

Business 4720 - Class 1

Introduction and Processes

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Terminology

- ▶ Data Analytics
- ▶ Data Science
- ▶ Business Analytics
- ▶ Machine Learning
- ▶ Artificial Intelligence
- ▶ Big Data
- ▶ Statistics

Terminology

- ▶ Method
- ▶ Technique
- ▶ Tool

Types of Analytics

Aims and Outcomes

- ▶ *Descriptive Analytics*: Describes "what is". Summarizes the data, makes comparisons, identifies historical trends. Typically model-free.
- ▶ *Predictive Analytics*: Predicts "what may be" in the future. Typically builds a model based on past data to predict future cases/events/outcomes.
- ▶ *Prescriptive Analytics*: Prescribes "what should be done". Builds a model that learns best actions based on past observations and actions.
- ▶ *Visual Analytics*: Uses graphs to visualize information for gaining insight. Employs human abilities to visually identify trends, make comparisons, etc.

Data and Models

Data

- ▶ In many analytics applications, 80% of time/cost/effort is spent on data management
- ▶ Data quality determines the quality of the analytics outcome

Models

- ▶ Statistical models, for example a linear regression model for prediction
- ▶ Describes the data (generating mechanism) in parameterized form, for example intercept and slope of linear model.

Supervised Learning

- ▶ Correct outcome (numerical value or target category) is given for each input/observation
- ▶ Examples: Linear regression model, generative pre-trained transformers (GPT)

Unsupervised Learning

- ▶ Unsupervised learning: No outcomes are provided
- ▶ Example: Clustering, components analysis

Analytics is not Statistics

- ▶ Both may use the same kinds of mathematical models

Explanation

- ▶ Sample or population statistics
- ▶ Model quality determined by fit between model and data
- ▶ Inferential statistics concerned with generalizing from sample to population
- ▶ Aims to identify data generating mechanism
- ▶ Not focused on individual cases/observations

Prediction

- ▶ Focus on individual cases/observations
- ▶ Model quality determined by precision/accuracy of individual predictions
- ▶ No inference to population
- ▶ Pragmatic, does not aim or claim to identify data generating mechanism

What You Will Learn:

- ▶ Introduction to Business Analytics
- ▶ Data Management (On-Premises & Cloud; SQL & NoSQL)
- ▶ Computational Foundations
- ▶ Descriptive and Visual Analytics
- ▶ Supervised and Unsupervised Machine Learning
 - ▶ Regression, Classification
 - ▶ Clustering, Component Analysis
 - ▶ Time-Series Models, incl. ARIMA and GARCH
- ▶ Predictive Analytics with Deep Neural Networks
- ▶ Prescriptive Analytics (Reinforcement Learning)
- ▶ Process Analytics (Mining and Prediction)
- ▶ ML and AI Processes
- ▶ Ethical and Legal Issues
- ▶ Management and Governance

- ▶ Open-source
- ▶ Cross-platform (Linux, Windows Mac)
- ▶ Multi-architecture (x64/amd64 "Intel/AMD" and arm64 "ARM/Apple")



- ▶ Language and Software for Statistical Computing
 - ▶ First appeared August 1993
 - ▶ Open-source, multi-platform
 - ▶ More than 16,000 packages available on CRAN ("Comprehensive R Archive Network")
-

- ▶ Tidyverse packages (tidyr, dplyr, stringr)
- ▶ GGPlot2

<https://www.r-project.org/>



- ▶ Programming Language
 - ▶ First appeared February 1991
 - ▶ Open-source reference implementation, multi-platform
 - ▶ More than 450,000 packages available on PyPI ("Python Package Index")
-

- ▶ PyCharm
- ▶ JupyterLab Desktop
- ▶ Numpy, Pandas, Plotly
- ▶ Tensorflow, Keras

<https://www.python.org/>

Virtual Machine Environment



- ▶ Virtual Machine Appliance for x64/amd64 architecture
 - ▶ "Computer within a computer"
 - ▶ Includes guest operating system and all required software and data sets
-



- ▶ Most popular Linux distribution
- ▶ Open-source, multi-hardware
- ▶ Frequently used in software development

Username: busi4720 **Password:** busi4720



- ▶ Relational Database Management System
 - ▶ Open-source, multi-hardware
 - ▶ First appeared July 1996
 - ▶ Active DBMS features such as triggers and stored procedures in PLSQL and other languages
-



- ▶ Graph Database (NoSQL)
- ▶ Supports property graphs
- ▶ Open-source community edition
- ▶ Cypher query language

Software Versions and Sources

R	4.1.2	www.r-project.org
dplyr	1.1.3	www.tidyverse.org
tidyr	1.3.0	www.tidyverse.org
ggplot2	3.4.4	www.tidyverse.org
Python	3.8	www.python.org
numpy	1.24.4	numpy.org
pandas	2.0.3	pandas.pydata.org
plotly	5.18.0	plotly.com
tensorflow	2.13.1	www.tensorflow.org
Postgres	16.0-1	www.postgresql.org
pgAdmin4	7.8	www.pgadmin.org
PyCharm	2023.2.3	www.jetbrains.com/pycharm/
Jupyterlab	4.0.7-1	//github.com/jupyterlab/jupyterlab-de
Neo4J	5.14.0	www.neo4j.com

Database Management Systems

- ▶ MongoDB (a document database)
- ▶ ArangoDB (a multimodel database)
- ▶ OrientDB (a graph database)
- ▶ Redis (a key/value database)
- ▶ Cassandra (a NoSQL database)

Infrastructure

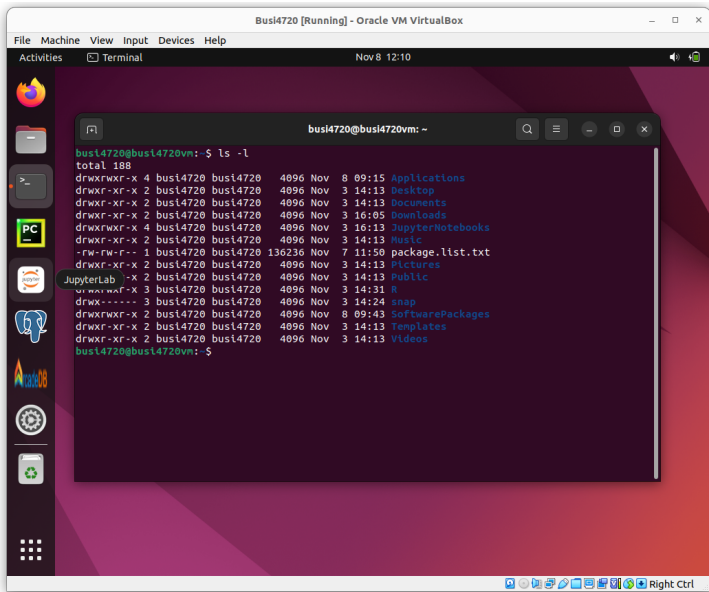
- ▶ Hadoop (a distributed file system)
- ▶ Spark (an analytics engine on Hadoop)
- ▶ HBase (a distributed database)
- ▶ Hive (a data warehouse system)

Either

- 1 Download and install the required software on your computer¹:
 - ▶ R → www.r-project.org
 - ▶ Python → www.python.org
 - ▶ Ensure you install "pip", the Python package installer
 - ▶ Postgres → www.postgresql.org
 - ▶ PyCharm → www.jetbrains.com/pycharm/
 - ▶ Neo4J → www.neo4j.com
- 2 Download VirtualBox and import the virtual machine appliance from the course Brightspace site
 - ▶ VirtualBox → www.virtualbox.org

¹You do not need to install the R and Python packages yet, you will do this later in the course when you need them.

Intro to Ubuntu



```
Busi4720 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Nov 8 12:10

busi4720@busi4720vm: ~
total 188
drwxrwxr-x 4 busi4720 busi4720 4096 Nov  8 09:15 Applications
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 14:13 Desktop
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 14:13 Documents
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 16:05 Downloads
drwxrwxr-x 4 busi4720 busi4720 4096 Nov  3 16:13 JupyterNotebooks
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 14:13 Music
-rw-rw-r-- 1 busi4720 busi4720 136236 Nov  7 11:50 package.list.txt
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 14:13 Pictures
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 14:13 Public
drwxr-xr-x 3 busi4720 busi4720 4096 Nov  3 14:31 R
drwxr-xr-x 3 busi4720 busi4720 4096 Nov  3 14:24 snap
drwxrwxr-x 2 busi4720 busi4720 4096 Nov  8 09:43 SoftwarePackages
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 14:13 Templates
drwxr-xr-x 2 busi4720 busi4720 4096 Nov  3 14:13 Videos
busi4720@busi4720vm: ~
```

- ▶ Version of Linux created and distributed by Canonical Inc.
- ▶ Open source and multi-hardware support
- ▶ Long term support (LTS) versions released every 2 years, supported for 5 years
- ▶ Based on the Debian distribution
- ▶ User interface is called "Gnome" or "Gnome Shell"
- ▶ Software is installed in packages
 - ▶ Typically from the Ubuntu online repository or manually using Debian package files
 - ▶ Use the "apt" command-line tool or the "Synaptic" graphical tool to manage packages

- ▶ Multi-user capable
 - ▶ User files are in the directory/folder `"/home/busi4720/"`
- ▶ Users have limited permissions to files and folders (read, write, eXecute)
- ▶ Users have limited privileges
 - ▶ But some users are *administrator* users and/or have **"sudo"** privileges

The Ubuntu Command Line

In Ubuntu, you can open the Terminal using the key combination **Ctrl-Alt-T**, or by selecting the Terminal icon from the side bar or the application list. You can also open a terminal from the file browser.

Print the working directory:

```
_____ Bash _____  
busi4720@busi4720vm:~$ pwd  
/home/bus4720
```

Make a folder/directory:

```
_____ Bash _____  
busi4720@busi4720vm:~$ mkdir someFolder
```

Change the working directory:

```
_____ Bash _____  
busi4720@busi4720vm:~$ cd someFolder  
busi4720@busi4720vm:~/someFolder$ cd ..  
busi4720@busi4720vm:~$ cd ~
```

The Ubuntu Command Line

Special directory characters

~	User home directory
.	Current directory
..	Upwards in the directory tree
/	Root of directory tree

Tips

- ▶ Autocompletion of file names with the "tab" key (up to ambiguity)
- ▶ Recall earlier commands with the "up arrow" key
- ▶ Search earlier commands with the "Ctrl-R" key
- ▶ Cut/copy/paste with Ctrl-Shift-X , Ctrl-Shift-C , Ctrl-Shift-V

The Ubuntu Command Line

List folder/directory contents:

```
Bash
busi4720@busi4720vm:~$ ls -l ~/Applications
total 4
drwxr-xr-x 8 busi4720 busi4720 4096 Nov  7 11:45 pycharm-community-20
```

The results show the total size in kB, and a list of entries:

- ▶ Type of entry ("d" = directory)
- ▶ Permissions for owner ("rwx"), users in the same group ("r-x") and other users ("r-x")
- ▶ Names of owner and groups ("busi4720")
- ▶ Size (in bytes)
- ▶ Last modification date and time
- ▶ File or directory name

The Ubuntu Command Line

Print a string of text:

```
_____ Bash _____  
$ echo "To be or not to be"  
To be or not to be
```

Redirect output to a file using the *redirect* symbol ">":

```
_____ Bash _____  
$ echo "To be or not to be" > someFile.txt  
$ ls -l someFile.txt  
-rw-rw-r-- 1 busi4720 busi4720 19 Nov  8 14:50 someFile.txt
```

Print contents of a file ("concatenate"):

```
_____ Bash _____  
$ cat someFile.txt  
To be or not to be
```

The Ubuntu Command Line

Copy a file:

```
_____ Bash _____  
$ cp someFile.txt someCopy.txt
```

Move a file:

```
_____ Bash _____  
$ mv someCopy.txt ~/someFolder
```

Renaming is moving:

```
_____ Bash _____  
$ mv someFile.txt newName.txt
```

Remove (delete) a file:

```
_____ Bash _____  
$ rm someFolder/someFile.txt
```


The Ubuntu Command Line

Remove a directory recursively (i.e. remove all its contents first):

```
Bash  
$ rm -r ~/someFolder
```

Use this very carefully!

View the command line history:

```
Bash  
$ history  
1  echo "To be or not to be"  
2  echo "To be or not to be" > someFile.txt  
3  ls -l someFile.txt  
4  less someFile.txt  
5  cat someFile.txt  
...
```

The Ubuntu Command Line

Remove write permissions:

```
Bash  
$ chmod -w newName.txt
```

Add write permissions:

```
Bash  
$ chmod +w newName.txt
```

Add execute permissions:

```
Bash  
$ chmod +x newName.txt
```

The Ubuntu Command Line

Get the manual for a command:

```
_____ Bash _____  
$ man ls
```

Find the processes running:

```
_____ Bash _____  
$ ps
```

Find something in a file or input stream:

```
_____ Bash _____  
$ cat newName.txt | grep be  
$ ls -l | grep .txt  
$ history | grep .txt
```

Note: The vertical bar is called a *"pipe"*, it pipes the output of one command as input into the next one

- ▶ <https://ubuntu.com/tutorials/command-line-for-beginners>
- ▶ <https://www.digitalocean.com/community/tutorials/a-linux-command-line-primer>
- ▶ <https://www.digitalocean.com/community/tutorial-series/getting-started-with-linux>

Hands-On Exercise I

The following are a set of connected exercises to help you practice your command line skills. Do them in the order listed.

1 Navigation and Listing

- 1.1 Open the terminal and use the `pwd` command to print the current working directory.
- 1.2 Use `ls` to list the contents of the current directory.
- 1.3 Create a new directory named "Exercise1" using `mkdir`.
- 1.4 Navigate into the "Exercise1" directory using `cd`.

2 File Manipulation

- 2.1 Create a new file named "file1.txt" inside the "Exercise1" directory using `touch`.
- 2.2 Use `cat` to display the contents of "file1.txt".
- 2.3 Append the text "Hello, Bash!" to "file1.txt" using `echo` and `>>`.
- 2.4 Display the updated contents of "file1.txt" using `cat`.

3 Removing and Renaming

- 3.1 Remove "file1.txt" using the `rm` command.

Hands-On Exercise II

- 3.2 Create a copy of the "Exercise1" directory named "Exercise1_backup" using `cp -r`.
- 3.3 Remove the original "Exercise1" directory using `rm -r`.

4 Directory Manipulation

- 4.1 Recreate the "Exercise1" directory.
- 4.2 Create three subdirectories inside "Exercise1" named "Subdir1", "Subdir2", and "Subdir3" using `mkdir`.
- 4.3 List the contents of "Exercise1" to verify the creation of subdirectories.

5 Searching and Filtering

- 5.1 Create a file named "keywords.txt" inside "Exercise1" and add some random text.
- 5.2 Use `grep` to search for a specific word (e.g., "Bash") in "keywords.txt".
- 5.3 Create a new file named "filtered.txt" and use `grep` to filter lines containing the word you searched for in "keywords.txt".

6 Process Management

Hands-On Exercise III

- 6.1 Use `ps` to display information about the current processes running on your system.
- 6.2 Use `ps aux | grep bash` to filter and display information about Bash processes.

7 Cleanup

- 7.1 Remove the entire "Exercise1" directory and its contents using `rm -r`.
- 7.2 Confirm that the "Exercise1" directory no longer exists by listing the contents of the current directory.