## INDEX

## A

actual measurement frequencies, 130, 131
alpha value ( $\alpha$ ), 159, 163
alternative hypothesis
accuracy of, 166
considerations, 174
Cramer's coefficient, 186
examples of, 161, 171-173
overview, 170-174
P-value and, 175-179
test of difference between population ratios, 173
arithmetic mean, 43, 73, 74
average (mean). See mean
AVERAGE function, 196
average savings, 46-47

## c

calculations. See Excel calculations
categorical data, 14-29
correlation ratio, 121
creating tables, 60-64
cylinder charts, 114
defined, 19
examples of, 20, 23-26
indexes, 117
overview, 14-19
as result of survey, 60-64
scatter charts, 114
charts
converting to graphs, 33-39
correlation ratio, 126
cylinder, 114
degree of relation and, 115
expenditure, 116-120
scatter. See scatter charts
CHIDIST function, 107
CHIINV function, 107, 205-206
chi-square distribution, 99-105
calculating, 130-133
degrees of freedom, 99-108
described, 99
examples of, 99-105, 152
points on horizontal axis, 205-206
chi-square symbol, 103
chi-square test of independence, 151-169

CHITEST function, 210-211
class midpoint, 36-39, 54, 56 classes
calculating with Sturges' Rule, 55, 56, 58
intraclass variance, 117, 123, 124, 126
range of, 39, 54-57, 84
coefficient
correlation, 116-120, 206-207
Cramer's. See Cramer's coefficient
CORREL function, 207
correlation, 115, 119
correlation coefficient, 116-120, 206-207
correlation ratio, 117, 121-127, 207
COUNTIF function, 197-198
Cramer's coefficient, 127-138 accuracy of, 147
alternative hypothesis, 186
calculating, 130-135, 141
examples of, 127-136
Excel and, 207
indexes, 117, 129
informal standard, 136
making informed decision about, 147-148
null hypothesis, 168, 186
ratio of preference, 155
variances in population, 145-150, 157, 186
Cramer's V. See Cramer's coefficient
critical region, 159, 165-167, 187
cross tabulation, 62-64, 128, 130,
$135,151,153,197-198$
curve, grading on. See standard scores
cylinder charts, 114
D
data
categorical. See categorical data
collection of, 186
immeasurable. See categorical data numerical. See numerical data "scattering of," $49,58,69,70,80$
unsuitable for correlation coefficient, 120
data point, 80
data types, 13-29, 117
degree of relation, 115, 116-120
degrees of freedom (df), 99-108
descriptive statistics, 57-58
deviation, standard, 48-53, 70-79
deviation scores, 74-80, 199-203
df (degrees of freedom), 99-108
distributions
chi-square. See chi-square distribution
Excel and, 107-109
F, 106-107
normal, 86-91
standard normal, 89-98, 204-205
t, 106

## $E$

estimation theory, 57-58
Euler's number, 86
Excel calculations, 191-211
chi-square distribution, 205-206
correlation coefficient, 206-207
cross tabulation, 197-198
deviation scores, 74-80, 199-203
distributions and, 107-109
frequency tables, 192-195
mean, 195-196
median, 195-196
standard deviation, 195-196
standard normal distribution, 204-205
standard scores, 199-202
tests of independence, 208-211
Excel files, downloading, 192
Excel functions
AVERAGE, 196
CHIDIST, 107
CHIINV, 107, 205-206
CHITEST, 210-211
CORREL, 207
COUNTIF, 197-198
FDIST, 107
FINV, 107
FREQUENCY, 193-194
NORMDIST, 107
NORMINV, 107
NORMSDIST, 107, 204
NORMSINV, 107

```
Excel functions, continued STANDARDIZE, 199-201 TDIST, 107
expected frequencies, 130, 131
expenditure chart, 116-120
```


## $F$

F distribution, 106-107
FDIST function, 107
FINV function, 107
freedom, degrees of, 99-108
frequency
actual, 130, 131
described, 36
distribution tables, 32-39
expected, 130, 131
relative, 36-37, 39
FREQUENCY function, 193-194
frequency tables
creating with Excel, 192-195
range of class of, 54-56

## $G$

geometric mean, 43
grading on a curve. See standard scores
graphs
converting price charts to, 33-39
converting surveys to, 62-64
shape of, 100-101
slope of, 101

## H

harmonic mean, 43
histograms
advantages of, 83
examples of, 39, 83, 84, 154
overview of, 38-39
probability density function, 83-84
range of class and, 84,85
variables, 39
homogeneity, test of, 184-186
horizontal axis, $39,102,107,109,125$
calculating points on, 107
hypothesis tests, 143-189. See also tests of independence
alternative hypothesis. See alternative hypothesis
chi-square test of independence, 151-169
conclusions, 187
defined, 149
examples of, 149, 168-174
null hypothesis. See null hypothesis
overview of, 144-150
population considerations, 149, 186
procedure for, 150, 175-179
P-value, 163, 175-179, 189
tests of correlation, 149, 171
tests of correlation ratio, 149, 171
tests of difference between population means, 149, 171, 173
tests of difference between population ratios, 149, 171, 173
tests of homogeneity, 184-186
tests of independence, 149, 171
types of, 149, 171

## I

immeasurable data. See categorical data
independent coefficient. See Cramer's coefficient
indexes
correlation coefficient, 120
Cramer's coefficient, 117, 129
numerical data, 117
intraclass variance, 117, 123, 124, 126

## $L$

linear relationships, 120

## M

mean (average)
arithmetic, 43, 73, 74
calculating with Excel, 195-196
defined, 43
examples, 40-44
geometric, 43
harmonic, 43
normal distribution and, 87-89
standard normal distribution and, 89-90
median
calculating with Excel, 195-196
defined, 45
examples of, 45-47
uses for, 44
Microsoft Excel. See Excel calculations,
Excel files, and Excel functions
midpoint, class, 36-39, 54, 56
multiple-choice answers, 28

## N

Napier's constant, 86
negative correlation, 119
non-linear relationships, 120
normal distribution, 86-91
normalization, 71-72
NORMDIST function, 107
NORMINV function, 107
NORMSDIST function, 107, 204
NORMSINV function, 107
null hypothesis
considerations, 174
Cramer's coefficient, 168, 186
difficulty of proving, 174
examples of, 167-174
failing to reject, 150, 167, 178, 179, 187
overview, 170-174
P-value and, 175-179
rejecting, 158, 159, 178
for tests of correlation, 172
for tests of correlation ratio, 172
for tests of difference between population ratios, 173
for tests of independence, 172
numerical data, 14-29
correlation ratio, 121
defined, 19
descriptive statistics, 57-58
estimation theory, 57-58
examples of, 21-23, 26
frequency tables, 32-39, 54-56, 58
histograms, 38-39, 54, 58
indexes, 117
mean (average), 40-43
median, 44-47
overview, 31-58
scatter charts, 114
standard deviation, 48-53, 70-79
$P$
Pearson's chi-square test statistic, 132, 152-155, 158
percentage, 5, 37, 62, 64
population
Cramer's coefficient, 145-150, 157, 186
defined, 6
hypothesis tests and, 149, 186
vs. sample, 52
standard deviation, 52
status of, 4, 7, 57
variances in, 145-150, 157, 186
population ratios, 149, 171, 173
positive correlation, 119
price charts, 33-39
probability, 81-109
associated, 104
chi-square distribution, 99-105, 205-206
defined, 82
degrees of freedom (df), 99-108
distributions and Excel, 107-109
F distribution, 106-107
normal distribution, 86-89
standard normal distribution, 89-98, 204-205
t distribution, 106
test results, 83-84
probability density function, 82-85, 99 , 107, 109
P-value
alternative hypothesis and, 175-179
hypothesis tests, 163, 175-179, 189
null hypothesis and, 175-179
tests of independence, 175

## Q

qualitative data. See categorical data quantitative data. See numerical data questionnaires, 15-19

## R

range, class, 39, 54-57, 84
relationships
correlation ratio, 117, 121-127
degree of, 115, 116-120
linear, 120
non-linear, 120
variables, 112-115
relative frequency, 36-37, 39

## $S$

samples, 6, 7, 52, 57
scatter charts
correlation ratio, 122, 126
examples of, 114, 116
monthly expenditures, 116-120
scattering, of data, 49, 58, 69, 70, 80
scores
deviation, 74-80
evaluating, 71
standard, 65-80, 73, 199-202
significance level ( $\alpha$ ), 159, 163
slope, graph, 101
standard deviation
calculating with Excel, 195-196
normal distribution and, 87-91
numerical data, 48-53, 70-79
population, 52
standard normal distribution and, 89-90
standard normal distribution, 89-98, 204-205
standard scores, 65-80, 73, 199-202
standardization, 71-72, 80
STANDARDIZE function, 199-201
statistical hypothesis testing. See hypothesis tests
statistical significance, 187
statistics
defined, 4
descriptive, 57-58
estimation theory, 4-7
STEP test, 23-25
Sturges' Rule, 55, 56, 58
surveys, 4-7
categorical data, 60-64
converting to graphs, 62-64
limitations of, 4-7
tests of independence, 137, 208-211

## $T$

t distribution, 106
tables
categorical data, 60-64
chi-square distribution, 102-105, 205-206
cross tabulation, 128, 130, 135, 151, 153
frequency. See frequency tables
normal distribution and, 107
standard normal distribution, 92-93, 104, 108
TDIST function, 107
test results
normal distribution, 86-89
probability density function, 83-84
standard normal distribution, 89-98
tests of correlation, 149, 171, 172
tests of correlation ratio, 149, 171, 172
tests of difference between population means, 149, 171, 173
tests of difference between population ratios, 149, 171, 173
tests of homogeneity, 184-186
tests of independence, 208-211. See also hypothesis tests
chi-square, 151-169
examples of, 149, 171, 184-186
P-value, 175
vs. tests of homogeneity, 186
uses for, 137, 149
TINV function, 107

## V

values
median, 44-47
P-value, 163, 175-179, 189
variables, 111-142
correlation coefficient, 116-120
correlation ratio, 121-127
Cramer's coefficient, 127-138, 141, 142
degree of relation, 115, 116-120
histograms, 39
relationships, 112-115
vertical axis, 39

## W

weather forecasts, 82

## Z

zero correlation, 119
z-score. See standard scores

