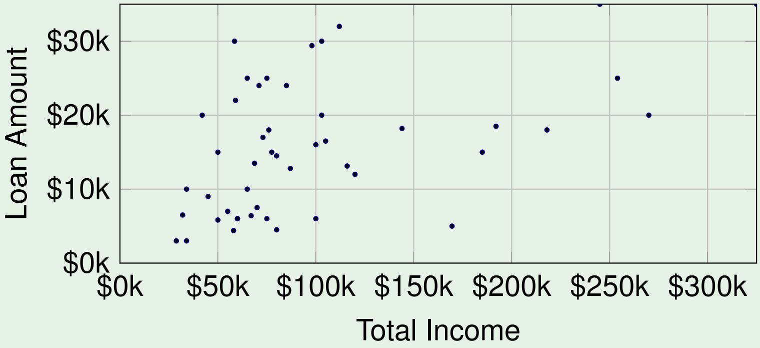
Examining Numerical Data

Colby Community College

Example 1

Let us consider a scatterplot of borrowers total income and the loan amount from the `loan50` data set.



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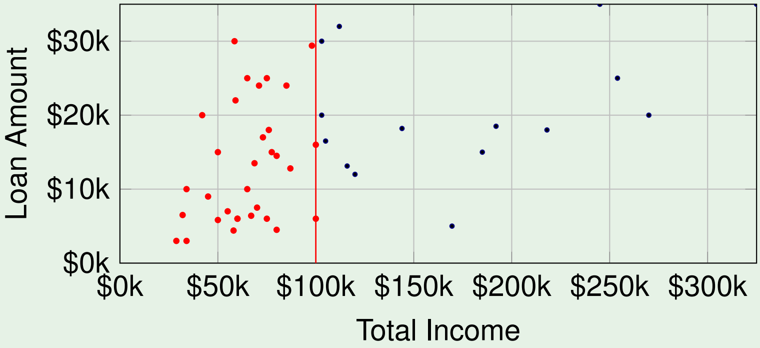

We can see that the many of borrowers earn $100,000 a year or less.

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It is clear there is a **nonlinear** association between the median household income and the poverty rate.

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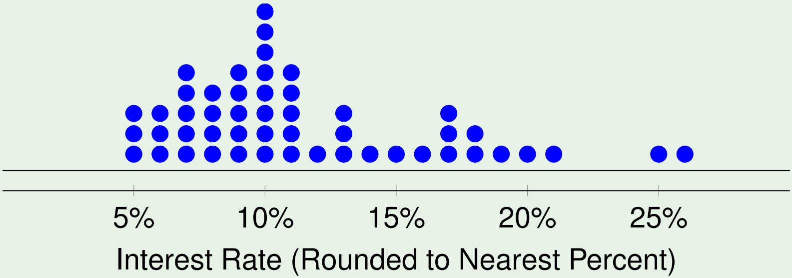

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Note

Parameter and population both start with a “P.”
Statistic and sample both start with a “S.”

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- Sample means drawn from the same population tend to vary less than other measures of center.

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Properties of the Mean

- Sample means drawn from the same population tend to vary less than other measures of center.
- A disadvantage of the mean is that just one extreme value can change the value of the mean substantially.

Common Notation

Sample statistics are usually represented by English letters, such as $\bar{x}$, while population parameters are usually represented by Greek letters, such as μ.

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N	represents the number of data values in a population.
$\bar{x} = \dfrac{\sum x}{n}$	is the mean of a set of sample values.
$\mu = \dfrac{\sum x}{N}$	is the mean of all values in a population.

Example 4

Suppose we measure the of data speeds of smartphones from the four major carriers. The table contains five data speeds, in megabits per second (Mbps), from this data set.

Carrier	Verizon	Verizon	Verizon	Verizon	Verizon
Mbps	38.5	55.6	22.4	14.1	23.1

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Note

Round statistics and parameters to one more decimal place than found in the data.

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It is common to mark the mean on a dot plot.

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The mean of `interest_rate` is: (Do not round the data values.)

$$\bar{x} = \frac{\left(\begin{array}{c} 5.31\% + 5.31\% + 5.32\% + 6.08\% + 6.08\% + 6.08\% + 6.71\% + 6.71\% + 7.34\% \\ +7.35\% + 7.35\% + 7.96\% + 7.96\% + 7.96\% + 7.97\% + 9.43\% + 9.43\% + 9.44\% \\ +9.44\% + 9.44\% + 9.92\% + 9.92\% + 9.92\% + 9.92\% + 9.93\% + 9.93\% + 10.42\% \\ +10.42\% + 10.9\% + 10.9\% + 10.91\% + 10.91\% + 10.91\% + 11.98\% + 12.62\% \\ +12.62\% + 12.62\% + 14.08\% + 15.04\% + 16.02\% + 17.09\% + 17.09\% + 17.09\% \\ +18.06\% + 18.45\% + 19.42\% + 20\% + 21.45\% + 24.85\% + 26.3\% \end{array}\right)}{50} = 11.567\%$$

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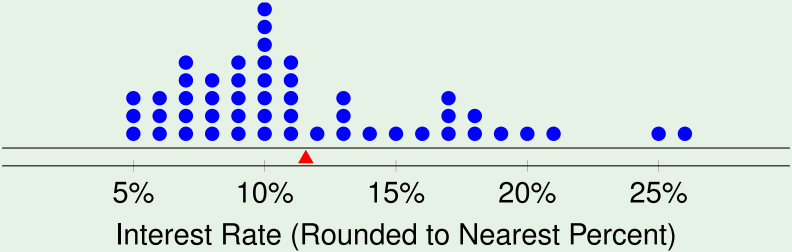

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We will discuss tools in Chapter 5 and beyond to determine how well a point estimate estimates a parameter.

Example 7

We would like to determine if a new drug is more effective at treating asthma attacks than the standard drug. A trial of 1500 adults is setup, giving the following data.

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But, when we calculate the means we get:

New drug: $200 \text{ attacks}/500 \text{ patients} = 0.4 \text{ attacks per patient}$

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Standard drug: 300 attacks$/$1000 patients $=$ 0.3 attacks per patient

The average number of asthma attacks per patient is higher with the new drug, so it's not more effective.

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Note

The mean gives a standardized a metric into something easier to interpret and compare.

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   $(\texttt{pop2017} \times \texttt{per\_capita\_income})$

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Using this method we would find the average income per person in the US is $\$30,861$. If we had used the simple mean of `per_capita_income` the result would have been $\$26,093$, which is much lower.

Definition

A **weighted mean** is a mean where some values contribute more than others.

$$\bar{x} = \frac{\sum w_x \cdot x}{\sum w_x}$$

The values w_x are called the **weights.**

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Your final grade in this class is a weighted mean of the following four values:

Value	% of Grade	Weight
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So, your final grade is calculated using the formula:

$$\text{Grade} = \frac{10 \cdot \overline{\text{attendance}} + 30 \cdot \overline{\text{assignments}} + 40 \cdot \overline{\text{exams}} + 20 \cdot \text{final}}{10 + 30 + 40 + 20}$$

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Note

We could also use the decimal versions of the percentages as the weights, instead of the whole numbers.

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Procedure

1. Sort the values.
2. - If the number of data values is odd, the median is the number located in the exact middle of the sorted list.
   - If the number of data values is even, the median is found by computing the mean of the two middle numbers in the sorted list.

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Let find the median data speed using the table from Example 4.

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We have 5 data values so the median is $\tilde{x} = 23.1$ Mbps.

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14.1	22.4	23.1	38.5	55.6

We have 5 data values so the median is $\tilde{x} = 23.1$ Mbps.

Note

This different than the mean 30.74 Mbps.

Example 12

Let find the median data speed using the table from Example 4, but with an extreme value added in.

Carrier	Verizon	Verizon	Verizon	Verizon	Verizon	Verizon
Mbps	38.5	55.6	22.4	14.1	23.1	192.6

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First sort the data values.

14.1	22.4	23.1	38.5	55.6	192.6

We have 6 data values so $\tilde{x} = \dfrac{23.1 + 38.5}{2} = 30.80$ Mbps.

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First sort the data values.

14.1	22.4	23.1	38.5	55.6	192.6

We have 6 data values so $\tilde{x} = \dfrac{23.1 + 38.5}{2} = 30.80$ Mbps.

Note

This is very different from the mean of this table.

$$\bar{x} = \frac{14.1 + 22.4 + 23.1 + 38.5 + 55.6 + 192.6}{6} = 173.15 \text{ Mbps}$$

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- Visually displays the shape of the distribution of the data.

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- Shows the location of the center of the data.
- Shows the spread of the data.
- Identifies extreme values.

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A **histogram** is a graph consisting of bars of equal width drawn adjacent to each other. Each bar represents a “bin” of data values and the height of each bar is how many data values are in the “bin”.

Important Uses

- Visually displays the shape of the distribution of the data.
- Shows the location of the center of the data.
- Shows the spread of the data.
- Identifies extreme values.

Note

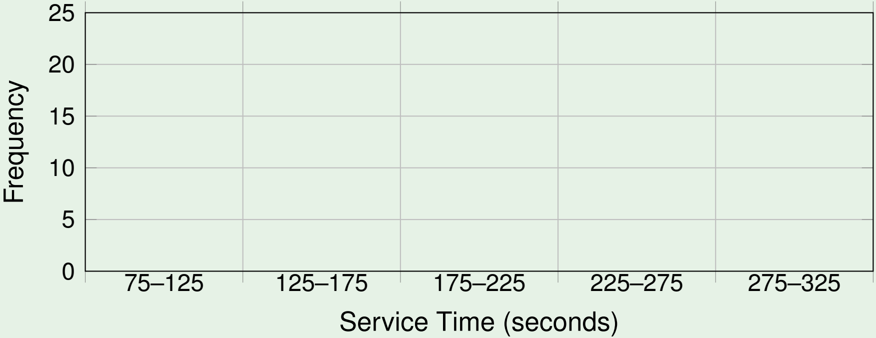
Histograms are similar to dot plots, except that each bar represents a range of data values.

Example 13

The table contains drive-through service times, in seconds.

107	139	197	209	281	254	163	150	127	308	206
169	83	127	133	140	143	130	144	91	113	153
252	200	117	167	148	184	123	153	155	154	100
101	138	186	196	146	90	144	119	135	151	197

Let's build a histrogram:



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107	139	197	209	281	254	163	150	127	308	206
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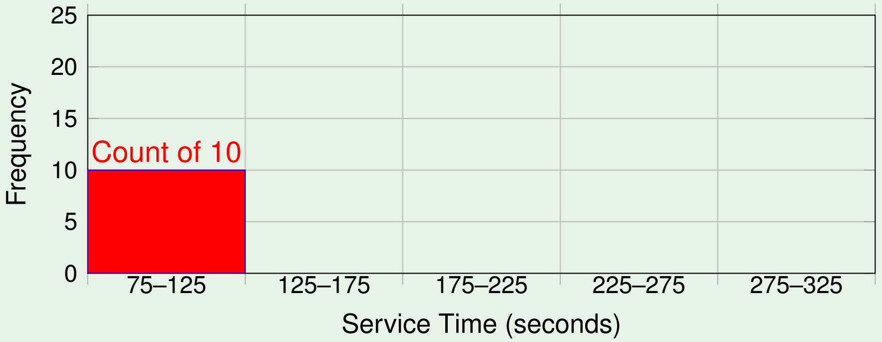

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107	139	197	209	281	254	163	150	127	308	206
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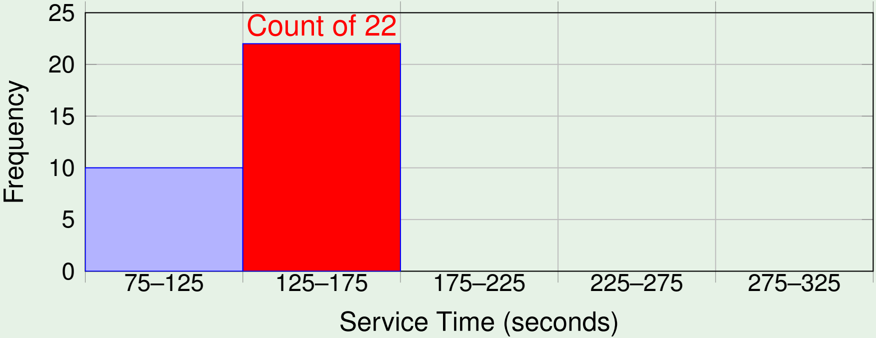

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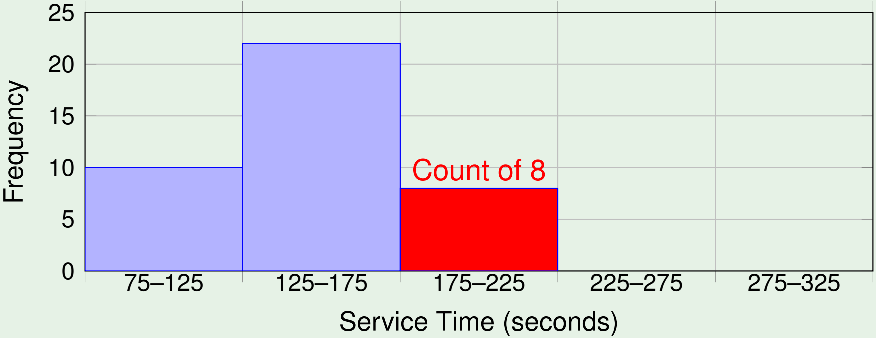

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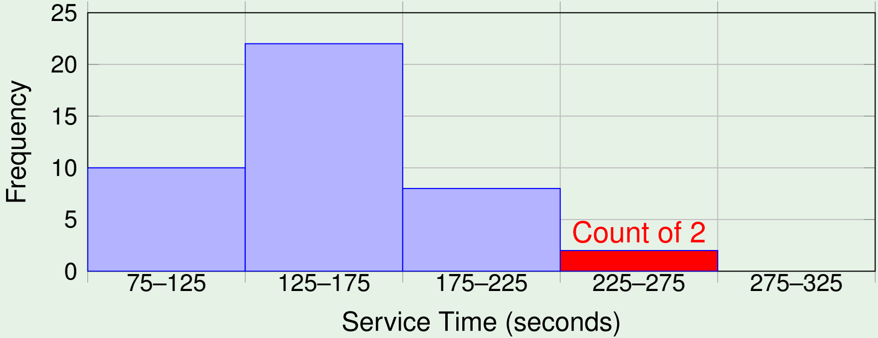

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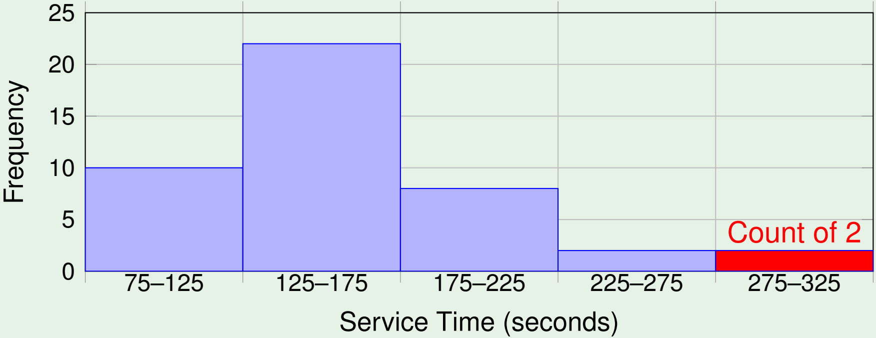

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