

# Supplemental Material

for

IEEE InfoVis 2016 Paper

## **VLAT: Development of a Visualization Literacy Assessment Test**

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This supplemental material contains:

- (1) The full rank of data visualization types in Source 2 (data visualization authoring tools) and Source 3 (news outlets).
- (2) The test instructions and all the 53 test items in the VLAT with associated data visualizations, stems, and options.
- (3) The summary table of difficulty indexes ( $P$ ) by data visualization types and by visualization tasks.

## Full Rank of Data Visualization Types in Source 2 and Source 3

Source 2 Data Visualization Authoring Tools		Source 3 News Outlets	
Bar Chart	11	Choropleth map	120
Pie Chart	11	Bar Chart	104
Area Chart	9	Line Chart	79
Area Chart (Stacked)	9	Bubble Chart	51
Line Chart	9	Bubble Map	40
Bar Chart (Stacked)	8	Dot Map	29
Bar Chart (100% Stacked)	8	Bar Chart (Stacked)	25
Bubble Chart	8	Heatmap	23
Area Chart (100%)	7	Area Chart	18
Choropleth map	7	Scatterplot	18
Scatterplot	7	Pictograph	17
Treemap	7	Timeline	14
Donut Chart	6	Dot Matrix	13
Box Plot	5	Area Chart (Stacked)	11
Histogram	5	Bar Chart (100% Stacked)	10
Radar Chart	5	Connection / Flow Map	10
Trendline	5	Treemap	10
Table	5	Stepped Area	9
Bubble Map	4	Trendline	8
Heatmap	4	Word Cloud	8
Pareto Chart	4	Area Chart (100%)	7
Polar Area Chart	4	Donut Chart	7
Chord Diagram	3	Span Chart	7
Step	3	Bullet Chart	6
Step (100%)	3	Pie Chart	6
Stepped Area	3	Slopegraph	6
Stepped Area (100%)	3	Interval Chart	6
Sunburst	3	Calendar Charts	5
Waterfall Chart	3	Circle Packing	4
Gantt Chart	3	Graph / Node-link Diagram	4
Bullet Chart	2	Polar Area Chart	4
Calendar Charts	2	Streamgraph	4
Candlestick Chart	2	Histogram	3
Graph / Node-link Diagram	2	Pareto Chart	3
Sankey Diagram	2	Sankey Diagram	2
Tree / HyperTree	2	Step	2
Word Cloud	2	Voronoi Daigram	2
Word Tree	2	Chord Diagram	1
Gauge Chart	2	Non-ribbon Chord Diagram	1
3D surface	2	Radar Chart	1
3D scatter	2	Waterfall Chart	1
3D line	2	SimulSort	1
Arc Diagram	1	Diff Chart	1
Adjacency Matrix	1	3D surface	1
Circular heat chart	1		
Circle Packing	1		
Connection / Flow Map	1		
Dot Map	1		
Icicle	1		
Narrative Charts	1		
Non-ribbon Chord Diagram	1		
Parallel Coordinates	1		
Parallel Sets	1		
Scatterplot Matrix	1		
Slopegraph	1		
Span Chart	1		
Streamgraph	1		
Voronoi Daigram	1		
Edge Bundling	1		
Interval Chart	1		
Diff Chart	1		
Marimekko Chart	1		
Map	1		
Org Chart	1		
Timeline	1		

## Instructions for the Test

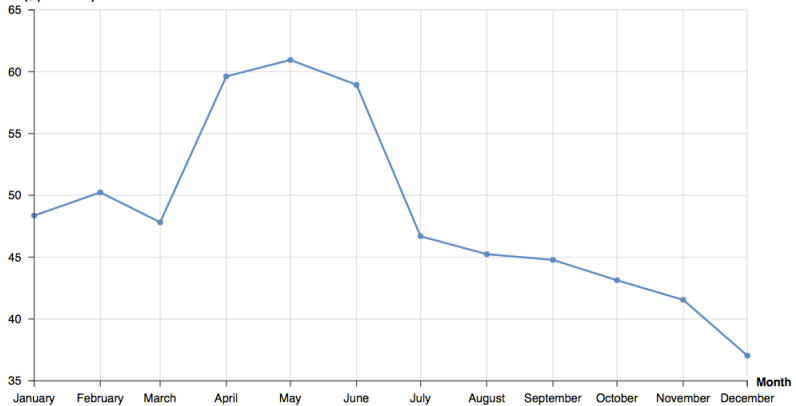
Please carefully read the following instructions before starting the test.

1. The primary purpose of this test is to measure the ability to read and interpret visually represented data of users, especially non-experts in data visualization. The test contains **53 multiple-choice questions** about 12 graphs/charts.
2. After you read these instructions, you will see the questions one by one with a graph/chart in a randomized order.
3. Select the **BEST** answer to the questions. You will be allowed **a maximum of 25 seconds** to answer to a question (a maximum of 22 minutes in total to complete the test).
4. **DO NOT GUESS.** Please select the “**Omit**” option if you are not sure about your answer or your answer is based on a guess. Some points will be deducted for a wrong answer and the score would be corrected for guessing.

## Item 1

# Monthly Oil Price History in 2015

Oil Price (\$ per barrel)



What was the price of a barrel of oil in February 2015?

\$57.36

\$47.82

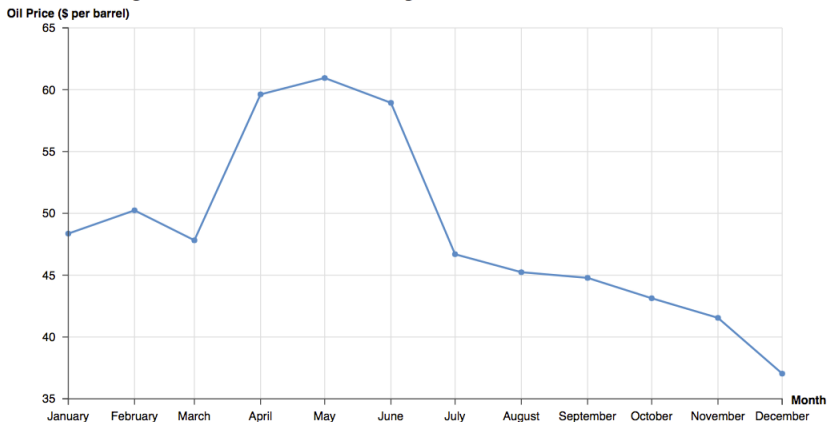
\$50.24

\$39.72

Omit

## Item 2

# Monthly Oil Price History in 2015



In which month was the price of a barrel of oil the lowest in 2015?

March

May

July

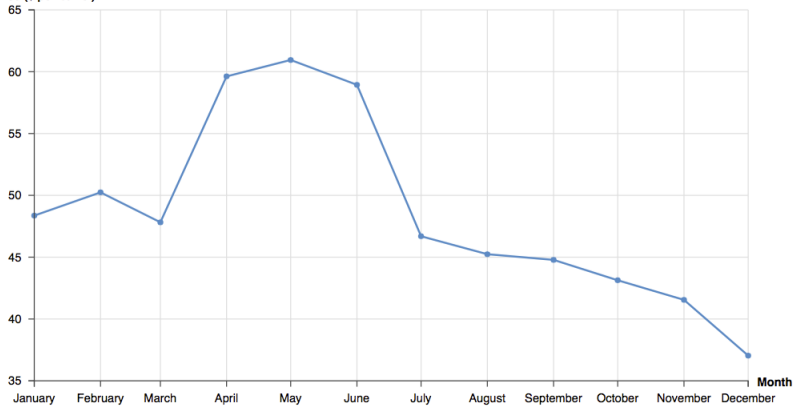
December

Omit

### Item 3

## Monthly Oil Price History in 2015

Oil Price (\$ per barrel)



What was the price range of a barrel of oil in 2015?

\$35 - \$65

\$48.36 - \$60.95

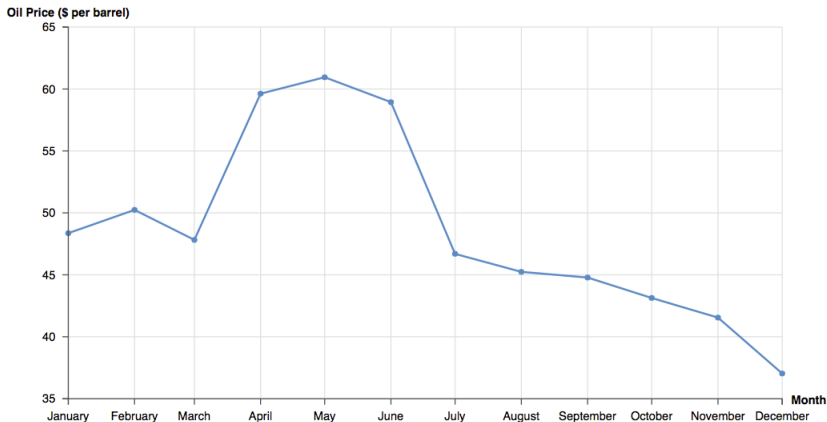
\$37.04 - \$48.36

\$37.04 - \$60.95

Omit

#### Item 4

## Monthly Oil Price History in 2015



Over the course of the second half of 2015, the price of a barrel of oil was \_\_\_\_\_.

rising

falling

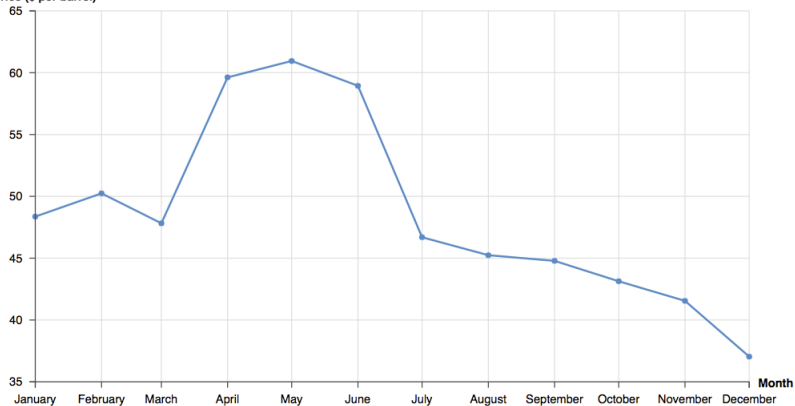
staying

Omit

## Item 5

# Monthly Oil Price History in 2015

Oil Price (\$ per barrel)



About how much did the price of a barrel of oil fall from April to September in 2015?

\$4

\$15

\$17

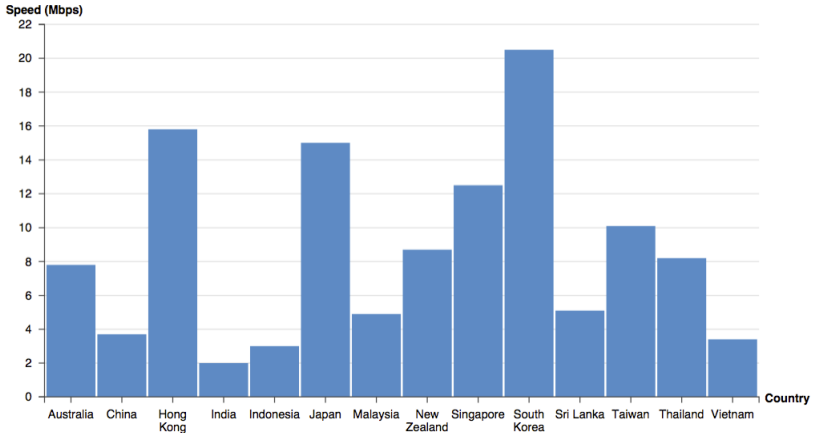
\$45

Omit



## Item 6

# Average Internet Speeds in Asia



What is the average internet speed in Japan?

10 Mbps

14 Mbps

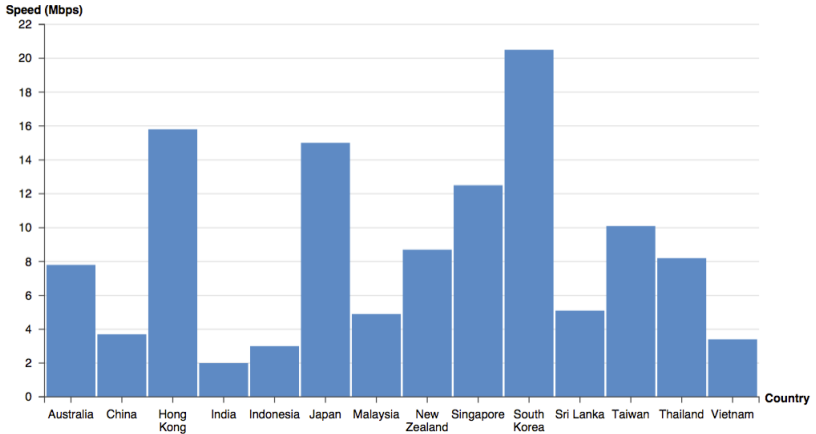
15 Mbps

16 Mbps

Omit

## Item 7

# Average Internet Speeds in Asia



In which country is the average internet speed the fastest in Asia?

China

Hong Kong

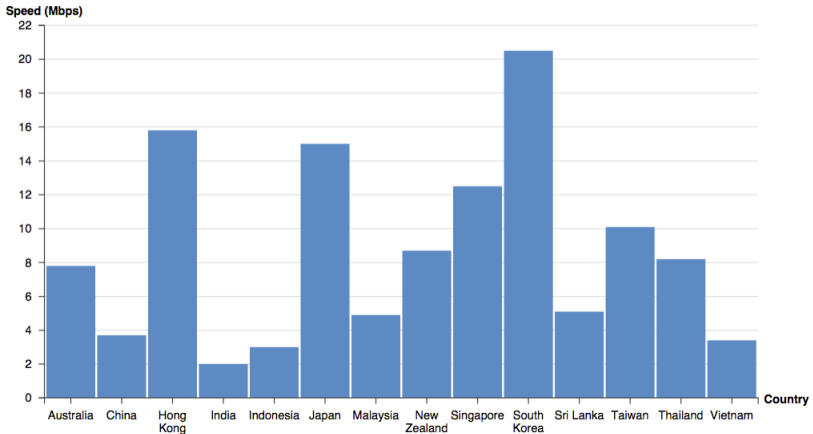
South Korea

Vietnam

Omit

## Item 8

# Average Internet Speeds in Asia



What is the range of the average internet speed in Asia?

0 - 22 Mbps

2 - 20.5 Mbps

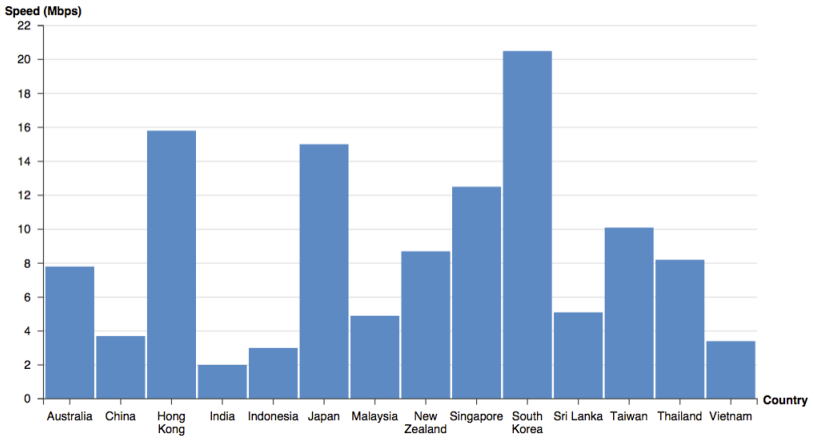
3 - 20 Mbps

3.4 - 7.8 Mbps

Omit

## Item 9

# Average Internet Speeds in Asia



How many countries in Asia is the average internet speed slower than Thailand?

5 countries

6 countries

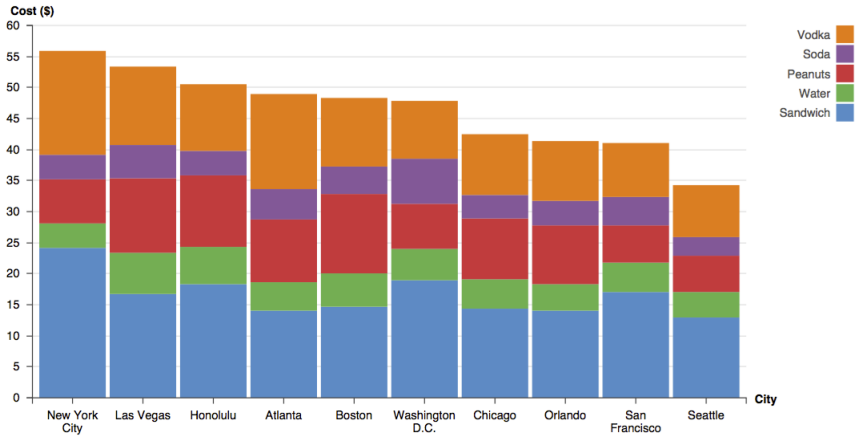
7 countries

8 countries

Omit

## Item 10

# Hotel Costs of Room Service



What is the cost of peanuts in Las Vegas?

\$12

\$16.7

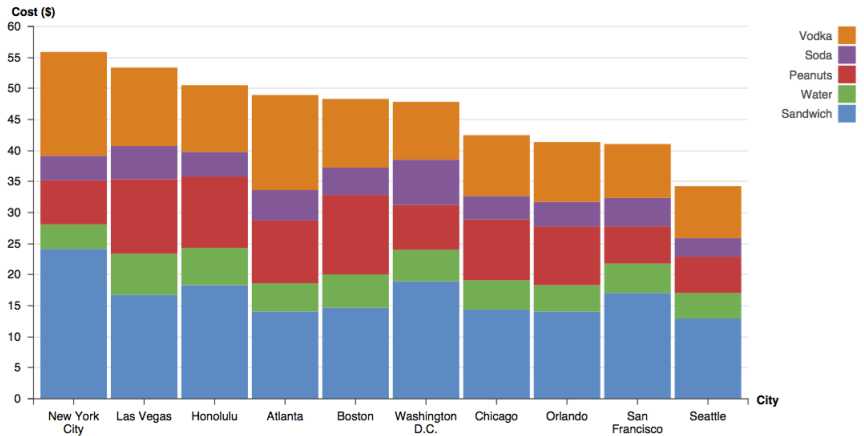
\$23.4

\$35.4

Omit

## Item 11

# Hotel Costs of Room Service



About what is the ratio of the cost of a sandwich to the total cost of room service in Seattle?

1 to 10

2 to 10

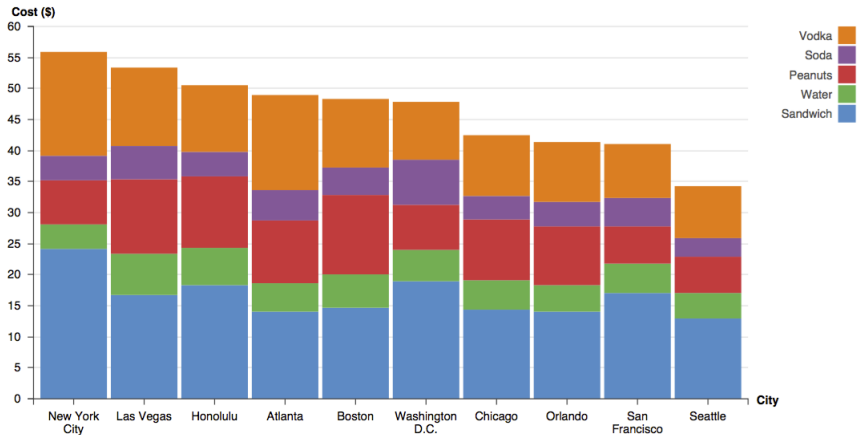
4 to 10

6 to 10

Omit

## Item 12

# Hotel Costs of Room Service



In which city is the cost of soda the highest?

New York City

Las Vegas

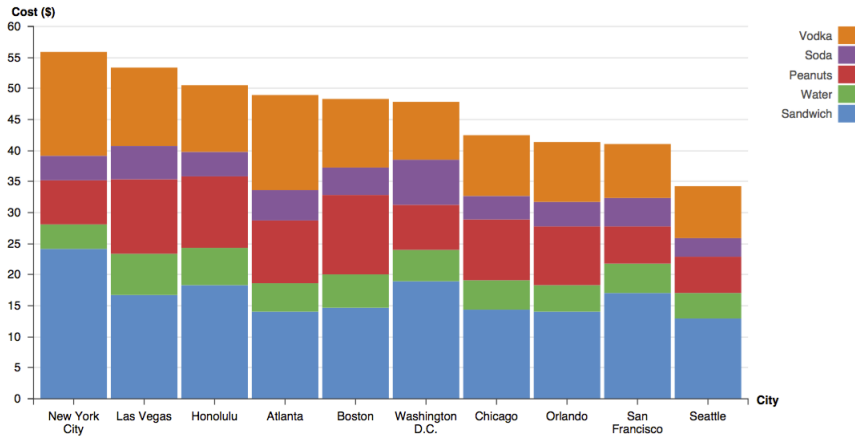
Atlanta

Washington D.C.

Omit

## Item 14

# Hotel Costs of Room Service



The cost of vodka in Atlanta is higher than that of Honolulu.

True

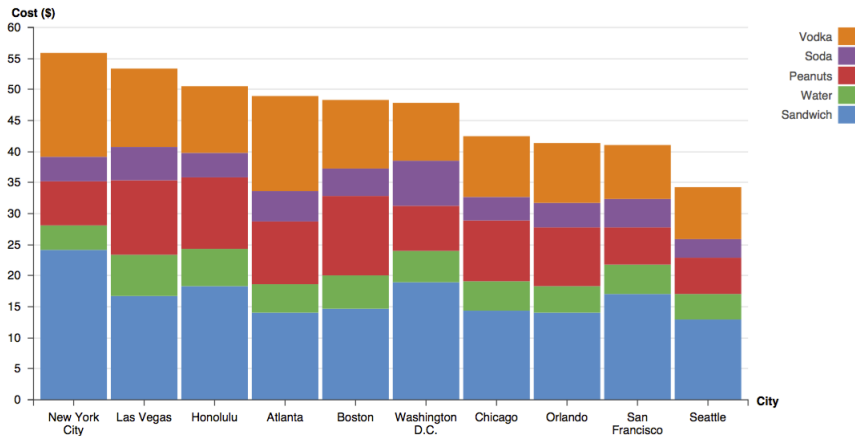
False

Omit



## Item 15

# Hotel Costs of Room Service



The ratio of the cost of Soda to the cost of Water in Orlando is higher than that of Washington D.C.

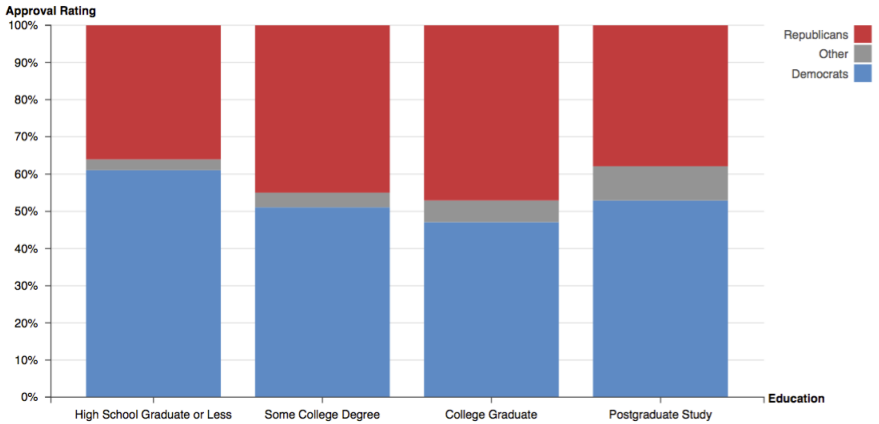
True

False

Omit

## Item 16

# Election Exit Poll of California State by Education



What is the approval rating of Republicans among the people who have the education level of Postgraduate Study?

38%

47%

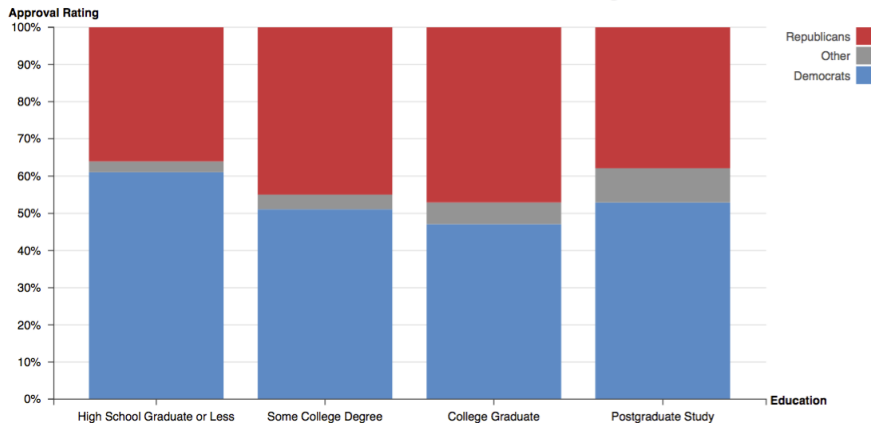
53%

62%

Omit

## Item 17

# Election Exit Poll of California State by Education



What is the education level of people in which the Democrats have the lowest approval rating?

High School Graduate or Less

Some College Degree

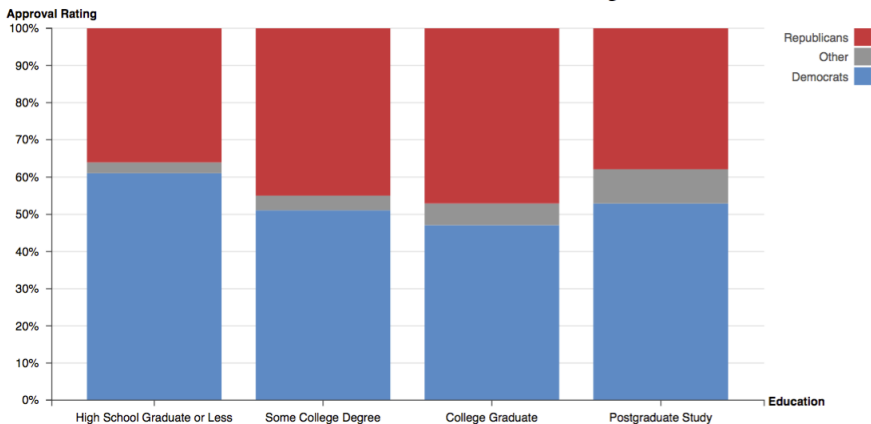
College Graduate

Postgraduate study

Omit

## Item 18

# Election Exit Poll of California State by Education



The approval rating of Republicans for the people who have the education level of Some College Degree is lower than that for the people who have the education level of Postgraduate Study.

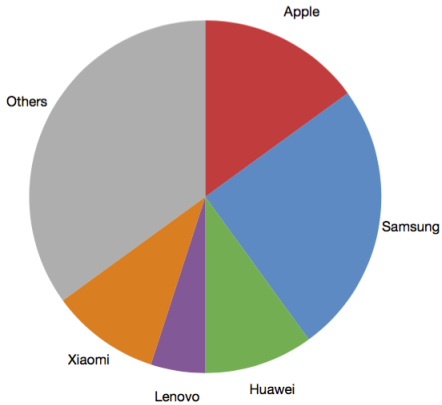
True

False

Omit

## Item 19

# Global Smartphone Market Share (%)



About what is the global smartphone market share of Samsung?

15%

25%

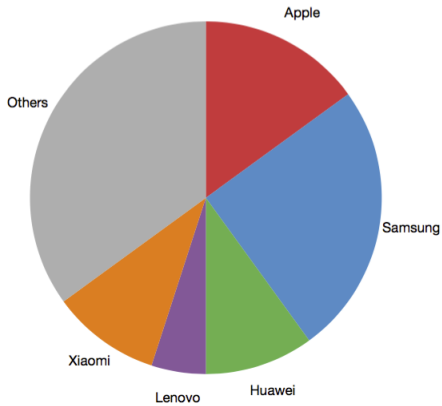
33%

50%

Omit

## Item 20

# Global Smartphone Market Share (%)



In which company is the global smartphone market share the smallest?

Apple

Xiaomi

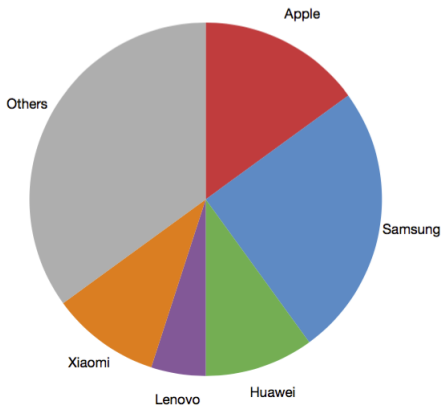
Lenovo

Others

Omit

## Item 21

# Global Smartphone Market Share (%)



The global smartphone market share of Apple is larger than that of Huawei.

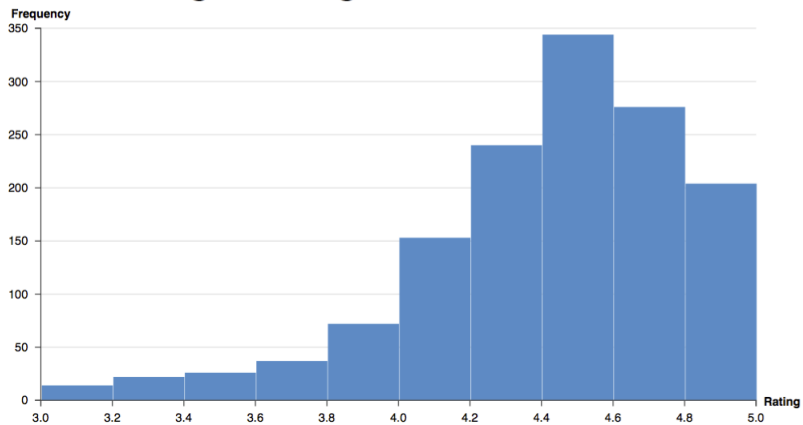
True

False

Omit

## Item 22

# Taxi Passenger Ratings



How many people have rated the taxi between 4.0 and 4.2?

145

153

200

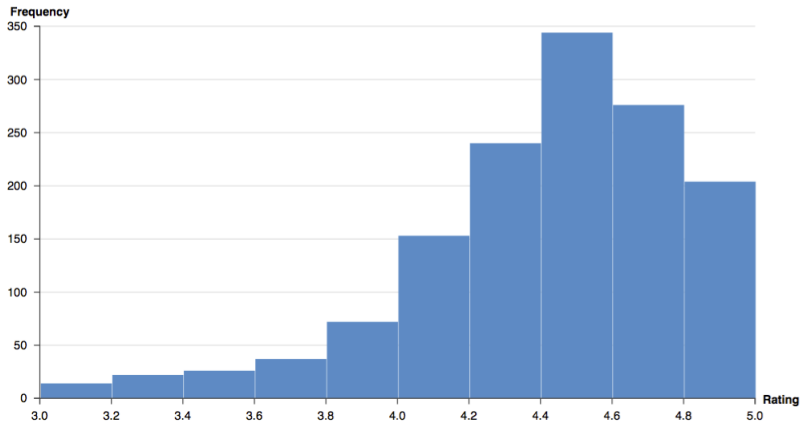
240

Omit



## Item 23

# Taxi Passenger Ratings



What is the rating that the people have rated the taxi the most?

4.2 - 4.4

4.4 - 4.6

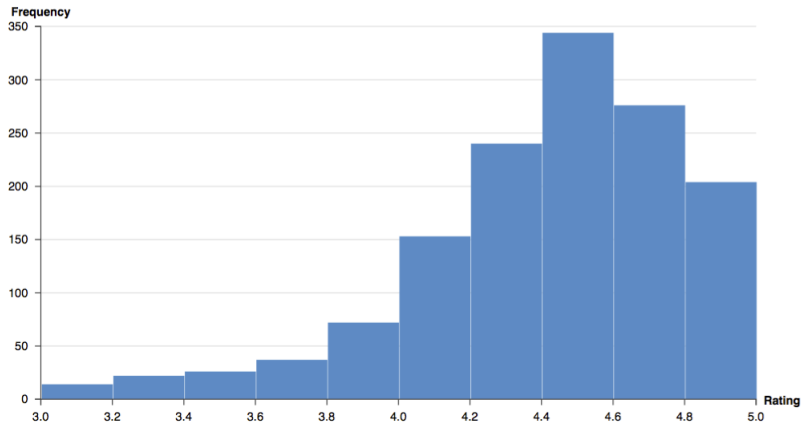
4.6 - 4.8

4.8 - 5.0

Omit

## Item 25

# Taxi Passenger Ratings



More people have rated the taxi between 4.6 and 4.8 than between 4.2 and 4.4.

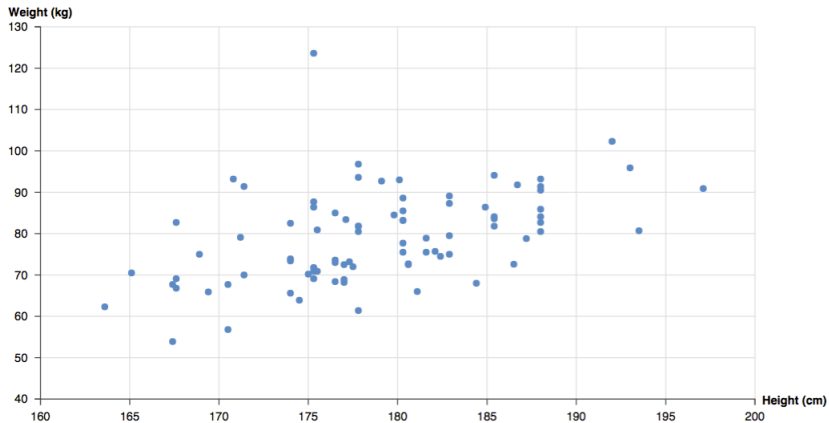
True

False

Omit

## Item 27

# Height vs. Weight of 85 Males



What is the weight for the person who is 165.1 cm tall?

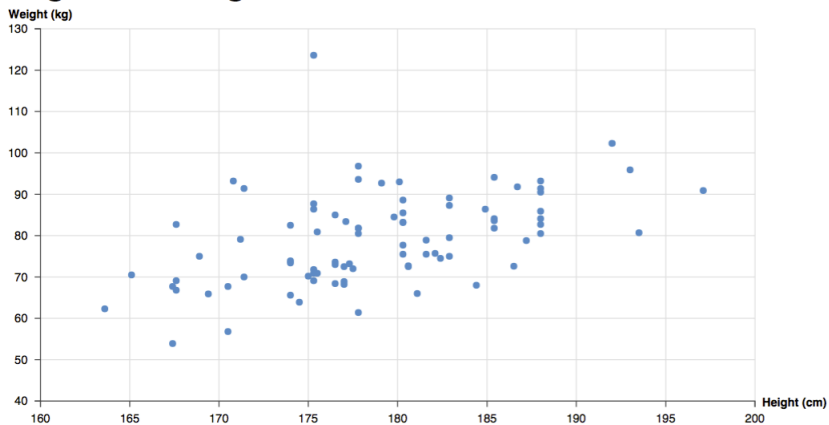
53.9 kg

67.7 kg

70.5 kg

82.7 kg

Omit

**Item 28****Height vs. Weight of 85 Males**

What is the height for the tallest person among the 85 males?

175.3 cm

192 cm

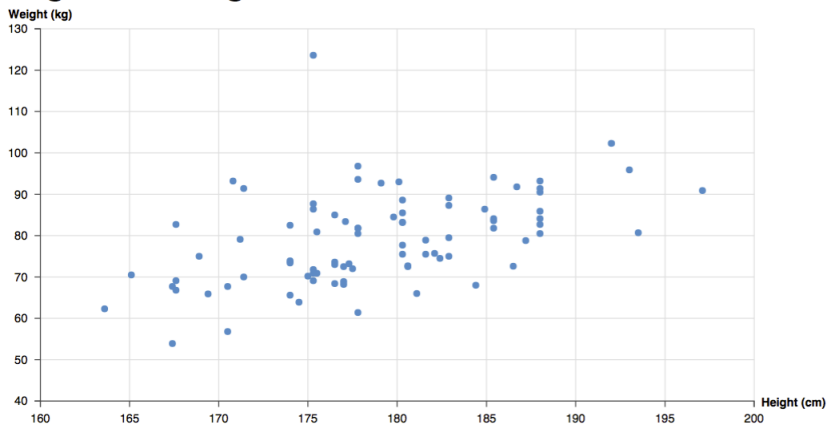
197.1 cm

200 cm

Omit

## Item 29

# Height vs. Weight of 85 Males



What is the range in weight for the 85 males?

40 - 130 kg

62.3 - 90.9 kg

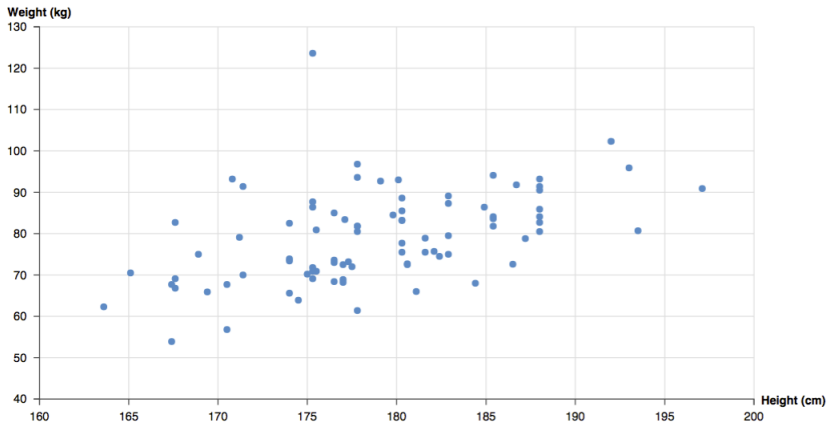
53.9 - 102.3 kg

53.9 - 123.6 kg

Omit

## Item 31

# Height vs. Weight of 85 Males



What is the height for a person who lies outside the others the most?

167.4 cm

175.3 cm

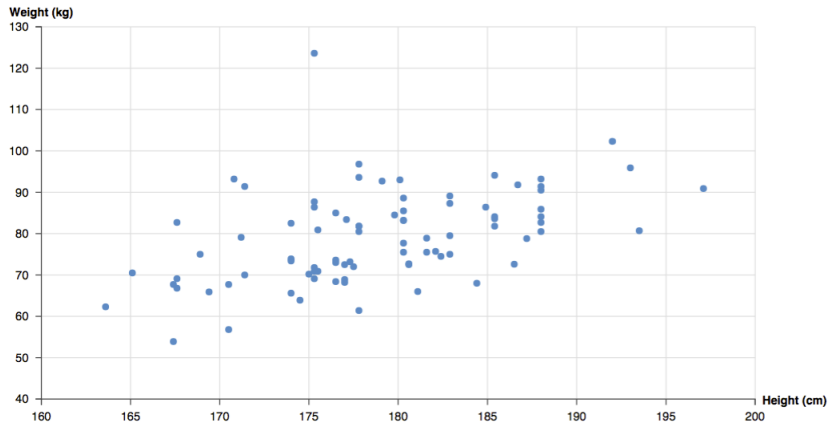
193 cm

197.1 cm

Omit

## Item 32

# Height vs. Weight of 85 Males



A group of males are gathered around the height of 176 cm and the weight of 70 kg.

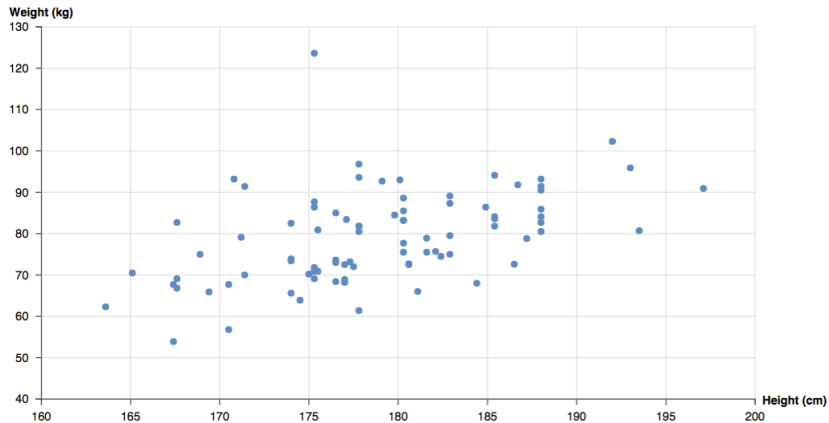
True

False

Omit

### Item 33

## Height vs. Weight of 85 Males



There is a negative linear relationship between the height and the weight of the 85 males.

True

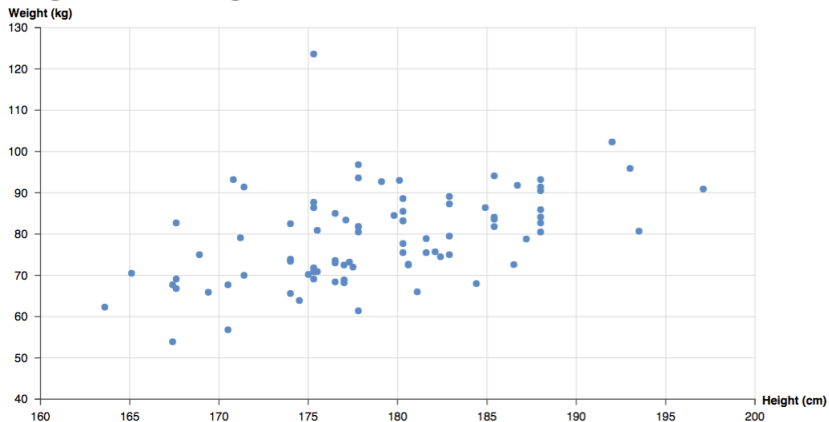
False

Omit



### Item 34

## Height vs. Weight of 85 Males



The weights for males with the height of 188 cm are all the same.

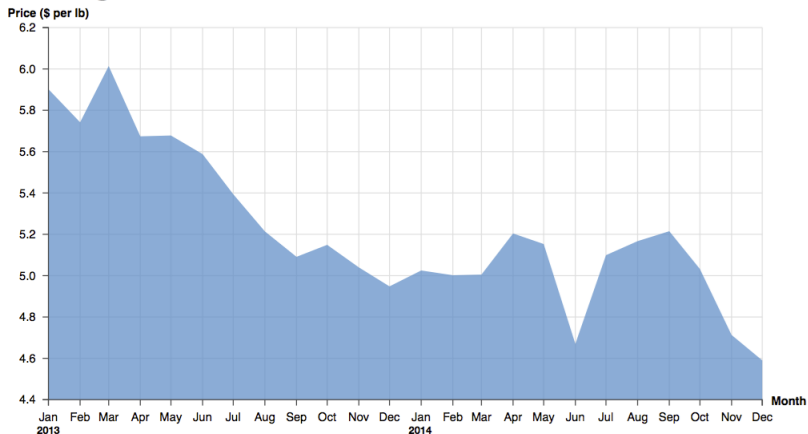
True

False

Omit

## Item 35

# Average Coffee Bean Price from 2013 to 2014



What was the average price of a pound of coffee beans in September 2013?

\$4.9

\$5.0

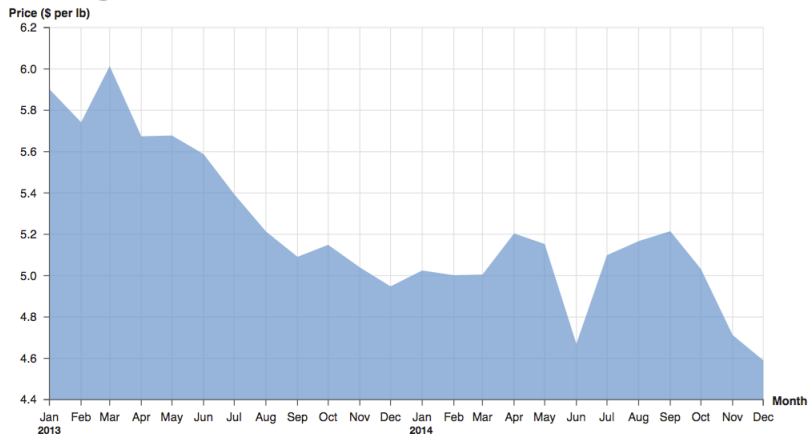
\$5.1

\$5.2

Omit

## Item 36

# Average Coffee Bean Price from 2013 to 2014



When was the average price of a pound of coffee beans at minimum?

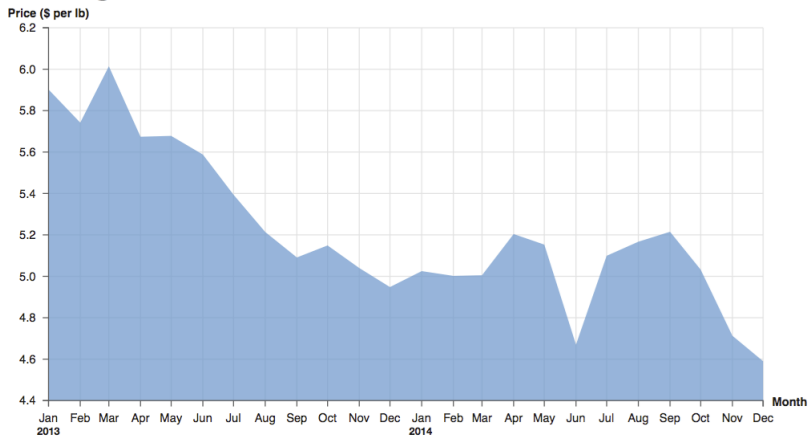
April 2013

September 2013

June 2014

December 2014

Omit

**Item 37****Average Coffee Bean Price from 2013 to 2014**

What was the range of the average price of a pound of coffee beans between January 2013 and December 2014?

\$4.4 - \$6.2

\$4.6 - \$5.9

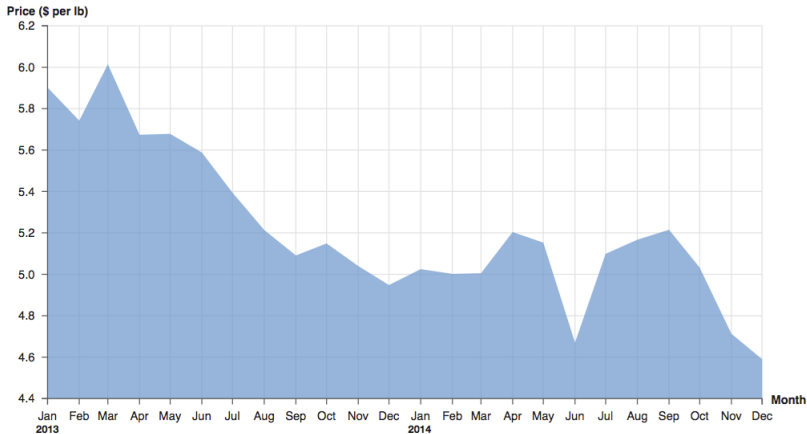
\$4.6 - \$6.0

\$4.6 - \$6.1

Omit

## Item 38

# Average Coffee Bean Price from 2013 to 2014



Over the course of 2013, the average price of a pound of coffee beans was \_\_\_\_\_.

rising

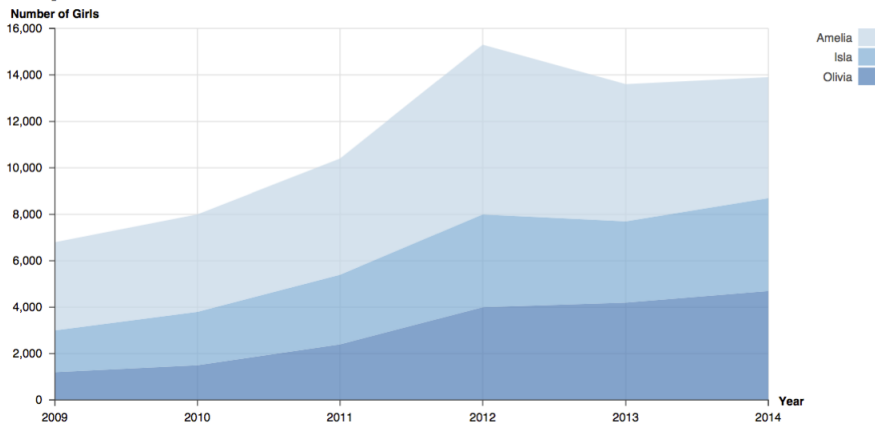
falling

staying

Omit

## Item 40

# Popular Girls' Names in the UK



What was the number of girls named 'Amelia' in 2010 in the UK?

1,500

3,800

4,200

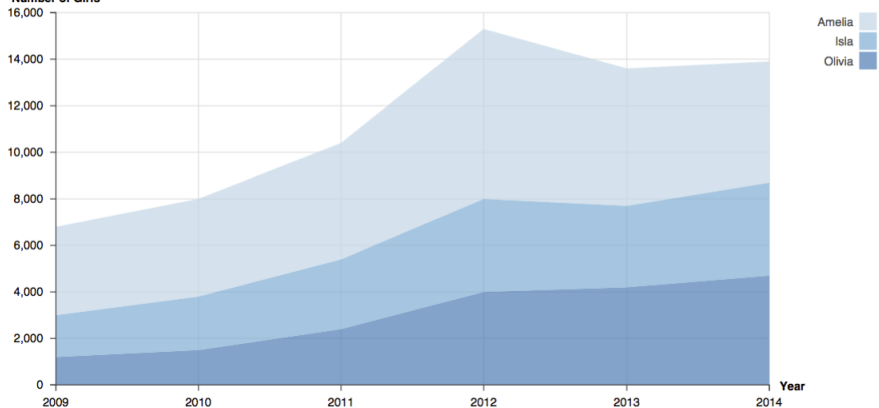
8,000

Omit

## Item 41

# Popular Girls' Names in the UK

Number of Girls



About what was the ratio of the number of girls named 'Olivia' to those named 'Isla' in 2014 in the UK?

1 to 1

1 to 2

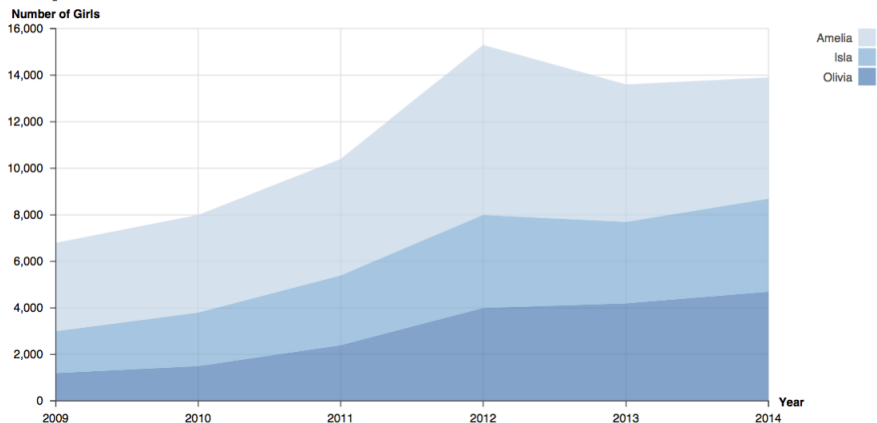
1 to 3

1 to 4

Omit

## Item 42

# Popular Girls' Names in the UK



Over the course of years between 2009 and 2014, when was the number of girls named 'Amelia' at the maximum?

2009

2011

2012

2014

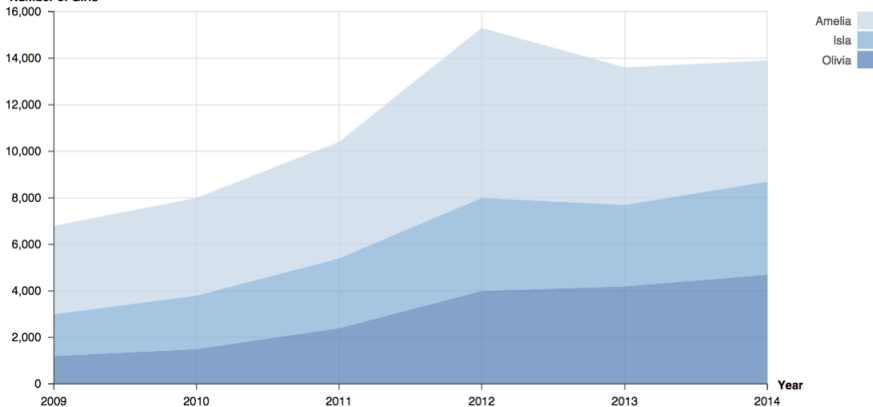
Omit



## Item 44

# Popular Girls' Names in the UK

Number of Girls



The number of girls named 'Isla' was \_\_\_\_\_ from 2009 to 2012.

rising

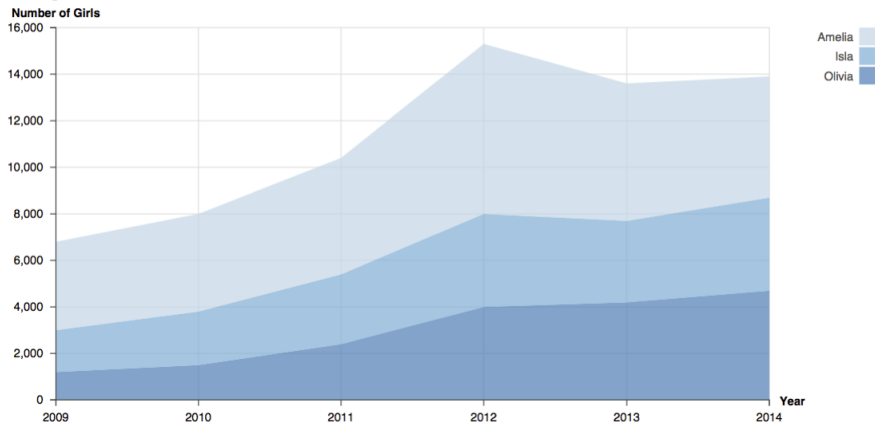
falling

staying

Omit

## Item 45

# Popular Girls' Names in the UK



In the UK, the number of girls named 'Amelia' in 2014 was more than it was in 2013,

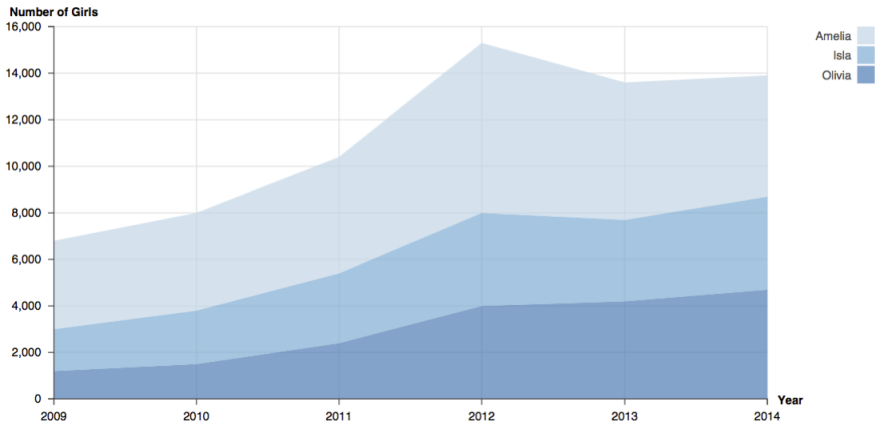
True

False

Omit

## Item 46

# Popular Girls' Names in the UK



Over the course of years between 2009 and 2014, the number of girls named 'Isla' was always more than 'Olivia'.

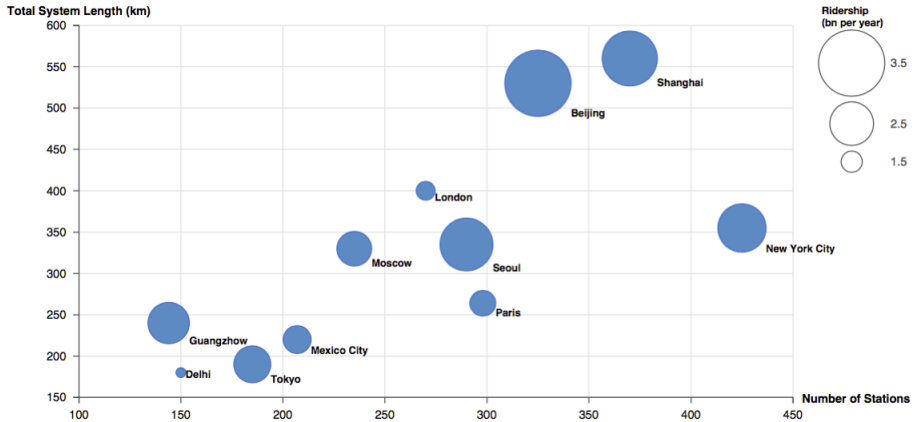
True

False

Omit

## Item 47

# Metro Systems of the World



What is the total length of the metro system in Beijing?

330 km

400 km

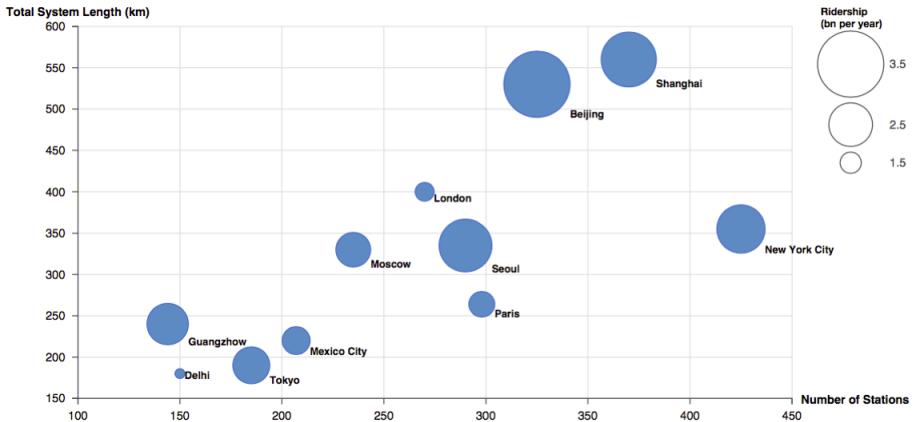
530 km

560 km

Omit

## Item 48

# Metro Systems of the World



Which city's metro system has the largest number of stations?

Seoul

Beijing

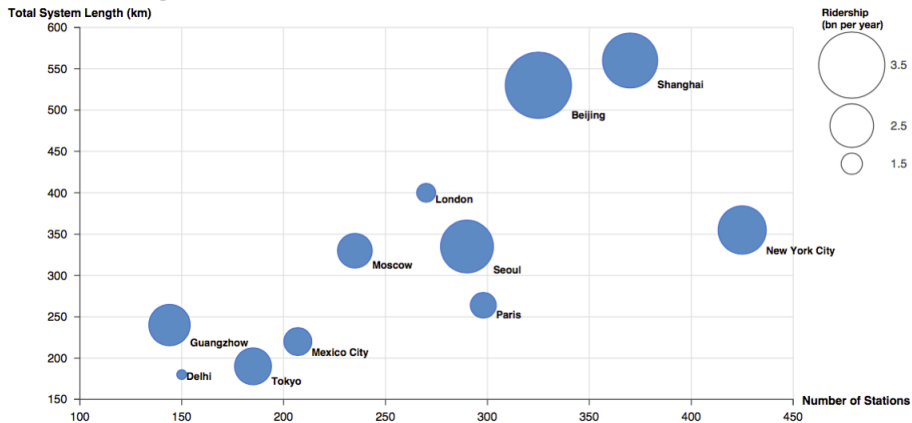
New York City

Shanghai

Omit

## Item 49

# Metro Systems of the World



What is the range of the total length of the metro systems?

150 - 600 km

240 - 380 km

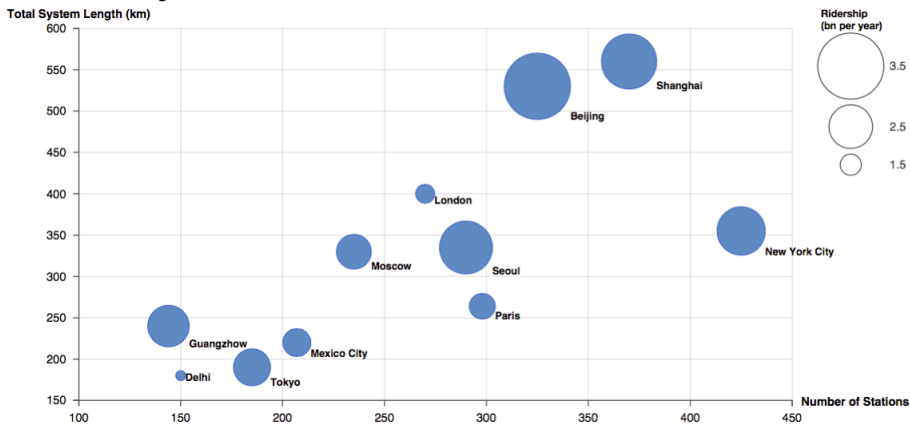
240 - 560 km

180 - 560 km

Omit

## Item 51

# Metro Systems of the World



Which city's metro system does lie outside the relationship between the total system length and the number of stations most?

Tokyo

New York City

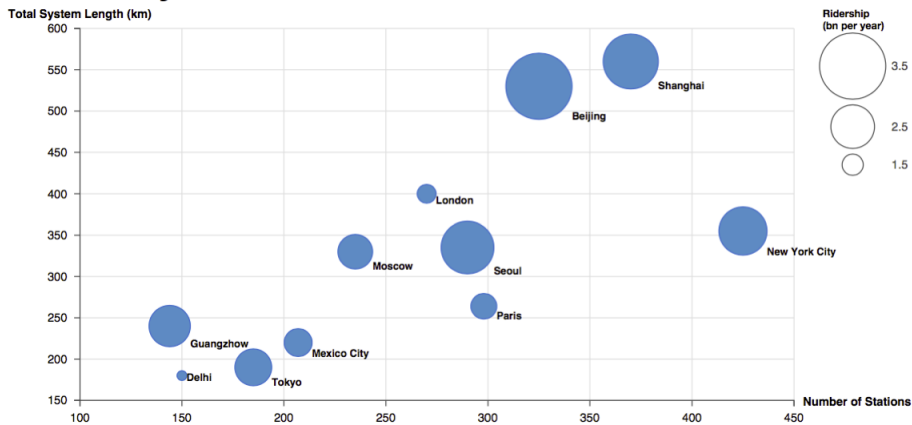
Beijing

London

Omit

## Item 52

# Metro Systems of the World



A group of the metro systems of the world has approximately 300 stations and around a 200 km system length.

True

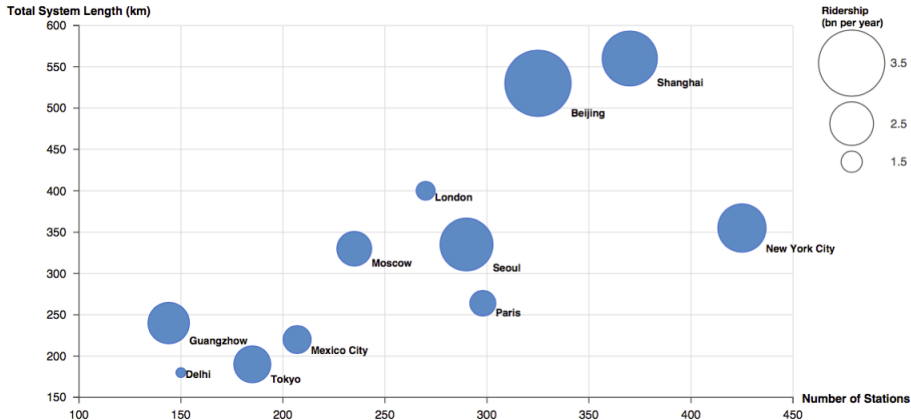
False

Omit



## Item 53

# Metro Systems of the World



In general, the ridership of the metro system increases as the number of stations increases.

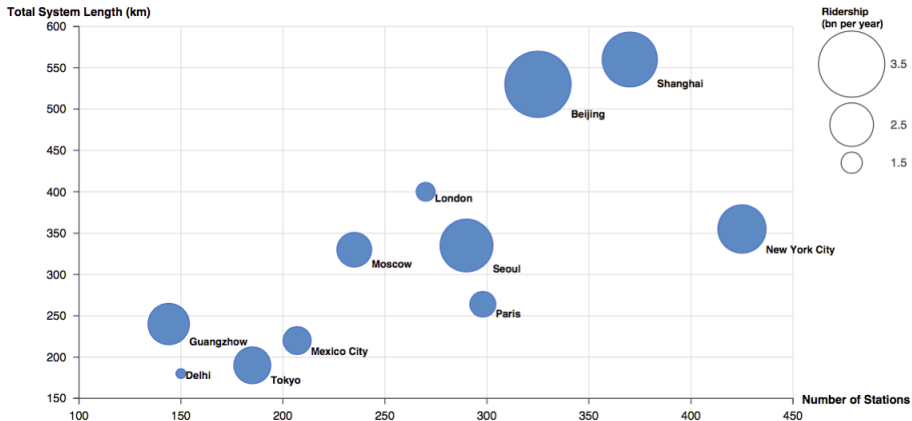
True

False

Omit

## Item 54

# Metro Systems of the World



The metro system in Shanghai has more ridership than the metro system in Beijing.

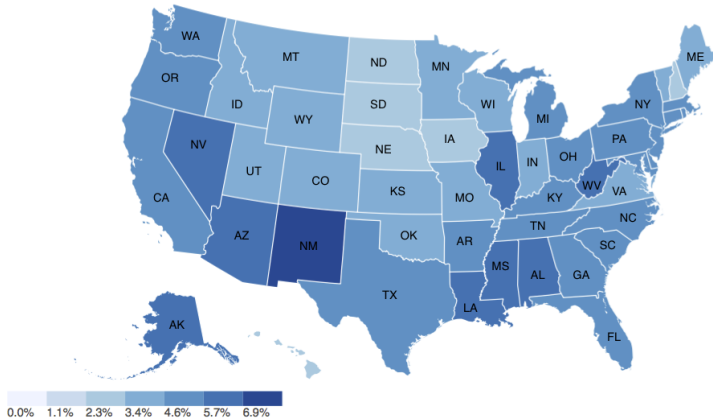
True

False

Omit

## Item 55

# Unemployment Rates for States in 2015



What was the unemployment rate for Indiana (IN) in 2015?

1.1% - 2.3%

2.3% - 3.4%

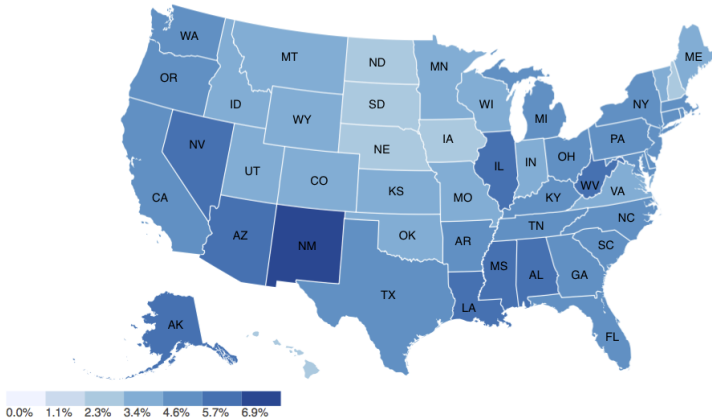
3.4% - 4.6%

4.6% - 5.7%

Omit

## Item 56

# Unemployment Rates for States in 2015



In which state was the unemployment rate the highest in 2015?

Alaska (AK)

New Mexico (NM)

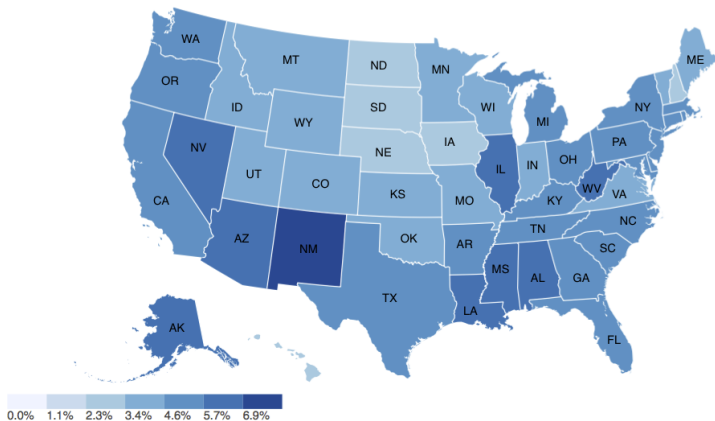
Florida (FL)

New York (NY)

Omit

Item 57

## Unemployment Rates for States in 2015



In 2015, the unemployment rate for Washington (WA) was higher than that of Wisconsin (WI).

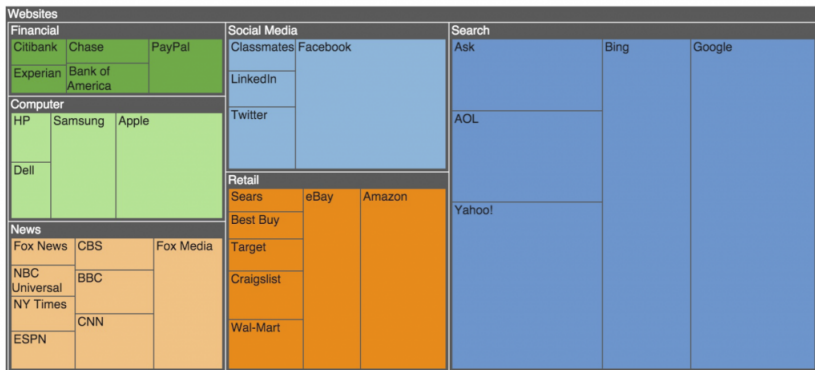
True

False

Omit

## Item 59

# The Number of Unique Visitors for Websites in 2010



For which website was the number of unique visitors the largest in 2010?

Facebook

Amazon

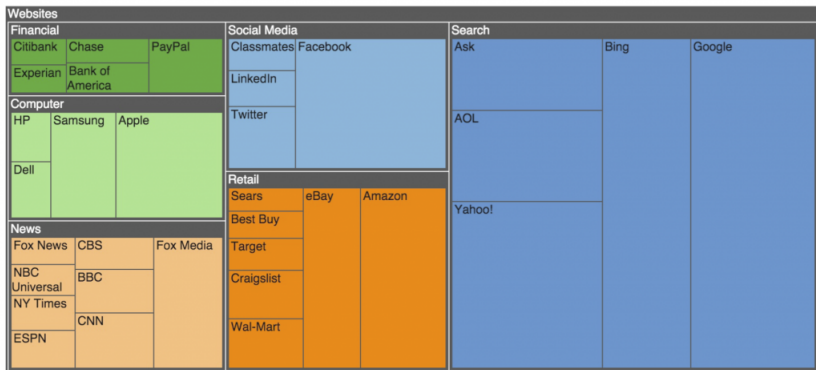
Bing

Google

Omit

## Item 60

# The Number of Unique Visitors for Websites in 2010



The number of unique visitors for Amazon was more than that of Yahoo in 2010.

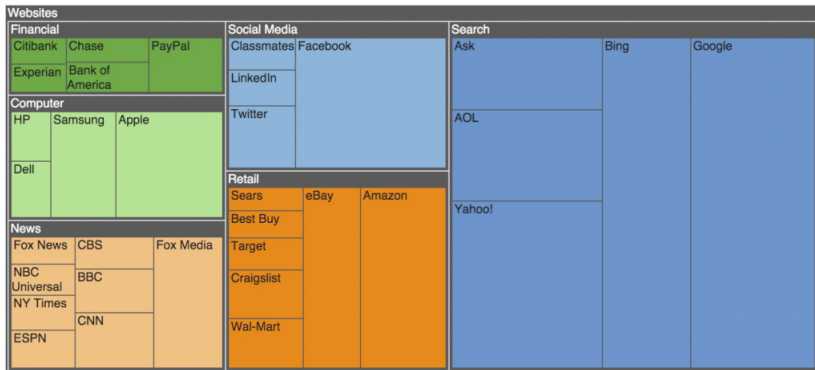
True

False

Omit

## Item 61

## The Number of Unique Visitors for Websites in 2010



Samsung is nested in the Financial category.

True

False

Omit



### The Summary of Difficulty Indexes (P)

Visualization	Visualization Task																	Average	
	Retrieve Value (Absolute Value)	Retrieve Value (Relative Value)	Retrieve Value (Derived Value)	Retrieve Value (Approximate Value)	Find Extremum (Absolute Value)	Find Extremum (Relative Value)	Find Extremum (Derived Value)	Find Extremum (Approximate Value)	Determine Range	Characterize Distribution	Find Anomalies	Find Clusters	Find Correlations/ Trends	Make Comparisons (Absolute Value)	Make Comparisons (Relative Value)	Make Comparisons (Derived Value)	Make Comparisons (Approximate Value)		Identify the Hierarchical Structure
Line Chart	0.95				0.97				0.56				0.98	0.77					0.85
Bar Chart	0.88				0.98				0.54					0.4					0.70
Stacked Bar Chart	0.38	0.36			0.69									0.59	0.47				0.50
100% Stacked Bar Chart		0.49					0.9								0.54				0.64
Pie Chart		0.72			0.98										1				0.90
Histogram			0.84					0.94		0.16							0.86		0.70
Scatterplot	0.85				0.76				0.53		0.42	0.9	0.52	0.79					0.68
Area Chart	0.75				0.44				0.38				0.94						0.63
Stacked Area Chart	0.15	0.25			0.97								0.96	0.2	0.24				0.46
Bubble Chart	0.41				0.69					0.29	0.53	0.59	0.26	0.8					0.51
Choropleth Map				0.24							0.97							0.92	0.71
Treemap						0.68									0.42			0.92	0.67
<b>Average</b>	0.62	0.46	0.84	0.24	0.79	0.85	0.94	0.97	0.46	0.16	0.48	0.75	0.73	0.59	0.53	0.86	0.92	0.92	