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# METGENO v3.0

## USER GUIDE





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Sabz-Qalam is a privately held company and its Department of Information Technology currently working in IT consulting, software development, testing and support.

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## *About Metgeno*

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### **Abstract**

The main purpose of this document is to provide a detailed description of the Metgeno installation and usage. The primary reason behind making Metgeno is to provide a free platform for downloading and installing Metagenomics tools on Ubuntu systems. Metgeno is a GUI based software package which installs Metagenomics tools and their respective dependencies.

### **Purpose of this guide**

This is a guide for all the users who are either unfamiliar with the working and execution of the tools included in Metgeno or are new to the Ubuntu operating system and having trouble to understand the interface.

### **Intended Audience**

This document is intended for users who install Metgeno and want to run pipeline analysis on data. Some familiarity with basic Linux operating system commands on behalf of user is assumed. Also, we assume that your hardware meets the requirements for installing Metgeno.

### **License**

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## How this Guide is Organized

This guide is organized into sections grouped according to the intended use by the user:

- + *About Metgeno* describes the details of authors, document's purpose and intended audience
- + *Software Installation Process* (Chapter 1) describes how to download and install Metgeno
- + *Virtualization* (Chapter 2) and (Chapter 3) describe a step by step procedure to configure a virtual OS for Metgeno on Windows and MacOS respectively
- + *Selection Criteria* (Chapter 4) has table for Software Selection Criteria
- + *Packaged Tools* (Chapter 5) has table for all the Included Tools
- + *Software Pipeline* (Chapter 6) contain brief definition of software pipeline including necessary diagrams to facilitate learning of the field and has included all the packaged tools with respective categories

## Contact

If you have general, non-technical or technical question:

- + Send an email to [sharozemehraj@gmail.com](mailto:sharozemehraj@gmail.com) or [hasaniqbal777@gmail.com](mailto:hasaniqbal777@gmail.com)

## *Chapter-1: Software Installation*

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1. Install Ubuntu operating system of the recommended version on your system.
2. Download **Metgeno** from the website:  
<https://github.com/sharozem/Metgeno-bin>
3. Metgeno can also be downloaded from the git command through terminal but for that your system should have installed **git**, if it is not installed you can simply install it by typing the following command in terminal:

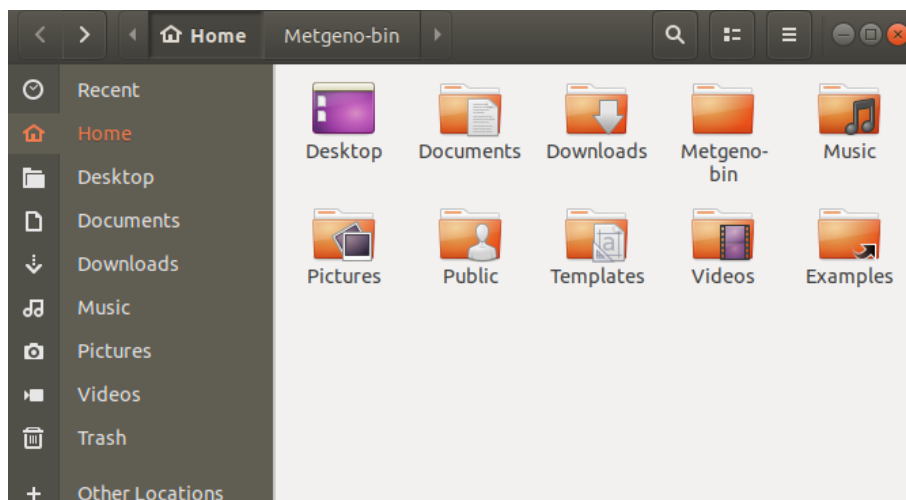
```
$ sudo apt install git
```

```
$ git clone https://github.com/sharozem/Metgeno-bin
```

---

**Note:** Proper Internet Connection is required to download and install Metgeno.

4. Then the files of Metgeno will be downloaded and available in Home menu in the folder named **Metgeno-bin**.



*Figure 1.1: Downloaded Files of Metgeno*

5. Now run the following commands in terminal:

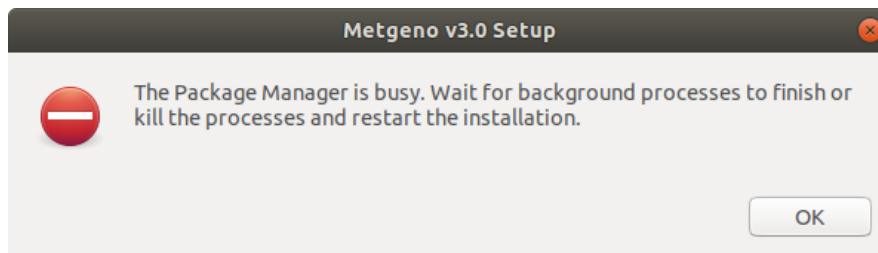
```
$ cd Metgeno-bin
```

```
$ chmod +x Metgeno_setup_enUS
```

```
$ ./Metgeno_setup_enUS
```

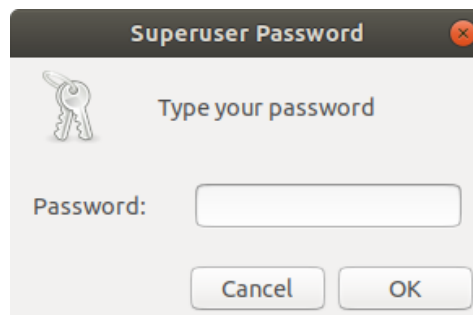


6. If the package manager of your linux distribution is busy the installation will terminate. Wait for the background processes to finish or restart the system to reset all the programs running in the background (recommended).



*Figure 1.2: Busy Package Manager*

7. Enter your superuser credentials to start Metgeno Installation.



*Figure 1.3: Password Screen*

8. If the superuser password is incorrect the installation will terminate.



*Figure 1.4: Incorrect Password Warning Screen*

9. Click **OK** to proceed and confirm the internet connection.



*Figure 1.5: Internet Connection Checking Screen*

10. Installation is terminated if there is no internet connection.



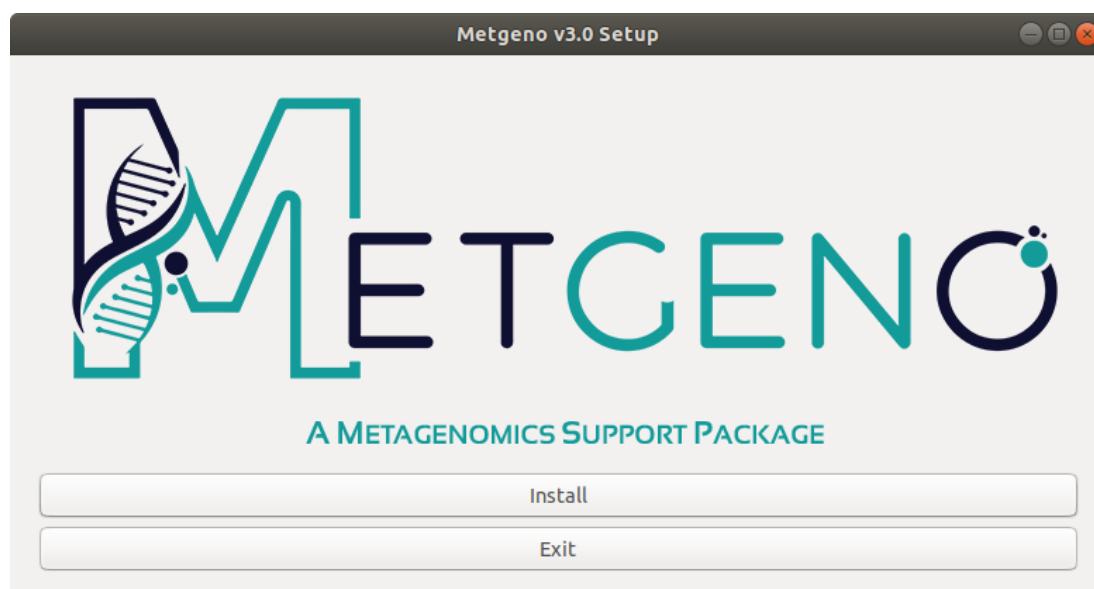
*Figure 1.6: Internet Connection Failed Screen*

11. Installation wizard of Metgeno will start.



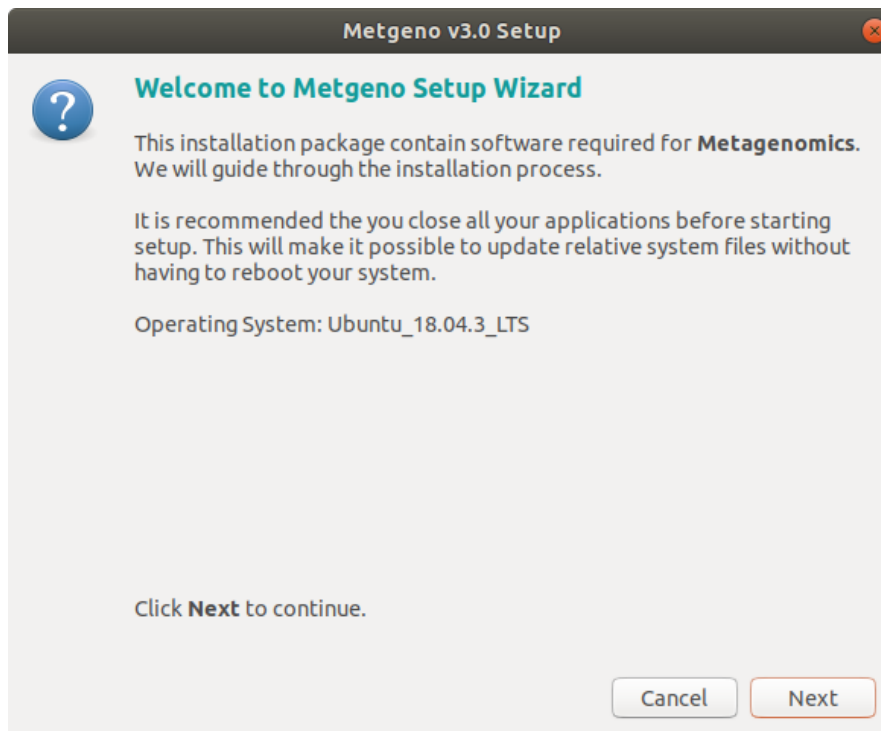
*Figure 1.7: Splash Screen*

12. Select you want to install or exit Metgeno.



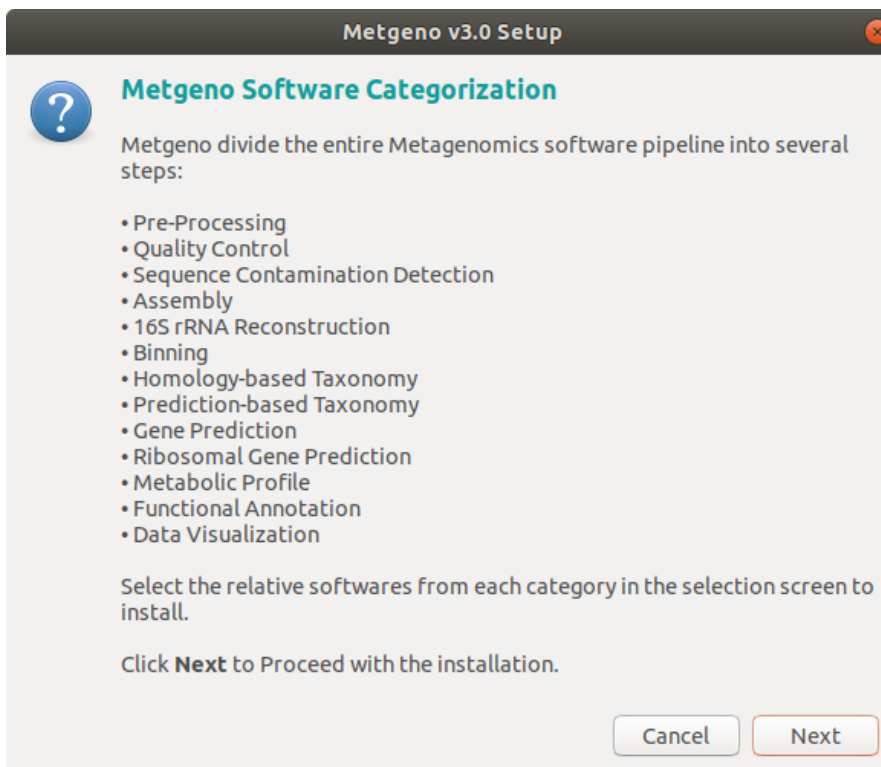
*Figure 1.8: Installer Selection Screen*

**13.** Click **Next** to proceed with the installation.



*Figure 1.9: Installation Welcome Screen*

**14.** Metgeno pipeline detail screen is displayed. It has the information about which software you want to install. Click **Next** to Proceed.



*Figure 1.10: Pipeline Information Screen*

15. Selection screen for Pre-processing Tools is displayed. Select the required tools and Click **Next**.

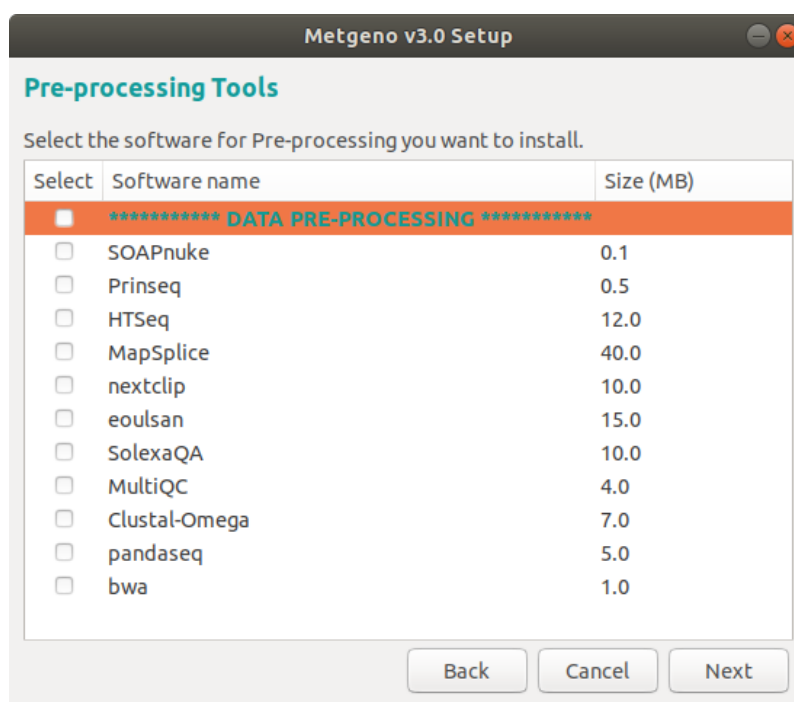


Figure 1.11: Pre-processing Tools Selection Screen

16. Selection screen for Quality Control Tools is displayed. Select the required tools and Click **Next**.

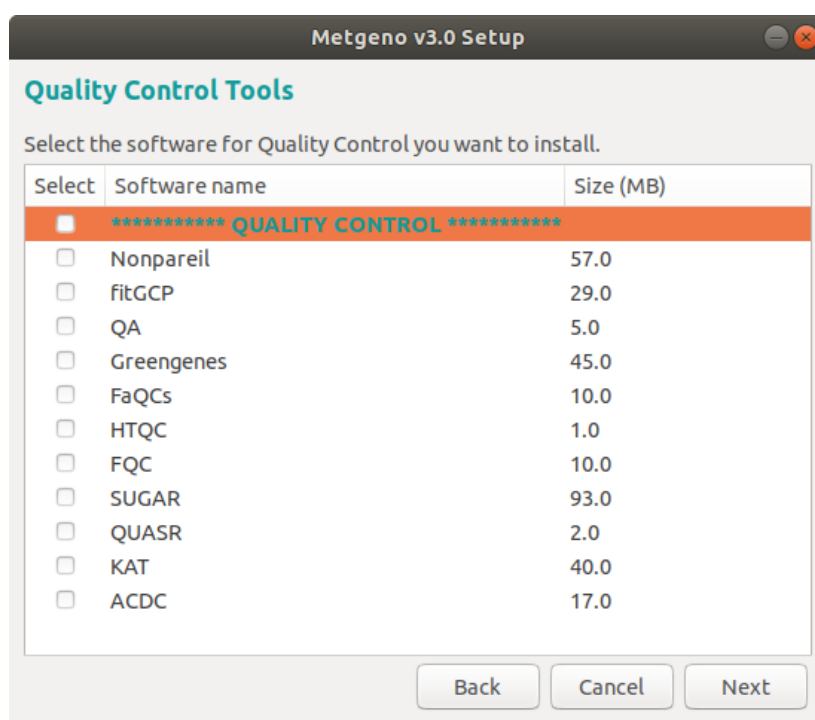


Figure 1.12: Quality Control Tools Selection Screen

17. Selection screen for Sequence Contamination Detection Tools is displayed. Select the required tools and Click **Next**.

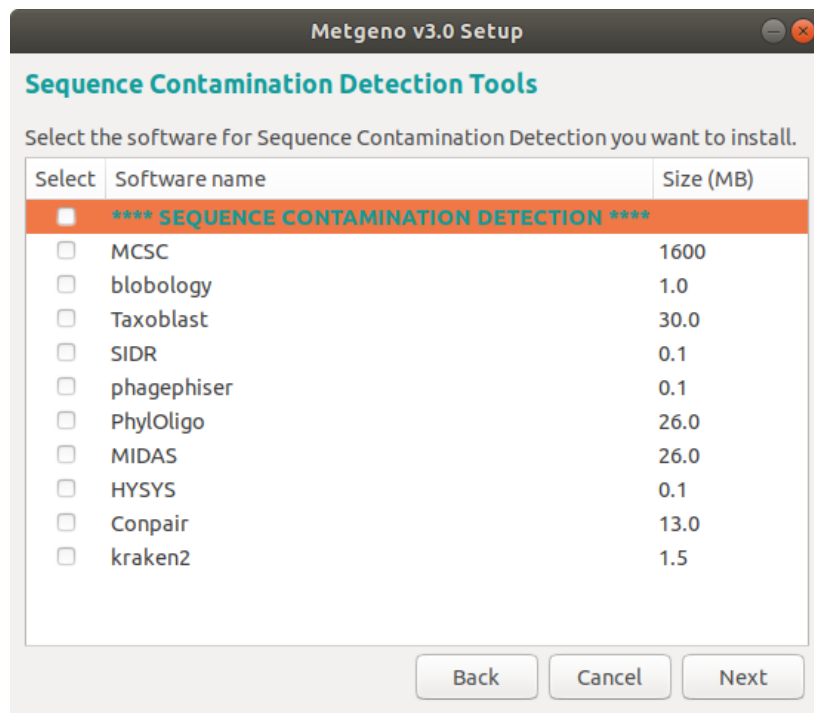


Figure 1.13: Sequence Contamination Detection Tools Selection Screen

18. Selection screen for Assembly Tools is displayed. Select the required tools and Click **Next**.

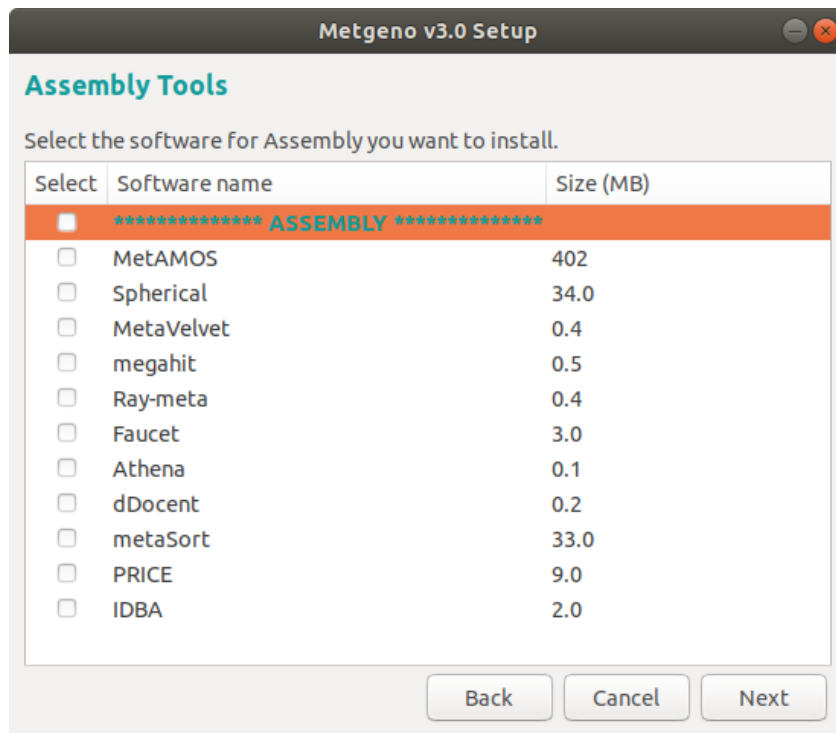


Figure 1.14: Assembly Tools Selection Screen

19. Selection screen for 16S rRNA Reconstruction Tools is displayed. Select the required tools and Click **Next**.

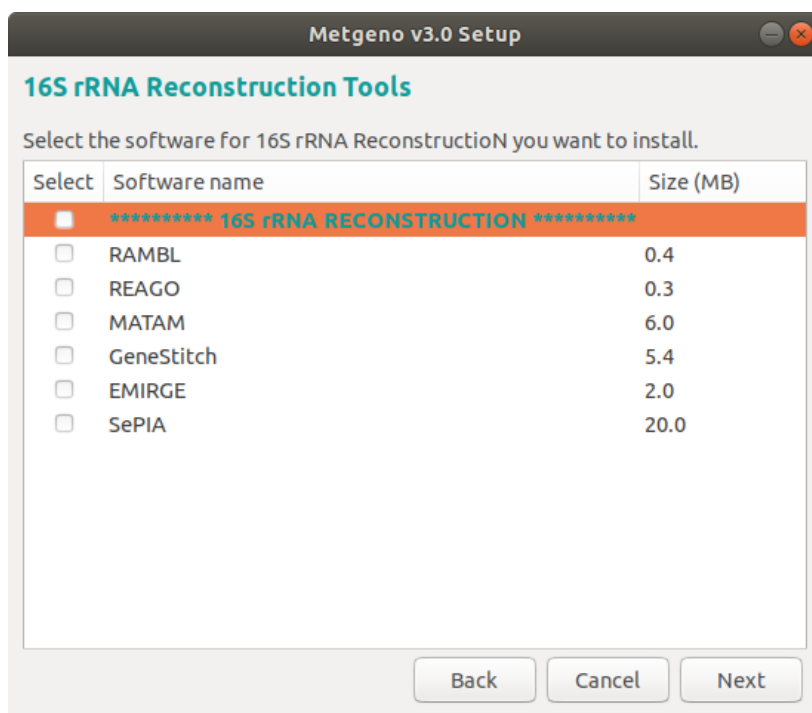


Figure 1.15: 16S rRNA Reconstruction Tools Selection Screen

20. Selection screen for Binning Tools is displayed. Select the required tools and Click **Next**.

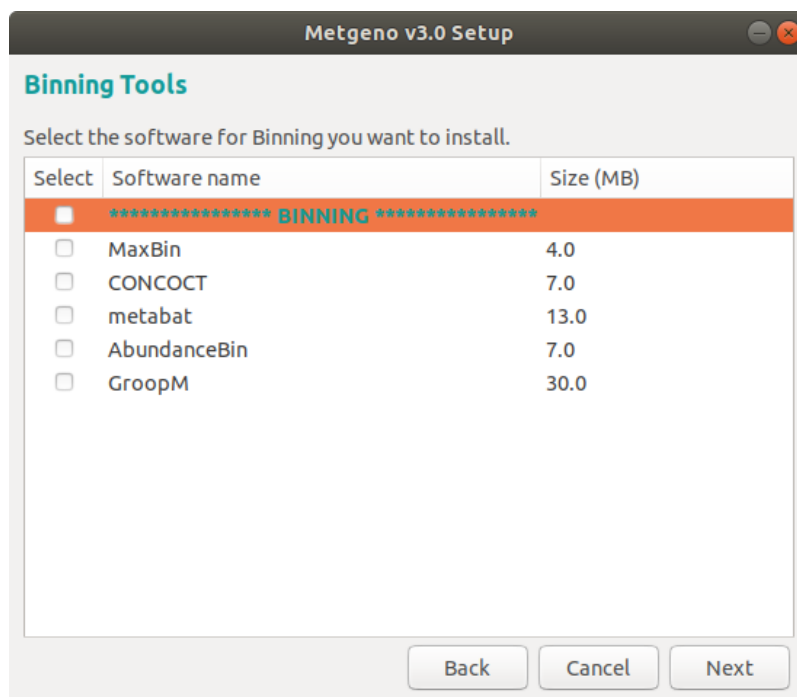
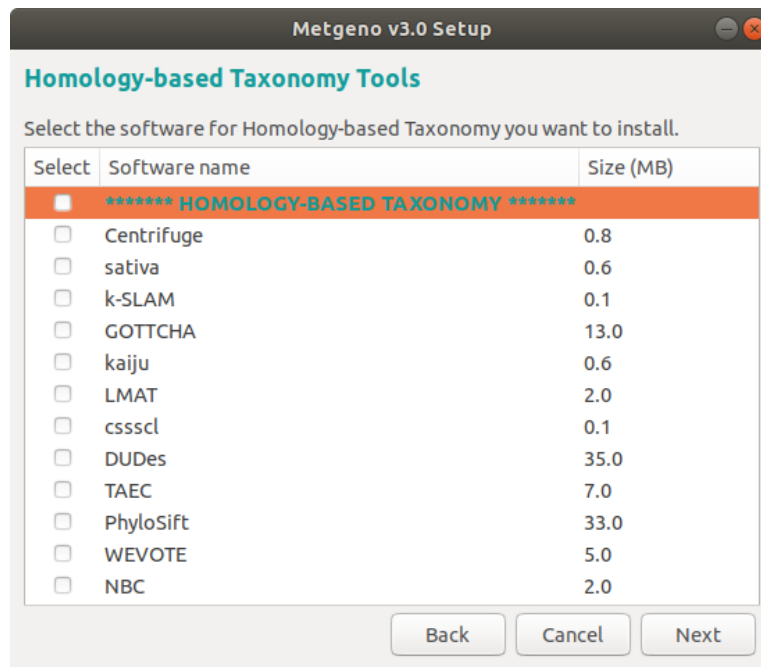


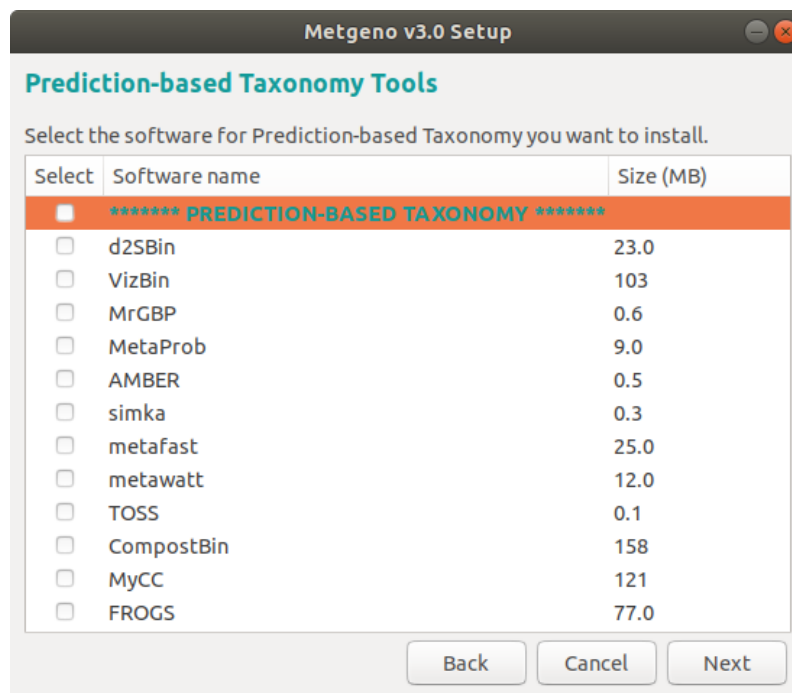
Figure 1.16: Binning Tools Selection Screen

21. Selection screen for Homology-based Taxonomy Tools is displayed. Select the required tools and Click **Next**.



*Figure 1.17: Homology-based Taxonomy Tools Selection Screen*

22. Selection screen for Prediction-based Taxonomy Tools is displayed. Select the required tools and Click **Next**.



*Figure 1.18: Prediction-based Taxonomy Tools Selection Screen*

23. Selection screen for Gene Prediction Tools is displayed. Select the required tools and Click **Next**.

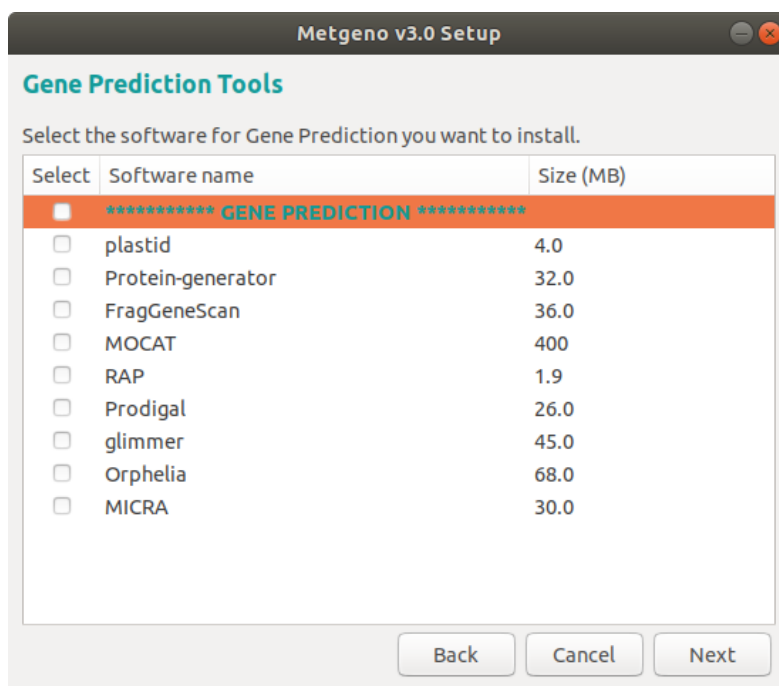


Figure 1.19: Gene Prediction Tools Selection Screen

24. Selection screen for Ribosomal Gene Prediction Tools is displayed. Select the required tools and Click **Next**.

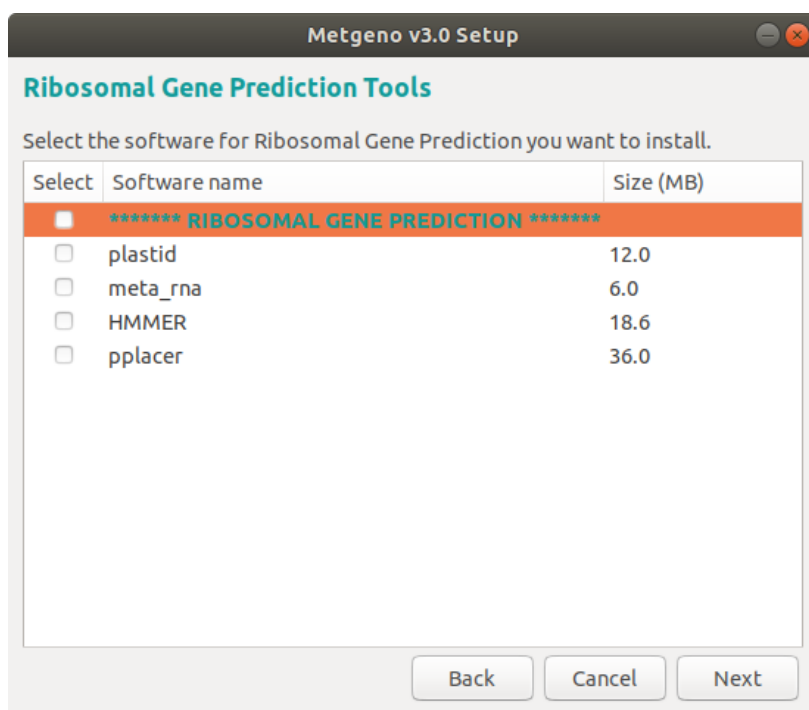


Figure 1.20: Ribosomal Gene Prediction Tools Selection Screen



25. Selection screen for Metabolic Profiling Tools is displayed. Select the required tools and Click **Next**.

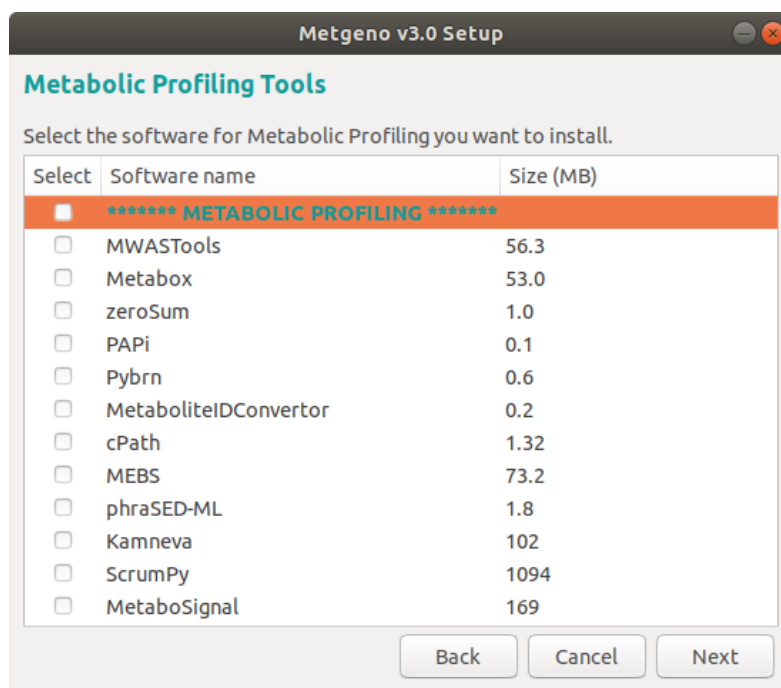


Figure 1.21: Metabolic Profiling Tools Selection Screen

26. Selection screen for Functional Annotation Tools is displayed. Select the required tools and Click **Next**.

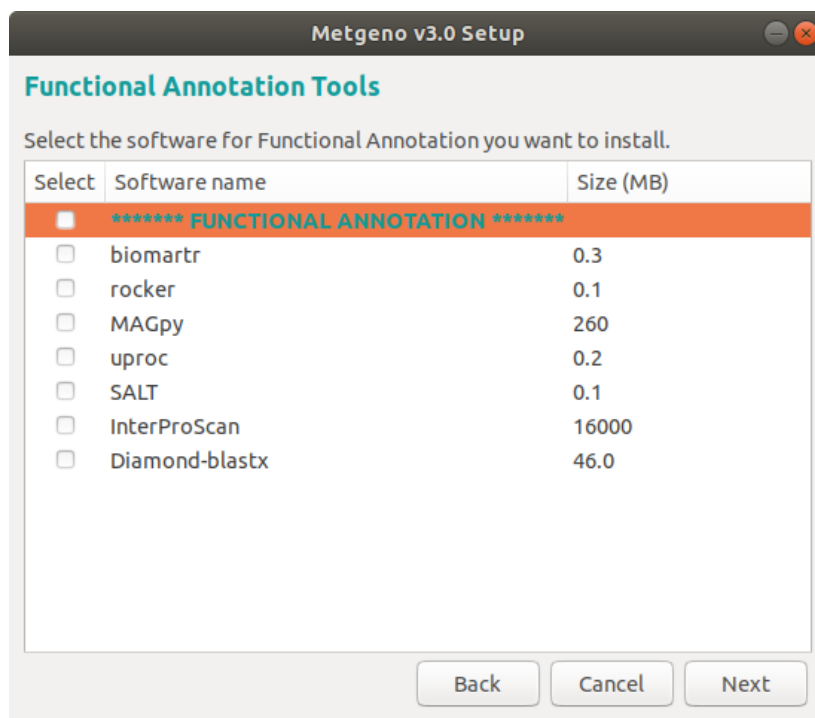


Figure 1.22: Functional Annotation Tools Selection Screen

27. Selection screen for Data Visualization Tools is displayed. Select the required tools and Click **Next**.

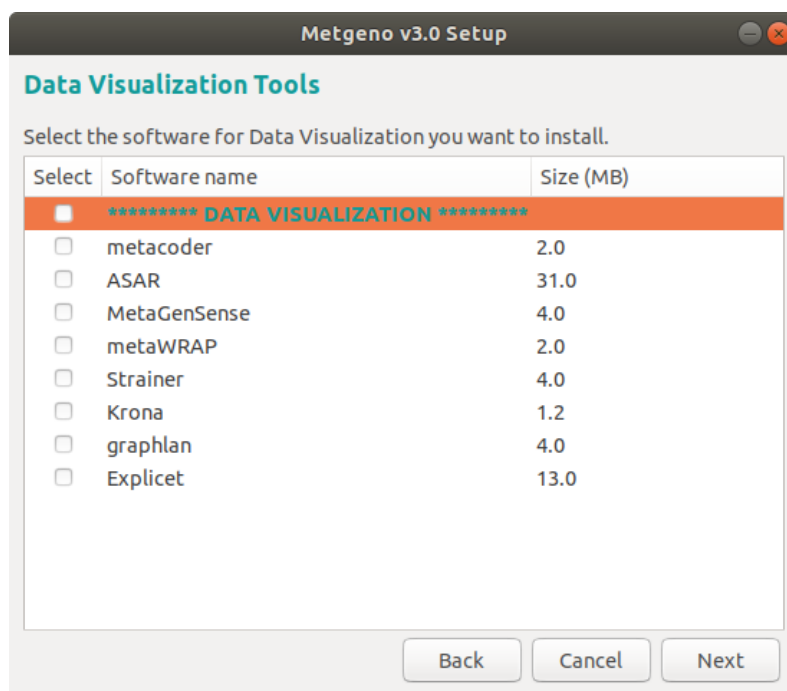


Figure 1.23: Data Visualization Tools Selection Screen

28. Click **Next** to proceed with the installation.

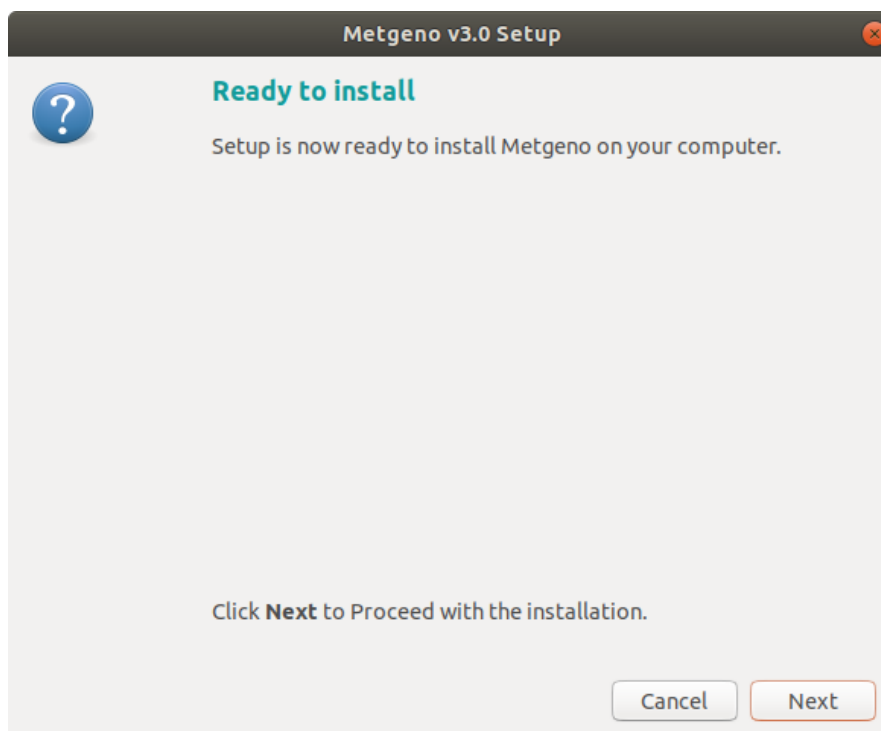
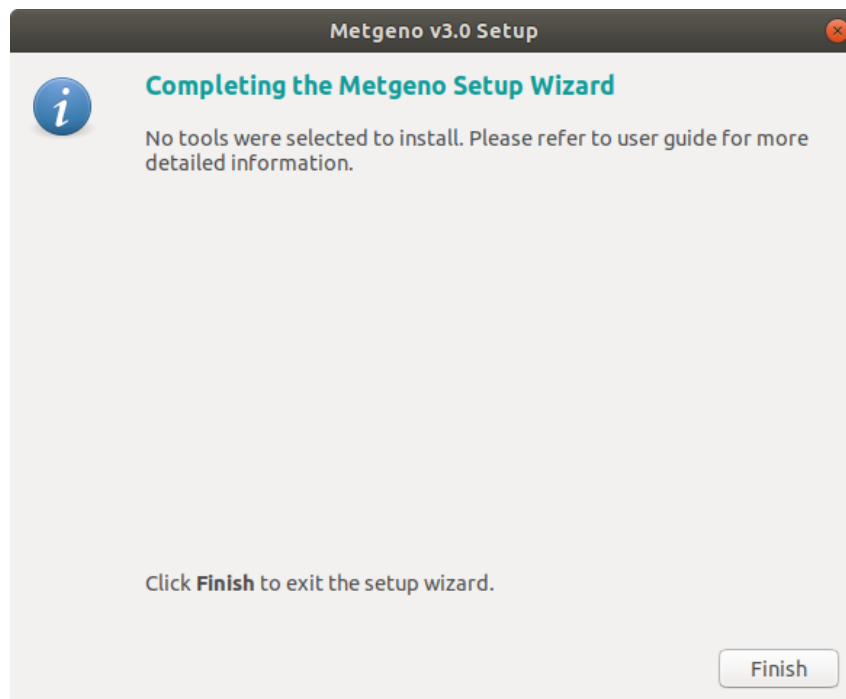


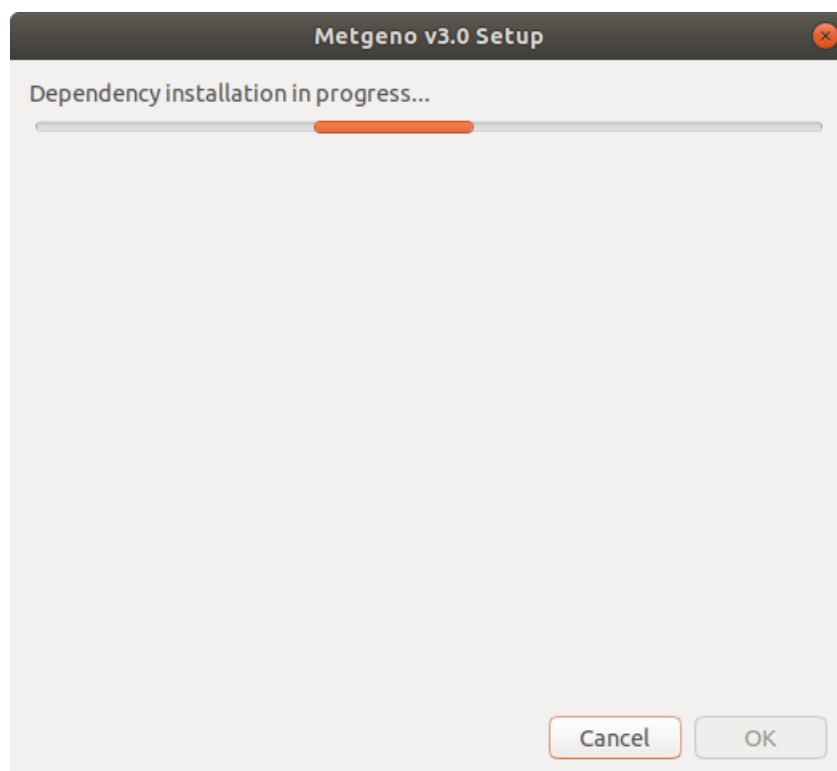
Figure 1.24: Ready to Install Screen

**29.** If no software tool is selected the installation will Finish.



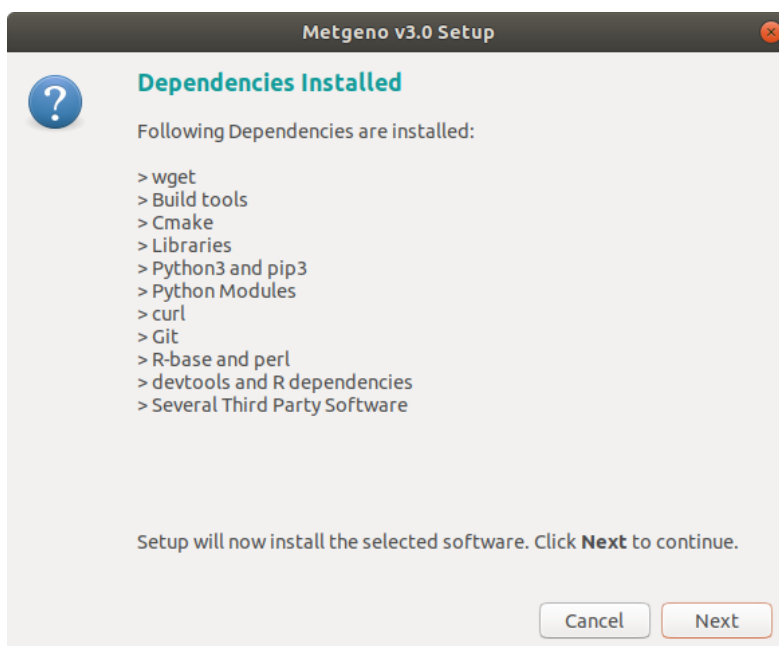
*Figure 1.25: No Tools Selected Warning*

**30.** Dependencies related to software will start installing.



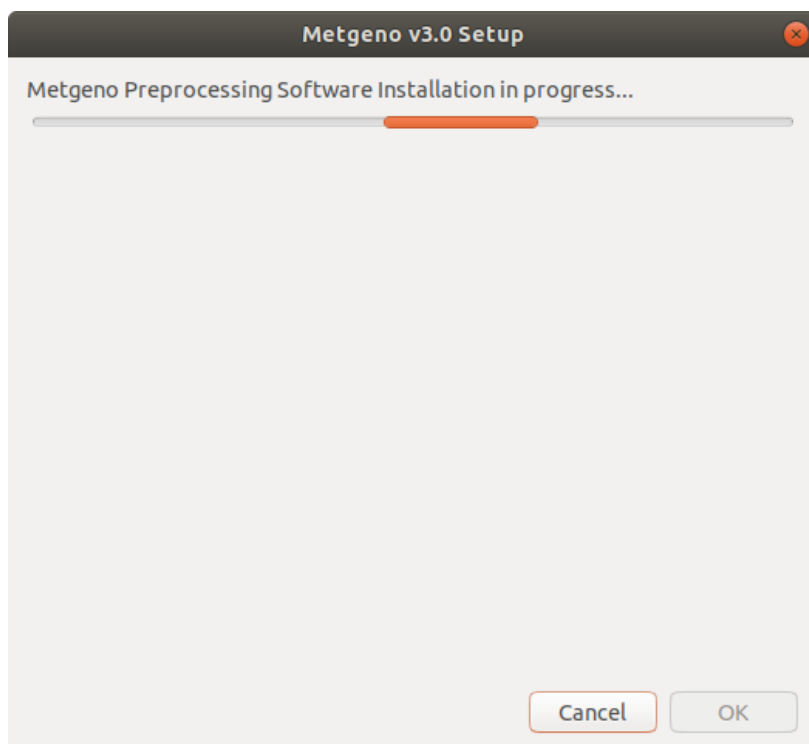
*Figure 1.26: Dependencies Installation Screen*

31. All the dependencies which are installed are displayed at the end of the installation. Click **OK**.



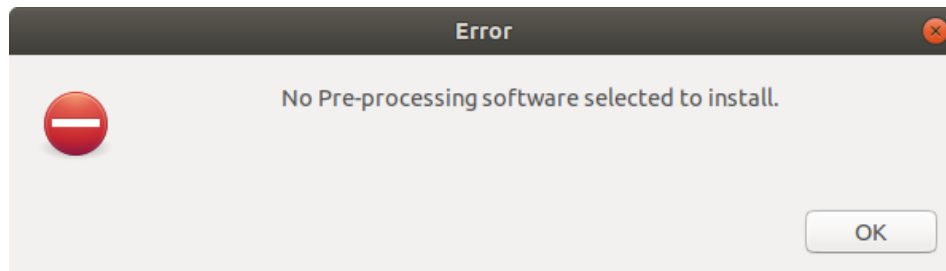
*Figure 1.27: Dependencies Installation Finished Screen*

32. Tool installation will continue. Some tools install as standalone installation will be called automatically.



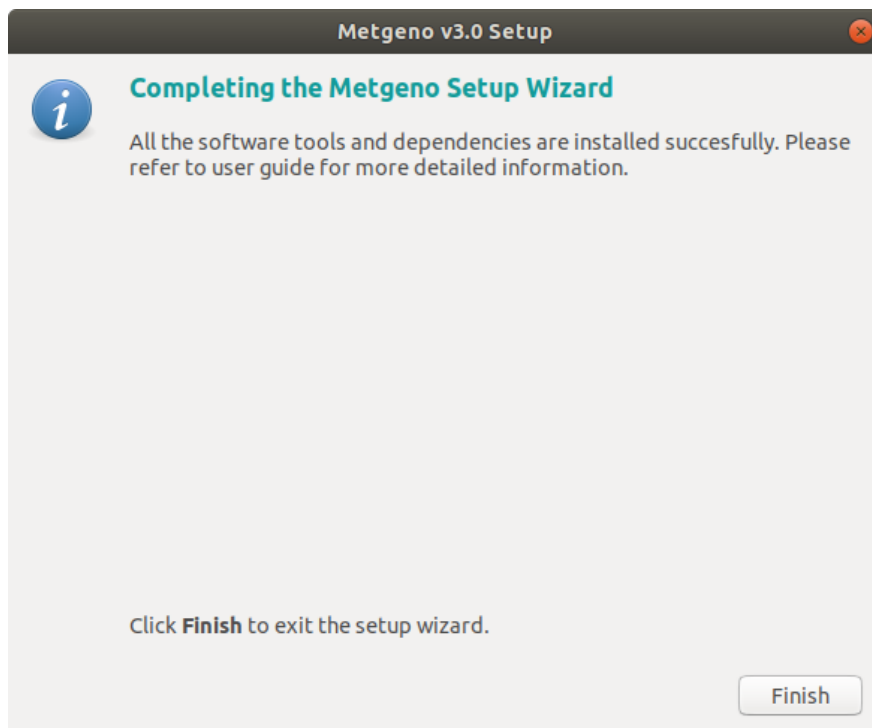
*Figure 1.28: Downloading Screen*

33. Metgeno will notify you if no software is selected from a category.



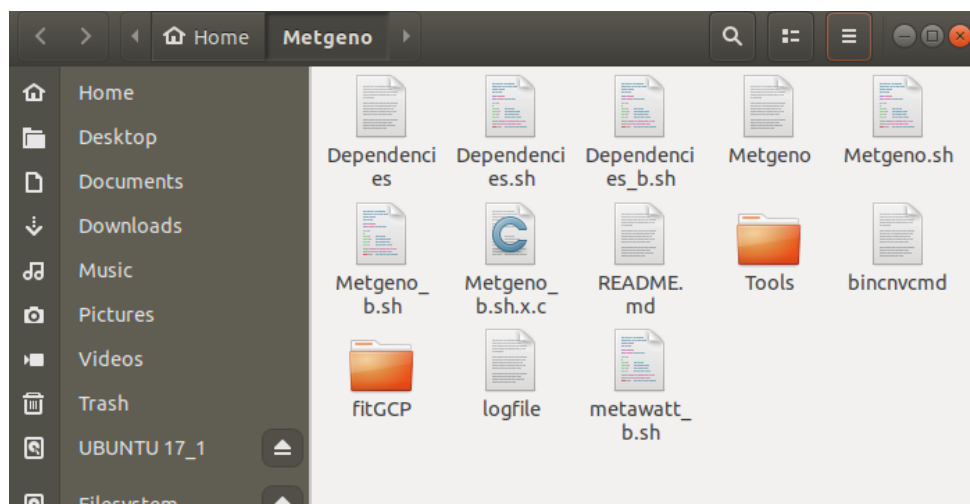
*Figure 1.29: Warning Screen*

34. Installation of Metgeno is now finished. Click **Finish** to use the tools.



*Figure 1.30: Finishing Installation Screen*

35. At the end software will show the successfully installed tools and following window will appear:



*Figure 1.31: Installed Tools showing Screen*

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**Note:** See the README file of every software to know *How to use it?*

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## Chapter-2: Microsoft Windows Support

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If you don't want to dual boot Linux/Ubuntu with windows you can use Linux in a virtual machine which gives you the option to try Linux within Windows without making any changes in your Windows system.

**VirtualBox** is a free and open source virtualization software from Oracle. It enables you to install other operating systems in virtual machines. It is advised that your systems should have at least 4GB RAM to get a decent performance from the virtual operating system.

### Requirements:

- ✚ Good internet connection to download software and Linux ISO. You can also use some other computer with internet connection to download these files
- ✚ Windows system with at least 12 GB of free space
- ✚ Windows system with 4GB of recommended RAM. It can work with less RAM as well, but your system will start to lag while using Linux in the virtual machine

### Download:

- ✚ Go to the website of Oracle VirtualBox and get the latest stable version
- ✚ Next, you need to download the ISO file of the Linux distribution. You can get this image from the official website of the Linux distribution you are trying to use

### Installation:

1. To installing VirtualBox just click on the downloaded file, it is like installing the regular software on Windows.
2. **Start** VirtualBox and click on the **New** symbol.

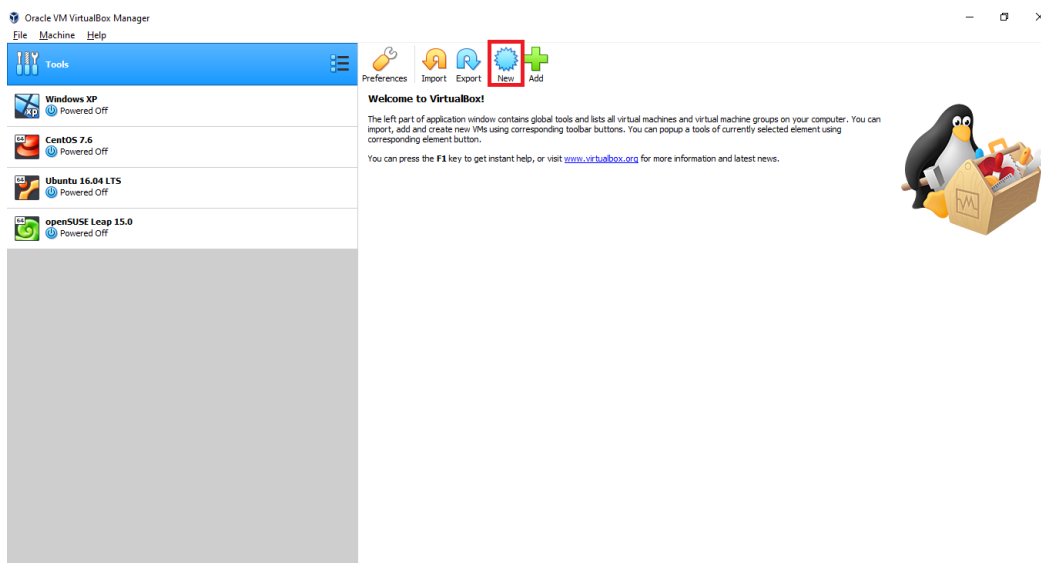


Figure 2.1: New Virtual OS

3. Give the virtual OS a relevant **Name**. Select the **Type** (Linux) and **Version** (Ubuntu 64-bit) and Click **Next**.

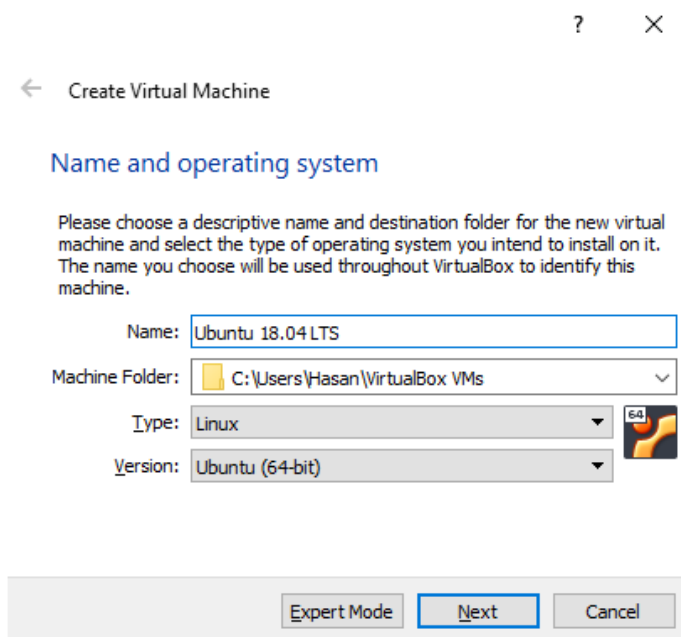


Figure 2.2: Assigning Name

4. Allocate RAM to the virtual OS. Following system has 8GB of RAM so 4GB of RAM is allocated. You can use more RAM if your system has enough extra RAM.

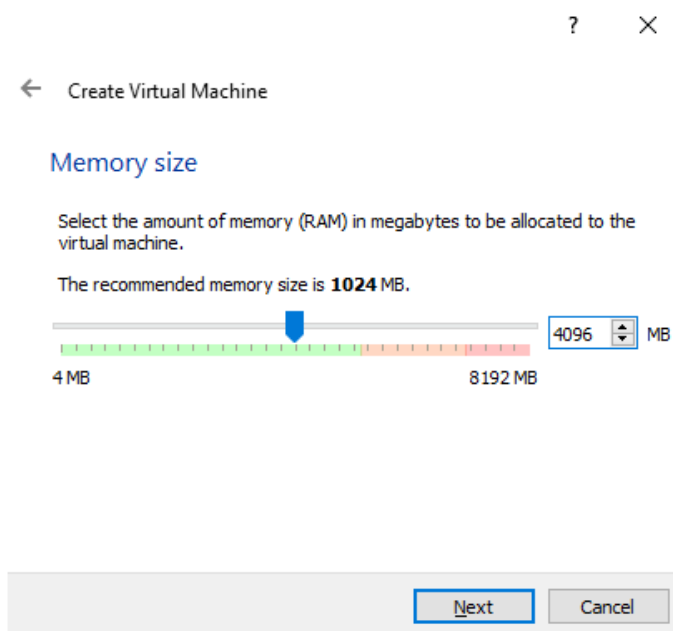
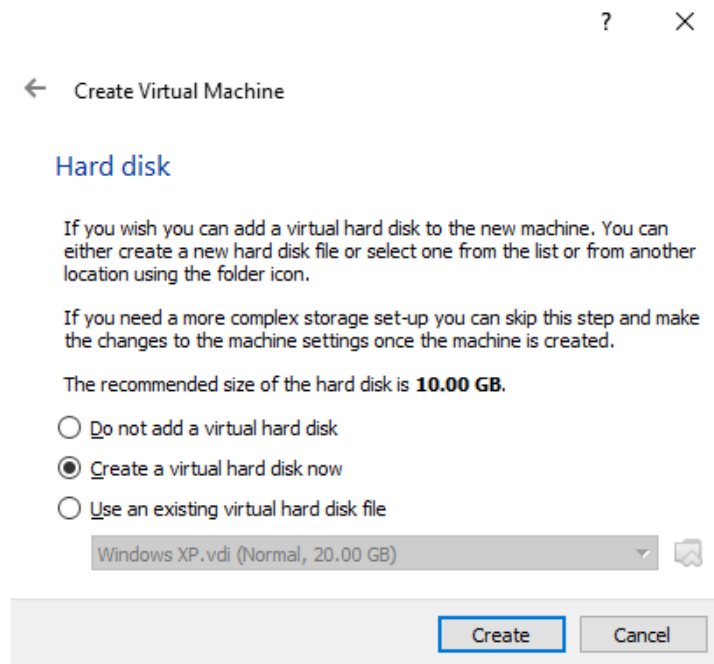


Figure 2.3: Setting Memory Size

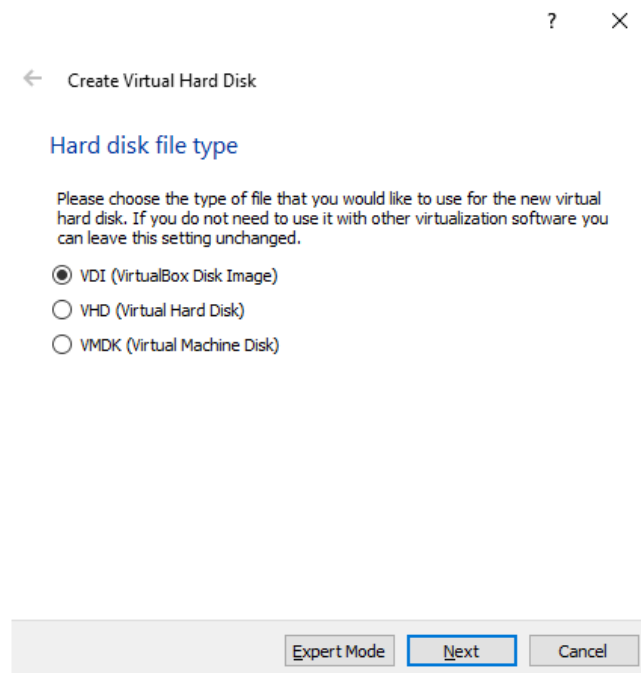


5. **Create** a virtual disk. This works as the hard disk of the virtual Linux system. This is where the virtual system will store its files. Click **Create**.



*Figure 2.4: Creating a Virtual Hard disk*

6. Select **VDI file type** here (recommended). Click **Next**.



*Figure 2.5: Hard disk file type*

7. You can choose either of Dynamically allocated or Fixed size option for creating the virtual hard disk. Choose ***Dynamically allocated*** (recommended). Click **Next**.

**Note:** Dynamic allocation is allocated as time passes and data is increased whereas fixed is allocated instantly.

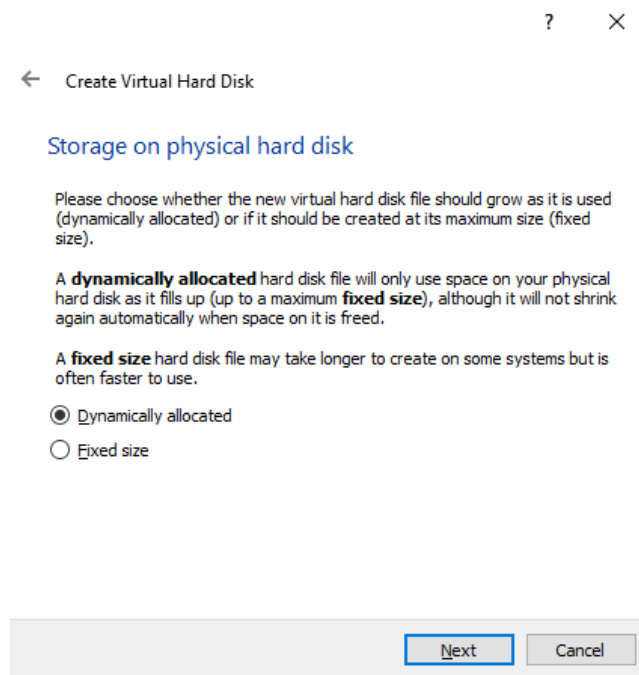


Figure 2.6: Storage type

8. Select the ***Hard Disk size*** (recommended size: 100 GB). Click **Create**.

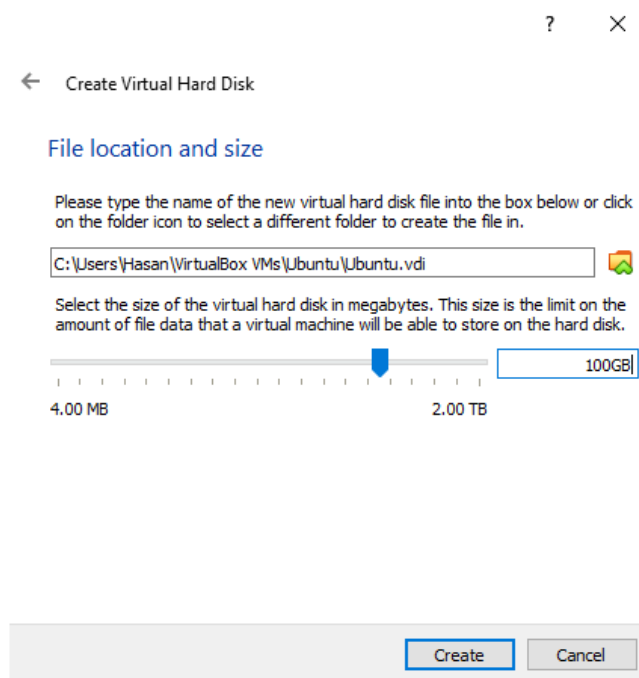


Figure 2.7: File location and Size of Virtual Hard disk

9. Now, Select **Settings** to assign the image file of respective OS to VB.

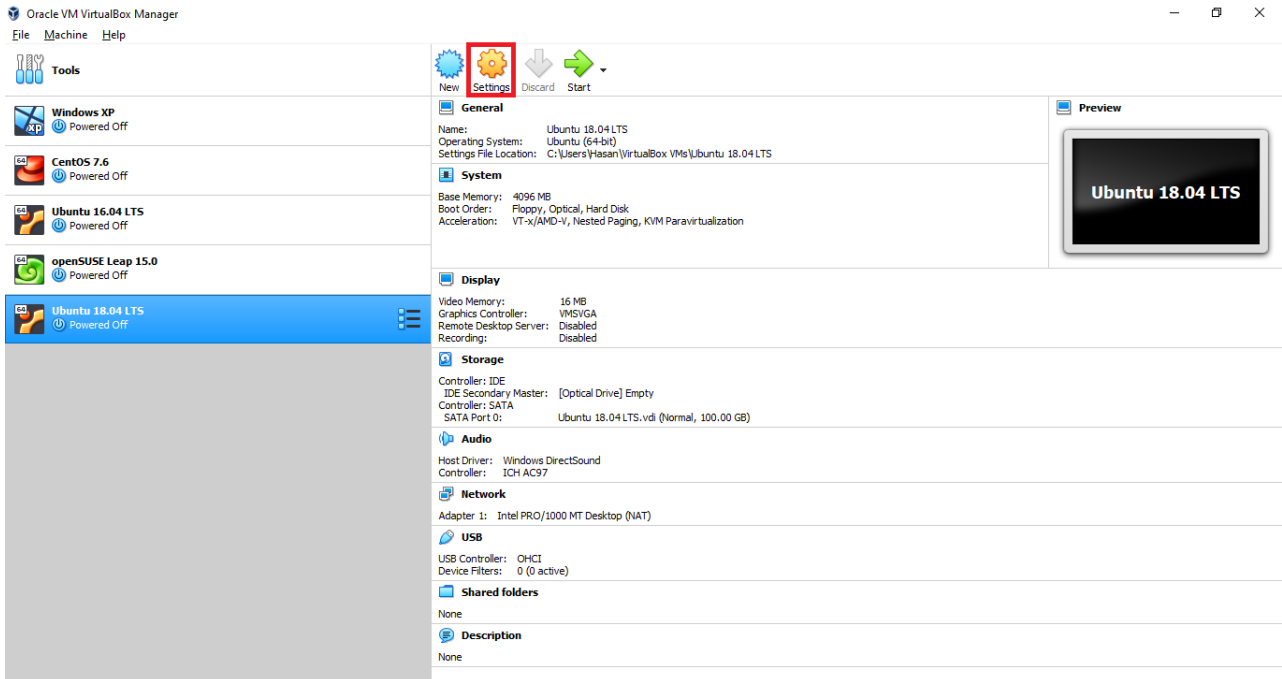


Figure 2.8: Select Settings

10. Select **General** → **Advanced**. Now, select the **Shared Clipboard** and **Drag'n'Drop** option to **Bidirectional**.

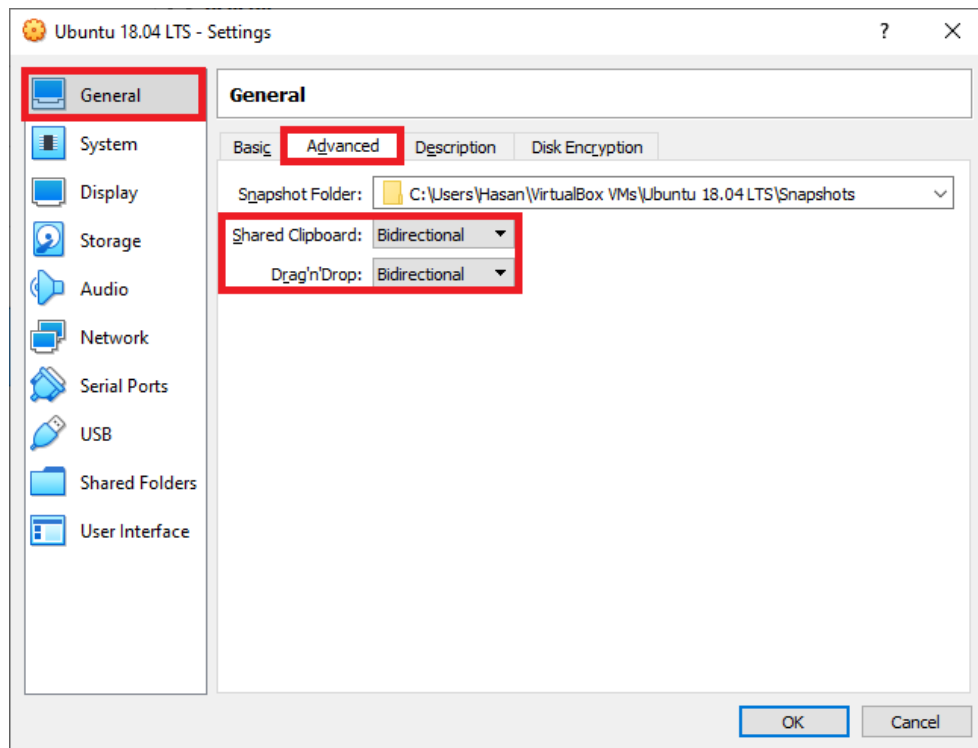


Figure 2.9: Advanced Settings

11. Select **Settings** to assign the image file of respective OS to VB. Select **Storage** → **Controller: IDE** → **Empty**. Now, in the **Attributes** tab, click on **New Disk** and provide the path of downloaded image file of Ubuntu OS. Click **OK**.

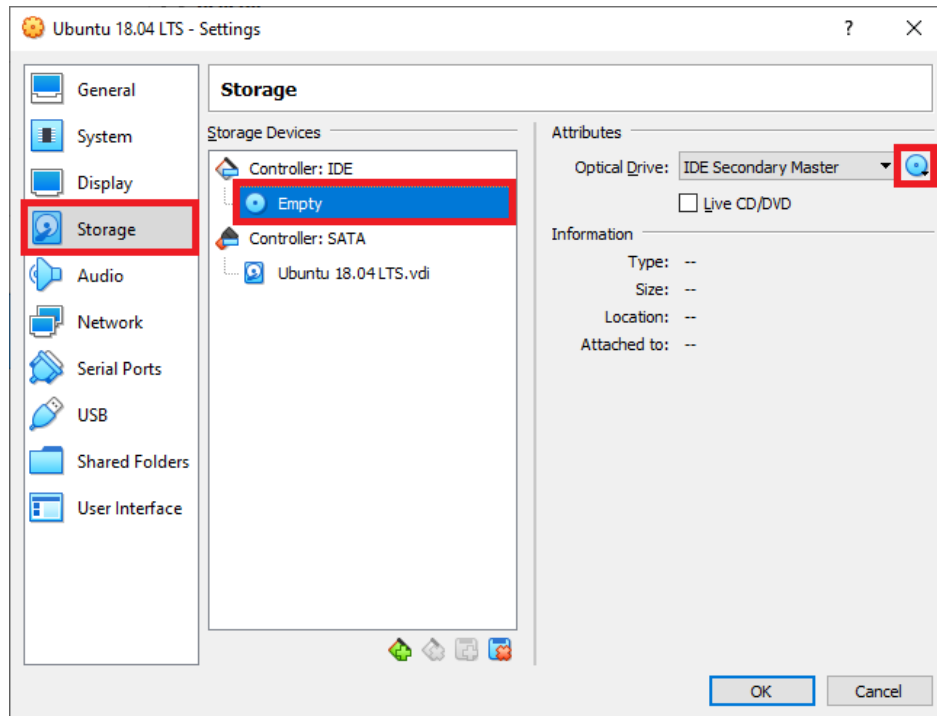


Figure 2.10: Providing Image file

12. Once everything is in place, it's time to boot that ISO and install Linux as a virtual operating system. Click **Start**.

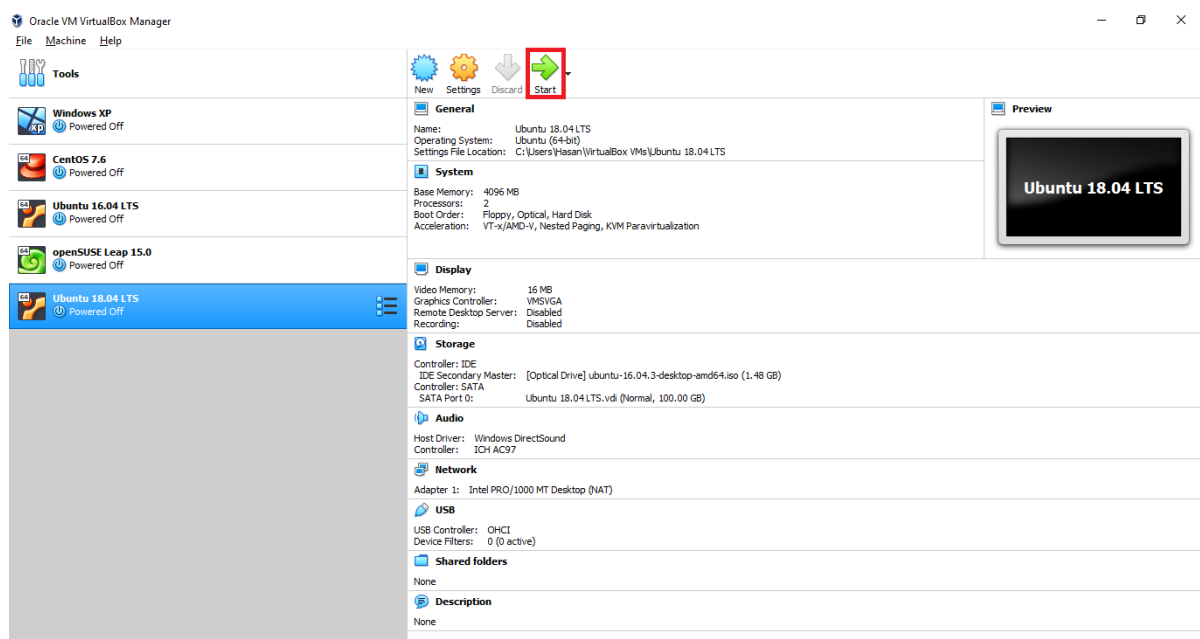
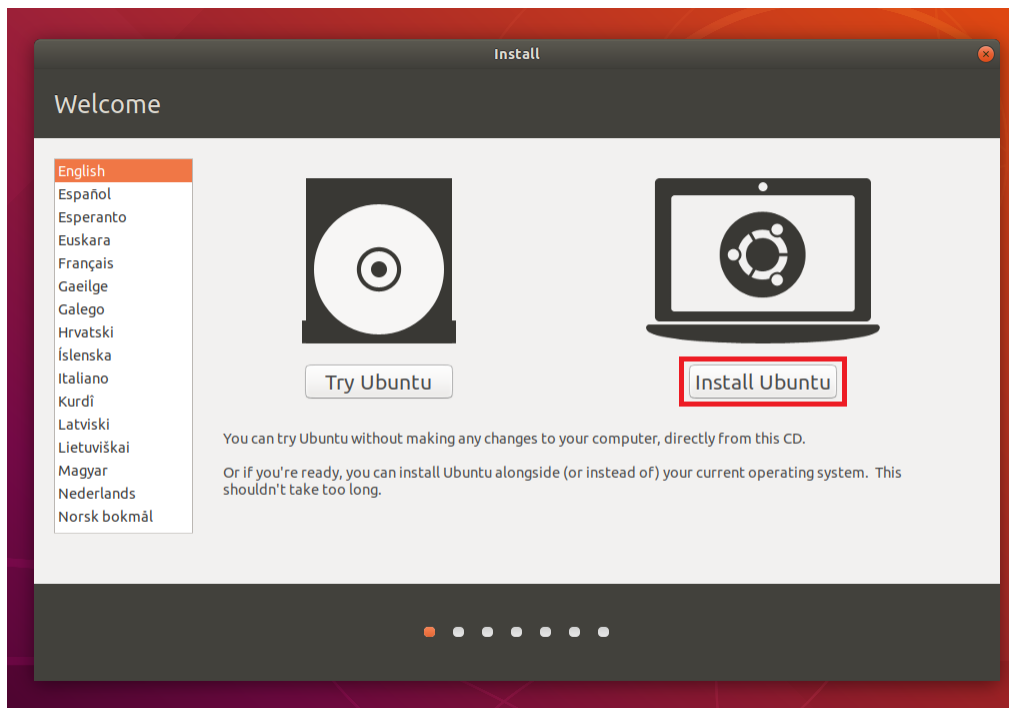


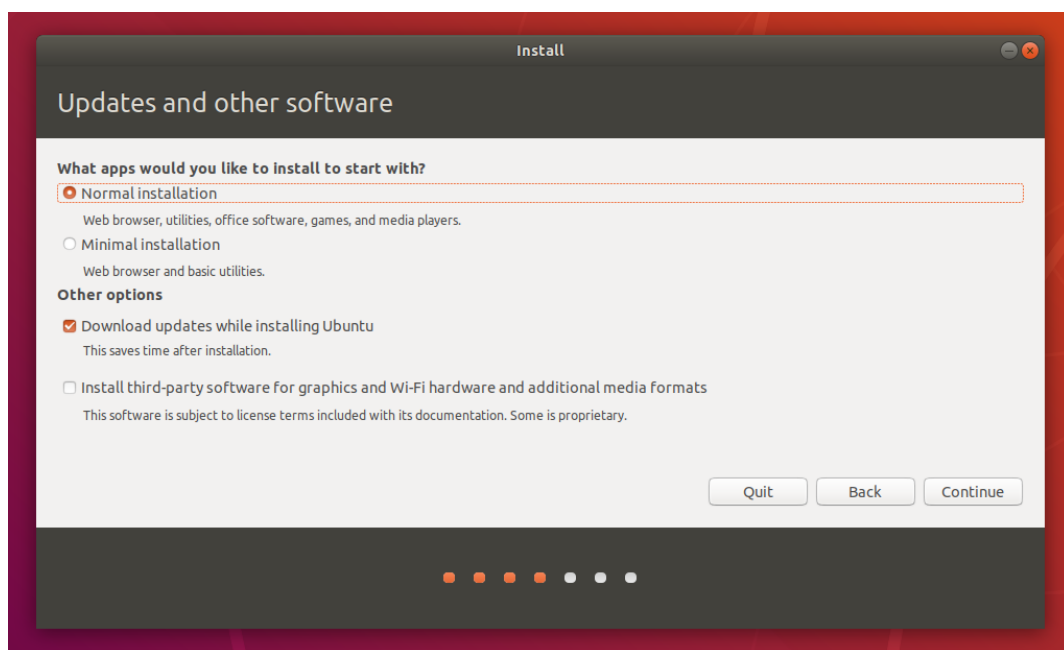
Figure 2.11: Starting Virtual OS

13. Virtual OS will boot into Linux Installation process. You should be presented with the option to install it. Click **Install Ubuntu**.



*Figure 2.12: Installing Ubuntu*

14. Continue with *Normal Installation*.



*Figure 2.13: Update Screen*

15. Select *Erase disk and install Ubuntu*. Don't worry. It won't delete anything on your Windows operating system. You are using the virtual disk space of 100GB that we created in previous steps. It won't impact the real operating system.

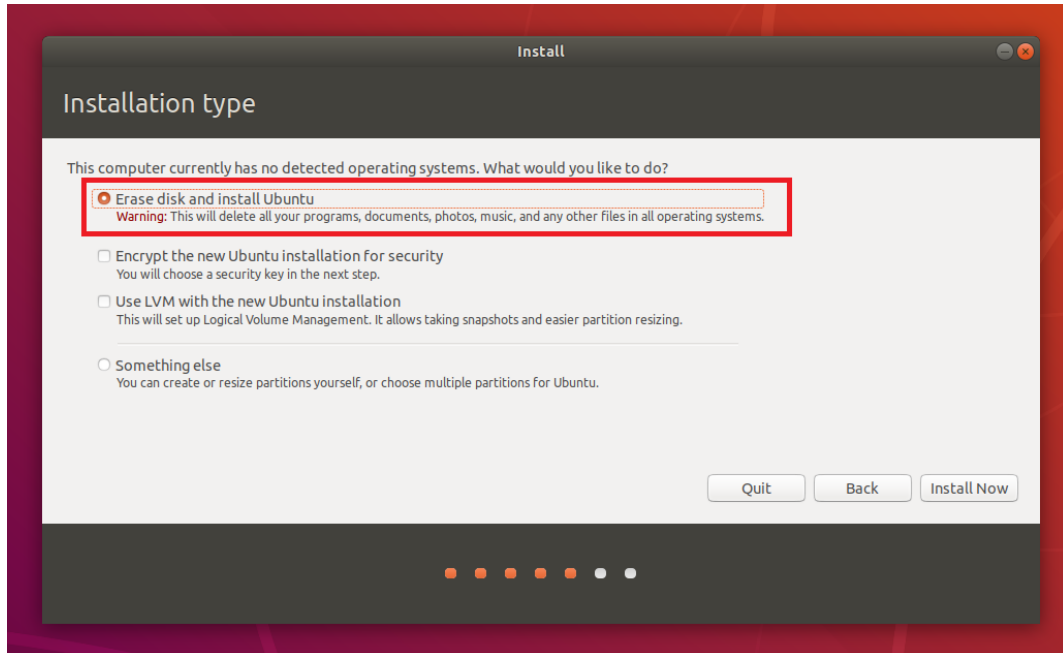


Figure 2.14: Installation type Screen

16. After that click on **Continue**.

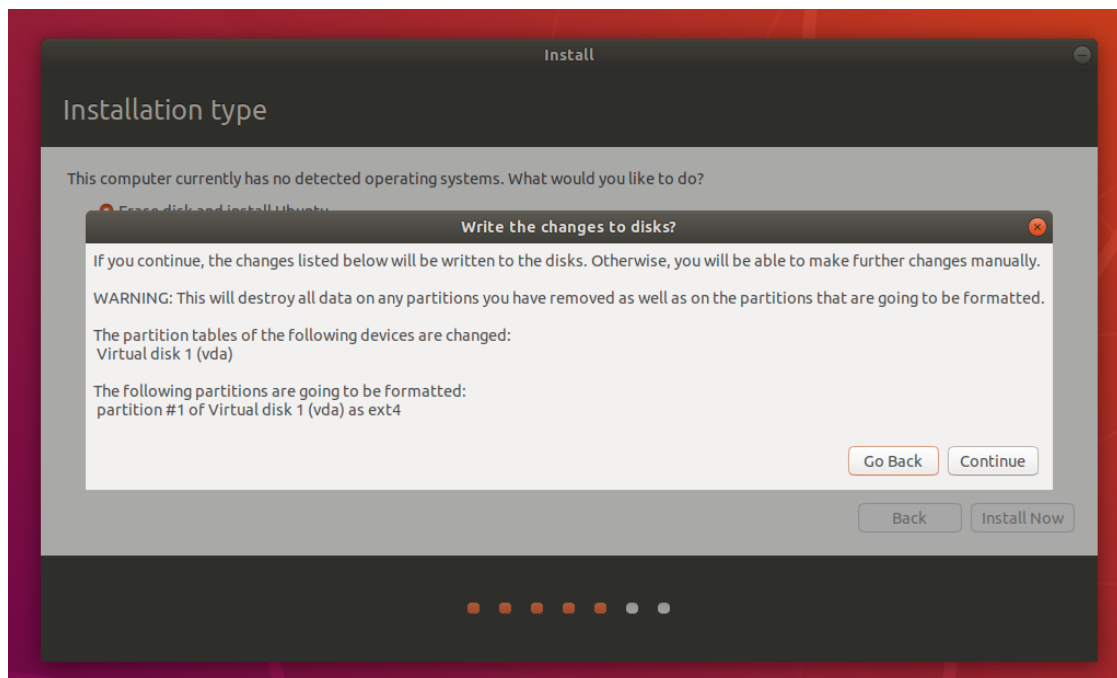
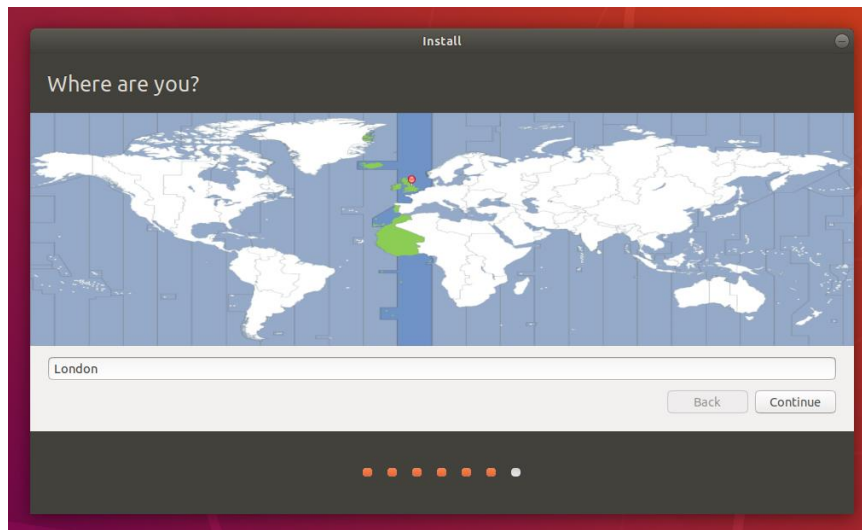
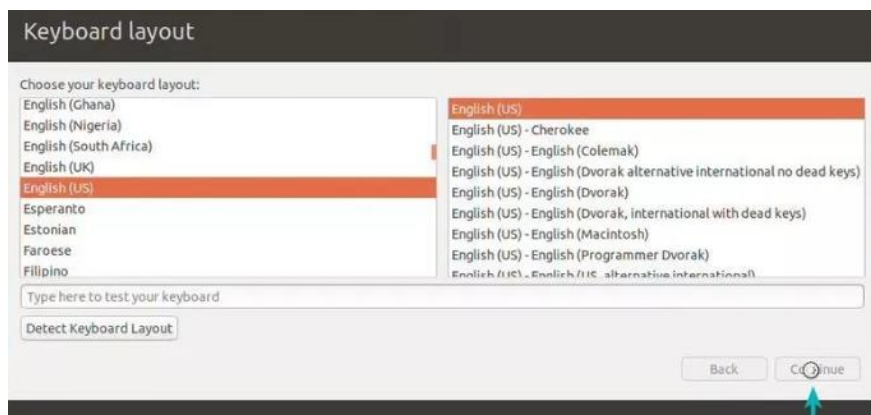
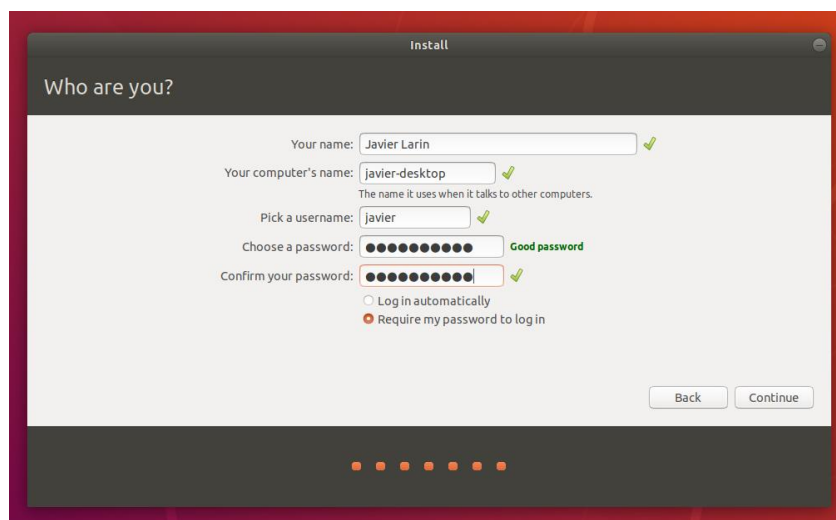
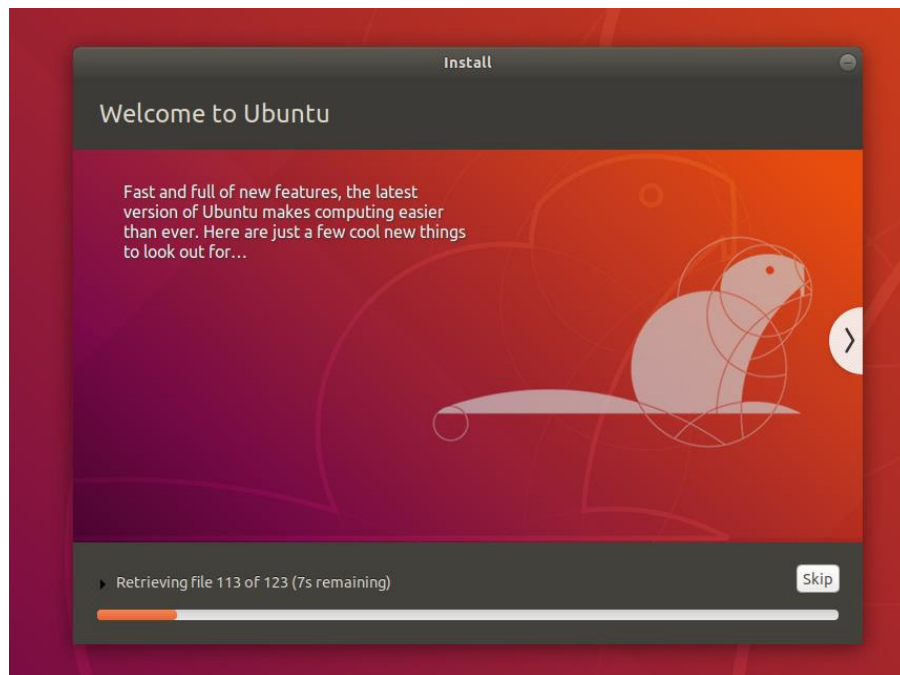


Figure 2.15: Confirmation Screen

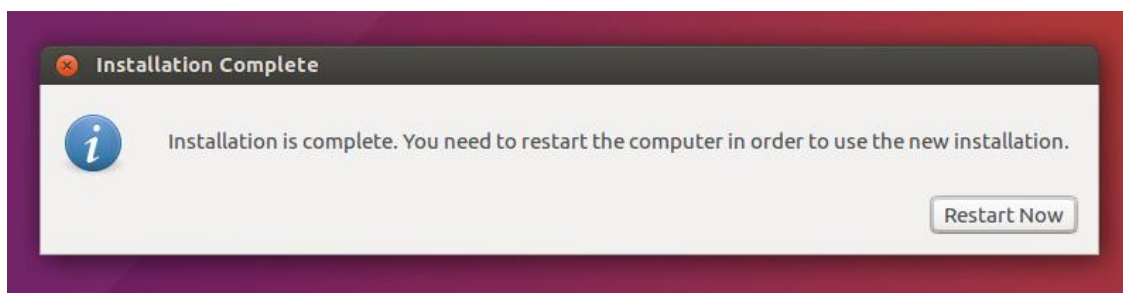
**17. Select your *Current Location* and *Continue*.***Figure 2.16: Location selection screen***18. Select *keyboard layout* and *Continue*.***Figure 2.17: Selecting Keyboard Layout***19. Fill your Info and click *Continue*.***Figure 2.18: Filling Name and Password*

20. You are almost done. It should take 10-15 minutes to complete the installation.



*Figure 2.19: Installing Ubuntu*

21. Installation is Complete. Click **Restart Now**.



*Figure 2.20: Installation Completion Screen*

22. After that you'll be able to install the software package by following the steps discussed in chapter 1.



## ***Chapter-3: macOS Support***

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You can use Metgeno using Linux in a virtual machine which gives you the option to try Linux within the OS without making any changes in your macOS.

**VirtualBox** is a free and open source virtualization software from Oracle. It enables you to install other operating systems in virtual machines. It is advised that your systems should have at least 2GB RAM to get a decent performance from the virtual operating system.

### **Requirements:**

- ✚ Good internet connection to download software and Linux ISO. You can also use some other computer with internet connection to download these files
- ✚ macOS with at least 10 GB of free space
- ✚ macOS with minimum 2GB of RAM

### **Download:**

- ✚ Go to the website of Oracle VirtualBox and get the latest stable version or you can download it from the following link:

<https://download.virtualbox.org/virtualbox/6.1.10/VirtualBox-6.1.10-138449-OSX.dmg>

- ✚ Next, you need to download the ISO file of the Linux distribution. You can get this image from the official website of the Linux distribution you are trying to use or you can download it from the following link:

<http://releases.ubuntu.com/18.04.3/ubuntu-18.04.3-desktop-amd64.iso>

### **Installation:**

1. To installing VirtualBox in macOS host just click on the downloaded dmg file.
2. Start VirtualBox and click on the **New** symbol.



Figure 3.1: New Virtual OS

3. Give the virtual OS a relevant **Name**. Select the **Type** (Linux) and **Version** (Ubuntu 64-bit). Allocate RAM to the virtual OS. Following system has 16GB of RAM so 2GB of RAM is allocated. You can use more RAM if your system has enough extra RAM. Create a virtual disk. This works as the hard disk of the virtual Linux system. This is where the virtual system will store its files. Click **Create**.

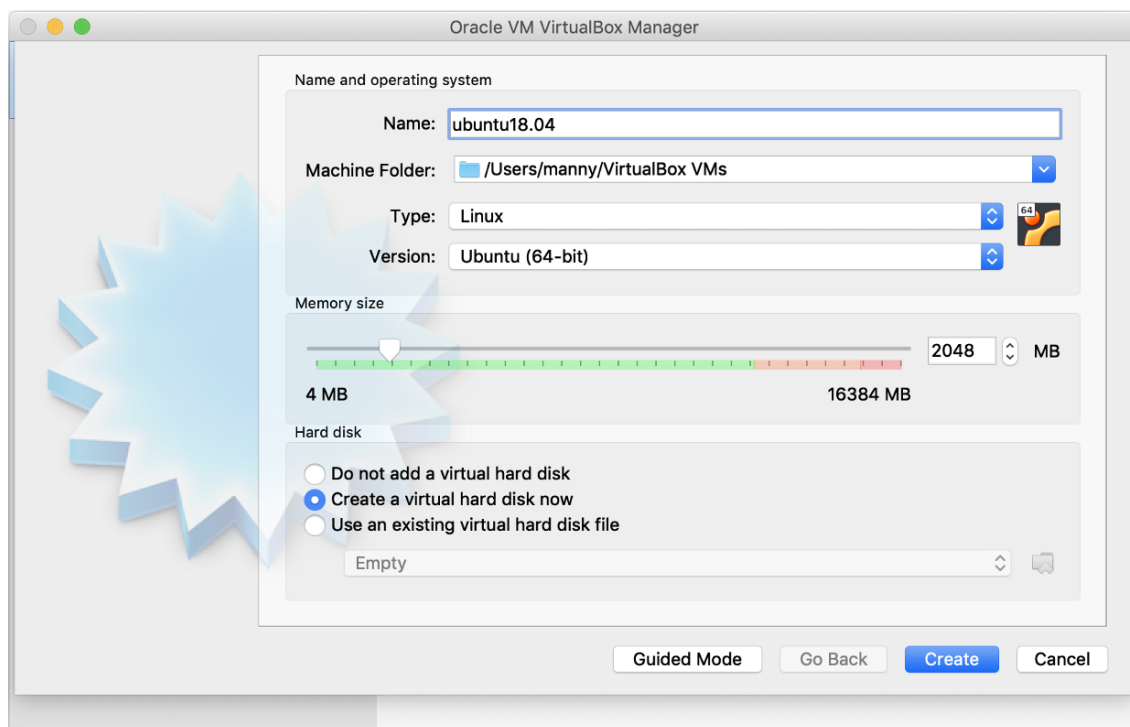


Figure 3.2: Assigning Information

4. Create Select **VDI file type** here (recommended) and Select the **Hard Disk size** (recommended size: 100 GB). You can choose either of Dynamically allocated or Fixed size option for creating the virtual hard disk. Choose **Dynamically allocated** (recommended). Click **Create**.

**Note:** Dynamic allocation is allocated as time passes and data is increased whereas fixed is allocated instantly.

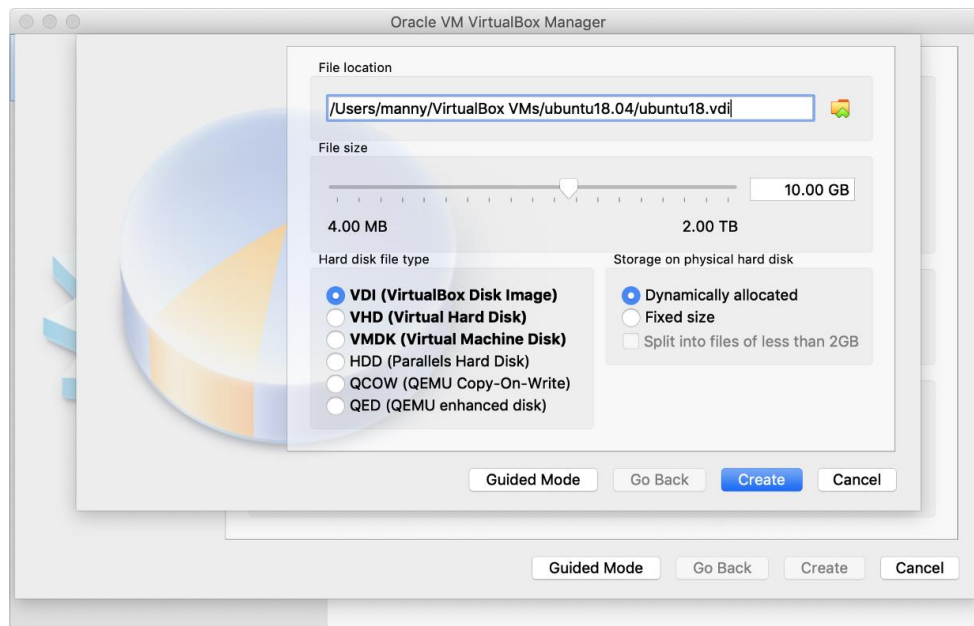


Figure 3.3: Hard disk file type

5. Once your machine settings are setup, you should see the following:

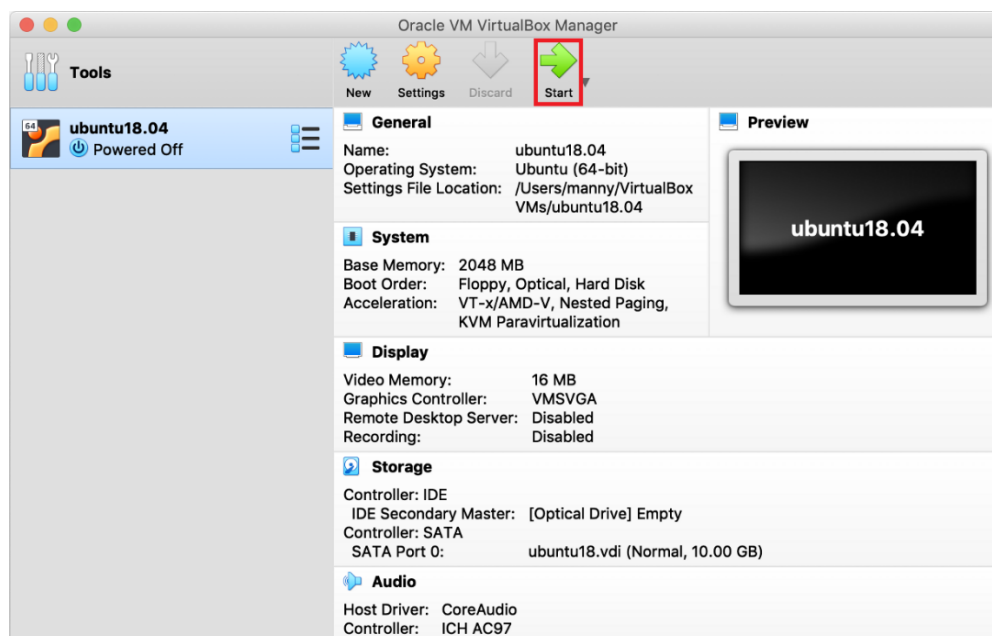
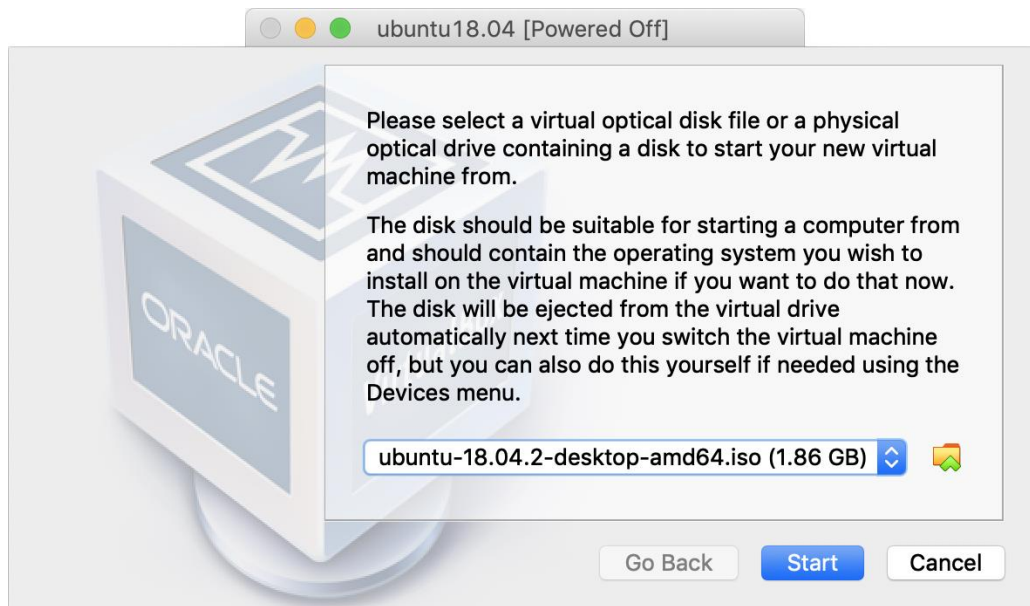


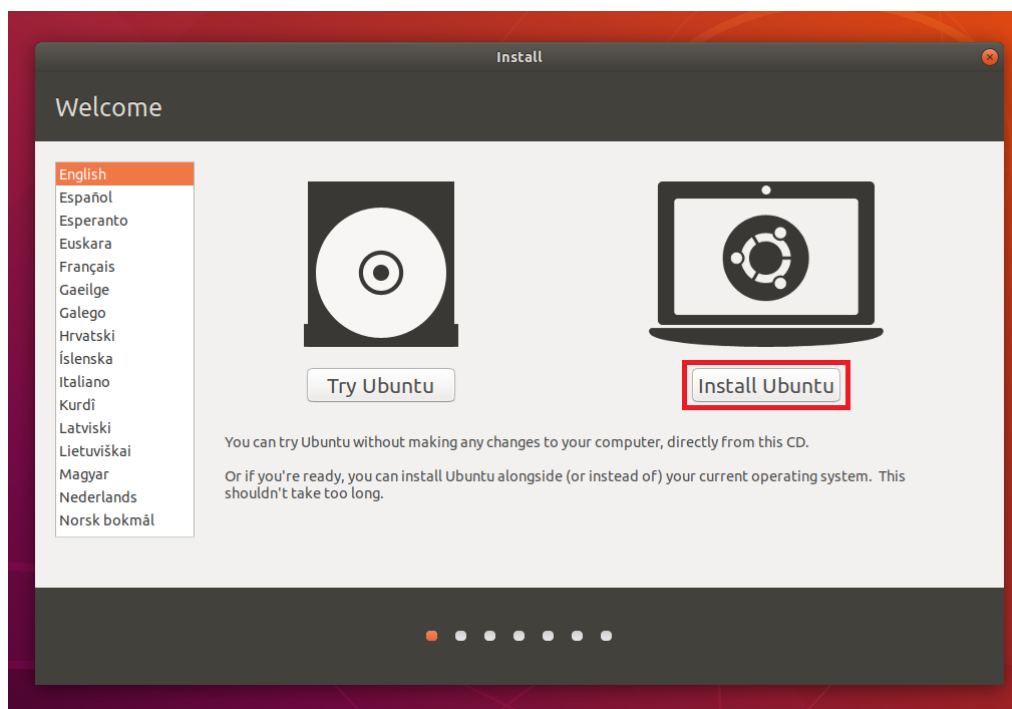
Figure 3.4: Splash Screen

6. To assign the image file of respective OS to VB. Select the machine and just click the Green Start Arrow Icon. We'll soon be prompted with the following, where we'll now select our file, and click **Start**.



*Figure 3.5: Assigning Image file*

7. Virtual OS will boot into Linux Installation process. You should be presented with the option to install it. Click **Install Ubuntu**.



*Figure 3.6: Installing Ubuntu*

## 8. Continue with *Normal Installation*.

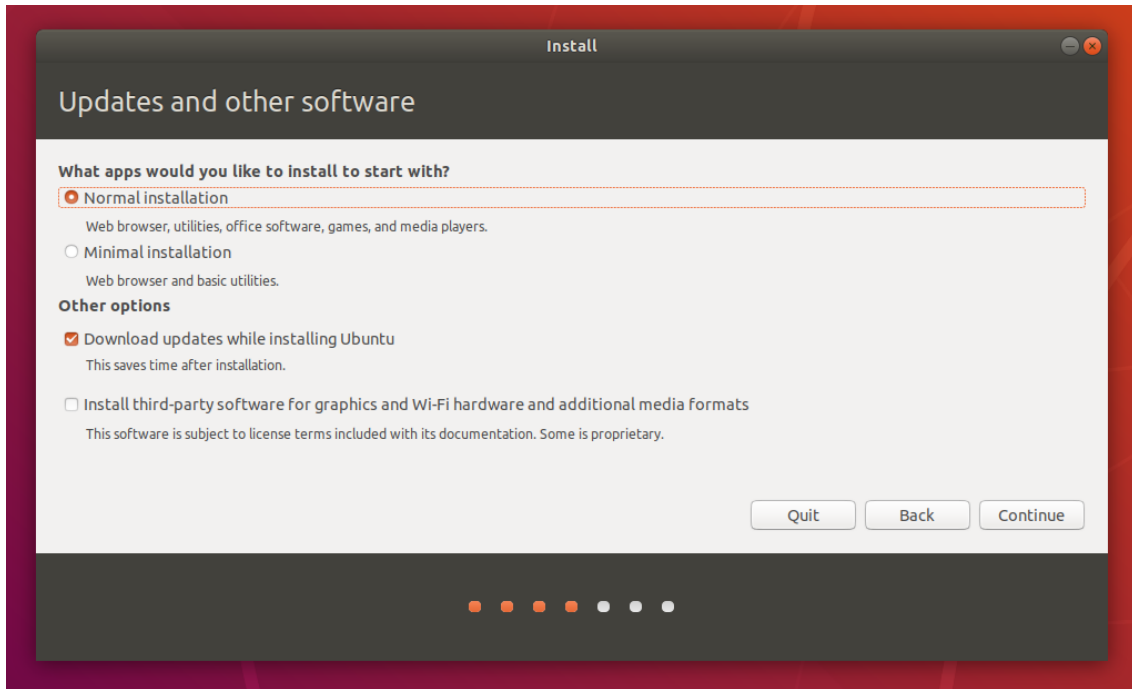


Figure 3.7: Update Screen

9. Select *Erase disk and install Ubuntu*. Don't worry. It won't delete anything on your macOS. You are using the virtual disk space of 10 GB that we created in previous steps. It won't impact the real operating system.

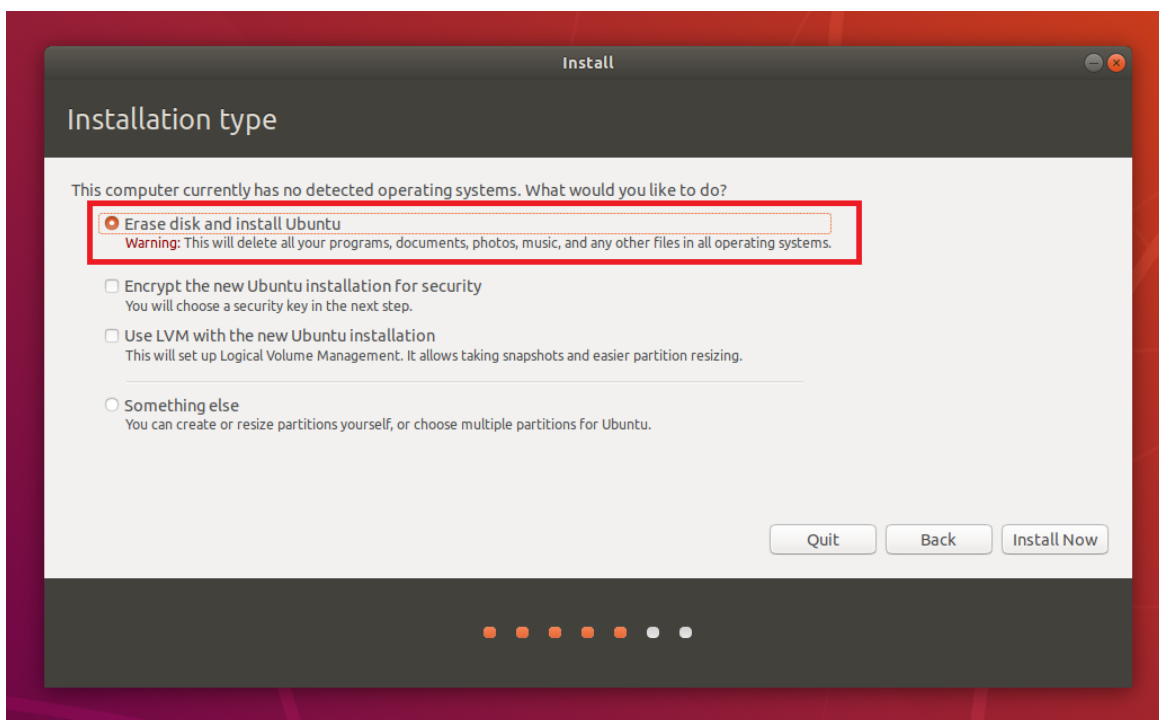


Figure 3.8: Installation type Screen

10. After that click on **Continue**.

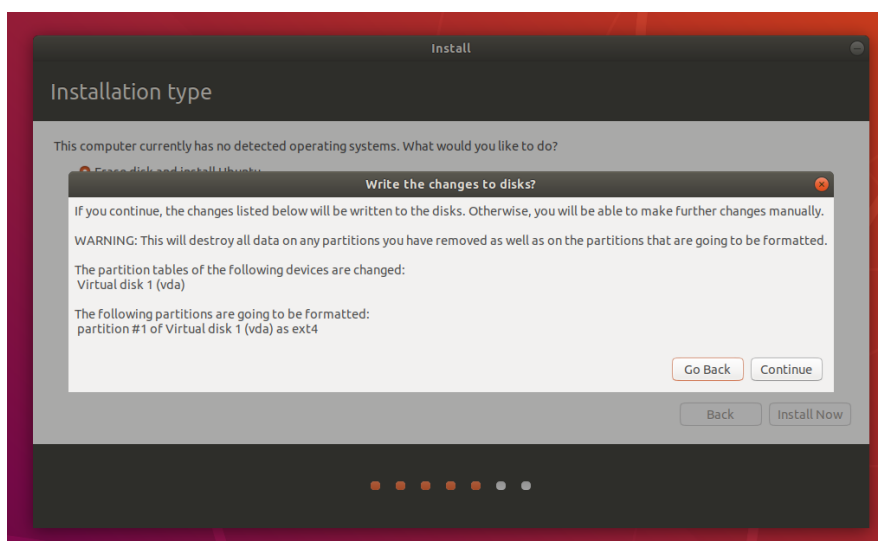


Figure 3.9: Confirmation Screen

11. Select your **Current Location** and **Continue**.

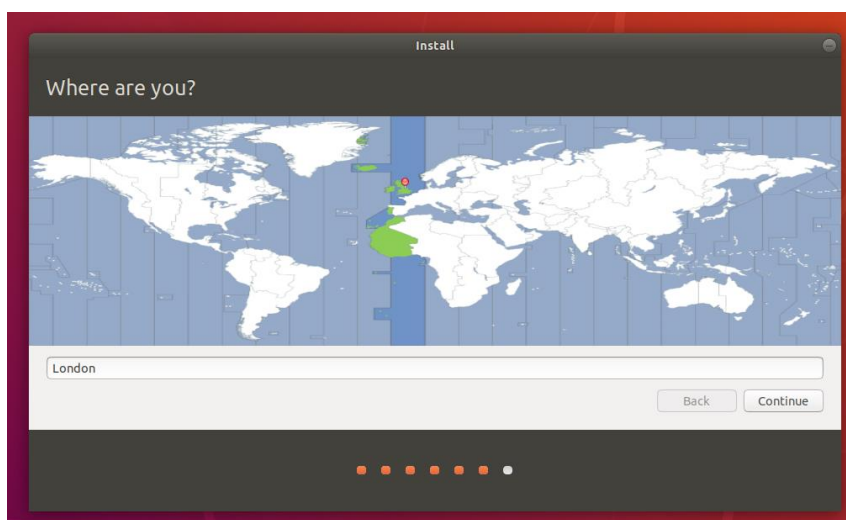


Figure 3.10: Location selection screen

12. Select **keyboard layout** and **Continue**.

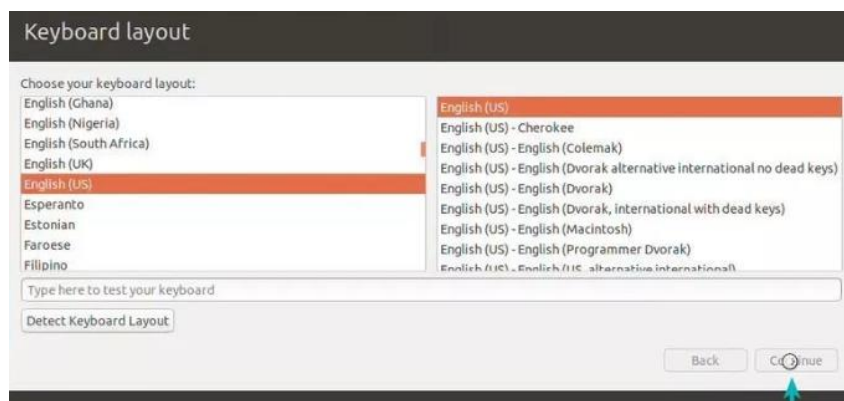
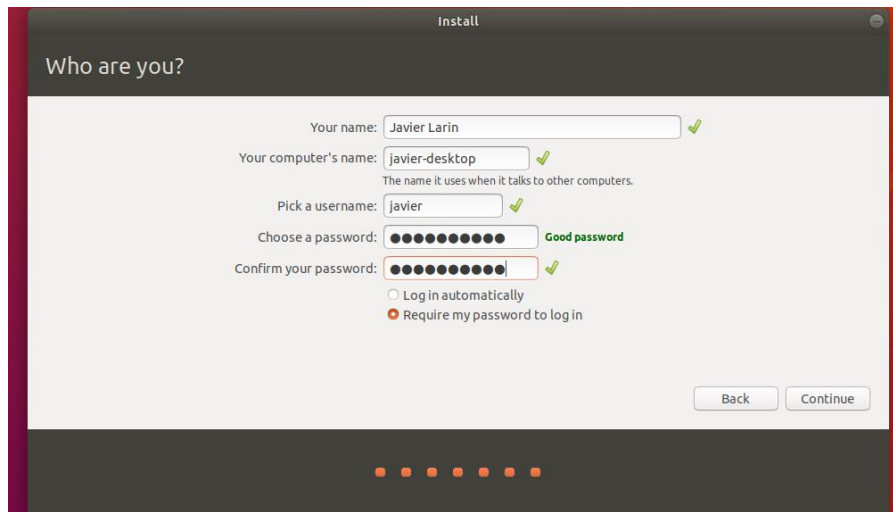


Figure 3.11: Selecting Keyboard Layout

**13.** Fill your Info and click **Continue**.



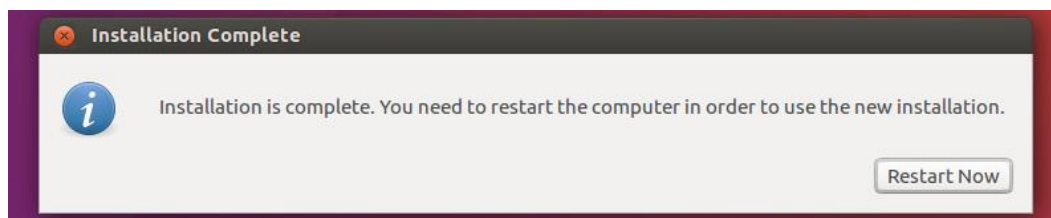
*Figure 3.12: Filling Name and Password*

**14.** You are almost done. It should take 10-15 minutes to complete the installation.



*Figure 3.13: Installing Ubuntu*

**15.** Installation is Complete. Click **Restart Now**.



*Figure 3.14: Installation Completion Screen*

**16.** After that you'll be able to install the software package by following the steps discussed in chapter 1.

## ***Chapter-4: Selection Criteria***

**Note:** The Selection criteria employed in choosing the tools is that all the included tools are (1) Desktop-based i.e. they do not require an active internet connection for execution. All the tools are (2) Linux based, (3) Published after 2012 and have (4) Freeware License. Also, MATLAB based tools are not included in this package because it is a paid software. Most of the tools are in their stable version and are regularly maintained according to the website *omictools*. However, detailed selection criterion is shown in the **Table I**.

**TABLE I. Metgeno (Selection Criteria)**

<b><i>Sr. No.</i></b>	<b><i>Software Tool Name</i></b>	<b><i>Pub. Date (after 2012)</i></b>	<b><i>Linux Based</i></b>	<b><i>Offline</i></b>	<b><i>Free</i></b>
<b>Pre-processing</b>					
1	MultiQC [1]	✓	✓	✓	✓
2	HTSeq [2]	✓	✓	✓	✓
3	RobiNA [3]	✓	✓	✓	✓
4	MapSplice [4]		✓	✓	✓
5	Hercules [5]	✓	✓	✓	✓
6	QuickNGS [6]	✓	✓	✓	✓
7	SAMStat [7]		✓	✓	✓
8	NextClip [8]	✓	✓	✓	✓
9	Eoulsan [9]	✓	✓	✓	✓
10	wapRNA [10]		✓	✓	✓
11	oneChannelGUI [11]		✓	✓	✓
12	BBT [12]	✓	✓	✓	✓
13	RseqFlow [13]		✓	✓	✓
14	aRNApipe [14]	✓	✓	✓	✓
15	NGS-Bits [15]	✓	✓	✓	✓
16	NGS-pipe [16]	✓	✓	✓	✓
17	ST Pipeline [17]	✓	✓	✓	✓
18	AlmostSignificant [18]	✓	✓	✓	✓
19	SOAPnuke [19]	✓	✓	✓	✓
20	miARma-Seq [20]	✓	✓	✓	✓
21	CoVaCS [21]	✓	✓		
22	NGS QC Toolkit [22]	✓	✓	✓	✓
23	RNA-QC-Chain [23]	✓	✓	✓	✓
24	miRPursuit [24]	✓	✓	✓	✓
25	SolexaQA [25]		✓	✓	✓
26	mubiomics [26]	✓		✓	✓
27	OncoRep [27]	✓	✓	✓	✓



28	S-MART [28]		✓	✓	✓
29	ReQON [29]	✓	✓	✓	✓
30	TRAPLINE [30]	✓		✓	✓
31	PyroTrimmer [31]	✓	✓	✓	✓
32	Rnnotator [32]		✓	✓	✓
33	TRUFA [33]	✓	✓		
34	BIGpre [34]		✓	✓	✓
35	QuaCRS [35]	✓	✓		
36	preassemble [36]		✓	✓	✓
37	PRINSEQ [37]	✓	✓	✓	✓
38	Pyrocleaner [38]		✓	✓	✓
39	PANDaseq [39]	✓	✓	✓	✓
40	Clustal Omega [40]	✓	✓	✓	✓
<b>Quality Control</b>					
1	Greengenes [41]				✓
2	Nonpareil [42]	✓	✓	✓	✓
3	CorQ [43]	✓	✓	✓	✓
4	FQC [44]	✓		✓	✓
5	QA [45]		✓	✓	✓
6	FaQCs [46]	✓	✓	✓	✓
7	AfterQC [47]	✓	✓	✓	✓
8	HTQC [48]	✓	✓	✓	✓
9	SUGAR [49]	✓	✓	✓	✓
10	KAT [50]	✓	✓	✓	✓
11	FastQ_brew [51]	✓	✓	✓	✓
12	QUASR [52]	✓	✓	✓	✓
13	NGS-QC Generator [53]	✓	✓	✓	✓
14	NGS-eval [54]	✓	✓		
15	mistagging [55]	✓	✓	✓	✓
16	ShortRead [56]		✓	✓	✓
17	sigQC [57]	✓	✓	✓	✓
18	StatsDB [58]	✓	✓	✓	✓
19	G-CNV [59]	✓	✓	✓	✓
20	fitGCP [60]	✓	✓	✓	✓
21	Pheniqs [61]	✓	✓	✓	✓
22	QASDRA [62]	✓	✓	✓	✓
23	Fast-GBS [63]	✓	✓	✓	✓
24	ClinQC [64]	✓	✓	✓	✓
25	SeqAssist [65]	✓	✓	✓	✓
26	PathoQC [66]	✓	✓	✓	✓
27	Zseq [67]	✓	✓	✓	✓
28	MuffinInfo [68]	✓	✓	✓	✓
29	A-Game [69]	✓	✓		
30	MT-Toolbox [70]	✓	✓	✓	✓

31	StreamingTrim [71]	✓	✓	✓	✓
32	FASTQC [72]	✓	✓	✓	✓
33	ACDC [73]	✓			✓
<b>Sequence Contamination Detection</b>					
1	SqClean [74]		✓	✓	✓
2	Vecuum [75]		✓	✓	✓
3	PhylOligo [76]	✓	✓	✓	✓
4	AFS [77]	✓	✓	✓	✓
5	MCSC [78]	✓	✓	✓	✓
6	DeconSeq [79]		✓	✓	✓
7	Kraken [80]	✓	✓	✓	✓
8	Conpair [81]	✓	✓	✓	✓
9	ContEst [82]		✓	✓	✓
10	decontam [83]	✓	✓	✓	✓
11	SIDR [84]	✓	✓	✓	✓
12	MIDAS [85]	✓	✓	✓	✓
13	Cookiecutter [86]	✓			✓
14	Blobology [87]	✓	✓	✓	✓
15	PhagePhisher [88]	✓	✓	✓	✓
16	Taxoblast [89]	✓	✓	✓	✓
17	HYSYS [90]	✓	✓	✓	✓
<b>Assembly</b>					
1	Orione [91]	✓	✓		
2	MetAMOS [92]	✓	✓	✓	✓
3	dDocent [93]	✓	✓	✓	✓
4	Ray Meta [94]	✓	✓	✓	✓
5	TaxMan [95]	✓	✓		
6	DRAP [96]	✓	✓	✓	✓
7	MetaVelvet [97]	✓	✓	✓	✓
8	IDBA-UD [98]	✓	✓	✓	✓
9	MetaSort [99]	✓	✓	✓	✓
10	Snowball [100]	✓	✓	✓	✓
11	Meta-IDBA [101]		✓	✓	✓
12	PRICE [102]	✓	✓	✓	✓
13	Phrap [103]		✓	✓	✓
14	BBAP [104]	✓	✓	✓	✓
15	BBMAP [105]	✓	✓	✓	✓
16	MEGAHIT [106]	✓	✓	✓	✓
17	Xander [107]	✓	✓	✓	✓
18	InteMAP [108]	✓	✓	✓	✓
19	Genovo [109]		✓	✓	✓
20	MetaStorm [110]	✓	✓		
21	Faucet [111]	✓	✓	✓	✓

22	Athena [112]	✓	✓	✓	✓
23	MetaFinisherSC [113]	✓	✓	✓	✓
24	MetaVelvet-SL [114]	✓	✓	✓	✓
25	Mapsembler [115]	✓	✓	✓	✓
26	Spherical [116]	✓	✓	✓	✓
27	BinSanity [117]	✓	✓	✓	✓
28	Xgenovo [118]	✓	✓	✓	✓
29	SAT-Assembler [119]	✓	✓	✓	✓
30	DIME [120]	✓	✓	✓	✓
<b>16S rRNA Reconstruction</b>					
1	Virtual Metagenome [121]	✓	✓		
2	RAMBL [122]	✓	✓	✓	✓
3	SePIA [123]	✓	✓	✓	✓
4	EMIRGE [124]		✓	✓	✓
5	MATAM [125]	✓	✓	✓	✓
6	REAGO [126]	✓	✓	✓	✓
7	TRFMA [127]		✓		
8	GeneStitch [128]	✓	✓	✓	✓
<b>Binning</b>					
1	BUSCO [129]	✓	✓	✓	✓
2	CONCOCT [130]	✓	✓	✓	✓
3	MaxBin [131]	✓	✓	✓	✓
4	MetaCompass [132]	✓	✓	✓	✓
5	MetaCluster-TA [133]	✓	✓	✓	✓
6	CAMI [134], [135]	✓	✓	✓	✓
7	ALE [136]	✓	✓	✓	✓
8	MegaGTA [137]	✓	✓	✓	✓
9	MetaBAT [138]	✓	✓	✓	✓
10	AbundanceBin [139]		✓	✓	✓
11	CheckM [140]	✓	✓	✓	✓
12	MetaQuast [141]	✓	✓	✓	✓
13	GroopM [142]	✓	✓	✓	✓
<b>Homology-based Taxonomy</b>					
1	MetaPhlAn [143]	✓	✓	✓	✓
2	MEGAN [144]	✓	✓	✓	✓
3	Pyrotools [145]	✓	✓	✓	✓
4	Taxonomer [146]	✓	✓		
5	Centrifuge [147]	✓	✓	✓	✓
6	mOTU [148]	✓	✓	✓	✓
7	CARMA [149]		✓	✓	✓
8	Treephyler [150]		✓	✓	✓
9	SATIVA [151]	✓	✓	✓	✓

10	MGmapper [152]	✓	✓	✓	✓
11	CSSSCL [153]	✓	✓	✓	✓
12	TaxSOM [154]		✓	✓	✓
13	Kaiju [155]	✓	✓	✓	✓
14	WebMGA [156]		✓	✓	✓
15	MetaPhyler [157]		✓	✓	✓
16	k-SLAM [158]	✓	✓	✓	✓
17	LMAT [159]	✓	✓	✓	✓
18	Binning_refiner [160]	✓	✓	✓	✓
19	MLTreeMap [161]				✓
20	TACOA [162]		✓	✓	✓
21	deSPI [163]	✓	✓	✓	✓
22	GOTTCHA [164]	✓	✓	✓	✓
23	MBMC [165]	✓	✓	✓	✓
24	LCASstar [166]	✓	✓	✓	✓
25	PROTAX [167]	✓	✓	✓	✓
26	DUDes [168]	✓	✓	✓	✓
27	HTTMM [169]	✓	✓	✓	✓
28	Bracken [170]	✓	✓	✓	✓
29	One Codex [171]	✓	✓		
30	MTR [172]		✓	✓	✓
31	SPANNER [173]	✓	✓	✓	✓
32	TAEC [174]	✓	✓	✓	✓
33	PhyloSift [175]	✓	✓	✓	✓
34	MetaBinG [176]		✓	✓	✓
35	TAMER [177]	✓	✓	✓	✓
36	TAC-ELM [178]	✓	✓	✓	✓
37	Kraken [179]	✓	✓	✓	✓
38	LikelyBin [180]		✓	✓	✓
39	Genometa [181]	✓	✓	✓	✓
40	MyTaxa [182]	✓	✓	✓	✓
41	WEVOTE [183]	✓	✓	✓	✓
42	MetaAmp [184]	✓	✓		
43	MIPE [185]	✓	✓	✓	✓
44	ClaMS [186]		✓	✓	✓
45	MetaCV [187]	✓	✓	✓	✓
46	CoMeta [188]	✓	✓	✓	✓
47	Sequedex [189]	✓	✓	✓	✓
48	RIEMS [190]	✓	✓	✓	✓
49	NBC [191]		✓	✓	✓
50	RITA [192]	✓	✓	✓	✓
51	WGSQuikr [193]	✓	✓	✓	✓
<b>Prediction-based Taxonomy</b>					
1	SHERA [194]		✓	✓	✓

2	PPS [195]	✓	✓	✓	✓
3	d2SBin [196]	✓	✓	✓	✓
4	cuCLARK [197]	✓	✓	✓	✓
5	FROGS [198]	✓	✓	✓	✓
6	TOSS [199]	✓	✓	✓	✓
7	MetaFAST [200]	✓	✓	✓	✓
8	COCACOLA [201]	✓	✓	✓	✓
9	PHYSCIMM [202]		✓	✓	✓
10	VizBin [203]	✓	✓	✓	✓
11	MetaProb [204]	✓	✓	✓	✓
12	MetaWatt [205]	✓	✓	✓	✓
13	AMBER [206]	✓	✓	✓	✓
14	MrGBP [207]	✓	✓	✓	✓
15	MyCC [208]	✓	✓	✓	✓
16	DectICO [209]	✓	✓	✓	✓
17	MBBC [210]	✓	✓	✓	✓
18	Simka [211]	✓	✓	✓	✓
19	BiMeta [212]	✓	✓	✓	✓
20	crAss [213]	✓	✓		
21	CompostBin [214]		✓	✓	✓
22	PhymmBL [215]		✓	✓	✓
<b>Gene Prediction</b>					
1	Glimmer [216]		✓		
2	FragGeneScan [217]	✓	✓	✓	✓
3	GeneMark [218]		✓	✓	✓
4	MICRA [219]	✓	✓	✓	✓
5	MGA [220]		✓	✓	✓
6	Plastid [221]	✓	✓	✓	✓
7	Orphelia [222]		✓	✓	✓
8	RAP [223]	✓			✓
9	Topological-Pressure [224]	✓		✓	✓
10	Protein generator [225]	✓	✓	✓	✓
11	MetaGeneTack [226]	✓	✓	✓	✓
12	TransGeneScan [227]	✓		✓	✓
13	MOCAT [228]	✓	✓	✓	✓
14	Prodigal [229]	✓	✓	✓	✓
<b>Ribosomal Gene Prediction</b>					
1	meta_rna [230]	✓	✓	✓	✓
2	Barrnap [231]	✓	✓	✓	✓
3	RNAmmmer [232]		✓		
4	Pplacer [233]		✓	✓	✓
5	HMMER [234]	✓	✓	✓	✓

Functional Annotation					
1	InterProScan [235]	✓	✓	✓	✓
2	biomartr [236]	✓	✓	✓	✓
3	GhostKOALA [237]	✓	✓		
4	SALT [238]	✓	✓	✓	✓
5	Diamond-blastx [239]	✓	✓	✓	✓
6	ROCKcr [240]	✓	✓	✓	✓
7	UProC [241]	✓	✓	✓	✓
8	Woods [242]	✓	✓	✓	✓
9	RTMg [243]	✓	✓	✓	✓
10	MAGpy [244]	✓	✓	✓	✓
11	metaSAMS [245]	✓	✓		
Metabolic Profiling					
1	MEBS [246]	✓	✓	✓	✓
2	phraSED-ML [247]	✓	✓	✓	✓
3	Kamneva [248]	✓	✓	✓	✓
4	ScrumPY [249]		✓	✓	✓
5	MetaboSignal [250]	✓	✓	✓	✓
6	JMassBalance [251]		✓	✓	✓
7	Pyabolism [252]	✓	✓	✓	✓
8	Mapping Tool [253]		✓	✓	✓
9	MWASTools [254], [255]	✓	✓	✓	✓
10	Pybrn [256]	✓	✓	✓	✓
11	Metabox [257]	✓	✓	✓	✓
12	zeroSum [258]	✓	✓	✓	✓
13	Papi [259]		✓	✓	✓
14	MetaboliteIDConveter [260]	✓	✓	✓	✓
15	cPath [261]		✓	✓	✓
Data Visualization					
1	BURRITO [262]	✓	✓		
2	Metacoder [263]	✓	✓	✓	✓
3	Explicet [264]	✓	✓	✓	✓
4	GrammR [265]	✓	✓	✓	✓
5	Krona [266]		✓	✓	✓
6	VAMPS [267]	✓	✓		
7	GraPhlAn [268]	✓	✓		
8	ASAR [269]	✓	✓	✓	✓
9	MetaViz [270]	✓	✓		
10	SynTVView [271]	✓	✓	✓	✓
11	AmphoraVizu [272]	✓	✓		
12	FuncTree [273]	✓	✓		
13	MetaGenSense [274]	✓	✓	✓	✓

14	Elviz <a href="#">[275]</a>	✓	✓		
15	metaWRAP <a href="#">[276]</a>	✓	✓	✓	✓
16	Strainer <a href="#">[277]</a>	✓	✓	✓	✓

## ***Chapter-5: Packaged Tools***

**Note:** The selection criterion (already mentioned in Table I) filtered most of the available software retaining only about **133** software tools which are now packaged in Metgeno and mentioned in **Table II** with the download size for user convenience. The remaining tools either does not lie on the basic selection criteria or have following notable issues:

- ✚ Software is free but its dependencies are paid
- ✚ Obsolete or not available
- ✚ Credentials or Subscription needed to avail the software

**TABLE II. Metgeno (Packaged Tools)**

<i>Sr. No.</i>	<i>Software Tool Name</i>	<i>Size (MB)</i>
<b>Pre-processing</b>		
1	MultiQC [1]	4
2	HTSeq [2]	12
3	MapSplice [4]	40
4	NextClip [8]	10
5	Eoulsan [9]	15
6	SOAPnuke [19]	0.1
7	SolexaQA [25]	10
8	PRINSEQ [37]	0.5
9	PANDAsseq [39]	5
10	Clustal Omega [40]	7
11	BWA	1
<b>Quality Control</b>		
12	Greengenes [41]	45
13	Nonpareil [42]	57
14	FQC [44]	10
15	QA [45]	5
16	FaQCs [46]	10
17	HTQC [48]	1
18	SUGAR [49]	93
19	KAT [50]	40
20	QUASR [52]	2
21	ShortRead [56]	40
22	fitGCP [60]	29
23	PathoQC [66]	24
24	FASTQC [72]	37
25	ACDC [73]	17



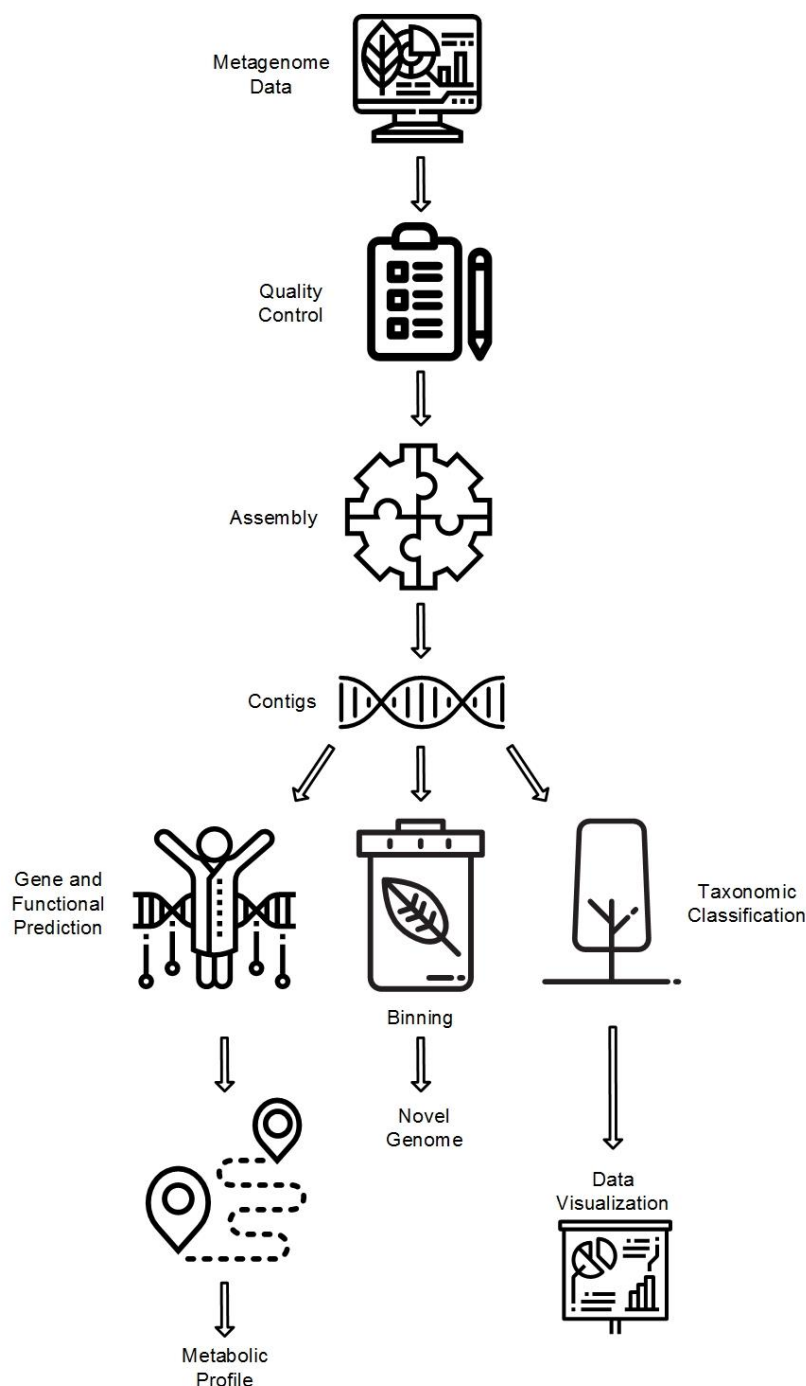
Sequence Contamination Detection		
26	PhylOligo [76]	26
27	MCSC [78]	16 GB
28	Kraken [80]	1.5
29	Conpair [81]	13
30	SIDR [84]	0.1
31	MIDAS [85]	26
32	Blobology [87]	1
33	PhagePhisher [88]	0.1
34	Taxoblast [89]	30
35	HYSYS [90]	0.1
Assembly		
36	MetAMOS [92]	402
37	dDocent [93]	0.4
38	Ray Meta [94]	0.4
39	MetaVelvet [97]	0.2
40	IDBA-UD [98]	2
41	MetaSort [99]	33
42	Snowball [100]	1
43	PRICE [102]	9
44	BBAP [104]	1.4
45	BBMAP [105]	26
46	MEGAHIT [106]	0.5
47	Faucet [111]	3
48	Athena [112]	0.1
49	MetaFinisherSC [113]	36
50	Spherical [116]	34
16S rRNA Reconstruction		
51	RAMBL [122]	0.4
52	SePIA [123]	20
53	EMIRGE [124]	2
54	MATAM [125]	6
55	REAGO [126]	0.3
56	GeneStitch [128]	5.4
Binning		
57	CONCOCT [130]	7
58	MaxBin [131]	4
59	MetaBAT [138]	13
60	AbundanceBin [139]	7
61	GroopM [142]	30

Homology-based Taxonomy		
62	MEGAN [144]	102
63	Centrifuge [147]	0.8
64	mOTU [148]	26
65	SATIVA [151]	0.6
66	CSSSCL [153]	0.1
67	Kaiju [155]	0.6
68	k-SLAM [158]	0.1
69	LMAT [159]	2
70	GOTTCHA [164]	13
71	DUDes [168]	35
72	TAEC [174]	7
73	PhyloSift [175]	33
74	WEVOTE [183]	5
75	NBC [191]	2
Prediction-based Taxonomy		
76	PPS [195]	12
77	d2SBin [196]	23
78	cuCLARK [197]	0.1
79	FROGS [198]	77
80	TOSS [199]	0.1
81	MetaFAST [200]	25
82	VizBin [203]	103
83	MetaProb [204]	9
84	MetaWatt [205]	12
85	AMBER [206]	0.5
86	MrGBP [207]	0.6
87	MyCC [208]	121
88	Simka [211]	0.3
89	CompostBin [214]	158
90	PhymmBL [215]	5
Gene Prediction		
91	Glimmer [216]	45
92	FragGeneScan [217]	36
93	MICRA [219]	30
94	Plastid [221]	4
95	Orphelia [222]	68
96	RAP [223]	1.9
97	Protein generator [225]	32
98	MOCAT [228]	400
99	Prodigal [229]	26

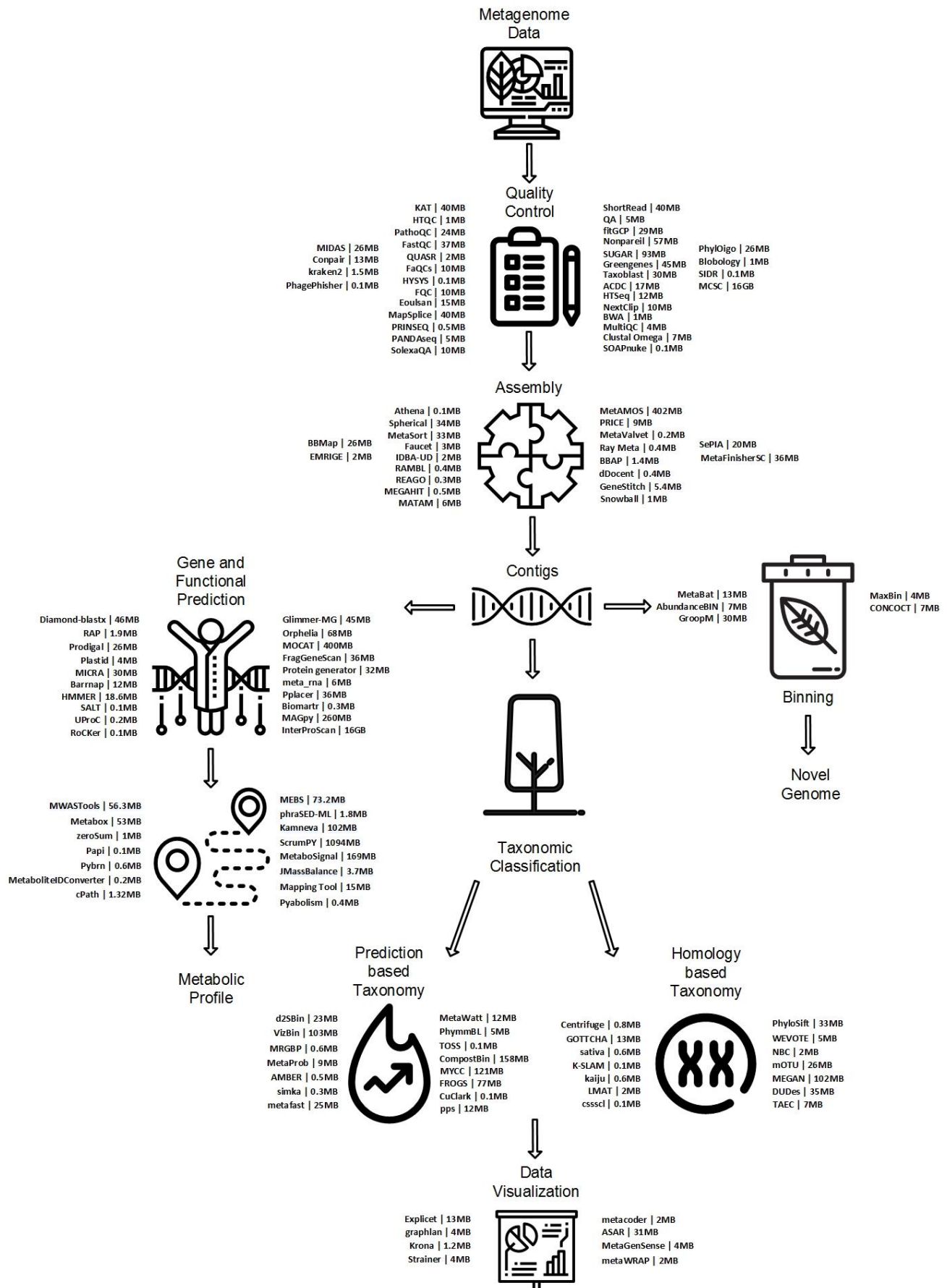
Ribosomal Gene Prediction		
100	meta_rna [230]	6
101	Barrnap [231]	12
102	Pplacer [233]	36
103	HMMER [234]	18.6
Functional Annotation		
104	InterProScan [235]	16 GB
105	biomartr [236]	0.3
106	SALT [238]	0.1
107	Diamond-blastx [239]	46
108	ROCK [240]	0.1
109	UProC [241]	0.2
110	MAGpy [244]	260
Metabolic Profiling		
111	MEBS [246]	73.2
112	phraSED-ML [247]	1.8
113	Kamneva [248]	102
114	ScrumPY [249]	1.07 GB
115	MetaboSignal [250]	169
116	JMassBalance [251]	4
117	Pyabolism [252]	0.4
118	Mapping Tool [253]	15
119	MWASTools [254], [255]	56.3
120	Pybrn [256]	0.6
121	Metabox [257]	53
122	zeroSum [258]	1
123	Papi [259]	0.1
124	MetaboliteIDConveter [260]	0.2
125	cPath [261]	1.32
Data Visualization		
126	Metacoder [263]	2
127	Explicet [264]	13
128	Krona [266]	1.2
129	GraPhlAn [268]	4
130	ASAR [269]	31
131	MetaGenSense [274]	4
132	metaWRAP [276]	2
133	Strainer [277]	4

## Chapter-6: Software Pipeline

**Note:** The First figure shows the pipeline with steps used for Metagenomical Analysis. The Second Figure shows the pipeline with steps including all the software packaged in **Metgeno**.



*Figure 5.1: Genomes of multiple microorganisms (metagenomics) are obtained as reads through Next Generation Sequencing of environmental samples. These reads are filtered and trimmed to obtain the best quality reads. These reads are assembled to form contigs. Contigs belonging to the same organism are either binned together to obtain final assemblies, or undergo taxonomic classification to understand their standing within the tree-of-life. Alternatively, the same contigs may be employed to expound upon their functional roles.*



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