptive Technologies for Changing the Game, Arvind Sathi, 1st Edition,
IBM Corporation, 2012.

REFERENCES:

1.Big Data and Business Analytics, Jay Liebowitz, Auerbach Publications, CRC press (2013).
2. Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop, Tom Plunkett, Mark Hornick, McGraw-Hill/Osborne Media (2013), Oracle press.
3. Professional Hadoop Solutions, Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Wiley, ISBN: 9788126551071, 2015.
4. Understanding Big data, Chris Eaton, Dirk deroos et al., McGraw Hill, 2012.
5. Intelligent Data Analysis, Michael Berthold, David J. Hand, Springer, 2007.

6. Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced
Analytics, Bill Franks, 1st Edition, Wiley and SAS Business Series, 2012.

INDEX

Experiment 1 : Implement a simple map-reduce job that builds an inverted index on the set of input documents (Hadoop)

Aim: To implement an Inverted index on Hadoop.

Resources:Hadoop,Java,Ecplise

Theory; Hadoop is an open-source framework that allows to store and process big data in a distributed environment across clusters of computers using simple programming models. It is designed to scale up from single servers to thousands of machines, each offering local computation and storage. Hadoop runs applications using the MapReduce algorithm, where the data is processed in parallel with others. In short, Hadoop is used to develop applications that could perform complete statistical analysis on huge amounts of data.

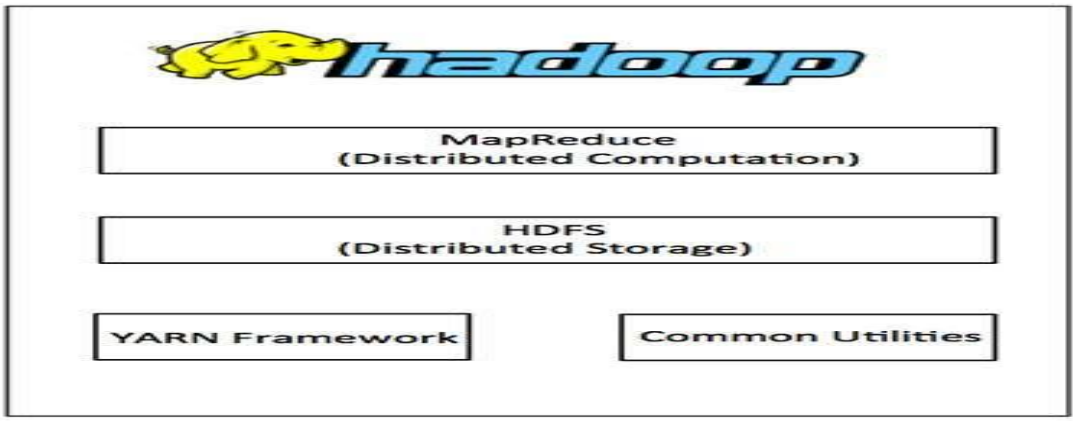
Hadoop is an Apache open source framework written in java that allows distributed processing of large datasets across clusters of computers using simple programming models. The Hadoop framework application works in an environment that provides distributed storage and computation across clusters of computers. Hadoop is designed to scale up from single server to thousands of machines, each offering local computation and storage.

Hadoop Architecture

At its core, Hadoop has two major layers namely –

- Processing/Computation layer (MapReduce), and
- Storage layer (Hadoop Distributed File System).

Hadoop is an Apache open source framework written in java that allows distributed processing of large datasets across clusters of computers using simple programming models. The Hadoop framework application works in an environment that provides distributed *storage* and *computation* across clusters of computers. Hadoop is designed to scale up from single server to thousands of machines, each offering local computation and storage.



MapReduce

MapReduce is a processing technique and a program model for distributed computing based on java. The MapReduce algorithm contains two important tasks, namely Map and Reduce.

Map takes a set of data and converts it into another set of data, where individual elements are broken down into tuples (key/value pairs). Secondly, reduce task, which takes the output from a map as an input and combines those data tuples into a smaller set of tuples.

As the sequence of the name MapReduce implies, the reduce task is always performed after the map job.

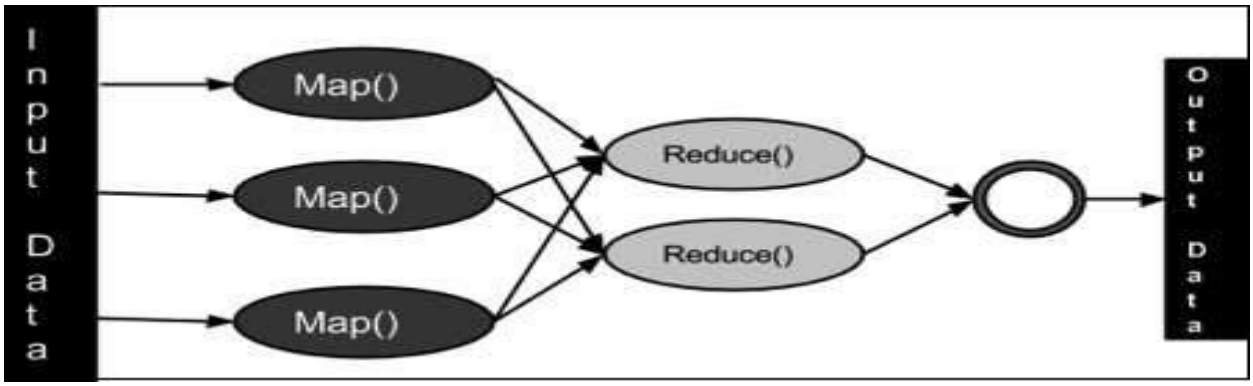
The major advantage of MapReduce is that it is easy to scale data processing over multiple computing nodes. Under the MapReduce model, the data processing primitives are called mappers and reducers.

Decomposing a data processing application into *mappers* and *reducers* is sometimes nontrivial. But, once we write an application in the MapReduce form, scaling the application to run over hundreds, thousands, or even tens of thousands of machines in a cluster is merely a configuration change. This simple scalability is what has attracted many programmers to use the MapReduce model.

The Algorithm

- Generally MapReduce paradigm is based on sending the computer to where the data resides!
- MapReduce program executes in three stages, namely map stage, shuffle stage, and reduce stage.
    - **Map stage** – The map or mapper's job is to process the input data. Generally the input data is in the form of file or directory and is stored in the Hadoop file system (HDFS). The input file is passed to the mapper function line by line. The mapper processes the data and creates several small chunks of data.
    - **Reduce stage** – This stage is the combination of the **Shuffle** stage and the **Reduce** stage. The Reducer's job is to process the data that comes from the mapper. After processing, it produces a new set of output, which will be stored in the HDFS.
- During a MapReduce job, Hadoop sends the Map and Reduce tasks to the appropriate servers in the cluster.

- The framework manages all the details of data-passing such as issuing tasks, verifying task completion, and copying data around the cluster between the nodes.
- Most of the computing takes place on nodes with data on local disks that reduces the network traffic.
- After completion of the given tasks, the cluster collects and reduces the data to form an appropriate result, and sends it back to the Hadoop server.



Inputs and Outputs (Java Perspective)

The MapReduce framework operates on <key, value> pairs, that is, the framework views the input to the job as a set of <key, value> pairs and produces a set of <key, value> pairs as the output of the job, conceivably of different types.

The key and the value classes should be in serialized manner by the framework and hence, need to implement the Writable interface. Additionally, the key classes have to implement the Writable-Comparable interface to facilitate sorting by the framework. Input and Output types of a **MapReduce job** – (Input) <k1, v1> → map → <k2, v2> → reduce → <k3, v3>(Output).

	Input	Output
Map	<k1, v1>	list (<k2, v2>)
Reduce	<k2, list(v2)>	list (<k3, v3>)

Procedure:

Steps to install Hadoop:

1. Make sure java is installed.

```
java -version
```

If java is not installed, then type in the following commands:

```
sudo apt-get install update
sudo apt-get update
sudo apt-get install default-jdk
```

Make sure now java is installed.

```
java -version
```

```
husseinfadl@husseinfadl:/home$ java -version
openjdk version "11.0.10" 2021-01-19
OpenJDK Runtime Environment (build 11.0.10+9-Ubuntu-0ubuntu1.18.04)
OpenJDK 64-Bit Server VM (build 11.0.10+9-Ubuntu-0ubuntu1.18.04, mixed mode, sharing)
husseinfadl@husseinfadl:/home$
```

2. Install ssh server

```
sudo apt-get install ssh-server
```

Generate public/private RSA key pair.

```
ssh-keygen -t rsa -P “”
```

When prompted for the file name to save the key, press Enter (leave it blank).

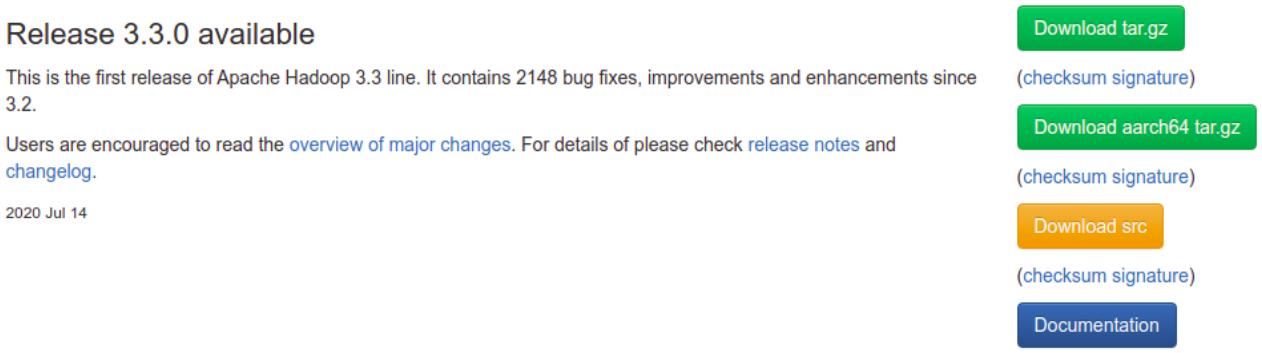
```
husseinfadl@husseinfadl:/home$ ssh-keygen -t rsa -P “”
Generating public/private rsa key pair.
Enter file in which to save the key (/home/husseinfadl/.ssh/id_rsa):
Your identification has been saved in /home/husseinfadl/.ssh/id_rsa.
Your public key has been saved in /home/husseinfadl/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:XqVfPkZlmsIG7z9I1pX/zMJZo2hWX7K9HtcgjIjLEyQ husseinfadl@husseinfadl
The key's randomart image is:
+---[RSA 2048]----+
|                 |
|                 |
|    E .   . .   +|
|     o . . O   *.|
|      o S + B.*..|
|     . + . +oBoo=|
|      + .  o=o*X*|
|       .   +.+*oB|
|          o   o=.|
+----[SHA256]-----+
```

Type the following commands:

```
cat $HOME/.ssh/id_rsa.pub >> $HOME/.ssh/authorized_keys
ssh localhost
exit
```

```
husseinfadl@husseinfadl:~$ ssh localhost
Welcome to Ubuntu 18.04.5 LTS (GNU/Linux 4.15.0-139-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

 * Canonical Livepatch is available for installation.
   - Reduce system reboots and improve kernel security. Activate at:
     https://ubuntu.com/livepatch

80 packages can be updated.
27 of these updates are security updates.
To see these additional updates run: apt list --upgradable

New release '20.04.2 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

Last login: Tue Apr 13 15:29:36 2021 from 127.0.0.1
husseinfadl@husseinfadl:~$

husseinfadl@husseinfadl:~$ exit
logout
Connection to localhost closed.
husseinfadl@husseinfadl:/home$
```

3. Install Hadoop by navigating to the following link and downloading the tar.gz file for Hadoop version 3.3.0 (or a later version if you wish). (478 MB)
   https://hadoop.apache.org/release/3.3.0.html



4. Once downloaded, open the terminal and cd to the directory where it is downloaded (assume the desktop for example) and extract it as follows:

   ```
   cd Desktop
   sudo tar -xvzf hadoop-3.3.0.tar.gz
   ```

   You can now check that there is an extracted file named hadoop-3.3.0 by typing the command "ls" or by visually inspecting the files.

5. Now, we move the extracted file to the location /usr/local/hadoop

   ```
   sudo mv hadoop-3.3.0 /usr/local/hadoop
   ```

6. Let’s configure the hadoop system.

   Type the following command:

   sudo gedit ~/.bashrc

   At the end of the file, add the following lines: (Note: Replace the java version with the version number you already have. You can navigate to the directory /usr/lib/jvm and check the file name java-xx-openjdk-amd64)

   export JAVA_HOME=/usr/lib/jvm/java-**11**-openjdk-amd64

   export HADOOP_HOME=/usr/local/hadoop

   export PATH=$PATH:$HADOOP_HOME/bin

   export PATH=$PATH:$HADOOP_HOME/sbin

   export HADOOP_MAPRED_HOME=$HADOOP_HOME

   export HADOOP_COMMON_HOME=$HADOOP_HOME

   export HADOOP_HDFS_HOME=$HADOOP_HOME

   export YARN_HOME=$HADOOP_HOME

   export HADOOP_COMMON_LIB_NATIVE_DIR=$HADOOP_HOME/native

   export HADOOP_OPTS="-Djava.library.path=$HADOOP_HOME/native"

```
# enable programmable completion features (you don't need to enable
# this, if it's already enabled in /etc/bash.bashrc and /etc/profile
# sources /etc/bash.bashrc).
if ! shopt -oq posix; then
  if [ -f /usr/share/bash-completion/bash_completion ]; then
    . /usr/share/bash-completion/bash_completion
  elif [ -f /etc/bash_completion ]; then
    . /etc/bash_completion
  fi
fi

export JAVA_HOME=/usr/lib/jvm/java-11-openjdk-amd64
export HADOOP_HOME=/usr/local/hadoop
export PATH=$PATH:$HADOOP_HOME/bin
export PATH=$PATH:$HADOOP_HOME/sbin
export HADOOP_MAPRED_HOME=$HADOOP_HOME
export HADOOP_COMMON_HOME=$HADOOP_HOME
export HADOOP_HDFS_HOME=$HADOOP_HOME
export YARN_HOME=$HADOOP_HOME
export HADOOP_COMMON_LIB_NATIVE_DIR=$HADOOP_HOME/native
export HADOOP_OPTS="-Djava.library.path=$HADOOP_HOME/native"
```

7. Save the file and close it.
8. Now from the terminal, type the following command:

```
source ~/.bashrc
```

9. We start configuring Hadoop by opening **hadoop-env.sh** as follows:

```
sudo gedit /usr/local/hadoop/etc/hadoop/hadoop-env.sh
```

Search for the line starting with **export JAVA_HOME=** and replace it with the following line.

```
export JAVA_HOME=/usr/lib/jvm/java-11-openjdk-amd64
```

Save the file by clicking on “Save” or (Ctrl+S)

```
# The java implementation to use. By default, this environment
# variable is REQUIRED on ALL platforms except OS X!
export JAVA_HOME=/usr/lib/jvm/java-11-openjdk-amd64

# Location of Hadoop.  By default, Hadoop will attempt to determine
# this location based upon its execution path.
# export HADOOP_HOME=

# Location of Hadoop's configuration information.  i.e., where this
# file is living. If this is not defined, Hadoop will attempt to
# locate it based upon its execution path.
#
```

10. Open **core-site.xml** as follows:

```
sudo gedit /usr/local/hadoop/etc/hadoop/core-site.xml
```

Add the following lines between the tags <configuration> and </configuration> and save it (Ctrl+S).

```
<property>
   <name>fs.default.name</name>
   <value>hdfs://localhost:9000</value>
</property>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>
<!--
  Licensed under the Apache License, Version 2.0 (the "License");
  you may not use this file except in compliance with the License.
  You may obtain a copy of the License at

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  distributed under the License is distributed on an "AS IS" BASIS,
  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
  See the License for the specific language governing permissions and
  limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->

<configuration>
 <property>
   <name>fs.default.name</name>
   <value>hdfs://localhost:9000</value>
 </property>
</configuration>
```

11. Open **hdfs-site.xml** as follows:

```
sudo gedit /usr/local/hadoop/etc/hadoop/hdfs-site.xml
```

Add the following lines between the tags <configuration> and </configuration> and save it (Ctrl+S).

```
<property>
  <name>dfs.replication</name>
  <value>1</value>
</property>
<property>
 <name>dfs.namenode.name.dir</name>
 <value>file:/usr/local/hadoop_space/hdfs/namenode</value>
</property>
<property>
 <name>dfs.datanode.data.dir</name>
 <value>file:/usr/local/hadoop_space/hdfs/datanode</value>
</property>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>
<!--
  Licensed under the Apache License, Version 2.0 (the "License");
  you may not use this file except in compliance with the License.
  You may obtain a copy of the License at

    http://www.apache.org/licenses/LICENSE-2.0

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  distributed under the License is distributed on an "AS IS" BASIS,
  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
  See the License for the specific language governing permissions and
  limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->

<configuration>
  <property>
    <name>dfs.replication</name>
    <value>1</value>
  </property>
  <property>
    <name>dfs.namenode.name.dir</name>
    <value>file:/usr/local/hadoop_tmp/hdfs/namenode</value>
  </property>
  <property>
    <name>dfs.datanode.data.dir</name>
    <value>file:/usr/local/hadoop_tmp/hdfs/datanode</value>
  </property>
</configuration>
```

Open **yarn-site.xml** as follows:

```
sudo gedit /usr/local/hadoop/etc/hadoop/yarn-site.xml
```

Add the following lines between the tags <configuration> and </configuration> and save it (Ctrl+S)

```
 <property>
   <name>yarn.nodemanager.aux-services</name>
   <value>mapreduce_shuffle</value>
 </property>
 <property>
   <name>yarn.nodemanager.aux-
services.mapreduce.shuffle.class</name>
   <value>org.apache.hadoop.mapred.ShuffleHandler</value>
```

```
 </property>
```

```
<?xml version="1.0"?>
<!--
  Licensed under the Apache License, Version 2.0 (the "License");
  you may not use this file except in compliance with the License.
  You may obtain a copy of the License at

    http://www.apache.org/licenses/LICENSE-2.0

  Unless required by applicable law or agreed to in writing, software
  distributed under the License is distributed on an "AS IS" BASIS,
  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
  See the License for the specific language governing permissions and
  limitations under the License. See accompanying LICENSE file.
-->

<configuration>
<!-- Site specific YARN configuration properties -->
 <property>
   <name>yarn.nodemanager.aux-services</name>
   <value>mapreduce_shuffle</value>
 </property>
 <property>
   <name>yarn.nodemanager.aux-services.mapreduce.shuffle.class</name>
   <value>org.apache.hadoop.mapred.ShuffleHandler</value>
 </property>
</configuration>
```

12. Open **mapred-site.xml** as follows:

```
sudo gedit /usr/local/hadoop/etc/hadoop/mapred-site.xml
```

Add the following lines between the tags <configuration> and </configuration> and save it (Ctrl+S)

```
 <property>
  <name>mapreduce.framework.name</name>
  <value>yarn</value>
 </property>
 <property>
  <name>yarn.app.mapreduce.am.env</name>
  <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
 </property>
 <property>
  <name>mapreduce.map.env</name>
  <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
 </property>
 <property>
  <name>mapreduce.reduce.env</name>
  <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
 </property>
```

```
  Unless required by applicable law or agreed to in writing, software
  distributed under the License is distributed on an "AS IS" BASIS,
  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
  See the License for the specific language governing permissions and
  limitations under the License. See accompanying LICENSE file.
-->

<!-- Put site-specific property overrides in this file. -->

<configuration>
 <property>
  <name>mapreduce.framework.name</name>
  <value>yarn</value>
 </property>
 <property>
  <name>yarn.app.mapreduce.am.env</name>
  <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
 </property>
 <property>
  <name>mapreduce.map.env</name>
  <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
 </property>
 <property>
  <name>mapreduce.reduce.env</name>
  <value>HADOOP_MAPRED_HOME=${HADOOP_HOME}</value>
 </property>
</configuration>
```

13. Now, run the following commands on the terminal to create a directory for hadoop space, name node and data node.

```
sudo mkdir -p /usr/local/hadoop_space
sudo mkdir -p /usr/local/hadoop_space/hdfs/namenode
sudo mkdir -p /usr/local/hadoop_space/hdfs/datanode
```

Now we have successfully installed Hadoop.

14. Format the namenode as follows:

```
hdfs namenode -format
```

```
husseinfadl@husseinfadl:~$ hdfs namenode -format
2021-04-13 14:15:15,047 INFO namenode.NameNode: STARTUP_MSG:
/************************************************************
STARTUP_MSG: Starting NameNode
STARTUP_MSG:   host = husseinfadl/127.0.1.1
STARTUP_MSG:   args = [-format]
STARTUP_MSG:   version = 3.3.0
STARTUP_MSG:   classpath = /usr/local/hadoop/etc/hadoop:/usr/local/hadoop/share/hadoop/commo
n/lib/curator-recipes-4.2.0.jar:/usr/local/hadoop/share/hadoop/common/lib/failureaccess-1.0.
jar:/usr/local/hadoop/share/hadoop/common/lib/jackson-annotations-2.10.3.jar:/usr/local/hado
op/share/hadoop/common/lib/jersey-json-1.19.jar:/usr/local/hadoop/share/hadoop/common/lib/ke
rb-core-1.0.1.jar:/usr/local/hadoop/share/hadoop/common/lib/jackson-core-asl-1.9.13.jar:/usr
/local/hadoop/share/hadoop/common/lib/slf4j-log4j12-1.7.25.jar:/usr/local/hadoop/share/hadoo
p/common/lib/metrics-core-3.2.4.jar:/usr/local/hadoop/share/hadoop/common/lib/kerby-xdr-1.0.
1.jar:/usr/local/hadoop/share/hadoop/common/lib/j2objc-annotations-1.1.jar:/usr/local/hadoop
/share/hadoop/common/lib/javax.servlet-api-3.1.0.jar:/usr/local/hadoop/share/hadoop/common/l
ib/curator-client-4.2.0.jar:/usr/local/hadoop/share/hadoop/common/lib/kerb-server-1.0.1.jar:
/usr/local/hadoop/share/hadoop/common/lib/zookeeper-jute-3.5.6.jar:/usr/local/hadoop/share/h
adoop/common/lib/slf4j-api-1.7.25.jar:/usr/local/hadoop/share/hadoop/common/lib/curator-fram
```

This step should end by shutting down the namenode as follows:

```
2021-04-13 14:16:46,808 INFO namenode.FSImageFormatProtobuf: Image file /usr/local/hadoop_tm
p/hdfs/namenode/current/fsimage.ckpt_0000000000000000000 of size 406 bytes saved in 0 second
s .
2021-04-13 14:16:46,900 INFO namenode.NNStorageRetentionManager: Going to retain 1 images wi
th txid >= 0
2021-04-13 14:16:46,909 INFO namenode.FSImage: FSImageSaver clean checkpoint: txid=0 when me
et shutdown.
2021-04-13 14:16:46,909 INFO namenode.NameNode: SHUTDOWN_MSG:
/************************************************************
SHUTDOWN_MSG: Shutting down NameNode at husseinfadl/127.0.1.1
************************************************************/
```

15. Before starting the Hadoop Distributed File System (hdfs), we need to make sure that the rcmd type is “ssh” not “rsh” when we type the following command

    `pdsh -q -w localhost`

```
husseinfadl@husseinfadl:~$ pdsh -q -w localhost
-- DSH-specific options --
Separate stderr/stdout  Yes
Path prepended to cmd   none
Appended to cmd         none
Command:                none
Full program pathname   /usr/bin/pdsh
Remote program path     /usr/bin/pdsh

-- Generic options --
Local username          husseinfadl
Local uid               1000
Remote username         husseinfadl
Rcmd type               rsh
one ^C will kill pdsh   No
Connect timeout (secs)  10
Command timeout (secs)  0
Fanout                  32
Display hostname labels Yes
Debugging               No

-- Target nodes --
localhost
```

16. If the rcmd type is “rsh” as in the above figure, type the following commands:

```
export PDSH_RCMD_TYPE=ssh
cat $HOME/.ssh/id_rsa.pub >> $HOME/.ssh/authorized_keys
chmod 0600 ~/.ssh/authorized_keys
```

Run Step 16 again to check that the rcmd type is now ssh.

If not, skip that step.

17. Start the HDFS System using the command.

```
start-dfs.sh
```

```
husseinfadl@husseinfadl:~$ start-dfs.sh
Starting namenodes on [localhost]
Starting datanodes
Starting secondary namenodes [husseinfadl]
2021-04-13 14:48:34,832 WARN util.NativeCodeLoader: Unable to load nat
ive-hadoop library for your platform... using builtin-java classes whe
re applicable
```

18. Start the YARN using the command

```
start-yarn.sh
```

```
husseinfadl@husseinfadl:~$ start-yarn.sh
Starting resourcemanager
Starting nodemanagers
```

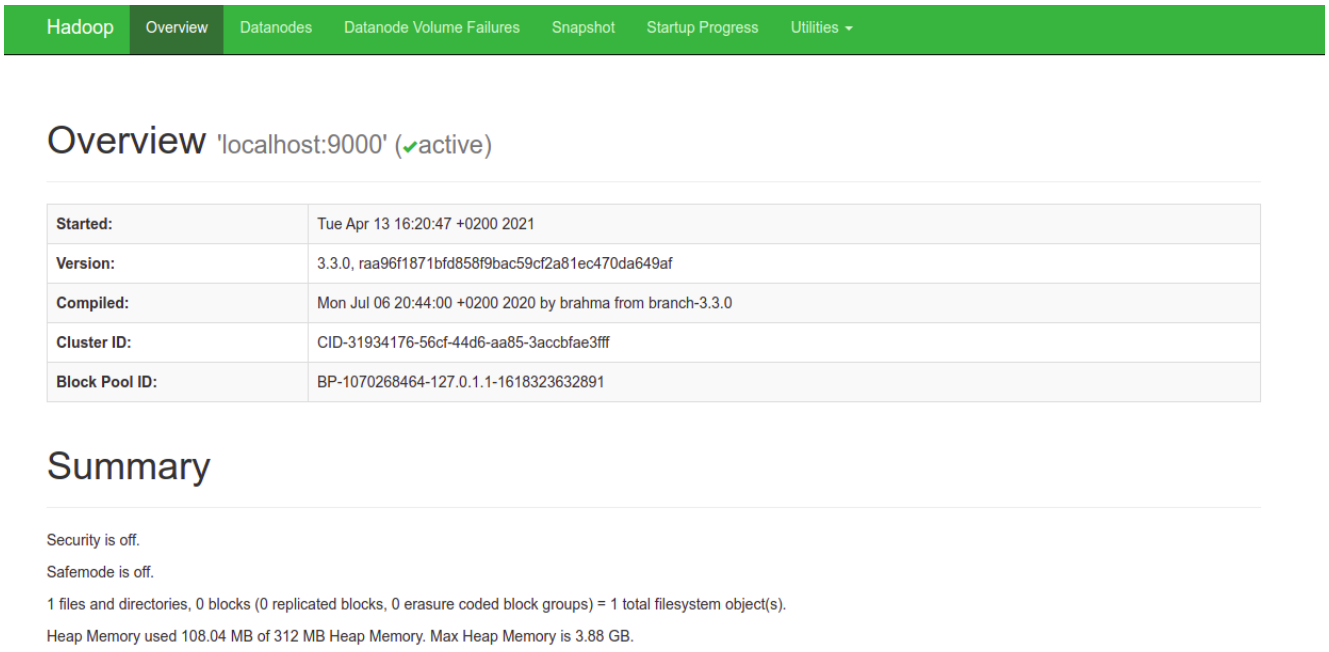
19. Type the following command. You should see an output similar to the one in the following figure.

```
jps
```

```
husseinfadl@husseinfadl:~$ jps
8484 ResourceManager
7719 NameNode
8680 NodeManager
8201 SecondaryNameNode
9517 Jps
9263 DataNode
```

Make sure these nodes are listed: (ResourceManager, NameNode, NodeManager, SecondaryNameNode, Jps and DataNode).

20. Go to localhost:9870 from the browser. You should expect the following



Steps to run WordCount Program on Hadoop:

1. Make sure Hadoop and Java are installed properly

```
hadoop version
```

```
javac -version
```

2. Create a directory on the Desktop named Lab and inside it create two folders; one called “Input” and the other called “tutorial_classes”.
[You can do this step using GUI normally or through terminal commands]

```
cd Desktop
```

```
mkdir Lab
mkdir Lab/Input
mkdir Lab/tutorial_classes
```

3. Add the file attached with this document "WordCount.java" in the directory Lab

4. Add the file attached with this document "input.txt" in the directory Lab/Input.

5. Type the following command to export the hadoop classpath into bash.
   ```
   export HADOOP_CLASSPATH=$(hadoop classpath)
   ```
   Make sure it is now exported.
   ```
   echo $HADOOP_CLASSPATH
   ```
6. It is time to create these directories on HDFS rather than locally. Type the following commands.
   ```
   hadoop fs -mkdir /WordCountTutorial
   hadoop fs -mkdir /WordCountTutorial/Input
   hadoop fs -put Lab/Input/input.txt /WordCountTutorial/Input
   ```
7. Go to localhost:9870 from the browser, Open "Utilities → Browse File System" and you should see the directories and files we placed in the file system.
8. Then, back to local machine where we will compile the WordCount.java file. Assuming we are currently in the Desktop directory.
   ```
   cd Lab
   javac -classpath $HADOOP_CLASSPATH -d tutorial_classes
   WordCount.java
   ```
   Put the output files in one jar file (There is a dot at the end)
   ```
   jar -cvf WordCount.jar -C tutorial_classes .
   ```

9. Now, we run the jar file on Hadoop.
   ```
   hadoop jar WordCount.jar WordCount /WordCountTutorial/Input
   /WordCountTutorial/Output
   ```

10. Output the result:
    ```
    hadoop dfs -cat /WordCountTutorial/Output/*
    ```

Program:

First Create Indexmapper.java class

```
Packagemr03.inverted_index;

                        import org.apache.hadoop.io.LongWritable;
                        import org.apache.hadoop.io.Text;
                        import org.apache.hadoop.mapreduce.Mapper;
                        import org.apache.hadoop.mapreduce.lib.input.FileSplit;

                        import java.io.IOException;
                        import java.util.StringTokenizer;

                        public class IndexMapper extends Mapper<LongWritable,
                        Text, Text, Text> {
                            private final Text wordAtFileNameKey = new Text();
                            private final Text ONE_STRING = new Text("1");

                            @Override
                            protected void map(LongWritable key, Text value,
                                               Context context) throws
                        IOException, InterruptedException {
                                FileSplit split = (FileSplit)
                        context.getInputSplit();
                                StringTokenizer tokenizer = new
                        StringTokenizer(value.toString());
                                while (tokenizer.hasMoreTokens()) {
                                    String fileName =
                        split.getPath().getName().split("\\.")[0];
                                    //remove special char using
                                    // tokenizer.nextToken().replaceAll("[^a-zA-
                        Z]", "").toLowerCase()
                                    //check for empty words
                                    wordAtFileNameKey.set(tokenizer.nextToken() +
                        "@" + fileName);
                                    context.write(wordAtFileNameKey, ONE_STRING);
                                }
                            }
                        }
```

IndexReducer.java

```
package
mr03.inverted_index;

                    import org.apache.hadoop.io.Text;
```

```
import org.apache.hadoop.mapreduce.Reducer;

public class IndexReducer extends Reducer<Text, Text, Text, Text>
{

    private final Text allFilesConcatValue = new Text();
    @Override
    protected void reduce(Text key, Iterable<Text> values,
                          Context context) throws
java.io.IOException ,InterruptedException {
        StringBuilder filelist = new StringBuilder("");
        for(Text value:values) {
            filelist.append(value.toString()).append(";");
        }
        allFilesConcatValue.set(filelist.toString());
        context.write(key, allFilesConcatValue);
    };
}
```

IndexDriver.java

```
package
mr03.inverted_index;

import org.apache.hadoop.fs.FileSystem;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;
import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.Text;

public class IndexDriver {

    public static void main(String[] args) throws Exception {
        if (args.length != 2) {
            System.err.println("Usage IndexDriver <input_dir>
<output_dir>");
            System.exit(2);
        }
        Configuration conf = new Configuration();
        String input = args[0];
        String output = args[1];

        FileSystem fs = FileSystem.get(conf);
```

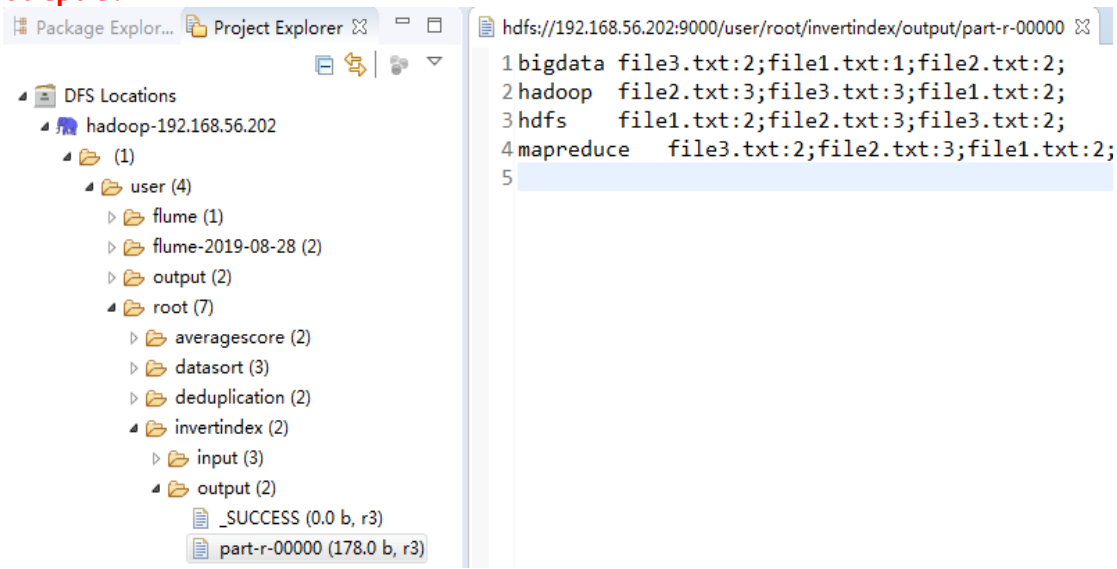
```
        boolean exists = fs.exists(new Path(output));
        if(exists) {
            fs.delete(new Path(output), true);
        }
        Job job = Job.getInstance(conf);
        job.setJarByClass(IndexDriver.class);

        job.setMapperClass(IndexMapper.class);
        job.setCombinerClass(IndexCombiner.class);
        job.setReducerClass(IndexReducer.class);

        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(Text.class);

        FileInputFormat.addInputPath(job, new Path(input));
        FileOutputFormat.setOutputPath(job, new Path(output));
        System.exit(job.waitForCompletion(true)?0:1);

    }

}
```

IndexCombiner.java

```
package
mr03.inverted_inde
x;

import java.io.IOException;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Reducer;

public class IndexCombiner extends Reducer<Text, Text, Text, Text>
{

    private final Text fileAtWordFreqValue = new Text();
    @Override
    protected void reduce(Text key, java.lang.Iterable<Text>
values,
                          Context context) throws IOException
,InterruptedException {
        int sum = 0;
        for(Text value:values) {
            sum += Integer.parseInt(value.toString());
        }
        int splitIndex = key.toString().indexOf("@");
```

```
        fileAtWordFreqValue.set(key.toString().substring(splitIndex+1)+":"
        +sum);
                key.set(key.toString().substring(0,splitIndex));
                context.write(key, fileAtWordFreqValue);
            }
        }
```

Output:



Experiment 2. Process big data in HBase

Aim:To create a table and process the big data in Hbase

Resources:Hadoop,oracle virtual box,Hbase

Theory:
Hbase is an open source and sorted map data built on Hadoop. It is column oriented and horizontally scalable.

It is based on Google's Big Table.It has set of tables which keep data in key value format. Hbase is well suited for sparse data sets which are very common in big data use cases. Hbase provides APIs enabling development in practically any programming language. It is a part of the Hadoop ecosystem that provides random real-time read/write access to data in the Hadoop File System.

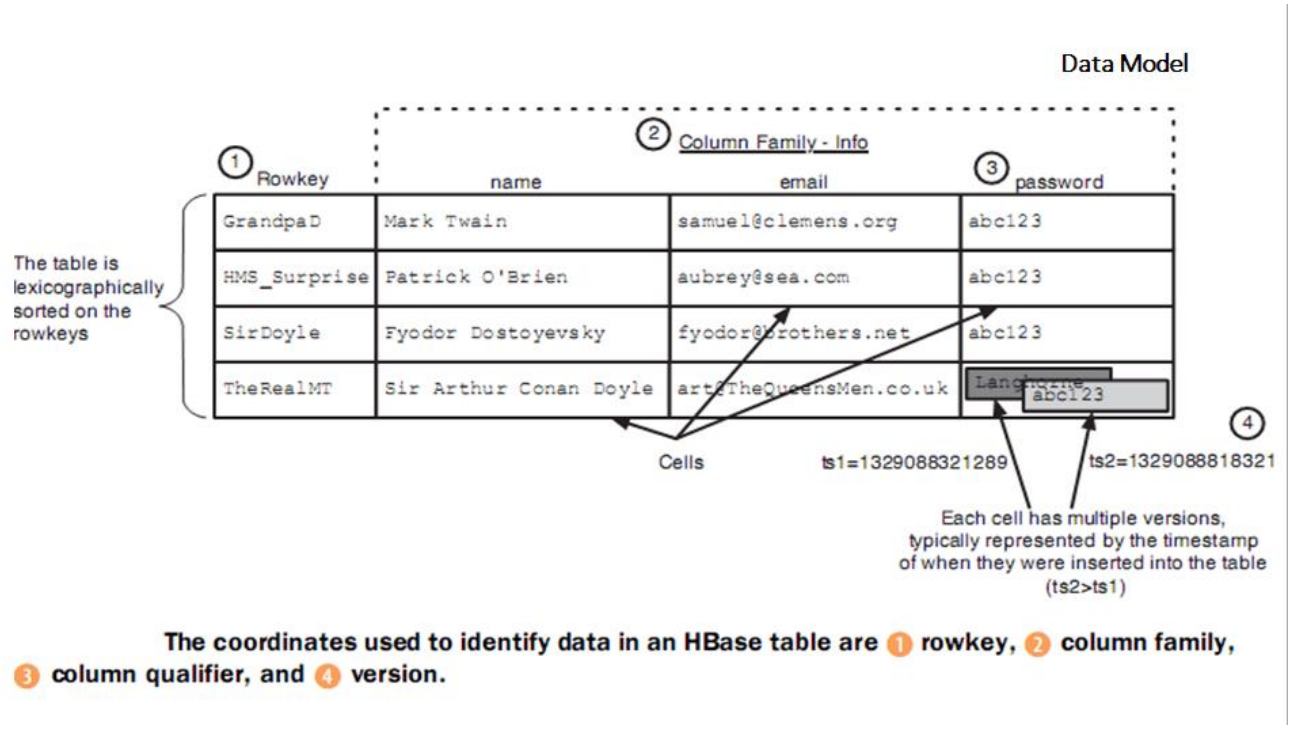
- RDBMS get exponentially slow as the data becomes large
- Expects data to be highly structured, i.e. ability to fit in a well-defined schema
- Any change in schema might require a downtime
- For sparse datasets, too much of overhead of maintaining NULL values

Features of Hbase

- Horizontally scalable: You can add any number of columns anytime.
- Automatic Failover: Automatic failover is a resource that allows a system administrator to automatically switch data handling to a standby system in the event of system compromise
- Integrations with Map/Reduce framework: Al the commands and java codes internally implement Map/ Reduce to do the task and it is built over Hadoop Distributed File System.
- sparse, distributed, persistent, multidimensional sorted map, which is indexed by rowkey, column key,and timestamp.
- Often referred as a key value store or column family-oriented database, or storing versioned maps of maps.
- fundamentally, it's a platform for storing and retrieving data with random access.
- It doesn't care about datatypes(storing an integer in one row and a string in another for the same column).
- It doesn't enforce relationships within your data.
- It is designed to run on a cluster of computers, built using commodity hardware.

Cloudera VM is recommended as it has Hbase preinstalled on it.

Starting Hbase: Type Hbase shell in terminal to start the hbase.



Cloudera VM is recommended as it has Hbase preinstalled on it.

Hbase commands

Step 1:First go to terminal and type **StartCDH.sh**

Step 2:Next type **jps** command in the terminal

```
hadoop@hadoop-laptop:~$ jps
3961 Jps
2235 SecondaryNameNode
2597 ResourceManager
2990 JobHistoryServer
1923 NameNode
2729 NodeManager
2057 DataNode
3153 Bootstrap
hadoop@hadoop-laptop:~$
```

Step 3:Type **hbase shell**

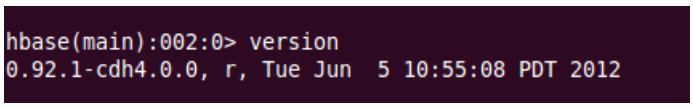
```
hadoop@hadoop-laptop: ~
File  Edit  View  Terminal  Help
hadoop@hadoop-laptop:~$ hbase shell
23/04/02 10:51:58 WARN conf.Configuration: hadoop.native.lib is deprecated. Inst
ead, use io.native.lib.available
HBase Shell; enter 'help<RETURN>' for list of supported commands.
Type "exit<RETURN>" to leave the HBase Shell
Version 0.92.1-cdh4.0.0, r, Tue Jun  5 10:55:08 PDT 2012

hbase(main):001:0>
```

Step 4:hbase(main):001:0> **list**

List will gives you list of tables in Hbase

```
hbase(main):001:0> list
TABLE
```

Step 5:hbase(main):001:0>**version**



Version will gives you the version of hbase

Create Table Syntax

```
CREATE 'name_space:table_name', 'column_family'
```

hbase(main):011:0> create 'newtbl','knowledge'
hbase(main):011:0>describe 'newtbl'
hbase(main):011:0>status
1 servers, 0 dead, 15.0000 average load

HBase – Using PUT to Insert data to Table

To insert data into the HBase table use `PUT` command, this would be similar to insert statement on RDBMS but the syntax is completely different. In this article I will describe how to insert data into HBase table with examples using PUT command from the HBase shell.

HBase PUT command syntax

Below is the syntax of PUT command which is used to insert data (rows and columns) into a HBase table.

HBase PUT command syntax

Below is the syntax of PUT command which is used to insert data (rows and columns) into a HBase table.

put '<name_space:table_name>', '<row_key>' '<cf:column_name>', '<value>'
hbase(main):015:0> **put 'newtbl','r1','knowledge:sports','cricket'**
0 row(s) in 0.0150 seconds

hbase(main):016:0> **put 'newtbl','r1','knowledge:science','chemistry'**
0 row(s) in 0.0040 seconds

hbase(main):017:0> **put 'newtbl','r1','knowledge:science','physics'**
0 row(s) in 0.0030 seconds

hbase(main):018:0> **put 'newtbl','r2','knowledge:economics','macroeconomics'**
0 row(s) in 0.0030 seconds

hbase(main):019:0> **put 'newtbl','r2','knowledge:music','songs'**
0 row(s) in 0.0170 seconds
hbase(main):020:0> **scan 'newtbl'**

```
ROW                COLUMN+CELL
 r1                column=knowledge:science, timestamp=1678807827189, value
                   =physics
 r1                column=knowledge:sports, timestamp=1678807791753, value=
                   cricket
 r2                column=knowledge:economics, timestamp=1678807854590, val
```

```
                ue=macroeconomics
 r2              column=knowledge:music, timestamp=1678807877340, value=s
                ongs
2 row(s) in 0.0250 seconds
```

To retrieve only the row1 data

hbase(main):023:0> **get 'newtbl', 'r1'**

output

```
COLUMN              CELL
 knowledge:science   timestamp=1678807827189, value=physics
 knowledge:sports    timestamp=1678807791753, value=cricket
2 row(s) in 0.0150 seconds.
```

```
hbase(main):025:0> disable 'newtbl'
0 row(s) in 1.2760 seconds
```

Verification

After disabling the table, you can still sense its existence through **list** and **exists** commands. You cannot scan it. It will give you the following error.

```
hbase(main):028:0> scan 'newtbl'
ROW       COLUMN + CELL
ERROR: newtbl is disabled.
```

is_disabled

This command is used to find whether a table is disabled. Its syntax is as follows.

```
hbase> is_disabled 'table name'
```

```
hbase(main):031:0> is_disabled 'newtbl'
true
0 row(s) in 0.0440 seconds
```

disable_all

This command is used to disable all the tables matching the given regex. The syntax for **disable_all** command is given below.

```
hbase> disable_all 'r.*'
```

Suppose there are 5 tables in HBase, namely raja, rajani, rajendra, rajesh, and raju. The following code will disable all the tables starting with **raj.**

```
hbase(main):002:07> disable_all 'raj.*'
raja
rajani
```

```
rajendra
rajesh
raju
Disable the above 5 tables (y/n)?
y
5 tables successfully disabled
```

Enabling a Table using HBase Shell

Syntax to enable a table:

```
enable ‘newtbl’
```

Example

Given below is an example to enable a table.

```
hbase(main):005:0> enable 'newtbl'
0 row(s) in 0.4580 seconds
```

Verification

After enabling the table, scan it. If you can see the schema, your table is successfully enabled.

```
hbase(main):006:0> scan 'newtbl'
```

is_enabled

This command is used to find whether a table is enabled. Its syntax is as follows:

```
hbase> is_enabled 'table name'
```

The following code verifies whether the table named **emp** is enabled. If it is enabled, it will return true and if not, it will return false.

```
hbase(main):031:0> is_enabled 'newtbl'
true
0 row(s) in 0.0440 seconds
```

describe

This command returns the description of the table. Its syntax is as follows:

```
hbase> describe 'table name'
```

```
hbase(main):006:0> describe 'newtbl'
  DESCRIPTION
    ENABLED
```

Experiment: 3 Store and retrieve data in Pig

Aim:To perform storing and retrieval of big data using Apache pig

Resources:Apache pig

Theory:

Pig is a platform that works with large data sets for the purpose of analysis. The Pig dialect is called Pig Latin, and the Pig Latin commands get compiled into MapReduce jobs that can be run on a suitable platform, like Hadoop.

Apache Pig is a platform for analyzing large data sets that consists of a high-level language for expressing data analysis programs, coupled with infrastructure for evaluating these programs. The salient property of Pig programs is that their structure is amenable to substantial parallelization, which in turns enables them to handle very large data sets.

At the present time, Pig's infrastructure layer consists of a compiler that produces sequences of Map-Reduce programs, for which large-scale parallel implementations already exist (e.g., the Hadoop subproject). Pig's language layer currently consists of a textual language called Pig Latin, which has the following key properties:

- **Ease of programming.** It is trivial to achieve parallel execution of simple, "embarrassingly parallel" data analysis tasks. Complex tasks comprised of multiple interrelated data transformations are explicitly encoded as data flow sequences, making them easy to write, understand, and maintain.
- **Optimization opportunities.** The way in which tasks are encoded permits the system to optimize their execution automatically, allowing the user to focus on semantics rather than efficiency.
- **Extensibility.** Users can create their own functions to do special-purpose processing.

Pig Latin – Relational Operations

- The following table describes the relational operators of Pig Latin.

Operator	Description
Loading and Storing	
LOAD	To Load the data from the file system (local/HDFS) into a relation.
STORE	To save a relation to the file system (local/HDFS).

Filtering	
FILTER	To remove unwanted rows from a relation.
DISTINCT	To remove duplicate rows from a relation.
FOREACH, GENERATE	To generate data transformations based on columns of data.
STREAM	To transform a relation using an external program.
Grouping and Joining	
JOIN	To join two or more relations.
COGROUP	To group the data in two or more relations.
GROUP	To group the data in a single relation.
CROSS	To create the cross product of two or more relations.
Sorting	
ORDER	To arrange a relation in a sorted order based on one or more fields (ascending or descending).
LIMIT	To get a limited number of tuples from a relation.
Combining and Splitting	
UNION	To combine two or more relations into a single relation.
SPLIT	To split a single relation into two or more relations.
Diagnostic Operators	
DUMP	To print the contents of a relation on the console.
DESCRIBE	To describe the schema of a relation.
EXPLAIN	To view the logical, physical, or MapReduce execution plans to compute a relation.
ILLUSTRATE	To view the step-by-step execution of a series of statements.

For the given Student dataset and Employee dataset,perform Relational operations like Loading, Storing, Diagnostic Operations (Dump, Describe, Illustrate & Explain) in Hadoop Pig framework using Cloudera

Student ID	First Name	Age	City	CGPA
001	Jagruthi	21	Hyderabad	9.1
002	Praneeth	22	Chennai	8.6
003	Sujith	22	Mumbai	7.8
004	Sreeja	21	Bengaluru	9.2
005	Mahesh	24	Hyderabad	8.8
006	Rohit	22	Chennai	7.8
007	Sindhu	23	Mumbai	8.3

Employee ID	Name	Age	City
001	Angelina	22	LosAngeles
002	Jackie	23	Beijing
003	Deepika	22	Mumbai
004	Pawan	24	Hyderabad
005	Rajani	21	Chennai
006	Amitabh	22	Mumbai

Step-1: **Create a Directory**in HDFS with the name **pigdir** in the required path using **mkdir**:

$ hdfs dfs -mkdir /bdalab/pigdir

Step-2: The input file of Pig contains each tuple/record in individual lines with the entities separated by a delimiter (“,”).

In the local file system, **create an input file student_data.txt** containing data as shown below.	In the local file system, **create an input file employee_data.txt** containing data as shown below.
001,Jagruthi,21,Hyderabad,9.1 002,Praneeth,22,Chennai,8.6 003,Sujith,22,Mumbai,7.8 004,Sreeja,21,Bengaluru,9.2 005,Mahesh,24,Hyderabad,8.8 006,Rohit,22,Chennai,7.8 007,Sindhu,23,Mumbai,8.3	001,Angelina,22,LosAngeles 002,Jackie,23,Beijing 003,Deepika,22,Mumbai 004,Pawan,24,Hyderabad 005,Rajani,21,Chennai 006,Amitabh,22,Mumbai

Step-3: **Move the file** from the local file system to HDFS using **put (Or) copyFromLocal** command and verify using -cat command

To get the path of the file student_data.txt type the below command

readlink -f student_data.txt

$ hdfs dfs -put /home/hadoop/Desktop/student_data.txt /bdalab/pigdir/

$ hdfs dfs -cat /bdalab/pigdir/student_data

$ hdfs dfs -put /home/hadoop/Desktop/employee_data /bdalab/pigdir/

Step-4: **Apply Relational Operator – LOAD to load the data** from the file student_data.txt into Pig by executing the following Pig Latin statement in the **Grunt shell**. Relational Operators are **NOT case sensitive.**

$ pig => will direct to **grunt> shell**

grunt> student = LOAD ' /bdalab/pigdir/student_data.txt' USING PigStorage(',')as (id:int, name:chararray, age:int, city:chararray, cgpa:double);

grunt>employee = LOAD ' /bdalab/pigdir/employee_data.txt' USING PigStorage(',')as (id:int, name:chararray, age:int, city:chararray);

Step-5: **Apply Relational Operator – STORE** to **Store the relation** in the HDFS directory "/pig_output/" as shown below.

grunt> STORE student INTO ' /bdalab/pigdir/pig_output/ ' USING PigStorage (',');

grunt> STORE employee INTO ' /bdalab/pigdir/pig_output/ ' USING PigStorage (',');

Step-6: **Verify the stored data** as shown below

$ hdfs dfs -ls /bdalab/pigdir/pig_output/

$ hdfs dfs -cat /bdalab/pigdir/pig_output/**part-m-00000**

Step-7: **Apply Relational Operator – Diagnostic Operator – DUMP toPrint the contents of the relation**.

grunt> Dump student

grunt> Dump employee

Step-8: **Apply Relational Operator – Diagnostic Operator – DESCRIBE toView the schema of a relation**.

grunt> Describe student

grunt> Describe employee

Step-9: **Apply Relational Operator – Diagnostic Operator – EXPLAIN toDisplay the logical, physical, and MapReduce executionplans** of a relation using**Explain** operator

grunt> Explain student

grunt>Explain employee

Step-9: **Apply Relational Operator – Diagnostic Operator – ILLUSTRATE to give the step-by-step execution of a sequence of statements**

grunt>Illustrate student

grunt>Illustrate employee

Experiment 4.Perform Social media analysis using Cassandra

Aim: To perform the social media data analysis using Cassandra

Resources: Cassandra

Procedure:

- Apache Cassandra is an open-source distributed database management system designed to handle large amounts of data across many commodity servers.
- Cassandra provides high availability with no single point of failure.
- Cassandra offers robust support for clusters spanning multiple data centers, with asynchronous master-less replication allowing low latency operations for all clients.

Cassandra is a distributed database for low latency, high throughput services that handle real time workloads comprising of hundreds of updates per second and tens of thousands of reads per second.

When looking to replace a key-value store with something more capable on the real-time replication and data distribution, research on Dynamo, the CAP theorem and eventual consistency model shows Cassandra fits this model quite well. As one learns more about data modeling capabilities, we gradually move towards decomposing data.

If one is coming from a relational database background with strong ACID semantics, then one must take the time to understand the eventual consistency model.

Understand Cassandra's architecture very well and what it does under the hood. With Cassandra 2.0 you get lightweight transaction and triggers, but they are not the same as the traditional database transactions one might be familiar with. For example, there are no foreign key constraints available – it has to be handled by one's own application. Understanding one's use cases and data access patterns clearly before modeling data with Cassandra and to read all the available documentation is a must.

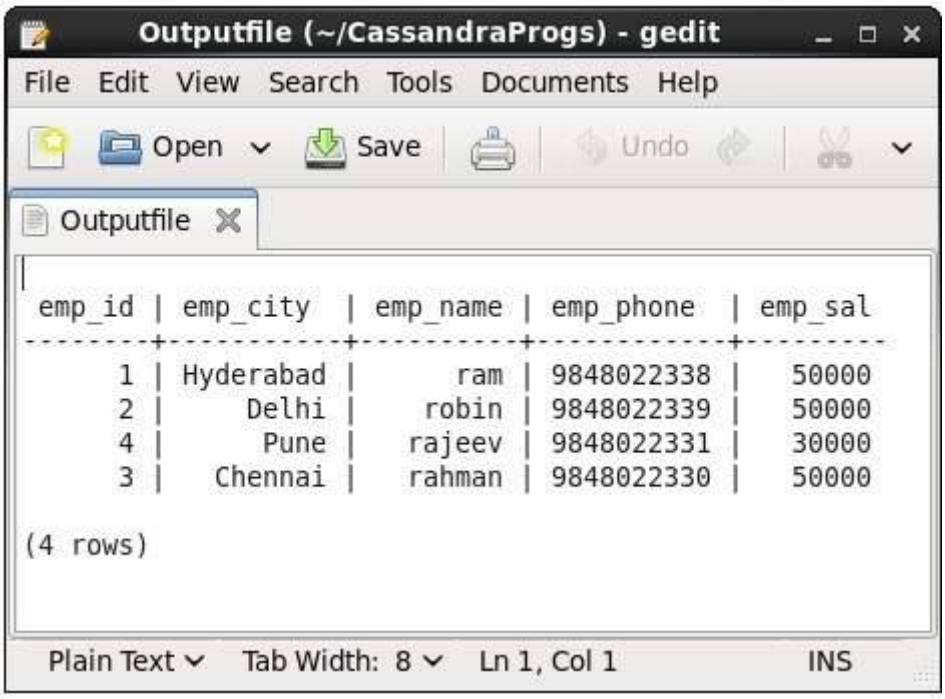
Capture

This command captures the output of a command and adds it to a file. For example, take a look at the following code that captures the output to a file named **Outputfile**.

```
cqlsh> CAPTURE '/home/hadoop/CassandraProgs/Outputfile'
```

When we type any command in the terminal, the output will be captured by the file given. Given below is the command used and the snapshot of the output file.

```
cqlsh:tutorialspoint> select * from emp;
```



You can turn capturing off using the following command.

```
cqlsh:tutorialspoint> capture off;
```

Consistency

This command shows the current consistency level, or sets a new consistency level.

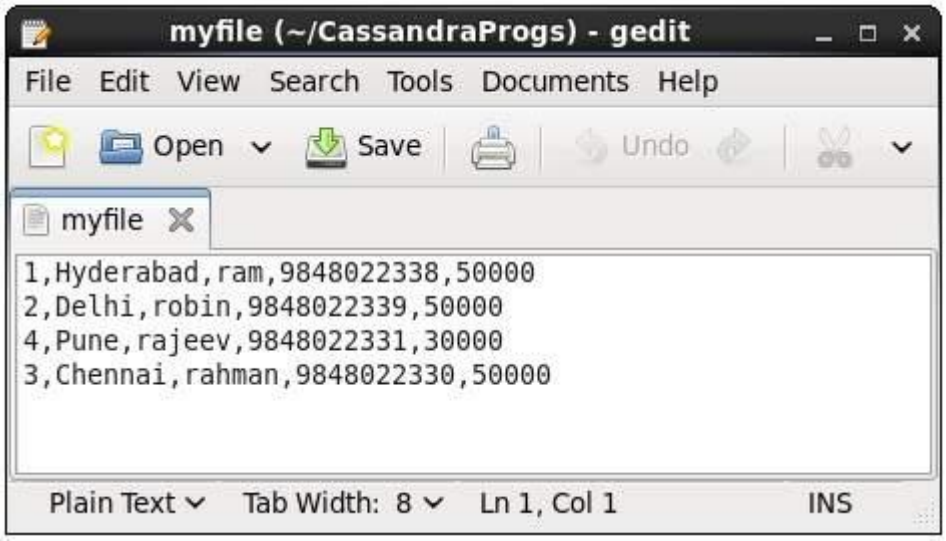
```
cqlsh:tutorialspoint> CONSISTENCY
Current consistency level is 1.
```

Copy

This command copies data to and from Cassandra to a file. Given below is an example to copy the table named **emp** to the file **myfile**.

```
cqlsh:tutorialspoint> COPY emp (emp_id, emp_city, emp_name, emp_phone,emp_sal) TO
‘myfile’;
4 rows exported in 0.034 seconds.
```

If you open and verify the file given, you can find the copied data as shown below.



Describe

This command describes the current cluster of Cassandra and its objects. The variants of this command are explained below.

Describe cluster – This command provides information about the cluster.

```
cqlsh:tutorialspoint> describe cluster;

Cluster: Test Cluster
Partitioner: Murmur3Partitioner

Range ownership:
-658380912249644557 [127.0.0.1]
-2833890865268921414 [127.0.0.1]
-6792159006375935836 [127.0.0.1]
```

Describe Keyspaces – This command lists all the keyspaces in a cluster. Given below is the usage of this command.

```
cqlsh:tutorialspoint> describe keyspaces;

system_traces system tp tutorialspoint
```

Describe tables – This command lists all the tables in a keyspace. Given below is the usage of this command.

```
cqlsh:tutorialspoint> describe tables;
emp
```

Describe table – This command provides the description of a table. Given below is the usage of this command.

```
cqlsh:tutorialspoint> describe table emp;

CREATE TABLE tutorialspoint.emp (
emp_id int PRIMARY KEY,
```

```
emp_city text,
emp_name text,
emp_phone varint,
emp_sal varint
) WITH bloom_filter_fp_chance = 0.01
AND caching = '{"keys":"ALL", "rows_per_partition":"NONE"}'
AND comment = ''
AND compaction = {'min_threshold': '4', 'class':
'org.apache.cassandra.db.compaction.SizeTieredCompactionStrategy',
'max_threshold': '32'}

AND compression = {'sstable_compression':
'org.apache.cassandra.io.compress.LZ4Compressor'}

AND dclocal_read_repair_chance = 0.1
AND default_time_to_live = 0
AND gc_grace_seconds = 864000
AND max_index_interval = 2048
AND memtable_flush_period_in_ms = 0
AND min_index_interval = 128
AND read_repair_chance = 0.0
AND speculative_retry = '99.0PERCENTILE';
CREATE INDEX emp_emp_sal_idx ON tutorialspoint.emp (emp_sal);
```

Describe Type

This command is used to describe a user-defined data type. Given below is the usage of this command.

```
cqlsh:tutorialspoint> describe type card_details;

CREATE TYPE tutorialspoint.card_details (
num int,
pin int,
name text,
cvv int,
phone set<int>,
mail text
);
```

Describe Types

This command lists all the user-defined data types. Given below is the usage of this command. Assume there are two user-defined data types: **card** and **card_details**.

```
cqlsh:tutorialspoint> DESCRIBE TYPES;

card_details card
```

Expand

This command is used to expand the output. Before using this command, you have to turn the expand command on. Given below is the usage of this command.

```
cqlsh:tutorialspoint> expand on;
cqlsh:tutorialspoint> select * from emp;

@ Row 1
-----------+------------
emp_id | 1
emp_city | Hyderabad
emp_name | ram
emp_phone | 9848022338
emp_sal | 50000

@ Row 2
-----------+------------
emp_id | 2
emp_city | Delhi
emp_name | robin
emp_phone | 9848022339
emp_sal | 50000

@ Row 3
-----------+------------
emp_id | 4
emp_city | Pune
emp_name | rajeev
emp_phone | 9848022331
emp_sal | 30000

@ Row 4
-----------+------------
emp_id | 3
emp_city | Chennai
emp_name | rahman
emp_phone | 9848022330
emp_sal | 50000
(4 rows)
```

Note – You can turn the expand option off using the following command.

```
cqlsh:tutorialspoint> expand off;
Disabled Expanded output.
```

Exit

This command is used to terminate the cql shell.

Show

This command displays the details of current cqlsh session such as Cassandra version, host, or data type assumptions. Given below is the usage of this command.

```
cqlsh:tutorialspoint> show host;
Connected to Test Cluster at 127.0.0.1:9042.

cqlsh:tutorialspoint> show version;
[cqlsh 5.0.1 | Cassandra 2.1.2 | CQL spec 3.2.0 | Native protocol v3]
```

Source

Using this command, you can execute the commands in a file. Suppose our input file is as follows –

Then you can execute the file containing the commands as shown below.

```
cqlsh:tutorialspoint> source '/home/hadoop/CassandraProgs/inputfile';

emp_id | emp_city | emp_name | emp_phone | emp_sal
--------+-----------+----------+------------+---------
1 | Hyderabad | ram | 9848022338 | 50000
2 | Delhi | robin | 9848022339 | 50000
3 | Pune | rajeev | 9848022331 | 30000
4 | Chennai | rahman | 9848022330 | 50000
(4 rows)
```

Experiment 5. Buyer event analytics using Cassandra on suitable product sales data.

Aim: To perform the buyer event analysis using Cassandra on sales data

Resources Required: Apache Hadoop, Apache Cassandra

Theory:

Users can access Cassandra through its nodes using Cassandra Query Language (CQL). CQL treats the database **(Keyspace)** as a container of tables. Programmers use **cqlsh:** a prompt to work with CQL or separate application language drivers.

Clients approach any of the nodes for their read-write operations. That node (coordinator) plays a proxy between the client and the nodes holding the data.

Write Operations

Every write activity of nodes is captured by the **commit logs** written in the nodes. Later the data will be captured and stored in the **mem-table.** Whenever the mem-table is full, data will be written into the **SStable** data file. All writes are automatically partitioned and replicated throughout the cluster. Cassandra periodically consolidates the SSTables, discarding unnecessary data.

Read Operations

During read operations, Cassandra gets values from the mem-table and checks the bloom filter to find the appropriate SSTable that holds the required data.

Apache is an open-source platform. This web server delivers web-related content using the internet. It has gained huge popularity over the last few years, as the most used web server software. Cassandra is a database management system that is open-source. It has the capacity to handle a large amount of data across servers. It was first developed by Facebook for the inbox search feature and was released as an open-source project back in 2008.

The following year, Cassandra became a part of Apache incubation, and combined with Apache, it has reached new heights. To put it in simple terms, Apache Cassandra is a powerful open-source distributed database system that can work efficiently to handle a massive amount of data across multiple servers.

Considering all the features of Apache Cassandra, be it Cassandra fault-tolerance, Cassandra data migration, Cassandra enterprise support, Cassandra cluster optimization and tuning, many organizations have opted for this product. Starting from big players in the market to startups, Cassandra has changed the way of database management. Let's consider Netflix, the largest online streaming platform. Netflix has successfully provided updated data to its users day after day. Apache Cassandra has undeniably a huge role to play in this feat.

DATA-MODELLING

The way data is modeled is a major difference between Cassandra & MySQL. .

Let us consider a platform where users can post. Now, you have commented on a post of another user. In these two databases, the information will be stored differently. In Cassandra, you can store the data in a single table. The comments for each user is stored in the form of a list(as one single row).

In MySQL, you have to make two tables with one-to-many relationships between them. As MySQL does not permit unstructured data such as a List or a Map, one-to-many relationships are required among these tables.

READ PERFORMANCE

The query to retrieve the comments made by a user(for example '5') in MySQL, will look like this.

SELECT * from Users u, Comments c WHERE u.user_id=c.user_id and user_id=5;

When you utilize indexing in MySQL, it saves the data like a binary tree.

In Cassandra, it is surprisingly simple:

SELECT * from Users WHERE user_id=3;

You only have to store a single row in Cassandra for a specific user_id. It will require just one lookup.

WRITE PERFORMANCE

A search needs to be done with every INSERT/UPDATE/DELETE in MySQL. If you have to update a record with an existing primary key,

1. **It will first search for the row, and**
2. **Then update it**

Cassandra leverages an append-only model. Insert & update have no fundamental difference. If you want to insert a row that comes with the same primary key as an existing row, the row will be replaced. Or, if you update a row with a non-existent primary key, Cassandra will create the row. Cassandra is very fast and stores large swathes of data on commodity hardware without compromising the read efficiency in any way.

TRANSACTIONS

MySQL facilitates ACID transactions like any other Relational Database Management System

- Atomicity
- Consistency
- Isolation
- Durability

On the other hand, Cassandra has certain limitations to provide ACID transactions. Cassandra can achieve consistency if data duplication is not allowed. But, that will kill Cassandra's availability. So, the systems that require ACID transactions must avoid NoSQL databases.

Procedure:

A sample query to insert a record into an Apache Cassandra table is as follows:

```
INSERT INTO employee
      (empid, firstname, lastname, gender)
VALUES
      ('1', 'FN', 'LN', 'M')
```

The same query in MongoDB will have an implementation as follows:

```
db.employee.insert(
      {
        empid: '1',
        firstname: 'FN',
        lastname: 'LN',
        gender: 'M'
      }
)
```

```
cqlsh>
 SELECT TTL(name) FROM learn_cassandra.todo_by_user_email WHERE
user_email='john@email.com';

 ttl(name)
-----------
        43

(1 rows)
cqlsh>
 SELECT * FROM learn_cassandra.todo_by_user_email WHERE
user_email='john@email.com';

 user_email | creation_date | todo_uuid | name
-----------+---------------+-----------+------

(0 rows)
```

Let’s insert a new record:

```
cqlsh>
```

```
 INSERT INTO learn_cassandra.todo_by_user_email (user_email, creation_date, name)
VALUES(' ('john@email.com', '2021-03-14 16:07:19.622+0000', 'Insert query');

cqlsh>
 UPDATE learn_cassandra.todo_by_user_email SET
   name = 'Update query'
 WHERE user_email = 'john@email.com' AND creation_date = '2021-03-14
16:10:19.622+0000';
```

2 new rows appear in our table:

```
cqlsh>
 SELECT * FROM learn_cassandra.todo_by_user_email WHERE
user_email='john@email.com';

 user_email    | creation_date                | name
---------------+------------------------------+--------------
 john@email.com | 2021-03-14 16:10:19.622000+0000 | Update query
 john@email.com | 2021-03-14 16:07:19.622000+0000 | Insert query

(2 rows)
```

Let’s only update if an entry already exists, by using IF EXISTS:

```
cqlsh>
 UPDATE learn_cassandra.todo_by_user_email SET
   name = 'Update query with LWT'
 WHERE user_email = 'john@email.com' AND creation_date = '2021-03-14
16:07:19.622+0000' IF EXISTS;

 [applied]
-----------
     True

cqlsh>
 INSERT INTO learn_cassandra.todo_by_user_email (user_email,creation_date,name)
VALUES('john@email.com', toTimestamp(now()), 'Yet another entry') IF NOT EXISTS;

 [applied]
-----------
     True
```

Experiment:6 using a power pivot(Excel) perform the following on any data set

Aim: To perform the big data analytics using power pivot in Excel

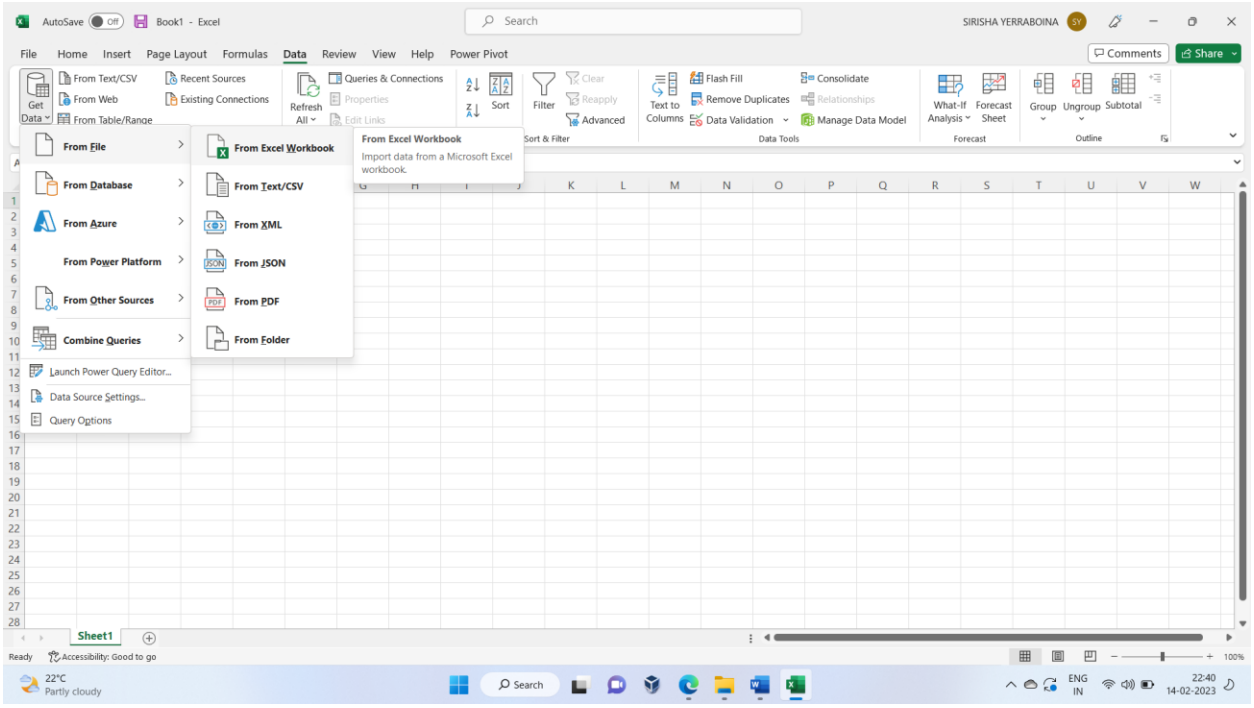
Resources: Microsoft Excel

Theory: Power Pivot is an Excel add-in you can use to perform powerful data analysis and create sophisticated data models. With Power Pivot, you can mash up large volumes of data from various sources, perform information analysis rapidly, and share insights easily.

In both Excel and in Power Pivot, you can create a Data Model, a collection of tables with relationships. The data model you see in a workbook in Excel is the same data model you see in the Power Pivot window. Any data you import into Excel is available in Power Pivot, and vice versa.

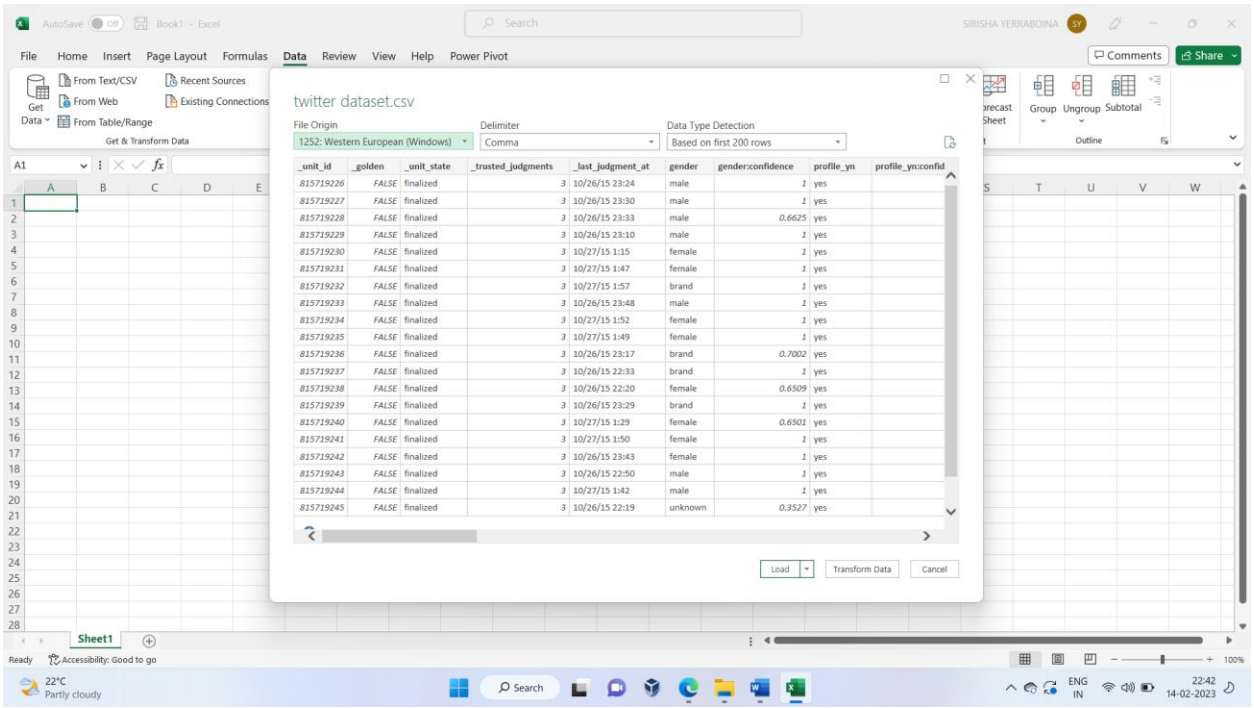
Procedure:

Open the Microsoft Excel and go to data menu and click get data

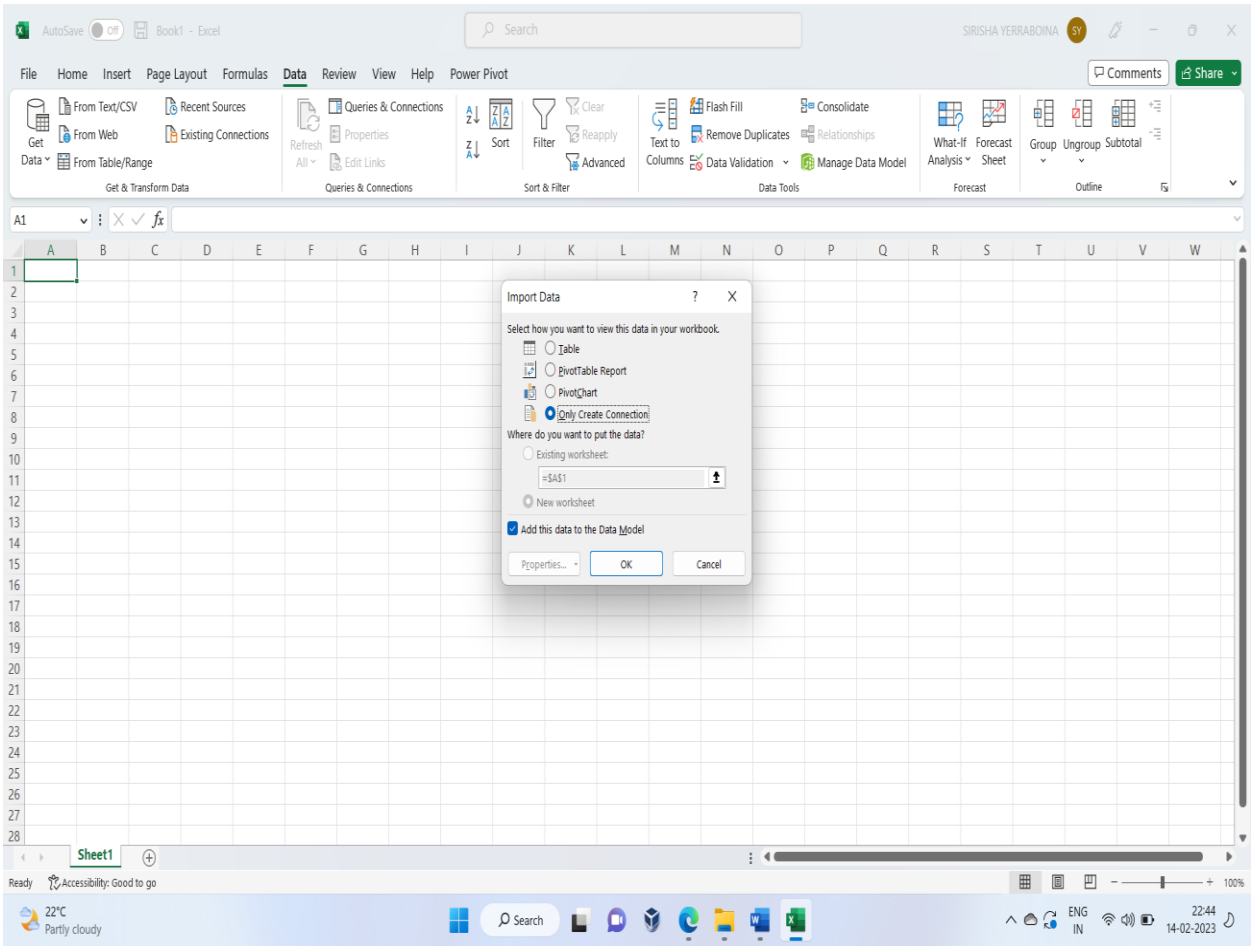


Import the Twitter data set and click load to button

Now from the excel data will starts importing

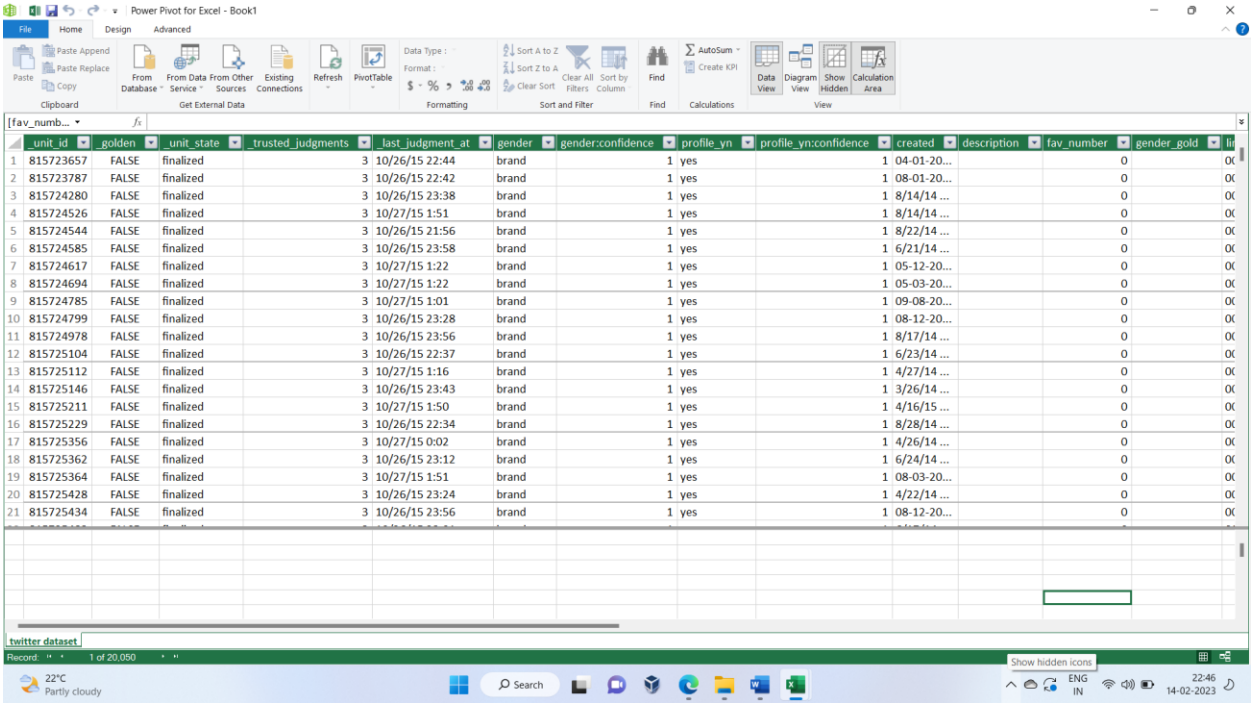


Next click create connection and click the check box add to the data model

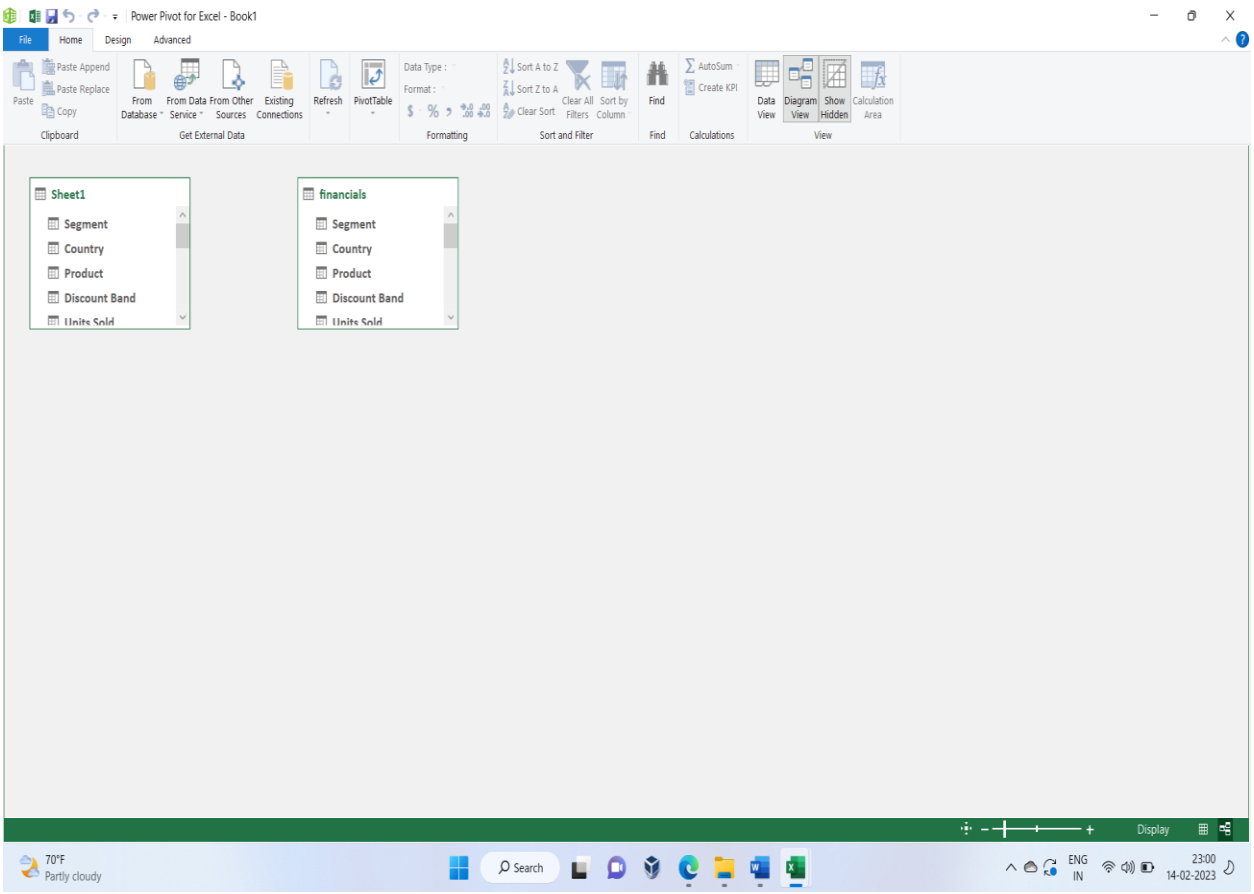


Next click manage data model and see that all the twitter data is loaded as model and close the power pivot window.

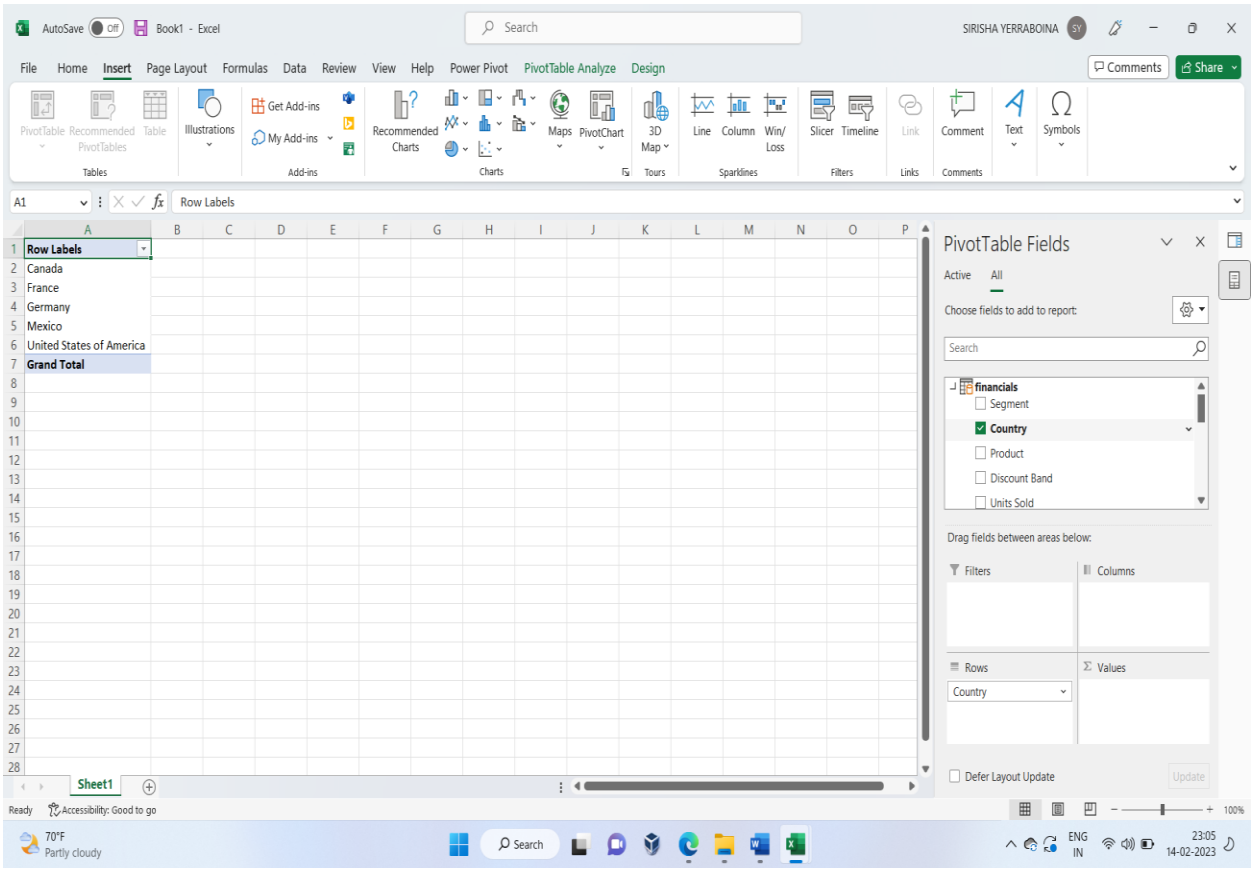
Save the excel file as sample.xls



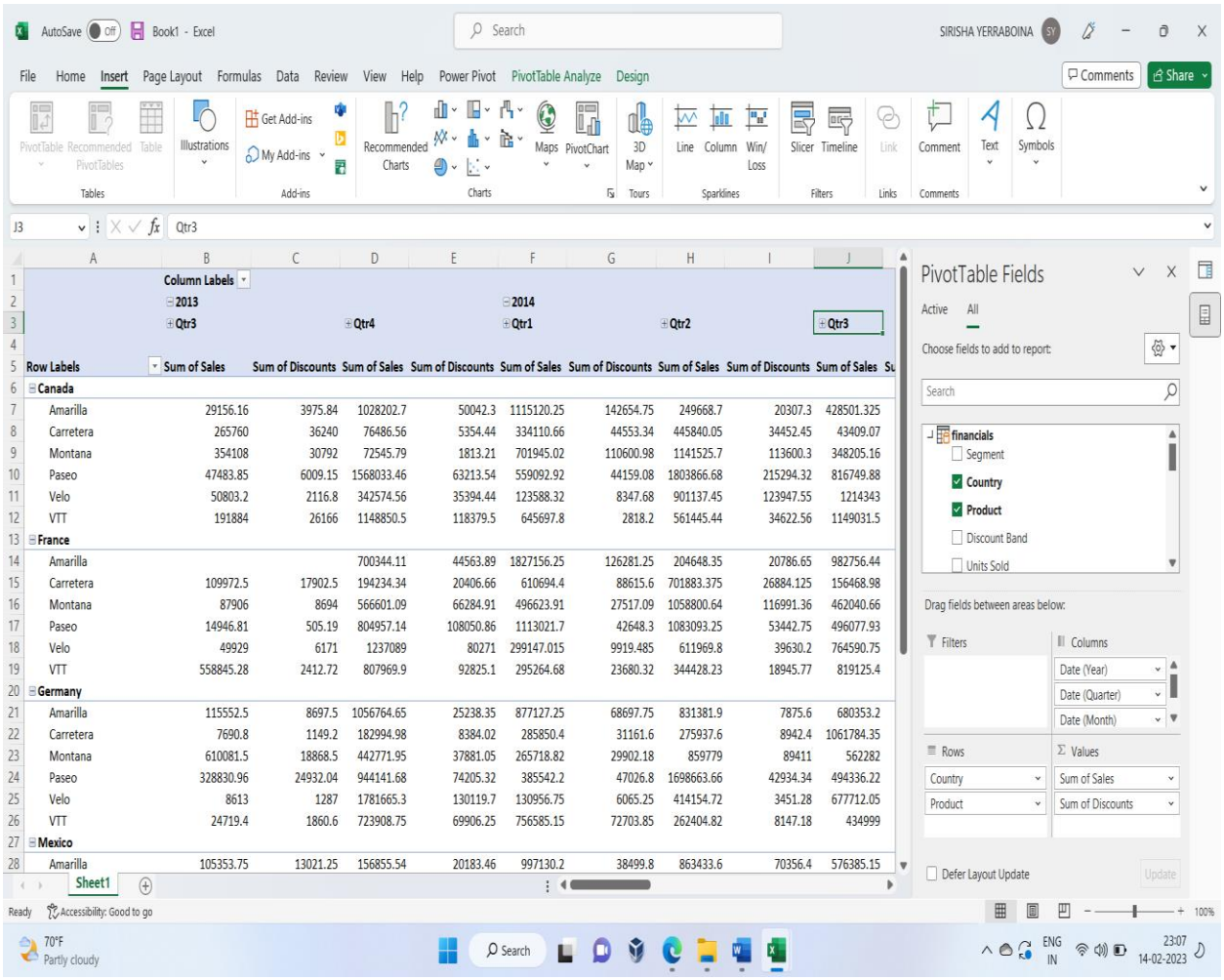
Click the diagram view and give the relation ships between the tables



Go to the Insert menu and click pivot table



Select the columns and u can perform drill down and rollup operations using pivot table



We can load 10mllions rows of data also from multiple resources.

Experiment 6:Using Power Pivot perform the following on any data set

B)Big data Charting

Aim :To create variety of charts using Excel for the given data

Resources:Microsoft Excel

Theory:

When your data sets are big, you can use Excel Power Pivot that can handle hundreds of millions of rows of data. The data can be in external data sources and Excel Power Pivot builds a Data Model that works on a memory optimization mode. You can perform the calculations, analyze the data and arrive at a report to draw conclusions and decisions. The report can be either as a Power PivotTable or Power PivotChart or a combination of both.

You can utilize Power Pivot as an ad hoc reporting and analytics solution. Thus, it would be possible for a person with hands-on experience with Excel to perform the high-end data analysis and decision making in a matter of few minutes and are a great asset to be included in the dashboards.

Uses of Power Pivot

You can use Power Pivot for the following −

- To perform powerful data analysis and create sophisticated Data Models.
- To mash-up large volumes of data from several different sources quickly.
- To perform information analysis and share the insights interactively.
- To create Key Performance Indicators (KPIs).
- To create Power PivotTables.
- To create Power PivotCharts.

Differences between PivotTable and Power PivotTable

Power PivotTable resembles PivotTable in its layout, with the following differences −

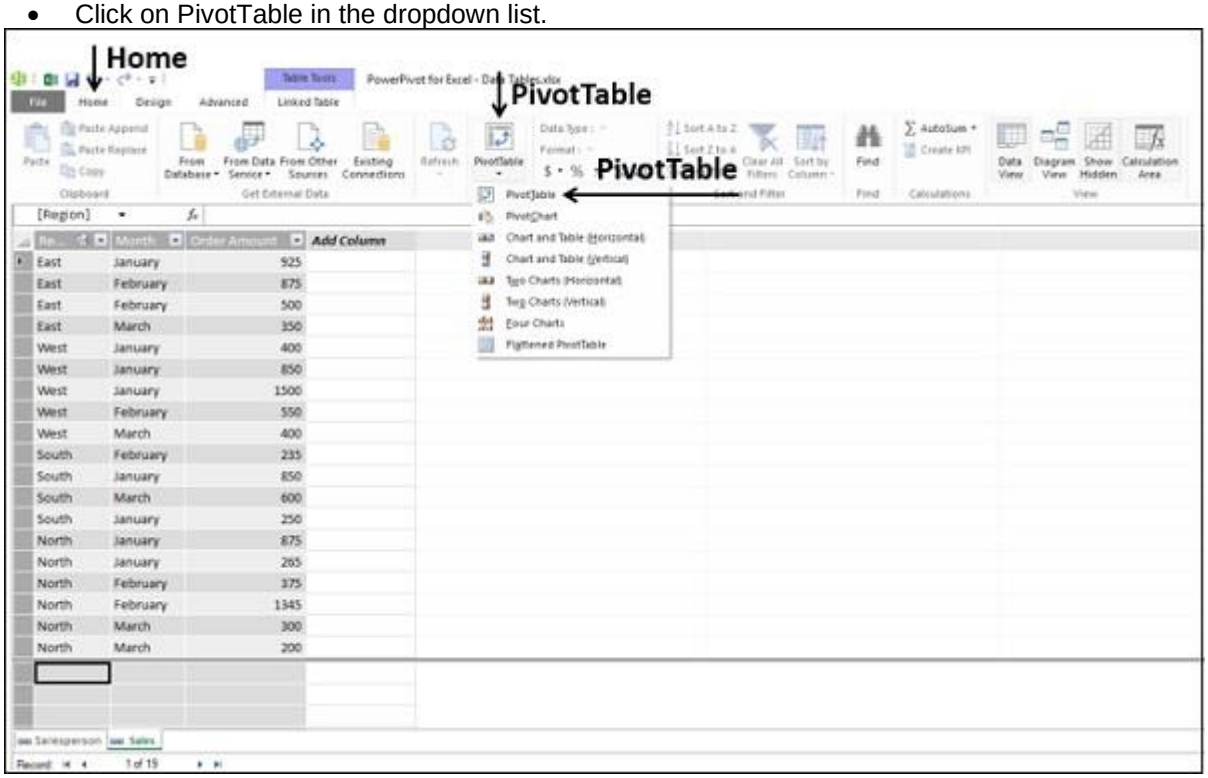
- PivotTable is based on Excel tables, whereas Power PivotTable is based on data tables that are part of Data Model.
- PivotTable is based on a single Excel table or data range, whereas Power PivotTable can be based on multiple data tables, provided they are added to Data Model.

- PivotTable is created from Excel window, whereas Power PivotTable is created from PowerPivot window.

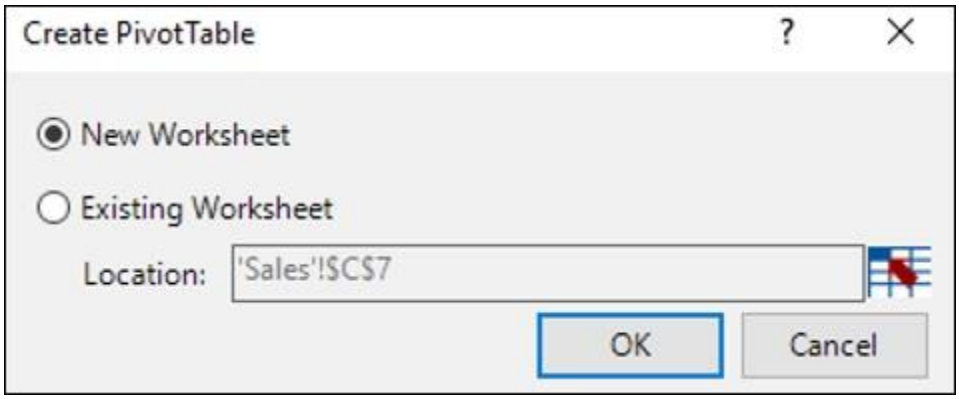
Creating a Power PivotTable

Suppose you have two data tables – Salesperson and Sales in the Data Model. To create a Power PivotTable from these two data tables, proceed as follows −

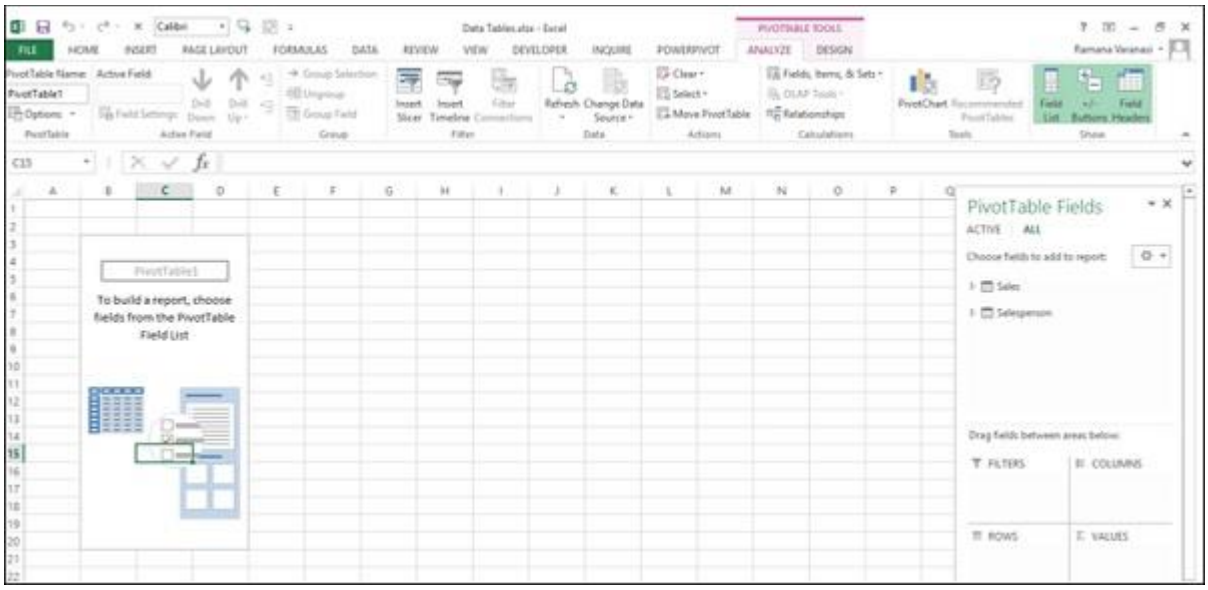
- Click on the Home tab on the Ribbon in PowerPivot window.
- Click on PivotTable on the Ribbon.
- Click on PivotTable in the dropdown list.



Create PivotTable dialog box appears. Click on New Worksheet.



Click the OK button. New worksheet gets created in Excel window and an empty Power PivotTable appears.



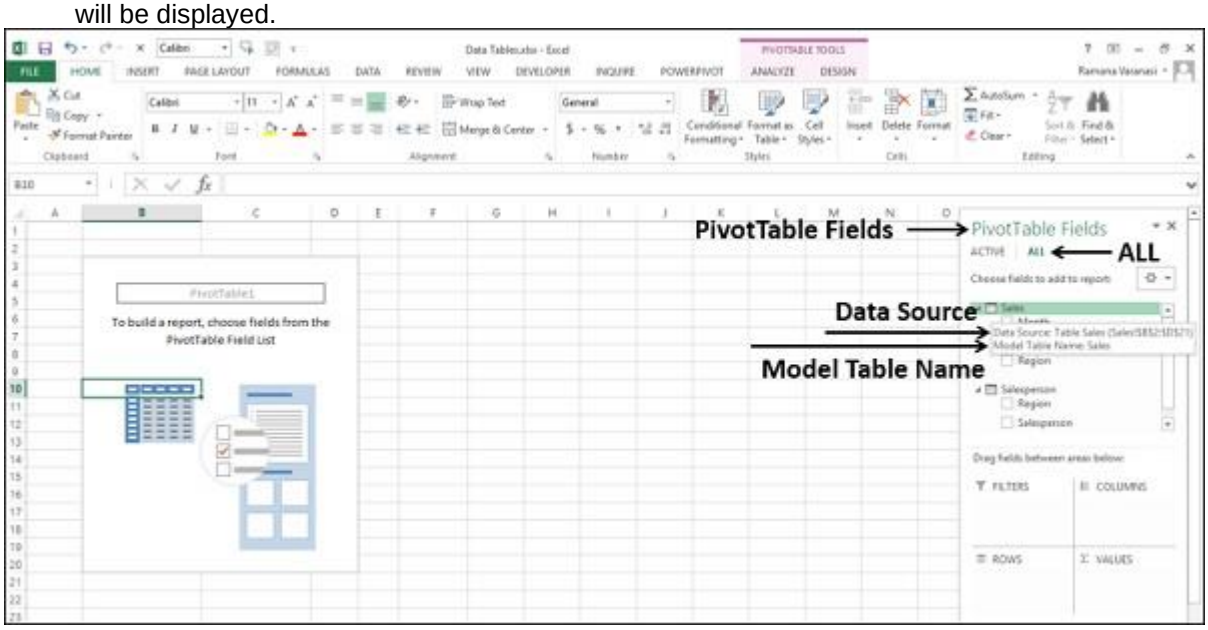
As you can observe, the layout of the Power PivotTable is similar to that of PivotTable.

The PivotTable Fields List appears on the right side of the worksheet. Here, you will find some differences from PivotTable. The Power PivotTable Fields list has two tabs − ACTIVE and ALL, that appear below the title and above the fields list. ALL tab is highlighted. The ALL tab displays all the data tables in the Data Model and ACTIVE tab displays all the data tables that are chosen for the Power PivotTable at hand.

- Click the table names in the PivotTable Fields list under ALL.

The corresponding fields with check boxes will appear.

- Each table name will have the symbol  on the left side.
- If you place the cursor on this symbol, the Data Source and the Model Table Name of that data table will be displayed.

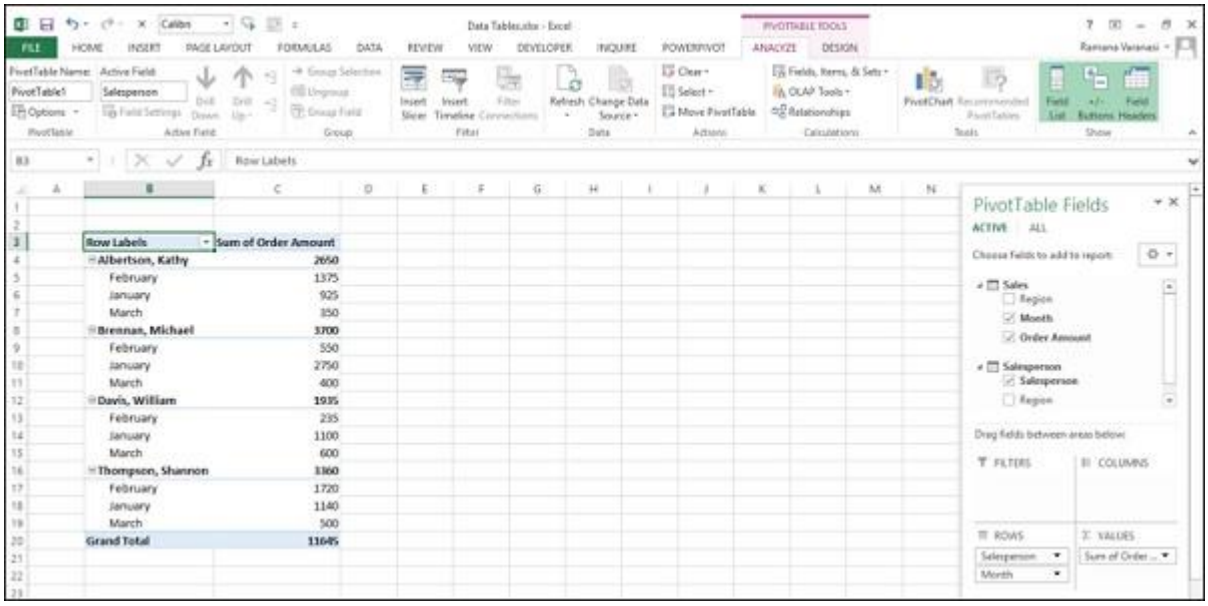


- Drag Salesperson from Salesperson table to ROWS area.
- Click on the ACTIVE tab.

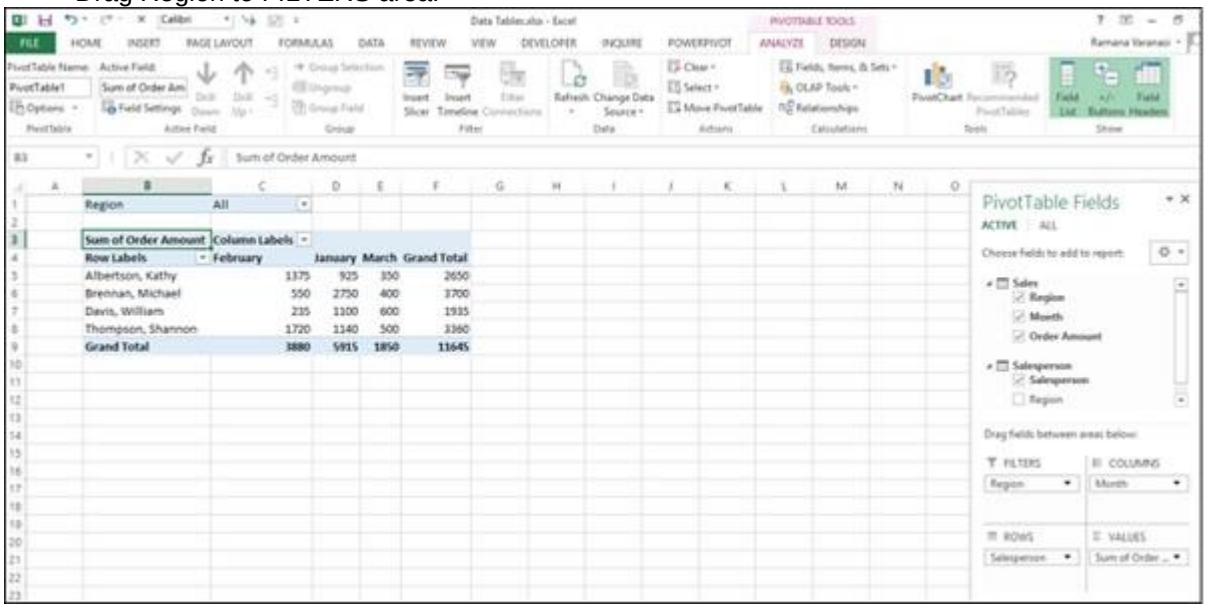
The field Salesperson appears in the Power PivotTable and the table Salesperson appears under ACTIVE tab.

- Click on the ALL tab.
- Click on Month and Order Amount in the Sales table.
- Click on the ACTIVE tab.

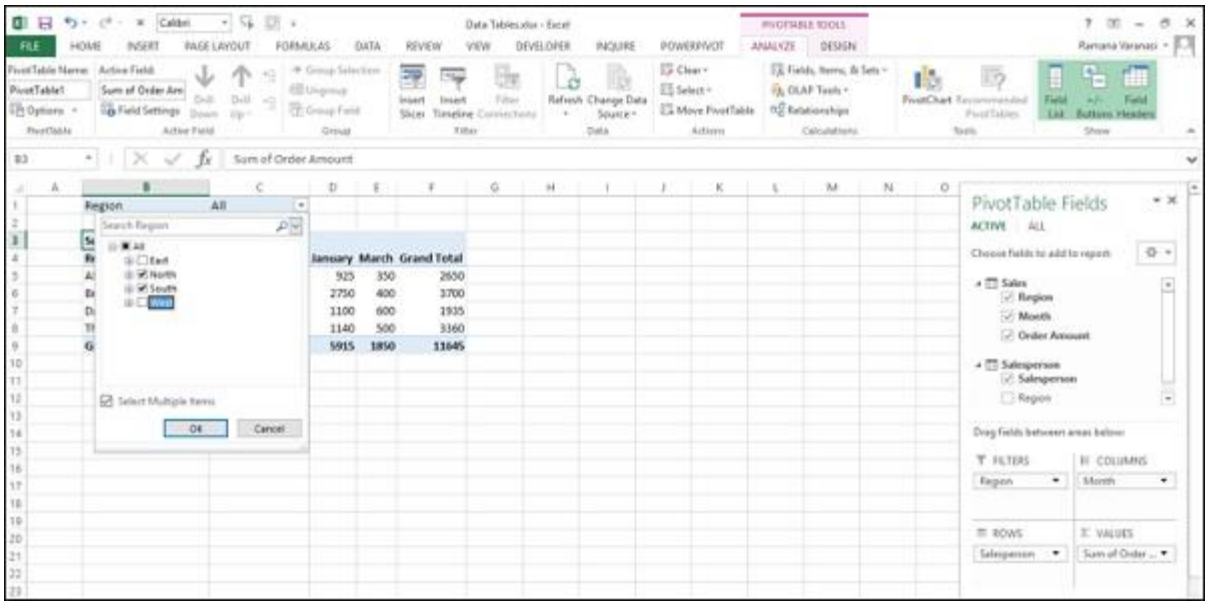
Both the tables – Sales and Salesperson appear under the ACTIVE tab.



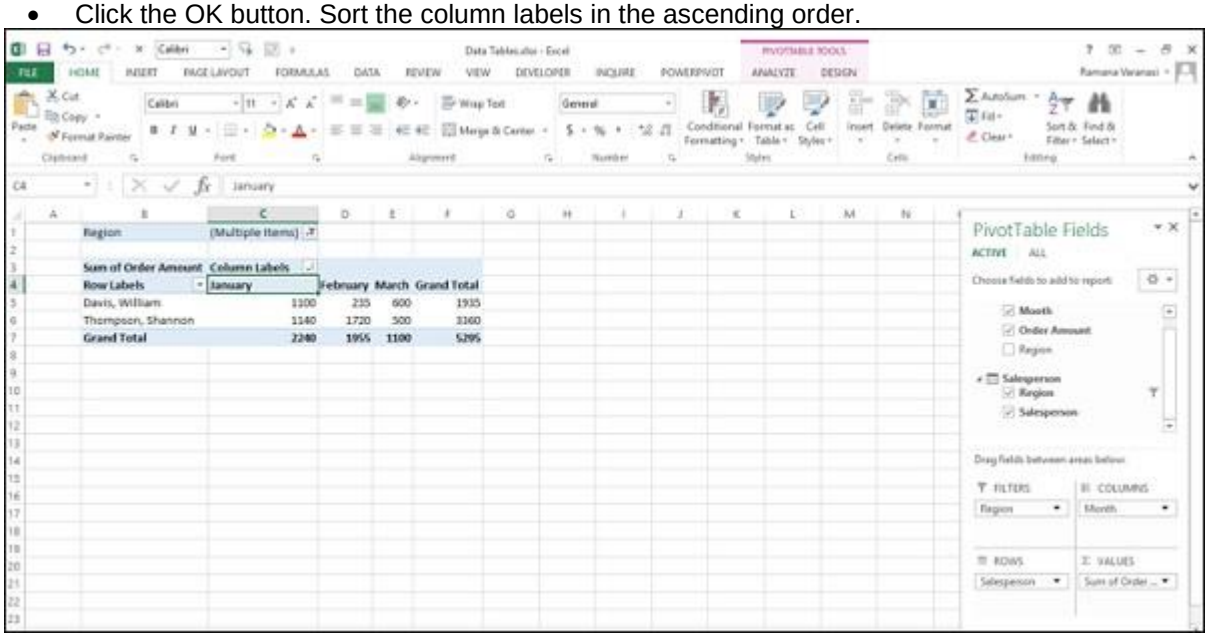
- Drag Month to COLUMNS area.
- Drag Region to FILTERS area.



- Click on arrow next to ALL in the Region filter box.
- Click on Select Multiple Items.
- Click on North and South.



- Click the OK button. Sort the column labels in the ascending order.

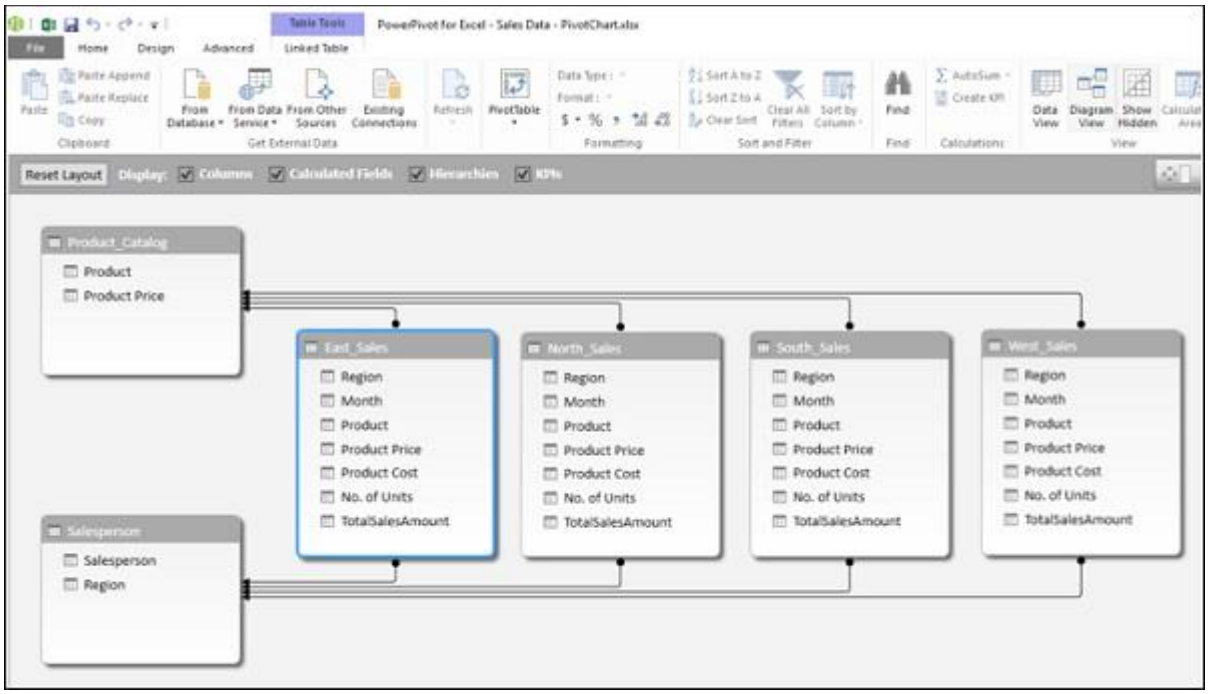


Power PivotTable can be modified dynamically to explore and report data.

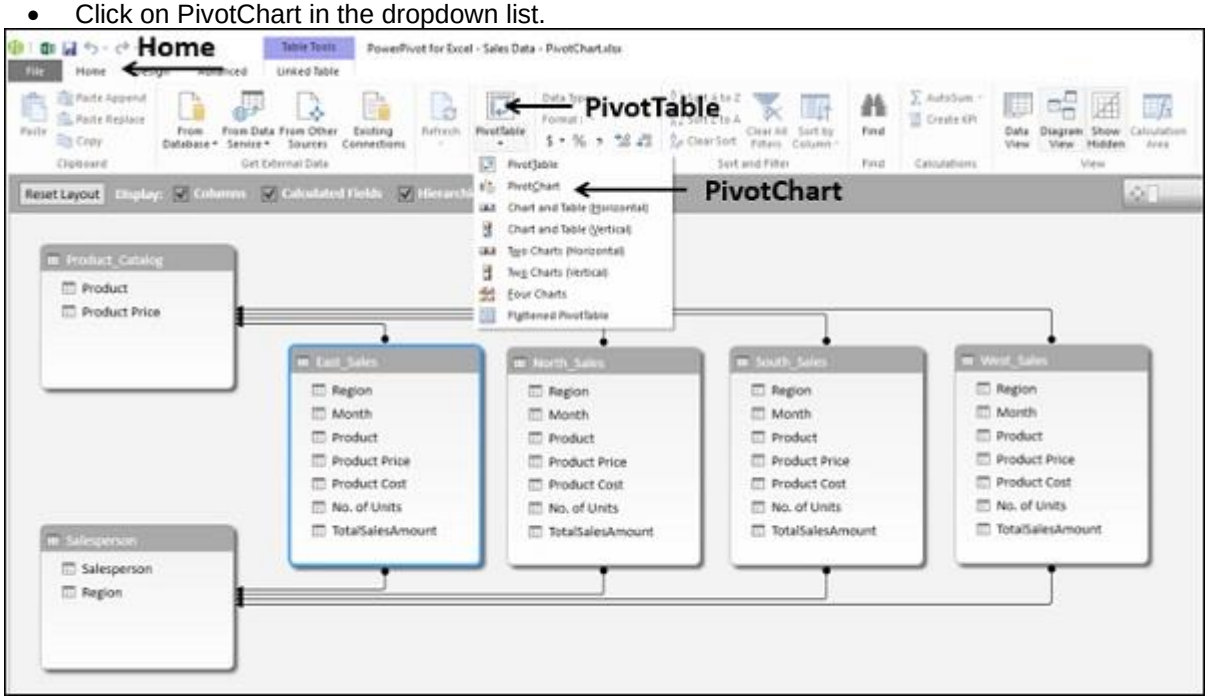
Creating a Power PivotChart

A Power PivotChart is a PivotChart that is based on Data Model and created from the Power Pivot window. Though it has some features similar to Excel PivotChart, there are other features that make it more powerful.

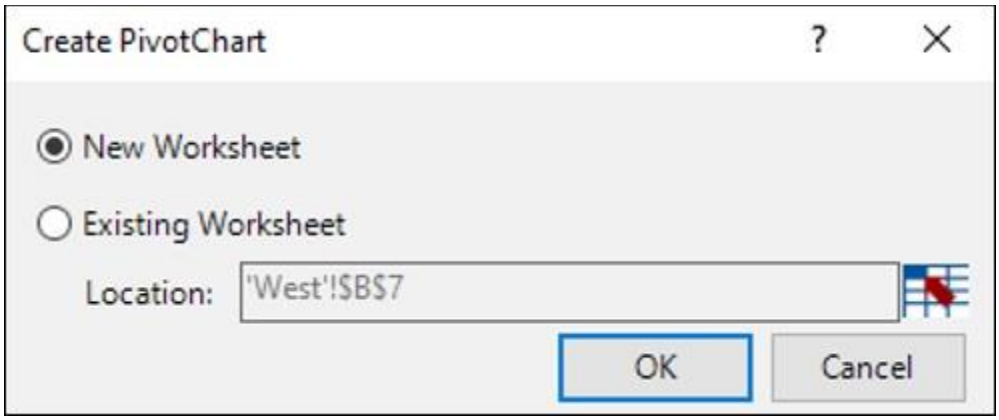
Suppose you want to create a Power PivotChart based on the following Data Model.



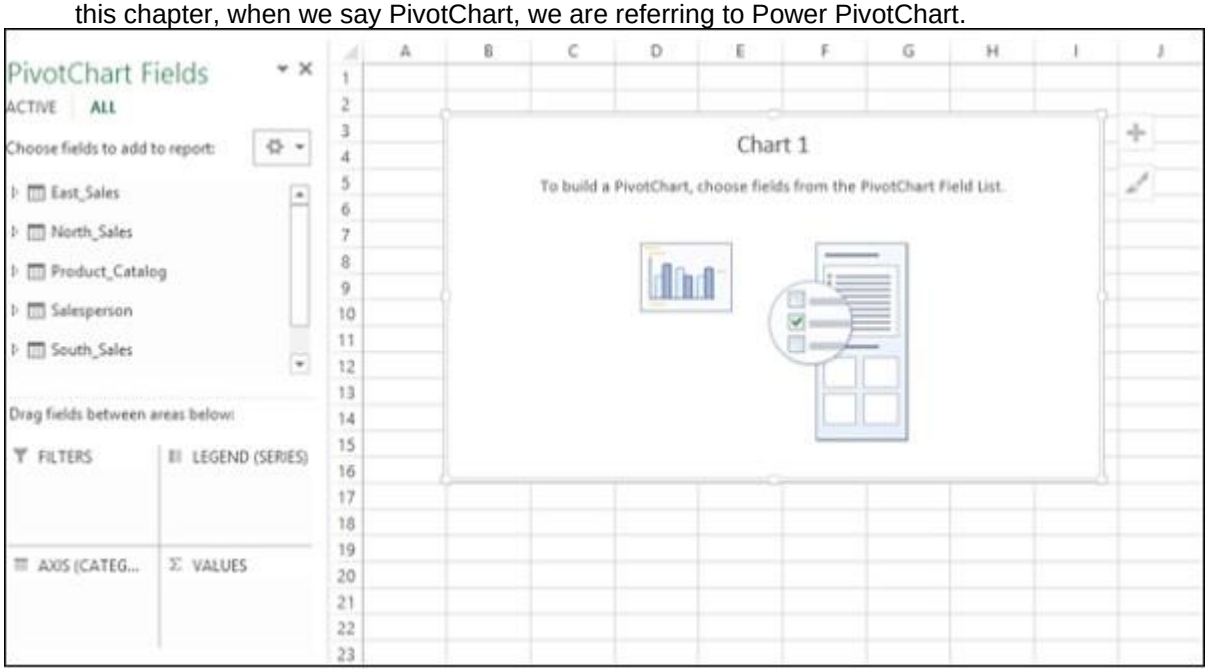
- Click on the Home tab on the Ribbon in the Power Pivot window.
- Click on PivotTable.
- Click on PivotChart in the dropdown list.



Create PivotChart dialog box appears. Click New Worksheet.



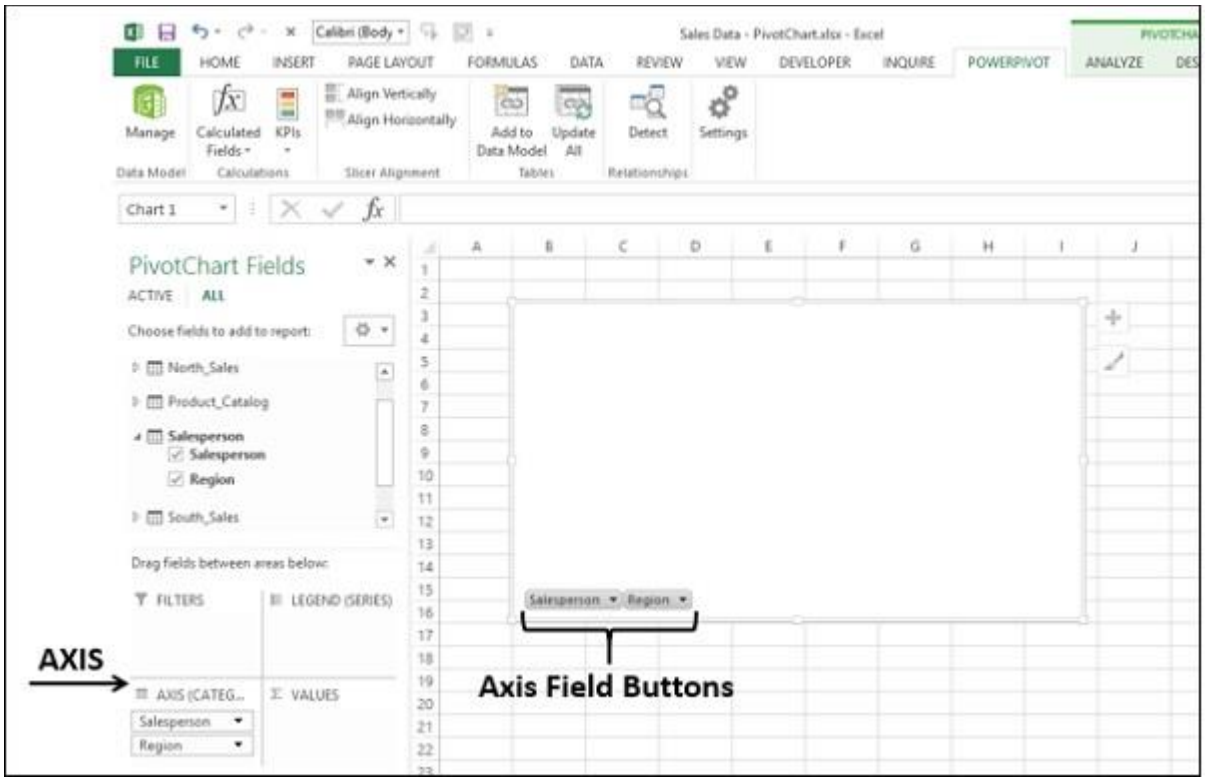
- Click the OK button. An empty PivotChart gets created on a new worksheet in the Excel window. In this chapter, when we say PivotChart, we are referring to Power PivotChart.



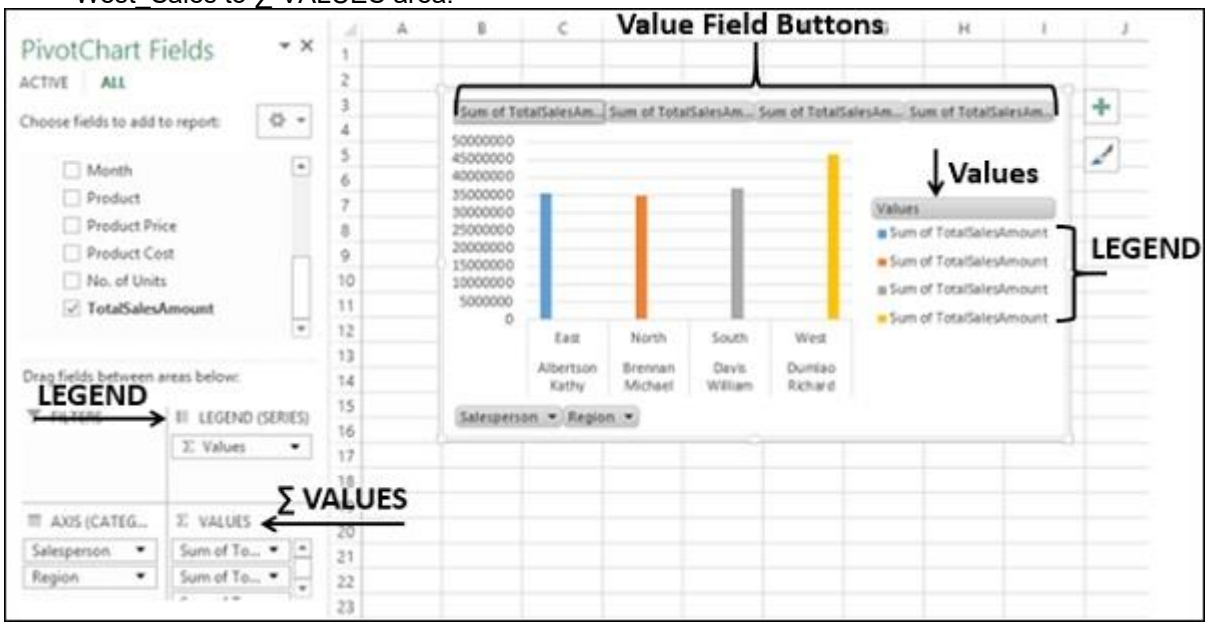
As you can observe, all the tables in the data model are displayed in the PivotChart Fields list.

- Click on the Salesperson table in the PivotChart Fields list.
- Drag the fields – Salesperson and Region to AXIS area.

Two field buttons for the two selected fields appear on the PivotChart. These are the Axis field buttons. The use of field buttons is to filter data that is displayed on the PivotChart.



- Drag TotalSalesAmount from each of the 4 tables – East_Sales, North_Sales, South_Sales and West_Sales to ∑ VALUES area.

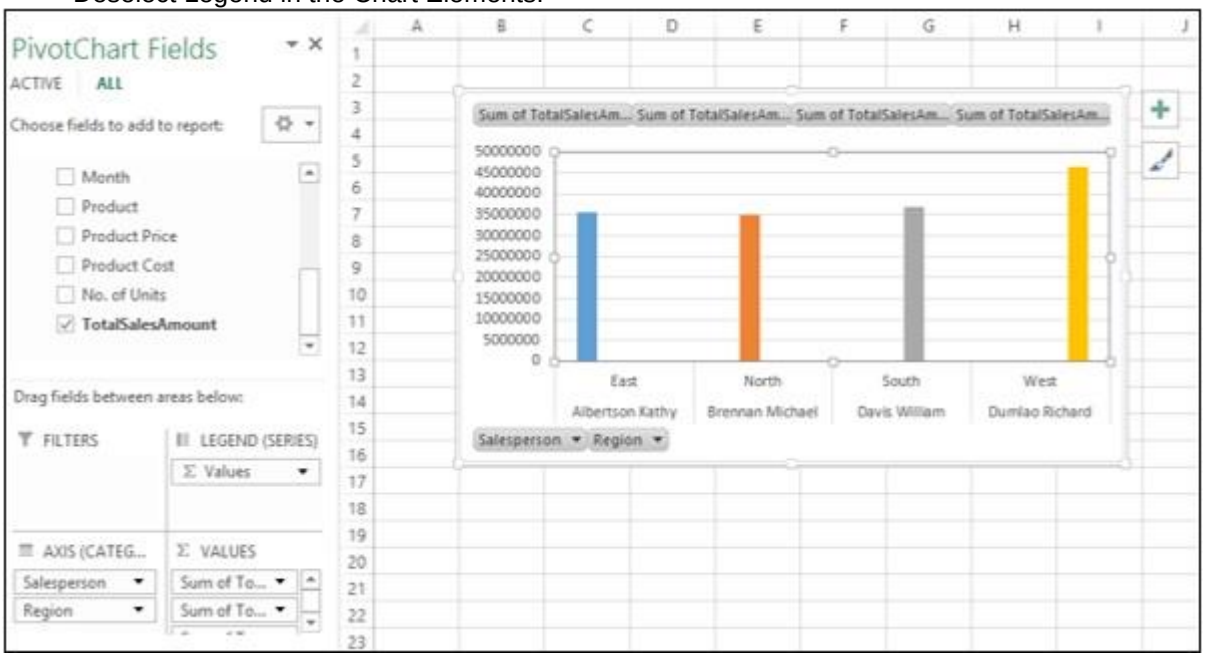


As you can observe, the following appear on the worksheet −

- In the PivotChart, column chart is displayed by default.
- In the LEGEND area, ∑ VALUES gets added.
- The Values appear in the Legend in the PivotChart, with title Values.
- The Value Field Buttons appear on the PivotChart.

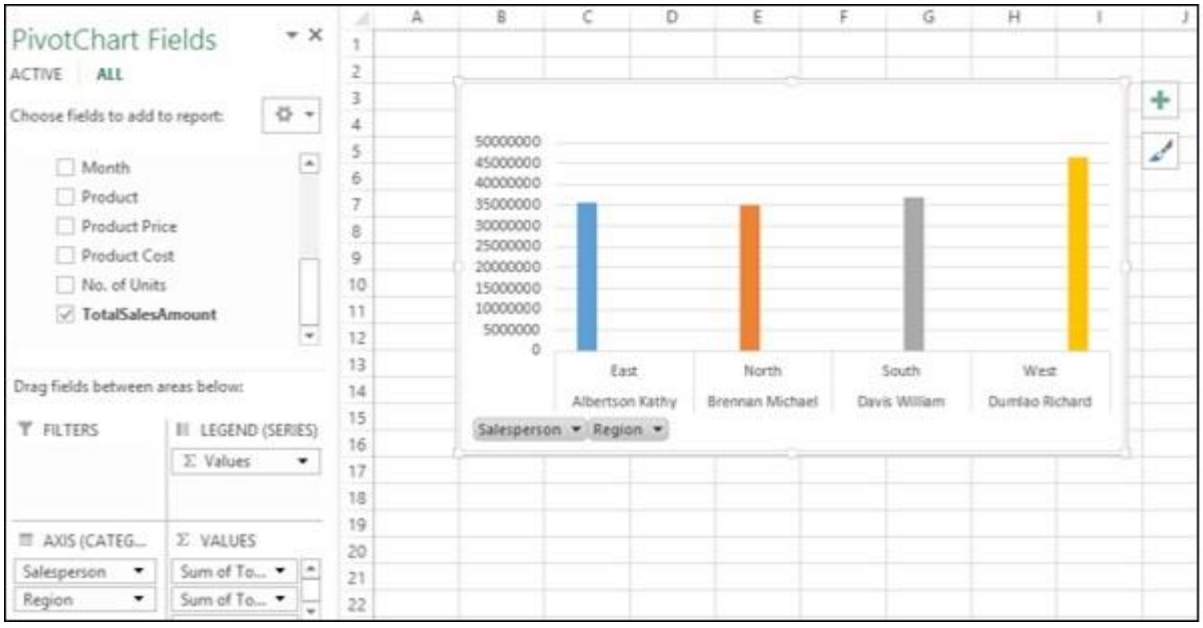
You can remove the legend and the value field buttons for a tidier look of the PivotChart.

- Click on the + button at the top right corner of the PivotChart.
- Deselect Legend in the Chart Elements.



- Right click on the value field buttons.
- Click on Hide Value Field Buttons on Chart in the dropdown list.

The value field buttons on the chart will be hidden.



Note that display of Field Buttons and/or Legend depends on the context of the PivotChart. You need to decide what is required to be displayed.

As in the case of Power PivotTable, Power PivotChart Fields list also contains two tabs − ACTIVE and ALL. Further, there are 4 areas −

- AXIS (Categories)

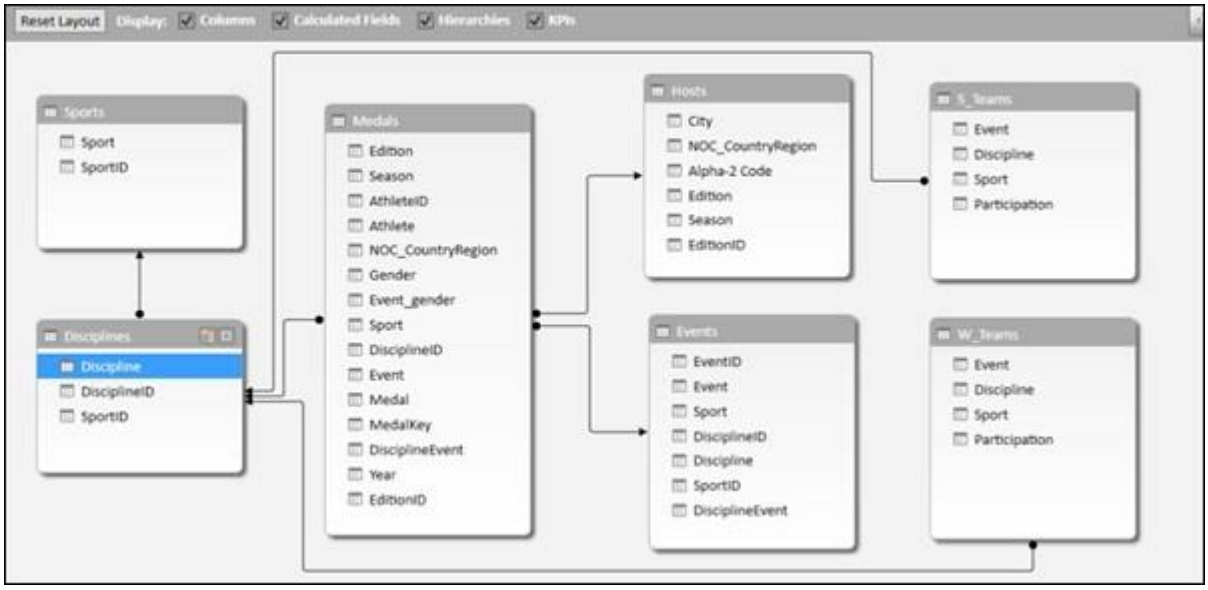
- LEGEND (Series)
- ∑ VALUES
- FILTERS

As you can observe, Legend gets populated with ∑ Values. Further, Field Buttons get added to the PivotChart for the ease of filtering the data that is being displayed. You can click on the arrow on a Field Button and select/deselect values to be displayed in the Power PivotChart.

Table and Chart Combinations

Power Pivot provides you with different combinations of Power PivotTable and Power PivotChart for data exploration, visualization and reporting.

Consider the following Data Model in Power Pivot that we will use for illustrations −



You can have the following Table and Chart Combinations in Power Pivot.

- Chart and Table (Horizontal) - you can create a Power PivotChart and a Power PivotTable, one next to another horizontally in the same worksheet.

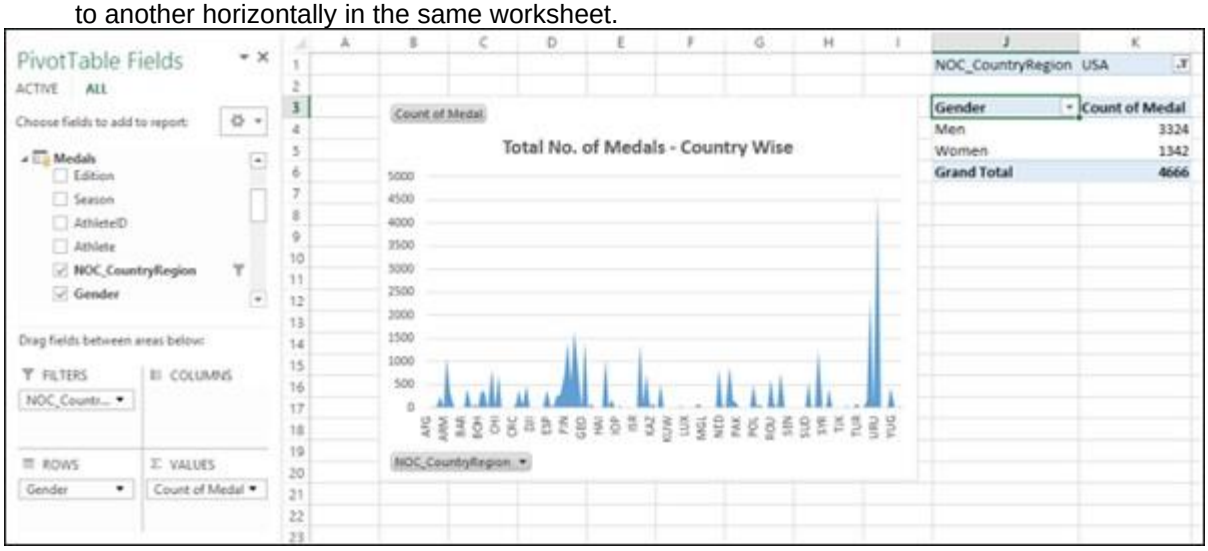
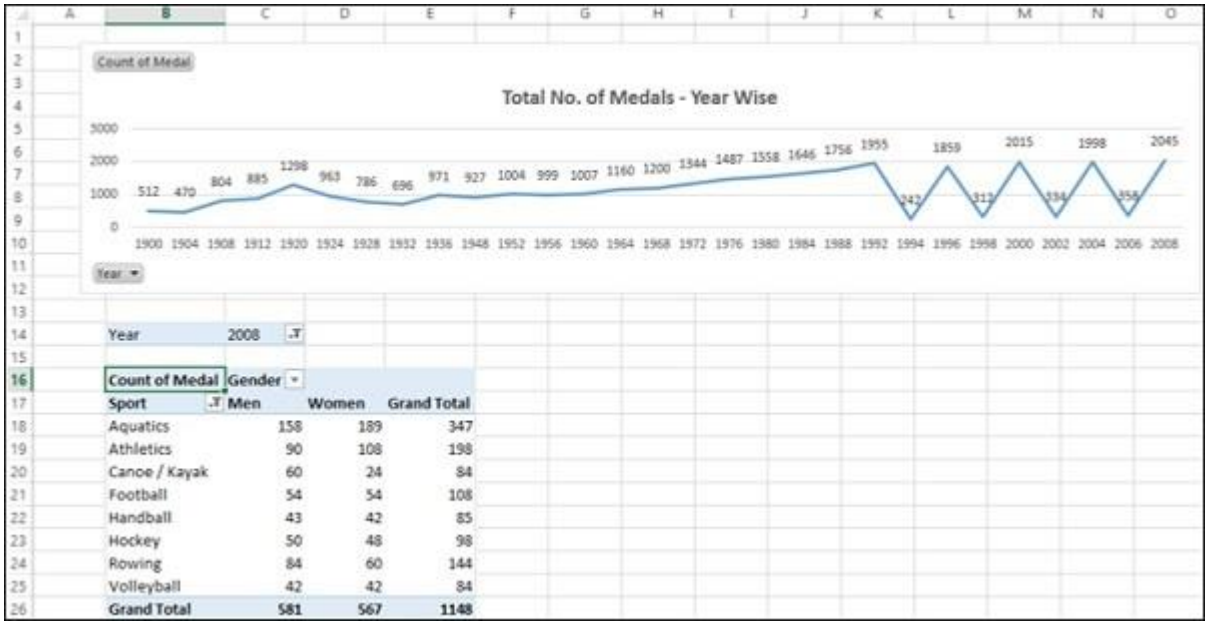


Chart and Table (Vertical) - you can create a Power PivotChart and a Power PivotTable, one below another vertically in the same worksheet.

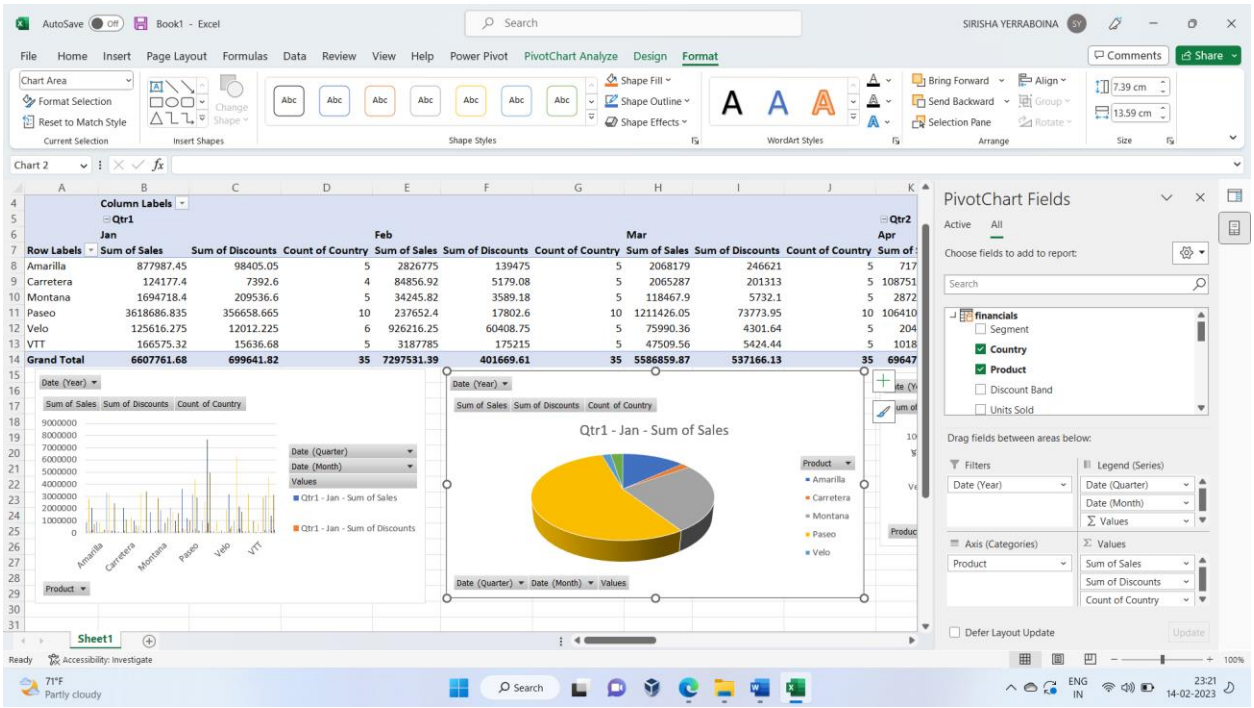


Year	2008		
Count of Medal	Gender		
Sport	Men	Women	Grand Total
Aquatics	158	189	347
Athletics	90	108	198
Canoe / Kayak	60	24	84
Football	54	54	108
Handball	43	42	85
Hockey	50	48	98
Rowing	84	60	144
Volleyball	42	42	84
Grand Total	581	567	1148

These combinations and some more are available in the dropdown list that appears when you click on PivotTable on the Ribbon in the Power Pivot window.

Click on the pivot chart and can develop multiple variety of charts

Output:



Experiment 7:using R project to carry out statistical analysis of big data

Aim:To perform the statistical analysis of big data using R

Theory: Statistics is the science of analyzing, reviewing and conclude data.

Some basic statistical numbers include:

- Mean, median and mode
- Minimum and maximum value
- Percentiles
- Variance and Standard Devation
- Covariance and Correlation
- Probability distributions

The R language was developed by two statisticians. It has many built-in functionalities, in addition to libraries for the exact purpose of statistical analysis.

Procedure:

Installation of R and Rstudio
step 1:
sudo apt-get update
sudo apt-get install r-base
step 2:
Installation of R studio

https://posit.co/download/rstudio-desktop/#download

step 1:download R studio for ubuntu

step 2 :wget -c https://download1.rstudio.org/desktop/jammy/amd64/rstudio-2022.07.2-576-amd64.deb

step 2:sudo dpkg -i rstudio-2022.07.2-576-amd64.deb

step 3 :sudo apt install -f

step 4:rstudio

launch R studio

procedure:
-->install.packages("gapminder")
-->library(gapminder)

-->data(gapminder)
output:

A tibble: 1,704 × 6

country	continent	year	lifeExp	pop	gdpPercap
<fct>	<fct>	<int>	<dbl>	<int>	<dbl>
1 Afghanistan	Asia	1952	28.8	8425333	779.
2 Afghanistan	Asia	1957	30.3	9240934	821.
3 Afghanistan	Asia	1962	32.0	10267083	853.
4 Afghanistan	Asia	1967	34.0	11537966	836.
5 Afghanistan	Asia	1972	36.1	13079460	740.
6 Afghanistan	Asia	1977	38.4	14880372	786.
7 Afghanistan	Asia	1982	39.9	12881816	978.
8 Afghanistan	Asia	1987	40.8	13867957	852.
9 Afghanistan	Asia	1992	41.7	16317921	649.
10 Afghanistan	Asia	1997	41.8	22227415	635.

… with 1,694 more rows

-->summary(gapminder)

summary(gapminder)

output:

country	continent	year
Afghanistan: 12	Africa :624	Min. :1952
Albania : 12	Americas:300	1st Qu.:1966
Algeria : 12	Asia :396	Median :1980
Angola : 12	Europe :360	Mean :1980
Argentina : 12	Oceania : 24	3rd Qu.:1993

```
 Australia  :  12                  Max.   :2007
 (Other)    :1632
    lifeExp           pop              gdpPercap
 Min.   :23.60   Min.   :6.001e+04   Min.   :   241.2
 1st Qu.:48.20   1st Qu.:2.794e+06   1st Qu.:  1202.1
 Median :60.71   Median :7.024e+06   Median :  3531.8
 Mean   :59.47   Mean   :2.960e+07   Mean   :  7215.3
 3rd Qu.:70.85   3rd Qu.:1.959e+07   3rd Qu.:  9325.5
 Max.   :82.60   Max.   :1.319e+09   Max.   :113523.1
```

-->x<-mean(gapminder$gdpPercap)

Type X to get mean value of gapminder

-->x

output:[1] 7215.327

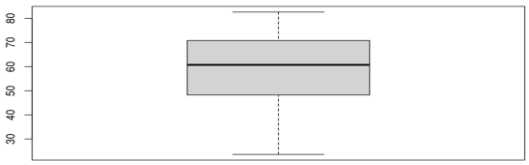
-->attach(gapminder)

-->median(pop)

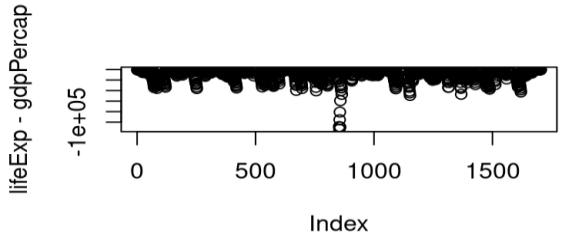
output:[1] 7023596

-->hist(lifeExp)

-->boxplot(lifeExp)
will plot the below images



-->plot(lifeExp - gdpPercap)



-->install.packages("dplyr")

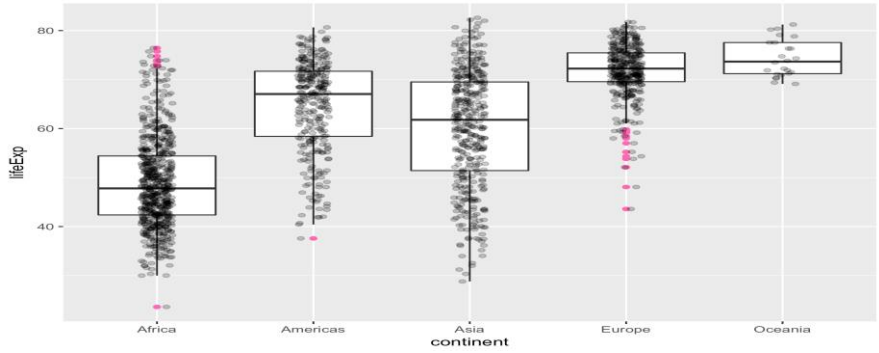
-->gapminder %>%
+ filter(year == 2007) %>%
+ group_by(continent) %>%
+ summarise(lifeExp = median(lifeExp))

output:

```
# A tibble: 5 × 2
  continent lifeExp
  <fct>       <dbl>
1 Africa       52.9
2 Americas     72.9
3 Asia         72.4
4 Europe       78.6
5 Oceania      80.7
```

-->install.packages("ggplot2")
--> library("ggplot2")
-->ggplot(gapminder, aes(x = continent, y = lifeExp)) +
geom_boxplot(outlier.colour = "hotpink") +
geom_jitter(position = position_jitter(width = 0.1, height = 0), alpha = 1/4)

output:



-->head(country_colors, 4)

output:

Nigeria Egypt Ethiopia
"#7F3B08" "#833D07" "#873F07"
Congo, Dem. Rep.
"#8B4107"
-->head(continent_colors)

```
mtcars
                   mpg cyl  disp  hp drat    wt  qsec vs am gear carb
Mazda RX4         21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4
Mazda RX4 Wag     21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4
Datsun 710        22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
Hornet 4 Drive    21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
Hornet Sportabout 18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2
Valiant           18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
Duster 360        14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4
Merc 240D         24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
Merc 230          22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
Merc 280          19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4
Merc 280C         17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4
Merc 450SE        16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3
Merc 450SL        17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3
Merc 450SLC       15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3
Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4
Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4
Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4
Fiat 128          32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1
Honda Civic       30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2
Toyota Corolla    33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1
Toyota Corona     21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
Dodge Challenger  15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2
AMC Javelin       15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2
Camaro Z28        13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4
Pontiac Firebird  19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2
Fiat X1-9         27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
Porsche 914-2     26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
Lotus Europa      30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2
Ford Pantera L    15.8   8 351.0 264 4.22 3.170 14.50  0  1    5    4
Ferrari Dino      19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6
Maserati Bora     15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8
Volvo 142E        21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
```

```
> Data_Cars <- mtcars
```

```
> dim(Data_Cars)
[1] 32 11
> names(Data_Cars)
 [1] "mpg"  "cyl"  "disp" "hp"   "drat" "wt"   "qsec" "vs"   "am"   "gear" "car
b"
> Data_Cars <- mtcars
> Data_Cars$cyl
 [1] 6 6 4 6 8 6 8 4 4 6 6 8 8 8 8 8 8 4 4 4 4 8 8 8 8 4 4 4 8 6 8 4
> Data_Cars <- mtcars
> sort(Data_Cars$cyl)
 [1] 4 4 4 4 4 4 4 4 4 4 4 6 6 6 6 6 6 6 8 8 8 8 8 8 8 8 8 8 8 8 8 8
> Data_Cars <- mtcars
>
> summary(Data_Cars)
      mpg             cyl             disp             hp             drat
 Min.   :10.40   Min.   :4.000   Min.   : 71.1   Min.   : 52.0   Min.   :2.760
 1st Qu.:15.43   1st Qu.:4.000   1st Qu.:120.8   1st Qu.: 96.5   1st Qu.:3.080
 Median :19.20   Median :6.000   Median :196.3   Median :123.0   Median :3.695
 Mean   :20.09   Mean   :6.188   Mean   :230.7   Mean   :146.7   Mean   :3.597
 3rd Qu.:22.80   3rd Qu.:8.000   3rd Qu.:326.0   3rd Qu.:180.0   3rd Qu.:3.920
 Max.   :33.90   Max.   :8.000   Max.   :472.0   Max.   :335.0   Max.   :4.930
       wt             qsec             vs              am              gear
 Min.   :1.513   Min.   :14.50   Min.   :0.0000   Min.   :0.0000   Min.   :3.00
0
 1st Qu.:2.581   1st Qu.:16.89   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:3.00
0
 Median :3.325   Median :17.71   Median :0.0000   Median :0.0000   Median :4.00
0
 Mean   :3.217   Mean   :17.85   Mean   :0.4375   Mean   :0.4062   Mean   :3.68
8
 3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:4.00
0
 Max.   :5.424   Max.   :22.90   Max.   :1.0000   Max.   :1.0000   Max.   :5.00
0
      carb
 Min.   :1.000
 1st Qu.:2.000
 Median :2.000
 Mean   :2.812
 3rd Qu.:4.000
 Max.   :8.000
> Data_Cars <- mtcars
>
> max(Data_Cars$hp)
[1] 335
> min(Data_Cars$hp)
[1] 52
> Data_Cars <- mtcars
>
> which.max(Data_Cars$hp)
[1] 31
> which.min(Data_Cars$hp)
[1] 19
> Data_Cars <- mtcars
> rownames(Data_Cars)[which.max(Data_Cars$hp)]
[1] "Maserati Bora"
> rownames(Data_Cars)[which.min(Data_Cars$hp)]
[1] "Honda Civic"
> median(Data_Cars$wt)
[1] 3.325
> names(sort(-table(Data_Cars$wt)))[1]
[1] "3.44"

> Data_Cars <- mtcars
>
> mean(Data_Cars$wt)
[1] 3.21725

Data_Cars <- mtcars

median(Data_Cars$wt)
```

```
[1] 3.325
Data_Cars <- mtcars

names(sort(-table(Data_Cars$wt)))[1]

Data_Cars <- mtcars

# c() specifies which percentile you want
quantile(Data_Cars$wt, c(0.75))
75%
3.61

Data_Cars <- mtcars
>
> quantile(Data_Cars$wt)
     0%     25%     50%     75%    100%
1.51300 2.58125 3.32500 3.61000 5.42400
```

Regression analysis using R

Regression analysis is a very widely used statistical tool to establish a relationship model between two variables. One of these variable is called predictor variable whose value is gathered through experiments. The other variable is called response variable whose value is derived from the predictor variable.

In Linear Regression these two variables are related through an equation, where exponent (power) of both these variables is 1. Mathematically a linear relationship represents a straight line when plotted as a graph. A non-linear relationship where the exponent of any variable is not equal to 1 creates a curve.

The general mathematical equation for a linear regression is –

$$y = ax + b$$

Following is the description of the parameters used –

- **y** is the response variable.
- **x** is the predictor variable.
- **a** and **b** are constants which are called the coefficients.

Steps to Establish a Regression

A simple example of regression is predicting weight of a person when his height is known. To do this we need to have the relationship between height and weight of a person.

The steps to create the relationship is –

- Carry out the experiment of gathering a sample of observed values of height and corresponding weight.
- Create a relationship model using the **lm()** functions in R.
- Find the coefficients from the model created and create the mathematical equation using these

- Get a summary of the relationship model to know the average error in prediction. Also called **residuals**.
- To predict the weight of new persons, use the **predict()** function in R.

Input Data

Below is the sample data representing the observations –

```
# Values of height
151, 174, 138, 186, 128, 136, 179, 163, 152, 131

# Values of weight.
63, 81, 56, 91, 47, 57, 76, 72, 62, 48
```

lm() Function

This function creates the relationship model between the predictor and the response variable.

Syntax

The basic syntax for **lm()** function in linear regression is –

```
lm(formula,data)
```

Following is the description of the parameters used –

- **formula** is a symbol presenting the relation between x and y.
- **data** is the vector on which the formula will be applied.

Create Relationship Model & get the Coefficient

```
x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)
y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)

# Apply the lm() function.
relation <- lm(y~x)

print(relation)
```

Result:

```
Call:
lm(formula = y ~ x)

Coefficients:
(Intercept)            x
   -38.4551        0.6746
```

To get the summary of the relation ships

```
x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)
y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)

# Apply the lm() function.
relation <- lm(y~x)

print(summary(relation))
```

Result:

```
Call:
lm(formula = y ~ x)

Residuals:
   Min     1Q    Median     3Q    Max
-6.3002   -1.6629  0.0412   1.8944  3.9775

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -38.45509    8.04901  -4.778  0.00139 **
x           0.67461    0.05191  12.997 1.16e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.253 on 8 degrees of freedom
Multiple R-squared:  0.9548,    Adjusted R-squared:  0.9491
F-statistic: 168.9 on 1 and 8 DF,  p-value: 1.164e-06
```

predict() Function

Syntax

The basic syntax for predict() in linear regression is –

```
predict(object, newdata)
```

Following is the description of the parameters used –

- **object** is the formula which is already created using the lm() function.
- **newdata** is the vector containing the new value for predictor variable.

Predict the weight of new persons

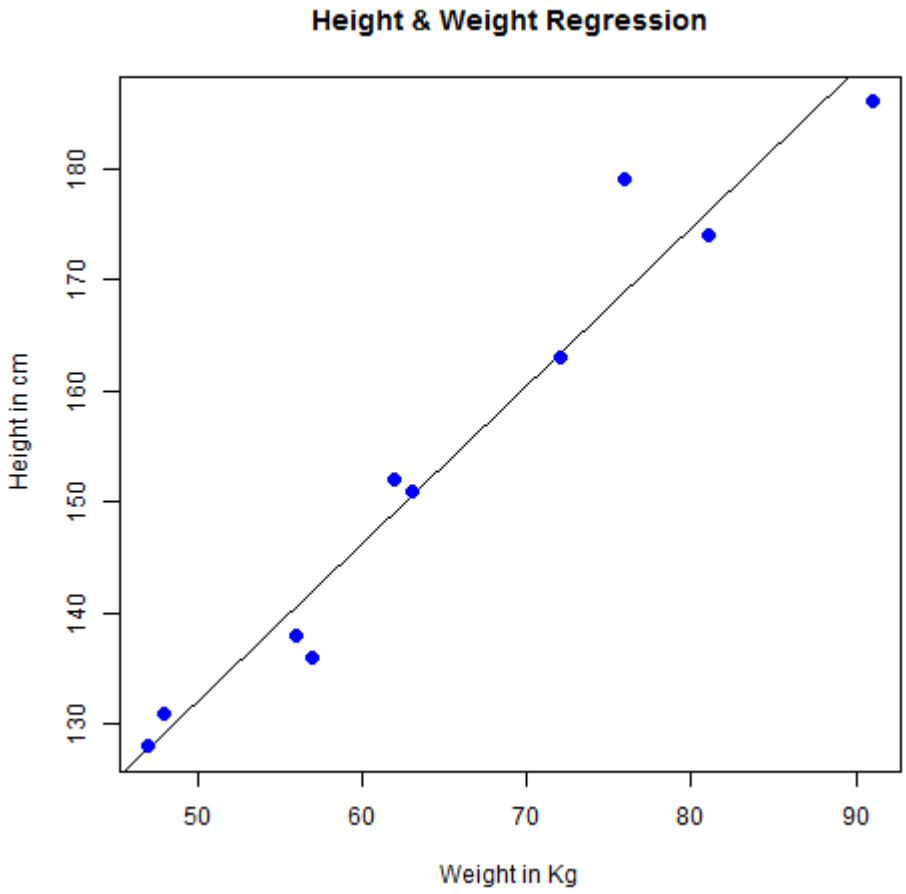
```
# The predictor vector.
x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)

# The response vector.
y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)

# Apply the lm() function.
relation <- lm(y~x)

# Find weight of a person with height 170.
a <- data.frame(x = 170)
result <-  predict(relation,a)
print(result)
```

Result:

```
       1
76.22869
```

Visualize the Regression Graphically

```
# Create the predictor and response variable.
x <- c(151, 174, 138, 186, 128, 136, 179, 163, 152, 131)
y <- c(63, 81, 56, 91, 47, 57, 76, 72, 62, 48)
relation <- lm(y~x)

# Give the chart file a name.
png(file = "linearregression.png")

# Plot the chart.
plot(y,x,col = "blue",main = "Height & Weight Regression",
abline(lm(x~y)),cex = 1.3,pch = 16,xlab = "Weight in Kg",ylab = "Height in cm")

# Save the file.
dev.off()
```


Height & Weight Regression
Height in cm
130
140
150
160
170
180
50
60
70
80
90
Weight in Kg

Experiment 8:Using R project for data visualization of social media

Aim:To perform data visualization using R programming

Theory:

Data visualization is the technique used to deliver insights in data using visual cues such as graphs, charts, maps, and many others. This is useful as it helps in intuitive and easy understanding of the large quantities of data and thereby make better decisions regarding it.

Data Visualization in R Programming Language
The popular data visualization tools that are available are Tableau, Plotly, R, Google Charts, Infogram, and Kibana. The various data visualization platforms have different capabilities, functionality, and use cases. They also require a different skill set. This article discusses the use of R for data visualization.

R is a language that is designed for statistical computing, graphical data analysis, and scientific research. It is usually preferred for data visualization as it offers flexibility and minimum required coding through its packages.

Types of Data Visualizations
Some of the various types of visualizations offered by R are:

Bar Plot

There are two types of bar plots- horizontal and vertical which represent data points as horizontal or vertical bars of certain lengths proportional to the value of the data item. They are generally used for continuous and categorical variable plotting. By setting the **horiz** parameter to true and false, we can get horizontal and vertical bar plots respectively.

Bar plots are used for the following scenarios:

- To perform a comparative study between the various data categories in the data set.
- To analyze the change of a variable over time in months or years.

Histogram

A histogram is like a bar chart as it uses bars of varying height to represent data distribution. However, in a histogram values are grouped into consecutive intervals called bins. In a Histogram, continuous values are grouped and displayed in these bins whose size can be varied.

For a histogram, the parameter **xlim** can be used to specify the interval within which all values are to be displayed.
Another parameter **freq** when set to *TRUE* denotes the frequency of the various values in the histogram and when set to *FALSE*, the probability densities are represented on the y-axis such that they are of the histogram adds up to one.
Histograms are used in the following scenarios:

- To verify an equal and symmetric distribution of the data.

- To identify deviations from expected values.

Box Plot

The statistical summary of the given data is presented graphically using a boxplot. A boxplot depicts information like the minimum and maximum data point, the median value, first and third quartile, and interquartile range.

Box Plots are used for:

- To give a comprehensive statistical description of the data through a visual cue.
- To identify the outlier points that do not lie in the inter-quartile range of data.

Scatter Plot

A scatter plot is composed of many points on a Cartesian plane. Each point denotes the value taken by two parameters and helps us easily identify the relationship between them.

Scatter Plots are used in the following scenarios:

- To show whether an association exists between bivariate data.
- To measure the strength and direction of such a relationship.

Heat Map

Heatmap is defined as a graphical representation of data using colors to visualize the value of the matrix. heatmap() function is used to plot heatmap.

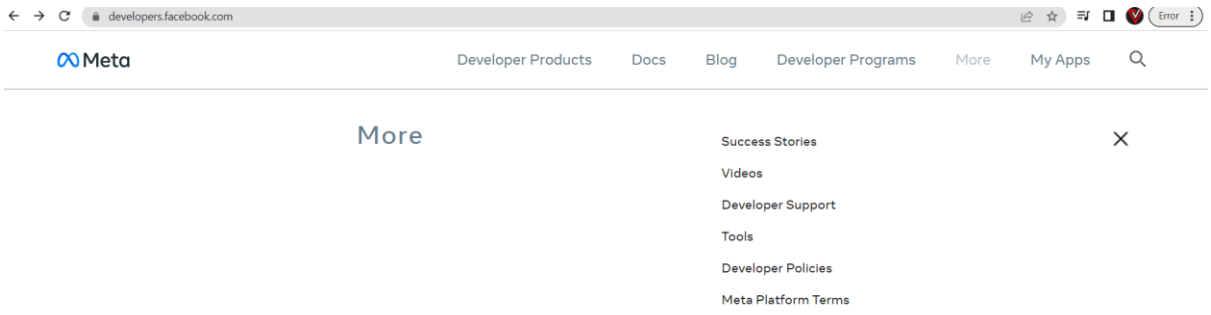
Syntax: *heatmap(data)*
Parameters: *data: It represent matrix data, such as values of rows and columns*
Return: *This function draws a heatmap.*

Procedure:

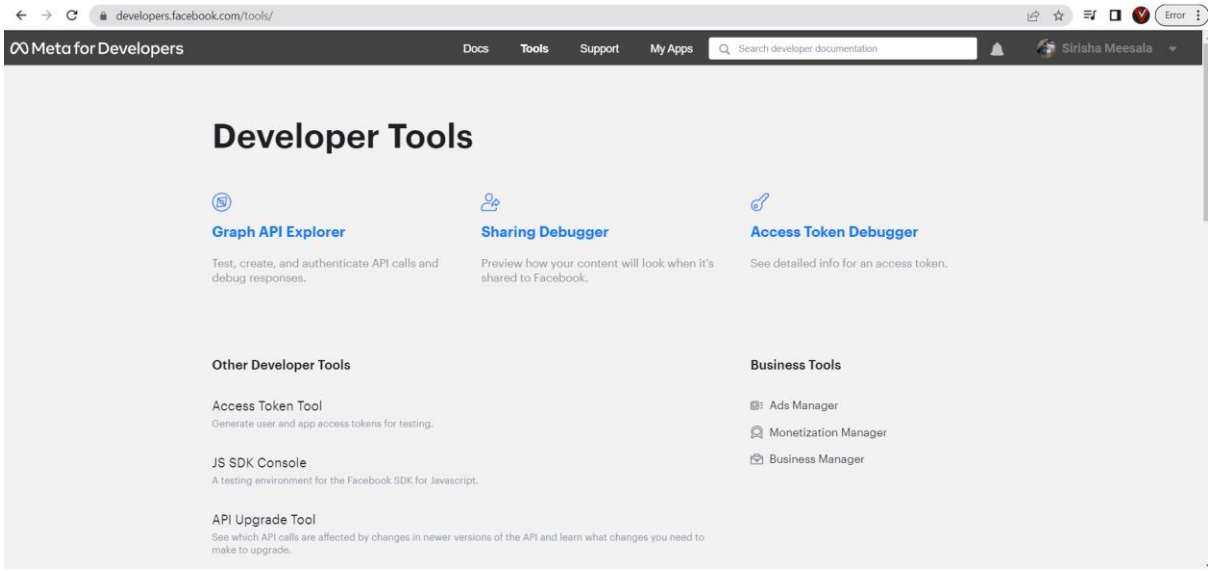
Step I : Facebook Developer Registration

Go to https://developers.facebook.com and register yourself by clicking on **Get Started** button at the top right of page (See the snapshot below). After it would open a form for registration which you need to fill it to get yourself registered.

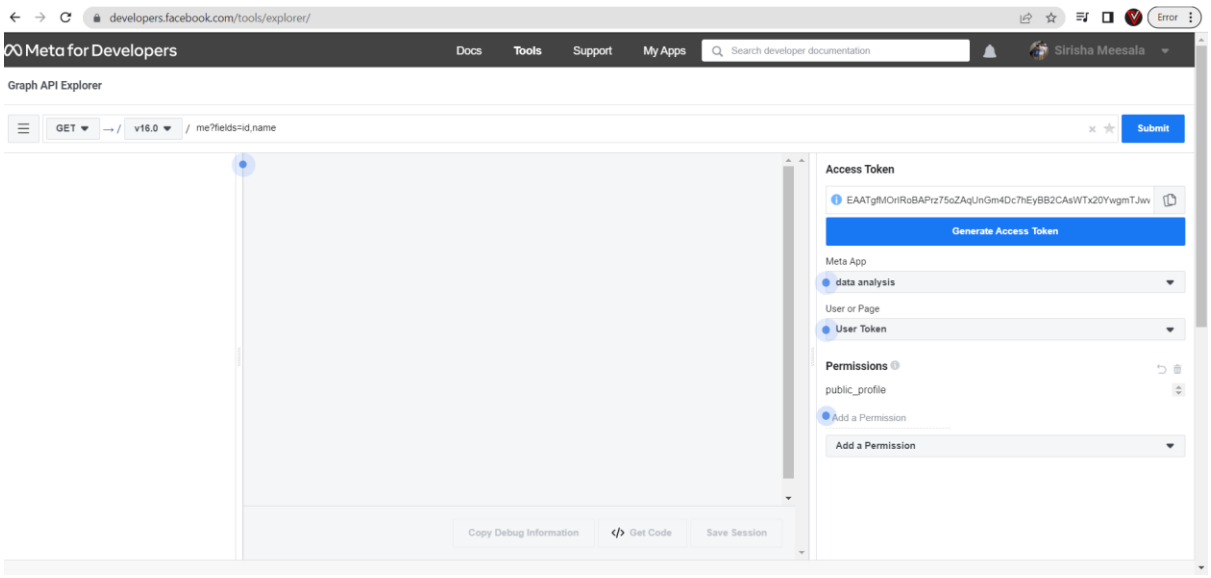
Step2:click on tools



Step3 :click on graphApi explorer



Step4:copy the access token



Copy the access token

Go to R studio and write this Script

install.packages("httpuv")

install.packages("Rfacebook")

install.packages("RcolorBrewer")

install.packages("Rcurl")

install.packages("rjson")

install.packages("httr")

library(Rfacebook)

library(httpuv)

library(RcolorBrewer)

acess_token="EAATgfMOrIRoBAOR9XUl3VGzbLMuWGb9FqGkTK3PFBuRyUVZAWAL7ZBw0xN3AijCsPiZBylucovck4YUhUfkWLMZBo640k2ZAupKgsaKog9736lecP8E52qkl5de8M963oKG8KOCVUXqqLiRcI7yIbEONeQt0eyLI6LdoeZA65Hyxf8so1UMbywAdZCZAQBpNiZAPPj7G3UX5jZAvUpRLZCQ5SIG"

options(RCurloptions=list(verbose=FALSE,capath=system.file("CurlSSL","cacert.pem",package = "Rcurl"),ssl.verifypeer=FALSE))

me<-getUsers("me",token=acess_token)

View(me)

myFriends<-getFriends(acess_token,simplify = FALSE)

table(myFriends)

pie(table(myFriends$gender))

output