03/21/2023

Histograms and Boxplots
Data Analysis Tool Pack
Scaling and Unit Conversions

Ways of Graphing Numerical Data (one set of numerical data)
Histogram is similar to a bar graph, but the "categories" are bins (ranges) of values.
To do this by hand:
First decide on the number of bins (categories) – something between 5 and 20
Find the range of the data (max minus the min)
Divide the range by the number of bins – gives you the bin width – you should generally round up a little bit to get a nice value to work with.
Start with the min and add the bin width to get the bottom value of the next bin.
For example, if the range of values in the data is from 10 to 50 and the bin width is 7:
The first bin goes from 10 to <17
The second bin goes from 17 to <24
Third bin goes from 24 to <31
Fourth bin goes from 31 to <38
Fifth bin goes from 38 to <45
Sixth bin goes from 45 to 50 (largest value) <52
Build a summary table and count the number of values in each range (bin)
From that summary table you build essentially a bar graph. The bins are labeled: either by their endpoints, or some plot the midpoint of the bins. Excel writes intervals.

This is one way of looking at the way numerical data is distributed.

Boxplots (Box and Whisker Plots)
The simplest box plots are built from the 5-number summary: minimum, 1^{st} quartile, median, 3^{rd} quartile, maximum.

Draw the central box between the 1^{st} and 3^{rd} quartiles. Mark the median in the box with a line. Extend a whisker (line) from one end of the box to the minimum. And another from the other end of the box to the maximum.

Some boxplots (like in Excel) will also mark the extreme values.
Depends on the IQR.
Boundary of the extreme value range is determined by the fences. Lower fence is 1^{st} Q - 1.5*IQR. Upper fence is 3^{rd} Q + 1.5*IQR.
Any values beyond this are extreme values. They get marked on the box plot with dots. The whisker will only extend to the last value less (or greater) than the fence.

Outer fences: are 3*IQR away from the quartiles, and some programs will mark these values differently than ones merely beyond the (inner) fences.

Go to Excel for examples.

Good graphs:

Descriptive Title
Axis titles (if there is only one boxplot, then you can get away with only one axis title).
Adjust the axes or bin sizes as needed to make the graph easier to read and interpret

Be able to describe the shape of the distribution as roughly symmetric, right-skewed, or left-skewed.

Skewness is determined by the tail.

Scaling and Conversions

American Linear Units	
12 inches (in)	1 foot (ft)
3 feet	1 yard (yd)
36 inches	1 yard
63,360 inches	1 mile (mi)
5,280 feet	1 mile
1,760 yards	1 mile

Weight and Mass	
1 Ton (T)	2,000 pounds
1 pound (lb)	16 ounces (oz)
1 Ton	32,000 ounces
1 metric ton (t)	1000 kg
60 grains	1 dram

Converting American Units	
Larger unit → smaller unit	*Multiply*
smaller unit → Larger unit	*Divide*

American to Metric Units	
1 inch	2.540 centimeters
1 foot	0.305 meters
1 yard	0.914 meters
1 mile	1.609 kilometers
1 gallon	3.78 Liters
1 quart	0.95 Liter
1 pound	0.45 kilogram
1 ounce	28.35 grams
1 fluid ounce	29.57 mL
1 grain	60 milligrams (mg)
1 teaspoon (tsp)	5 mL
1 fluid dram	4 mL
1 tablespoon (tbsp)	15 mL
1 pint (pt)	500 mL (approx)
1 quart (qt)	1000 mL (approx)
1 pound (lb)	453.6 g

American Capacity	
8 fluid ounces (fl oz)	1 cup
16 fluid ounces	2 cups
2 cups	1 pint (pt)
16 fluid ounces	1 pint
2 pints	1 quart (qt)
4 quarts	1 gallon
8 pints	1 gallon
32 fluid ounces	1 quart
8 fluid dram	1 fluid ounce
3 teaspoon (tsp)	1 tablespoon (tbsp)
6 teaspoon	1 fluid ounce
2 tablespoon	1 fluid ounce
1 drop (gtt)	1 minim
60 drop	1 fluid dram
100 drop	1 teaspoon
60 minims	1 fluid dram

Metric Units

mega (M)	*	*	kilo (k)	hector (h)	deka (da)	unit (m, g, L)	deci (d)	centi (c)	milli (m)	*	*	micro (mc) (u)

When going from larger unit to smaller unit move decimal to the right →

When going from smaller unit to larger unit move decimal to the left ←

Time	
1 day	24 hours
1 hour (hr)	60 minutes (min)
1 minute	60 seconds (sec)
1 year (yr)	365.25 days
1 week	7 days
1 year	12 months (mon)
1440 minutes	1 day
3600 seconds	1 hour
Stones	
1 carat (karat)	200 mg

Metric to American Units	
1 km	0.621 miles
1 meter	1.094 yards
1 meter	3.281 feet
1 meter	39.370 inches
1 cm	0.3937 inch
1 Liter	0.26 gallon
1 Liter	1.06 quarts
1 kg	2.20 lbs
1 gram	0.035 oz
1 gram	15 grains
1 milliliter (mL)	15 minims

Temperature Formulas	
$C = \frac{(F - 32)}{1.8}$	$F = 1.8 \cdot C + 32$

Medical Application (Micrograms)	
1,000,000 micrograms (mcg)	1 gram
1,000,000 micrograms	1,000 mg
1 mL = 1 cc = 1 cm^3	
1 gram = 1 cm^3	
Nursing students 1fl oz = 30 mL	
Nursing students 1 in. = 2.5 cm	

What is the equivalent distance in miles for 400 km?

X miles = 400 km * $\frac{0.621\ miles}{1\ km}$ = 248.4 miles

What is the equivalent distance in kilometers for 750 miles?

X km = 750 miles * $\frac{1\ km}{0.621\ miles}$ = 1207.7 km

X km = 750 miles * $\frac{1.609\ km}{1\ miles}$ = 1206.75 km

How many miles is 1000 yards?

X miles = 1000 yards * $\frac{1\ miles}{1760\ yards}$ = 0.568 miles

Temperature conversions:

$$F = \frac{9}{5}C + 32$$
$$C = \frac{5}{9}(F - 32)$$

Convert 41-degrees Fahrenheit to Celsius.

$$C = \frac{5}{9}(41 - 32) = 5\ degrees$$

The temperature is -3 degrees Celsius, what is that in Fahrenheit?

$$F = \frac{9}{5}(-3) + 32 = 26.6\ degrees$$

Scaling

When you are scaling in distances (lengths) then scaling is like converting. But when you are scaling area, area is a squared-length unit and so the scaling factor also needs to be squared. When you are scaling volume, you need to multiply by the cube of the scaling factor.

Suppose you have built a scale model of a new fighter jet that needed a volume of 10 m^3 of metal to construct, and you want to scale up to the full-size model. If the model is a 1/6 scale model, how much metal will be needed to construct the full-size fighter jet?

1/6 scale is telling you how each dimension is being scaled.

$$10\ m \times m \times m \times (6) \times (6) \times (6) = 2160\ m^3$$

Suppose I have a full-size replication of Captain America in plastic. And I want to scale it down to a 1/20 size action figure. If I used 5 ft^3 of plastic in the full-size model, how much will I need to make the action figure?

$$5\ ft^3 \times \left(\frac{1}{20}\right)^3 = 0.000625\ ft^3$$

Suppose I have a painting that is 100 square inches and I am being commissioned to scale it up for a wall mural that is 100 square feet. What is the scaling factor?

$$100\ in^2 \times \left(\frac{1\ ft}{12\ in}\right)^2 = \frac{100}{144} ft^2 = 0.694\ ft^2$$

$$\frac{100}{0.6944\ldots} = 144\ (this\ is\ the\ scale\ of\ the\ area\ change)$$

Scaling factors are always given in one-dimensional units. For an area, take the square root of the ratio:

$$\sqrt{144} = 12$$