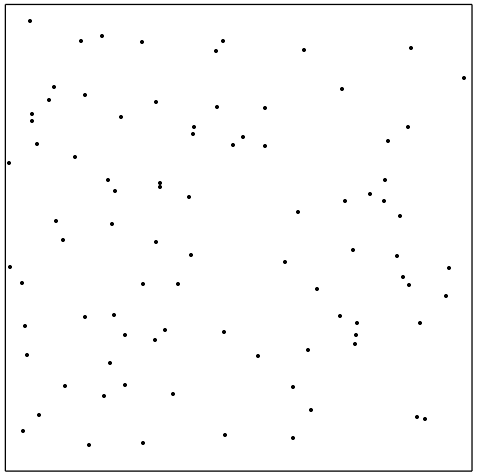
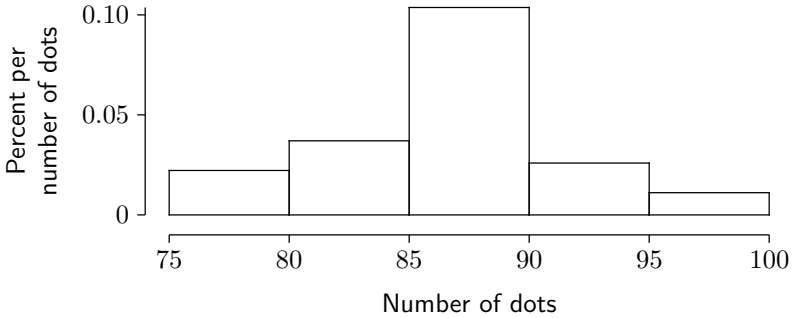
MEASUREMENT ERROR IN STATISTICS 200

• 54 students counted the dots in the square below, twice, without marking up their sheets in any way. (There are 87 dots.)



Here is a histogram of the first set of counts:



Why didn't everybody get 87?

MEASUREMENT ERROR IN THE SOCIAL SCIENCES

• A sample survey is conducted. One of the questions the interviewer asks is:

How old are you?

We may write

Answer = true age + error.

What are some sources of error?

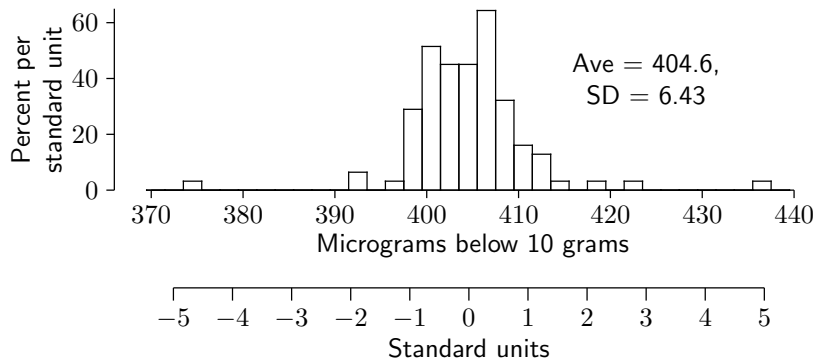
- Desire of teenagers to appear older, or the middle aged to appear younger, and of the very old to make it to 100.
- Tendency to round to the nearest decade, or multiple of five.
- Simple forgetfulness
- Recording errors and data entry errors

• In general, the wording of the question matters a lot.

- Keep it clear and simple.
- To avoid lies, you may have to ask the question indirectly. (See Section 6 of Chapter 19.)

MEASUREMENT ERROR IN THE PHYSICAL SCIENCES

• The figure below is a histogram of 100 measurements made on NB 10.



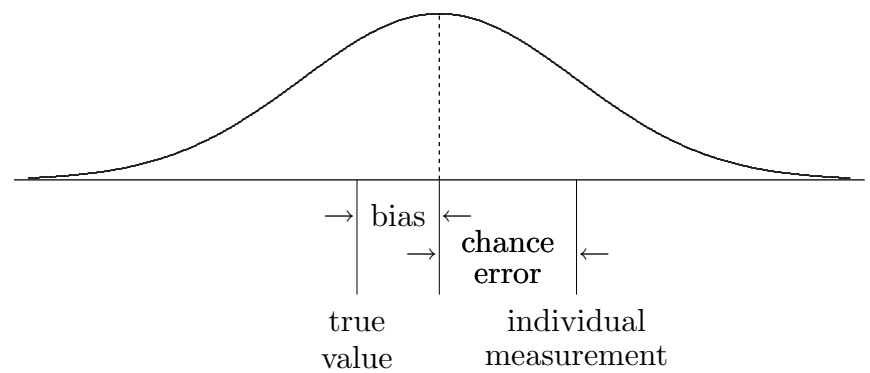
- The measurements vary. Why?
- What do you think NB 10 weighs. Why?
- How big do you think the chance error in an individual measurement on NB 10 is likely to be? Why?
- Suppose the same apparatus were used to weigh a similar object. Now what would the likely size of a chance error be?
- Suppose a new series of measurements on NB 10 gave 310, 301, 320, 307, ... micrograms below 10 grams. What would that mean?
- Do the measurements on NB 10 follow the normal curve?
- Are the outliers "real", or blunders?
- How to the outliers effect the average and the SD?

BIAS AND CHANCE ERROR

• We may write

$$\begin{matrix}\text{individual}\\ \text{measurement}\end{matrix} = \text{exact value} + \text{bias} + \text{chance error}.$$

- Bias affects all measurements the same way, pushing them in the same direction.
- Chance errors change from measurement to measurement, sometimes up and sometimes down.



- The bias in the measurements on NB 10 is thought to be negligible compared to the chance errors.

• Repeated measurements help:

- They allow you to estimate the likely size of the chance error in an individual measurement.
- The chance error in their average tends to be smaller than the chance errors in the individual measurements. (See Chapters 23 and 24.)