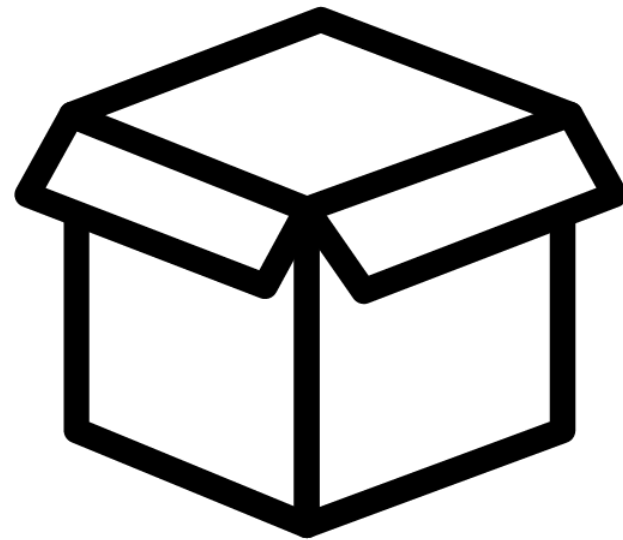


IQR

Box and Whisker Graphs

One Variable Data Management



&



Summary

THE QUARTILES AND THE INTERQUARTILE RANGE

The median divides the ordered data set into two halves and these halves are divided in half again by the **quartiles**.

The middle value of the lower half is called the **lower quartile** or **25th percentile**. One quarter or 25% of the data have values less than or equal to the lower quartile. 75% of the data have values greater than or equal to the lower quartile.

The middle value of the upper half is called the **upper quartile** or **75th percentile**. One quarter or 25% of the data have values greater than or equal to the upper quartile. 75% of the data have values less than or equal to the upper quartile.

The **interquartile range** is the range of the middle half or 50% of the data.

$$\text{interquartile range} = \text{upper quartile} - \text{lower quartile}$$

The data set is thus divided into quarters by the lower quartile (Q_1), the median (Q_2), and the upper quartile (Q_3).

So, the interquartile range,

$$\text{IQR} = Q_3 - Q_1.$$

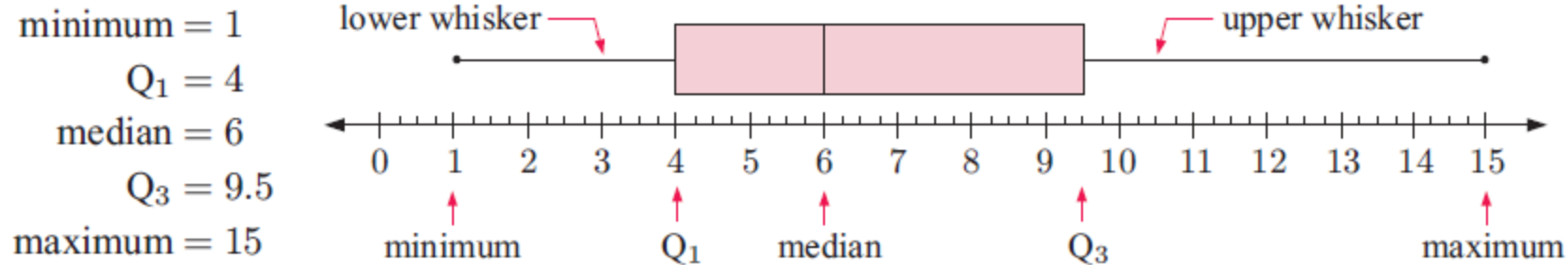
The interquartile range is not affected by extremely low or extremely high data values, as these lie outside the middle 50% of data values.

Summary

A **boxplot** or **box and whisker plot** is a visual display of some of the descriptive statistics of a data set. It shows:

- the minimum value
 - the lower quartile (Q_1)
 - the median (Q_2)
 - the upper quartile (Q_3)
 - the maximum value
- These five numbers form the **five-number summary** of the data set.

For the data set in **Example 8** on page 519, the five-number summary and boxplot are:



The rectangular box represents the ‘middle’ half of the data set.

The lower whisker represents the 25% of the data with smallest values.

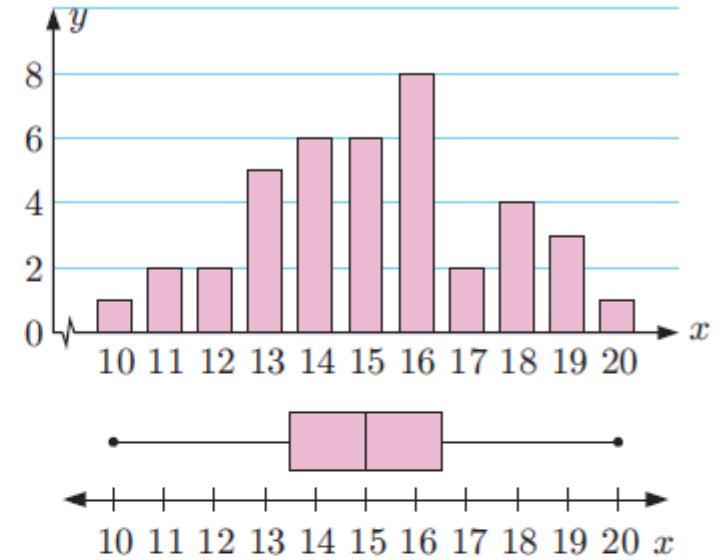
The upper whisker represents the 25% of the data with greatest values.

Summary

INTERPRETING A BOXPLOT

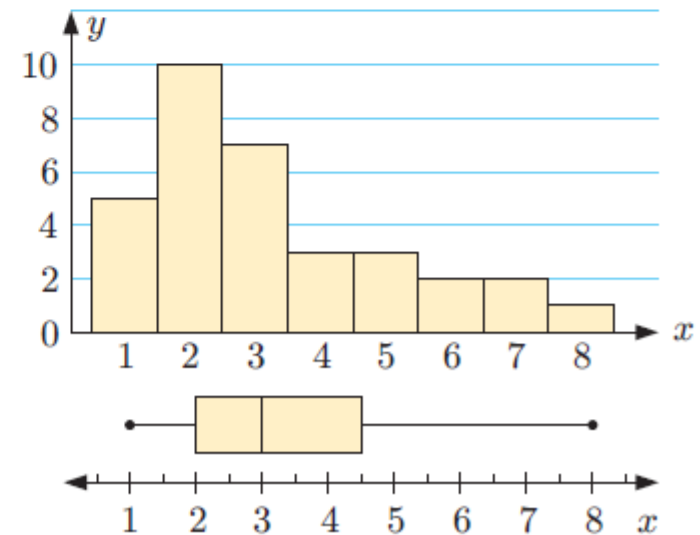
A set of data with a **symmetric distribution** will have a symmetric boxplot.

The whiskers of the boxplot are the same length and the median line is in the centre of the box.



A set of data which is **positively skewed** will have a positively skewed boxplot.

The right whisker is longer than the left whisker and the median line is to the left of the box.



Summary Example

Example 9



Consider the data set: 8 2 3 9 6 5 3 2 2 6 2 5 4 5 5 6

- Construct the five-number summary for this data.
- Draw a boxplot.
- Find the:
 - range
 - interquartile range of the data.
- Find the percentage of data values less than 3.

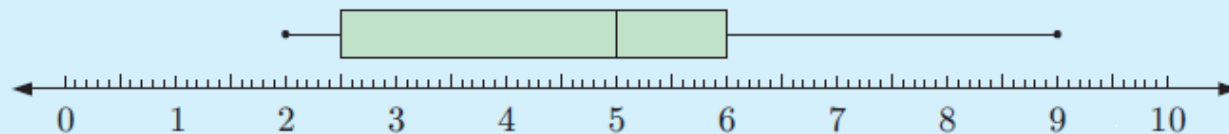
- a** The ordered data set is:

2 2 2 2 3 3 4 5 5 5 5 6 6 6 8 9 (16 of them)

$$Q_1 = 2.5 \quad \text{median} = 5 \quad Q_3 = 6$$

So the 5-number summary is: $\begin{cases} \text{minimum} = 2 & Q_1 = 2.5 \\ \text{median} = 5 & Q_3 = 6 \\ \text{maximum} = 9 \end{cases}$

- b**



- c**
- | | |
|------------------------------------|-----------------------------|
| i range = maximum – minimum | ii IQR = $Q_3 - Q_1$ |
| = 9 – 2 | = 6 – 2.5 |
| = 7 | = 3.5 |

- d** Using the ordered data set in **a**,
4 out of 16 data values are less than 3.
 \therefore 25% of the data values are less than 3.

When my stats teacher
said that I was average,
she was just being mean.

With my head in a fire
And my feet on some ice,
I'd say that, on average,
I feel rather nice.

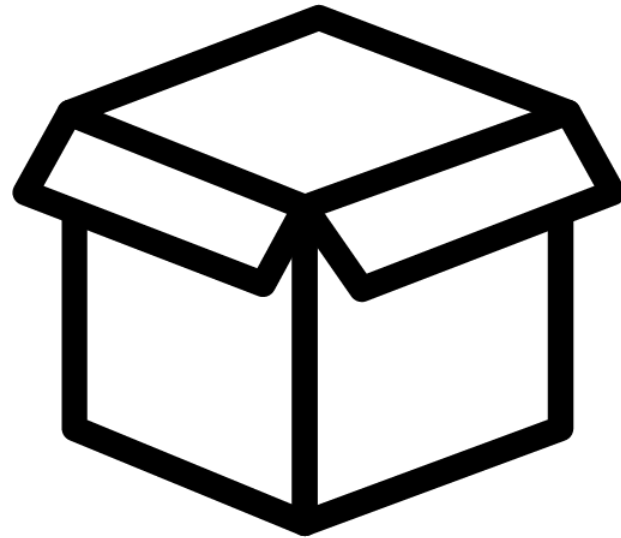
Two men are sitting in a bar when Mark Zuckerberg walks in. One of the men says to his friend, “How awesome! On average, everyone in this bar is a billionaire!”

Most people have an above-average
number of legs.

(The average person only has 1.99 legs.
Most have 2, but some have 1 or 0, making
the average less than 2)

Did you hear about the politician who promised that, if he was elected, he'd make certain that everybody would get an above average income?

Some stuff about
ecology.



&



TYPES OF LADYBUGS



Seven-spot
Ladybird



Yellow-shouldered
Ladybird



Two-spot
Ladybird



Nine-spotted
Lady Beetle



Twenty-spotted
Lady Beetle



Fifteen-spotted
Lady Beetle



Pink Spotted
Lady Beetle



Convergent
Lady Beetle



Fourteen-
spotted
Ladybug



Eighteen-
spotted
Ladybird



Large
Leaf-eating
Ladybird



Ten-spotted
Ladybird



Eyed
Ladybug



Transverse
Ladybird



Thirteen-spot
Lady Beetle



Mealybug
Ladybird



22-spot
Ladybird



Ashy Gray
Lady Beetle



Steelblue
Ladybird

Halloween
Beetle is an
invasive
species in
North
America.



13-spotted
Ladybug is
native to
Ontario.

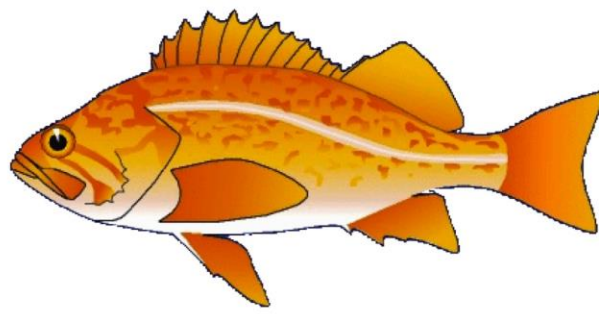


During the winter, species native to Ontario winter over in colonies to keep warm.



The invasive species, however, likes to winter inside people's houses.

Has the average mean length of fishes changed with time?



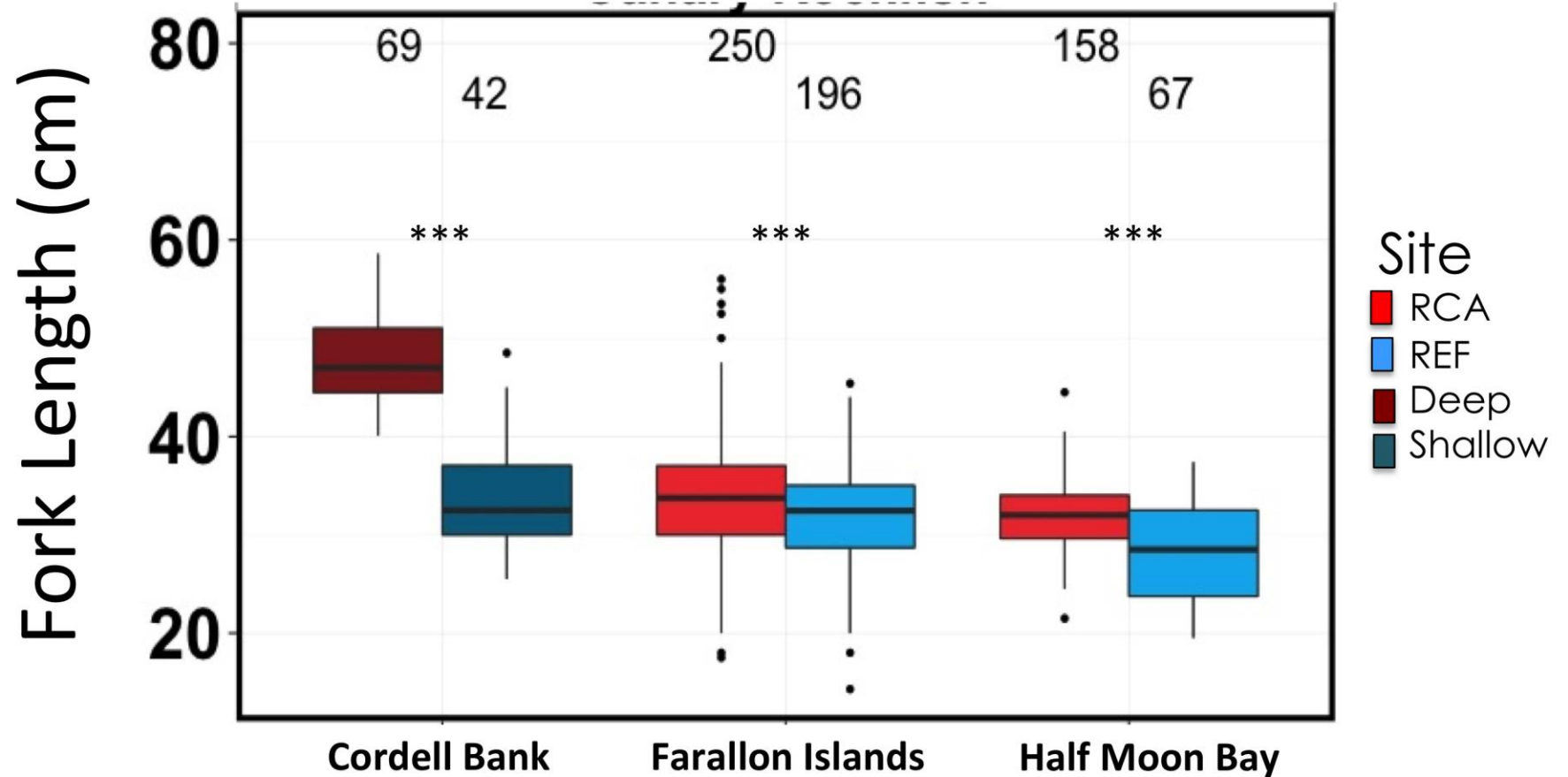
Canary Rockfish (*Sebastes pinniger*)

Median Length (cm) for fish caught
2012-2014

Lifespan: 84 yr
Max Size: 76 cm (29.6 in)



<https://mlml.sjsu.edu/fisheseries/has-average-length-of-fishes-changed/>



Median Length for Canary Rockfish. Blue represents shallow or REF sites; Red denotes deep or RCA sites. Sample size is displayed above each boxplot. [t-test statistical significance between median lengths: (*) $p \leq .05$; (**) $p \leq .01$; (***) $p \leq .001$]



This is a stonefly.

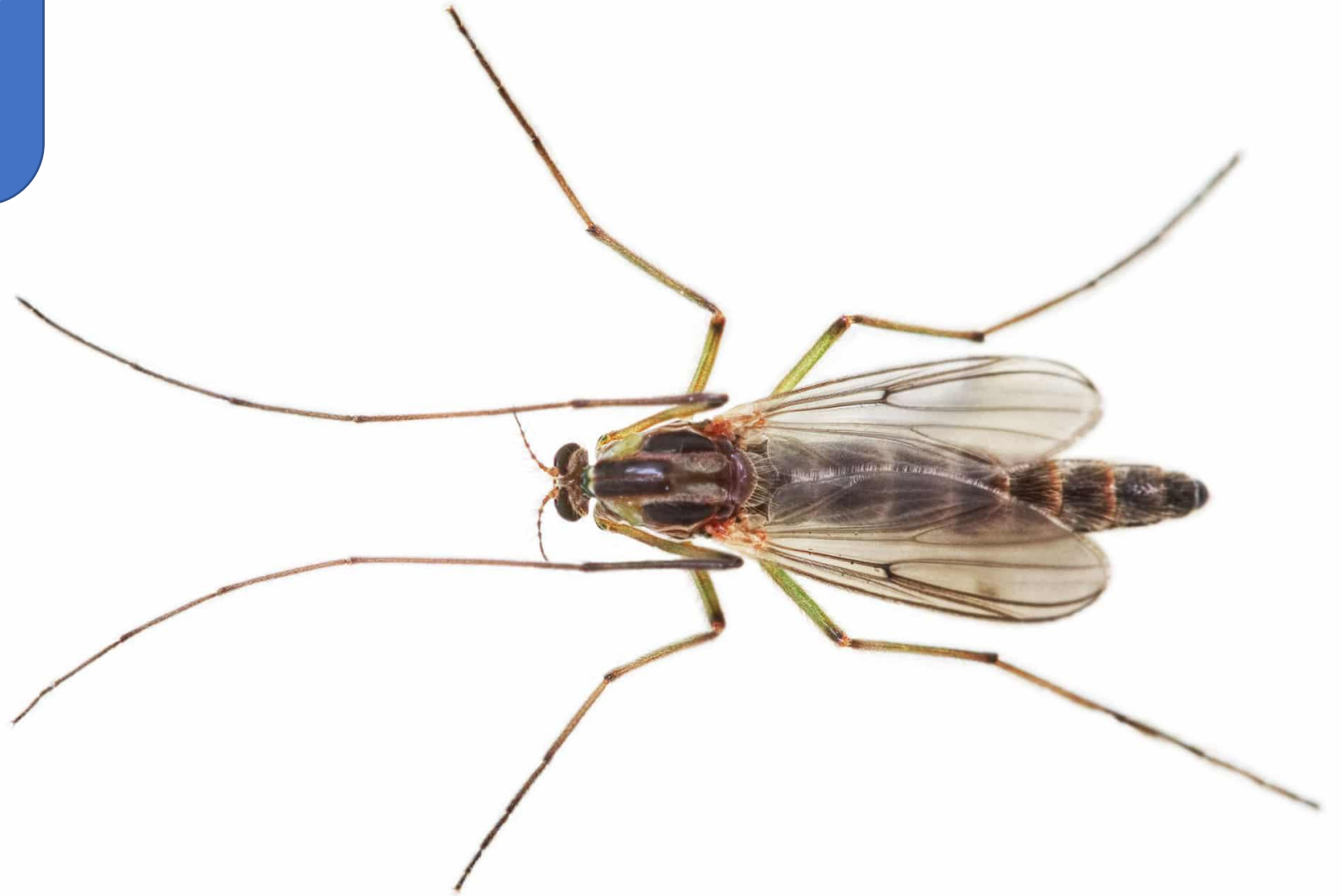




Some stonefly larvae have gills along their body to breathe water.

Some can breathe **DIRECTLY** through their exoskeleton.

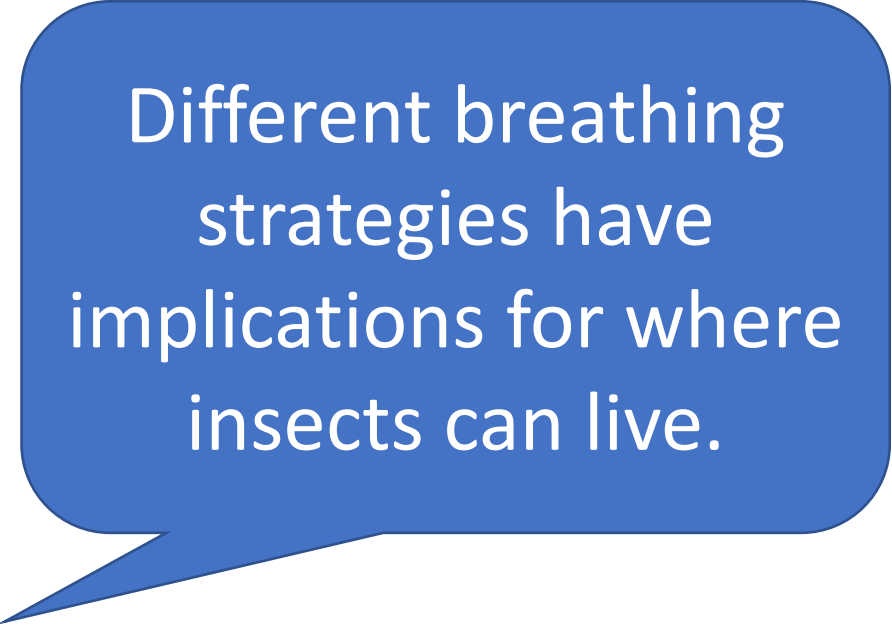
This is a midge.
They are tiny. Some
are only 1 mm
large!!





The larval stage of a midge is called a bloodworm.

They use hemoglobin to distribute oxygen.



Different breathing strategies have implications for where insects can live.

Different breathing strategies have implications for where insects can live.

If, like stoneflies, you get oxygen directly through water, then you need an oxygen rich environment.

Different breathing strategies have implications for where insects can live.

Fish also need an oxygen rich environment. If you've got stoneflies, then it is good water for fish too.

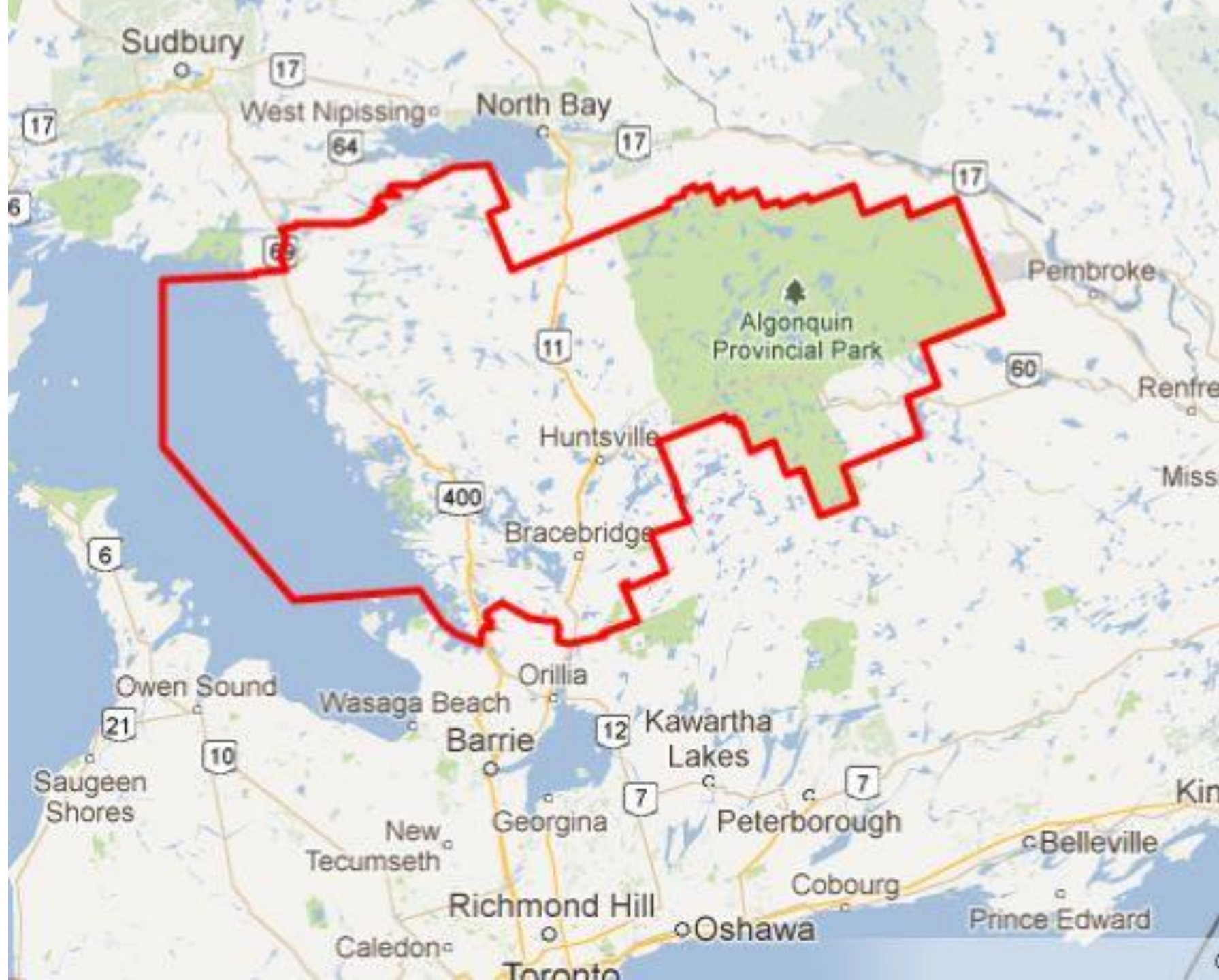
If, like stoneflies, you get oxygen directly through water, then you need an oxygen rich environment.

Different breathing strategies have implications for where insects can live.

Fish also need an oxygen rich environment. If you've got stoneflies, then it is good water for fish too.

If, like stoneflies, you get oxygen directly through water, then you need an oxygen rich environment.

Midges indicate low oxygen conditions and a possible problem.







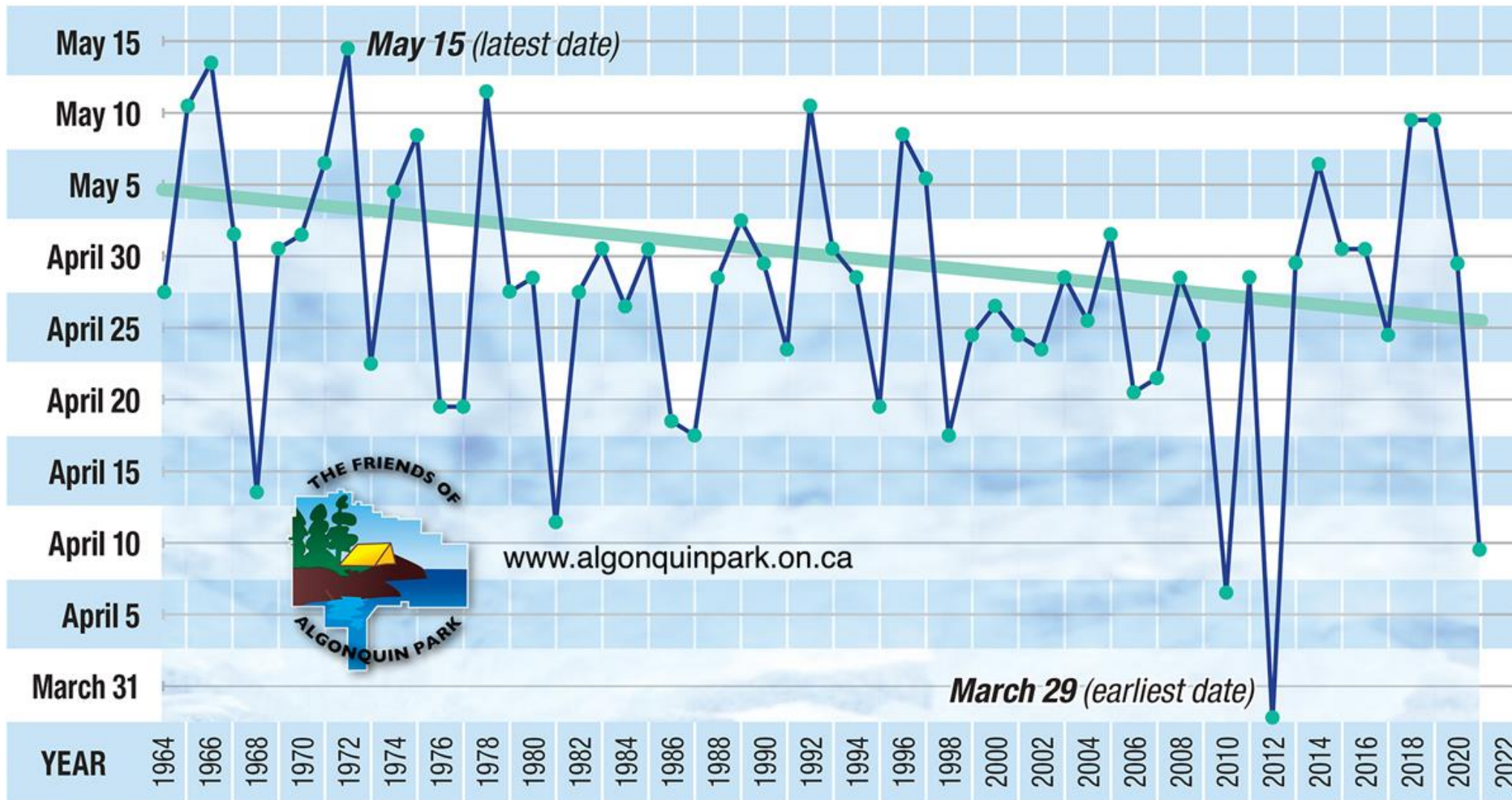






www.algonquinpark.on.ca

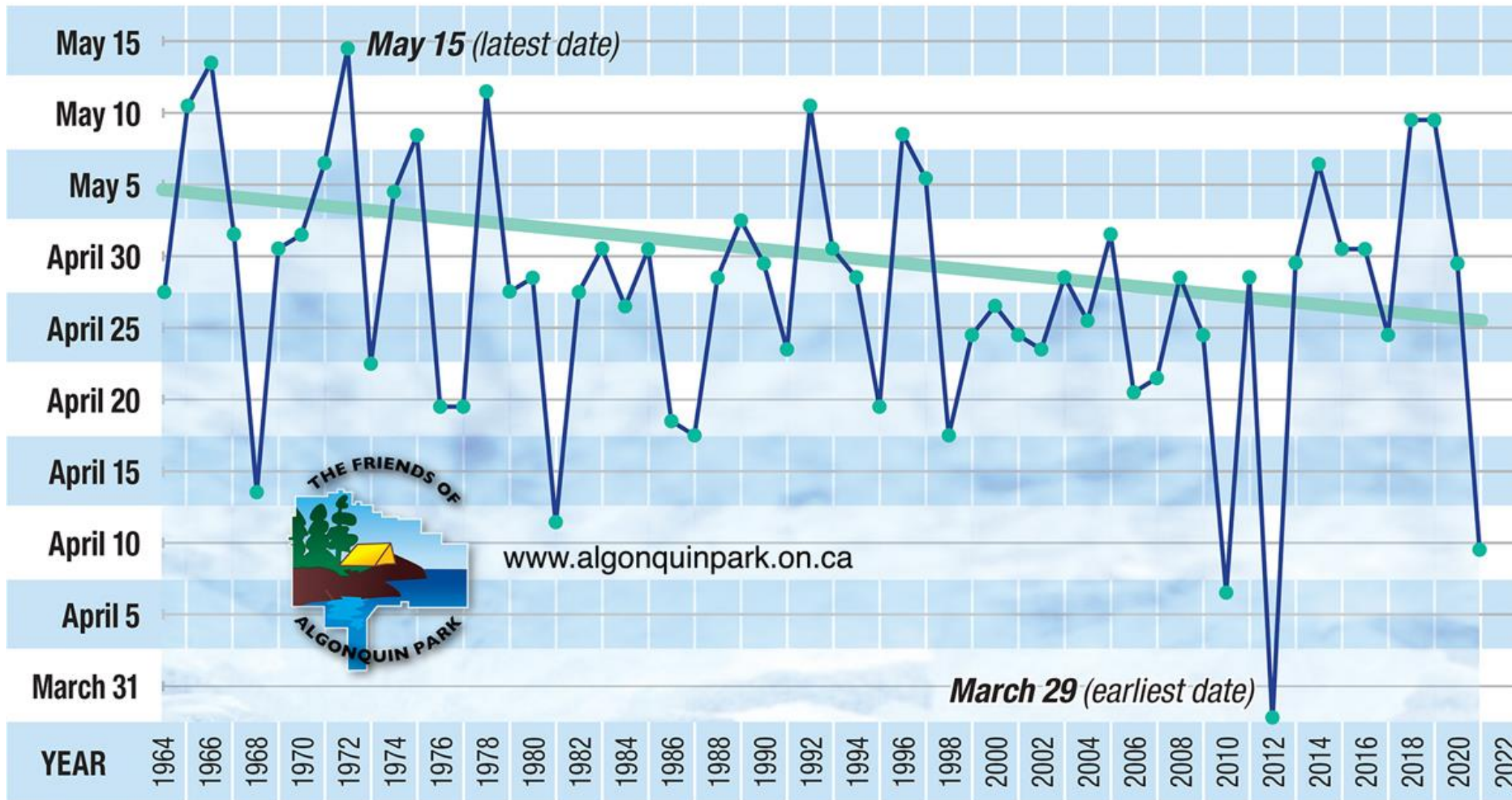
Lake Opeongo Ice Out Dates Since 1964



What kind of graph is this?

1. Concrete Graph
2. Pictograph
3. Line Plots
4. Bar Graph
5. Multiple Bar Graph
6. Stacked Bar Graph
7. Histogram
8. Broken Line Graph
9. Circle Graph
10. Scatterplot
11. Box and Whisker

Lake Opeongo Ice Out Dates Since 1964



What kind of graph is this?

1. Concrete Graph
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5. Multiple Bar Graph
6. Stacked Bar Graph
7. Histogram
8. Broken Line Graph
9. Circle Graph
10. Scatterplot
11. Box and Whisker

Year	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Ice Off Date	27-Apr	10-May	14-May	1-May	14-Apr	30-Apr	1-May	6-May	15-May	22-Apr	5-May	7-May
Days Jan to Ice Off	116	129	133	120	103	119	120	125	134	111	124	126
Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Ice Off Date	20-Apr	20-Apr	11-May	27-Apr	29-Apr	11-Apr	27-Apr	30-Apr	26-Apr	30-Apr	18-Apr	17-Apr
Days Jan to Ice Off	109	109	130	116	118	100	116	119	115	119	107	106
Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Ice Off Date	29-Apr	3-May	29-Apr	10-May	30-Apr	29-Apr	20-Apr	8-May	5-May	17-Apr	25-Apr	27-Apr
Days Jan to Ice Off	118	122	118	129	119	118	109	127	124	106	114	116
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ice Off Date	25-Apr	24-Apr	29-Apr	20-Apr	21-Apr	29-Apr	25-Apr	6-Apr	29-Apr	29-Mar	30-Apr	6-May
Days Jan to Ice Off	114	113	118	109	110	118	114	95	118	87	119	125
Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021		
Ice Off Date	29-Mar	30-Apr	7-May	1-May	1-May	25-Apr	10-May	10-May	30-Apr	10-Apr		
Days Jan to Ice Off	87	119	126	120	120	114	129	129	119	99		

Quartile

Quarter

Quarter
final

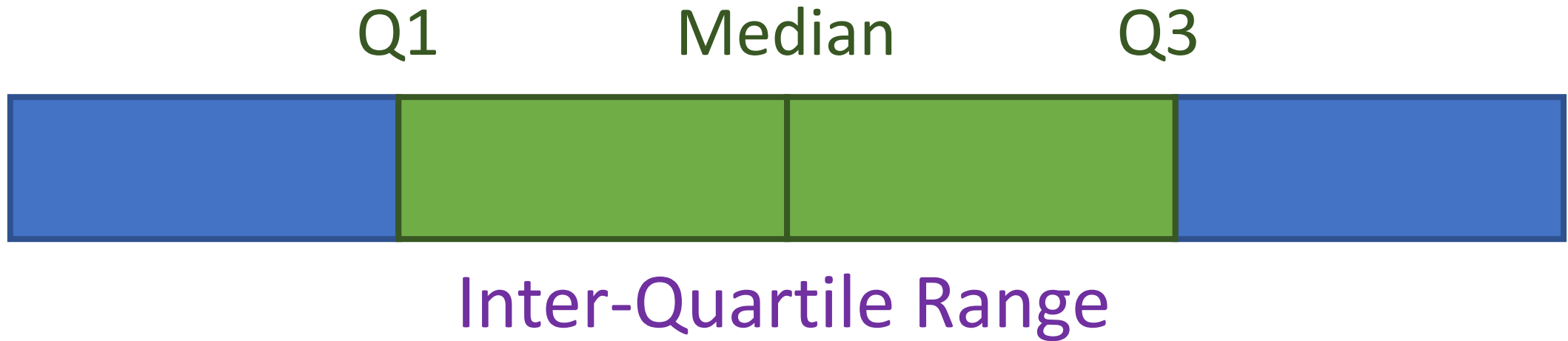
Quartet

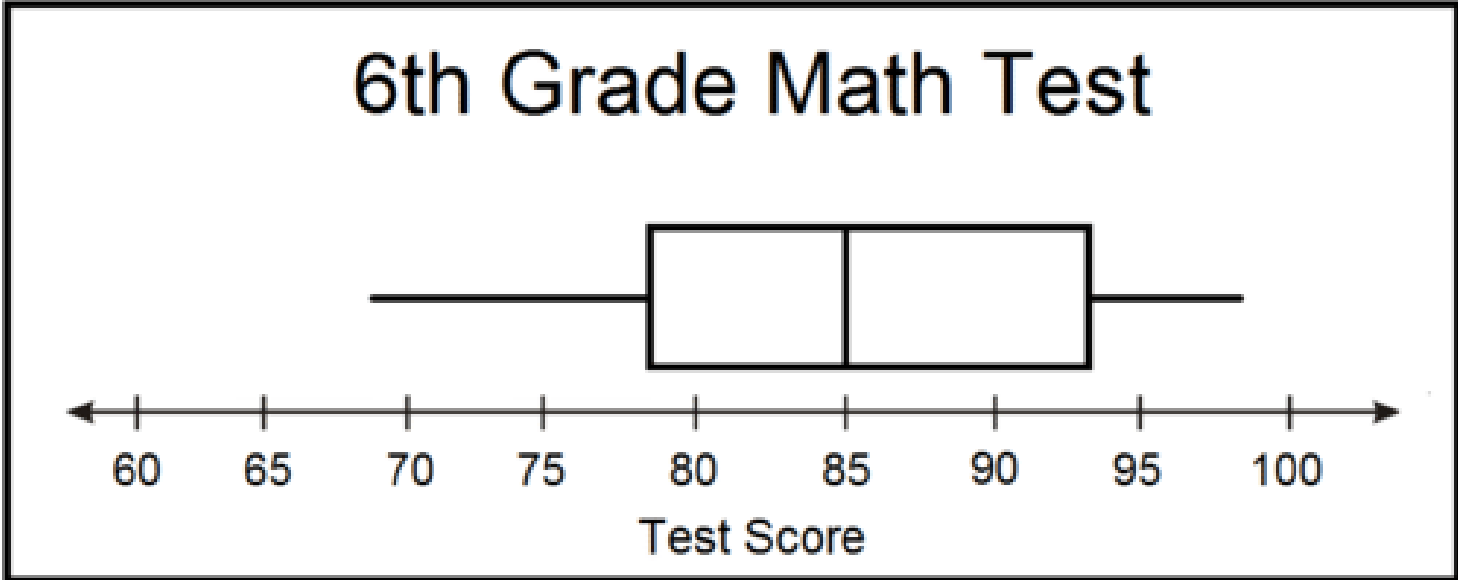


Quartered

Latin: Quattuor: Four
Old French: Quartier

Essentially, Quartiles divide the data into quarters.
The inter-quartile range goes from Q1 to Q3.





What was the lowest mark?

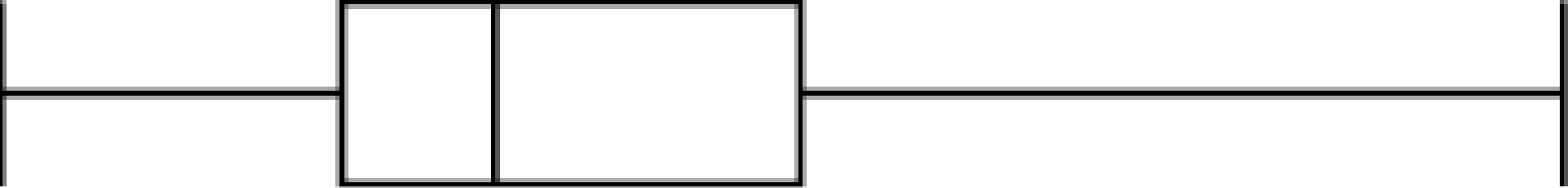
What was the highest mark?

What was the median?

What is the Q1?

What is the Q3?

Eight hundred insects were weighed, and the resulting measurements, in milligrams, are summarized in the boxplot below.



Lowest?

Q1?

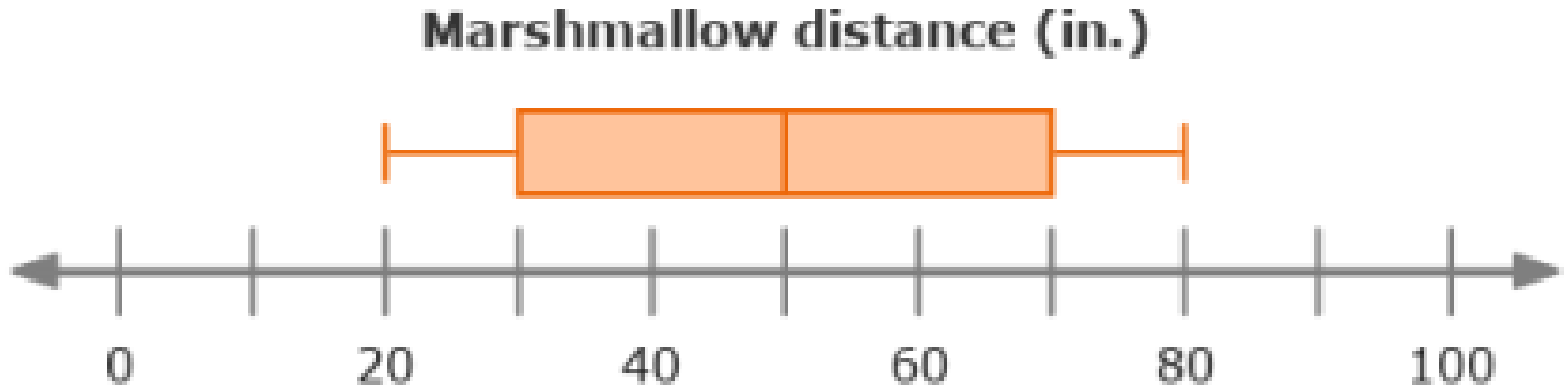
Highest?

Q3?

Median?

IQR?

For an engineering project, each student in Mr. McDonald's science class made a catapult and measured how far it flung a marshmallow. This box plot shows the results.



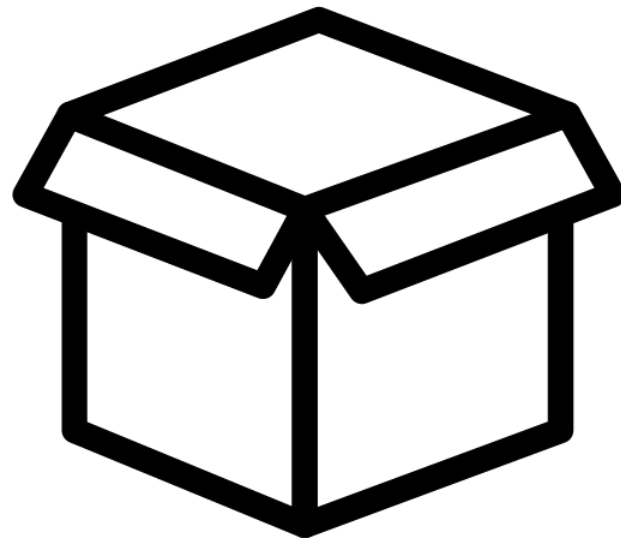
What fraction of the catapults flung a marshmallow 30 inches or less?

The following box-and-whisker plot shows the number of text messages sent by students in a school on a particular day.



Find the value of the interquartile range.

How do you make a
box and whisker
chart?



&



1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

23

26

26

29

30

31

31

31

33

33

34

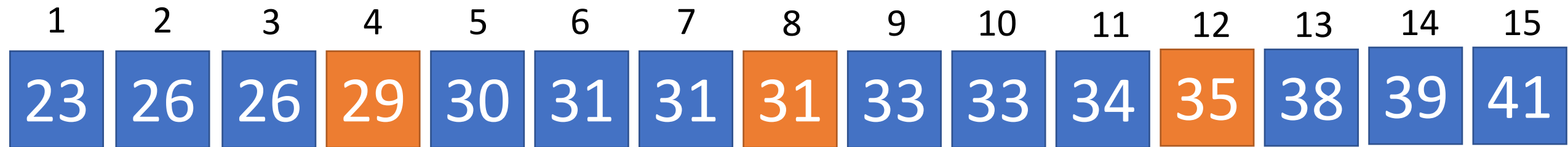
35

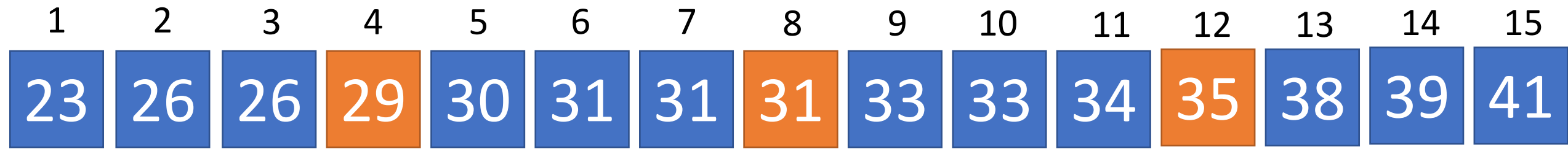
38

39

41

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
23	26	26	29	30	31	31	31	33	33	34	35	38	39	41





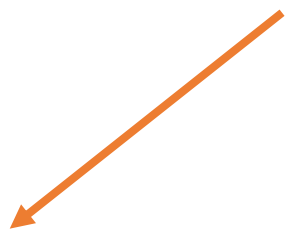
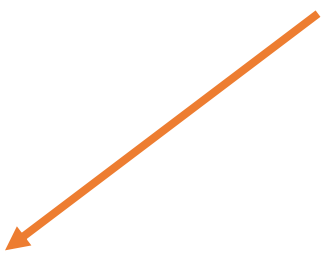
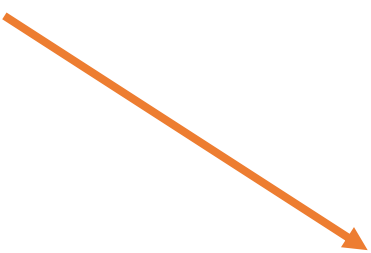
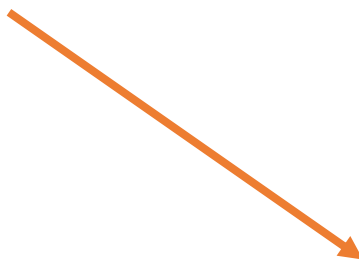
Min

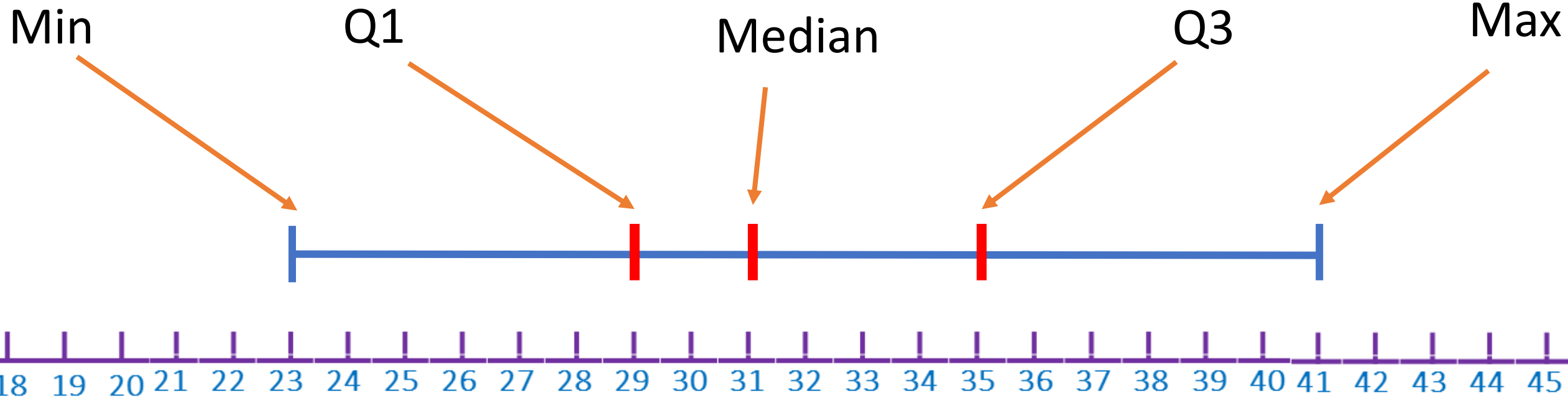
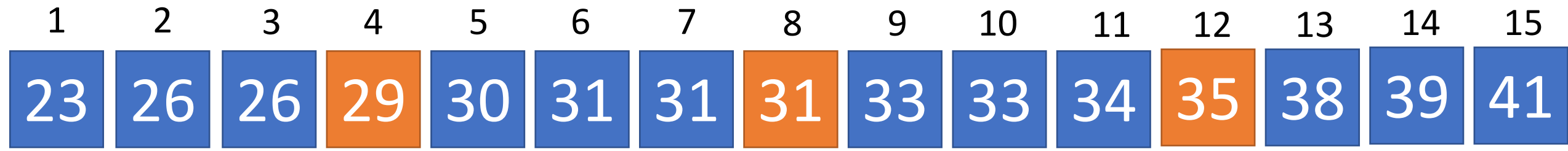
Q1

Median

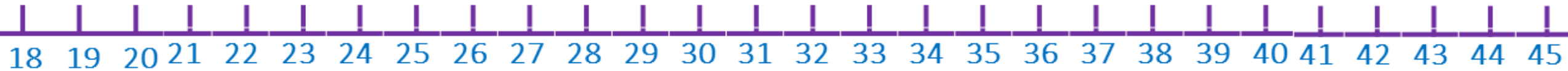
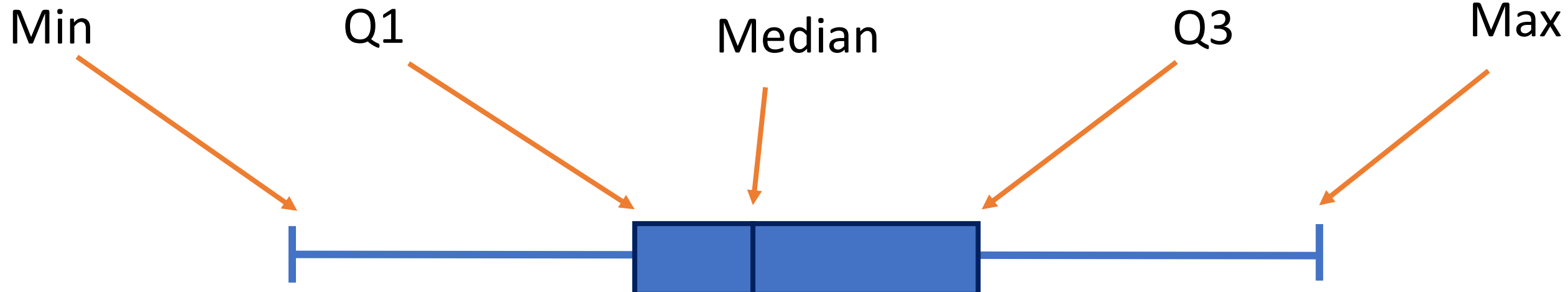
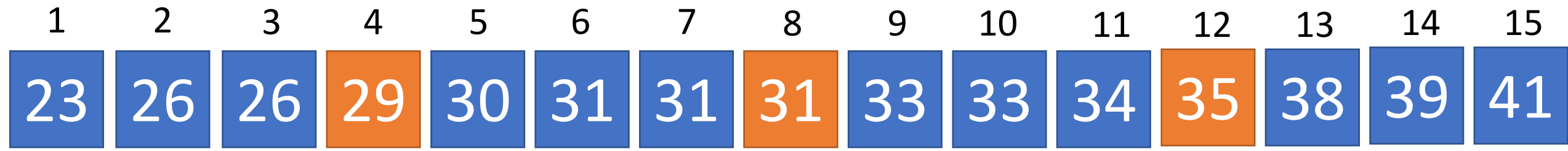
Q3

Max



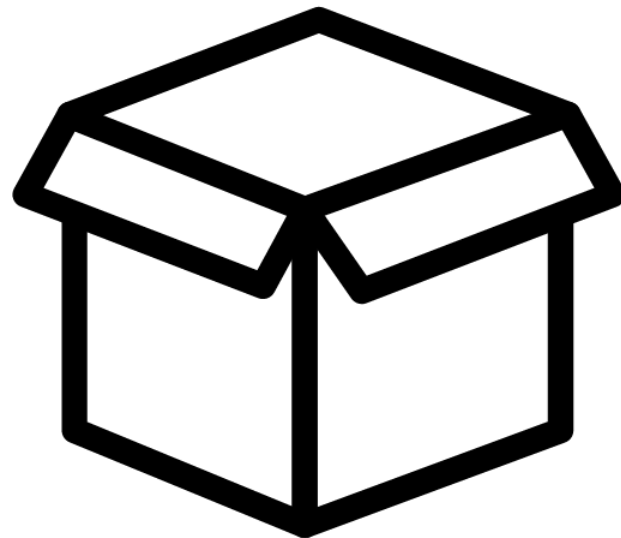


The inter-quartile range (IQR) is 29-35.



The inter-quartile range (IQR) is 29-35.

Let's make another!

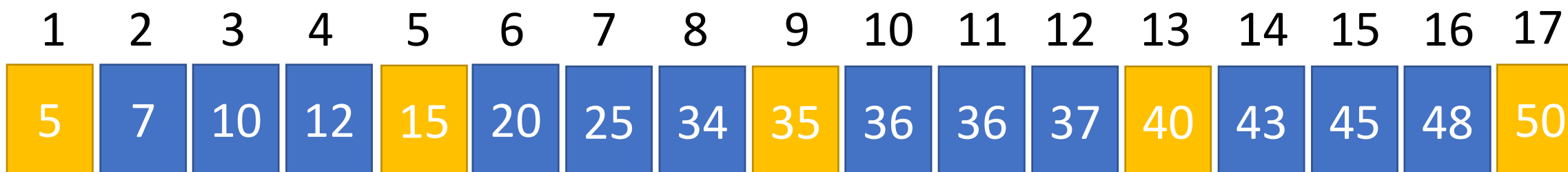
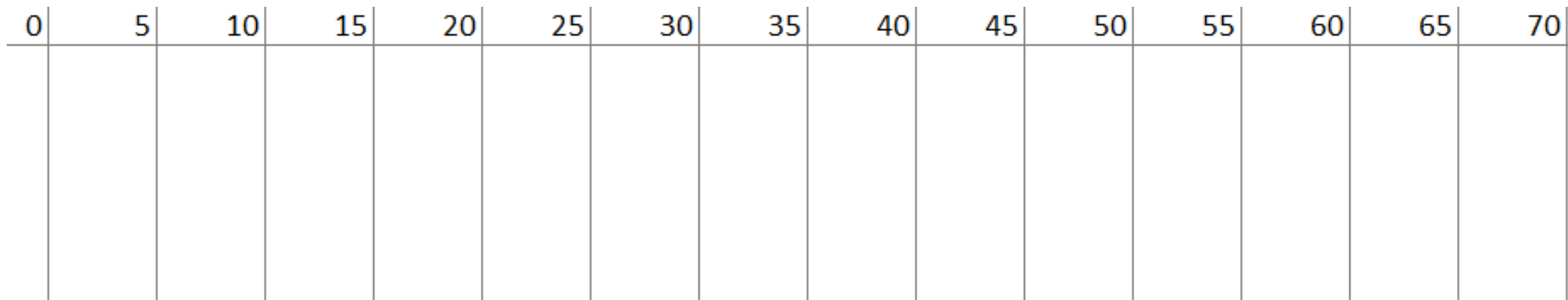


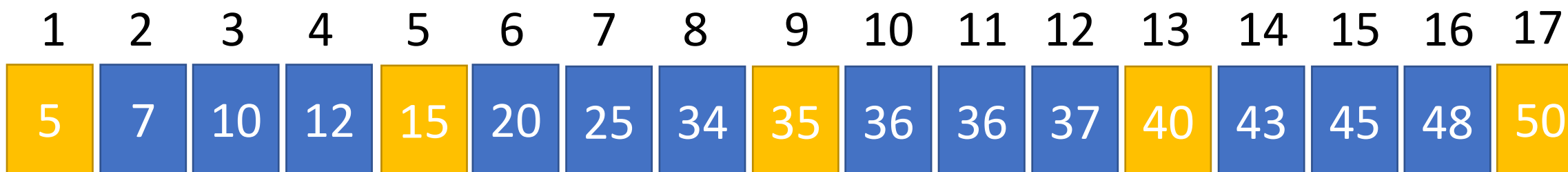
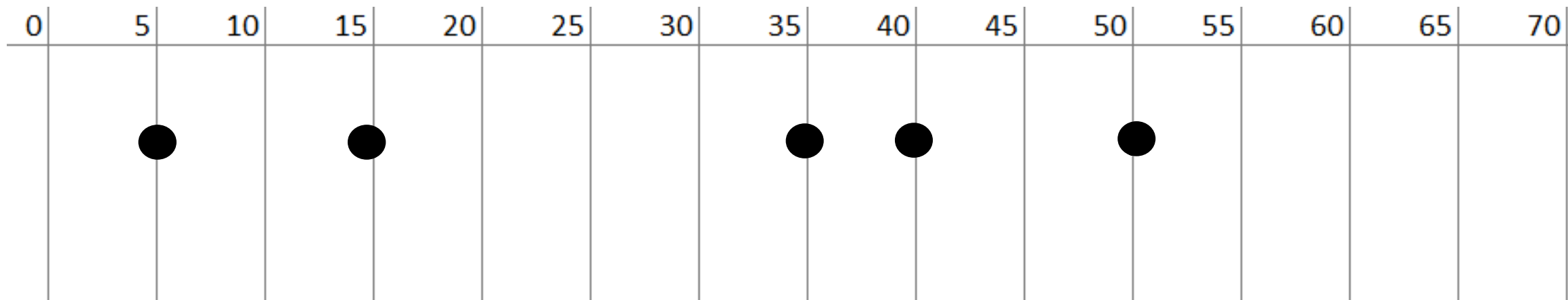
&

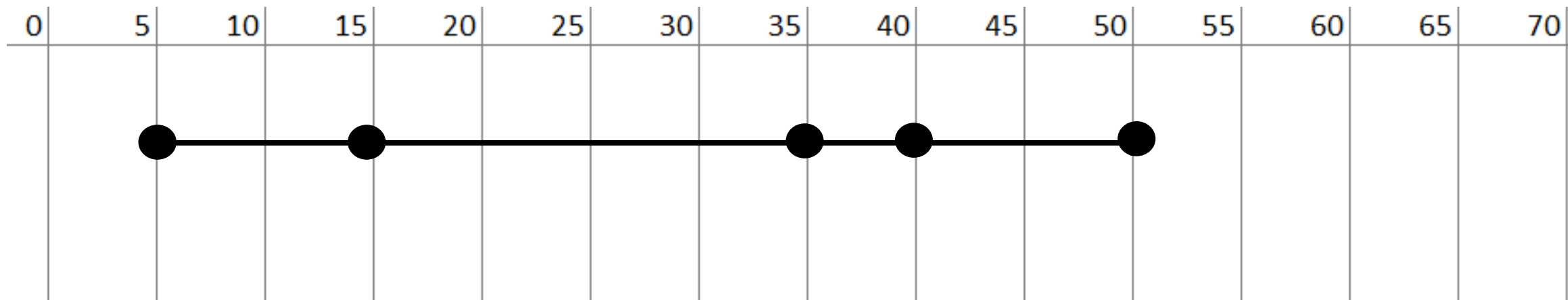


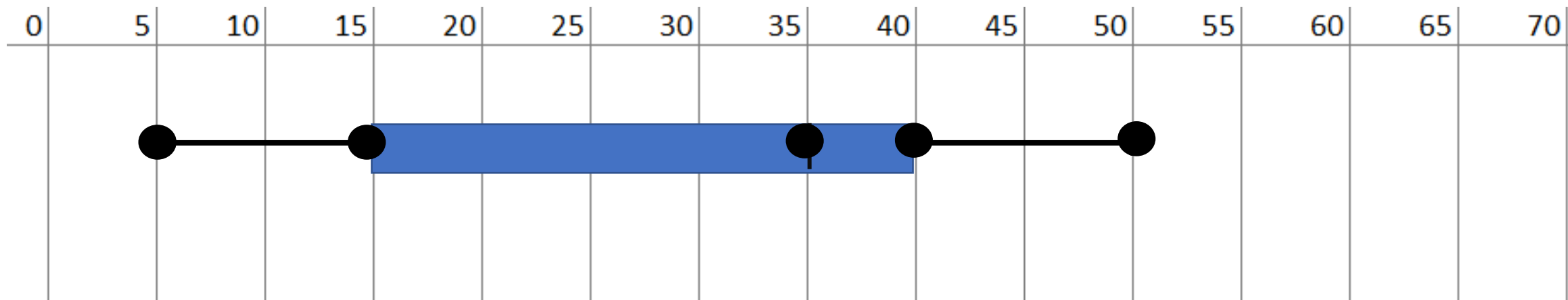
0	5	10	15	20	25	30	35	40	45	50	55	60	65	70

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
5	7	10	12	15	20	25	34	35	36	36	37	40	43	45	48	50

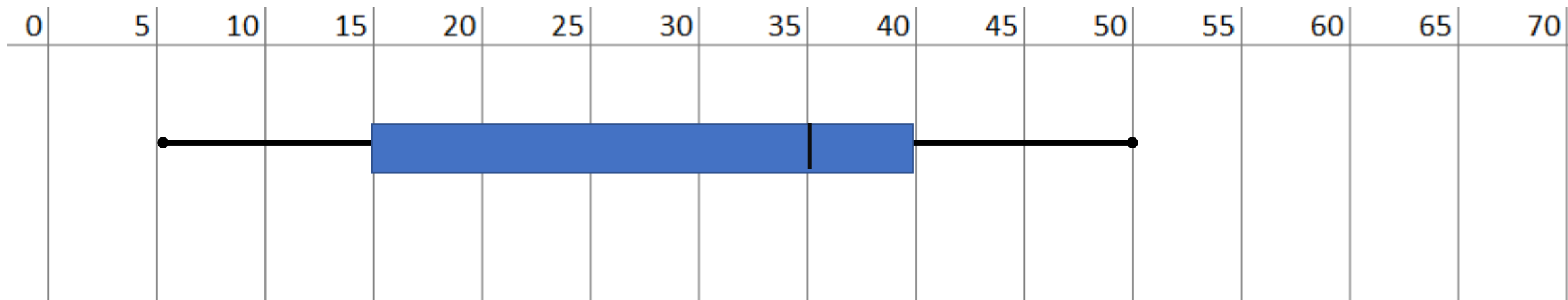




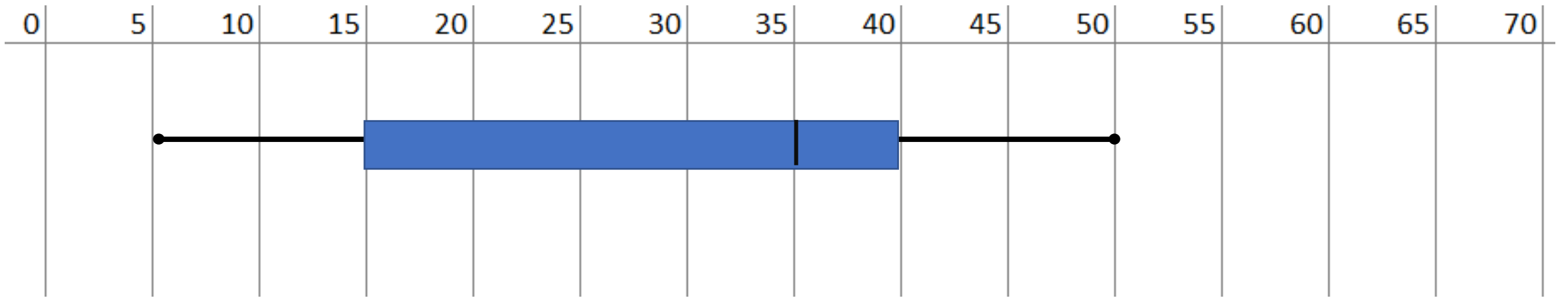




1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
5	7	10	12	15	20	25	34	35	36	36	37	40	43	45	48	50



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
5	7	10	12	15	20	25	34	35	36	36	37	40	43	45	48	50



Lowest?

Q1?

Highest?

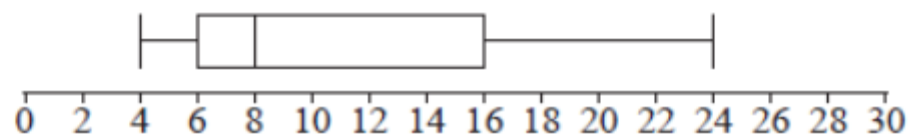
Q3?

Median?

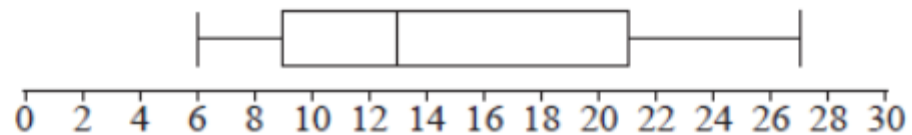
IQR?

A scientist has 100 female fish and 100 male fish. She measures their lengths to the nearest cm. These are shown in the following box and whisker diagrams.

Female fish

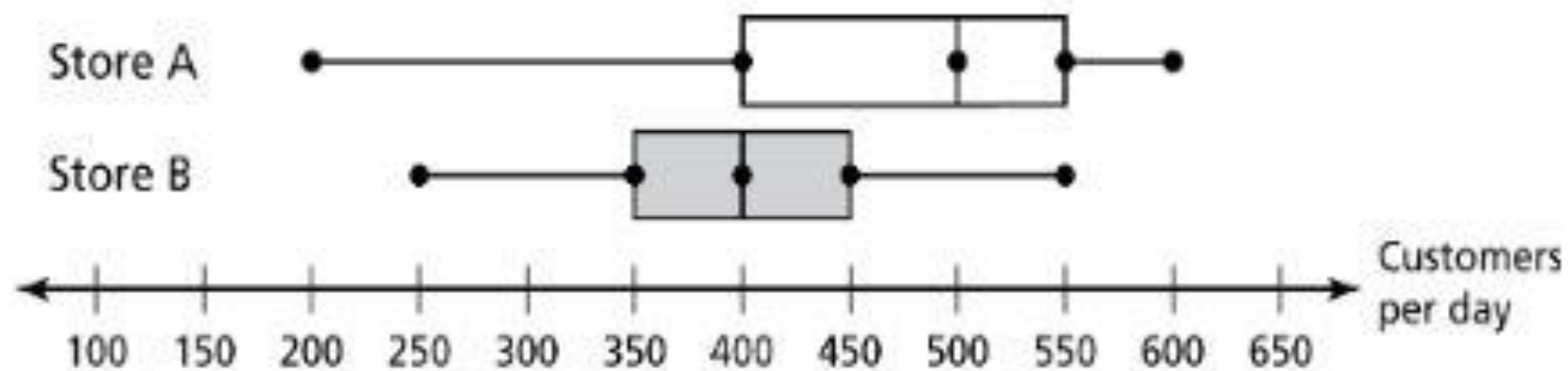


Male fish



Find the range of the lengths of **all** 200 fish.

Use the box-and-whisker plot to answer the question.



43.How often does Store A have 550 or more customers per day?

44.Identify the shape of each distribution.

45.Which store has more customers?

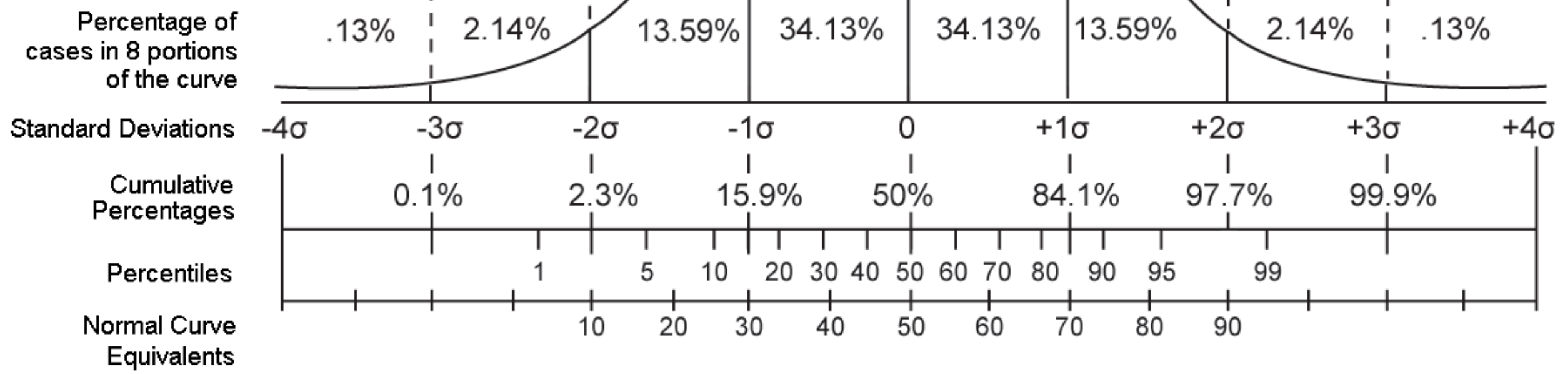
An orange speech bubble with a white border and a white triangle pointing to the left on its left side. The word "Percentile" is written inside in white, sans-serif font.

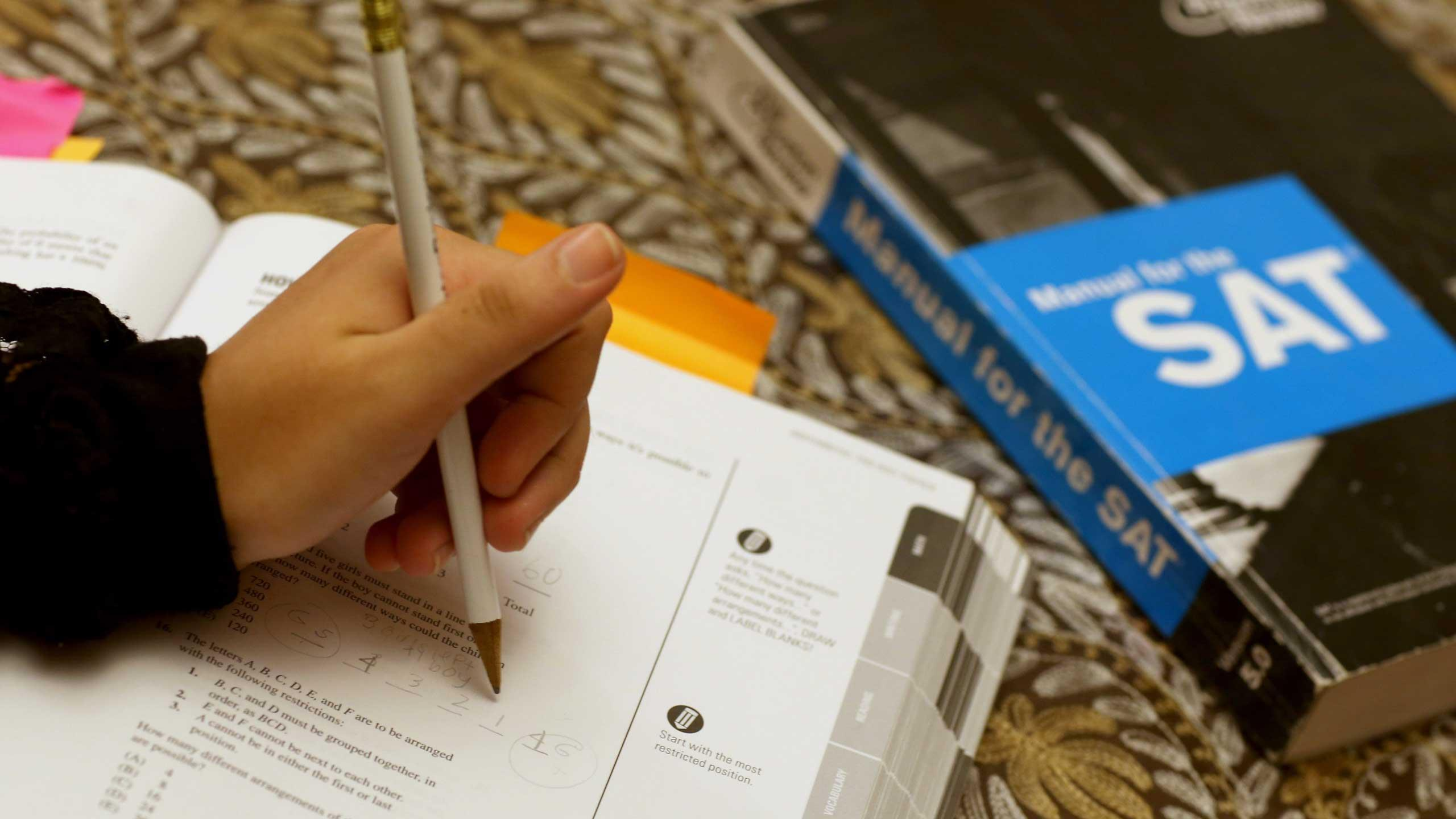
Percentile

Is similar to Quartiles, except instead of there being only 4 groups, there are 100.

It is used a lot to process Standardized Test Scores.

*Normal,
Bell-shaped Curve*





Manual for the SAT

Five girls must stand in a line. The boy cannot stand first or last. How many different ways could the children be arranged?

1. B, C, and D must be next to each other, in order, as BCD.

2. E and F cannot be grouped together, in any order.

3. A cannot be in either the first or last position.

How many different arrangements of the children are possible?

(A) 4
(B) 8
(C) 16
(D) 24
(E) 32

Total 60

16

Any time the question asks, "How many different ways..." or "How many different arrangements..." DRAW and LABEL BLANKS!

Start with the most restricted position.

VOCABULARY

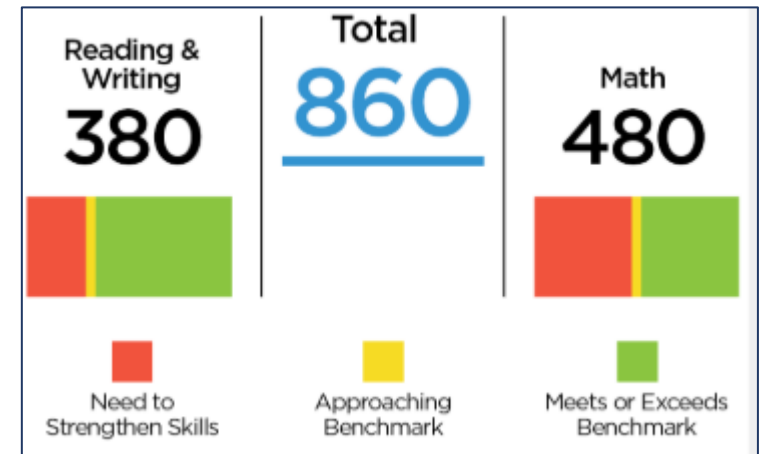
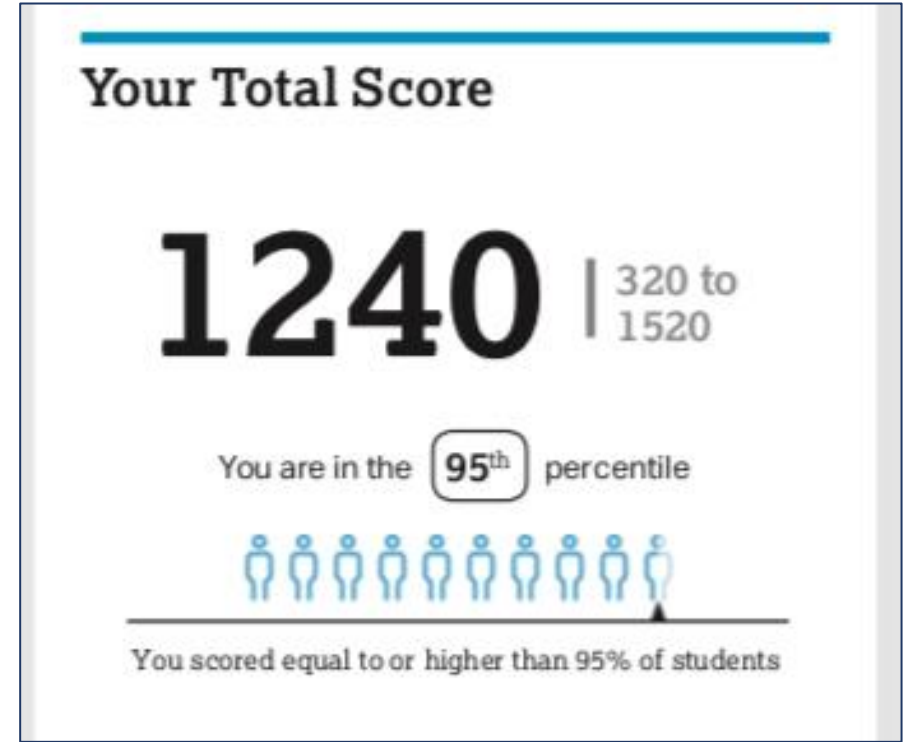
READING

LISTENING

WRITING

SAT scores use percentiles

SAT Composite Range	Percentile Score	Equivalent Letter Grade
1530-1600	99+	A+
1450-1530	99 to 99+	A+
1420-1450	98 to 99	A
1360-1420	95 to 98	A
1310-1360	92 to 95	A-
1270-1310	88 to 92	B+/A-
1210-1270	82 to 88	B+
1160-1210	76 to 82	B-/B
1120-1160	70 to 76	C
1060-1120	60 to 70	D
1000-1060	48 to 60	D
960-1000	40 to 48	F
910-960	31 to 40	F
850-910	21 to 31	F
800-850	14 to 21	F
750-800	9 to 15	F
630-750	1 to 9	F
620-630	1- to 1	F
620 and below	1-	F





Term Dean's Honours List

In recognition of outstanding academic achievement in an academic term, the designation "Term Dean's Honours List" is awarded to undergraduate Mathematics students who satisfy all of the following criteria for the term:

- registered in an honours plan with a Term Average (TAV) of at least 87%;
- normally enrolled in at least 2.5 units of courses with numeric or letter grades;
- no excluded courses; and
- no INC, IP, or UR grades.

But we used to say that only the top percentile (99th) made the honours list.

In 2014, about 72 out of 6939 made the list which was 1%.

Full Scale IQ	Classification	Percentile
130 and above	Very gifted	98 – 99.5
120-129	Gifted	91 – 97
110-119	High Average	75 – 90
90-109	Average	25 – 73
80-89	Below Average	9 – 23
70-79	Border Line	2 – 8
69 and below	Intellectually Poor	0.01 – 2

