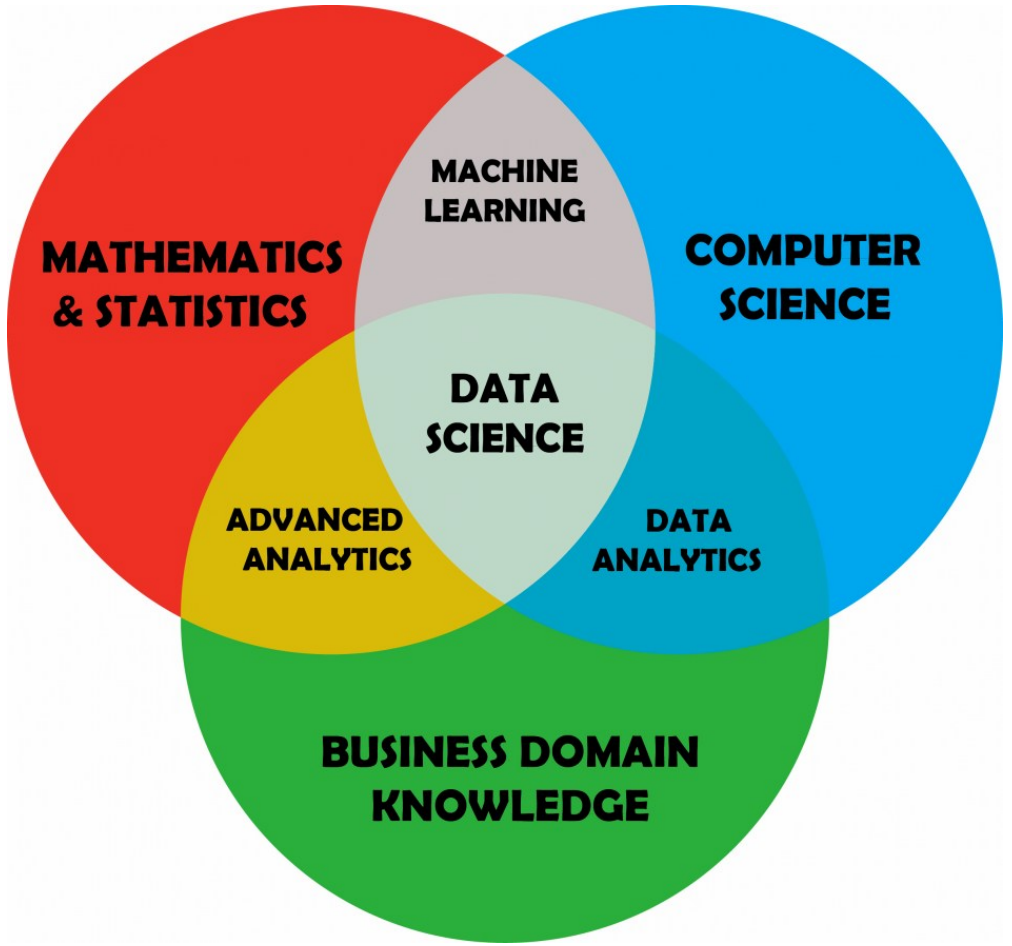

MATHEMATICS
& STATISTICS
MACHINE
LEARNING
COMPUTER
SCIENCE
DATA
SCIENCE
ADVANCED
ANALYTICS
DATA
ANALYTICS
BUSINESS DOMAIN
KNOWLEDGE

Descriptive Statistics

Descriptive Measures

Central Tendency

Variation

Relative Standing

Central Tendency

Mean

Median

Mode

Feature
0
1
2
3
4
5
5
5
7
8
40

Sum =

Mean	Median	Mode
4	**4.5**	**5**

Feature
0
1
2
3
4
5
5
5
7
8
40

Sum =

Mean	Median	Mode
4	**4.5**	**5**

Feature
0
1
2
3
4
5
5
5
7
8
40

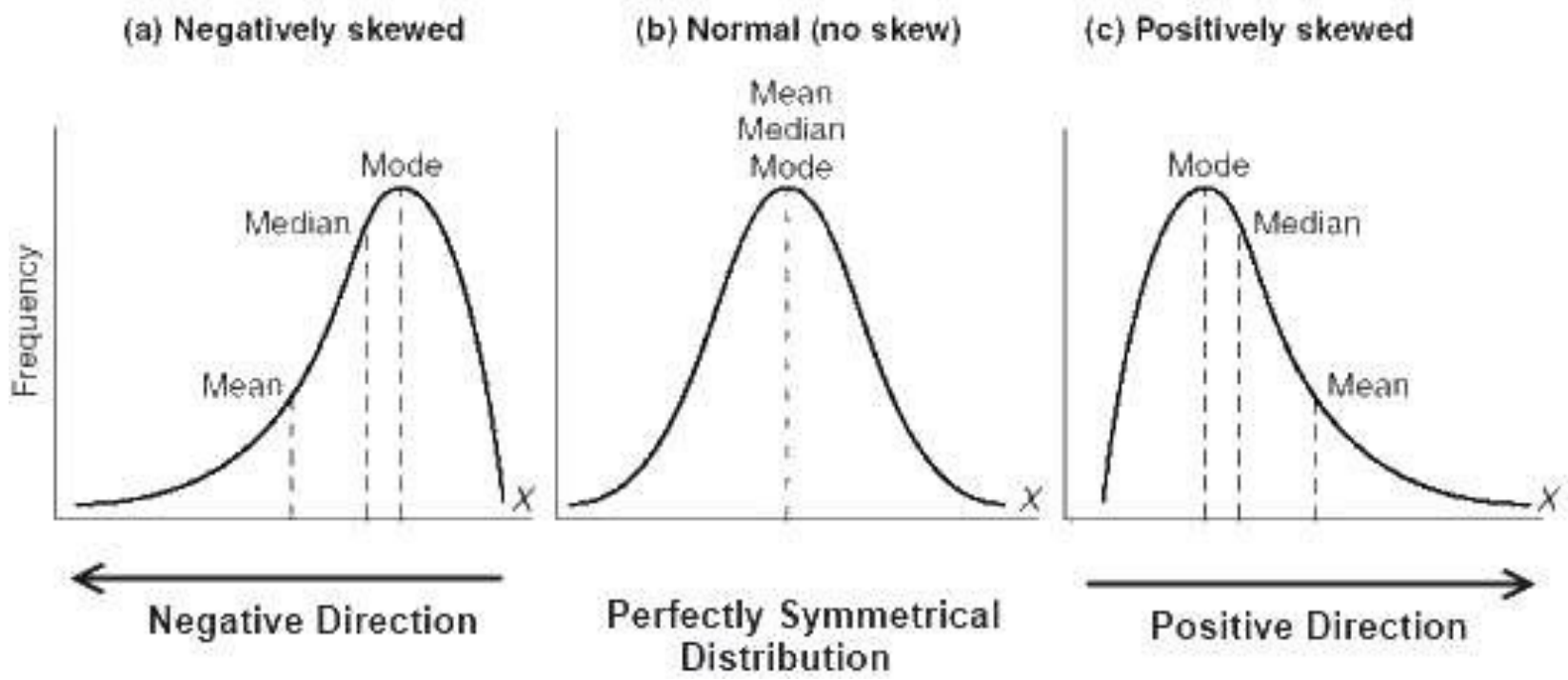
Sum =

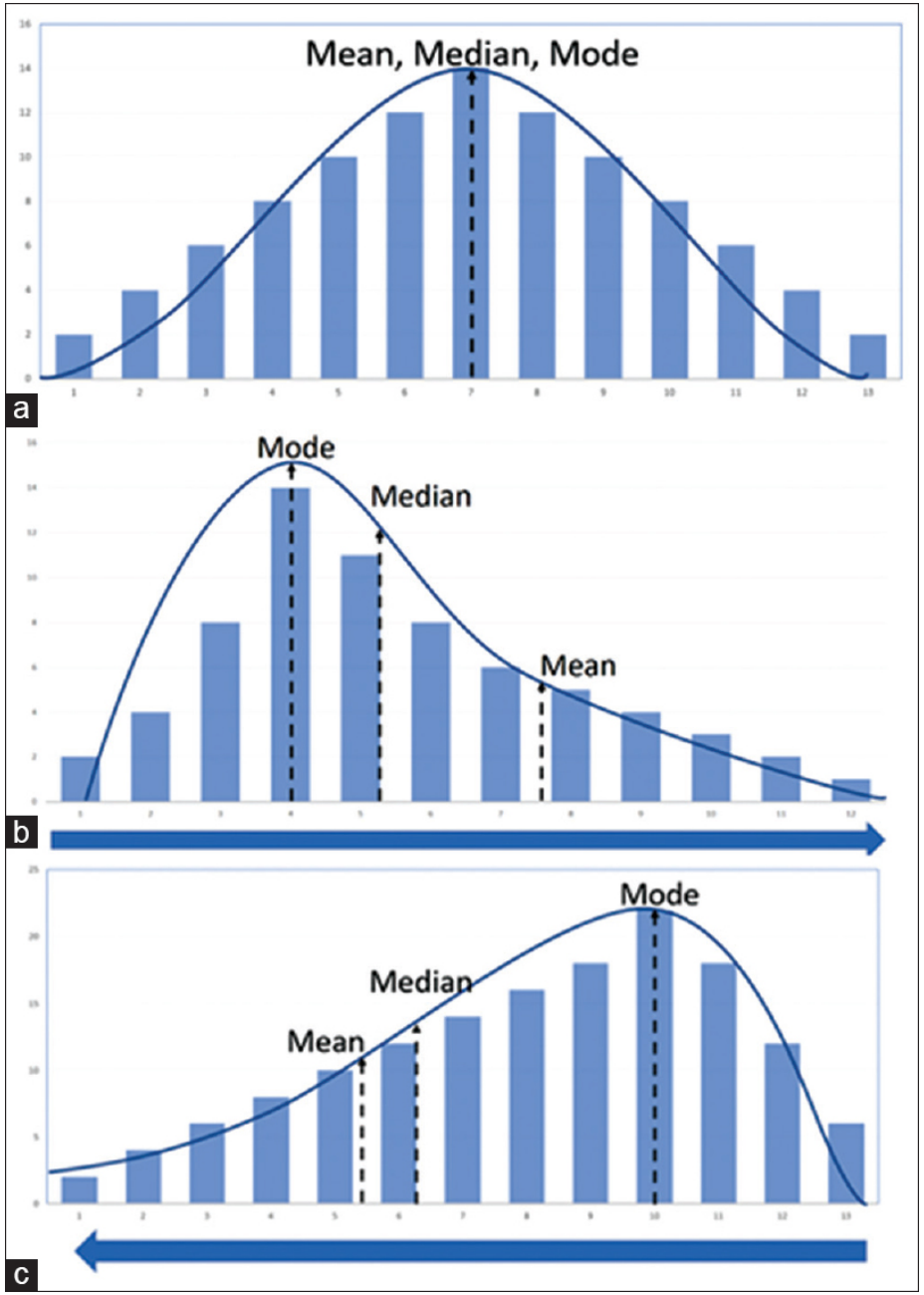
Mean	Median	Mode
4	**4.5**	**5**

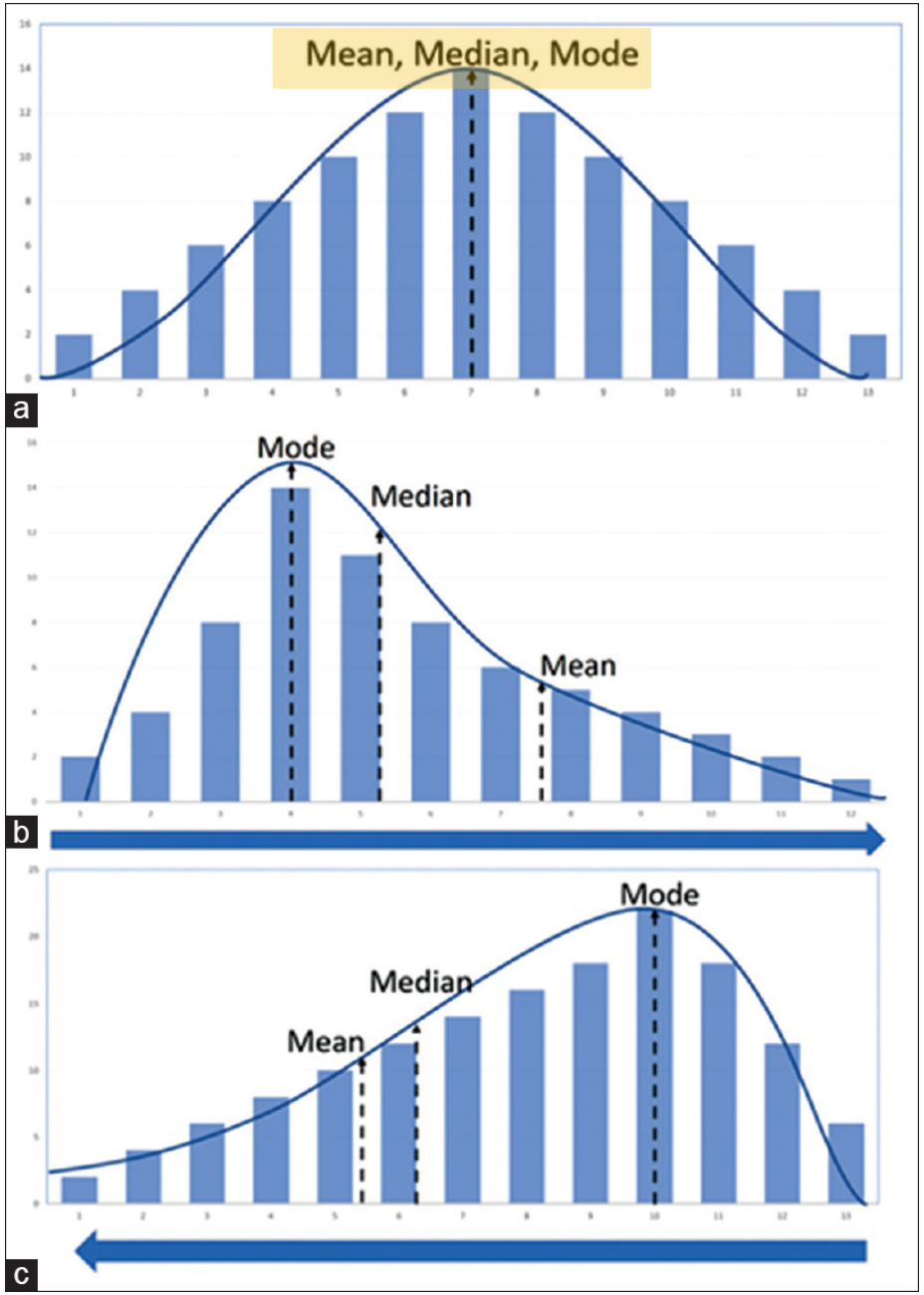
Feature
0
1
2
3
4
5
5
5
7
8
Sum = 40

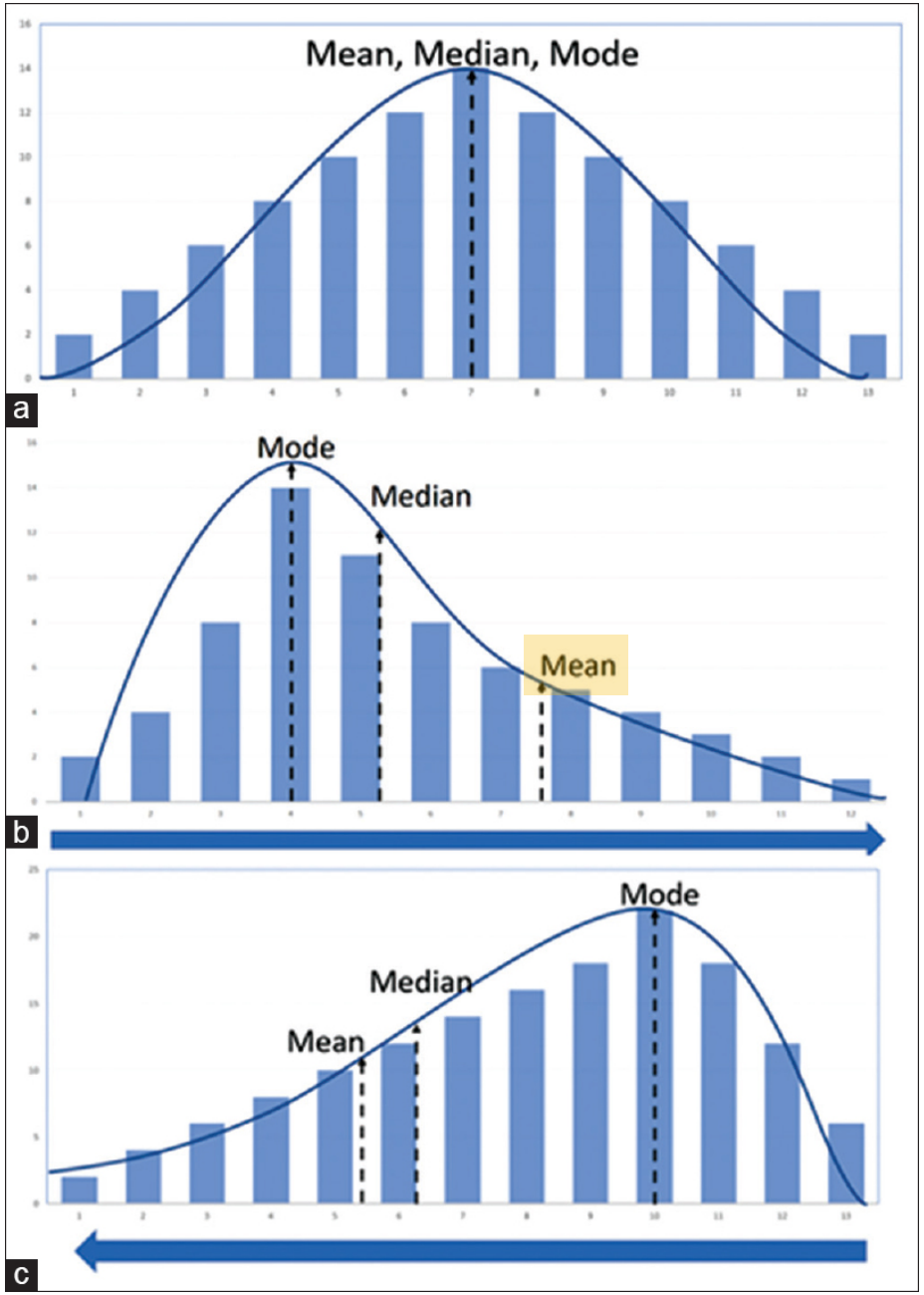
Mean	Median	Mode
4	4.5	5

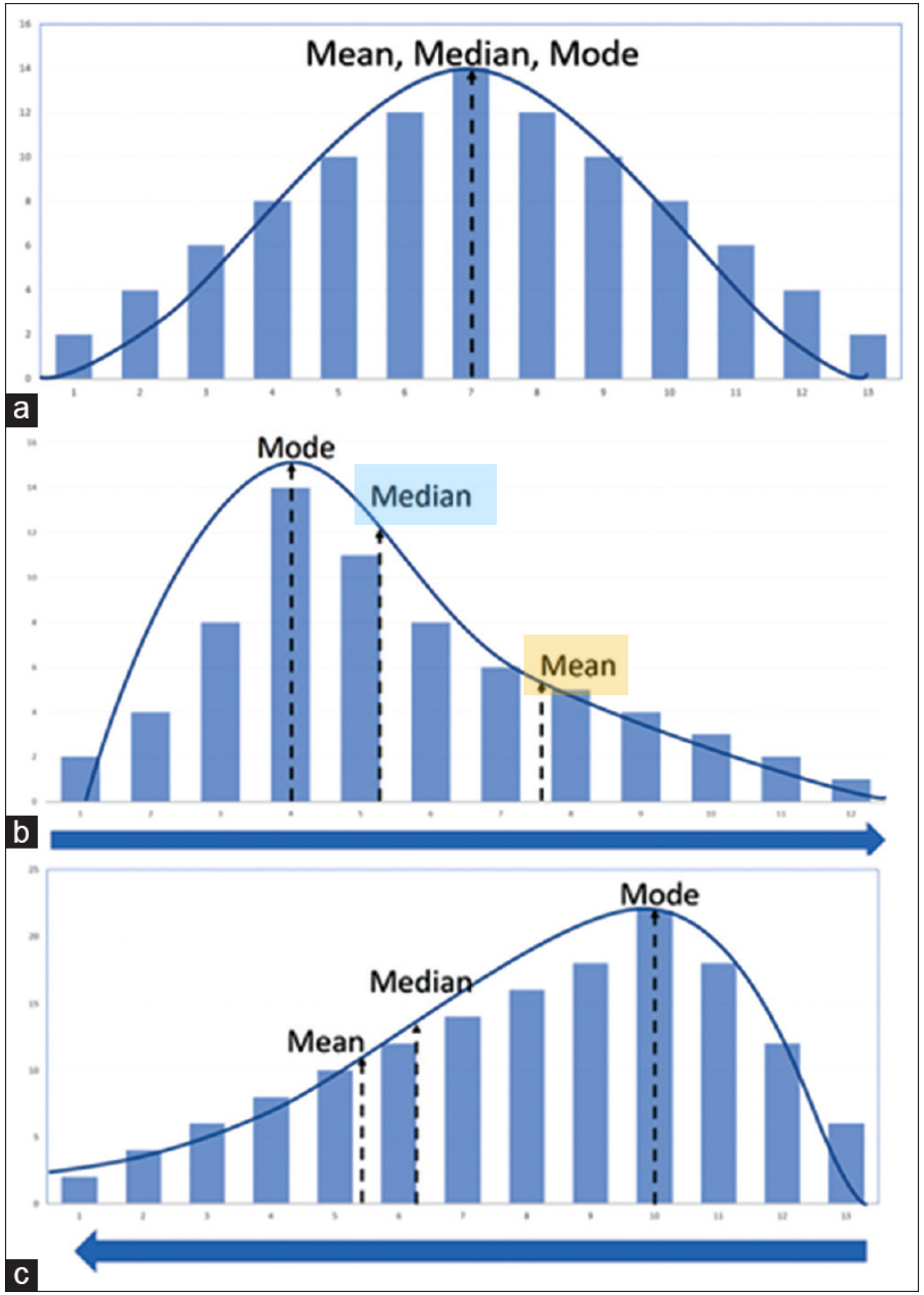
Skew


(a) Negatively skewed
(b) Normal (no skew)
(c) Positively skewed
Frequency
Mode
Median
Mean
Mean
Median
Mode
Mode
Median
Mean
X
X
X
Negative Direction
Perfectly Symmetrical Distribution
Positive Direction


Mean, Median, Mode
a
Mode
Median
Mean
b
Mode
Median
Mean
c


Mean, Median, Mode
a
Mode
Median
Mean
b
Mode
Median
Mean
c


Mean, Median, Mode
a
Mode
Median
Mean
b
Mode
Median
Mean
c


Mean, Median, Mode
a
Mode
Median
Mean
b
Mode
Median
Mean
c

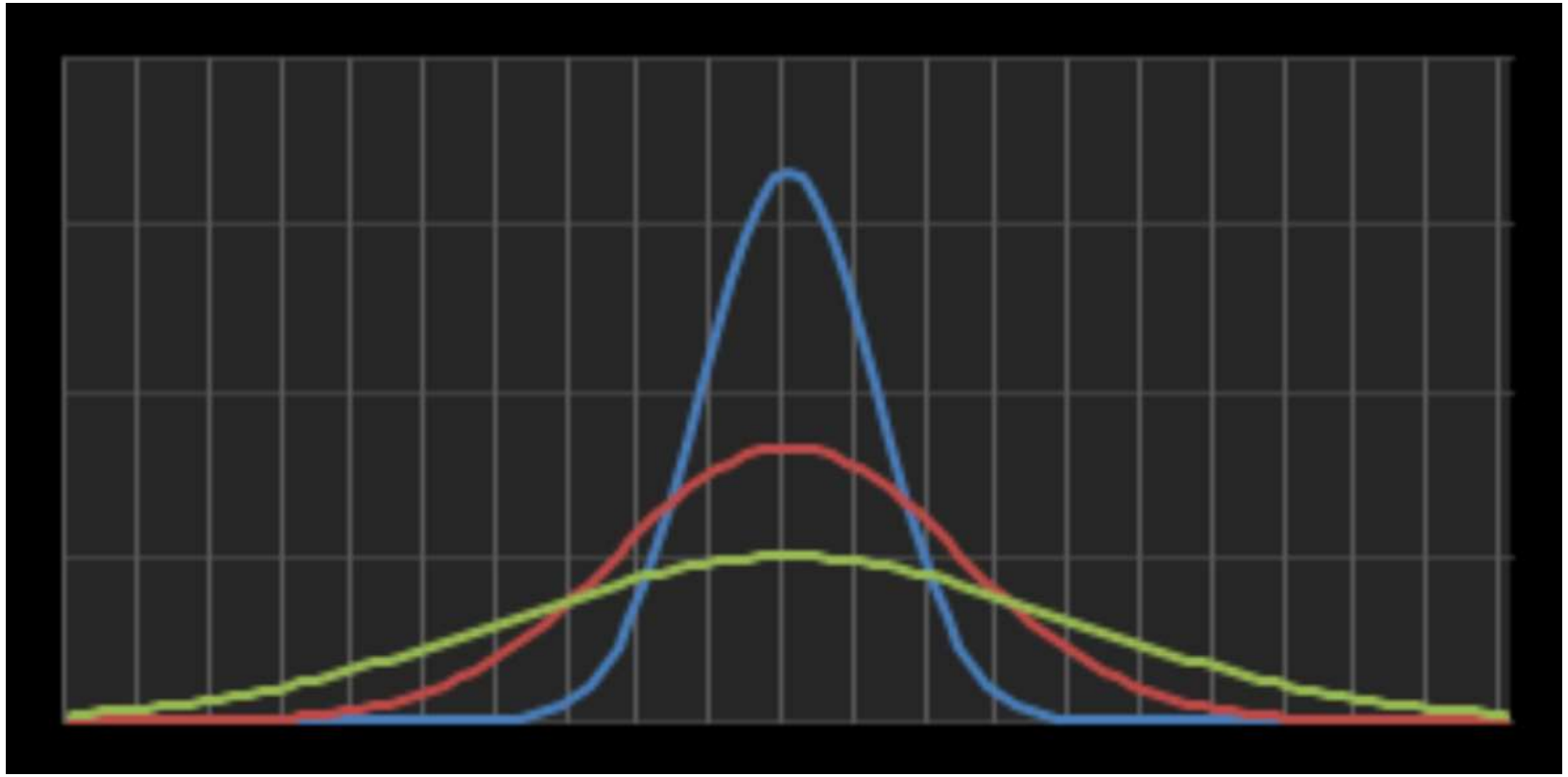
Variation

Variance

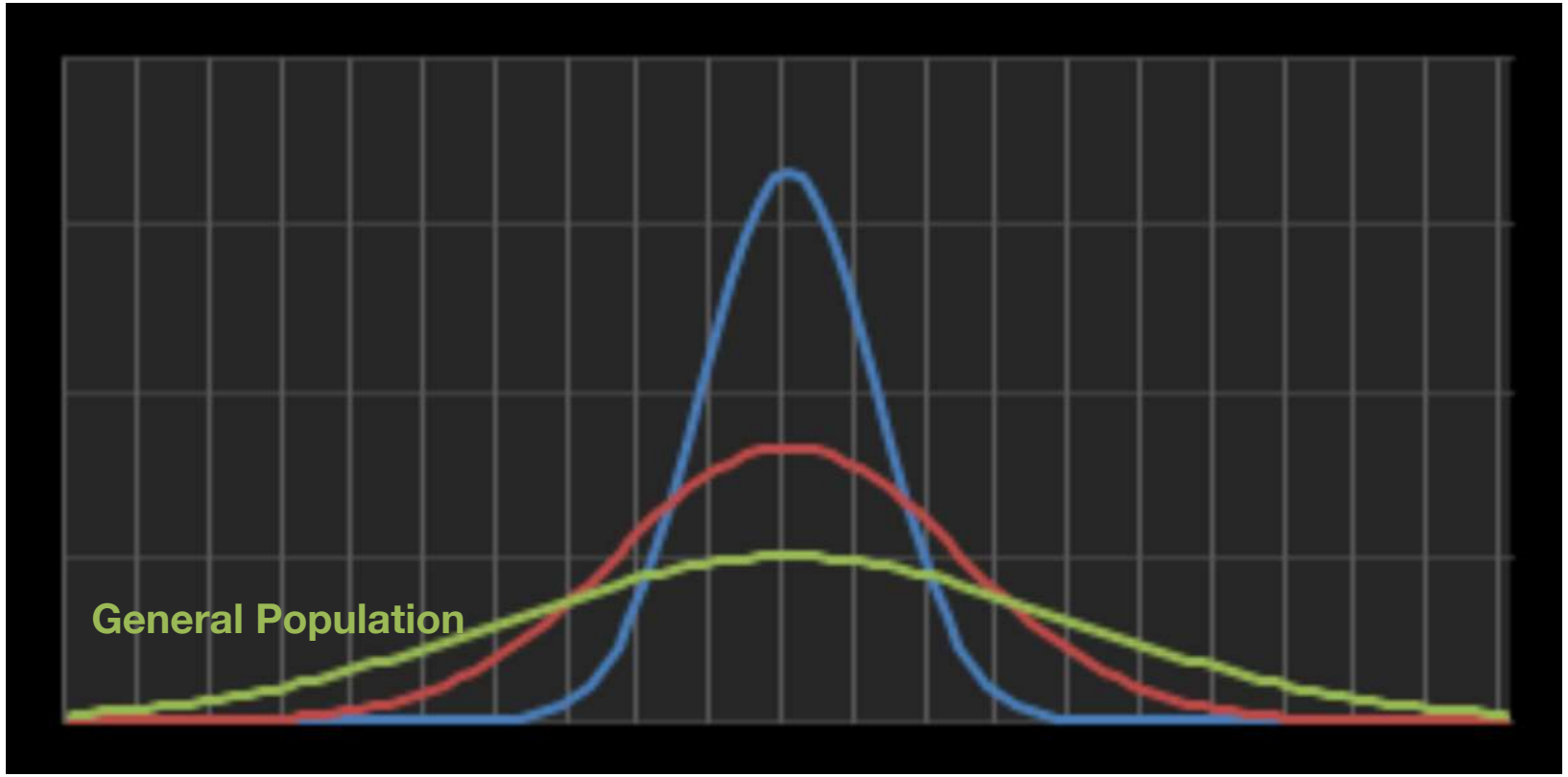
Standard Deviation

Range

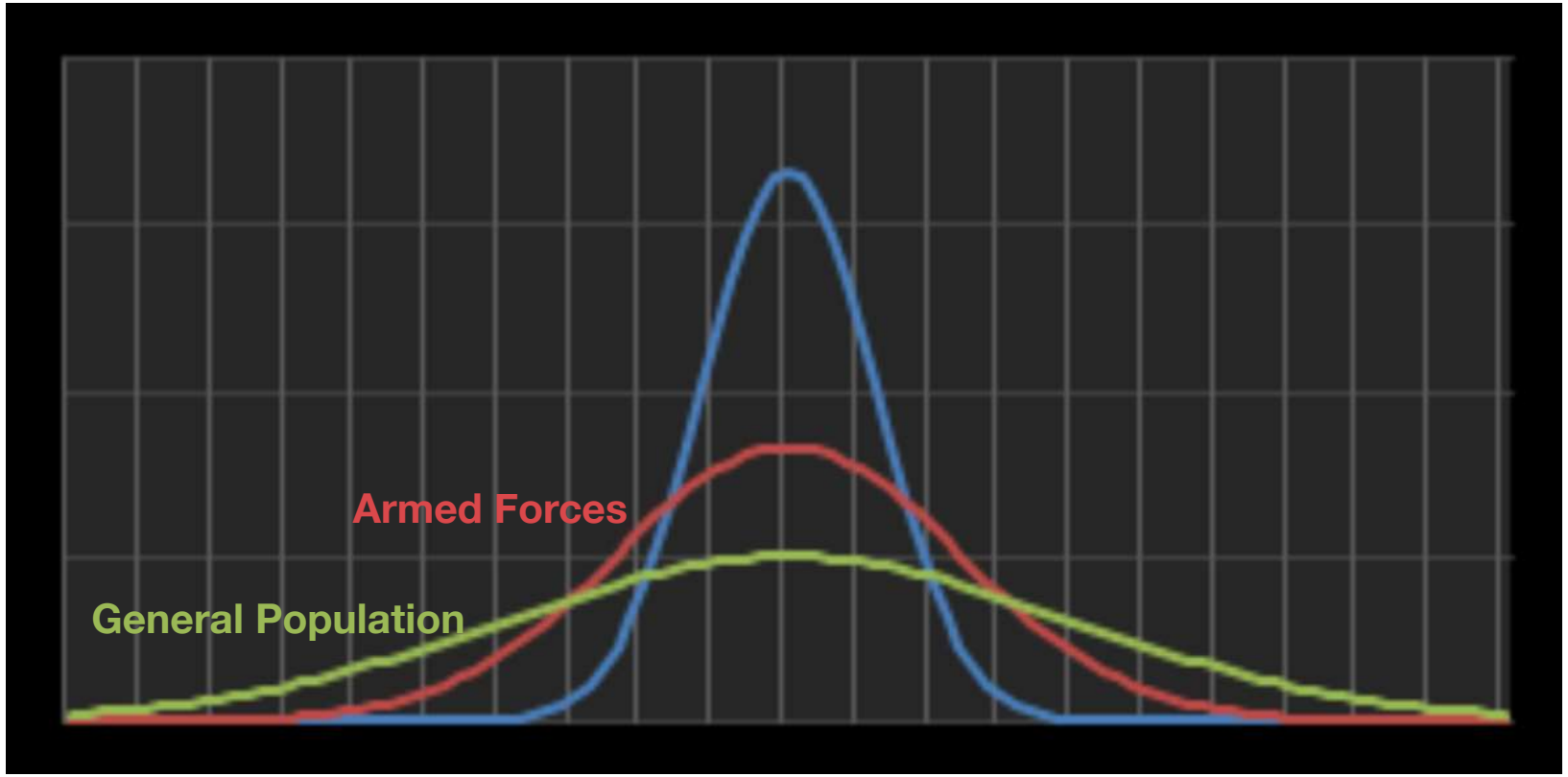
The spread of the data



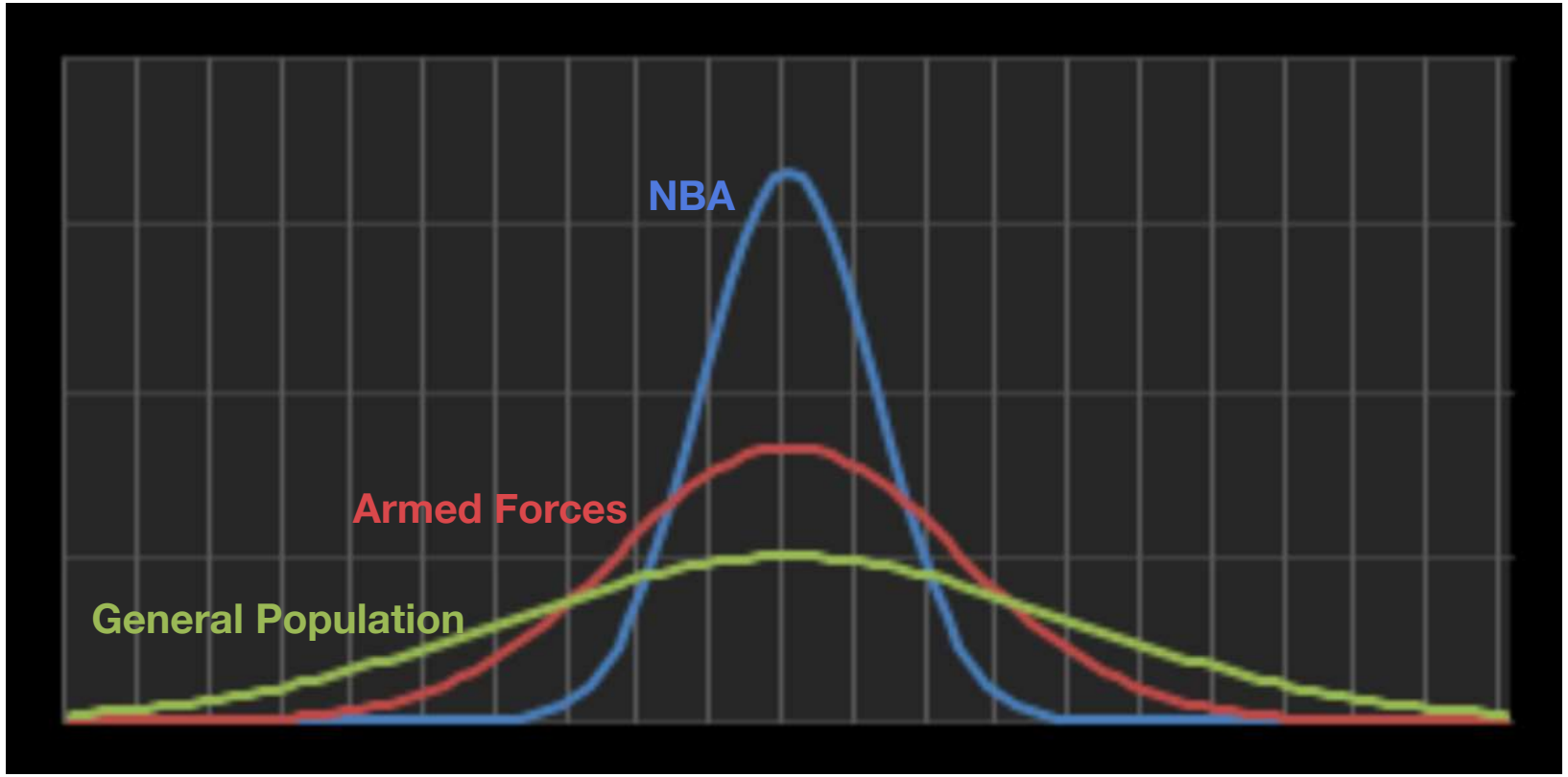
The spread of the data



The spread of the data



The spread of the data



Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
5	2	4
7	3	9
7	3	9
40	**0**	**54**

Mean

40/10 = 4

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Mean

40/10 = 4

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
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4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Mean

40/10 = 4

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Mean

40/10 = 4

Variance

54/9 = 6

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Mean

$40/10 = 4$

Variance

$54/9 = \sqrt{6}$

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Mean

$40/10 = 4$

Standard Deviation

$\sqrt{6} = 2.45$

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

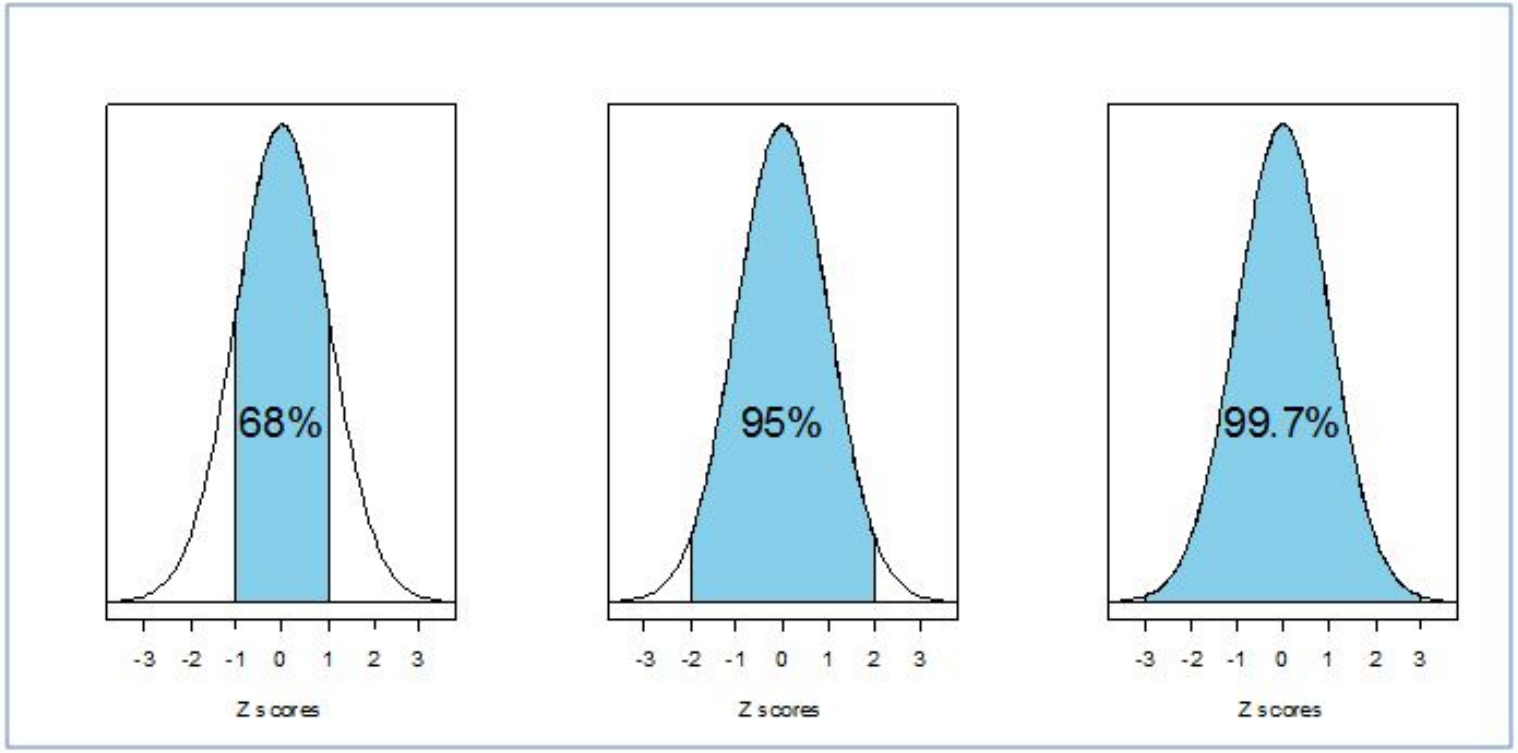
Mean

$40/10 = 4$

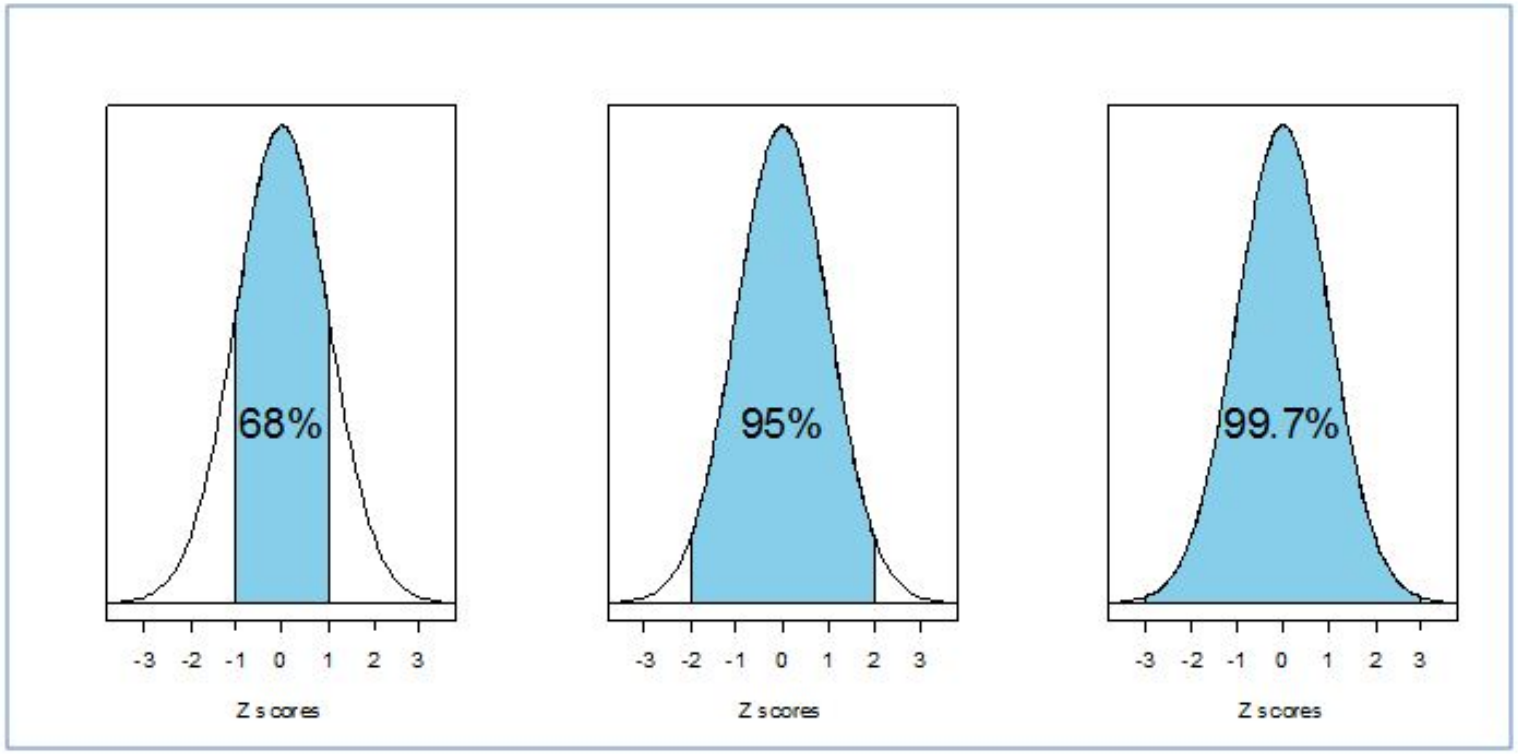
Standard Deviation

$\sqrt{6} = 2.45$

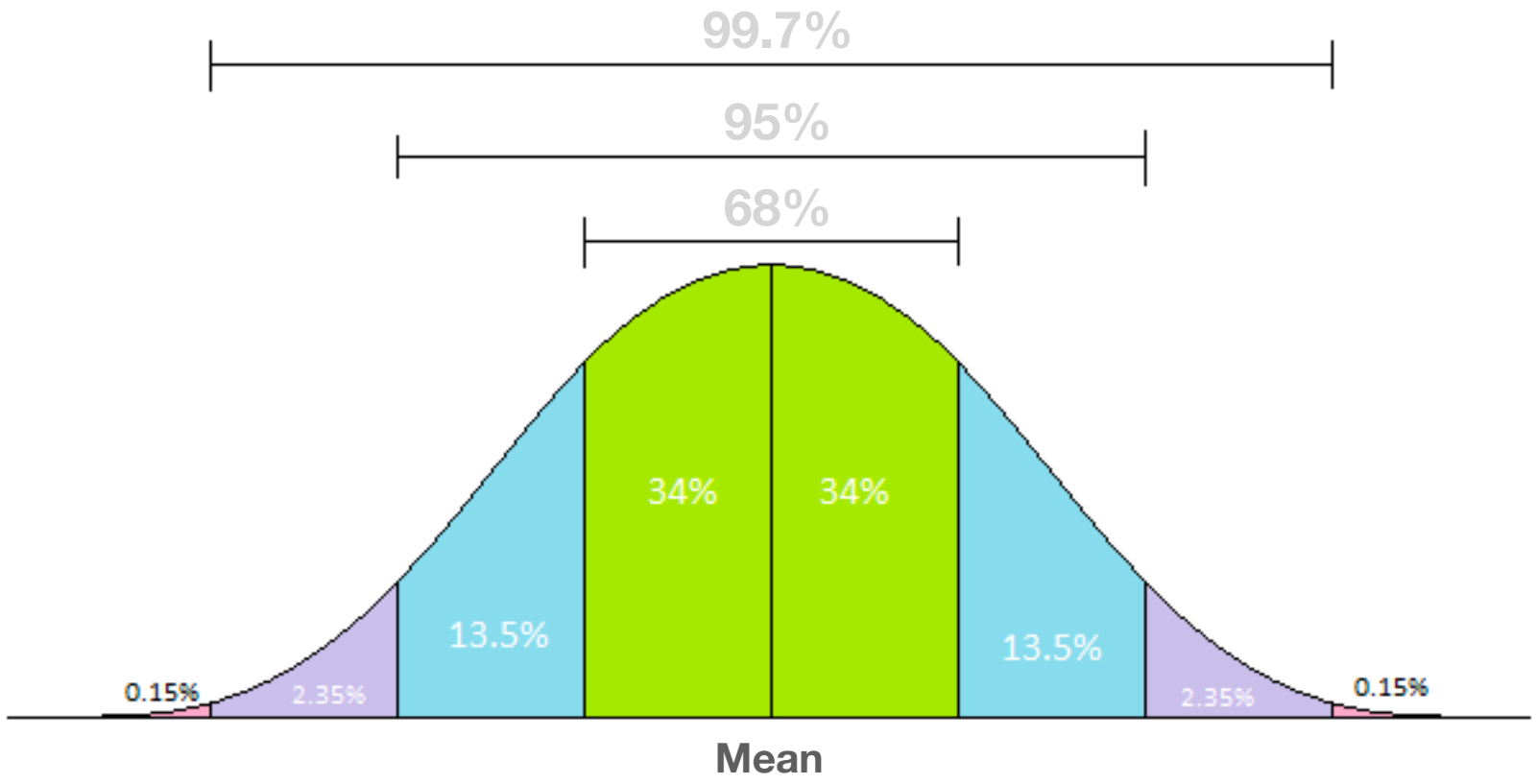
Empirical Rule



68 - 95 - 99.7 Rule

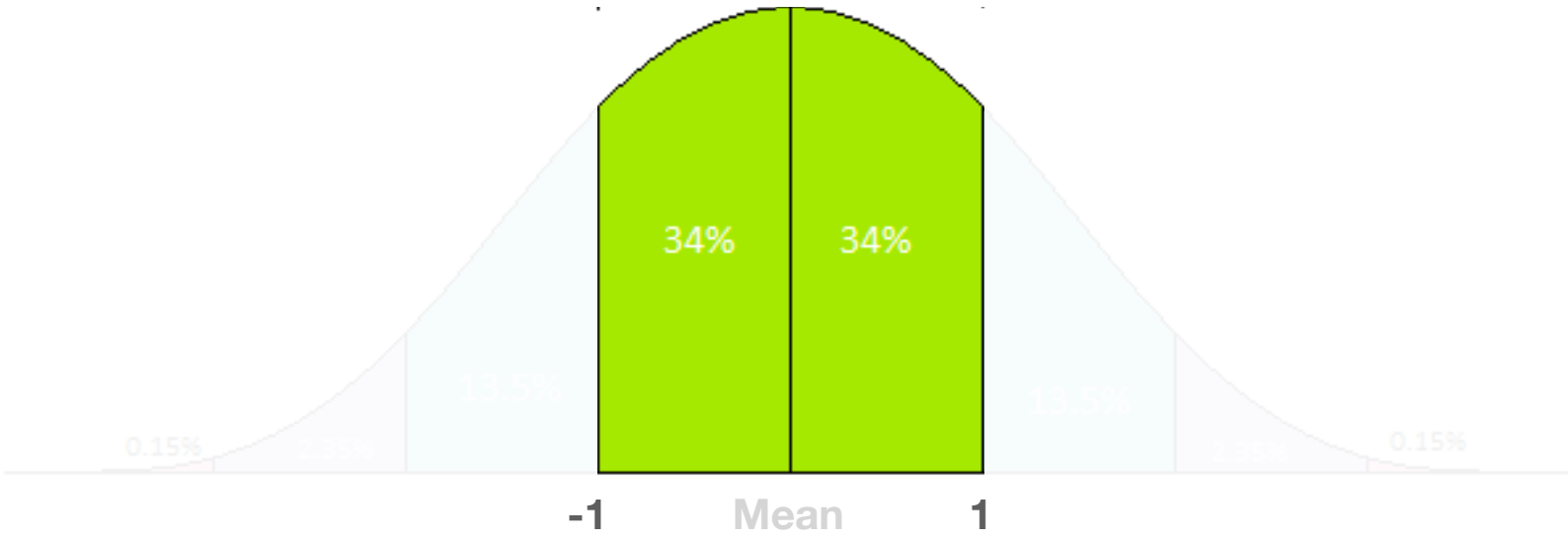


68 - 95 - 99.7 Rule



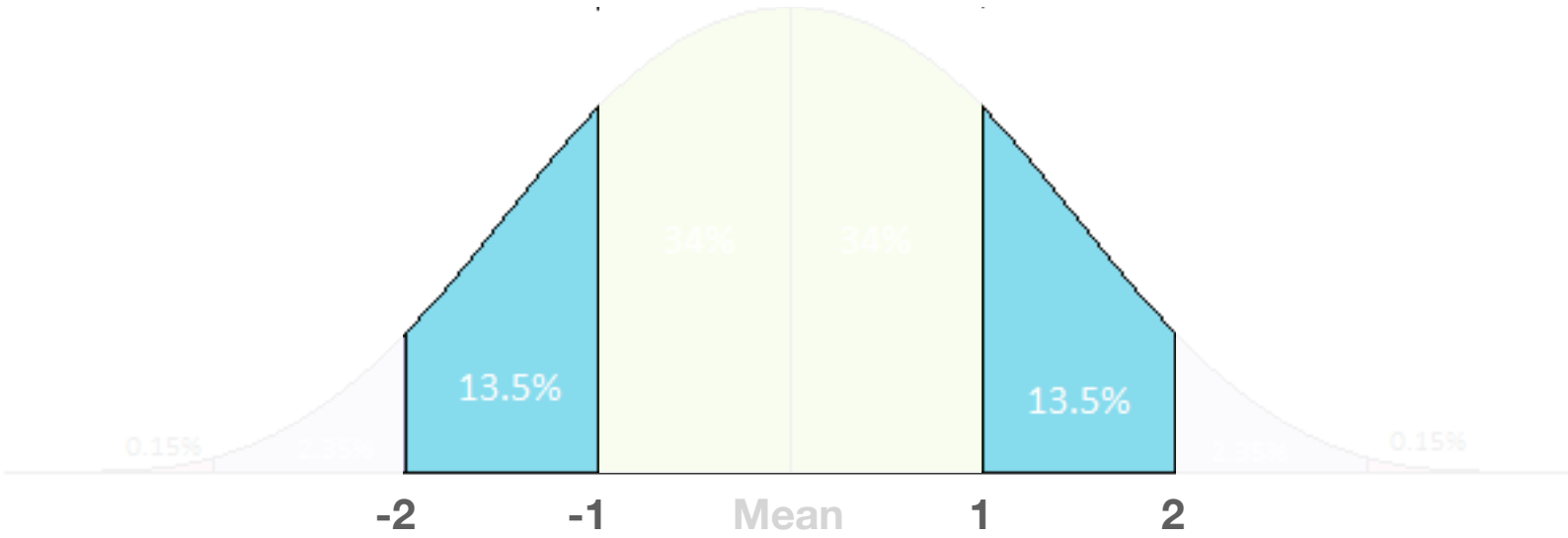
Normal Distribution

68%



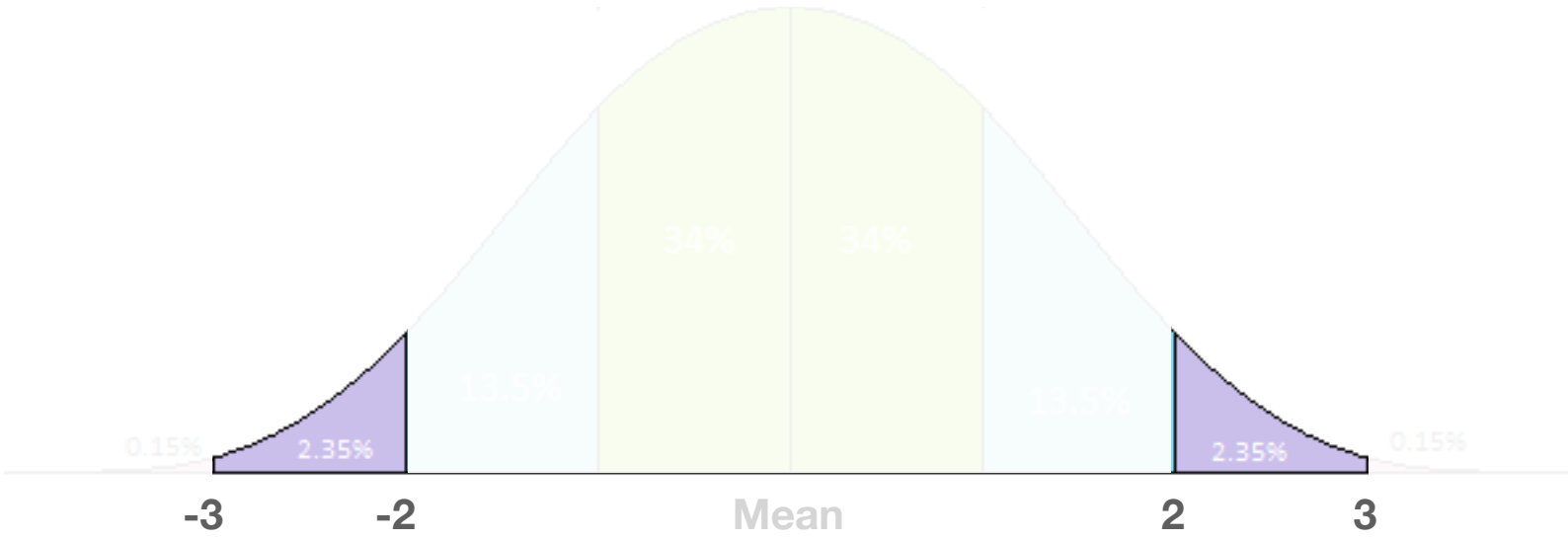
Normal Distribution

27%



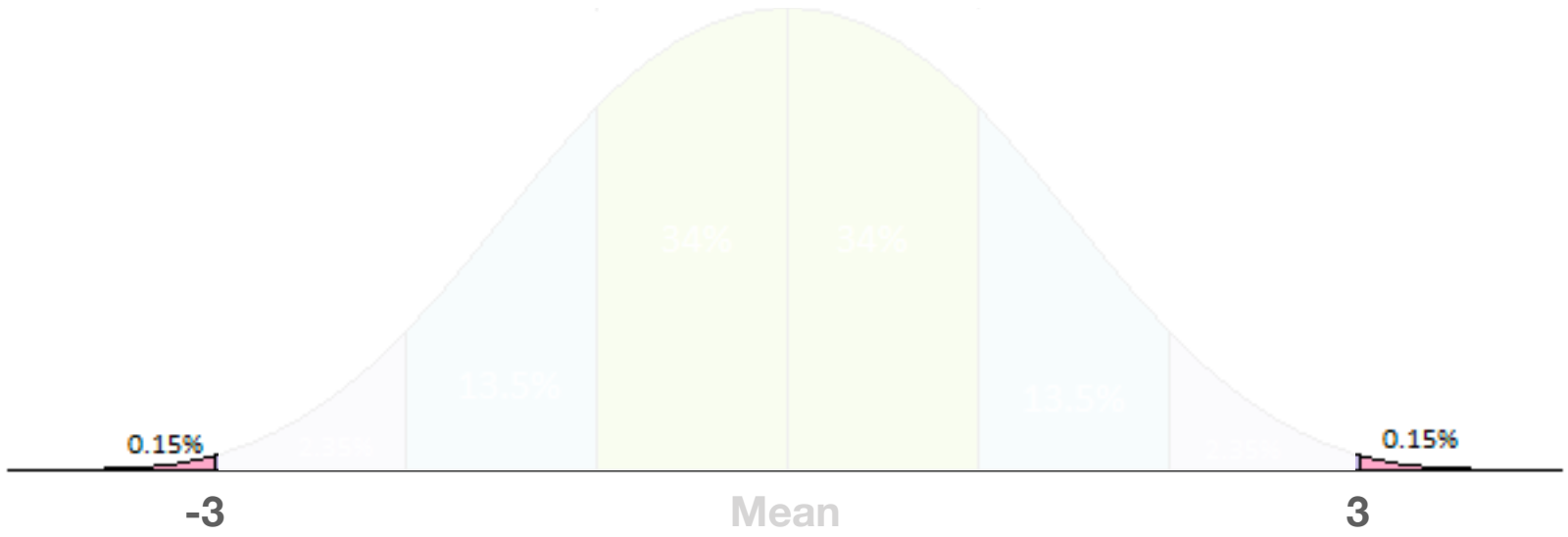
Normal Distribution

4.7%



Normal Distribution

.3%



Standardizing Values

Measure	Qty
Price	1 million
Sq. Ft.	2,500
Neighborhood Rating	79
# Bedrooms	4

Measure	Qty
Price	1 million
Sq. Ft.	2,500
Neighborhood Rating	79
# Bedrooms	4

4 79 2500 1 m

0

Standard Score

(z-score)

$$\text{standardization} = \frac{x - \text{mean}}{\text{sd}}$$

Standard Score

(z-score)

$$\text{standardization} = \frac{\text{x - mean}}{\text{sd}}$$

Standard Score

(z-score)

$$\text{standardization} = \frac{x - \text{mean}}{\text{sd}}$$

Standard Score

(z-score)

How different is x from normal?

$$\text{standardization} = \frac{x - \text{normal}}{\text{sd}}$$

Standard Score

(z-score)

$$\text{standardization} = \frac{x - \text{mean}}{\text{sd}}$$

Standard Score

(z-score)

$$\text{standardization} = \frac{x - \text{mean}}{\text{sd}}$$

Tells us the range of normal

Standard Score

(z-score)

$$\text{standardization} = \frac{x - \text{mean}}{\text{sd}}$$

Standard Score

(z-score)

$$\text{standardization} = \frac{x - \text{mean}}{\text{sd}}$$

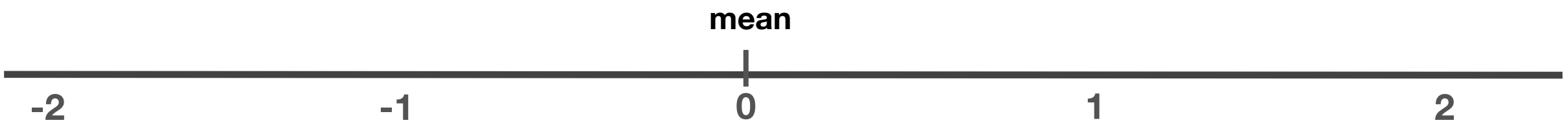
Values will primarily be between:

-3 and 3

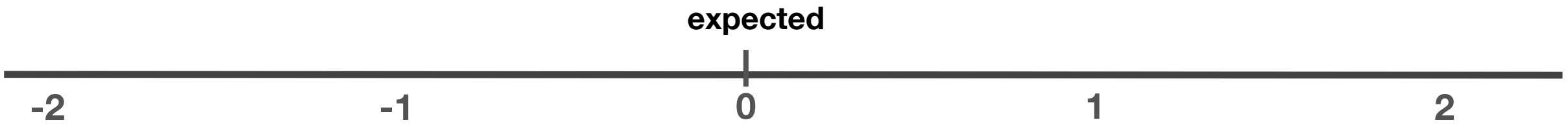
Measure	Qty
Price	1 million
Sq. Ft.	2,500
Neighborhood Rating	79
# Bedrooms	4

Measure	Qty	Standardized (z-score)
Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
# Bedrooms	4	1.32

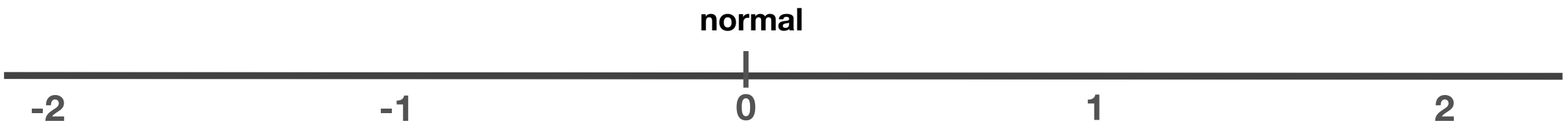
Measure	Qty	Standardized (z-score)
Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
# Bedrooms	4	1.32



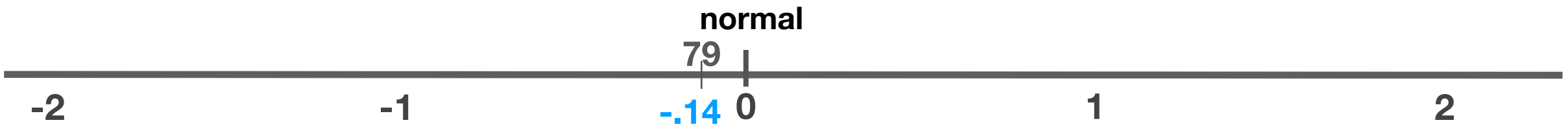
Measure	Qty	Standardized (z-score)
Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
# Bedrooms	4	1.32



Measure	Qty	Standardized (z-score)
Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
# Bedrooms	4	1.32



Measure	Qty	Standardized (z-score)
Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
# Bedrooms	4	1.32



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Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
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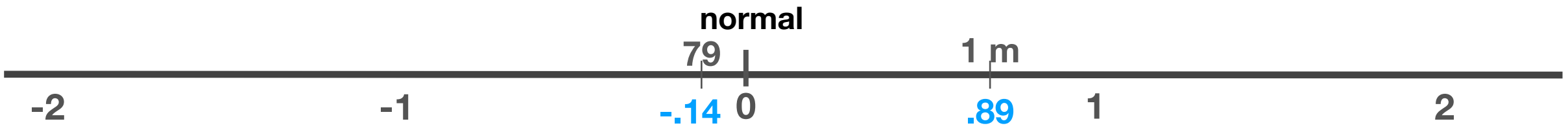
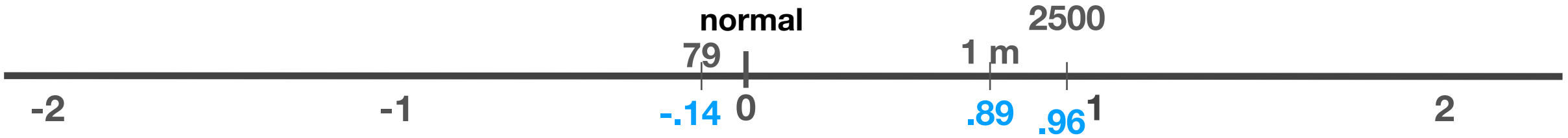


Measure	Qty	Standardized (z-score)
Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
# Bedrooms	4	1.32



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Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
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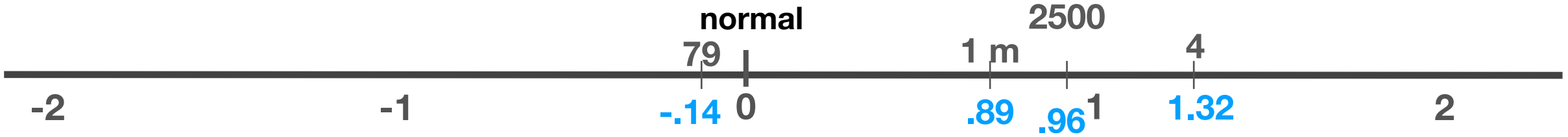
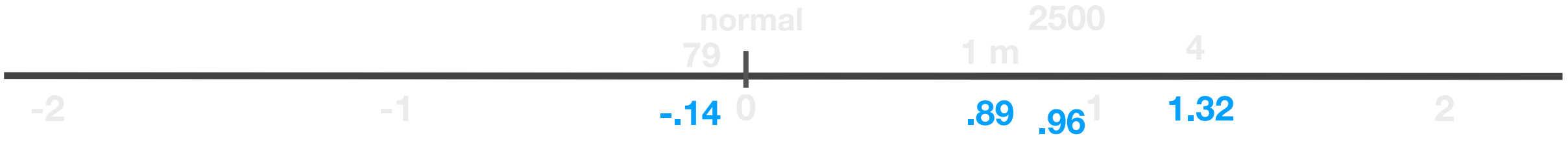


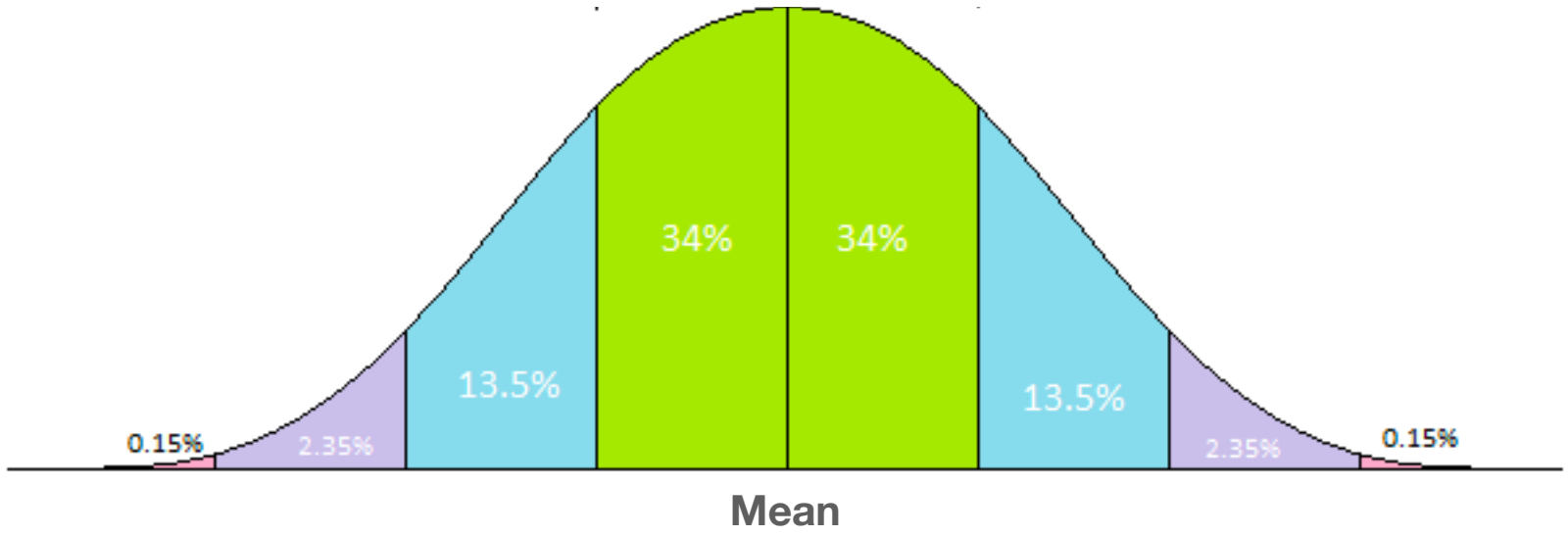
Measure	Qty	Standardized (z-score)
Price	1 million	0.89
Sq. Ft.	2,500	0.96
Neighborhood Rating	79	-0.14
# Bedrooms	4	1.32



Standardize

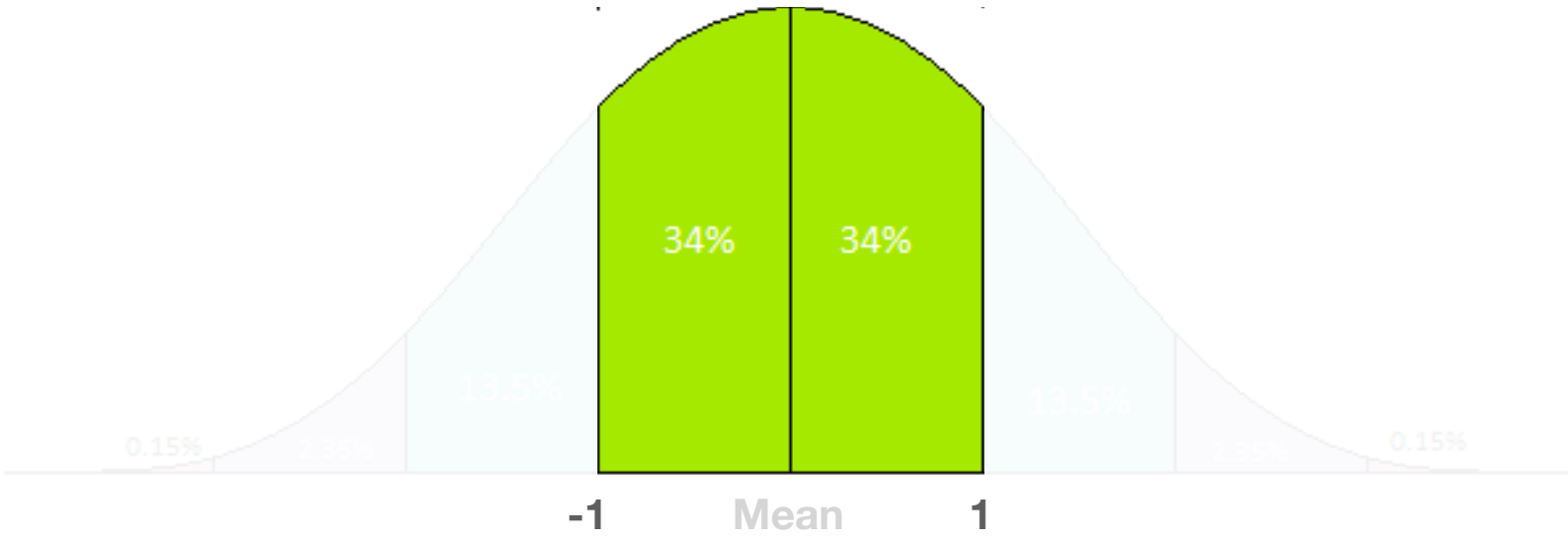
GRE	TOEFL	GPA
325	104	3.89

Normal Distribution



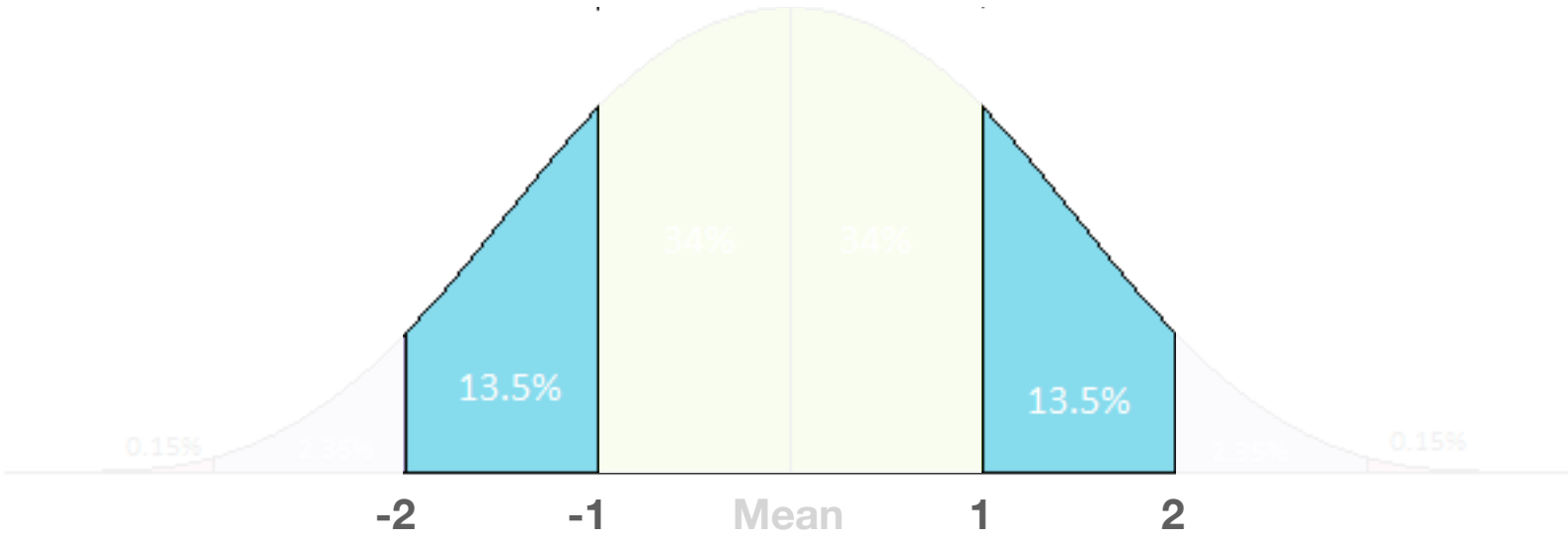
Normal Distribution

68%



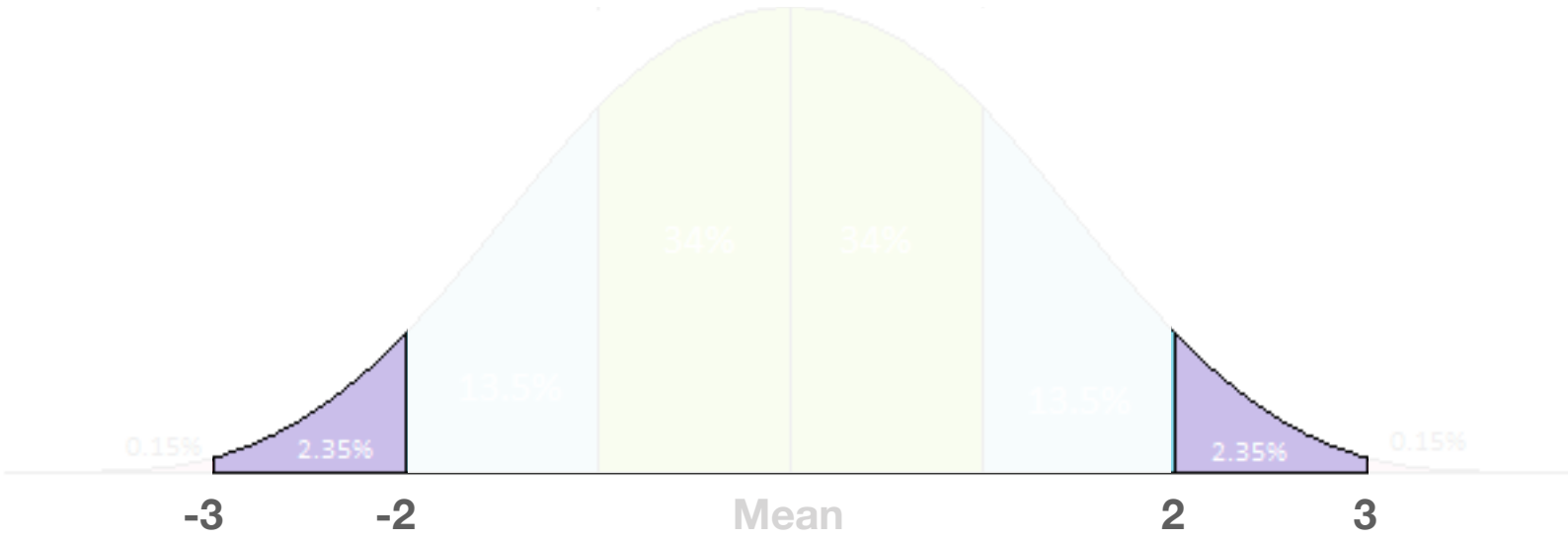
Normal Distribution

27%



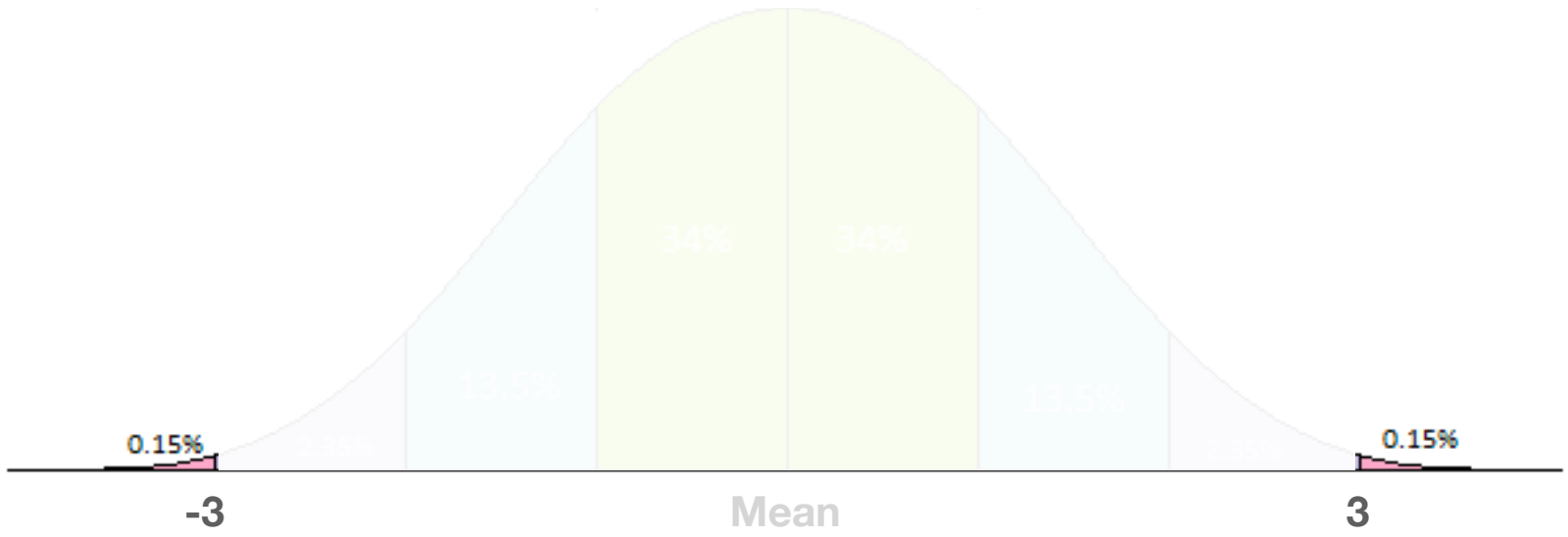
Normal Distribution

4.7%

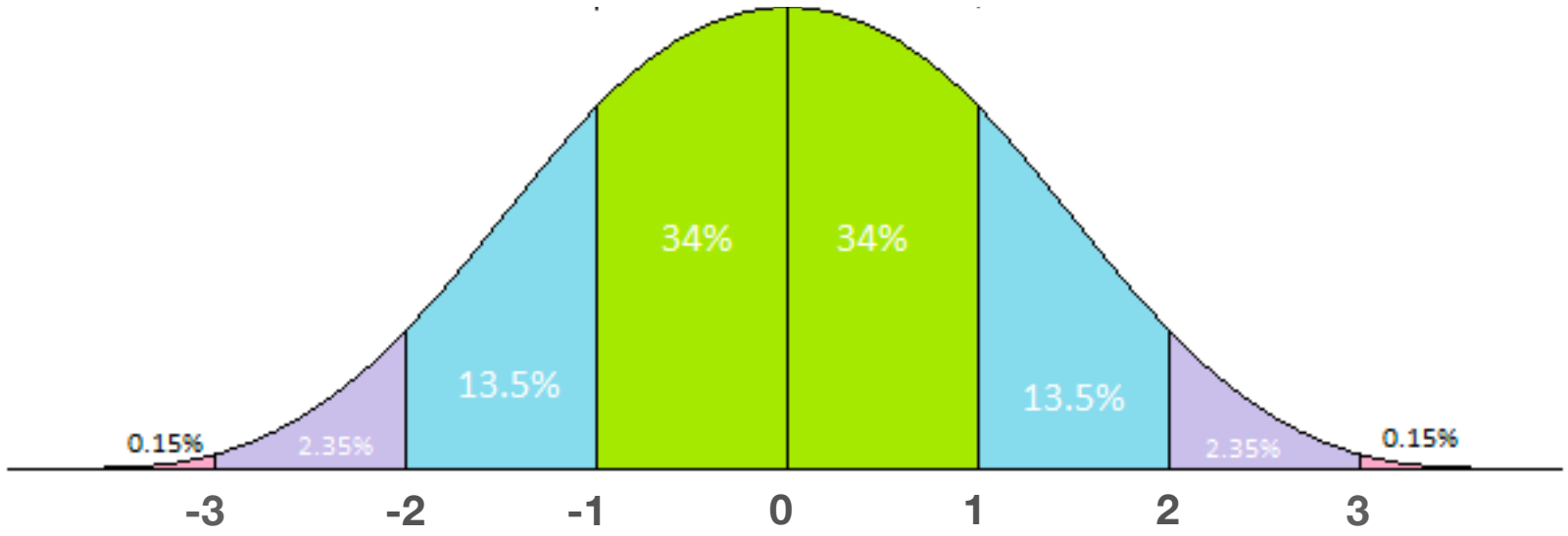


Normal Distribution

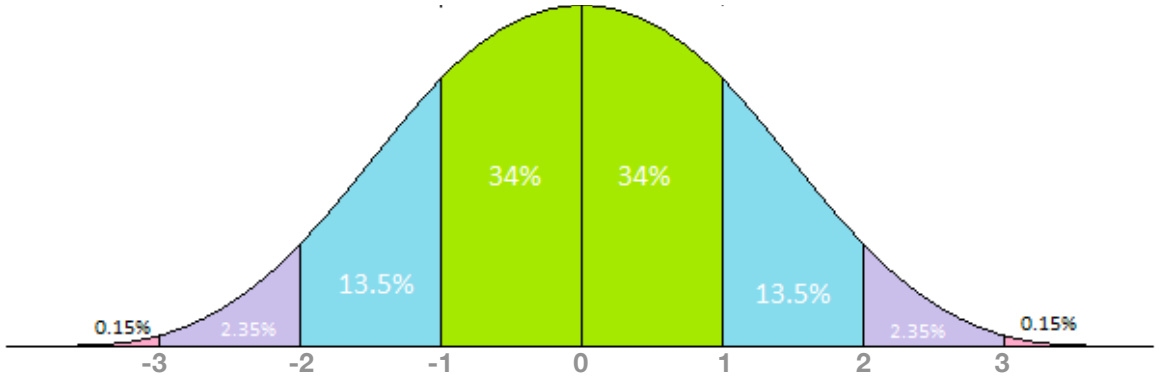
.3%



Normal Distribution

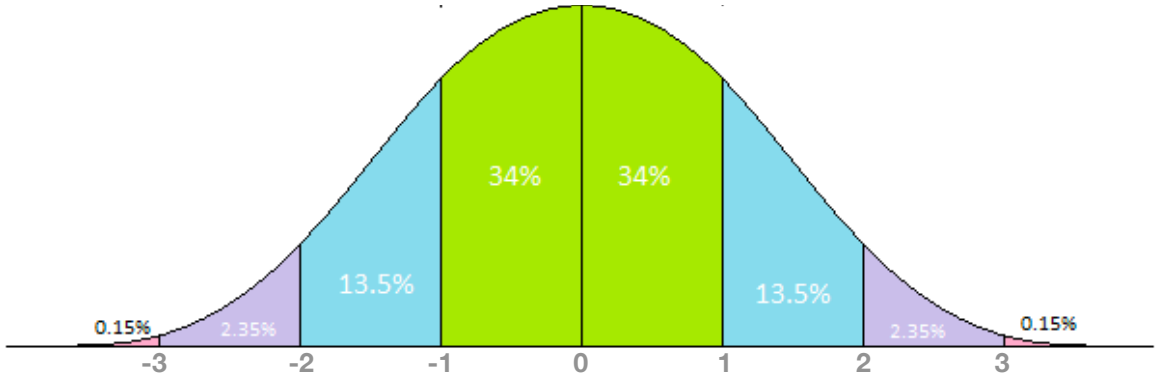


Standardization



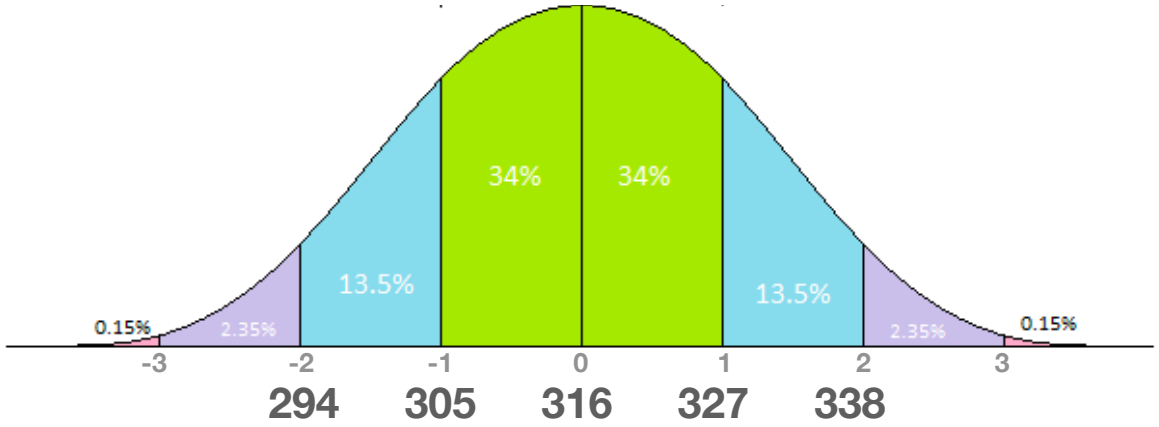
GRE	TOEFL	GPA
325	104	3.89

Standardization



GRE	TOEFL	GPA
325	104	3.89

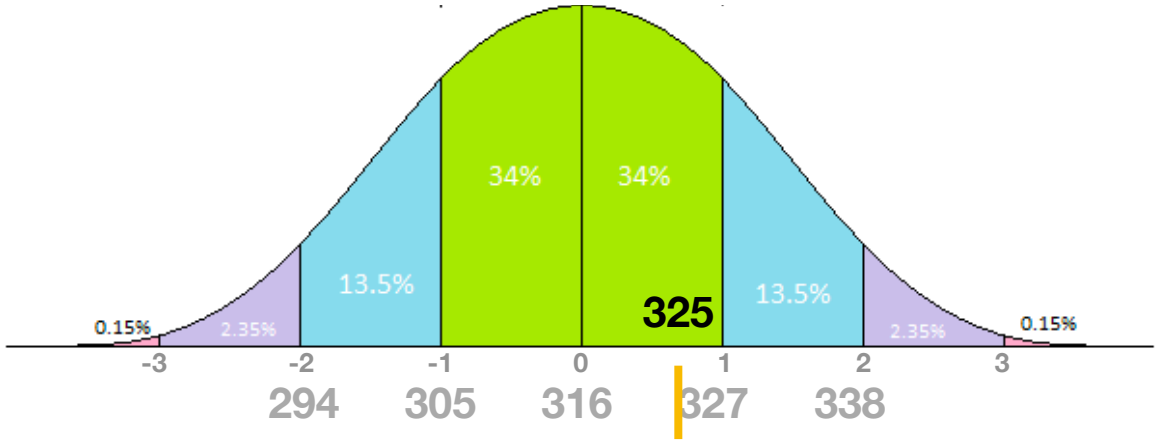
Standardization



sd = 11

GRE	TOEFL	GPA
325	104	3.89

Standardization

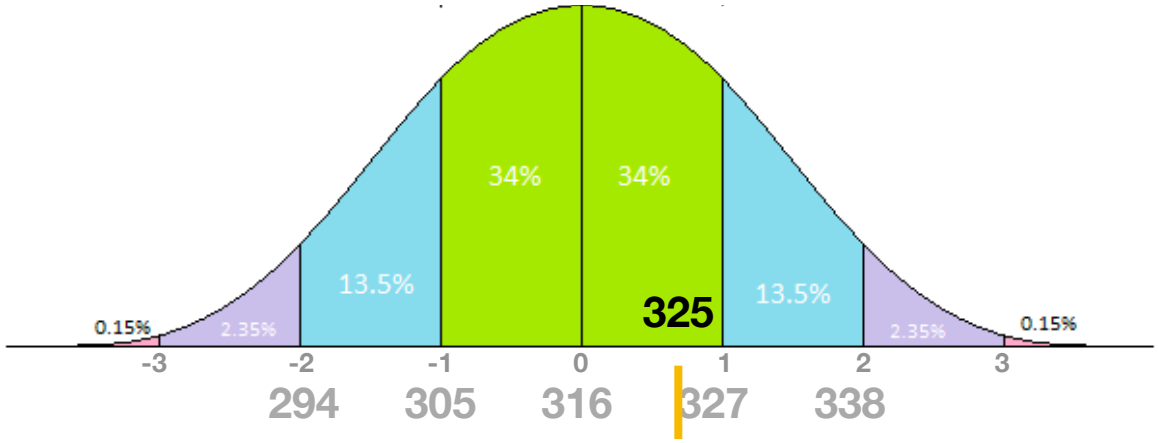


0.81

sd = 11

GRE	TOEFL	GPA
325	104	3.89

Standardization

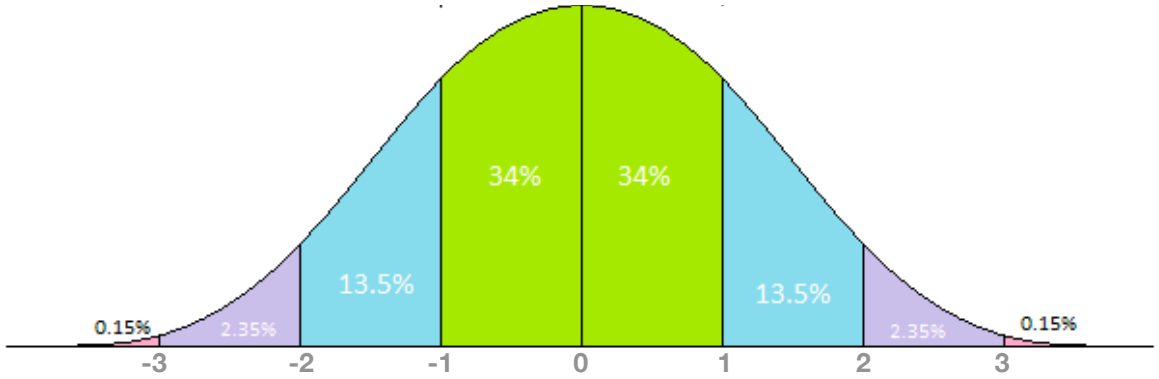


0.81

sd = 11

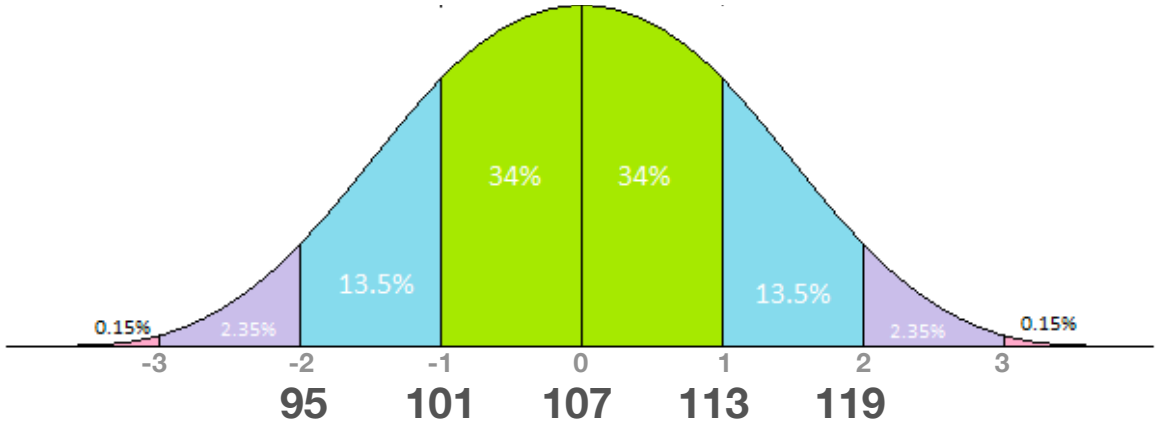
GRE	TOEFL	GPA
0.81	104	3.89

Standardization



GRE	TOEFL	GPA
0.81	104	3.89

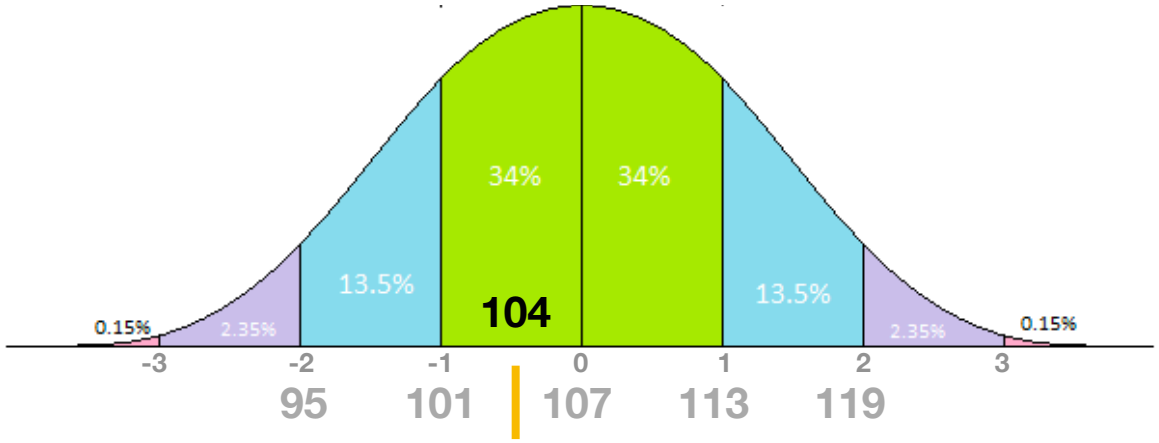
Standardization



sd = 6

GRE	TOEFL	GPA
0.81	104	3.89

Standardization

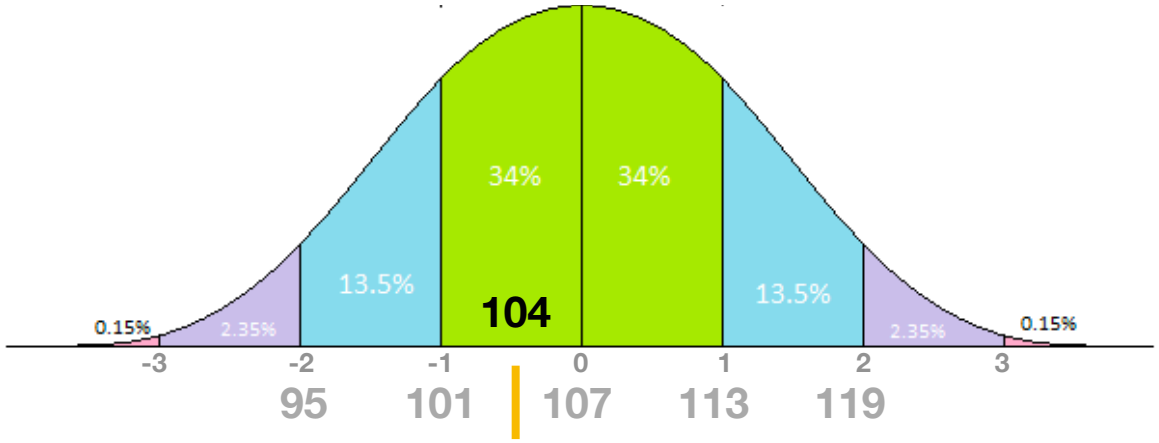


-0.53

sd = 6

GRE	TOEFL	GPA
0.81	104	3.89

Standardization

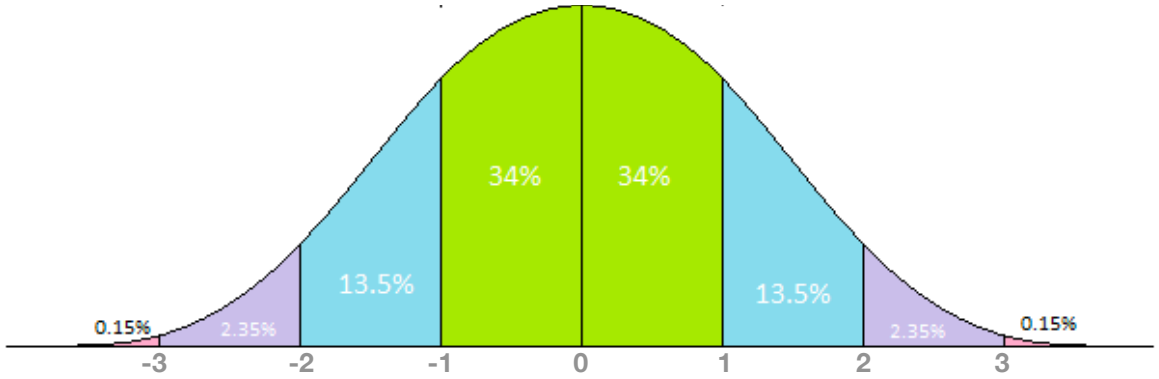


-0.53

sd = 6

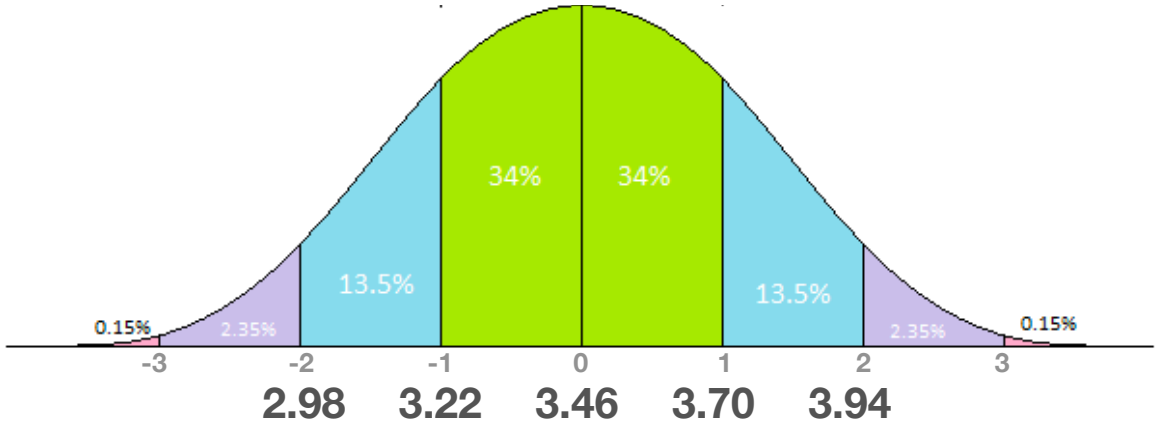
GRE	TOEFL	GPA
0.81	-0.53	3.89

Standardization



GRE	TOEFL	GPA
0.81	-0.53	3.89

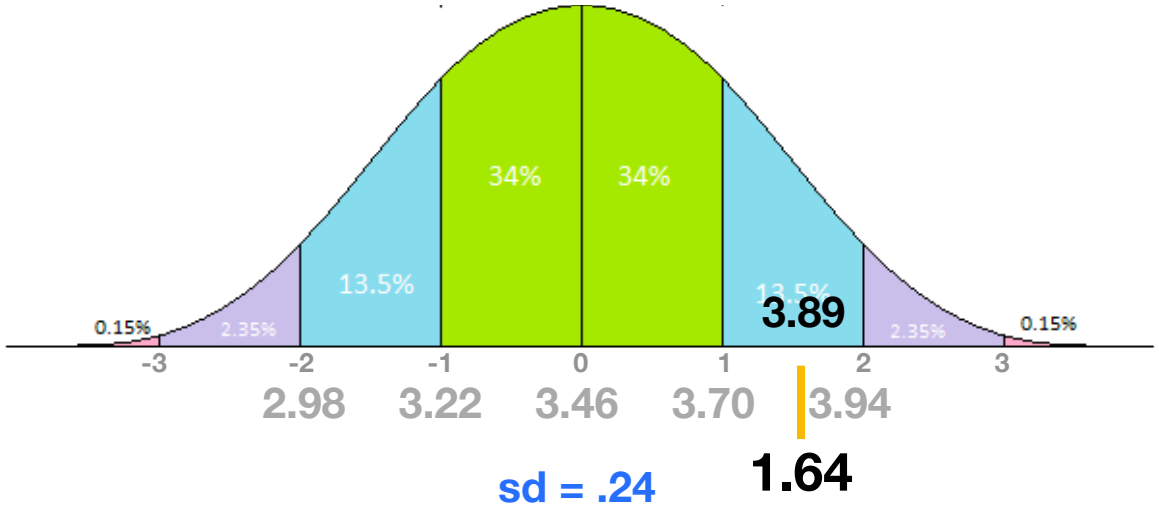
Standardization



sd = .24

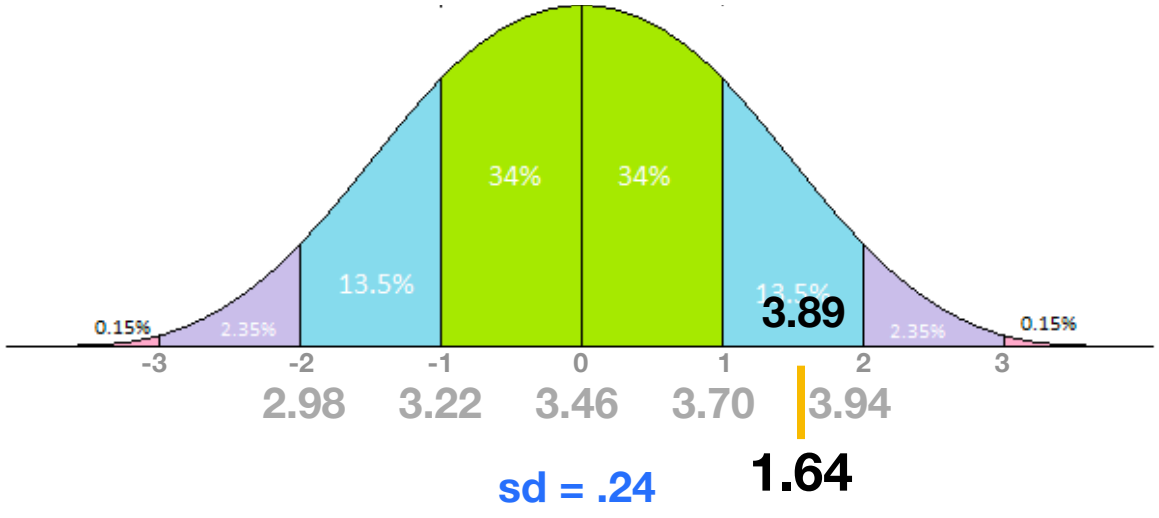
GRE	TOEFL	GPA
0.81	-0.53	3.89

Standardization



GRE	TOEFL	GPA
0.81	-0.53	3.89

Standardization



GRE	TOEFL	GPA
0.81	-0.53	1.64

Standardization

GRE	TOEFL	GPA
0.81	-0.53	1.64

Range

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Range

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Range

max value = 7

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Range

max value = 7

min value = 0

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

Range

max value = 7

min value = 0

max - min = 7

Normalizing Values

Normalization

(min-max scaling)

$$\text{normalization} = \frac{x - \min}{\max - \min}$$

Normalization

(min-max scaling)

$$\text{normalization} = \frac{x - \min}{\max - \min}$$

Normalization

(min-max scaling)

$$\text{normalization} = \frac{x - \min}{\text{range}}$$

Normalization

(min-max scaling)

$$\text{normalization} = \frac{x - \min}{\max - \min}$$

Normalization

(min-max scaling)

$$\text{normalization} = \frac{x - \min}{\max - \min}$$

At what proportion of the range does a given value lie

Values will be between:

0 and 1

(0% to 100%)

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

min value = 0

max value = 7

normalization

$$\frac{x - min}{max\text{-}min}$$

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

min value = 0

max value = 7

normalization

$$\frac{x - min}{max\text{-}min}$$

$$\frac{x - min}{max - min}$$

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

min value = 0

max value = 7

normalization

$$\frac{x - min}{max - min}$$

$$\frac{5 - 0}{\text{max-min}}$$

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

min value = 0

max value = 7

normalization

$$\frac{x - \text{min}}{\text{max-min}}$$

$$\frac{5 - 0}{7 - 0}$$

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

min value = 0

max value = 7

normalization

$$\frac{x - min}{max\text{-}min}$$

Feature	Deviations	Squared Deviation
0	-4	16
1	-3	9
2	-2	4
3	-1	1
4	0	0
5	1	1
5	1	1
6	2	4
7	3	9
7	3	9
40	**0**	**54**

min value = 0

max value = 7

normalization

$$\frac{x - min}{max - min}$$

$$\frac{5}{7} = .71$$

Relative Standing

Percentiles

Quartiles

Percentiles

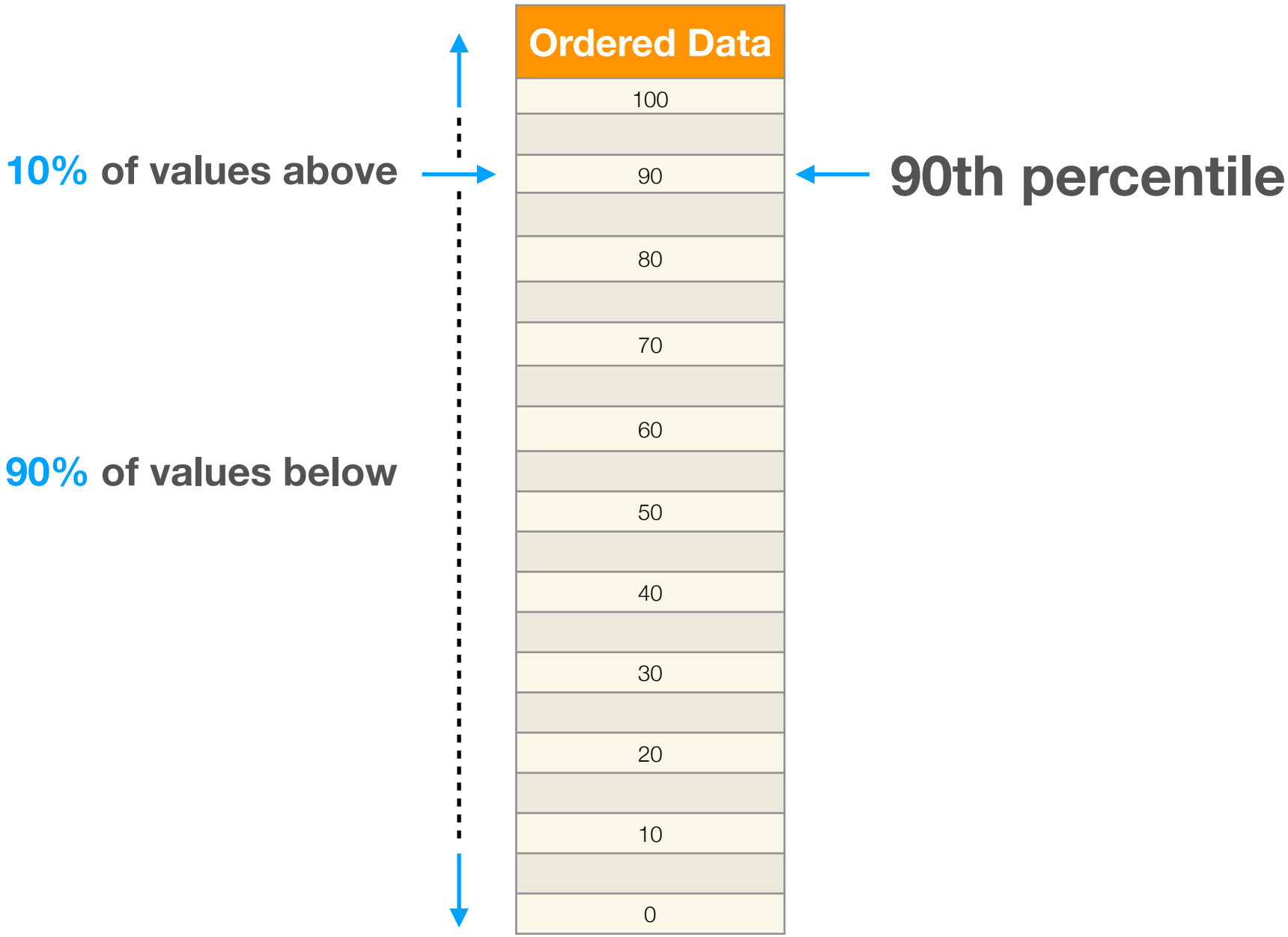
Ordered Data
100
90
80
70
60
50
40
30
20
10
0

Percentiles

Ordered Data
100
90
80
70
60
50
40
30
20
10
0

90th percentile

Percentiles

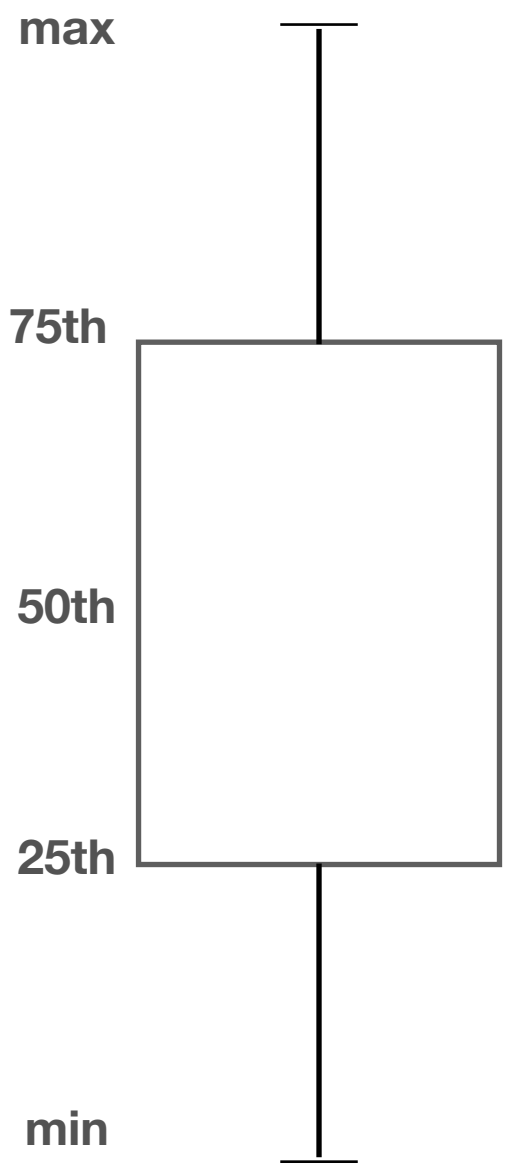


Quartiles

Ordered Data
100
90
80
70
60
50
40
30
20
10
0

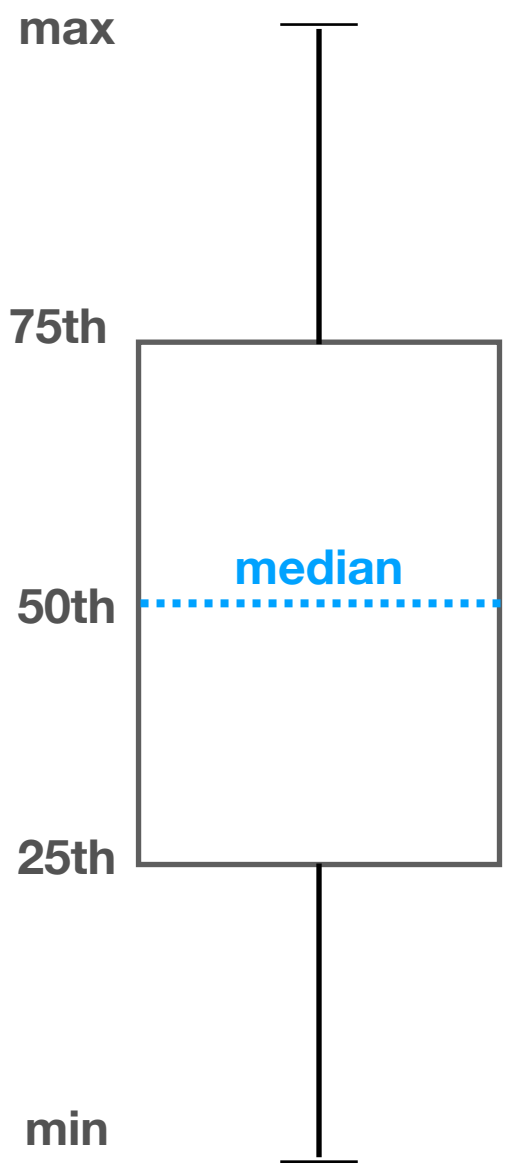
Quartiles

Ordered Data
100
90
80
70
60
50
40
30
20
10
0



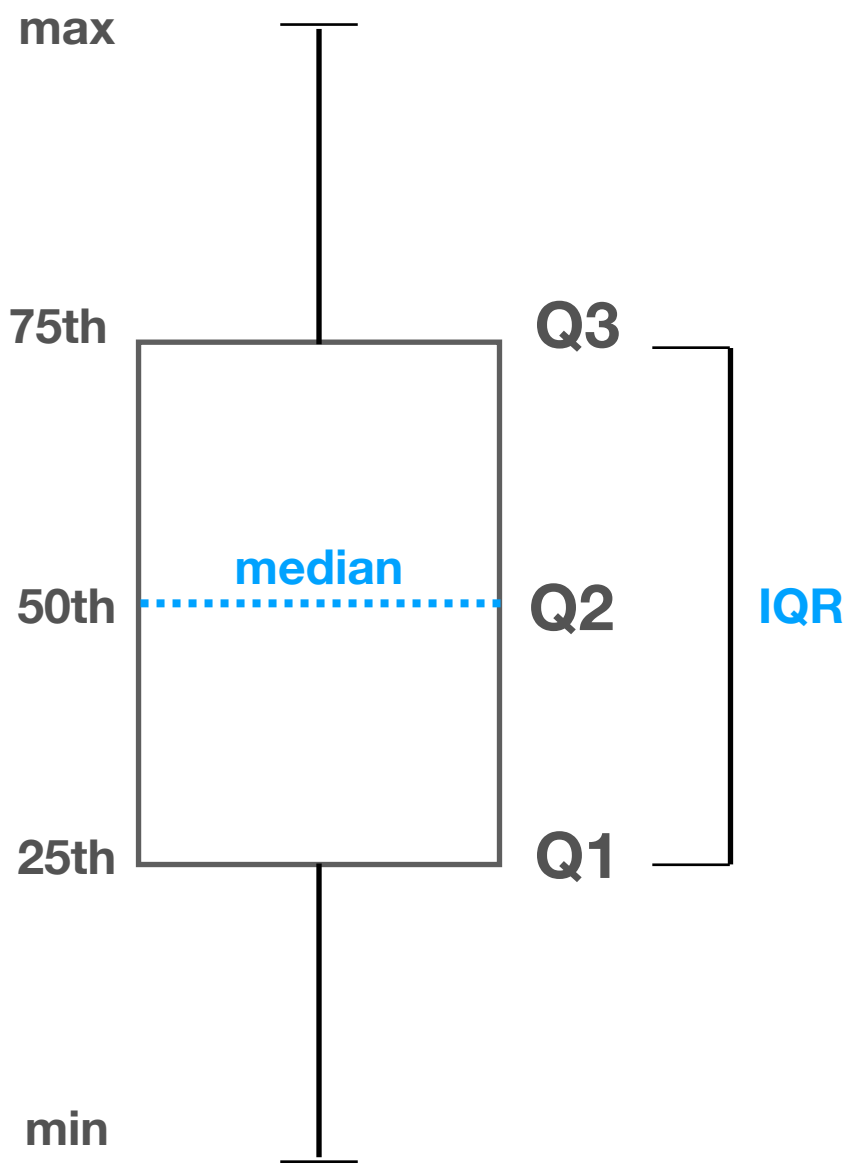
Quartiles

Ordered Data
100
90
80
70
60
50
40
30
20
10
0



Quartiles

Ordered Data
100
90
80
70
60
50
40
30
20
10
0



Explore the Data

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
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max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
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50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
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Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
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max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
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Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
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mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
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max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
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Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
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Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
count	1234	1234	1234	1234	1234	1234	1234	1234	1234
mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
max	28.00	37.50	92.20	100.00	100.00	51.60	39.70	29.00	22.40

Silicon Valley Diversity

	Black %	Hispanic %	Asian %	White %	Female %	Women of Color %	Asian Female %	Hispanic Female %	Black Female %
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mean	2.49	5.44	27.88	61.27	30.12	13.25	9.12	1.99	0.99
std	2.68	4.39	15.38	15.21	13.34	7.51	5.83	2.33	1.62
min	0.00	0.00	0.00	5.20	0.00	0.00	0.00	0.00	0.00
25%	0.90	3.10	16.53	51.90	21.40	8.80	5.10	0.60	0.00
50%	2.00	4.60	26.10	61.60	27.60	12.70	8.70	1.50	0.60
75%	3.20	6.70	37.08	71.88	37.58	16.70	12.10	2.60	1.30
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Silicon Valley Diversity

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