



HKUST
VISLAB

HKUST
HCI Initiative

COMP 4462

Data Visualization Tutorial

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Friday 20 September, 2024

Logistics

- **We make data visible! And beautiful!**
- Course homepage: <https://canvas.ust.hk/courses/58234>
- About assessment:
 - In-class exercises (10%)
 - Lab sessions (10%) (no attendance)
 - Top-vis competition and essay (10%)
 - Final project (30%)
 - Two In-Class Midterms (40%)
- Tutorial session
 - **Date & Time:** Friday 03:00PM - 03:50PM
 - **Venue:** Multi-function Room, LG4, LIB
 - **Tutors:** PAN Ziqi(zpanar@connect.ust.hk) and CHEN Chang(cchenda@connect.ust.hk)

Data Visualization

- Week 1: Introduction
- Principles:
 - Week 2: Color and Perception
 - Week 3: Design Principles
 - Week 4: Tasks and Rules
 - **Week 5: Top Vis Competition**
- Specific type of data
 - Week 6-7: Trajectories
 - **Week 8: Midterm I (Oct 21)**
 - **Week 8-9: Project Proposal**
 - Week 9-10: Multi-Dimensional Data
 - Week 10-11: Text
 - Week 11-12: Graph
 - **Week 12: Midterm II (Nov 22)**
- Miscellaneous:
 - Week 12: Interaction and Evaluations
 - **Week 13: Final Project Presentation**

About this tutorial

- Focus on tools, more hands-on, more coding
 - Get your hands dirty, learn by doing
- Cover most of common tools in data scientist toolbox
 - Visualization oriented, obviously
- Time allocation:
 - 20 mins go through slides, 30 mins hands-on
 - Use your own computer
 - Submit your work to Canvas
- Some programming experience will help, but not necessary (we will help)
 - To help you complete the course project
 - First two weeks will be no programming (Excel and Tableau)
 - Then, more and more coding (Python and Javascript)
- One session for “where to find data” and “where to find visualizations”
 - To help you on top-vis competition and project topics

Visualization tools

GUI base vis tools

[MS Excel](#)
[Tableau](#)
[MS PowerBI](#)
[Google Data Studio](#)

Python vis tools

[Matplotlib](#)
[Seaborn](#)
[Bokeh](#)
[Altair](#)

More Expressive JS vis tools

[D3.js](#)
[Three.js](#) (WebGL based)
[p5.js](#) (HTML5 Canvas based)
[Leaflet](#) (for maps)

R language vis tools

[ggplot2](#)
[qgis](#)

Specification base JS vis tools

[Vega-lite](#)
[Plotly.js](#)
[Highcharts](#)
[ECharts](#)

Frontend Framework, Backend Server & DB

Frontend ([React](#), [Vue.js](#))
[Node.js](#) ([express](#), [koa](#))
[Python](#) ([Flask](#), [Django](#))
[MongoDB](#), [PostgreSQL](#)

And many more upon discovery!

Schedule

- We will go through a subset of the tools
 - Excel, Tableau, Python (Jupyter, pandas), Javascript (Vega-lite, d3.js)
- Schedule
 - No coding
 - Tutorial 1: [Excel](#)
 - Tutorial 2: [Tableau](#)
 - Python
 - Tutorial 3: [Python](#), [Jupyter](#) and [pandas](#) basics
 - Tutorial 4: Where to find data and visualizations (+Project Proposal Consultation, In-Class Exercise Review)
 - Javascript
 - Tutorial 5: [Javascript](#) basics, [Vega-lite](#) and data processing libraries
 - Tutorial 6: [D3.js](#) basics and interaction
 - Revisions and Consultations:
 - Lab7: Exam I Checking and Project Consultation
 - Lab8: In-Class Exercise Review

Warm-up with Microsoft Excel

- Materials are hosted on <https://github.com/DelPanz7/DataVisualization2024>
 - Download the .xlsx and .csv in the directory “tutorial01”
- We will go through the followings with a simple dataset (lab1.xlsx):
 - VLOOKUP function
 - Pivot table
 - Filtering
 - Plotting
 - Customizing charts, reverse axis and labels
- Then, tasks on a bigger datasets (university_rankings.csv and university_countries.csv)
- Remember to submit your work to Canvas

VLOOKUP

- Use VLOOKUP when you need to find things in a table
- We will use it to lookup the country of an university and joint two tables
- See [documentation](#)

Subject	Ranking
CS	14
EE	23
CHEM	23
ACCT	16

Subject Ranking

Subject	School
CS	Engineering
EE	Engineering
CHEM	Science
ACCT	Business

Subject to School

fx =VLOOKUP(A2,Schools!A\$2:B\$5, 2, FALSE)

VLOOKUP

VLOOKUP(lookup_value,
table_array, col_index_num,
[range_lookup])

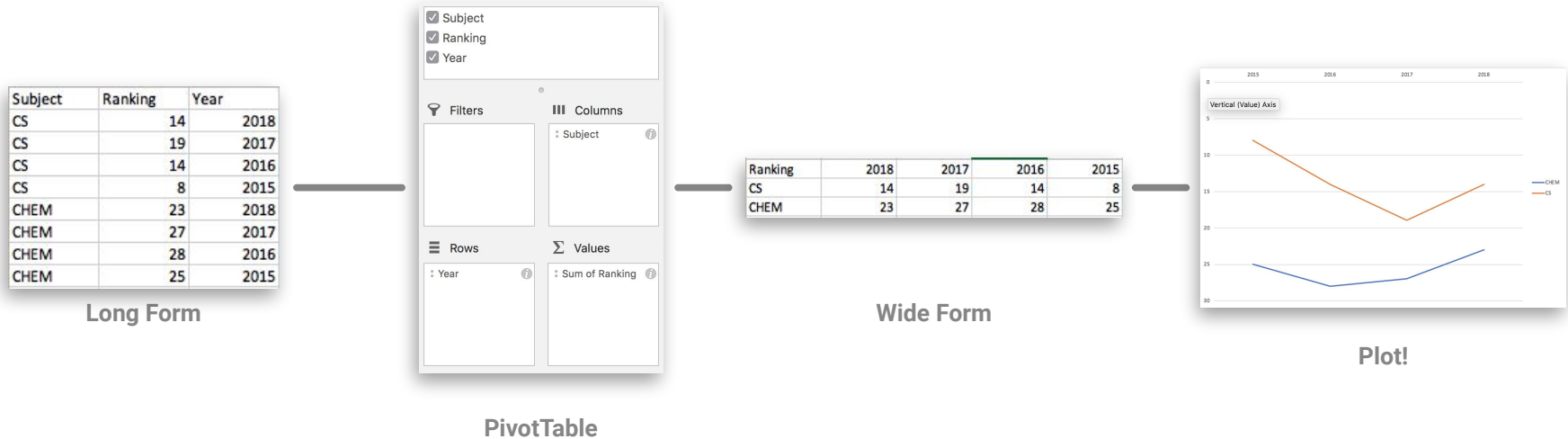
Subject	Ranking	School
CS	14	Engineering
EE	23	Engineering
CHEM	23	Science
ACCT	16	Business

Table joined!

=VLOOKUP(What you want to look up,
where you want to look for it,
the column number in the range
containing the value to return,
return an Approximate or Exact match –
indicated as 1/TRUE, or 0/FALSE)

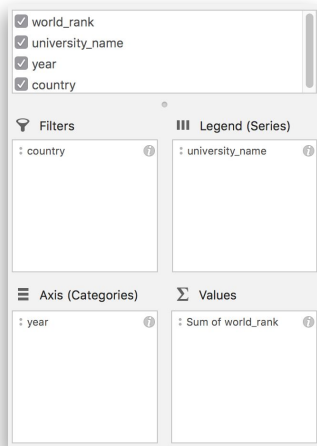
PivotTable

- Sometimes, data are in “Long Form”, but Excel plots charts with “Wide Form”
- We **transform** data with PivotTable (A pivot table is a table of grouped values that aggregates the individual items of a more extensive table)
- See [documentation](#)

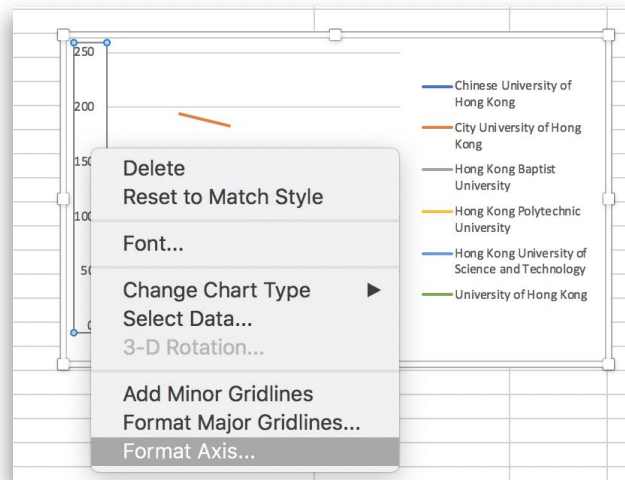


Filtering and reverse index

- Use the “Filters” field in PivotTable



- Use format axis to reverse y-axis
 - Check the option “Values in reverse order”



Lab exercise

- Tasks

- Download the two csv files (university_rankings.csv and university_countries.csv) from [GitHub](#)
- Import the data into Excel
- Lookup the countries of all the universities
- Apply PivotTable to transform “long form” to “wide form”
- Plot the rankings of all the universities from Hong Kong
 - Utilize the filter field in PivotTable
 - Remember to flip the y-axis, zero at the top-left
- Repeat for all the universities from Canada, China, Australia, UK and USA (Done by yourself)
 - To reduce your burden, you only need to choose any two of them
 - One sheet for one country

- Remember to upload your .xlsx file to Canvas (Due: Sep 24 11:59 PM)

- Your .xlsx file should have the following sheets: Countries, Ranking, Pivot Table_all, Pivot Table_HK, and two other Pivot tables.

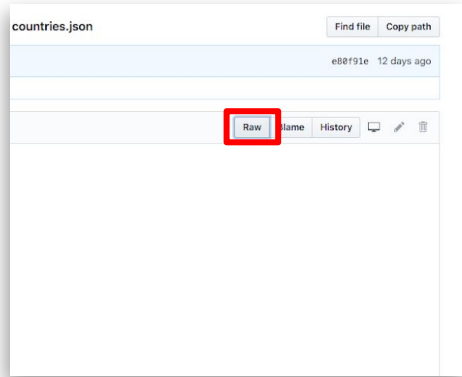
- Credit:

- Data source from [University Rankings.ch](#)

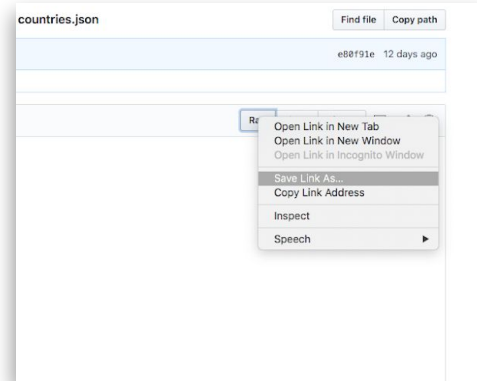
Download dataset from GitHub

1. Go to the [tutorial repository](#)
2. Go to the dataset file you want download, e.g. [university_rankings.csv](#)

3. Right click “Raw”

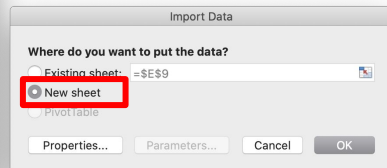
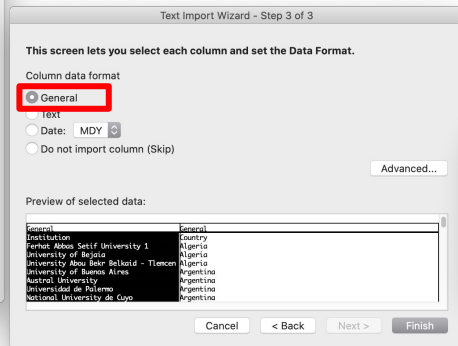
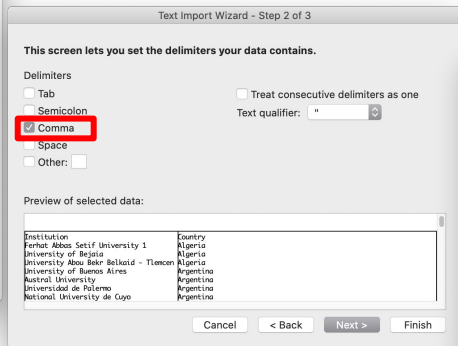
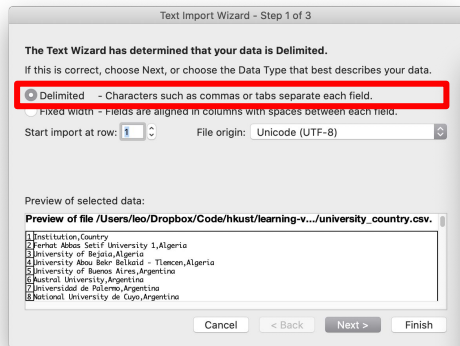
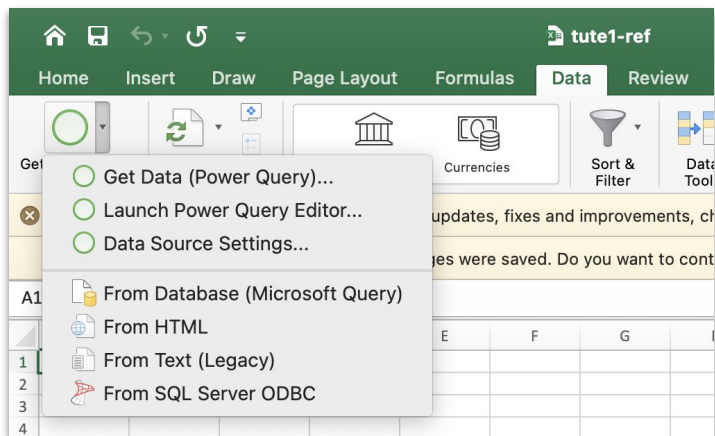


4. Save as file



Import dataset into Microsoft Excel

1. Data -> From Text
2. Choose file ("university_countries.csv")
3. In import wizard:
 - a. Step 1: Select "Delimited"
 - b. Step 2: Select "Comma"
 - c. Step 3: Select "General"
 - d. Last: Put data in "New Sheet"



Lookup the countries of all the universities

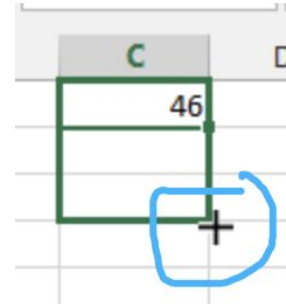
1. After importing the data, you should have two sheets. Name them as Countries and Ranking
2. Type `=VLOOKUP(B2, Countries!A$2:B$1521, 2, FALSE)` in Cell D2
 - a. A\$2:B\$1302 is the absolute positions in Excel. Remember to type \$
3. Move your cursor to the bottom right of Cell D2 and you will see your cursor becomes a black cross. Then Double Click the black cross to apply the formula to the whole column.

	A	B
1	Institution	Country
2	Ferhat Abbas Setif University 1	Algeria
3	University Abou Bekr Belkaid - Tlemcen	Algeria
4	University of Bejaia	Algeria
5	Universidad de Palermo	Argentina
6	National University de General San Martin	Argentina
7	National University de Cuyo	Argentina
8	National University of the South	Argentina
9	National University de Cordoba	Argentina

Navigation: Countries | Ranking | +

=VLOOKUP(B2, Countries!A\$2:B\$1521, 2, FALSE)

B	C	D
	Year	Country
Institute of Technology, MIT	2015	USA
London	2015	UK
Edge	2015	UK
	2015	USA
London	2015	UK



Apply PivotTable to transform “long form” to “wide form”

1. In Ranking sheet (with countries combined), insert->Pivot Table, choose *New worksheet*, then click OK.
2. Set PivotTable Fields
3. Name the sheet as *Pivot Table_all*

The screenshot shows the 'Create Pivot Table' dialog box in Microsoft Excel. The dialog is open over a worksheet that contains a table of university data. The dialog has two main sections: 'Choose the data that you want to analyse.' and 'Choose where to place the Pivot Table.'.

In the first section, the 'Select a table or range' radio button is selected. The 'Table/Range:' text box contains the formula 'Ranking!\$A\$1:\$D\$10051'. In the second section, the 'New worksheet' radio button is selected. The 'Table/Range:' text box contains the formula 'Ranking!\$F\$36'. At the bottom of the dialog, there are two buttons: 'Cancel' and 'OK'. The 'OK' button is highlighted in green.

The background worksheet shows a table with the following data:

Ranking	University	Country
1401	Federal University of Minas Gerais	Brazil
1401	Federal University of Uberlândia	Brazil
1401	Federal University of Pará	Brazil

PivotTable Fields

FIELD NAME

Search fields

- ☒ Ranking
- ☒ Institution
- ☒ Year
- ☐ Country

Filters

Columns

Year

Rows

Values

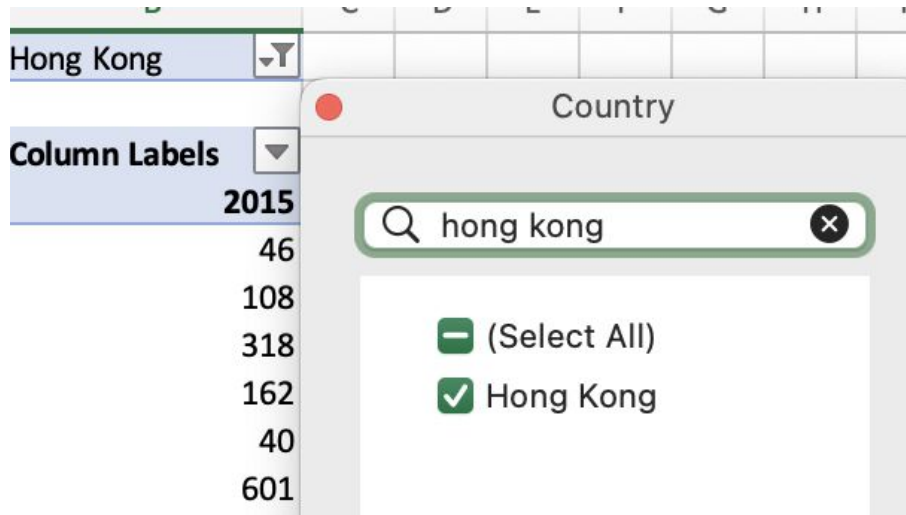
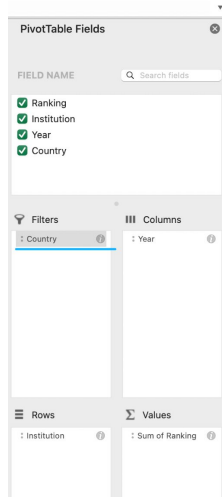
Institution

Sum of Ranking

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2													
3	Sum of Ranking												
4	Row labels	Column Labels	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Grand Total
5	Vilnius University											1201	1201
6	Aalto University		363	356	374	379	343	324	305	326	330	336	3436
7	Aalto University		187	139	133	137	134	127	112	116	109	107	1334
8	Aarhus University		96	107	117	119	141	145	147	155	161	143	1331
9	Aberystwyth University		601	501	491	481	432	484	485	541	651	661	5328
10	Abu Dhabi University		441	441	501	551	531	541	571	601	601	601	5380
11	Abu Dhabi University				701	751	701	701	701	701	651	580	5487
12	Adam Mickiewicz University in Poznań				801	801	801	801	801	801	801	781	5537
13	Addis Ababa University											851	851
14	AgdU University of Science and Technology				801	801	801	801	801	801	801	701	5707
15	Ain Shams University				701	701	801	801	801	801	721	721	6028
16	Airlangga University				701	701	751	651	521	465	369	345	4504
17	Aix-Marseille University		341	361	411	411	415	491	501	490	487	457	4557
18	Al-Farabi Kazakh National University					801	751	701	701	651	551	551	4156
19	Ajou University			651	601	651	651	601	551	531	488	631	5356
20	Akademi University											1201	1201
21	Al Alula University										751	751	1401
22	Al Ain University									701	601	611	1913
23	Al Ashwahan University of Irbid						801						801
24	Al Fuhaj University				701	801	801				1201	1201	4705
25	Al Quds University											1001	1001
26	Al-Ahliyya Amman University											801	801
27	Al-Balqa Applied University											1201	1201
28	Al-Farabi Kazakh National University		305	275	236	236	220	207	165	175	150	230	2199
29	Al Quds University											1001	1001
30	Alexandria University				701	751	801	801	801	1001	1001	801	5757
31	Alexandria University in Dubai						801					1201	4004
32	Alfaisal University										651	731	1382
33	Aligam Muslim University					801	801	801	801	1001	1001	1001	5206
34	Alimay Technological University									561	561	801	1362
35	Altai State University						601		571	561	521	701	2955
36	American University		431	373	384	471	541	601	651	651	701	791	5595
37	American University in Cairo		360	345	365	395	420	395	415	445	416	415	3967
38	American University in Dubai		601	551	551	601	561	601	601	601	651	601	5033
39	American University of Beirut		249	268	228	235	237	244	220	242	252	226	2401
40	American University of Sharjah		390	411	441	411	376	371	348	383	369	364	3854
41	American University of the Middle East								751	701	611	611	2123
42	Ankara University of Technology				501	501	498	489	477	465	443	375	3749
43	Antalya University									1001	1001	1001	2803
44	Antonia Vrhova Vojvodanin (Deemed University)						801	801	801	1001	1001	1001	4409
45	An-Najah National University									1001	1001	1001	2002
46	Antioch University		601	651	651	601	581	561	651	601	601	771	6721
47	Antioch University										1201	1201	2402
48	Antioch University										1201	1201	2402
49	Ankara University				701	801	801	801	801	801	1001	901	6608
50	Anena University					651	751	751	801	801	551	427	4733
51	Aoyama Gakuin University				701	801	801				1201	1201	4705
52	Applied Science University Bahrain							651	591	561	582	2885	2885
53	Arab Academy for Science, Technology and Maritime Transport											1001	1001
54	Arabian Gulf University		501	491	461	411							1964
55	Aristotle University of Thessaloniki		461	461	491	501	561	561	571	551	651	530	5339
56	Arizona State University		294	249	222	209	212	215	220	216	219	179	2235
57	Azerbaijan Kazakh National Medical University									601	651	901	2153
58	Asia Pacific University of Technology and Innovation											621	621
59	Asia University										1001	901	1502
60	Assiut University						801	801			1001	1001	3604
61	Assiut University		390	346	358	373	381	442	511	485	561	446	4293
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Plot the rankings of all the universities from Hong Kong

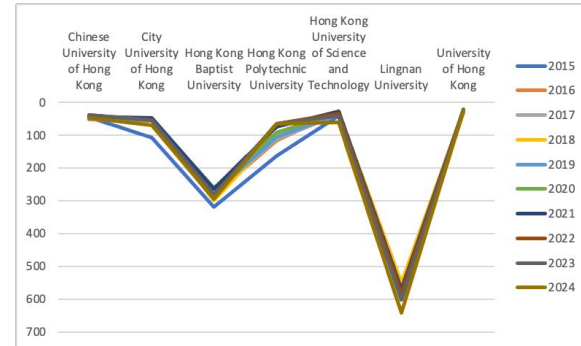
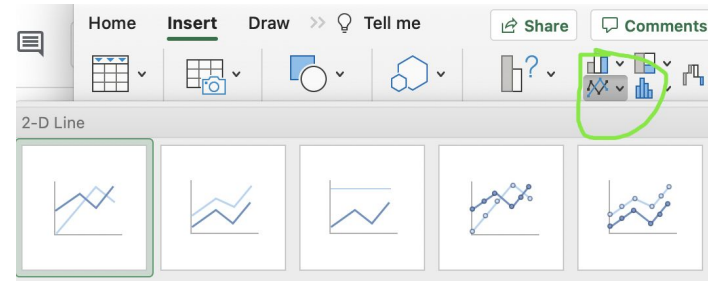
- Make a copy of Pivot Table_all and rename it as Pivot Table_HK
- Utilize the filter field in PivotTable
- Only select Hong Kong in the filter



Plot the rankings of all the universities from Hong Kong

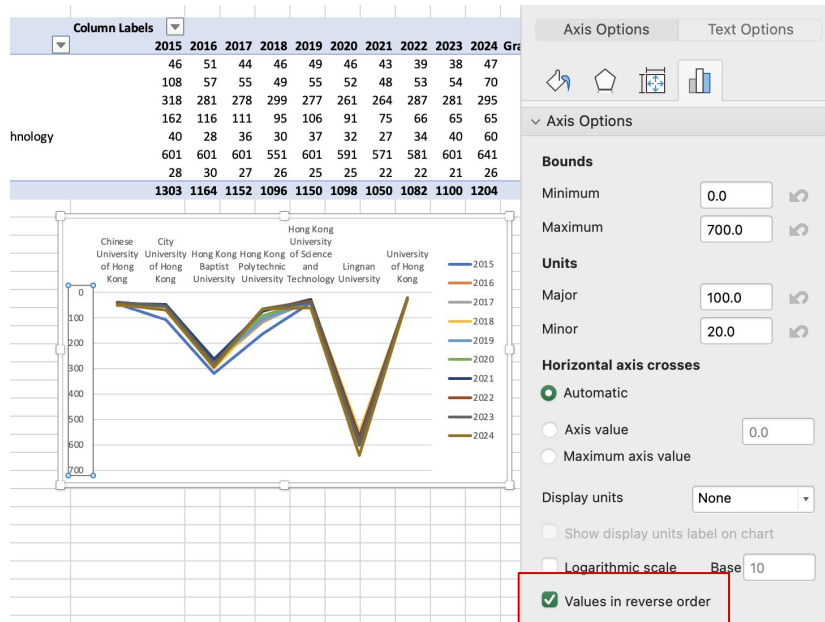
- Get line chart in sheet Pivot Table_HK
 - Select the data
 - Insert->2D-Line

Country	Hong Kong												
Sum of Ranking	Column Labels												
Row Labels	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Grand Total		
Chinese University of Hong Kong	46	51	44	46	49	46	43	39	38	47	449		
City University of Hong Kong	108	57	55	49	55	52	48	53	54	70	601		
Hong Kong Baptist University	318	281	278	299	277	261	264	287	281	295	2841		
Hong Kong Polytechnic University	162	116	111	95	106	91	75	66	65	65	952		
Hong Kong University of Science and Technology	40	28	36	30	37	32	27	34	40	60	364		
Lingnan University	601	601	601	551	601	591	571	581	601	641	5940		
University of Hong Kong	28	30	27	26	25	25	22	22	21	26	252		
Grand Total	1303	1164	1152	1096	1150	1098	1050	1082	1100	1204	11399		



Plot the rankings of all the universities from Hong Kong

- flip the y-axis, zero at the top-left



Checklist for your submission

- Countries sheet

Institution	Country
National University de La Plata	Argentina
Pontifical Catholic University Argentina	Argentina
Universidad de Palermo	Argentina
University of San Andres	Argentina
National Technological University	Argentina
National University de Tucumán	Argentina
National University de Rosario	Argentina
Buenos Aires Institute of Technology	Argentina
National University de Mar del Plata	Argentina
National University of the South	Argentina
National University de Río Cuarto	Argentina
National University de Cuyo	Argentina
University Torcuato di Tella	Argentina
University of Salvador	Argentina
National University de Quilmes	Argentina
National University de General San Martín	Argentina
Catholic University of Córdoba	Argentina
National University of the Littoral	Argentina
University of Belgrano	Argentina
University of Buenos Aires	Argentina
National University de San Luis	Argentina
National University de Córdoba	Argentina
National University of Central Buenos Aires	Argentina
National University del Comahue	Argentina
Austral University	Argentina
Yerevan State University	Armenia
Russian-Armenian (Slavonic) State University	Armenia
Flinders University	Australia

Checklist for your submission

- Ranking sheet with **Country Column**

A	B	C	D
Ranking	Institution	Year	Country
1	Massachusetts Institute of Technology, MIT	2015	USA
2	Imperial College London	2015	UK
2	University of Cambridge	2015	UK
4	Harvard University	2015	USA
5	University College London	2015	UK
5	University of Oxford	2015	UK
7	Stanford University	2015	USA
8	California Institute of Technology, Caltech	2015	USA
9	Princeton University	2015	USA
10	Yale University	2015	USA
11	University of Chicago	2015	USA
12	Swiss Federal Institute of Technology Zurich, ETHZ	2015	Switzerland
13	University of Pennsylvania	2015	USA
14	Johns Hopkins University	2015	USA
14	Columbia University	2015	USA
16	King's College London	2015	UK
17	Swiss Federal Institute of Technology Lausanne, EPFL	2015	Switzerland
17	University of Edinburgh	2015	UK
19	Cornell University	2015	USA
20	University of Toronto	2015	Canada
21	McGill University	2015	Canada
22	National University of Singapore	2015	Singapore
23	University of Michigan - Ann Arbor	2015	USA
24	Ecole Normale Supérieure de Paris	2015	France
25	Australian National University	2015	Australia
25	Duke University	2015	USA
27	University of California, Berkeley	2015	USA
28	University of Hong Kong	2015	Hong Kong
29	University of Bristol	2015	UK
30	University of Manchester	2015	UK
31	The University of Tokyo	2015	Japan
31	Seoul National University	2015	South Korea
33	University of Melbourne	2015	Australia
34	Northwestern University	2015	USA
35	Ecole Polytechnique	2015	France
36	Kyoto University	2015	Japan
37	University of Sydney	2015	Australia
37	University of California, Los Angeles	2015	USA
39	Nanyang Technological University	2015	Singapore
40	Hong Kong University of Science and Technology	2015	Hong Kong

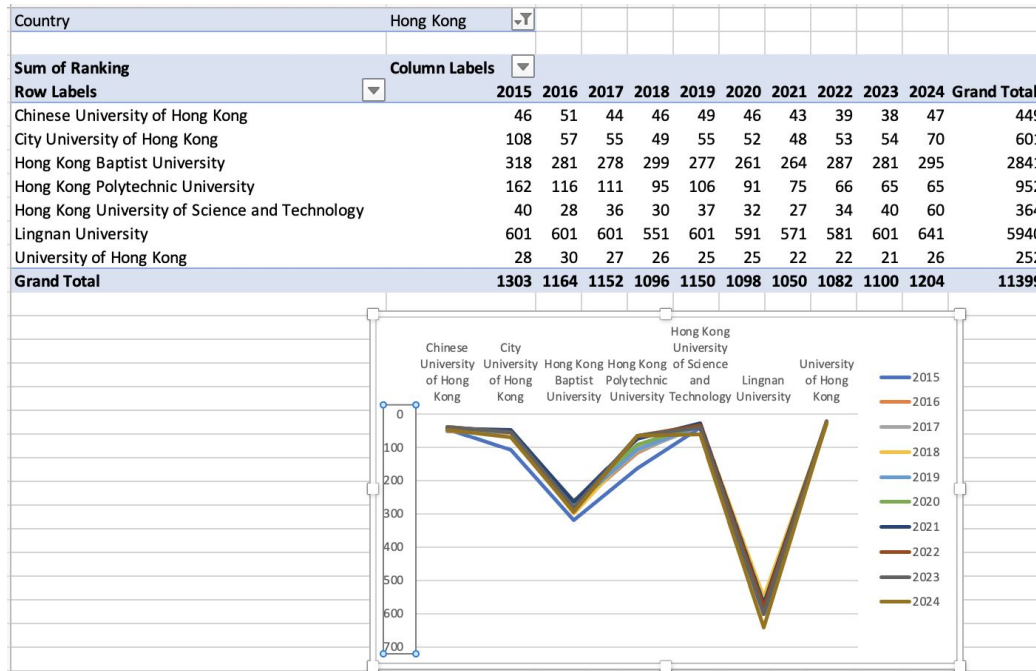
Checklist for your submission

- Pivot Table_all

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2													
3	Sum of Ranking	Column Labels											
4	Row Labels	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Grand Total	
5	Vibuda University										1201	1201	
6	Aalborg University	363	356	374	379	343	324	305	326	330	336	3436	
7	Aalto University	187	139	133	137	140	134	127	112	116	109	1334	
8	Aarhus University	96	107	117	119	141	145	147	155	161	143	1331	
9	Aberystwyth University	601	501	491	481	432	484	485	541	651	661	5328	
10	Abo Akademi University	441	441	501	551	531	541	571	601	601	601	5380	
11	Abu Dhabi University			701	751	701	701	701	701	651	580	5487	
12	Adam Mickiewicz University in Poznan				801	801	801	801	801	801	731	5537	
13	Addis Ababa University										851	851	
14	AGH University of Science and Technology				801	801	801	801	801	801	901	5707	
15	Ain Shams University			701	701	701	801	801	801	801	721	6028	
16	Airlangga University			701	701	751	651	521	465	369	345	4504	
17	Aix-Marseille University	341	361	411	411	453	491	511	501	490	387	4357	
18	Ajman University of Science and Technology					801	751	701	701	651	551	4156	
19	Ajou University		651	601	651	651	601	551	531	488	631	5356	
20	Akdeniz University									1201		1201	
21	Al Ahlia University									651	751	1402	
22	Al Ain University								701	601	611	1913	
23	Al Akhawayn University of Ifrane					801						801	
24	Al Azhar University			701	801	801				1201	1201	4705	
25	Al Quds University										1001	1001	
26	Al-Ahliyya Amman University										801	801	
27	Al-Balqa Applied University									1201		1201	
28	Al-Farabi Kazakh National University	305	275	236	236	220	207	165	175	150	230	2199	
29	Al-Quds University									1001		1001	
30	Alexandria University			701	751	801	801	801		1001	901	5757	
31	Alexandru Ioan Cuza University				801	801				1201	1201	4004	
32	Alfaisal University									651	731	1382	
33	Aligarh Muslim University				801	801	801	801		1001	1001	5206	
34	Almaty Technological University									561	801	1362	
35	Altai State University					601		571	561	521	701	2955	
36	American University	431	373	384	471	541	601	651	651	701	791	5595	
37	American University in Cairo	360	345	365	395	420	395	411	445	416	415	3967	
38	American University in Dubai	601	551	551	601	561	601	601	601	651	601	5920	

Checklist for your submission

- Pivot Table_HK and two other Pivot table with any two countries
- Line chart with y-axis reversed (Your line chart can have different styles)



More topics on MS Excel Visualization

- Coursera courses
 - [Problem Solving with Excel](#)
 - [Data Visualization with Advanced Excel](#)
- Other notable features of MS Excel
 - Power Pivot, PivotCharts, Solver, Goal Seek, Data Tables, Scenario Manager, Simulation Features, ToolPak, Macros, Dashboard, Power View, Conditional Formatting, Form Control, VBA
- [A detailed Excel visualization guide](#)
- [A list of data visualization with Excel websites](#)

Next tutorial

Data processing and
Tableau

- Install Tableau beforehand
 - Tableau student (Full version, preferred):
<https://www.tableau.com/academic/students>
 - Or Tableau Public: <https://public.tableau.com>

Tableau

- Tableau Public
 - Free
 - All saved works are public
 - Publicly viewable, downloadable
 - Must connect to the internet in order to save
 - Less data connectors
- Tableau Desktop
 - **Free for students, need verification**
 - Can save locally, use without connecting to the internet
 - More data connectors
- Tableau Server
 - Standalone, dedicated server
 - Enterprise level, expensive