PSY 201: Statistics in Psychology

Lecture 03

Plots

Why the space shuttle blew up.

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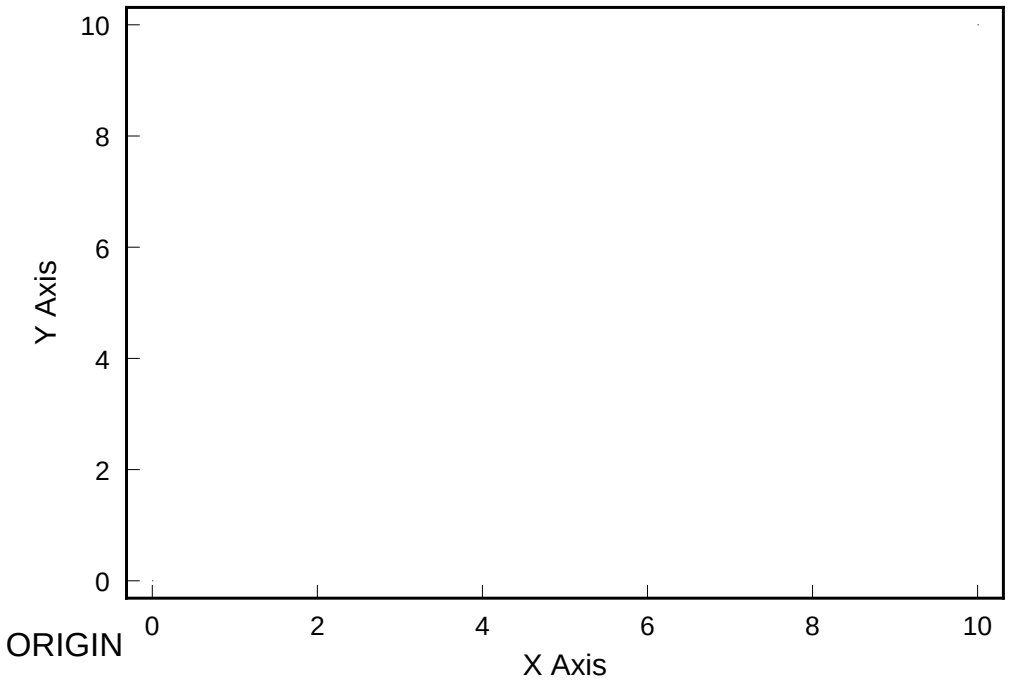
DATA

GOAL:

- organize data in a way that helps us understand it
- often take advantage of visual interpretations
- particularly important for very large sets of data

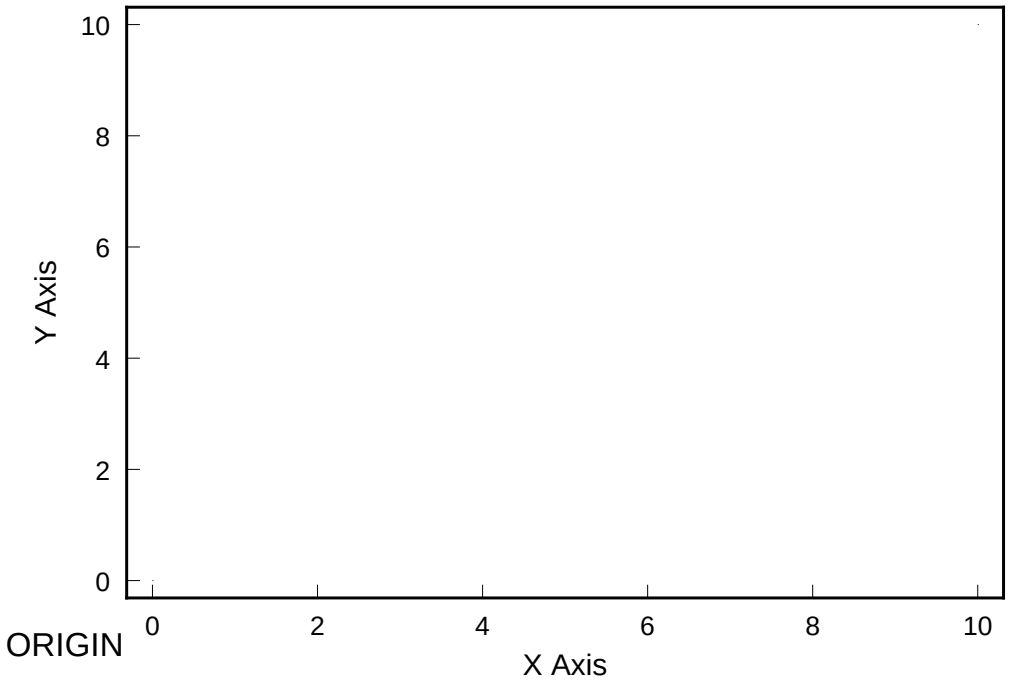
GRAPHS



- plot one variable against another

PLOTTING

- you make a graph to convey information
- place the dependent variable on the y-axis and the independent variable on the x-axis



- avoid everything else that might get in the way!

SPACE SHUTTLE

- January 28, 1986
- O-ring leaked
- the Challenger exploded 59 seconds after liftoff

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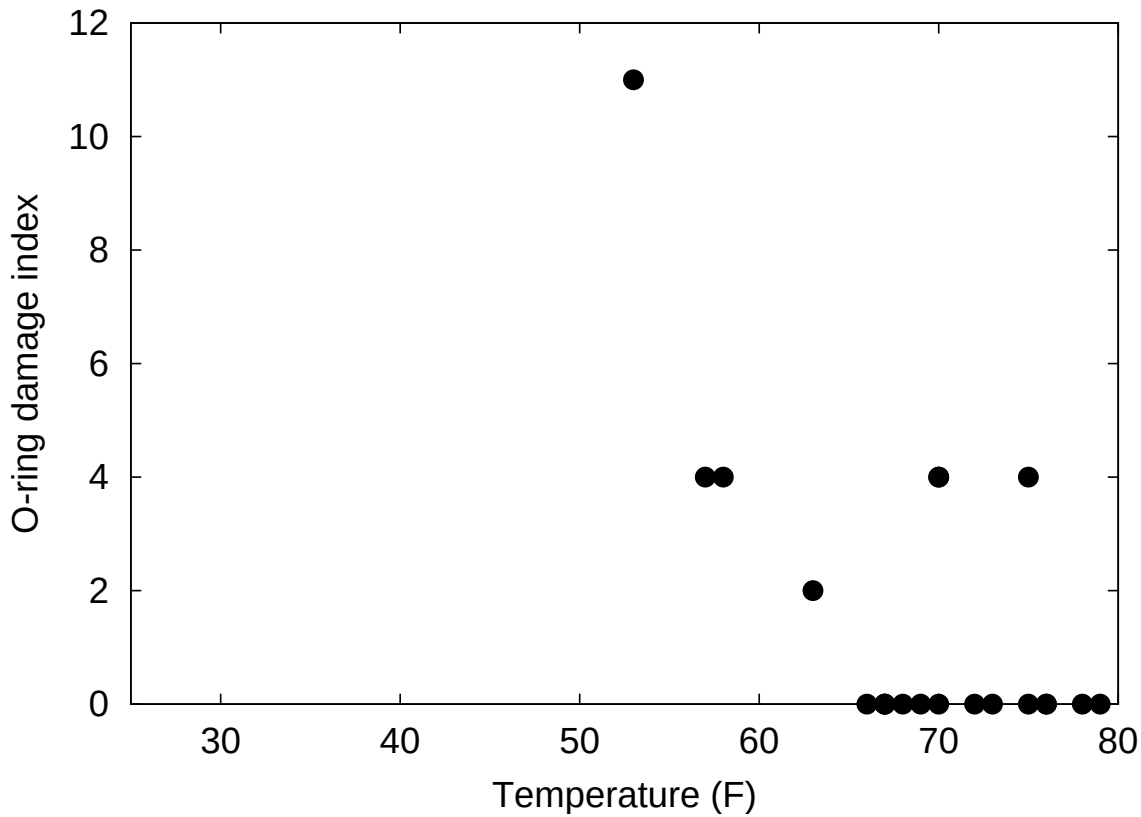
SPACE SHUTTLE

- the night before engineers warned O-rings would leak in cold (29°) weather
- the engineers failed to make their case, and the shuttle blew up
- they failed to *present* their data in a way to convince others

THE DATA

- previous launches showed damage to the O-rings increased as temperature got colder



THE MISTAKES

- when trying to convince NASA scientists to cancel the liftoff engineers:
  - used tables (not bad by itself, but a graph is often more convincing)

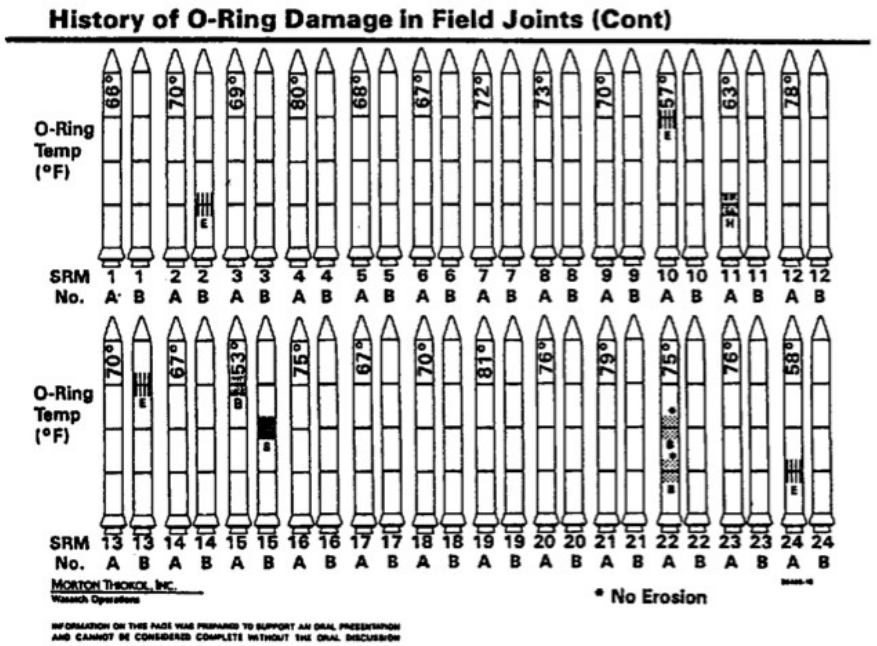
HISTORY OF O-RING TEMPERATURES (DEGREES - F)

MOTOR	MBT	AMB	O-RING	WIND
DM-1	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29 27	10 MPH 25 MPH

  - distributed information across several tables

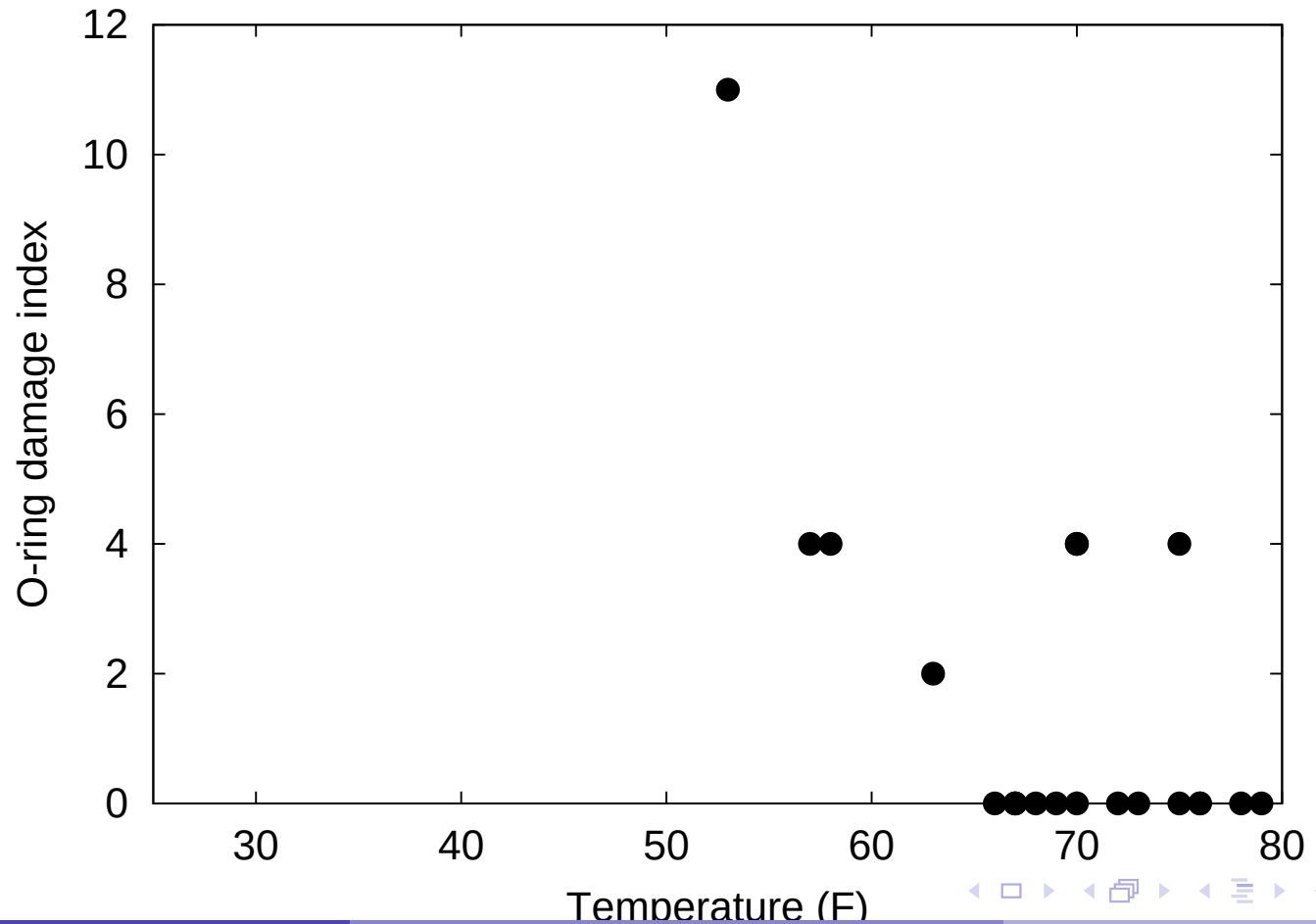
THE MISTAKES

- when trying to convince NASA scientists to cancel the liftoff engineers:
  - cluttered graphics with irrelevant information (motor type, date of launch,...)



THE MISTAKES

- when trying to convince NASA scientists to cancel the liftoff engineers:
  - failed to point out that all good launches were in warm temperatures
  - failed to point out that the forecasted temperature (29°) was *much* colder than for any other launch (good or bad)

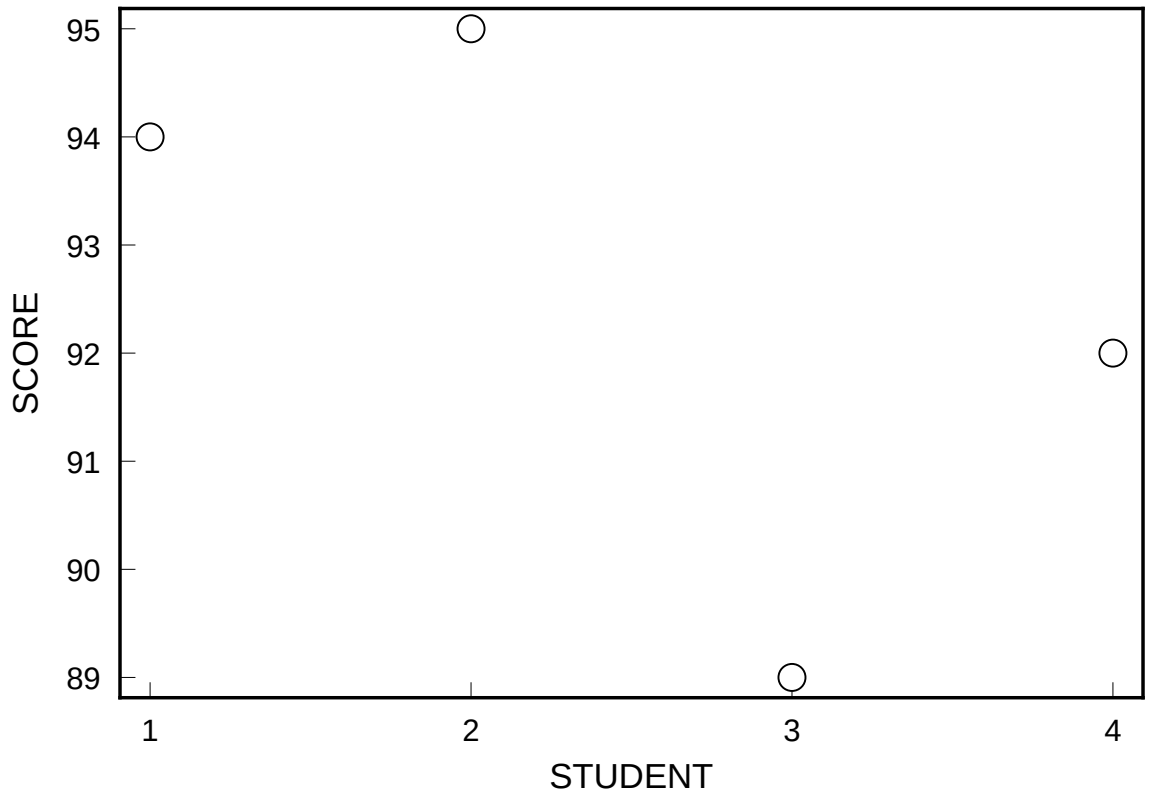


THE LESSON

- when trying to convince someone of something, you must present it properly
- avoid fancy graphics and 3D perspectives
- keep it simple
- present the right information
- will go over some basics of graphing...

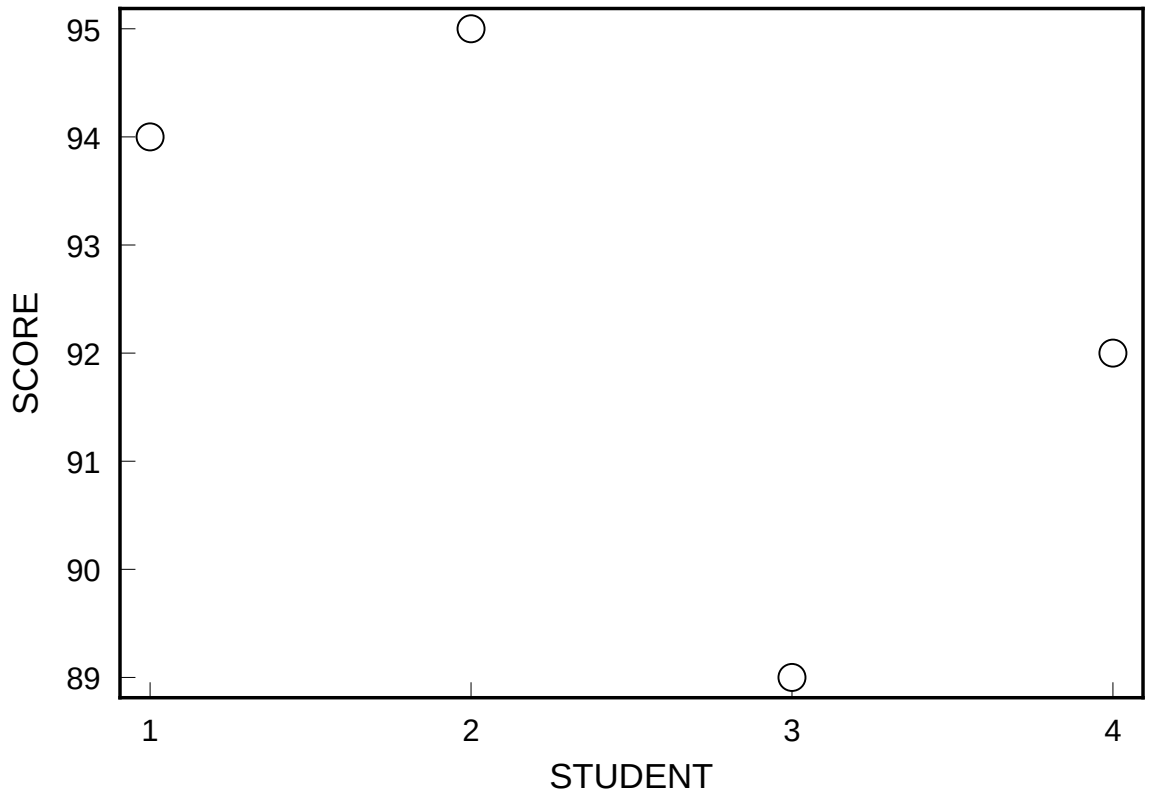
GRAPH

- using a small data set of four student's grades



GRAPH

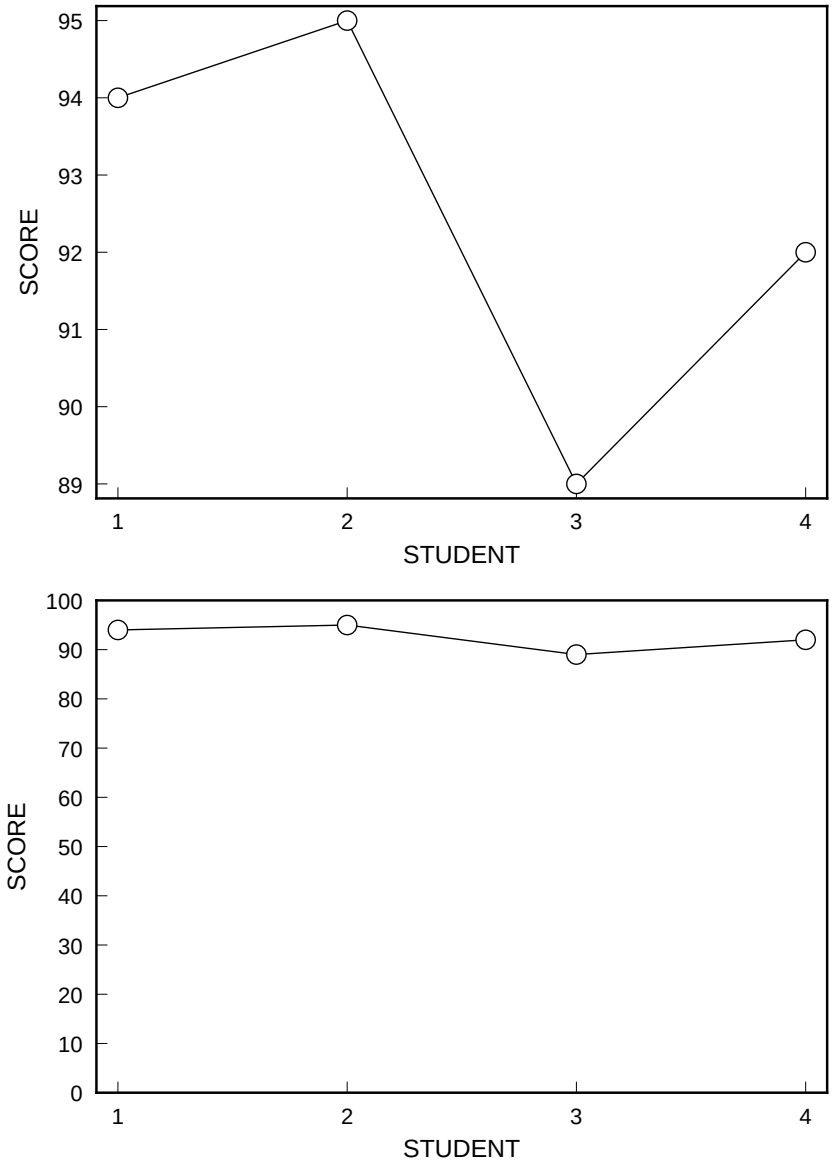
- using a small data set of four student's grades



- what measurement scale is the student variable?
- what measurement scale is the score variable?

DATA CURVE

- it sometimes helps to connect the points
- How well did the third student do?
- changing the axis' scale makes the information look different, even though it isn't
- what matters is whether the graph conveys the intended information!



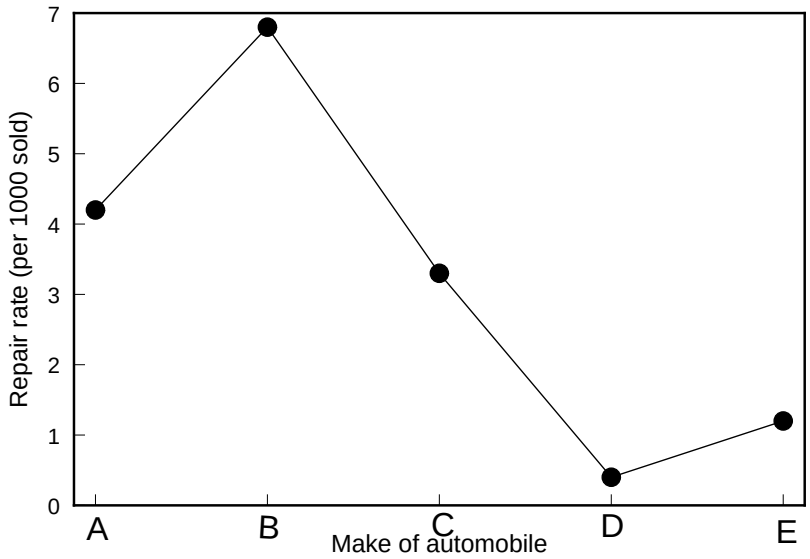
GRAPH TYPE

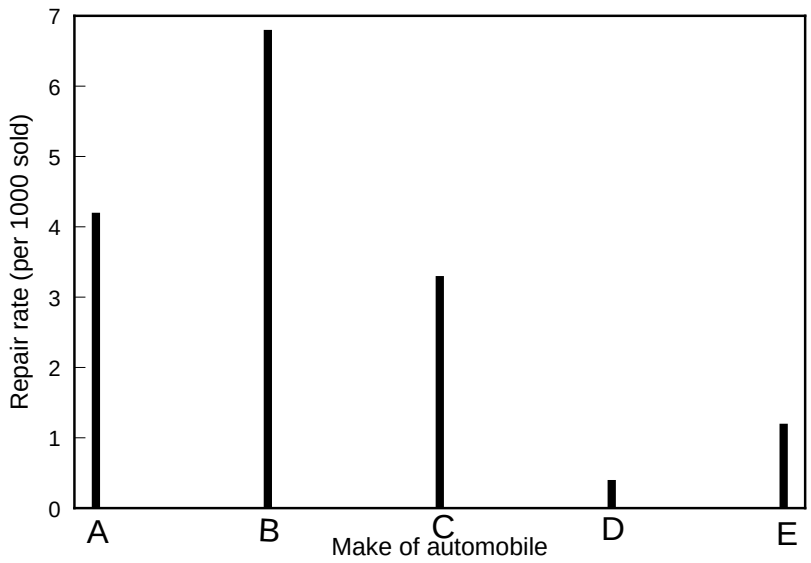
- type of data determines what type of graph to draw
- previous graph plotted ratio (or interval) data against nominal data
- consider the following data

Make of Automobile	Repair Rate (per 1000 sold)
A	4.2
B	6.8
C	3.3
D	0.4
E	1.2

- the graph should **not** suggest continuity of automobile make

WHICH IS BETTER?



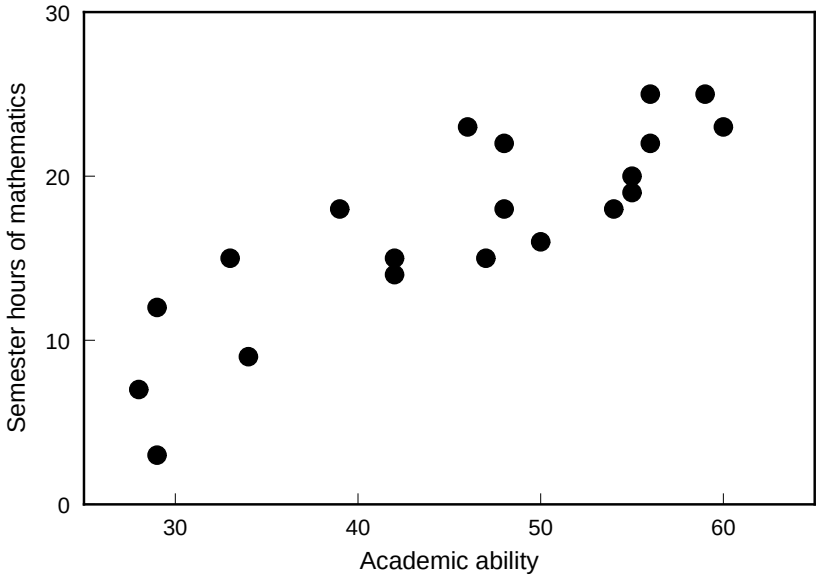


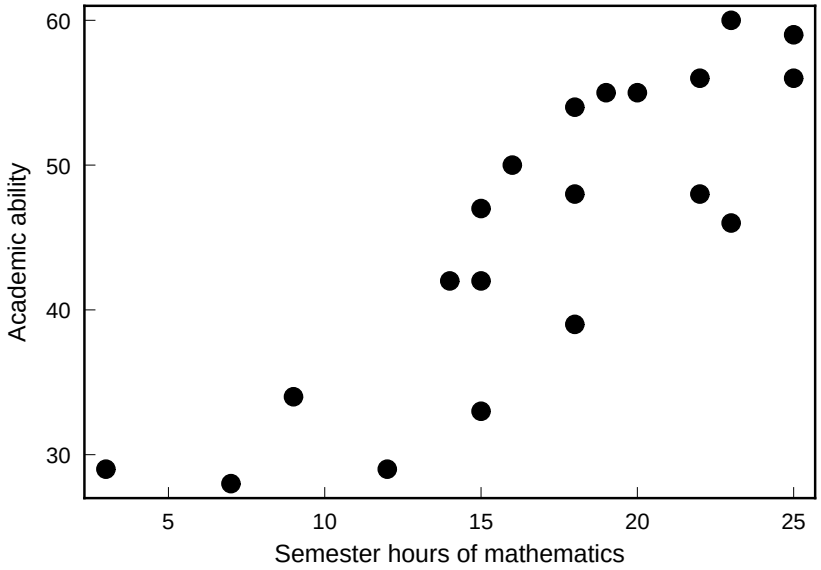
SCATTERGRAMS

- sometimes you want to look at co-occurrences of data

Student	Academic Ability Score	Hours of Mathematics
1	54	18
2	29	3
3	42	14
4	60	23
5	33	15
6	28	7
7	56	22
8	48	18
...	...	...

SCATTERGRAMS





GRAPHS

- Very useful for giving an overview of many types of data sets
- Useful for identifying trends in the data and relationships between variables
- Limited in that they depend on the viewer's interpretive abilities and sometimes graphs breakdown for really big or really small data sets
- We prefer more quantitative approaches

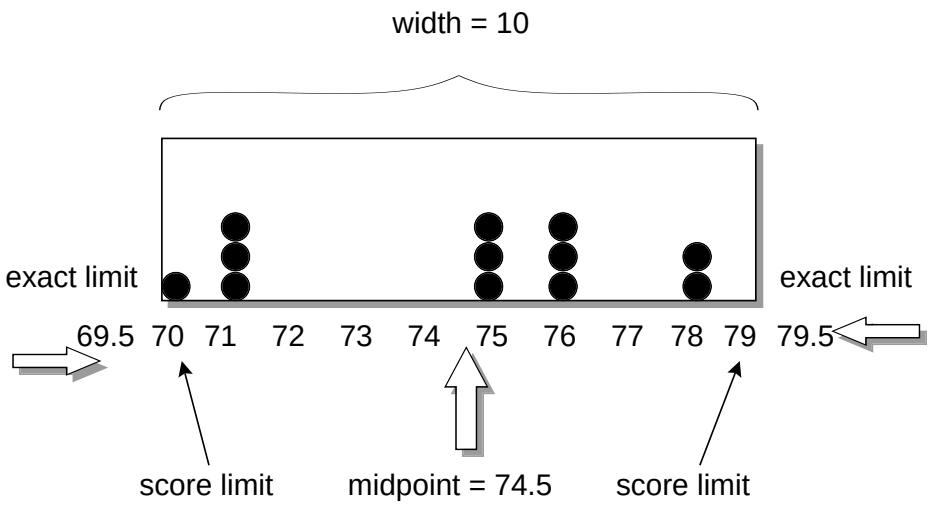
FREQUENCY

- for large data sets we cannot present all the scores
- we often look at the *number* or *frequency* of scores within certain limits
- we look at how scores are spread out across different values
- this reduces the number of *presented* scores and improves understanding

CLASS INTERVAL

Terminology

- width: exact upper limit - exact lower limit
- midpoint: value halfway between upper limit and lower limit
- exact limits: exact boundaries of interval
  - matter when we start to work with frequency distributions!
- score limits: highest and lowest possible scores that fall in the interval



FREQUENCIES

- compare a set of scores
  95, 22, 45, 45, 12, 79, 83, 46, 89, 96, 75, 33, 86, 57, 69, 94, 83, 75, 77, 88, 92, 85, 31, 69
- to frequencies

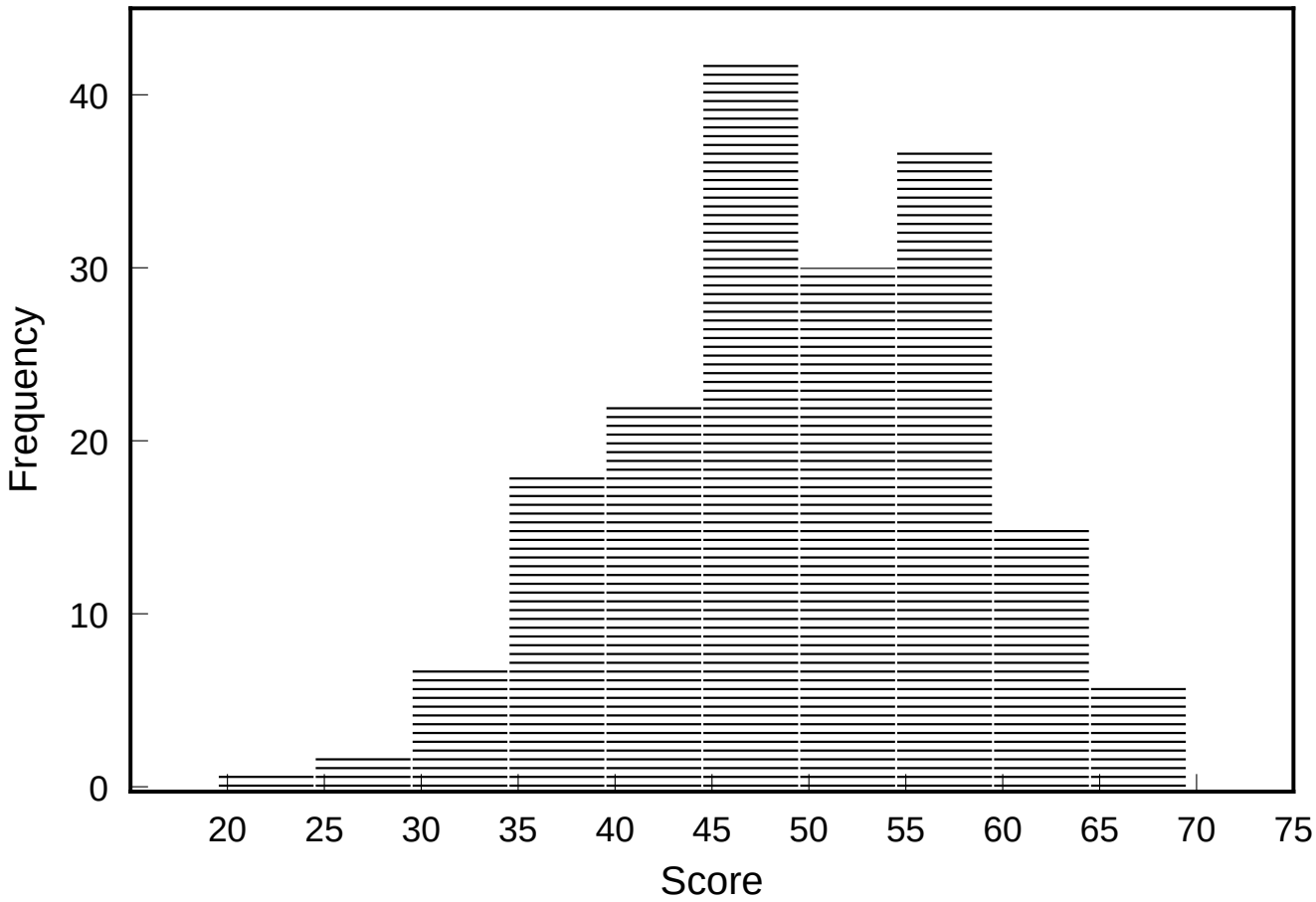
Class Interval	f
10–19	1
20–29	1
30–39	2
40–49	3
50–59	1
60–69	2
70–79	4
80–89	6
90–99	4

FREQUENCIES

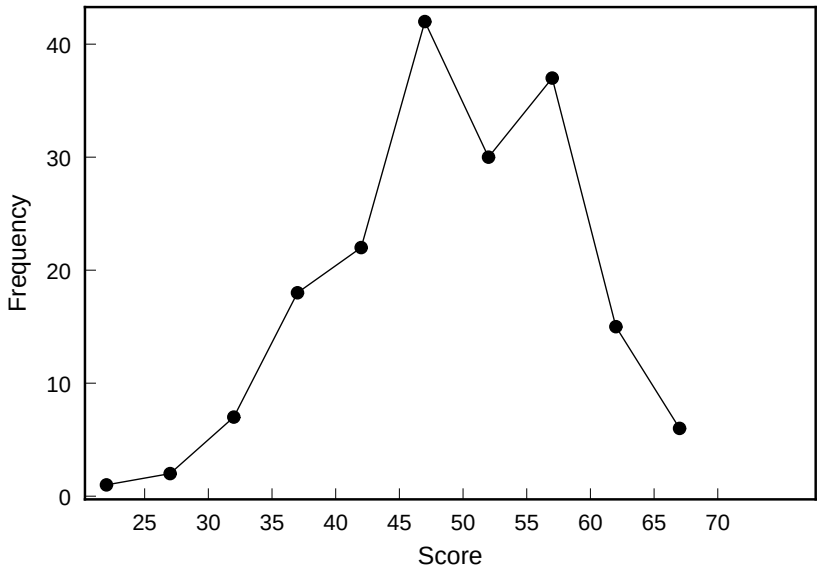
- ADVANTAGES
  - easier to see distribution of scores
  - easier to interpret data
- DISADVANTAGES
  - loss of information
  - individual scores are missing
  - midpoint score is often best guess
- often use frequency information to **supplement** other information (depends on your needs)

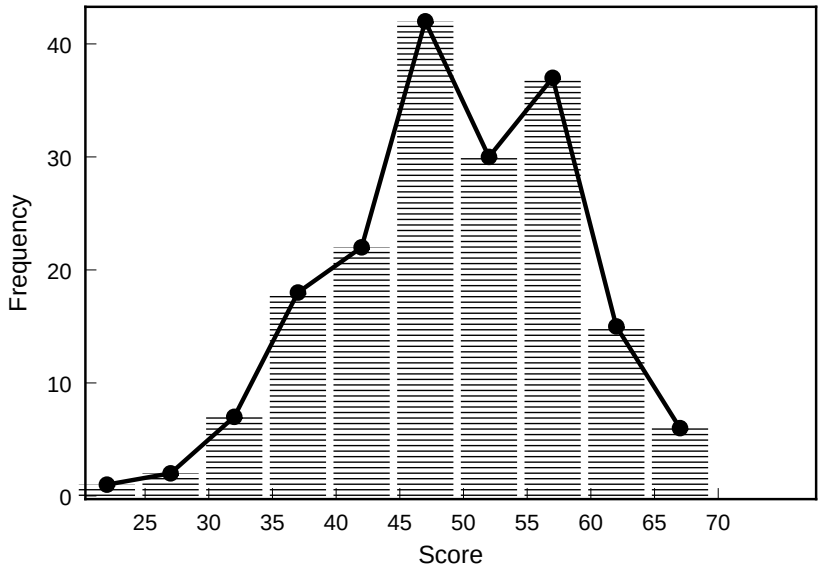
HISTOGRAMS

frequency versus score class interval



FREQUENCY POLYGON



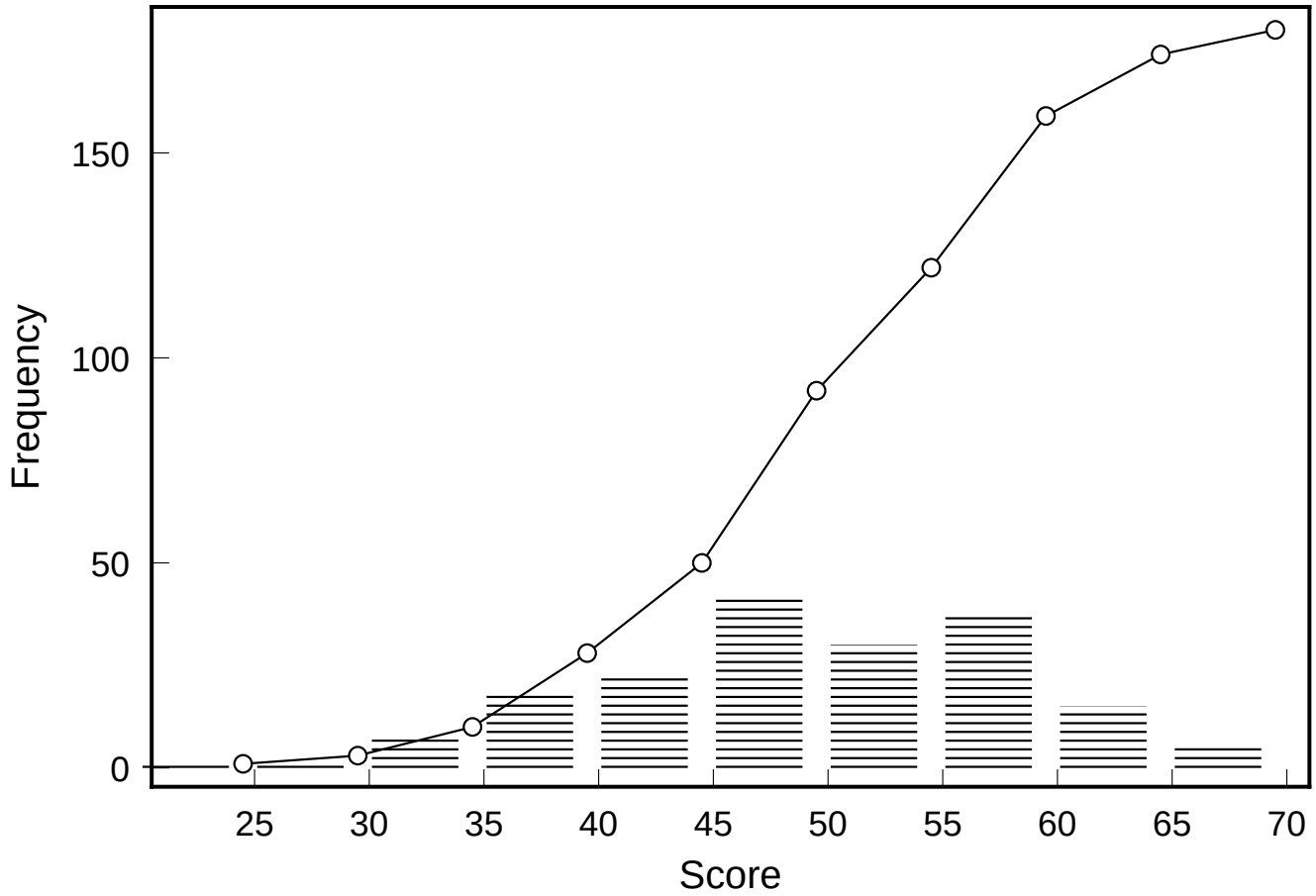


CUMULATIVE FREQUENCIES

- frequency distribution tells us how many scores in each class interval
- cumulative frequency distribution tells us how many scores in all class intervals below a specific score

Midpoint	f	cf
67	6	180
62	15	174
57	37	159
52	30	122
47	42	92
42	22	50
37	18	28
32	7	10
27	2	3
22	1	1

CUMULATIVE FREQUENCY DISTRIBUTION



Note: the point on the polygon has it's x-coordinate at the upper limit of the corresponding class interval

PERCENTAGES

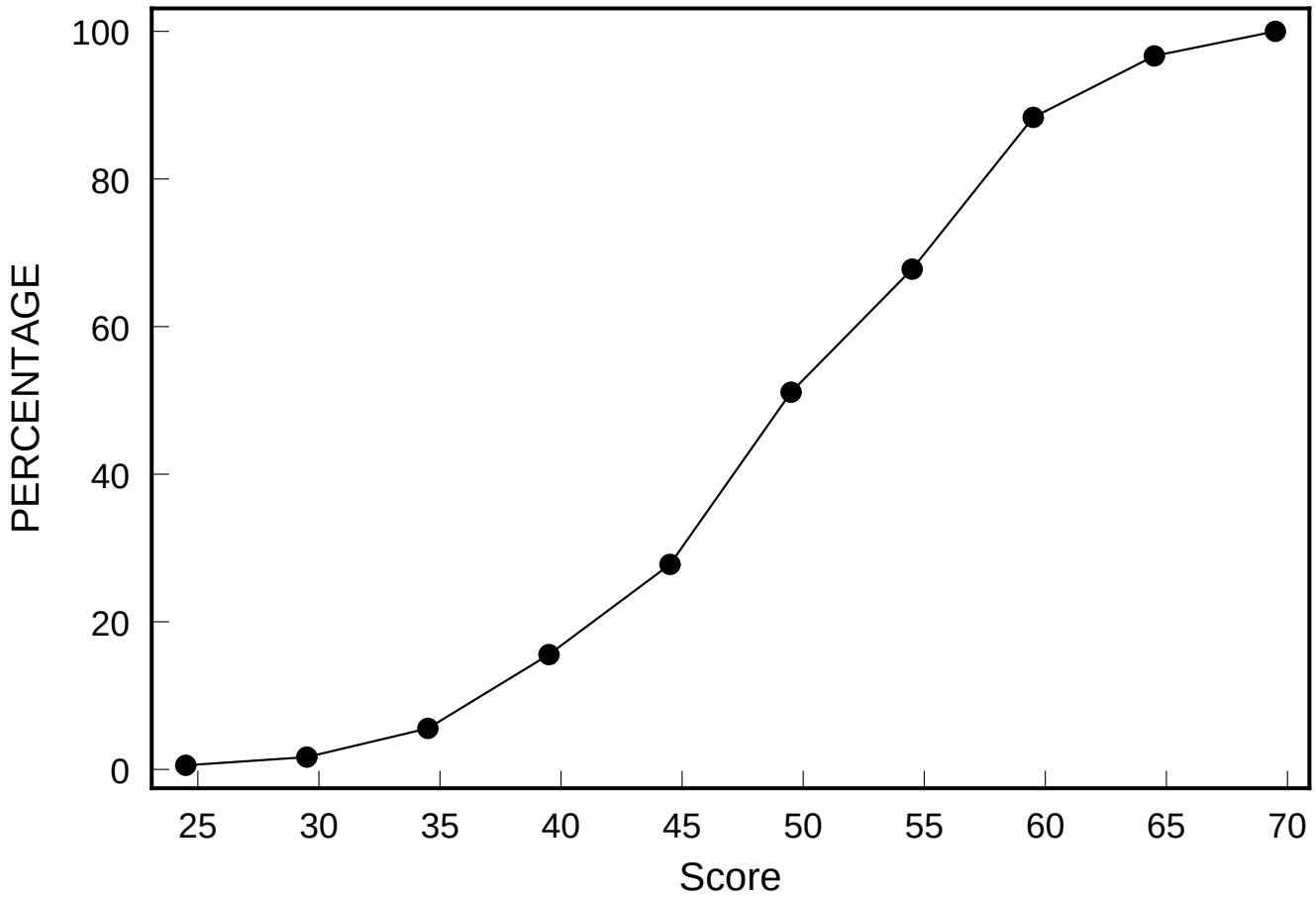
$$\% = \frac{\text{frequency}}{\text{total number of scores}}$$

$$\text{c}\% = \frac{\text{cumulative frequency}}{\text{total number of scores}}$$

Midpoint	f	cf	%	c%
67	6	180	3.33	100
62	15	174	8.33	96.67
57	37	159	20.56	88.34
52	30	122	16.67	67.78
47	42	92	23.33	51.11
42	22	50	12.22	27.78
37	18	28	10.00	15.56
32	7	10	3.89	5.56
27	2	3	1.11	1.67
22	1	1	0.56	0.56

OGIVE

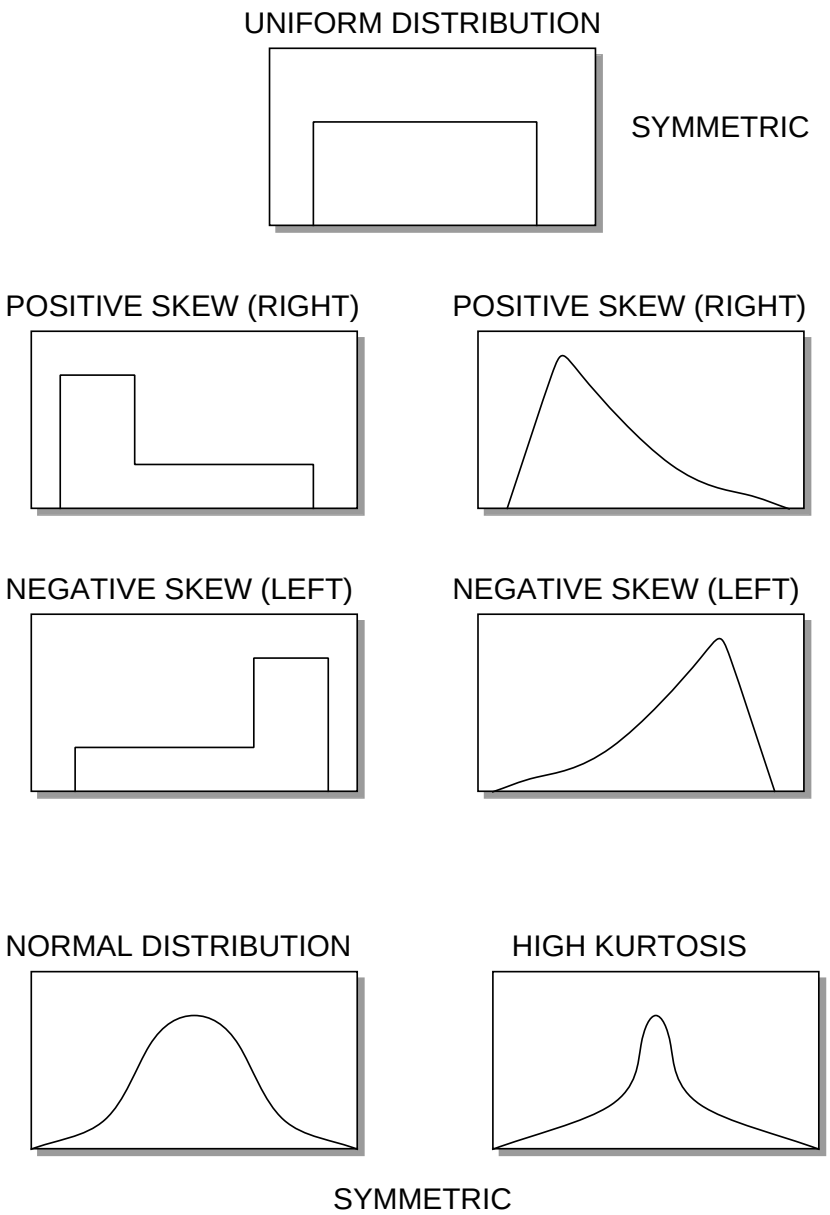
- plot cumulative frequency percentage against upper score class interval
- gives percentile points (next time)



FREQUENCY DISTRIBUTIONS

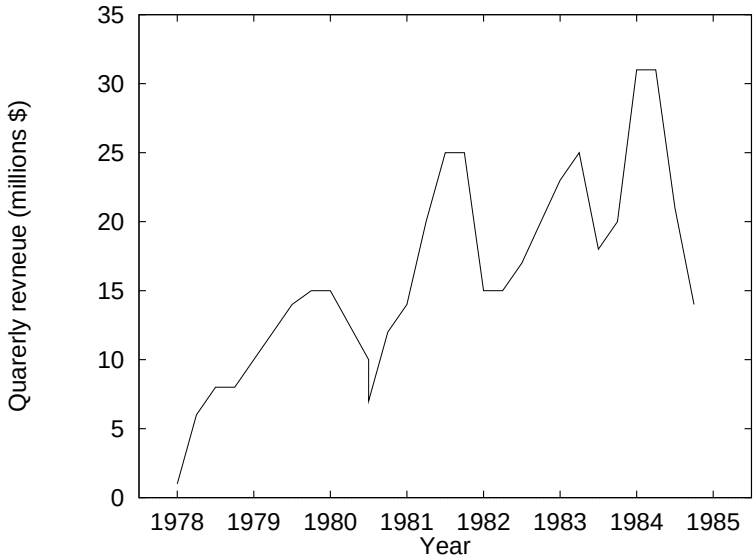
- useful to compare shapes
- any shape is possible
- some shapes are particularly important
  - uniform distribution
  - skewed distribution (long tail)
  - symmetric distribution
  - normal distribution
  - kurtosis (peakedness)

DISTRIBUTIONS



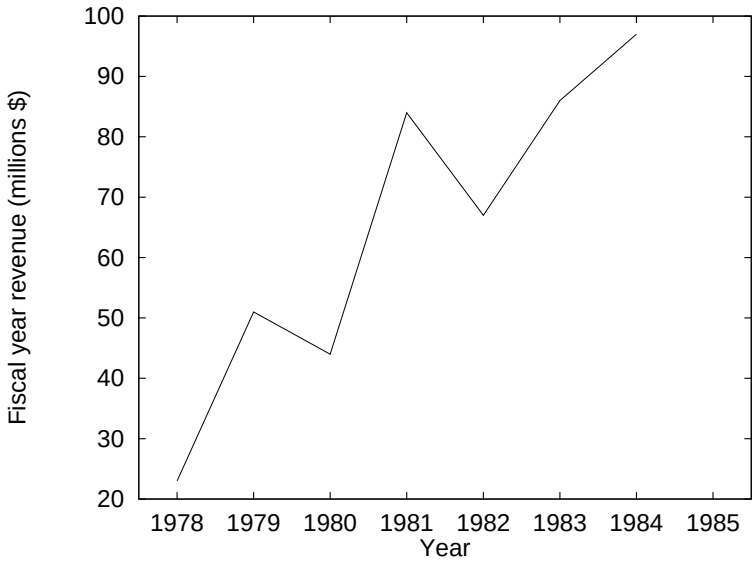
DISTRIBUTIONS

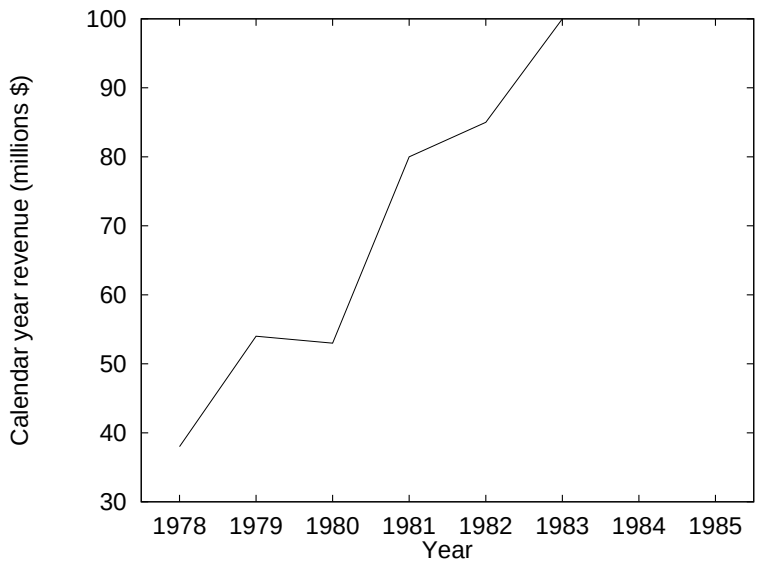
- with large data sets you *have* to group data together to make it manageable
- how you do it can sometimes have a profound effect on what people conclude
- consider revenue from a company: grouped by *quarterly* revenue



DISTRIBUTIONS

- now look at the data when grouped by fiscal or calendar year





DISTRIBUTIONS

- with computers people can now sift through huge amounts of data and present only those graphs that support what they want you to think
- a suspicious person might presume that the graphs you *do* see are the *best possible* for advancing the presenter's view
- the only way out of this is to either trust the presenter, or have access to the data and and knowledge to understand it

HONESTY

- so how you define class intervals can determine how you (or someone else) will interpret the data
- statistics don't lie (they are just numbers)
- but you could (and some people do) select certain statistics to make people believe one thing versus another
- the only thing you can do about this effect is to be aware that it exists
- you need to be aware of the limitations of the data and be on guard against things that might influence you

CONCLUSIONS

- graphing
- frequencies
- distributions
- remember: the goal is to correctly present information

NEXT TIME

- percentiles
- percentile ranks

How to score the SAT.