Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

1. Under H0, X is Binomial(n=20, p=0.4); observe x=10. Test HA: p is not 0.4 at alpha=0.1. Compute the exact p-value, critical region, and conclusion.

Assumptions: There are 20 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,20: 0.0000365616, 0.0004874878, 0.0030874227, 0.0123496907, 0.0349907904, 0.0746470195, 0.1244116992, 0.1658822656, 0.1797057878, 0.1597384780, 0.1171415505, 0.0709948791, 0.0354974396, 0.0145630521, 0.0048543507, 0.0012944935, 0.0002696862, 0.0000423037, 0.0000047004, 0.0000003299, 0.0000000110. Two-sided extremeness includes exactly outcomes with P0(X=x)<=P0(X=observed), using unrounded probabilities for ordering.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

2. **Data are 22, 23, 24, 25, 27. With known sigma=4, test H0: mu=21 against HA: mu>mu0 at alpha=0.01.**

Assumptions: The observations are independent and normal, or n is adequate for the mean; population sigma is known.

Reference: Normal reference at printed z=1.788854382: P(Z>=|z|)=0.0368190849. Critical z=2.326347015.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

3. **Under H0, X is Binomial(n=11, p=0.6); observe x=4. Test HA: p<0.6 at alpha=0.05. Compute the exact p-value, critical region, and conclusion.**

Assumptions: There are 11 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,11: 0.0000419430, 0.0006920602, 0.0051904512, 0.0233570304, 0.0700710912, 0.1471492915, 0.2207239373, 0.2364899328, 0.1773674496, 0.0886837248, 0.0266051174, 0.0036279706. Use the directed tail including the observed count.

Name the conditioning distribution, show the statistic and df, then state a contextual decision.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

4. **A sample has x-bar=25.1, n=16. With known sigma=6, test H0: mu=23 against HA: mu<mu0 at alpha=0.1.**

Assumptions: The observations are independent and normal, or n is adequate for the mean; population sigma is known.

Reference: Normal reference at printed z=1.400000000: Phi(z)=0.9192432862. Critical z=-1.281551956.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

5. **Under H0, X is Binomial(n=13, p=0.4); observe x=8. Test HA: p>0.4 at alpha=0.01. Compute the exact p-value, critical region, and conclusion.**

Assumptions: There are 13 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,13: 0.0013060694, 0.0113192681, 0.0452770726, 0.1106772886, 0.1844621476, 0.2213545771, 0.1967596241, 0.1311730827, 0.0655865414, 0.0242913116, 0.0064776831, 0.0011777606, 0.0001308623, 0.0000067109. Use the directed tail including the observed count.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

6. **Under H0, X is Binomial(n=14, p=0.5); observe x=10. Test HA: p>0.5 at alpha=0.05. Compute the exact p-value, critical region, and conclusion.**

Assumptions: There are 14 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,14: 0.0000610352, 0.0008544922, 0.0055541992, 0.0222167969, 0.0610961914, 0.1221923828, 0.1832885742, 0.2094726563, 0.1832885742, 0.1221923828, 0.0610961914, 0.0222167969, 0.0055541992, 0.0008544922, 0.0000610352. Use the directed tail including the observed count.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

7. **A sample has x-bar=23.7, n=16. With known sigma=9, test H0: mu=26 against HA: mu<mu0 at alpha=0.1.**

Assumptions: The observations are independent and normal, or n is adequate for the mean; population sigma is known.

Reference: Normal reference at printed z=-1.022222222: Phi(z)=0.1533378861. Critical z=-1.281551956.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

8. **Under H0, X is Binomial(n=16, p=0.3); observe x=7. Test HA: p is not 0.3 at alpha=0.01. Compute the exact p-value, critical region, and conclusion.**

Assumptions: There are 16 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,16: 0.0033232931, 0.0227882952, 0.0732480919, 0.1464961837, 0.2040482559, 0.2098782061, 0.1649043048, 0.1009618193, 0.0486780200, 0.0185440076, 0.0055632023, 0.0013004888, 0.0002322302, 0.0000306238, 0.0000028124, 0.0000001607, 0.0000000043. Two-sided extremeness includes exactly outcomes with P0(X=x)<=P0(X=observed), using unrounded probabilities for ordering.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

1. Under H0, X is Binomial(n=20, p=0.4); observe x=10. Test HA: p is not 0.4 at alpha=0.1. Compute the exact p-value, critical region, and conclusion.

Assumptions: There are 20 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,20: 0.0000365616, 0.0004874878, 0.0030874227, 0.0123496907, 0.0349907904, 0.0746470195, 0.1244116992, 0.1658822656, 0.1797057878, 0.1597384780, 0.1171415505, 0.0709948791, 0.0354974396, 0.0145630521, 0.0048543507, 0.0012944935, 0.0002696862, 0.0000423037, 0.0000047004, 0.0000003299, 0.0000000110. Two-sided extremeness includes exactly outcomes with P0(X=x)<=P0(X=observed), using unrounded probabilities for ordering.

Answer: p=0.3703; critical region {0,1,2,3,4,13,14,15,16,17,18,19,20}; Fail to reject H0 at alpha=0.1; the data do not establish that H0 is true.

1. Included outcomes: {0,1,2,3,4,5,10,11,12,13,14,15,16,17,18,19,20}.
2. Sum their printed ten-decimal table entries: p=0.3702617694, which rounds to 0.3703.
3. The alpha-0.1 critical region is {0,1,2,3,4,13,14,15,16,17,18,19,20}. Fail to reject H0 at alpha=0.1; the data do not establish that H0 is true.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

2. **Data are 22, 23, 24, 25, 27. With known sigma=4, test H0: mu=21 against HA: mu>mu0 at alpha=0.01.**

Assumptions: The observations are independent and normal, or n is adequate for the mean; population sigma is known.

Reference: Normal reference at printed z=1.788854382: P(Z>=|z|)=0.0368190849. Critical z=2.326347015.

Answer: z=1.7889, p=0.0368; critical region z>2.326347015; Fail to reject H0 at alpha=0.01; the data do not establish that H0 is true.

1. x-bar=24.2 from the printed data.
2. z=(24.2-21)/(4/sqrt(5))=1.788854382.
3. Use the printed normal reference to get p=0.0368190849. Reject for z>2.326347015. Fail to reject H0 at alpha=0.01; the data do not establish that H0 is true.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

3. Under H0, X is Binomial(n=11, p=0.6); observe x=4. Test HA: p<0.6 at alpha=0.05. Compute the exact p-value, critical region, and conclusion.

Assumptions: There are 11 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,11: 0.0000419430, 0.0006920602, 0.0051904512, 0.0233570304, 0.0700710912, 0.1471492915, 0.2207239373, 0.2364899328, 0.1773674496, 0.0886837248, 0.0266051174, 0.0036279706. Use the directed tail including the observed count.

Answer: p=0.0994; critical region {0,1,2,3}; Fail to reject H0 at alpha=0.05; the data do not establish that H0 is true.

1. Included outcomes: {0,1,2,3,4}.
2. Sum their printed ten-decimal table entries: p=0.0993525760, which rounds to 0.0994.
3. The alpha-0.05 critical region is {0,1,2,3}. Fail to reject H0 at alpha=0.05; the data do not establish that H0 is true.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

4. **A sample has x-bar=25.1, n=16. With known sigma=6, test H0: mu=23 against HA: mu<mu0 at alpha=0.1.**

Assumptions: The observations are independent and normal, or n is adequate for the mean; population sigma is known.

Reference: Normal reference at printed z=1.400000000: Phi(z)=0.9192432862. Critical z=-1.281551956.

Answer: z=1.4000, p=0.9192; critical region z<-1.281551956; Fail to reject H0 at alpha=0.1; the data do not establish that H0 is true.

1. Use the supplied summary.
2. z=(25.1-23)/(6/sqrt(16))=1.400000000.
3. Use the printed normal reference to get p=0.9192432862. Reject for z<-1.281551956. Fail to reject H0 at alpha=0.1; the data do not establish that H0 is true.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

5. **Under H0, X is Binomial(n=13, p=0.4); observe x=8. Test HA: p>0.4 at alpha=0.01. Compute the exact p-value, critical region, and conclusion.**

Assumptions: There are 13 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,13: 0.0013060694, 0.0113192681, 0.0452770726, 0.1106772886, 0.1844621476, 0.2213545771, 0.1967596241, 0.1311730827, 0.0655865414, 0.0242913116, 0.0064776831, 0.0011777606, 0.0001308623, 0.0000067109. Use the directed tail including the observed count.

Answer: p=0.0977; critical region {10,11,12,13}; Fail to reject H0 at alpha=0.01; the data do not establish that H0 is true.

1. Included outcomes: {8,9,10,11,12,13}.
2. Sum their printed ten-decimal table entries: p=0.0976708699, which rounds to 0.0977.
3. The alpha-0.01 critical region is {10,11,12,13}. Fail to reject H0 at alpha=0.01; the data do not establish that H0 is true.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

6. Under H0, X is Binomial(n=14, p=0.5); observe x=10. Test HA: p>0.5 at alpha=0.05. Compute the exact p-value, critical region, and conclusion.

Assumptions: There are 14 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,14: 0.0000610352, 0.0008544922, 0.0055541992, 0.0222167969, 0.0610961914, 0.1221923828, 0.1832885742, 0.2094726563, 0.1832885742, 0.1221923828, 0.0610961914, 0.0222167969, 0.0055541992, 0.0008544922, 0.0000610352. Use the directed tail including the observed count.

Answer: p=0.0898; critical region {11,12,13,14}; Fail to reject H0 at alpha=0.05; the data do not establish that H0 is true.

1. Included outcomes: {10,11,12,13,14}.
2. Sum their printed ten-decimal table entries: p=0.0897827149, which rounds to 0.0898.
3. The alpha-0.05 critical region is {11,12,13,14}. Fail to reject H0 at alpha=0.05; the data do not establish that H0 is true.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

7. **A sample has x-bar=23.7, n=16. With known sigma=9, test H0: mu=26 against HA: mu<mu0 at alpha=0.1.**

Assumptions: The observations are independent and normal, or n is adequate for the mean; population sigma is known.

Reference: Normal reference at printed z=-1.022222222: Phi(z)=0.1533378861. Critical z=-1.281551956.

Answer: z=-1.0222, p=0.1533; critical region z<-1.281551956; Fail to reject H0 at alpha=0.1; the data do not establish that H0 is true.

1. Use the supplied summary.
2. z=(23.7-26)/(9/sqrt(16))=-1.022222222.
3. Use the printed normal reference to get p=0.1533378861. Reject for z<-1.281551956. Fail to reject H0 at alpha=0.1; the data do not establish that H0 is true.

Name _____ Score _____ Teacher _____ Date _____

Exact Binomial and Known-Sigma z Tests

Worked Answer Key

For exact two-sided tests, include outcomes whose null probability is no larger than the observed outcome. For z tests, sigma is known.

8. Under H0, X is Binomial(n=16, p=0.3); observe x=7. Test HA: p is not 0.3 at alpha=0.01. Compute the exact p-value, critical region, and conclusion.

Assumptions: There are 16 independent binary trials with one common success probability.

Reference: Exact null table P0(X=x), x=0,...,16: 0.0033232931, 0.0227882952, 0.0732480919, 0.1464961837, 0.2040482559, 0.2098782061, 0.1649043048, 0.1009618193, 0.0486780200, 0.0185440076, 0.0055632023, 0.0013004888, 0.0002322302, 0.0000306238, 0.0000028124, 0.0000001607, 0.0000000043. Two-sided extremeness includes exactly outcomes with P0(X=x)<=P0(X=observed), using unrounded probabilities for ordering.

Answer: p=0.2747; critical region {0,11,12,13,14,15,16}; Fail to reject H0 at alpha=0.01; the data do not establish that H0 is true.

1. Included outcomes: {0,1,2,7,8,9,10,11,12,13,14,15,16}.
2. Sum their printed ten-decimal table entries: p=0.2746730496, which rounds to 0.2747.
3. The alpha-0.01 critical region is {0,11,12,13,14,15,16}. Fail to reject H0 at alpha=0.01; the data do not establish that H0 is true.