



Data Chart Types

IT 7113 Data Visualization

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<http://idi.Kennesaw.edu/it7113/>

Content Overview



Charts are the basic kind of data visualization tool and used universally in all kinds of reports and analysis.

This lecture notes (the first one on charting) provides an introduction of charts and their categorizations, with a focus on commonly used charts.

Topics of this lecture:

- Categorization of charts particularly by functions/purposes
- Summary of the most common type charts

Chart



- A chart is a graphical representation of data
 - Chart is a unique combination of symbols (visual elements) with visual properties which directly represents quantitative values
 - <http://en.wikipedia.org/wiki/Chart>
- Chart vs. Diagram
 - These two terms are very similar; they are often used together or interchangeably in daily life.
 - Chart is more abstractly presented and focuses more on quantitative values.
 - Diagrams also cover a lot of qualitative information like process, concepts, ideas, structures, etc.; they also intergrade more real-world contexts like maps.
 - Diagram is sometimes considered to include chart.

Basic Chart Types



- Basic or general-use charts serve a wide range of analysis and visualization needs.
 - They are commonly applied in all kinds of reports and analysis, and not limited to a particular type of business or industry.
 - The basis for other advanced charts, composite charts, or more specialized charts.
 - Commonly named directly by its visual elements, bar, pie, line, etc.
- List of basic chart types
 - bar/column chart
 - line/area chart
 - pie chart
 - scatter/bubble chart
 - spider/radar chart
- Other common charts
 - Histogram
 - Tree map
 - Heat map

Note:

Many of the chart variations mentioned in the following slides can be found in the chart catalogs listed in slide 5 and 6.

Chart Catalog and Selection Tool



- The following are detailed and interactive references for charts. They are good resources.

* I use this resource for reference a lot.

Ferdio*	http://datavizproject.com	An interactive resource with a lot of examples. Included diagrams and maps. Categorization by function and a unique category by data inputs. It provides details for each chart. I use it for reference a lot.
Data catalog*	http://www.datavizcatalogue.com	An interactive catalog with very detailed description for each chart. Added many smaller and specific categories. I use it for reference a lot.
From Data to Viz	https://www.data-to-viz.com	A classification of chart types based on input data format. It comes in the form of a decision tree. It also provide details for each chart.
Chart make directory	http://chartmaker.visualisingdata.com	This is a community effort to catalog charts by function and show solutions for each major visualization tool (with links to external resources).

Chart Categorization Quick Refs

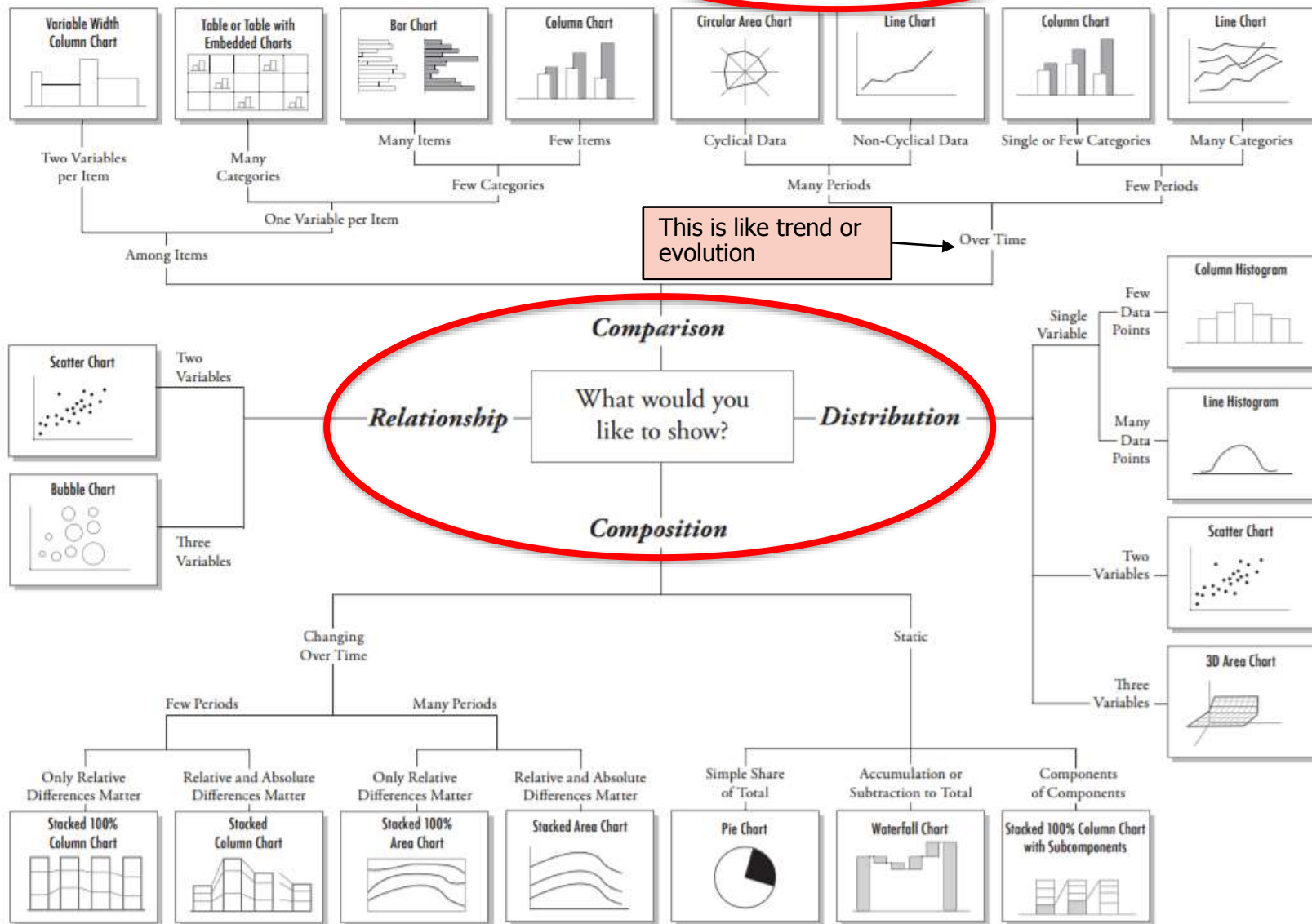


- The following are some efforts that simply try to categorize charts by purpose or data type without much explanation. They are good as a quick reference.

Abela's version	<ul style="list-style-type: none"> https://extremepresentation.com/design/7-charts/ https://www.qlik.com/blog/third-pillar-of-mapping-data-to-visualizations-usage 	This is the most widely referred version with a simple visual itself. But it was criticized by Stephen Few with a lot of details https://www.perceptualedge.com/blog/?p=2080 - Categorized by four purposes: compositions, comparison, distribution, and relationship.
Camões's version	https://excelcharts.com/classification-chart-types/	Influenced by Abela's version, added evolution (like trend) and profiling. The blog is very brief. He has an updated version with more details in his book "data at work" https://www.dataatworkbook.com .
Juice Analytics	https://www.juiceanalytics.com/chartchooser	Provided as an interactive online chooser with templates for Excel and PowerPoint. Categorized similarly but added an "trend" category.
Schwabish's Graphic Continuum	<ul style="list-style-type: none"> https://policyviz.com/2014/09/09/graphic-continuum/ https://www.informationisbeautifulawards.com/showcase/611-the-graphic-continuum 	A poster style visual presentation covering nearly 90 charts.
Financial Times Visual Vocabulary	https://www.ft.com/vocabulary	Financial Times Visual Vocabulary is based on the Graphic Continuum.
Fraconeri's version	http://experception.net	A quick reference in PDF that considers data types and inputs, rather than purposes.

Chart Suggestions—A Thought-Starter

Use your critical thinking



Andrew Abela's thought starter

- Figure from <http://extremepresentation.com/design/7-charts/>
- Details from <https://www.qlik.com/blog/third-pillar-of-mapping-data-to-visualizations-usage>
- Some critics from Stephen Few <https://www.perceptualedge.com/blog/?p=2080>

www.ExtremePresentation.com
© 2009 A. Abela — a.v.abela@gmail.com

Jorge Camoes Version



Trend can be thought of
comparison along timelines

A new category
is added

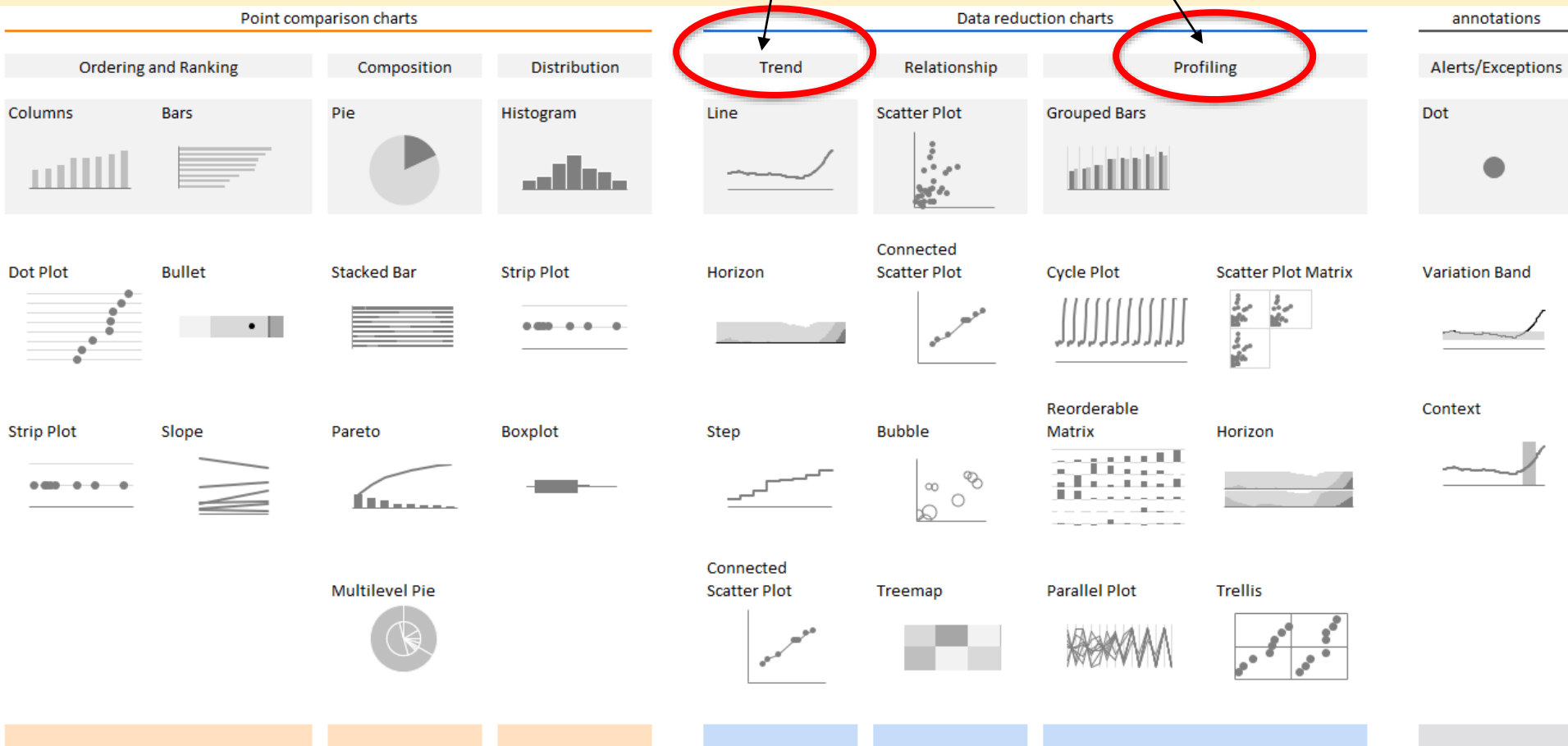


Image from <http://www.excelcharts.com/blog/classification-chart-types/>
Details in <https://www.dataatworkbook.com/data-work-07-how-choose-chart-graph/>

Purposes in Categorizing Charts



Charts are commonly categorized by the following purposes and functions. Please refer to the following for details

- <https://www.qlik.com/blog/third-pillar-of-mapping-data-to-visualizations-usage> (the basic four)
- <http://www.excelcharts.com/blog/classification-chart-types/> (added evolution and profiling)

Purpose/function	Description	Basic Charts
Comparison	Comparing and sorting data points; can also compare to benchmarks or norms.	Column/bar
Trend/evolution	Variation of comparison involving temporal data.	Line/area chart
Composition	A hierarchy relationship. Also, it may imply part-to-whole comparisons.	Pie chart Stacked column/bar chart Tree map
Distribution	Aggregated value (usually count) of data points placed in categories; the category can be value ranges or time (trend).	Histogram Scatter plot
Relationship	How things (data items) are related or positioned in a bigger context.	Scatter plot Bubble chart
Profiling	To comprehend things through visual shapes and patterns.	Spider/radar chart

1. Comparison



- Comparison is the most common purpose of using charts.
 - “Comparisons are found everywhere in data visualization, so much so that Edward Tufte says that “compared with what?” is “the deep, fundamental question in statistical analysis.” In a more or less explicit way, you’ll find comparisons at the heart of every category in our chart classification.” – From “Data at Work” Chapter 8
<https://www.dataatworkbook.com/data-work-08-sense-order-data-comparison-charts/>
- In this particular type of “comparison”, we usually compare discrete data items (entities, categories, etc.)
- Other purposes are more or less specific ways of comparisons
 - Part-whole comparison → “composition”
 - Relative positioning comparison → “relationship”
 - Time-based comparison → “trend”
 - Pattern comparison → “distribution” or “profile”
- Basic charts for comparison among data items
 - Column/bar chart
- Alternatives
 - Line/area chart
 - Dot plot

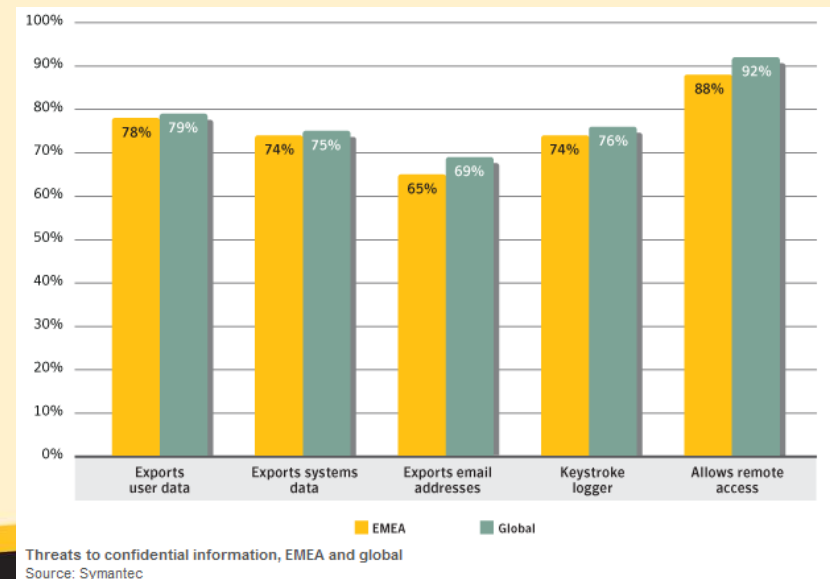
Bar/Column Charts



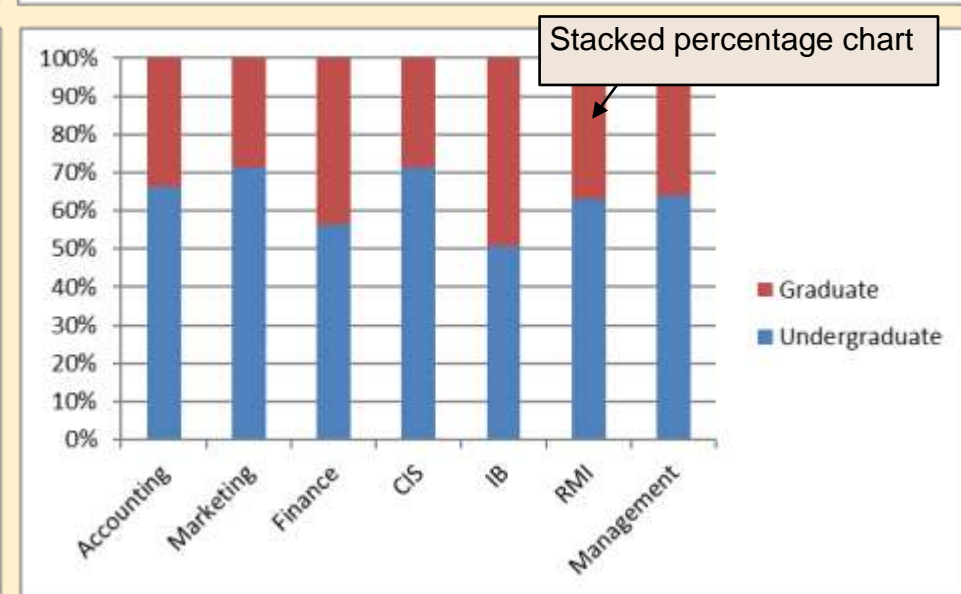
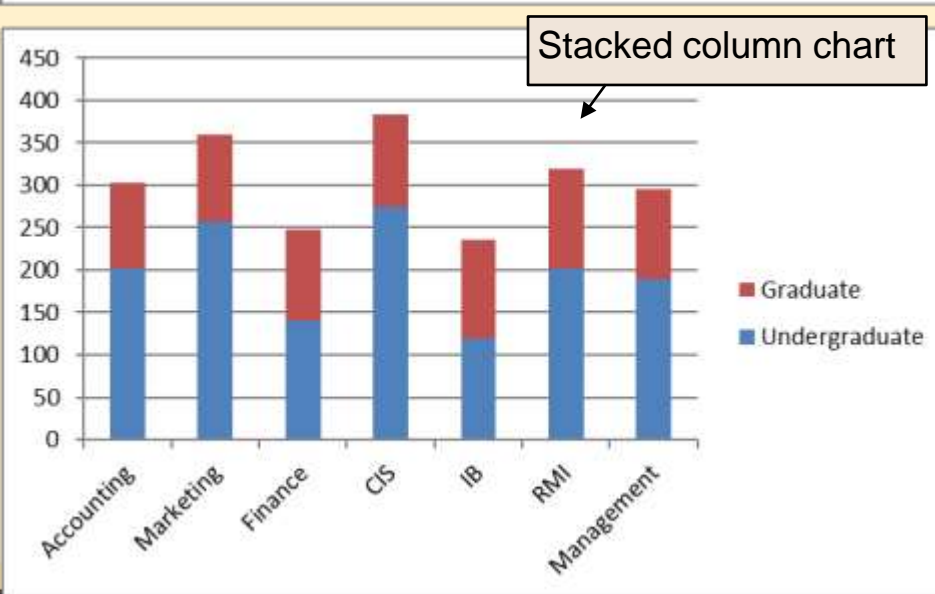
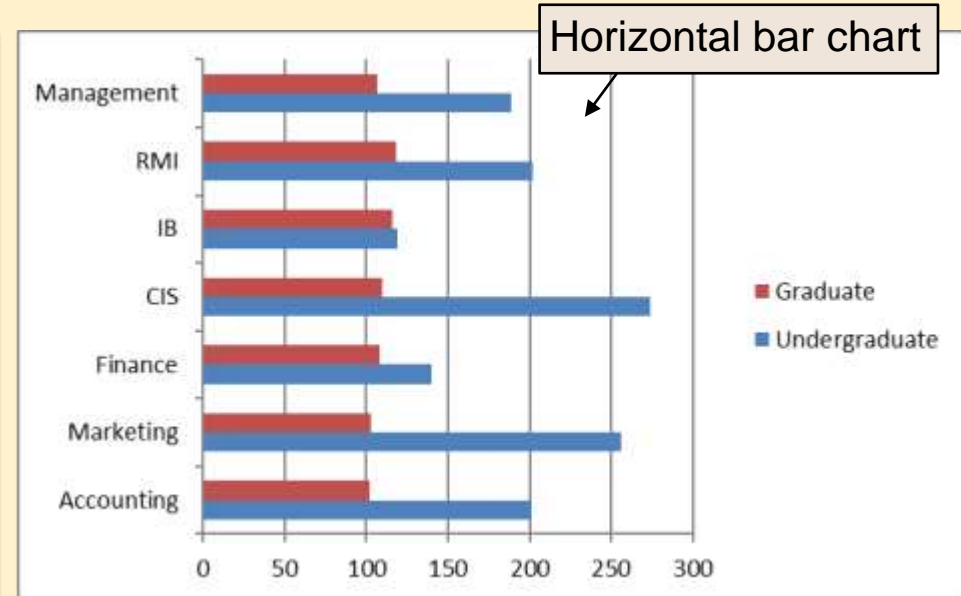
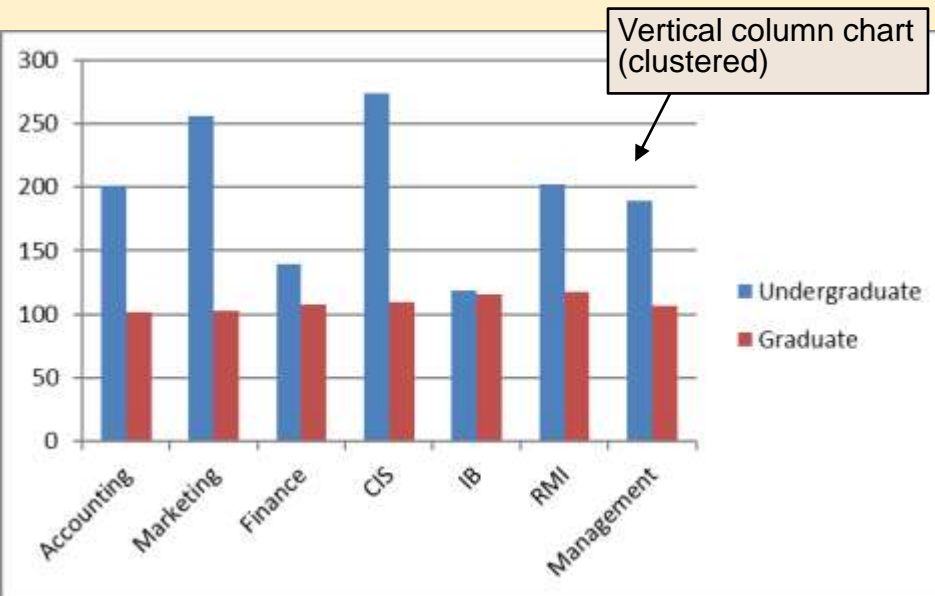
- Features and usage
 - Use rectangular bars with length/area proportional to the values they represent.
 - Often used to display and compare discrete data in different categories
 - Convention: column chart has vertical columns and bar chart has horizontal bars
 - Choose column or bar based on the size and shape of charting space
 - Use horizontal bar charts if data items are more than 10 to 15, depending on situations
- Style variations
 - Stacked bar/column
 - Stacked percentage
 - Lollipop or pin chart <https://www.tableau.com/about/blog/2017/1/viz-whiz-when-use-lollipop-chart-and-how-build-one-64267>
 - Butterfly diverging/bi-direction/mirror bar chart <https://datavizproject.com/data-type/butterfly-chart/>
 - Pyramid chart
 - Dot plot <https://www.investopedia.com/dot-plot-4581755>
 - Radial bar chart
- A basis for these more specialized chart types
 - Tornado chart
 - Bullet chart
 - Waterfall chart
 - Histogram
 - Candle stick chart
 - Gantt chart
 - Box plot

References:

- <https://datavizproject.com/data-type/bar-chart/>
- https://datavizcatalogue.com/methods/bar_chart.html
- <https://chartio.com/learn/charts/bar-chart-complete-guide/>



Some Basic Bar Chart Variations



2. Trend



- This category can be seen as a more specific comparison along the time dimension.
- Changes along the time can be viewed as continuous, rather than discrete – very often but still not always
- Major chart types to use
 - Line chart
 - Area chart
- Other alternatives
 - Circular line chart (emphasizing cycles like year or hour)
 - Bar chart (sometimes if too few time points)
 - Connected dots
 - <https://www.dataatworkbook.com/data-work-11-change-over-time/>

Line Chart

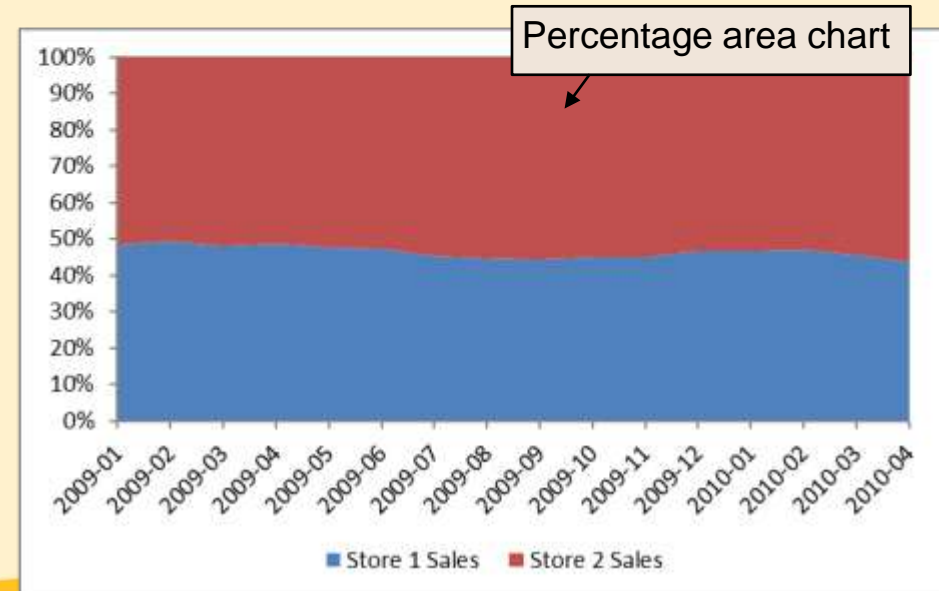
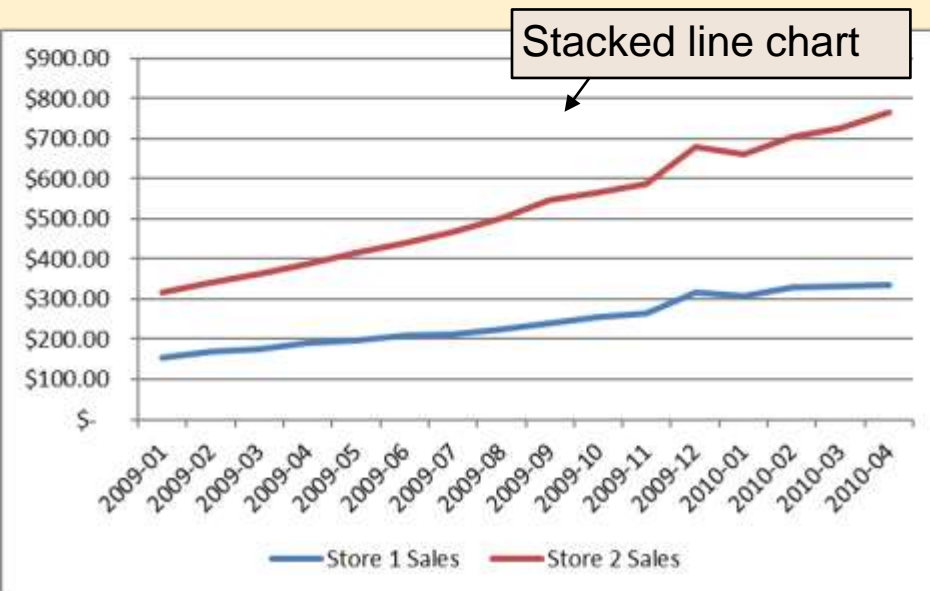
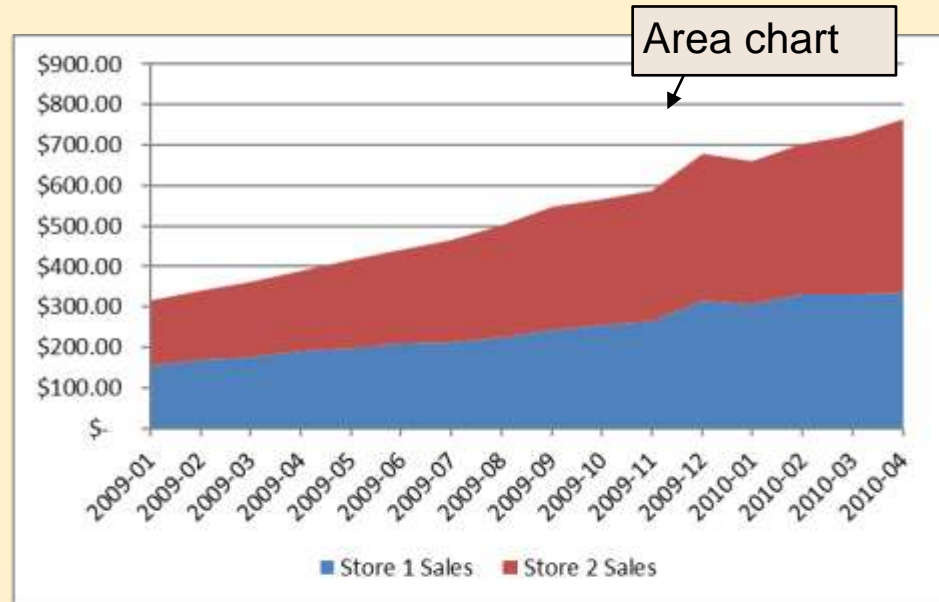


- Features and usage
 - Connecting value points along an axis
 - Displays continuous (or semi-continuous) data serials
 - Often used to visualize a trend in data over intervals of time
 - Compared to column chart, line chart can handle more data serials and more data points (time points)
- Style variations
 - Area chart https://datavizcatalogue.com/methods/area_graph.html
 - Curved/smoothed line chart
 - Stacked line/area chart
 - Stack percentage line/area chart
 - Circular line chart
- A basis for these more specialized chart types
 - Kagi chart https://en.wikipedia.org/wiki/Kagi_chart

Reference:

- <https://datavizproject.com/data-type/line-chart/>
- https://datavizcatalogue.com/methods/line_graph.html

Basic Line Chart Variations



3. Composition

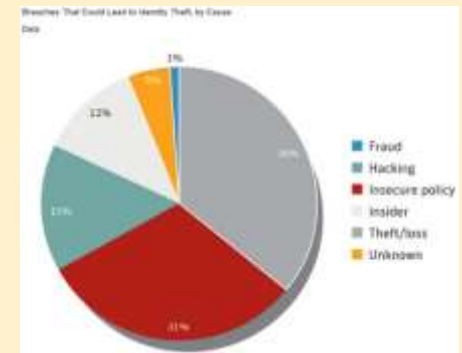


- This category can be seen as a more specific comparison among parts of a whole.
- The visual shows the relative percentages or weights, rather than absolute values
- Major chart type
 - Pie chart
 - Tree map
- Alternative charts (that also emphasis the part to whole comparison)
 - Stacked bar/column chart
 - Stacked percentage bar/column
 - Packed bubble/circle chart
 - Dot matrix or waffle chart
 - See some example in Excel from “data at work” chapter 9
<https://www.dataatworkbook.com/data-work-09-parts-whole-composition-charts/>

Pie Chart



- Features and usage
 - A circular chart divided into sectors, illustrating proportions. The arc length of each sector (or its angle and area) is proportional to the value it represents
 - To represent the different parts of a whole, or the % of a total
 - Can be seen as a circular variation of the stacked percentage bar chart, but adding a perspective of 100%
 - Capture and hold attention to the significant parts, but do not offer faster and precise readings or comparison
- Best practices
 - Starting from the up-north point and going clockwise
 - Order by percentages descending
- Critic on the pie chart
 - <https://priceconomics.com/should-you-ever-use-a-pie-chart/>
- Try alternatives
 - If comparing among similar items, use columns chart, or adding % labels
 - If more than 7 items, use other types of charts (**bar/column or tree map**); or group the rest into other, and use a second chart or table to present other
 - Have a set of pie charts? Try **stacked column/bar chart** to save space.



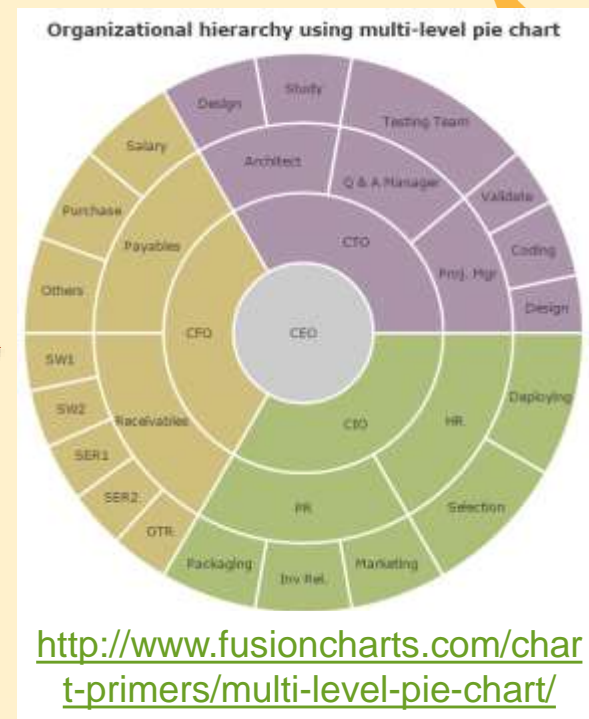
Reference

- <https://datavizproject.com/data-type/pie-chart/>
- https://datavizcatalogue.com/methods/pie_chart.html
- https://en.wikipedia.org/wiki/Pie_chart

Pie Chart Variations

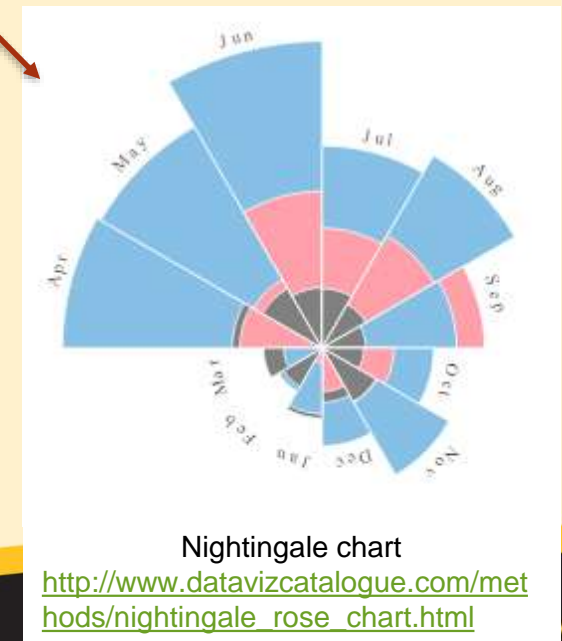
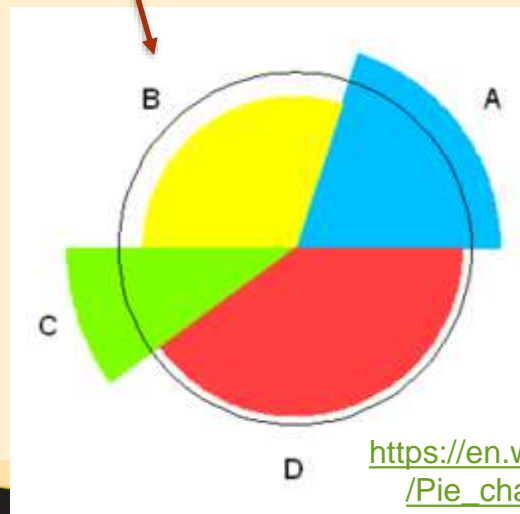
- Style variations

- Donut chart: hole in the center reserved for some key information, often the total
<https://datavizproject.com/data-type/donut-chart/>
- Multilevel pie chart, sunburst
https://datavizcatalogue.com/methods/sunburst_diagram.html



- A basis for

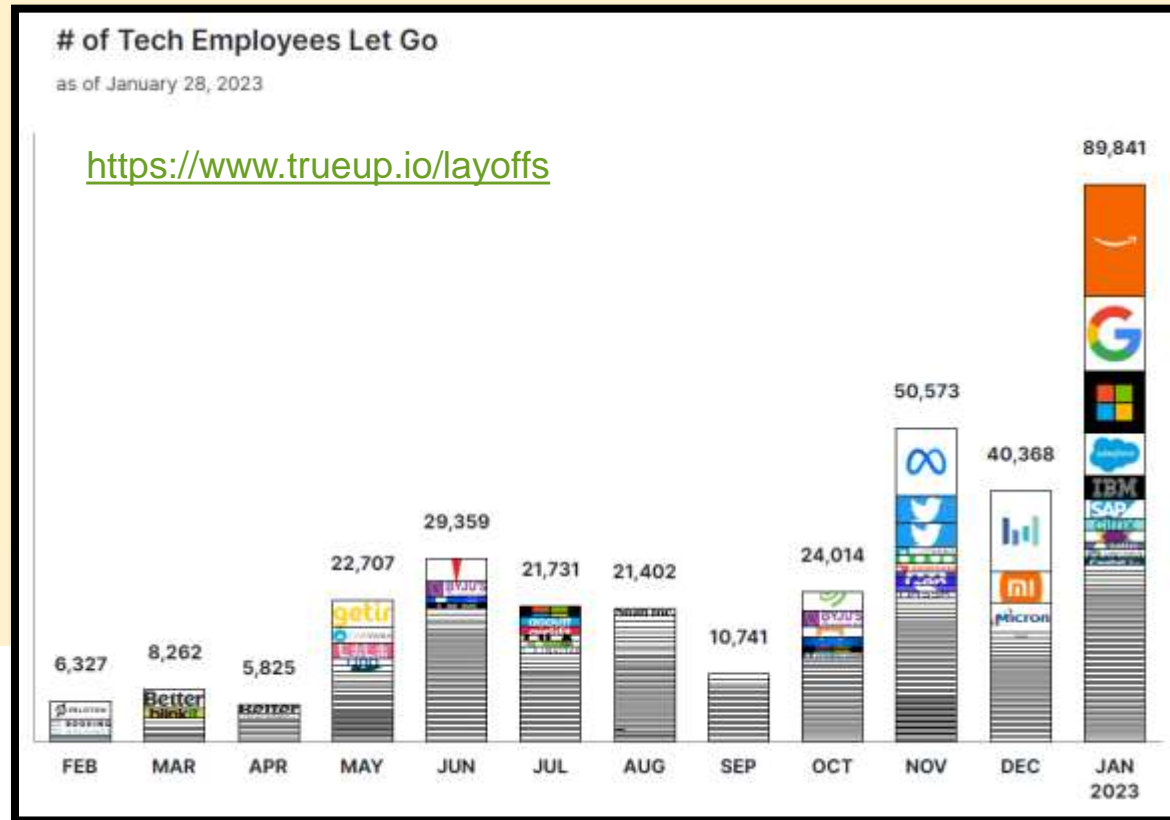
- Polar area (or rose) chart or radial pie chart
<https://datavizproject.com/data-type/polar-area-chart/> - uses length of the pie rather than angle of the pie
- Spie chart: uses both angle and length of the pie; adds a second measure for each data point (length of a pie)



Stacked Column/Bar for Composition



- Using a set of pie charts? Try stacked column/bar chart to save space.



2017 - 9.4 GWh in total, 96% cars vs 4% ESS



2018 - 19.6 GWh in total, 95% cars vs 5% ESS



2019 - 25.5 GWh in total, 94% cars vs 6% ESS



2020 - 35.3 GWh in total, 92% cars vs 8% ESS



2021 - 60.5 GWh in total, 94% cars vs 6% ESS



2022 - 90.9 GWh in total, 93% cars vs 7% ESS



All Time - 241.1 GWh in total, 93% cars vs 7% ESS



https://twitter.com/l_orenz/status/1619669226691887108

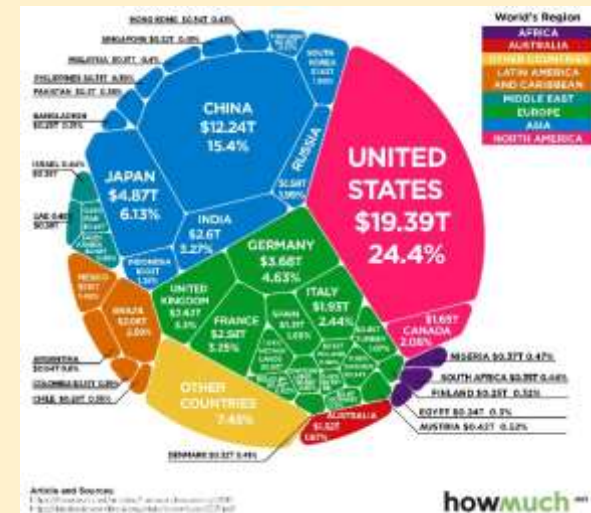
Tree Map



- Tree maps are an alternative way of visualizing the hierarchical structure of a tree Diagram while also displaying quantities for each category via area size.
 - Each category is assigned a rectangle area with the subcategory rectangles nested inside.
- Use a tree map if there are many parts
- Style variations
 - Convex tree map
<https://datavizproject.com/data-type/convex-treemap/>
 - Packed bubble chart



<https://finviz.com/map.ashx>

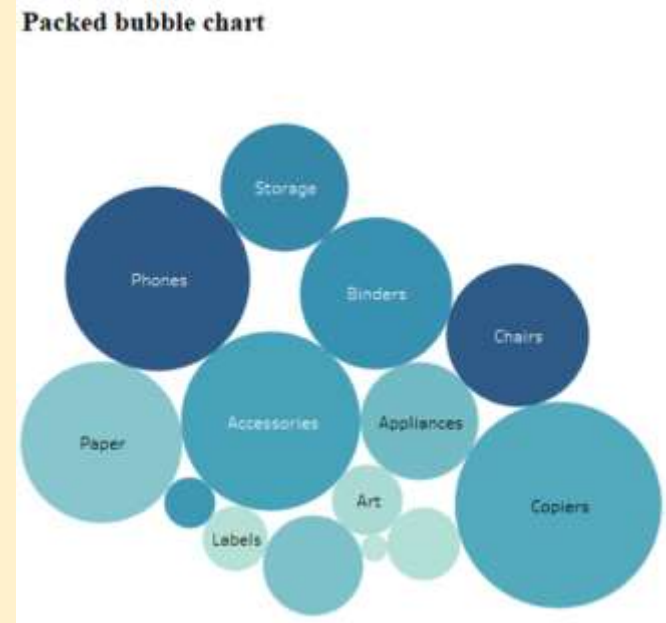


<https://www.visualcapitalist.com/80-trillion-world-economy-one-chart/>

Packed Bubble Chart



- “Packed bubble chart” (Tableau term) is different from scatterplot-based bubble chart
 - It looks like bubble chart but does not have the underlying x/y coordinates system.
 - Bubble size may represent weights or percentages – this is similar, and may be an alternative, to pie charts
- Similar visualizations (showing weights or size)
 - Tree map
 - Word cloud



4. Distribution

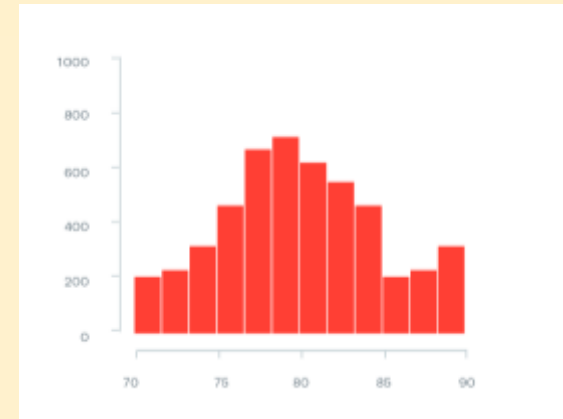


- Show how data items distributed along a range of values, so patterns can be detected
- Basic chart type
 - Histogram (1D) <https://datavizproject.com/data-type/histogram/>
 - Scatter plot (2D)
- Alternatives
 - Hex binning <https://datavizproject.com/data-type/hexagonal-binning/>
 - Strip plot (univariate scatter plot, single-axis scatter plot): similar to scatter plots but there is only one axis for one measure. <https://datavizproject.com/data-type/strip-plot/>
 - Dot map
 - Area chart

Histogram



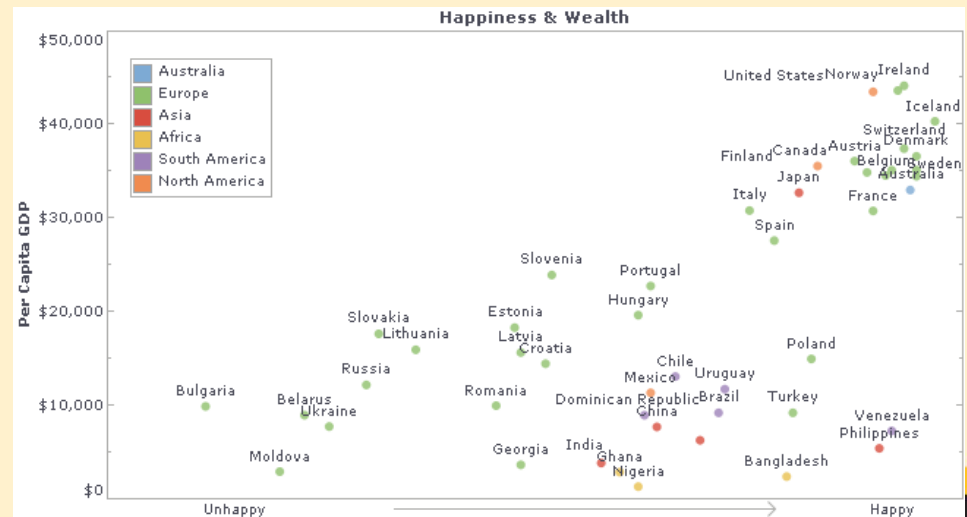
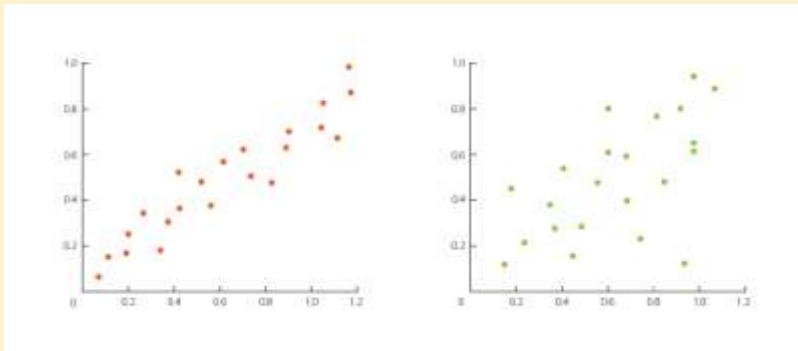
- A histogram is a chart that groups numeric data into bins, displaying the bins as segmented columns. They're used to depict the distribution of a dataset: how often values fall into ranges.
- Variation
 - Dot plot
- Reference
 - <https://datavizproject.com/data-type/histogram/>



Scatter Plot



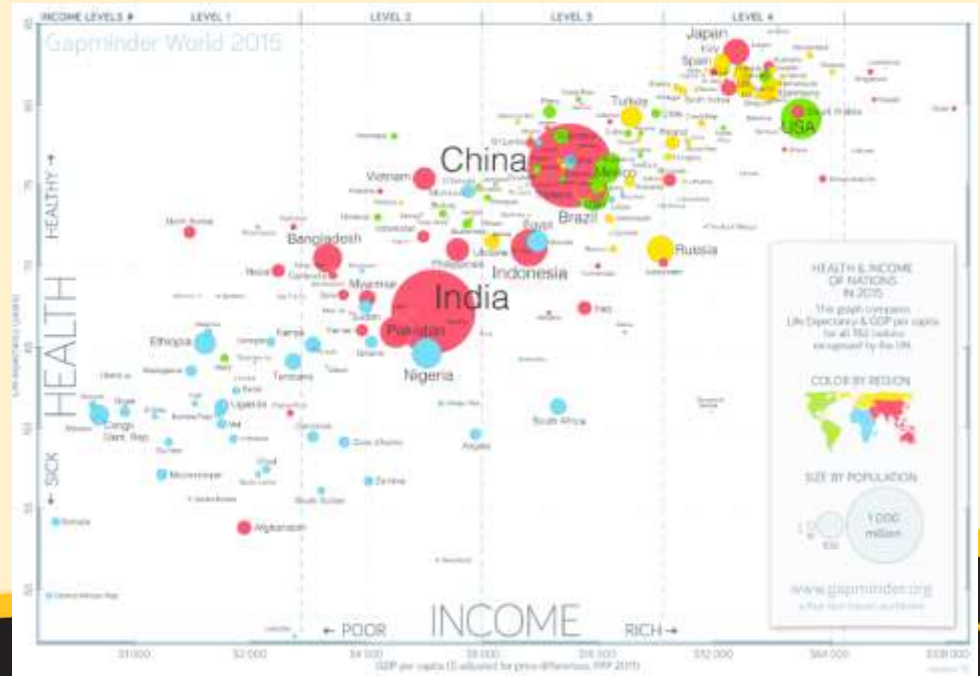
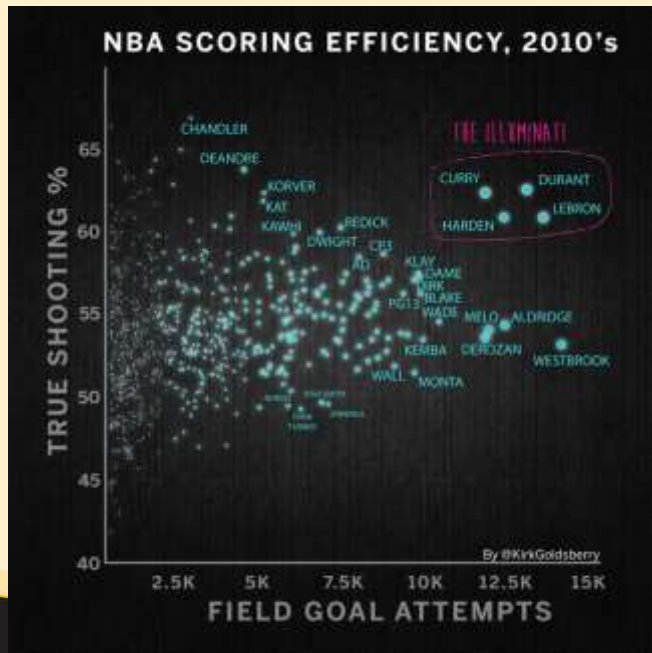
- Scatterplots use a collection of points placed in a 2D space (often with the Cartesian Coordinates) to represent data points. In this way we can detect how data points are related.
- Variations
 - **Bubble chart:** adds more visual variable to each data points to represent more dimensions: usually size and color.
- Basis for
 - Perceptual/positioning map
 - Connected scatter plot
- Reference
 - <https://datavizproject.com/data-type/scatter-plot/>
 - <https://chartio.com/learn/charts/what-is-a-scatter-plot/>



Bubble Chart



- Bubble chart adds more visual variable to each data points on the scatter plot to represent more dimensions: usually a measure will be mapped to bubble size.
 - Commonly used for perceptual/positioning map
- Example
 - [https://www.gapminder.org/tools/#\\$chart-type=bubbles](https://www.gapminder.org/tools/#$chart-type=bubbles)
 - <https://twitter.com/kirkgoldsberry/status/1174020669299810304>
 - <https://www.goodcarbadcar.net/2019-u-s-auto-manufacturer-sales-figures/>
- Reference
 - https://datavizcatalogue.com/methods/bubble_chart.html
 - <https://visage.co/data-visualization-101-bubble-charts/>
 - <https://www.displayr.com/what-is-a-bubble-chart/>



5. Relationship



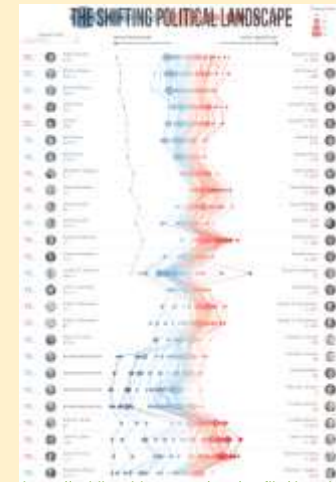
- You want to show the relationship between each data item, how each one relates (or connects) to other items or the underlying context, from a spatial and positional perspective.
 - Either 1D or 2D space
- Relationship is related to distribution, but emphasizes on individual entity and connection, not a summary view of groups
- Common uses
 - Showing connections <https://www.smashingmagazine.com/2023/01/guide-getting-data-visualization-right/>
 - Showing structures (hierarchy, network, linear)
 - Showing a pattern – related to distribution
- Common chart type
 - Bubble chart/Scatter plot
 - Strip plot
 - Network diagram
- Alternatives
 - Arc diagram <https://datavizproject.com/data-type/arc-diagram/>
 - Chord diagram <https://datavizproject.com/data-type/chord-diagram/>



6. Profile



- A “profile” consists of multiple (sometimes more) quantitative attributes that value the entity.
- Profiling is the representation of entities by creating an array of similar charts in which there are two readings: a reading of each individual profile and a comparison reading with other profiles. The integration and interdependence of these charts should lead us to consider them as a whole—as a single chart rather than as separate charts.
- The purpose here is to emphasize the identification and comparison of general patterns, rather than individual data attribute or data point.
 - Insight comes from observation of the whole rather than the individual chart/data item.
 - <https://www.dataatworkbook.com/chapter-13-profiling/>
- Commonly used in
 - Portfolio analysis
 - Scoring system
 - Visualization of large quantities of data
- Basic chart type
 - Radar/spider chart
 - Heat map
- Alternatives
 - Small multiples https://en.wikipedia.org/wiki/Small_multiple
 - Parallel coordinates http://www.datavizcatalogue.com/methods/parallel_coordinates.html
 - Radial column chart (polar histogram) <https://datavizproject.com/data-type/radial-histogram/>
 - Nightingale chart (polar area) chart http://www.datavizcatalogue.com/methods/nightingale_rose_chart.html

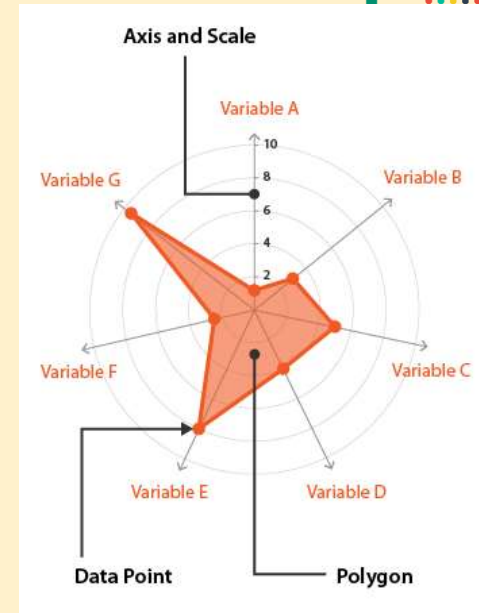


<https://public.tableau.com/app/profile/dataviz/viz/TheShiftingPoliticalLandscape/Shift>

Radar/Spider Chart

- As known as: Spider Chart, Web Chart, Polar Chart, Star Plots, snowflake chart
- Features
 - All axes are arranged radially, with equal distances between each other.
 - Sort of like area chart but categories are arranged radially.
 - The area usually forms a unique shape pattern to represent the item profile.
- Reference
 - <https://www.storytellingwithdata.com/blog/2021/8/31/what-is-a-spider-chart>
- Some critics
 - <http://blog.scottlogic.com/2011/09/23/a-critique-of-radar-charts.html>
 - <http://peltiertech.com/spider-chart-altern>
 - <https://community.tableau.com/ideas/14>

<https://simplywall.st/stocks/us/media/nasdaq-google/alphabet>



http://www.datavizcatalogue.com/methods/radar_chart.html

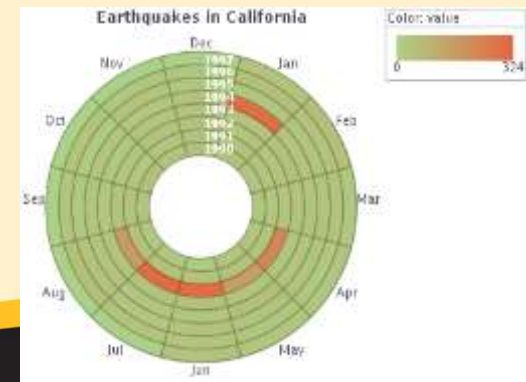
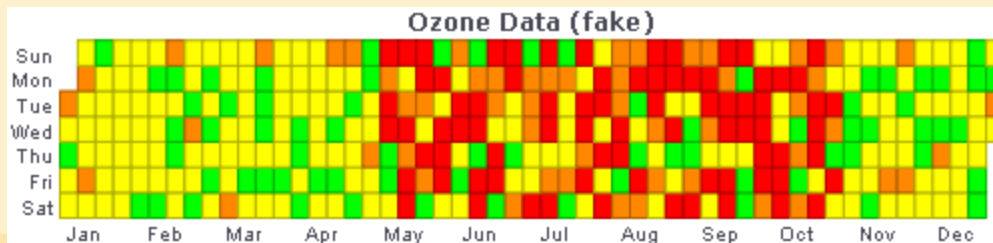
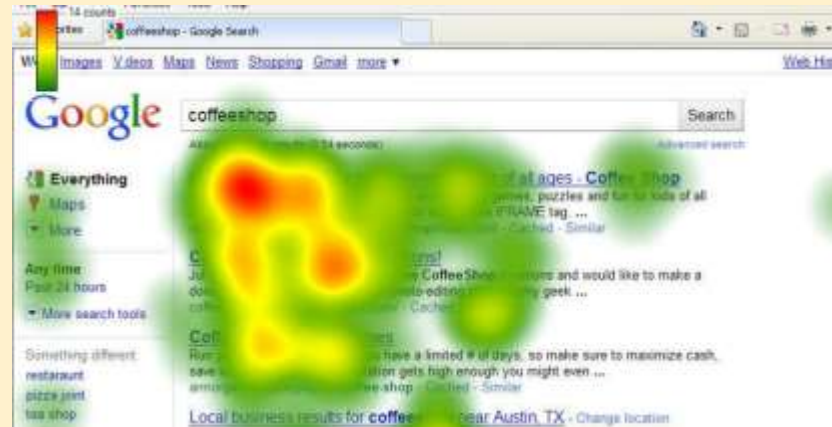


Source: Yahoo Finance

Heat Map



- A heat map is a colored representation of data displayed in a context (usually a table, matrix, X/Y chart (scatter plot), map, etc.) http://en.wikipedia.org/wiki/Heat_map
- It is not a chart by itself, but it is used together (overlay) with other types of visuals such as tiled/tree map, or maps.
- Often used for a single measure with a large number of data points.
- Examples



Key Readings and Resources



- Chart categories by purposes
 - The basic four: <https://www.qlik.com/blog/third-pillar-of-mapping-data-to-visualizations-usage>
 - <https://alexgonzalezc.dev/posts/data-visualization-principles.html>
- Tableau recommendation - Which chart or graph is right for you?
 - https://www.tableau.com/sites/default/files/media/which_chart_v6_final_0.pdf

Additional Good Resources



- More tips and practices
 - How to Choose the Right Data Visualization Types <https://www.datapine.com/blog/how-to-choose-the-right-data-visualization-types/>
 - Best Excel Charts Types for Data Analysis, Presentation and Reporting <https://www.optimizesmart.com/how-to-select-best-excel-charts-for-your-data-analysis-reporting/>
 - Google data visualization guidelines <https://m2.material.io/design/communication/data-visualization.html>
 - <https://blog.hubspot.com/marketing/types-of-graphs-for-data-visualization>
- Good tools and references
 - Data catalog: <http://www.datavizcatalogue.com>
 - Ferdio: <http://datavizproject.com>
 - From Data to Viz: <https://www.data-to-viz.com>
 - Chart make directory: <http://chartmaker.visualisingdata.com>
- Effective Data Visualization: The Right Chart for the Right Data
 - <https://www.amazon.com/Effective-Data-Visualization-Right-Chart/dp/1506303056/>
- Visage How to Design series
 - <https://visage.co/data-101-refresher-course/>
 - <https://visage.co/data-visualization-101-line-charts/>
 - <https://visage.co/data-visualization-101-area-charts/>
 - <https://visage.co/data-visualization-101-bar-charts/>
 - <https://visage.co/data-visualization-101-pie-charts/>
 - <https://visage.co/data-visualization-101-scatter-plots/>
 - <https://visage.co/data-visualization-101-bubble-charts/>
 - Free eBook: How to design charts and graphs <https://visage.co/content/data-visualization-101/>