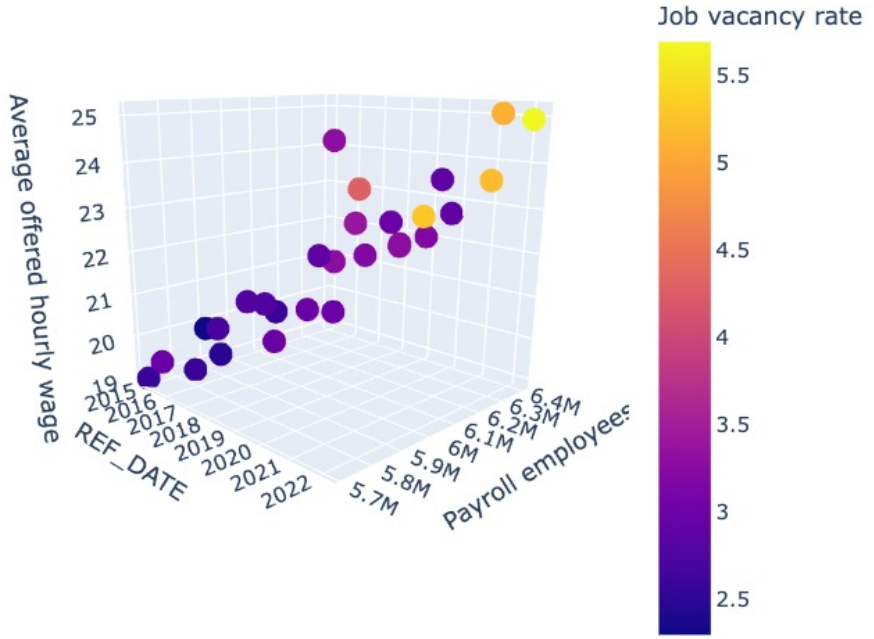
UNIVERSITY OF TORONTO SCARBOROUGH | MANAGEMENT Experience to Lead

Beyond 2D data visualization: Animated, interactive 3D and virtual reality visualizations



Presenters:
Mr. Bill Chau, CFA, FRM
Ms. Brittany Chen

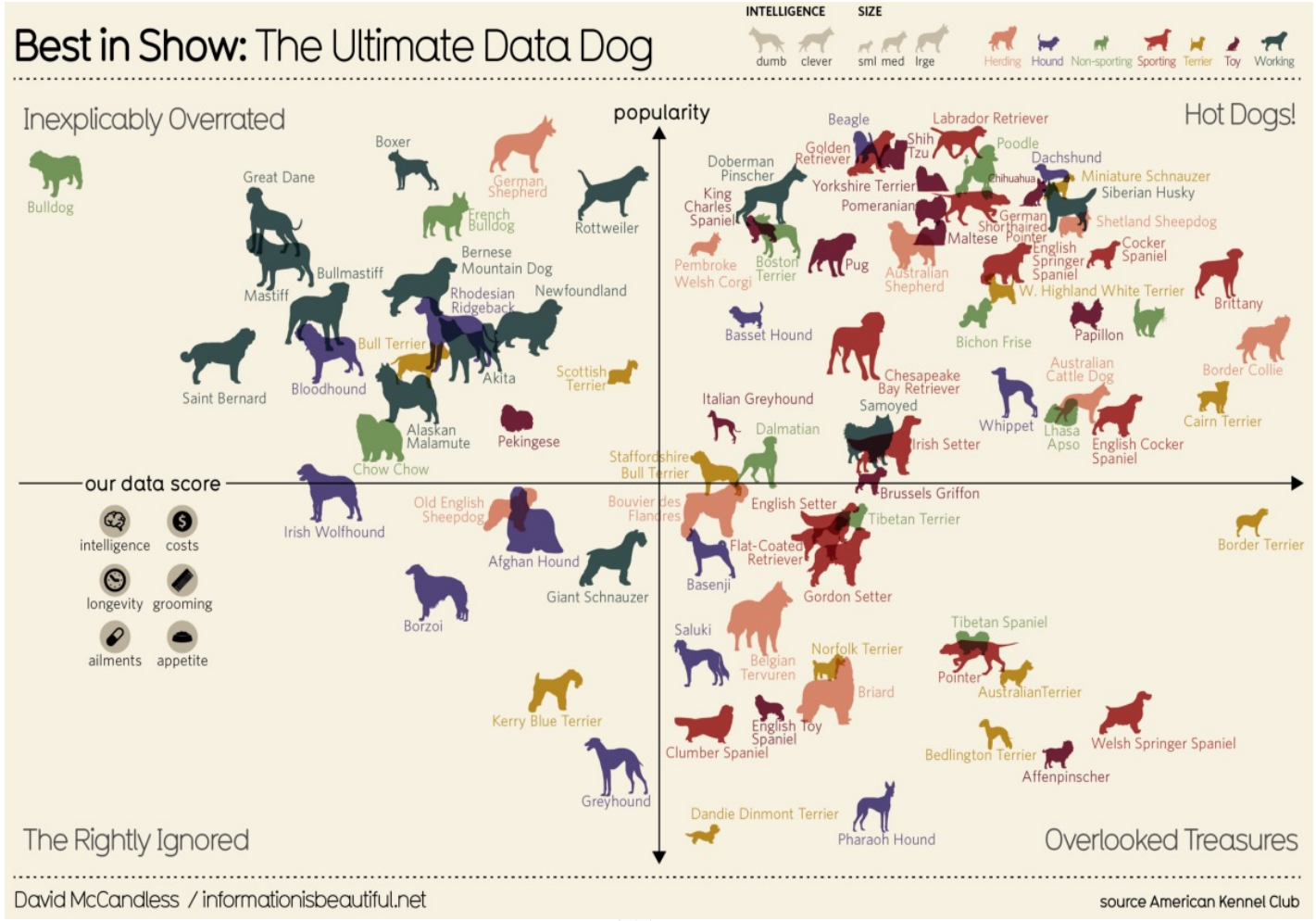
Data source: Statistics Canada. Table 14-10-0371-01 Job vacancies, payroll employees, and job vacancy rate by provinces and territories, monthly, unadjusted for seasonality

Agenda

- Introduction to Data Visualization and the application to Economic Data
- Data Animation with a PowerBI Example
- Data visualization in 3D and best practices
- 3D Visualization Coding example with Plotly
- Virtual Reality Visualization and its recent development

Introduction to Data Visualization

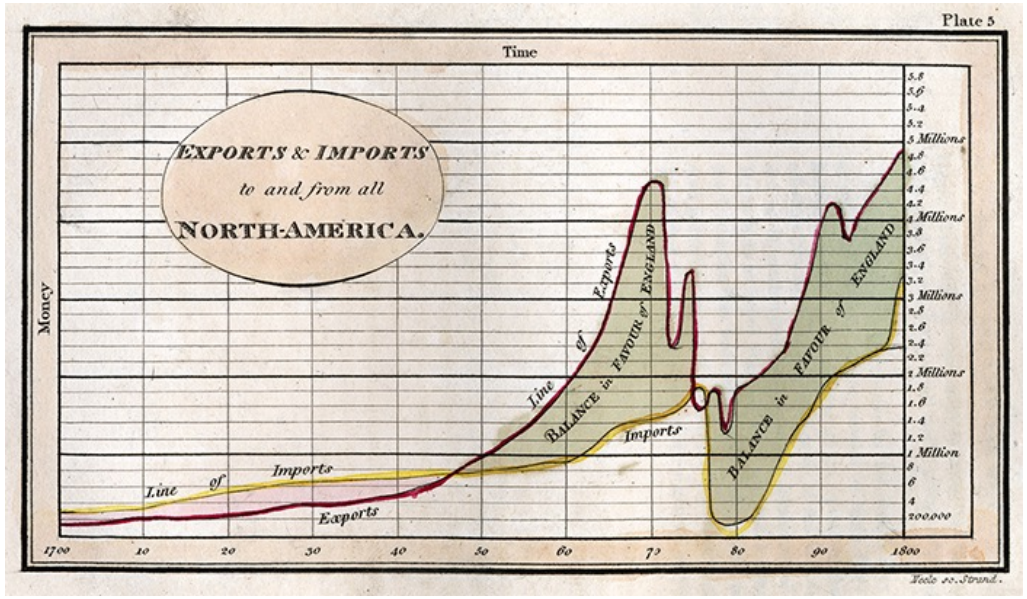
- Clearly and effectively transmit communication information through graphical
- More easily understand the content represented by data.
- Different datasets have different characteristics.
- Better showing the structural characteristics of the data itself can be achieved

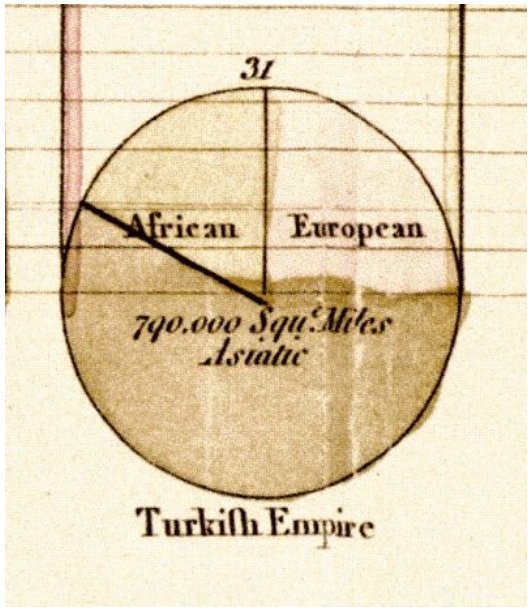


Du, Feng. "Development Model of China's Regional Economic Cooperation Based on Network Analysis and Multimedia Data Visualization." Advances in Multimedia, vol. 2021, 2021, pp. 1–7, https://doi.org/10.1155/2021/4266363

McCandless, D. (2014). *Knowledge is beautiful.* [Infographic] Harper Design.

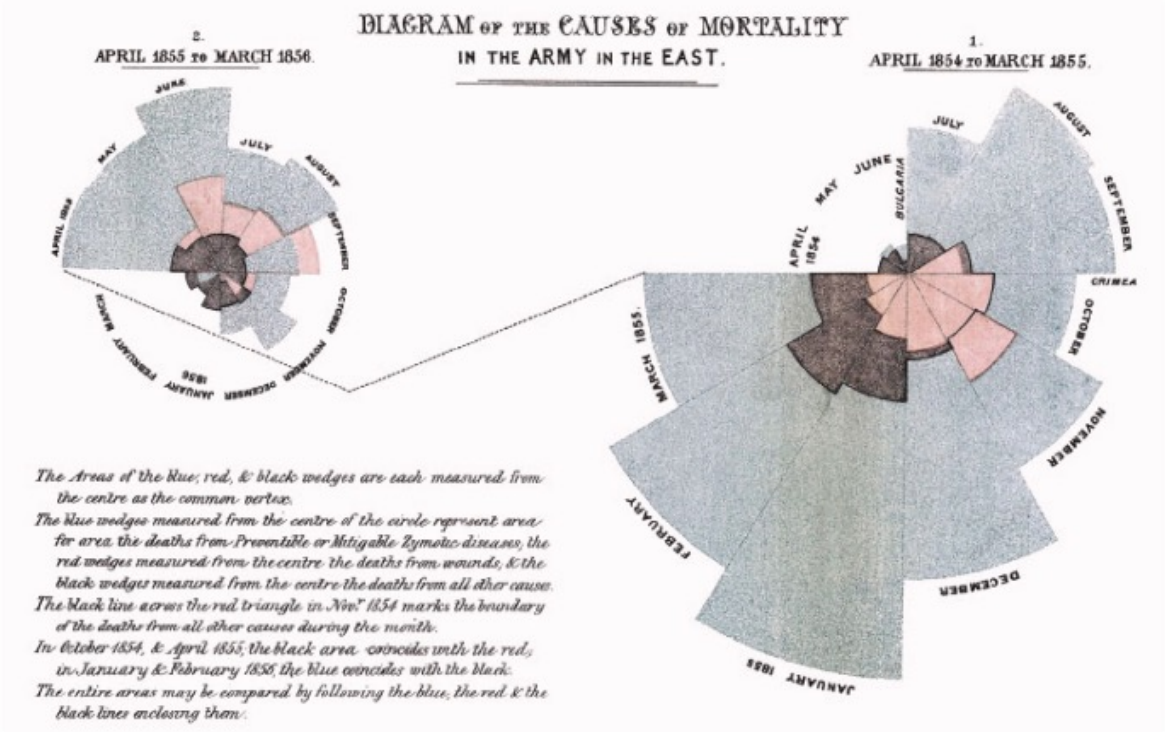
Brief History of Data Visualization





Late 1700s, The commercial and political atlas and Statistical breviary by William Playfair

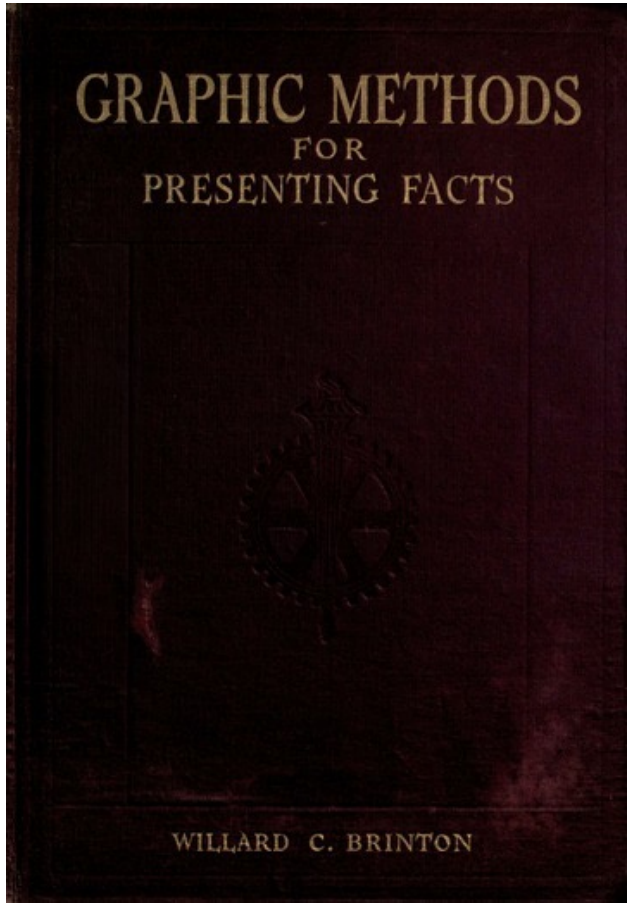
1858, Florence Nightingale, Coxcomb Diagrams

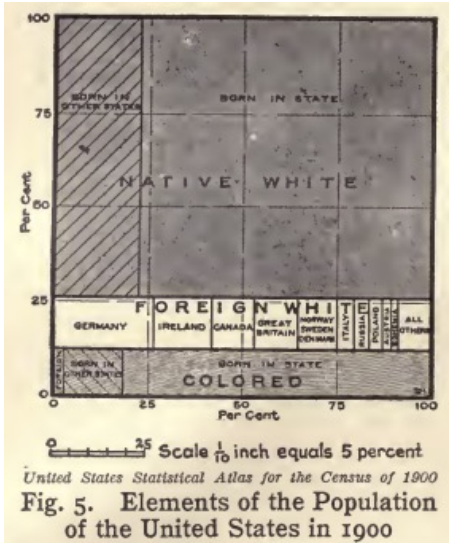


Playfair, W. (1801). *THE COMMERCIAL AND POLITICAL ATLAS Representing, by Means of STAINED COPPER-PLATE CHARTS, THE PROGRESS OF THE COMMERCE, REVENUES, EXPENDITURE, AND DEBTS OF ENGLAND, DURING THE WHOLE OF THE EIGHTEENTH CENTURY.* [Infographic]. Internet Achieve https://archive.org/details/PLAYFAIRWilliam1801TheCommercialandPoliticalAtlas/page/n39/mode/2up

Berinato, S. (2016). Good charts : the HBR guide to making smarter, more persuasive data visualizations. [Infographic]. Harvard Business Review Press.

Brief History of Data Visualization

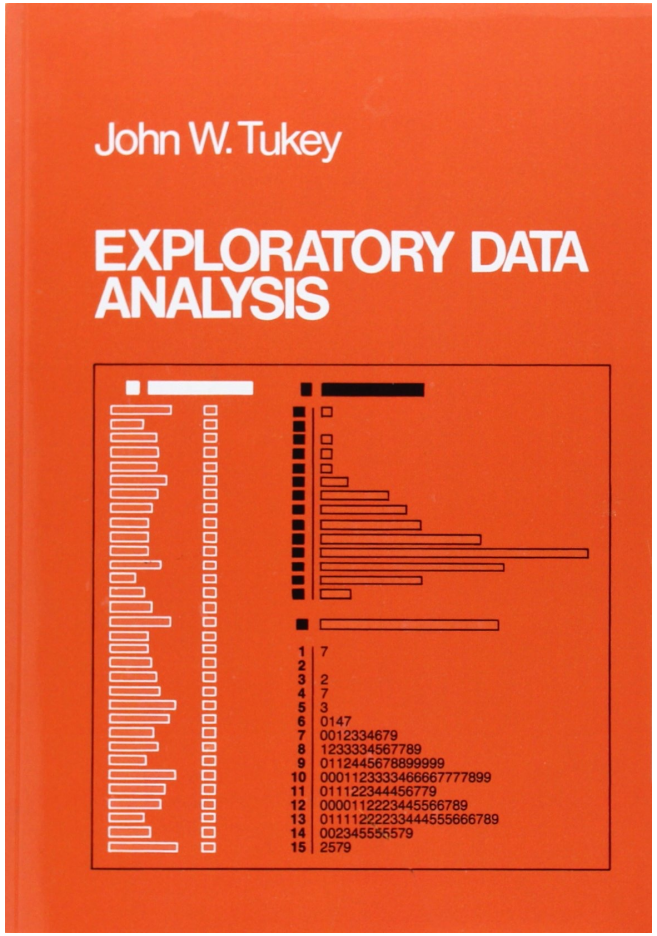




United States Statistical Atlas for the Census of 1900

Fig. 5. Elements of the Population of the United States in 1900

1914, Willard Brinton, Graphic Methods for Presenting Facts



Break table for two-decimal logs

A) MAIN BREAK TABLE

Break	log	Break	log	Break	log	Break	log	Break	log
9886		**1567**	.20	**2483**	.40	**3936**	.60	**6237**	.80
1012	.00	**1603**	.21	**2541**	.41	**4027**	.61	**6383**	.81
1035	.01	**1641**	.22	**2600**	.42	**4121**	.62	**6531**	.82
1059	.02	**1679**	.23	**2661**	.43	**4217**	.63	**6683**	.83
1084	.03	**1718**	.24	**2723**	.44	**4315**	.64	**6839**	.84
1109	.04	**1758**	.25	**2786**	.45	**4416**	.65	**6998**	.85
1135	05	**1799**	.26	**2851**	.46	**4519**	.66	**7161**	.86
1161	.06	**1841**	.27	**2917**	.47	**4624**	.67	**7328**	.87
1189	.07	**1884**	.28	**2985**	.48	**4732**	.68	**7499**	.88
1216	.08	**1928**	.29	**3055**	.49	**4842**	.69	**7674**	.89
1245	.09	**1972**	.30	**3126**	.50	**4955**	.70	**7852**	.90
1274	.10	**2018**	.31	**3199**	.51	**5070**	.71	**8035**	.91
1303	.11	**2065**	.32	**3273**	.52	**5188**	.72	**8222**	.92
1334	.12	**2113**	.33	**3350**	.53	**5309**	.73	**8414**	.93
1365	.13	**2163**	.34	**3428**	.54	**5433**	.74	**8610**	.94
1396	.14	**2213**	.35	**3508**	.55	**5559**	.75	**8810**	.95
1429	.15	**2265**	.36	**3589**	.56	**5689**	.76	**9016**	.96
1462	.16	**2317**	.37	**3673**	.57	**5821**	.77	**9226**	.97
1496	.17	**2371**	.38	**3758**	.58	**5957**	.78	**9441**	.98
1531	.18	**2427**	.39	**3846**	.59	**6095**	.79	**9661**	.99
1567	.19	**2483**		**3936**	.59	**6237**		**9886**	

When in doubt use an even answer; thus, 1462 gives .16 and 1496 gives .18.

B) SETTING DECIMAL POINTS

1	+0	−1	**1**
10	+1	−2	**0.1**
100	+2	−3	**0.01**
1000	+3	−4	**0.001**
10,000	+4	−5	**0.0001**
100,000	+5	−6	**0.00001**
1,000,000			**0.000001**

C) EXAMPLES

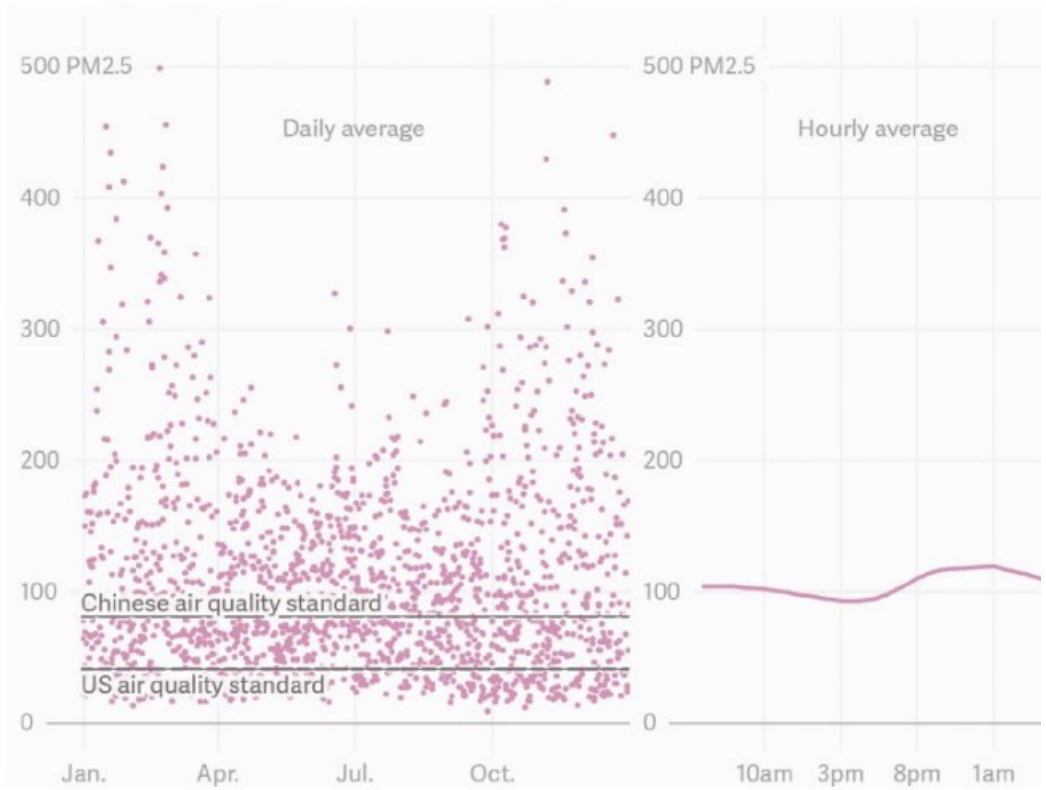
Number	B		A	log number
log 137.2	2	+ .14	=	2.14
log 0.03694	−2	+ .57	=	−1.43
log 0.896	−1	+ .95	=	−0.05
log 174,321	+5	+ .24	=	5.24

1970, John Tukey, Exploratory data analysis

Brinton, Willard C. (1914). *Graphic Methods for Presenting Facts.* Retrieved from https://aviz.fr/wiki/uploads/Bertifier/brinton-graphicMethods-1914.pdf

Tukey, John W. (1977). *Exploratory Data Analysis.* Retrieved from http://www.ru.ac.bd/wp-content/uploads/sites/25/2019/03/102_05_01_Tukey-Exploratory-Data-Analysis-1977.pdf

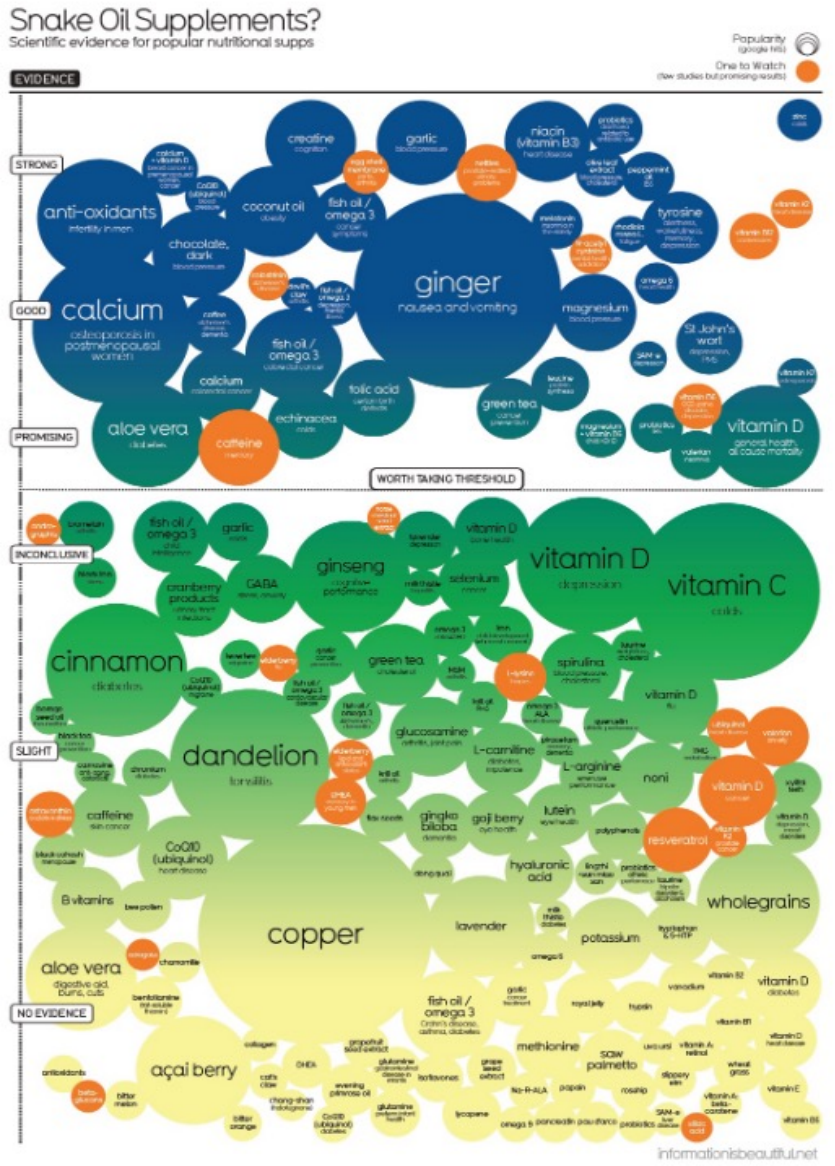
Brief History of Data Visualization



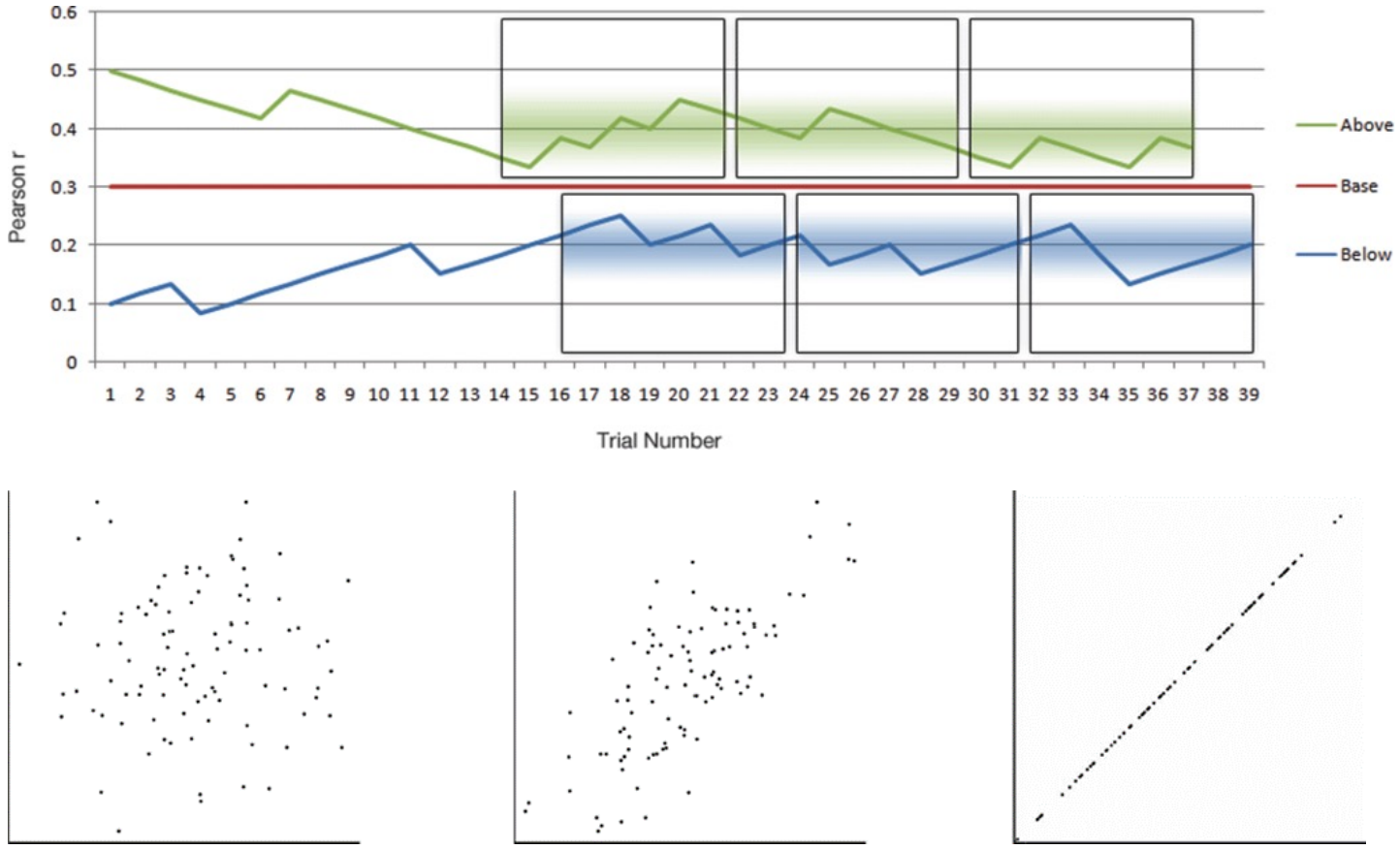
Once the province of a few experts and specialists, visualization now belongs to everyone, including designers, artists, journalists, and scientists.

1990s-2010s, Computer-driven data visualization

Berinato, S. (2016). Good charts : the HBR guide to making smarter, more persuasive data visualizations. [Infographic]. Harvard Business Review Press.



Brief History of Data Visualization



2010,Ronald Rensink, Perception of Correlation in Scatterplot

Rensink, R. A., & Baldridge, G. (2010). The Perception of Correlation in Scatterplots. Computer Graphics Forum, 29(3), 1203–1210. https://doi.org/10.1111/j.1467-8659.2009.01694.x

Today

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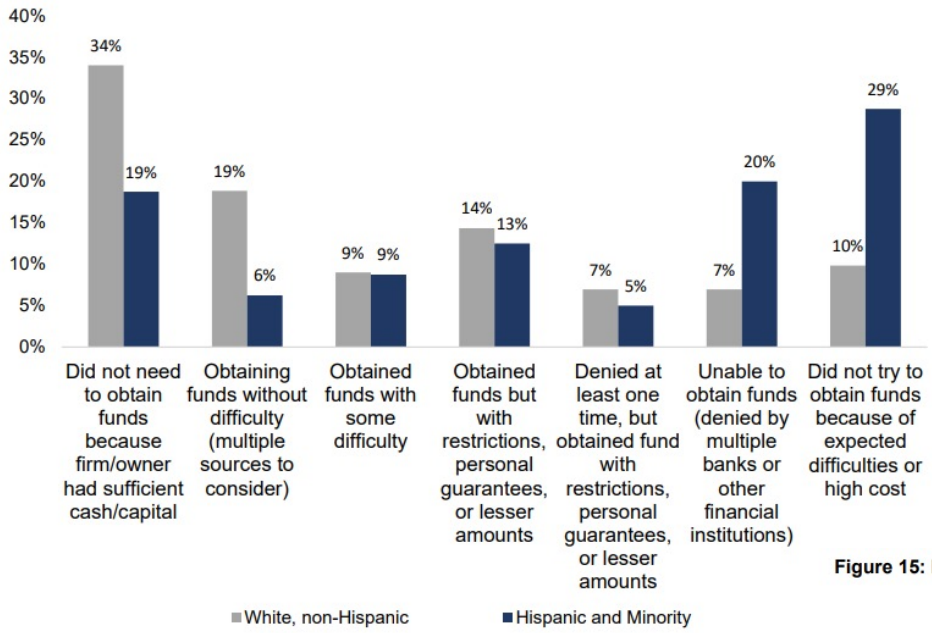
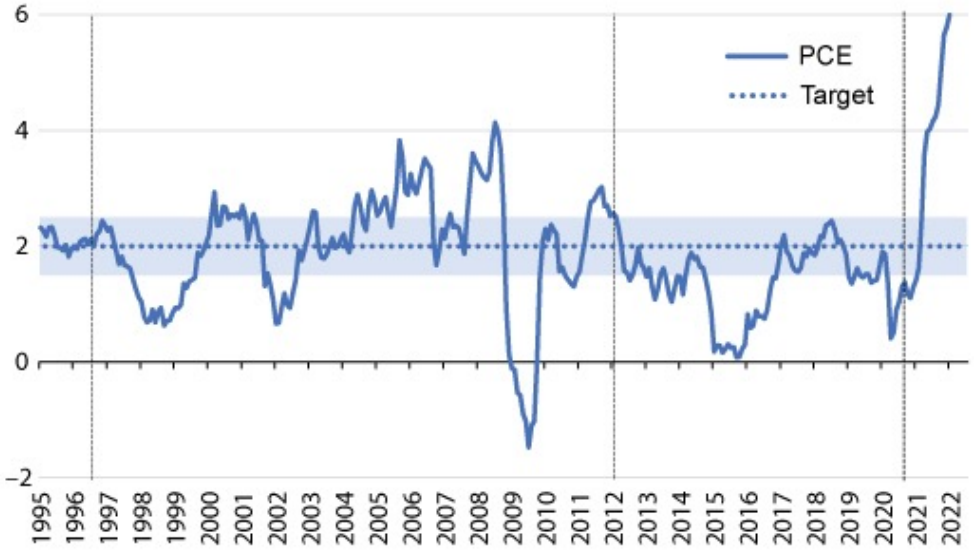
Figure 1b. Hispanic and minority firms report lower access to credit pre-pandemic



Gascon, C. et al., (Nov 2021).*Special Survey: The Impact of the COVID-19 Pandemic on Missouri Small Businesses and the Path Toward Recovery.* Economic Research Federal Reserve Bank of St. Louis Retrieved from https://files.stlouisfed.org/files/htdocs/uploads/2021_oct2_survey_Missouri_business_report_20211002.pdf

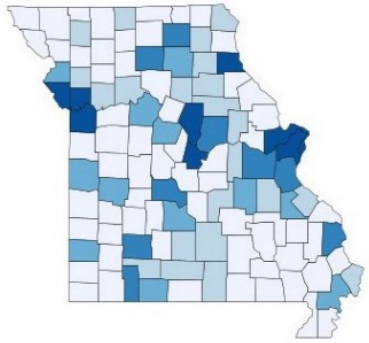
Figure 2
Actual and Target PCE Inflation

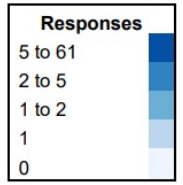


SOURCE: Haver, Bureau of Economic Analysis, and authors' calculations.

Garriga, C. & Werner, D., (2022). *Inflation, Part 3: What Is the Fed's Current Goal? Has the Fed Met Its Inflation Mandate?* Economic Research Federal Reserve Bank of St. Louis Retrieved from https://files.stlouisfed.org/files/htdocs/uploads/2021_oct2_survey_Missouri_business_report_20211002.pdf

Figure 15: Distribution of survey responses by county





Note: Shading represents the number of responses in a county, as reported by the respondent.

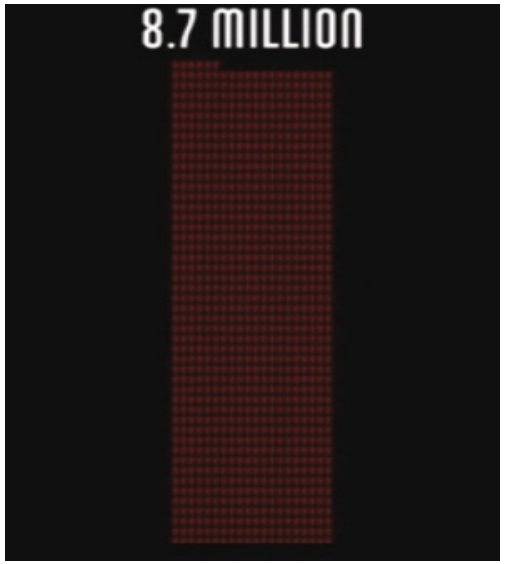
Data visualization in 2D

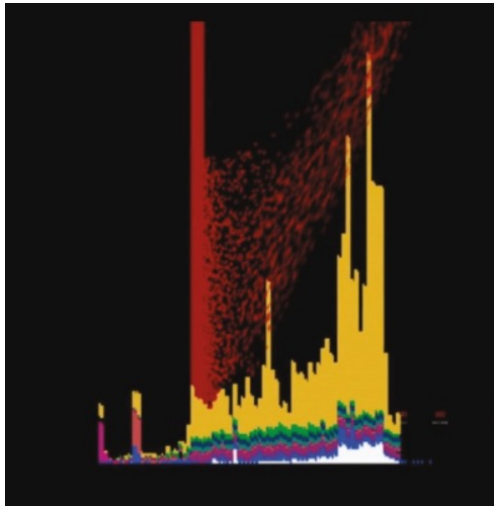
- 2D commonly used
- Many types within 2D
- Optional formant depends on the needs
- What if add a time?

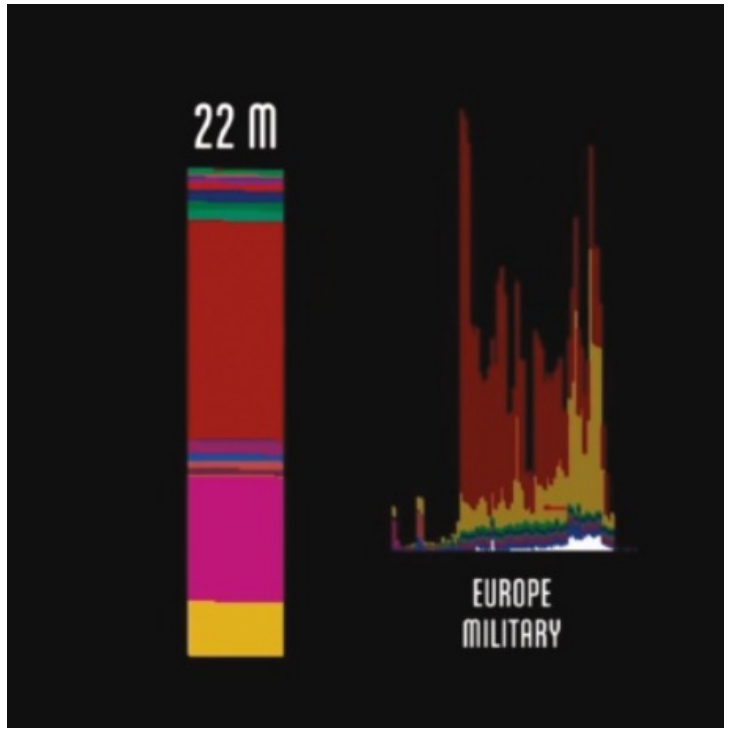
Ribecca, R. (2022). Retrieved from datavizcatalogue.com

What is Data Animation

- Deconstruction and reconstruction
- Engagement in learning of dynamic mechanism
- Example: World War II death
- https://www.youtube.com/watch?v=DwKPFT-RioU







Berinato, S. (2016). Good charts : the HBR guide to making smarter, more persuasive data visualizations. [Image]. Harvard Business Review Press.

2D amination chart code(how to do)

Français

Statistics Canada Statistique Canada

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Home > Data

Labour force characteristics by sex and detailed age group, monthly, unadjusted for seasonality (x 1,000)[1]

Frequency: Monthly

Help

Table: 14-10-0017-01 (formerly CANSIM 282-0001)

Save my customizations

Release date: 2022-10-07

Geography: Canada, Province or territory

▼ Customize table

Geography :[2] Canada

Labour force characteristics : Employment

Reference period From: April 1976 To: August 2022

Apply

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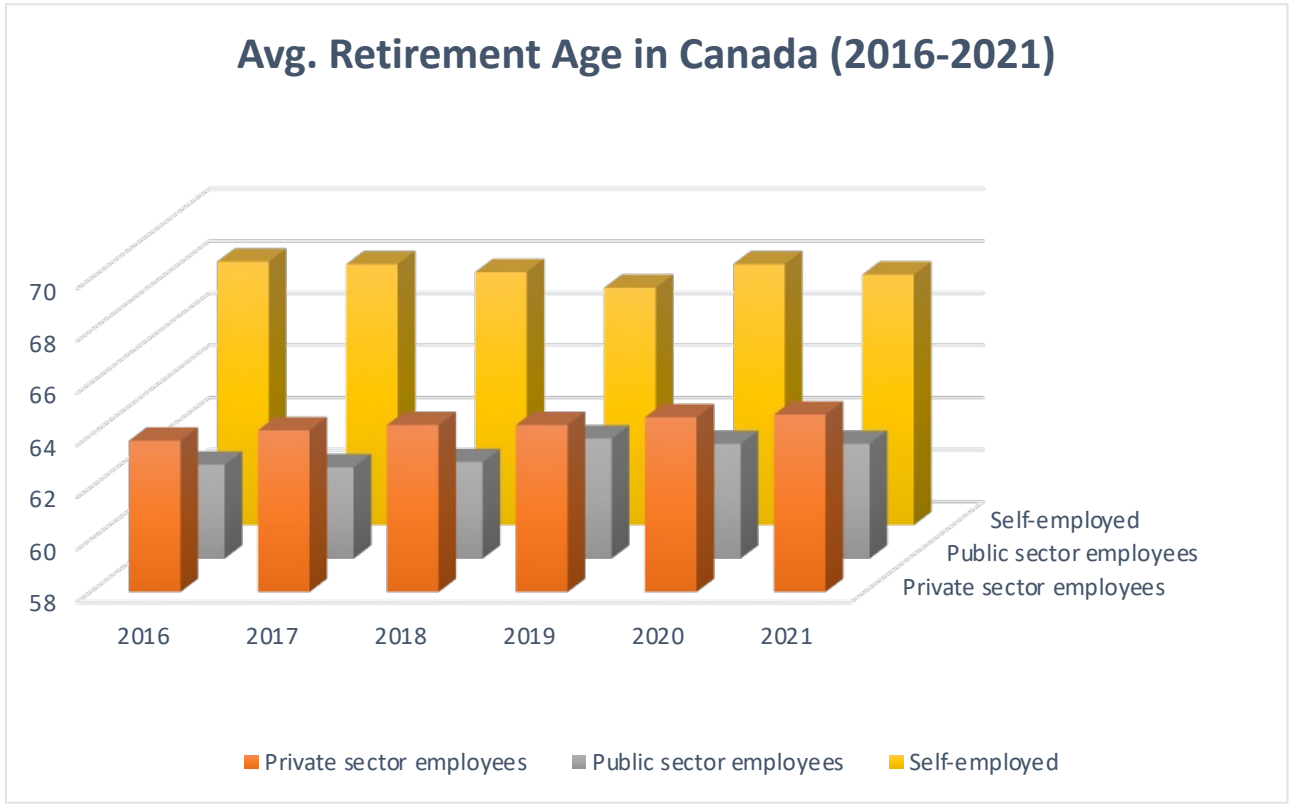
Showing 66 records | Filter | Reset

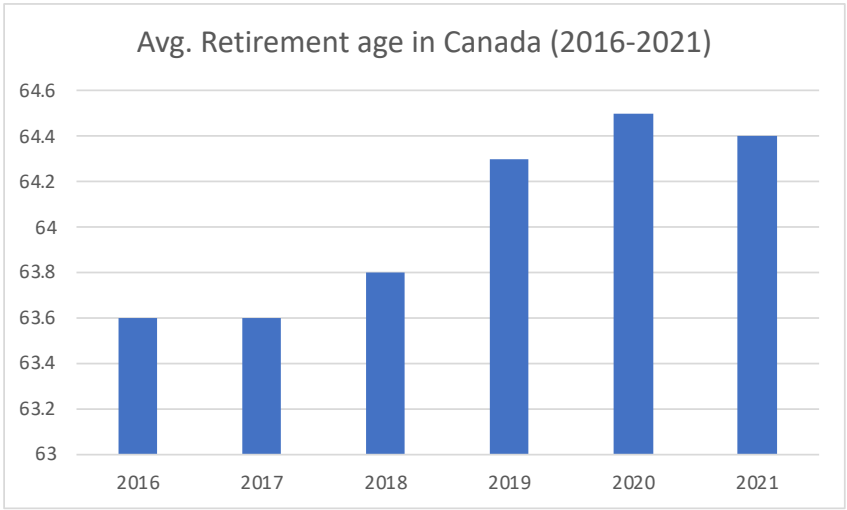
Geography[2]															
Labour force characteristics															
Sex	Age group	April 1976	May 1976	June 1976	July 1976	August 1976	September 1976	October 1976	November 1976	December 1976	January 1977	February 1977	March 1977	April 1977	May 1977
	15 years and over	9,503.0	9,766.4	10,030.9	10,221.8	10,206.6	9,864.0	9,844.1	9,789.7	9,719.1	9,485.7	9,534.7	9,591.3	9,649.1	9,996.2
	15 to 24 years	2,385.8	2,540.6	2,740.6	2,957.8	2,927.3	2,499.3	2,485.1	2,463.2	2,452.6	2,361.7	2,365.0	2,395.9	2,421.6	2,610.1
	25 years and over	7,117.2	7,225.8	7,290.3	7,264.0	7,279.3	7,364.7	7,358.9	7,326.5	7,266.5	7,124.0	7,169.7	7,195.4	7,227.5	7,386.1

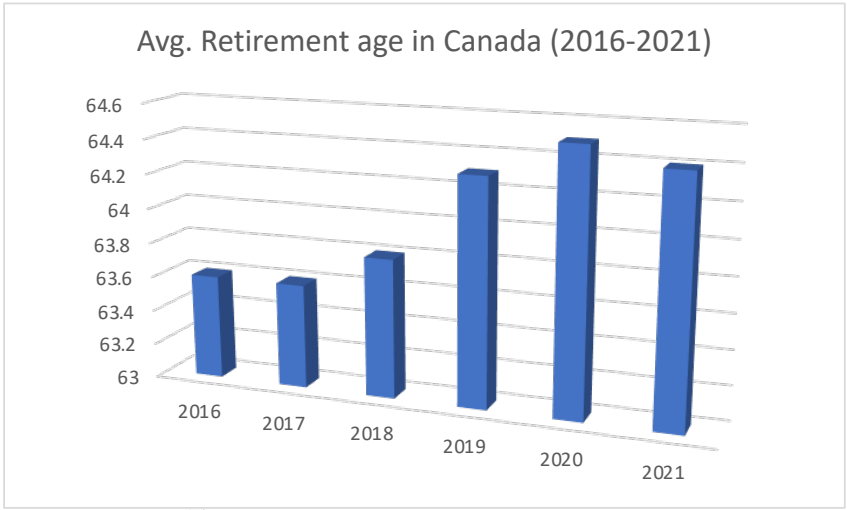
Data source: Statistics Canada. Table 14-10-0017-01 Labour force characteristics by sex and detailed age group, monthly, unadjusted for seasonality (x 1,000)

Data visualization in 3D

- There was a time when people think 3D was cool, but it turned out to be a horrible idea.
- It is hard to interpret and not very accurate



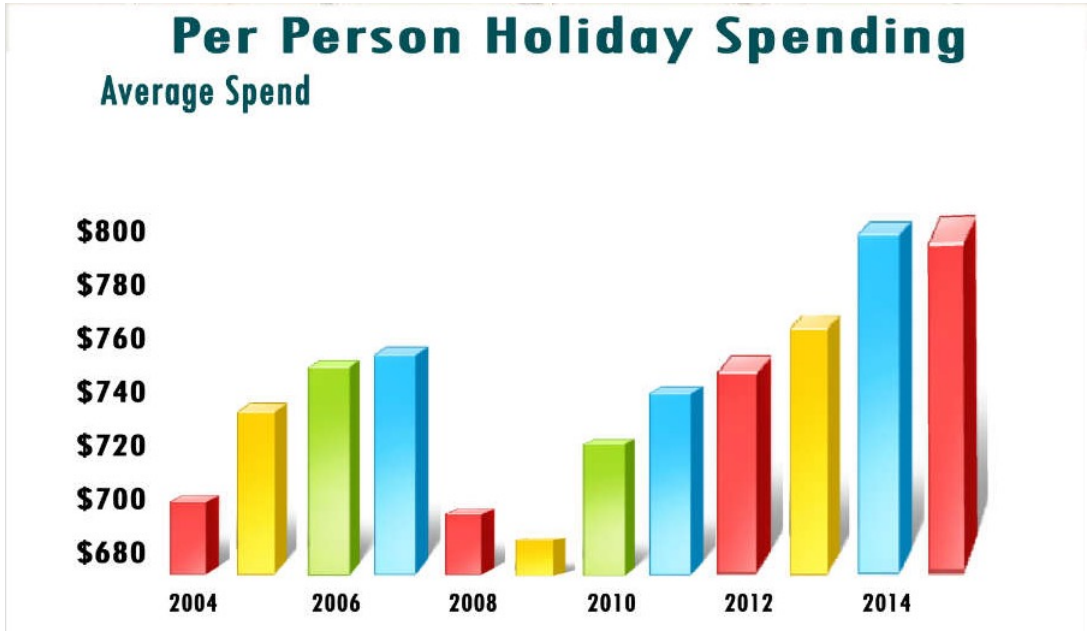




Data source: Statistics Canada. Table 14-10-0060-01 Retirement age by class of worker, annual

Bad 3D visualizations

- 3D Bar charts
- 3D Pie charts



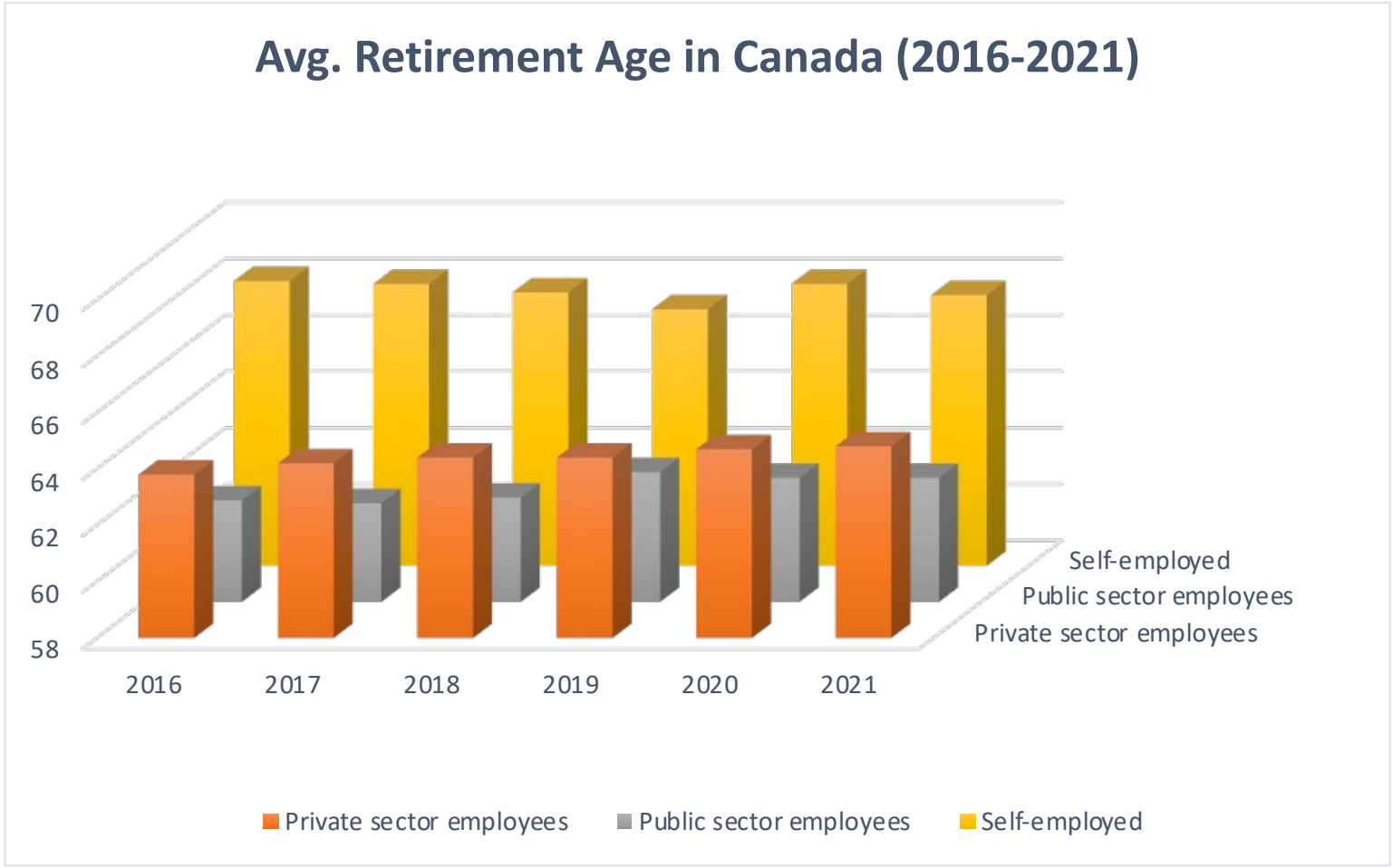
Source: unknown author, https://viz.wtf/, 2022

3D Visualization with a 3rd Axis

Problems with static 3D visualizations

- With a fixed perspective

  the size of an object can change based on its distance from the viewer, making it difficult to compare values



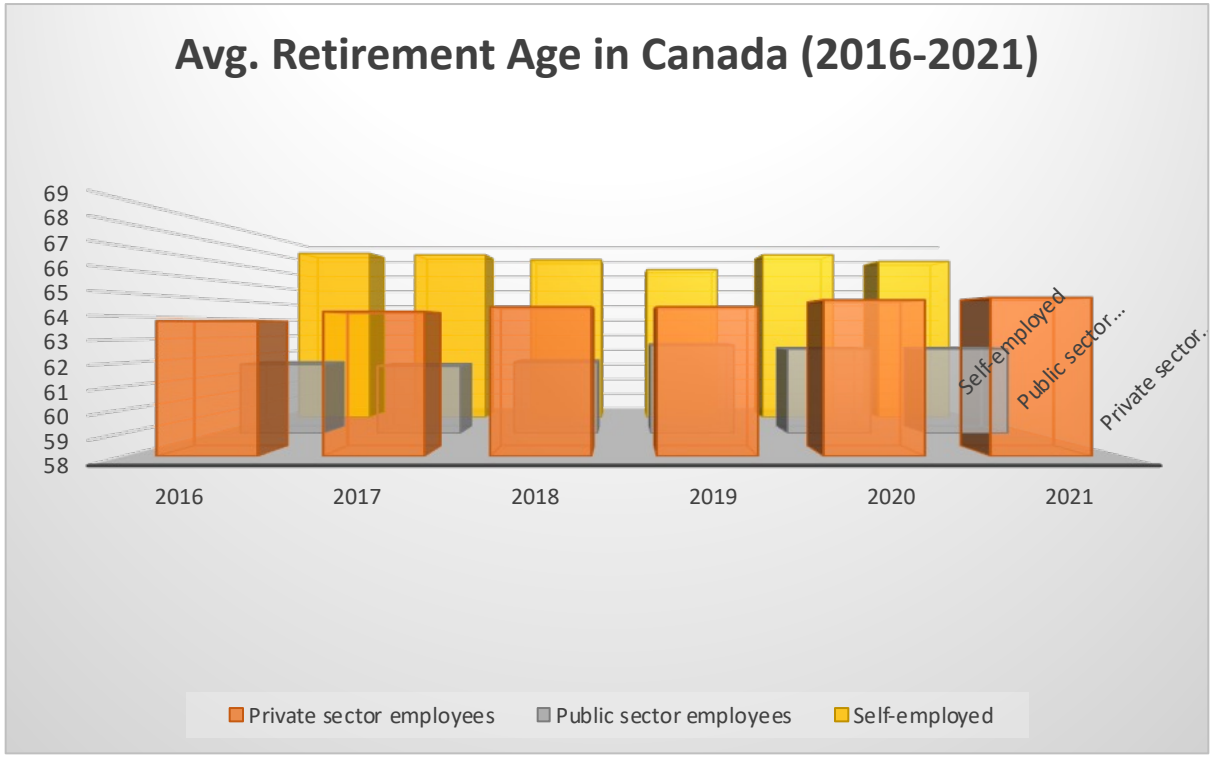
Data source: Statistics Canada. Table 14-10-0060-01 Retirement age by class of worker, annual

3D Visualization with a 3rd Axis

Problems with static 3D visualizations

- With a fixed viewpoint

  where to position our 'eye' relative to the chart. Details can be obstructed



Data source: Statistics Canada. Table 14-10-0060-01 Retirement age by class of worker, annual

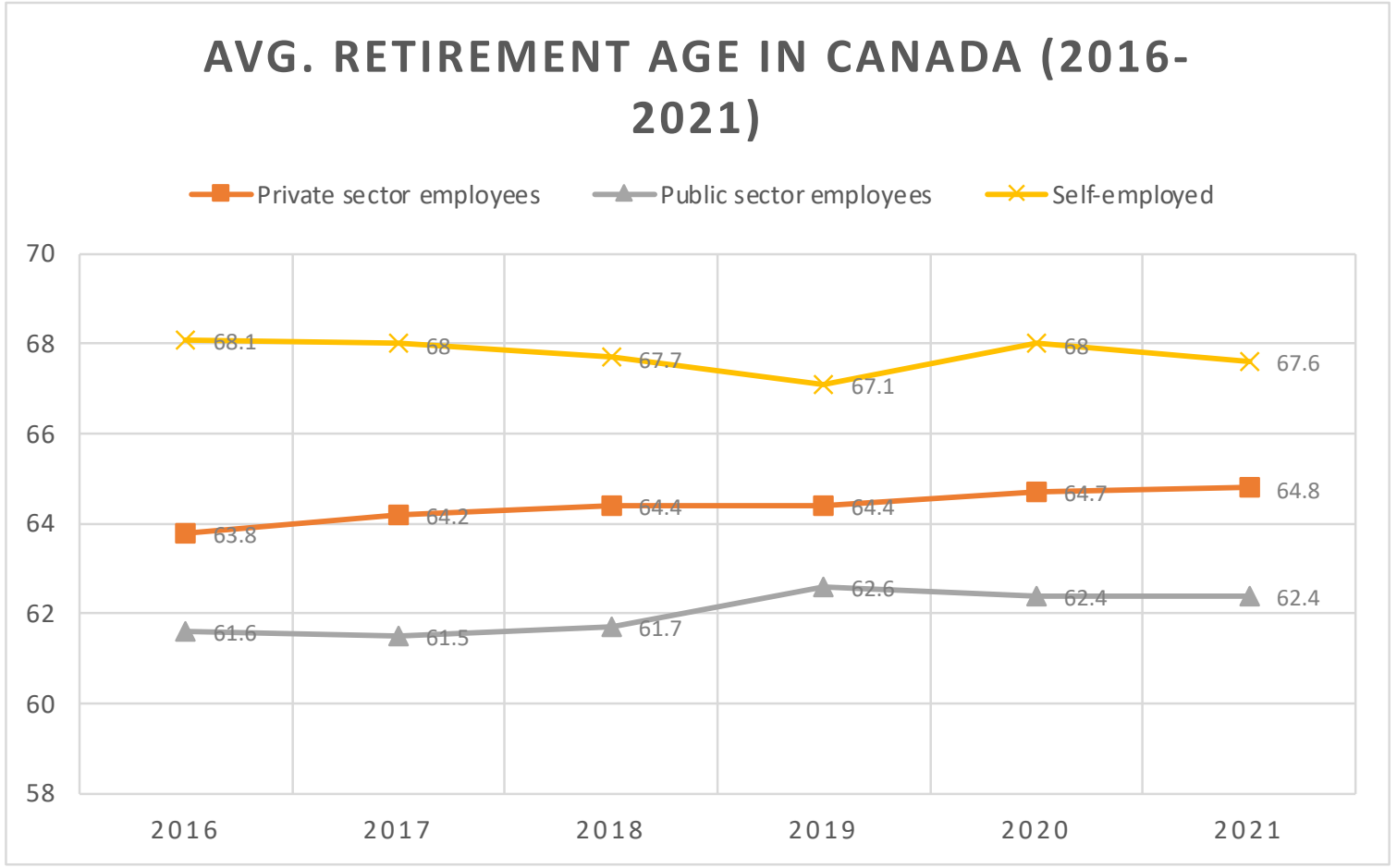
Showing 3D data without going 3D

For discrete data, use:

- Color
- Shape

For continuous data, use:

- Frequency gradient
- Size (Bubbles)



Data source: Statistics Canada. Table 14-10-0060-01 Retirement age by class of worker, annual

A successful example of 3D visualization

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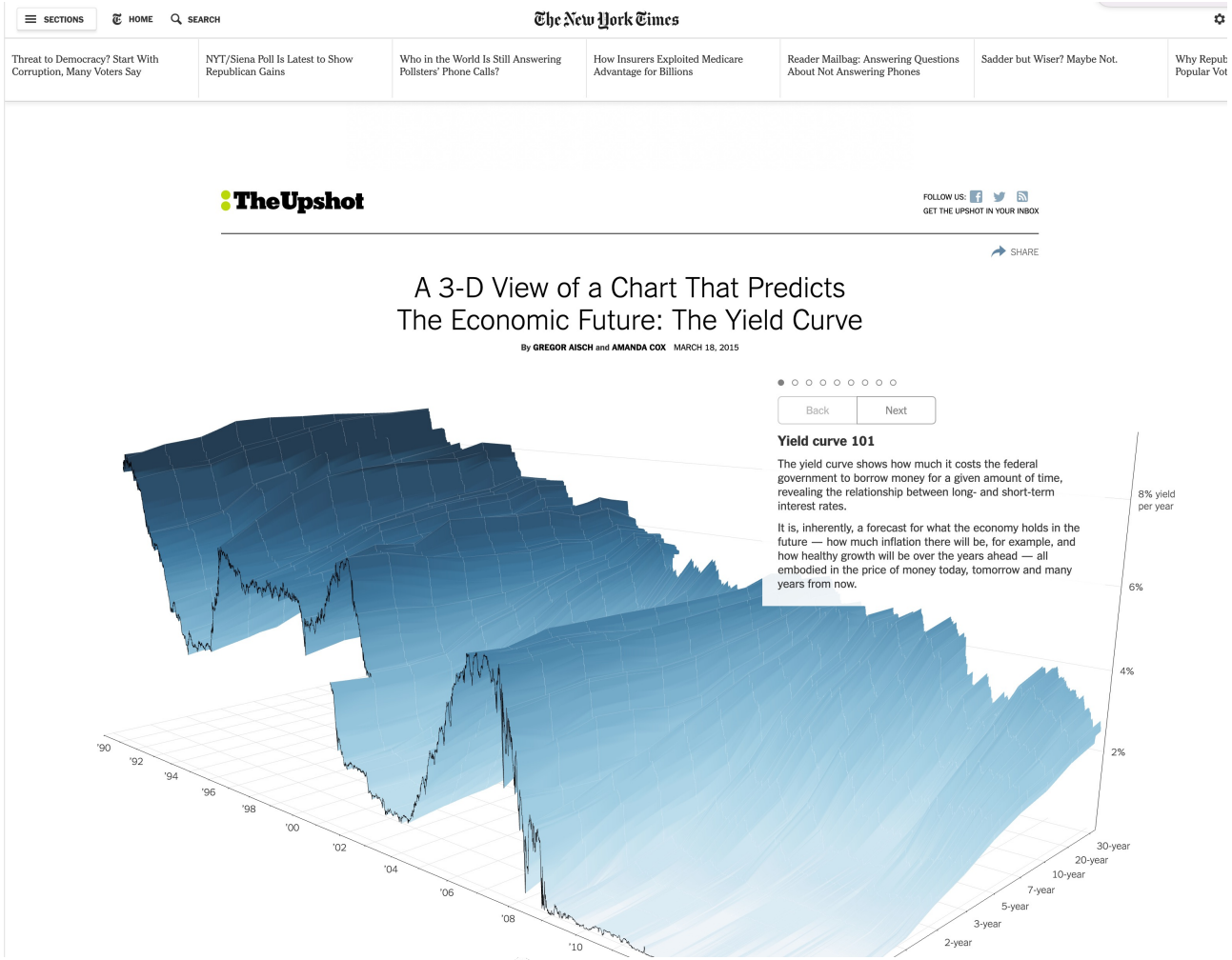
- The interactive features solved some of the problems of static 3D visualization
  - **Zooming**
  - **Panning(rotation)**
  - **Moving**
  - **Labels and details**



Source: Gregor Aisch and Amanda Cox, The New York Times, 2015

The Advantages of Interactive 3D Visualization

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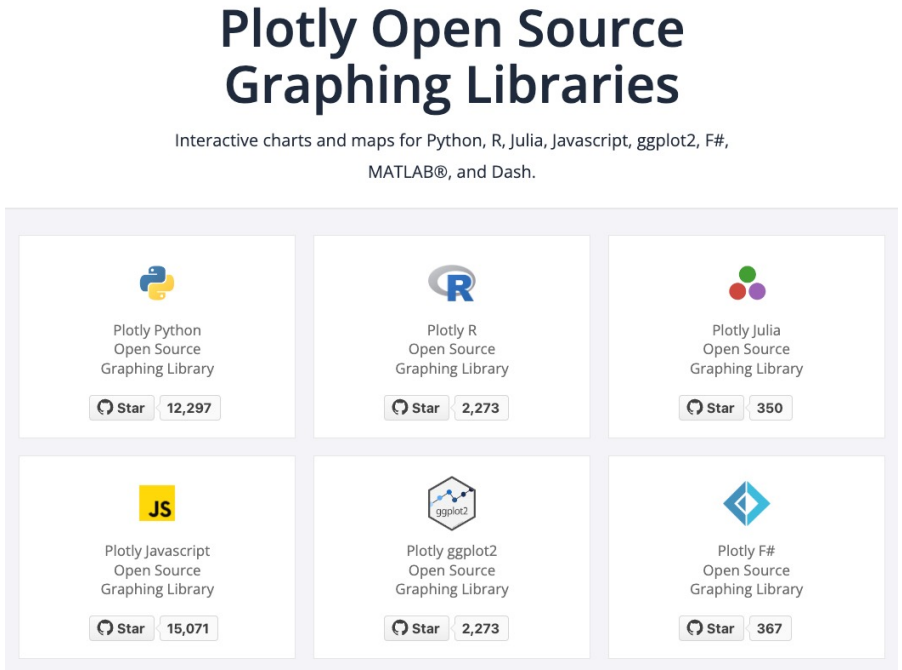
- One interactive 3D view vs many static 2D
- Empower user to explore
- The “Visual Information-Seeking Mantra”: overview first, zoom and filter, then details-on-demand
- Creates engagement with the audience who may not be interested in the data in the first place

Image source: The Globe and Mail

Plotly

- Free and open-source
- Available in Python, R, JS and Matlab etc.



https://plotly.com/graphing-libraries/

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Statistics Canada / Statistique Canada

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Home > Data

Job vacancies, payroll employees, and job vacancy rate by provinces and territories, monthly, unadjusted for seasonality[1, 2, 3]

Frequency: Monthly

Table: 14-10-0371-01

Release date: 2022-09-29

Geography: Canada, Province or territory

Help

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▶ Customize table

Add/Remove data | Download options

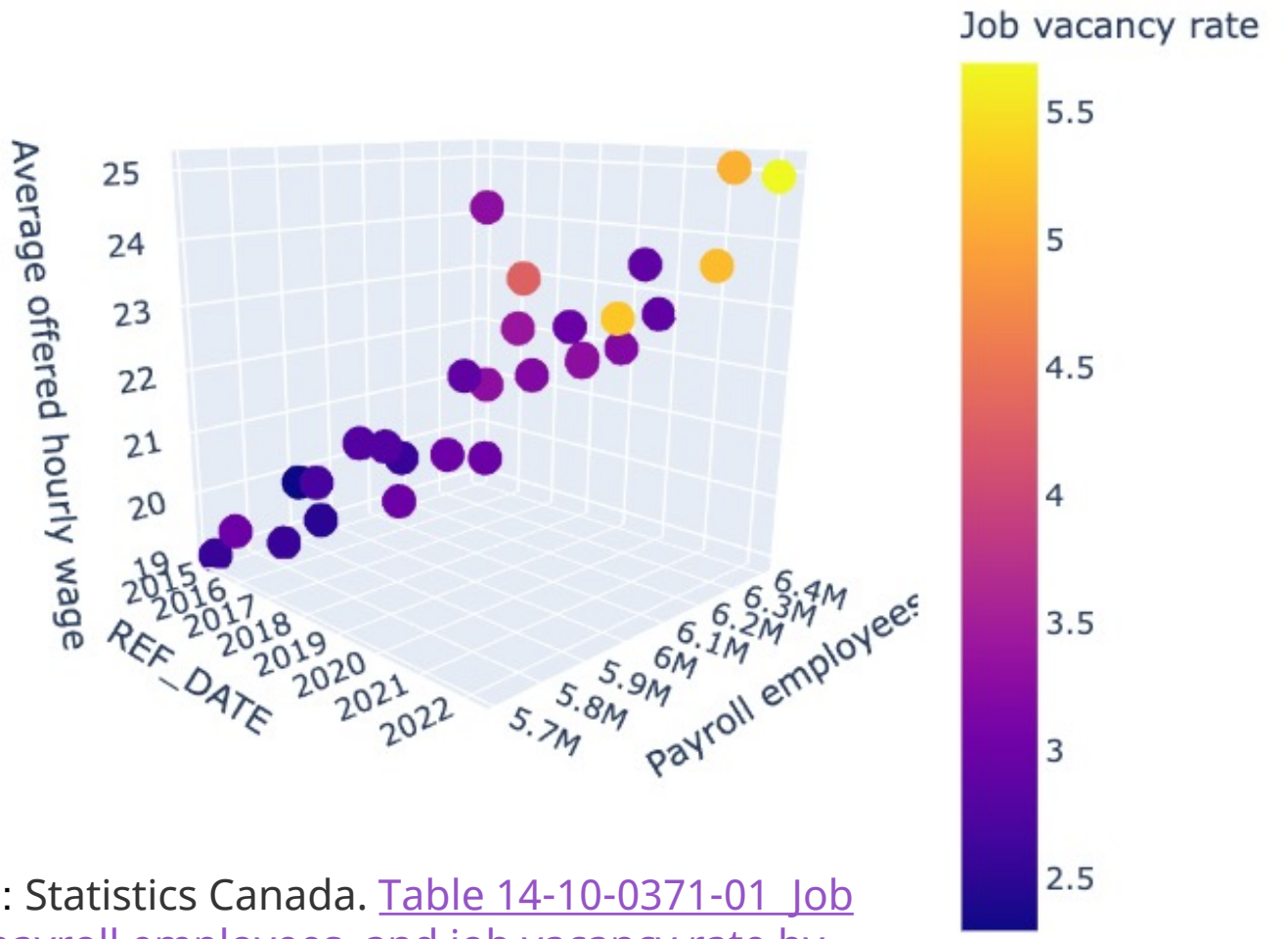
Didn't find what you're looking for? View related tables, including other calculations and frequencies

Showing 42 records | Filter | Reset

Geography	Statistics	March 2022	April 2022	May 2022	June 2022	July 2022
		Number				
Canada (map)	Job vacancies[4]	977,805[A]	1,034,105[A]	1,036,755[A]	1,020,395[A]	964,035[A]
	Payroll employees[5, 6]	16,071,855[A]	16,240,805[A]	16,477,295[A]	16,677,455[A]	17,055,040[A]
		Percentage				
	Job vacancy rate[7]	5.7[A]	6.0[A]	5.9[A]	5.8[A]	5.4[A]
		Number				
Newfoundland and Labrador (map)	Job vacancies[4]	7,790[B]	9,065[B]	9,705[D]	8,610[B]	8,160[D]
	Payroll employees[5, 6]	176,280[A]	206,605[B]	183,310[C]	199,945[A]	223,180[C]
		Percentage				
	Job vacancy rate[7]	4.2[B]	4.2[C]	5.0[D]	4.1[B]	3.5[D]
		Number				
Prince Edward Island (map)	Job vacancies[4]	3,190[D]	4,195[C]	5,570[E]	3,510[D]	2,320[E]
	Payroll employees[5, 6]	60,590[B]	61,430[A]	64,435[A]	71,000[A]	73,880[A]

Data source: Statistics Canada. Table 14-10-0371-01 Job vacancies, payroll employees, and job vacancy rate by provinces and territories, monthly, unadjusted for seasonality

Interactive 3D scatterplots



Data source: Statistics Canada. Table 14-10-0371-01 Job vacancies, payroll employees, and job vacancy rate by provinces and territories, monthly, unadjusted for seasonality

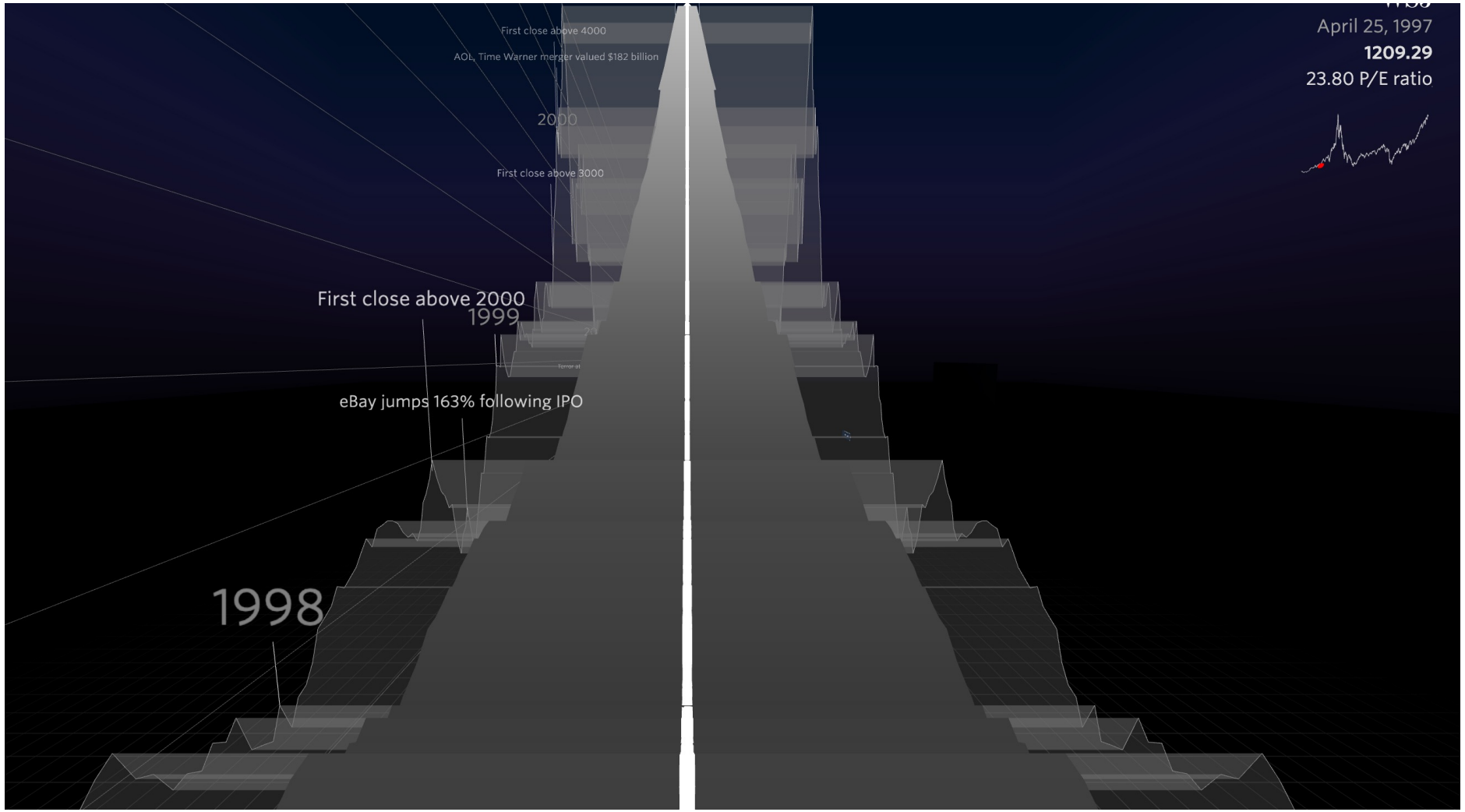
Best Practices and considerations

- 3-dimentional visualization on 3-dimentional data
- Ie. Data with 3 variables and their relationship is critical to the analysis

Although 3D graphs are relatively easy to produce with the aid of software it may not apply to printed publications.

Alternatively, consider using dashboard with multiple panels of 2D graphs

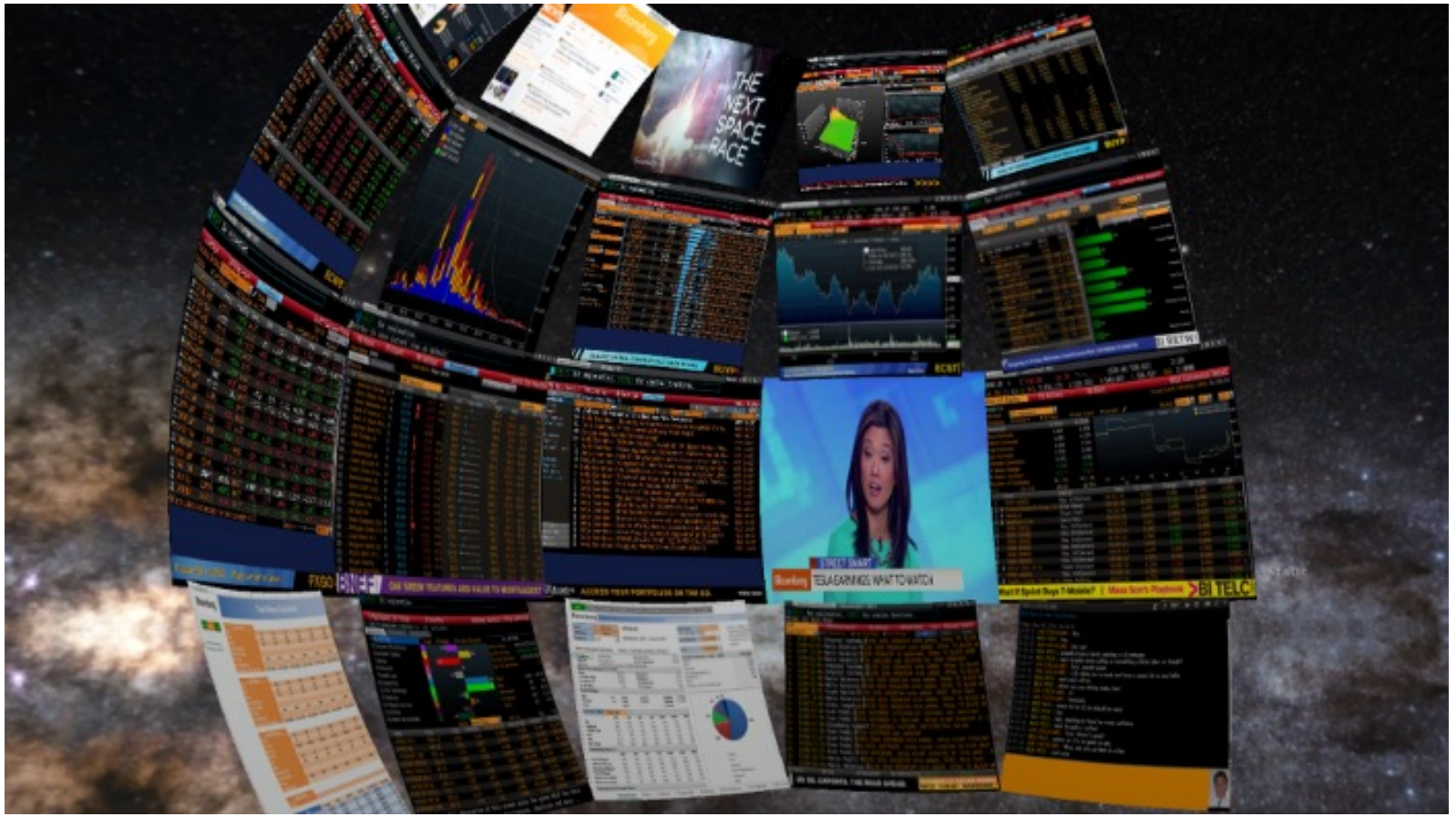
Virtual Reality



Kenny, R and Becker, A. A. (2015). Retrieved from http://graphics.wsj.com/3d-nasdaq/

Benefits of Virtual Reality

- Multi-dimensional data analysis
- Much more workspace
- More natural interaction



Source: Sward, Z.M, qz.com, 2015

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Thank you!

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