1. It is well known that higher vertebrates – mammals and birds – exhibit lateralized behaviors; in humans this is referred to as “handedness.” An investigator recently observed the coiling behavior of cottonmouth snakes. He created a “laterality index” that measured the tendency for snakes to coil clockwise or counterclockwise. If the snakes failed to exhibit laterality they would have a laterality index equal to 0.5. The investigator wishes to determine whether juvenile cottonmouths exhibit handedness.

   a) What is the appropriate null hypothesis in this study? \( H_0: p = 0.5 \)

   b) What is the appropriate alternative hypothesis in this study? \( H_a: p \neq 0.5 \)

   c) In the context of this study, describe a Type I and a Type II error.

2. In cities and towns on the borders between states there is “flight” across state lines to avoid high state taxes on gasoline. Some states have large rivers for borders and tolls to cross bridges. Do these tolls impede traffic to other states to buy cheaper gasoline? To test this hypothesis, an experimental Toll-Free Week will be instituted at the Farmington Bridge in Iowa, where currently approximately 50 cars per day drive back and forth. Let \( \mu \) denote the true average number of border crossings per day at Farmington if there were no toll.

   a) What is the appropriate null hypothesis in this study? \( H_0: \mu = 50 \)

   b) What is the appropriate alternative hypothesis in this study? \( H_a: \mu > 50 \)

   c) In the context of this study, describe a Type I and a Type II error.

   Say \( \mu \) is 50 or less
   When in fact it's more than 50

   Say \( \mu > 50 \)
   When in fact it's 50 or less
3. Bats are nocturnal mammals, feeding on insects at night and sleeping during the day. Many species of bats use bridges as daytime sleeping places. Their choice of daytime position on the underside of a bridge appears to be non-random. One theory is that the bats choose locations that will keep them safer from predators. The beams that support a bridge create two kinds of spaces: wide (approximately 55 cm) and narrow (approximately 17 cm); biologists believe the narrow spaces provide more safety. Investigators studying the sleeping position choices of the Big-eared Bat (*Corynorhinus rafinesquii*) observed that 67 out of 102 of them were in narrow beam spaces. The narrow beam spaces accounted for approximately 46% of the available area under the bridges. Does this sample provide sufficient evidence that the bats prefer narrow over wide sleeping space? Use a significance level of .05 to test the appropriate hypothesis.

**Assumptions**
- (1) Random
- (2) n is < 10% of pop.
- (3) np ≥ 10 and n(1-p) ≥ 10

\[ n = 102, \hat{p} = 67/102 \]

**Null Hypothesis**

\[ H_0: p = .46 \]

**Alternative Hypothesis**

\[ H_a: p > .46 \]

\[ Z = \frac{\hat{p} - p}{\sqrt{\frac{p(1-p)}{n}}} = \frac{.67 - .46}{\sqrt{\frac{.46(.54)}{102}}} = 4.05 \]

\[ P-value = \text{normal cdf}(4.05, 10000, 0, 1) \]

\[ .000000256 < .05 \]

There is convincing evidence that the proportion of bats that prefer narrow spaces is > .46.

4. A boat manufacturer claims that a particular boat and motor combination will burn less than 4.0 gallons of fuel per hour. Fuel consumption for a random sample of 10 similar boats resulted in the data below:

<table>
<thead>
<tr>
<th>Input</th>
<th>4.06, 4.29, 4.26, 4.64, 4.23, 3.93, 3.64, 4.13, 3.93, 3.86</th>
</tr>
</thead>
</table>

\[ n = 10 \]

\[ \bar{x} = 4.097 \]

\[ S = .279 \]

Is there sufficient evidence to conclude that the manufacturer's claim is correct? Use \( \alpha = .05 \) and test the appropriate hypothesis.

**Null Hypothesis**

\[ H_0: \mu = 4.0 \]

**Alternative Hypothesis**

\[ H_a: \mu < 4.0 \]

\( t = \frac{\bar{x} - \mu}{S/\sqrt{n}} = \frac{4.097 - 4.0}{.279/\sqrt{10}} = 1.099 \]

\[ P-value = tcdf(-10000, 1.099, 9) = .0822 \]

There is not enough evidence to disprove manuf claim.
When performing tests of hypotheses, there are assumptions that must be met in order for the test to be appropriate. For the test of a hypothesis about a population proportion, describe how you would check the assumptions.

1. Random sample
2. \( n \leq 10\% \) population
3. \( np \geq 10 \) and \( n(1-p) \geq 10 \)

If \( \mu \)
1. Random
2. \( n \geq 30 \) ... if not ... check normality using normal prob. plot or boxplot

Hermit crabs fight for ownership of shells. Fights are initiated when one crab raps on the shell of another with its big claw. An exchange of shells occurs approximately 50% of the time. Investigators wish to see if the rapping force helps decide the issue. They set up an experiment with a rubberized shell, which would dampen the force of the rapping. They reason that the reduced force should result in fewer exchanges of shells. They then observed 59 fights to see how many shell exchanges occurred.

\( p = \) proportion of shell exchanges

a) What null and alternate hypotheses should the investigators use? In a few sentences, justify your choice of the alternative hypothesis

\( H_0: p = .5 \)
\( H_a: p < .5 \)

They want to see if the lessened force will result in fewer exchanges.

b) Describe a Type I and Type II error in this context.

Say a lessened force results in fewer exchanges when in fact it doesn't

Say a lessened force doesn't reduce exchanges when in fact it does.
A company provides portable walkie-talkies to construction crews. Their batteries last, on average, 55 hours of continuous use. The purchasing manager receives a brochure advertising a new brand of batteries with a lower price, but suspects that the lifetime of the batteries may be shorter than the brand currently in use. To test this, 8 randomly selected new brand batteries are installed in the same model radio. Here are the results for the lifetime of the batteries (in hours):

45 52 56 55 51 57 48 52

Is there sufficient evidence to conclude that the purchasing manager is correct in his conjecture that the new brand has a shorter average lifetime?

\[ H_0: \mu = 55 \]
\[ H_a: \mu < 55 \]

\[ t = \frac{\bar{x} - \mu}{s / \sqrt{n}} \]
\[ \bar{x} = 52 \]
\[ s = 4.071 \]

\[ t = \frac{52 - 55}{4.071 / \sqrt{8}} = \frac{-3}{1.439...} = -2.084 \]

\[ p\text{-value} = \text{tcdf}(-1000, -2.084, 7) = .0378 \]

\[ P < \alpha \quad \text{Reject } H_0 \]

\[ .0378 < .05 \]

There is evidence to support the managers claim that the avg battery life is less than 55 hrs.
In an analysis of hunting by African lions, biologists filmed prey captures from the safety of their vehicles. The capture of prey was divided into a sequence of events for study, one of which is the stalk, defined as the reduction of predator-prey distance for prey that has been specifically located and the prey is unaware of or minimally alarmed by the predator. The investigators identified two types of stalk: (a) "crouching," -- the lion is concealed and either the lion advances toward the prey or the prey advances (unaware) toward the lion, and (b) "running," -- the lion is less concealed and advances toward the prey in a rapid manner.

Data on lions' stalks of Thomson's and Grant's gazelles from a random sample of 151 kills appear in the table below.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Numeric value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean stalking time</td>
<td>24.9 min</td>
</tr>
<tr>
<td>Standard deviation of stalk time</td>
<td>3.0 min</td>
</tr>
<tr>
<td>Proportion of stalks of the crouching type</td>
<td>0.79</td>
</tr>
</tbody>
</table>

\[\bar{x} = 24.9, \quad s = 3.0, \quad \frac{\sum}{151} = 0.79\]

\[\mu = 25.6, \quad H_0: \mu = 25.6, \quad H_a: \mu \neq 25.6\]

a) On the basis of monitoring radio-collared lions for many years, biologists believe that the average stalking time for all prey is approximately 25.6 minutes. Do the data above provide evidence that for this population of lions the average time to stalk Thomson's and Grant's gazelles is different from what was originally thought?

\[t = \frac{\bar{x} - 25.6}{\frac{s}{\sqrt{n}}} = \frac{24.9 - 25.6}{\frac{3}{\sqrt{151}}} = -2.867\]

\[p = 0.0047 < 0.05\]

Reject \(H_0\)

b) The same monitoring of radio-collared lions over the years has suggested that the overall proportion of stalks that are the crouching type is about 0.87. Do the data above provide evidence that for this population of lions the proportion of crouching stalks of Thomson's and Grant's gazelles is less than what was originally thought?

\[\hat{p} = 0.79, \quad \hat{p} = 0.79\]

\[\alpha = 0.05\]

\[10\% \text{ pop} \]

\[np \geq 10, n(1-p) \geq 10\]

\[151(0.87), 151(0.13)\]

\[\hat{p} - 0.87 = \frac{0.79 - 0.87}{\sqrt{0.87(1-0.87)} \sqrt{151}} = -2.92\]

\[p = 0.0018 < 0.05\]

Reject \(H_0\)

\[p = \text{normal cdf}(-10000, -2.92, 0, 1) = 0.0018\]