Problem 1. Sarah wants to determine the average height of all students at Wittenberg University. In this context, what type of distribution is described in each of the scenarios below?

a. Sarah surveys 40 students at Wittenberg University and asks them their height.

b. Sarah and her 20 classmates each survey 40 students at Wittenberg University and ask them their height. Each person calculates the average of their sample.

c. Sarah surveys all the students at Wittenberg University and asks them their height.

a. Data Dist’n

b. Sampling Dist’n

c. Pop’n Dist’n
Problem 2. In a certain year, according to the National Census Bureau, the number of people living in a household had a mean of 4.2 and a standard deviation of 1.9. This is based on census information for the population. Suppose the Census Bureau instead had estimated this mean using a sample of 100 homes. Suppose the sample had a mean of 4.8 and a standard deviation of 1.5.

a. What is the mean of the population distribution?
b. What is the standard deviation of the population distribution?
c. What is the mean of the data distribution?
d. What is the standard deviation of the data distribution?
e. What is the mean of the sampling distribution?
f. What is the standard deviation of the sampling distribution?

\[ \mu = 4.2 \]
\[ \sigma = 1.9 \]
\[ \bar{X} = 4.8 \]
\[ s = 1.5 \]
\[ \text{mean} = \mu = 4.2 \]
\[ \text{Standard error} = \frac{\sigma}{\sqrt{n}} = \frac{1.9}{\sqrt{100}} = \frac{1.9}{10} = 0.19 \]
Problem 3. The National Center for Health Statistics reports that the systolic blood pressure for all males 35-44 years old has a mean of 122 and a standard deviation of 12. The medical director of a very large company looks at the medical records of 100 randomly selected male executives in this age group and finds that the mean systolic blood pressure in this sample is $\bar{x} = 128.4$, with a standard deviation of 8.

a. What is the mean of the sampling distribution of $\bar{x}$?
b. What is the standard deviation of the sampling distribution of $\bar{x}$?
c. What is the shape of the sampling distribution of $\bar{x}$?

A. mean $= \mu = 122$

b. Standard error $= \frac{\sigma}{\sqrt{n}} = \frac{12}{\sqrt{100}} = \frac{12}{10} = 1.2$

C. $n=100 \rightarrow$ large sample

Sampling dist'n $\approx$ normal
Problem 4. A person’s blood pressure is monitored by taking 5 readings daily. The probability distribution of his readings has a mean of 130 and a standard deviation of 6. Suppose the population distribution of his blood pressure readings is normal.

a. What is the shape of the sampling distribution of $\bar{x}$ for a sample size of 5?
b. What is the probability that the sample mean exceeds 135 for a sample size of 5?

$$X = \text{blood pressure readings}$$

$$X \sim N(\mu = 130, \sigma = 6)$$

\[ a. \bar{X} \sim N(\text{mean} = 130, \text{std dev} = \frac{6}{\sqrt{5}}) \]

\[ b. P(\bar{X} > 135) \]

$$Z = \frac{135 - 130}{6/\sqrt{5}} = \frac{5}{2.6833} = 1.86$$

CP: $P(X < 135) = P(Z < 1.86) = 0.9686$

WTK: $P(\bar{X} > 135) = P(Z > 1.86)$

$$= 1 - P(Z < 1.86) = 1 - 0.9686 = 0.0314$$
Problem 5. Preschool aged children are on average 40 inches tall with a standard deviation of 3.1 inches. Heights are distributed approximately normally.

a. What is the probability that a randomly chosen preschool aged child is less than 37 inches tall?

b. Describe the sampling distribution of the mean height of 36 randomly chosen preschool aged children.

c. What is the probability that the mean height of 36 preschool aged children is less than 37 inches?

\[ z = \frac{37-40}{3.1} = \frac{-3}{3.1} = -0.97 \]

CP: \( P(X < 7) = P(z < -0.97) = 0.1660 \)

b. \( \bar{X} \sim \text{Normal} \left( \text{mean} = 40, \text{stdev} = \frac{3.1}{\sqrt{36}} = 0.5167 \right) \)

\[ z = \frac{37-40}{0.5167} = \frac{-3}{0.5167} = -5.81 \]

CP: \( P(\bar{X} < 7) = P(z < -5.81) \)
\[ P(z < -5.81) < 0.0002 \approx \phi \]
**Problem 6.** Jenna wants to know what the true average price of a gallon of gasoline in her city is, so she takes a random sample and creates a 95% confidence interval. The interval from her study is ($2.47, $2.85).

a. Based on her interval, is it plausible or possible that the true average price of a gallon of gasoline in her city is $2.99?

b. Based on her interval, is it plausible or possible that the true average price of a gallon of gasoline in her city is $2.59?

c. Based on her interval, is it plausible or possible that the true average price of a gallon of gasoline in her city is -$2.09?

\[ \begin{align*} 
\text{a. It is possible, but not plausible.} \\
\text{b. It is both possible and plausible.} \\
\text{c. Is neither possible nor plausible.} 
\end{align*} \]
Problem 7. Your local school board wants to determine the proportion of people who plan on voting for the school levy in the upcoming election. They conduct a random phone poll, where they contact 150 individuals and ask them whether or not they plan on voting for the levy. Of these 150 respondents, 78 people say they plan on voting for the levy. The school board wants to determine whether or not the data supports the idea that more than 50% of people plan on voting for the levy. **Create a 98% confidence interval for the true proportion of all people who plan on voting for the levy.**

a. What is the 98% confidence interval?

b. What is the correct interpretation of the confidence interval?

c. Are the assumptions met? Explain.

d. Based on the confidence interval, what can you say about the school board’s question?

\[
\hat{p} = \frac{78}{150} = 0.52
\]

\[
z^* = 2.326
\]

\[
n = 150
\]

\[
\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.52 \pm 2.326 \sqrt{\frac{0.52(1-0.52)}{150}}
\]

\[
0.52 \pm 1.236 \approx 0.4251 \text{ to } 0.6149
\]

**98% CI:** (0.4251, 0.6149)

**b. We are 98% confident that the true proportion of all people who plan on voting for the levy is between 0.4251 and 0.6149.**
Problem 7. Your local school board wants to determine the proportion of people who plan on voting for the school levy in the upcoming election. They conduct a random phone poll, where they contact 150 individuals and ask them whether or not they plan on voting for the levy. Of these 150 respondents, 78 people say they plan on voting for the levy. The school board wants to determine whether or not the data supports the idea that more than 50% of people plan on voting for the levy. **Create a 98% confidence interval for the true proportion of all people who plan on voting for the levy.**

a. What is the 98% confidence interval?  
b. What is the correct interpretation of the confidence interval?  
c. Are the assumptions met? Explain.  
d. Based on the confidence interval, what can you say about the school board’s question?

---

C. 1 Independence  
   - random ✓  
   - n < 10% pop'n? unknown

2 Success/failure  
   \[ \hat{p} \geq 10 \rightarrow (150)(0.52) = 78 \geq 10 \]  
   \[ n(1-p) \geq 10 \rightarrow (150)(0.48) = 72 \geq 10 \]

d. 98% CI: (0.4251, 0.6149)  
   Interval includes: values < 0.50  
   We don't know if > 50% will vote for levy.

We don't know if > 50% will vote for levy.

value = 0.50  
values > 0.50
Problem 8. Your local school board wants to determine the proportion of people who plan on voting for the school levy in the upcoming election. They conduct a random phone poll, where they contact 150 individuals and ask them whether or not they plan on voting for the levy. Of these 150 respondents, 78 people say they plan on voting for the levy. The school board wants to determine whether or not the data supports the idea that more than 50% of people plan on voting for the levy. **Conduct a hypothesis test at the 0.05 significance level to test this claim.**

a. What are the hypotheses?
b. What is the significance level?
c. What is the value of the test statistic?
d. What is the p-value?
e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?
g. Are the assumptions met? Explain.

\[ H_0 : \hat{p} = 0.50 \quad \text{[null value:]} \quad \hat{p}_0 = 0.50 \]
\[ H_A : \hat{p} > 0.50 \]
\[ \alpha = 0.05 \]

\[ \text{TS: } \frac{\hat{p} - \hat{p}_0}{\sqrt{\frac{\hat{p}_0(1-\hat{p}_0)}{n}}} = \frac{0.52 - 0.50}{\sqrt{\frac{0.50(1-0.50)}{150}}} = \frac{0.02}{0.0408} = \frac{0.49}{0.49} \]
Problem 8. Your local school board wants to determine the proportion of people who plan on voting for the school levy in the upcoming election. They conduct a random phone poll, where they contact 150 individuals and ask them whether or not they plan on voting for the levy. Of these 150 respondents, 78 people say they plan on voting for the levy. The school board wants to determine whether or not the data supports the idea that more than 50% of people plan on voting for the levy. Conduct a hypothesis test at the 0.05 significance level to test this claim.

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e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?
g. Are the assumptions met? Explain.

\[
d. P(\hat{p} > 0.52 | p = 0.50) = P(Z > 0.49) \]
\[
CP: P(Z < 0.49) = 0.6879
\]
\[
P(Z > 0.49) = 1 - P(Z < 0.49) \]
\[
= 1 - 0.6879 \]
\[
= 0.3121
\]
\[
e. 0.3121 > 0.05
\]
\[
p-value > \alpha
\]
\[
\text{Fail to Rej. } H_0
\]
Problem 8. Your local school board wants to determine the proportion of people who plan on voting for the school levy in the upcoming election. They conduct a random phone poll, where they contact 150 individuals and ask them whether or not they plan on voting for the levy. Of these 150 respondents, 78 people say they plan on voting for the levy. The school board wants to determine whether or not the data supports the idea that more than 50% of people plan on voting for the levy. Conduct a hypothesis test at the 0.05 significance level to test this claim.

a. What are the hypotheses?
b. What is the significance level?
c. What is the value of the test statistic?
d. What is the p-value?
e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?
g. Are the assumptions met? Explain.

f. The data does not provide statistically significant evidence that the true proportion of all people planning to vote for the levy is greater than 0.50.

g. ① Independent
   - random ✓
   - n < 10% pop? unknown

② Success/failures
   \[ n \hat{p}_0 \geq 10 \rightarrow (150)(0.50) = 75 \geq 10 ✓ \]
   \[ n(1-\hat{p}_0) \geq 10 \rightarrow (150)(0.50) = 75 \geq 10 \]
Problem 9. A news article reports that “Americans have differing views on two potentially inconvenient and invasive practices that airports could implement to uncover potential terrorist attacks.” This news piece was based on a survey conducted among a random sample of 1,137 adults nationwide, where one of the questions on the survey was “Some airports are now using ‘full-body’ digital x-ray machines to electronically screen passengers in airport security lines. Do you think these new x-ray machines should or should not be used at airports?” Below is a summary of responses based on party affiliation. Create a 95% confidence interval for the difference in the proportion of Republicans and Democrats who think the full-body scans should be applied in airports. Assume that all relevant conditions are met.

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a. What is the 96% confidence interval?

b. What is the correct interpretation of the confidence interval?

\[ \hat{p}_A - \hat{p}_B \pm Z^* \sqrt{\frac{\hat{p}_A(1-\hat{p}_A)}{n_A} + \frac{\hat{p}_B(1-\hat{p}_B)}{n_B}} \]

\[ \hat{p}_A = \hat{p}_R = \frac{264}{318} = 0.83 \]
\[ n_A = n_R = 318 \]
\[ \hat{p}_B = \hat{p}_D = \frac{299}{369} = 0.81 \]
\[ n_B = n_D = 369 \]
\[ Z^* = 2.054 \]
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a. What is the 96% confidence interval?

b. What is the correct interpretation of the confidence interval?

b. We are 96% confident that the true difference between the proportion of all Republicans and the proportion of all Democrats who believe full-body scans should be used at airports is between -0.0403 and 0.0803.
Problem 10. A news article reports that “Americans have differing views on two potentially inconvenient and invasive practices that airports could implement to uncover potential terrorist attacks.” This news piece was based on a survey conducted among a random sample of 1,137 adults nationwide, where one of the questions on the survey was “Some airports are now using ‘full-body’ digital x-ray machines to electronically screen passengers in airport security lines. Do you think these new x-ray machines should or should not be used at airports?” Below is a summary of responses based on party affiliation. Conduct an appropriate hypothesis test evaluating whether there is a difference in the proportion of Republicans and Democrats who think the full-body scans should be applied in airports. Assume that all relevant conditions are met.

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a. What are the hypotheses?
b. What is the significance level?
c. What is the value of the test statistic?
d. What is the p-value?
e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?

\[ \begin{align*} 
H_0 &: P_R = P_D \\
H_A &: P_R \neq P_D \\
\text{OR} \\
H_0 &: P_R - P_D = \emptyset \\
H_A &: P_R - P_D \neq \emptyset \\
\end{align*} \]

\[ \alpha = 0.05 \]
Problem 10. A news article reports that “Americans have differing views on two potentially inconvenient and invasive practices that airports could implement to uncover potential terrorist attacks.” This news piece was based on a survey conducted among a random sample of 1,137 adults nationwide, where one of the questions on the survey was “Some airports are now using ‘full-body’ digital x-ray machines to electronically screen passengers in airport security lines. Do you think these new x-ray machines should or should not be used at airports?” Below is a summary of responses based on party affiliation. Conduct an appropriate hypothesis test evaluating whether there is a difference in the proportion of Republicans and Democrats who think the full-body scans should be applied in airports. Assume that all relevant conditions are met.

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\[ T_S = \hat{P}_A - \hat{P}_B \]
\[ \hat{P}_A = \frac{\# \text{ SUCCESS}_A}{n_A} = \frac{264}{318} = 0.83 \]
\[ \hat{P}_B = \frac{\# \text{ SUCCESS}_B}{n_B} = \frac{299}{369} = 0.81 \]
\[ \hat{P}_{pooled} = \frac{\# \text{ SUCCESS}_A + \# \text{ SUCCESS}_B}{n_A + n_B} = \frac{563}{687} = 0.82 \]
Problem 10. A news article reports that “Americans have differing views on two potentially inconvenient and invasive practices that airports could implement to uncover potential terrorist attacks.” This news piece was based on a survey conducted among a random sample of 1,137 adults nationwide, where one of the questions on the survey was “Some airports are now using ‘full-body’ digital x-ray machines to electronically screen passengers in airport security lines. Do you think these new x-ray machines should or should not be used at airports?” Below is a summary of responses based on party affiliation. Conduct an appropriate hypothesis test evaluating whether there is a difference in the proportion of Republicans and Democrats who think the full-body scans should be applied in airports. Assume that all relevant conditions are met.

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\[
TS = \left( \frac{\hat{p}_R - \hat{p}_D}{\sqrt{\frac{\hat{p}_{pooled}(1-\hat{p}_{pooled})}{n_R} + \frac{\hat{p}_{pooled}(1-\hat{p}_{pooled})}{n_D}}} \right)
\]

\[
TS = \frac{(0.83 - 0.81)}{\sqrt{\frac{(0.82)(0.18)}{318} + \frac{(0.82)(0.18)}{369}}} = \frac{0.02}{0.0294} 
\]

\[
TS = 0.68
\]

C. continued
Problem 10. A news article reports that “Americans have differing views on two potentially inconvenient and invasive practices that airports could implement to uncover potential terrorist attacks.” This news piece was based on a survey conducted among a random sample of 1,137 adults nationwide, where one of the questions on the survey was “Some airports are now using ‘full-body’ digital x-ray machines to electronically screen passengers in airport security lines. Do you think these new x-ray machines should or should not be used at airports?” Below is a summary of responses based on party affiliation. Conduct an appropriate hypothesis test evaluating whether there is a difference in the proportion of Republicans and Democrats who think the full-body scans should be applied in airports. Assume that all relevant conditions are met.

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e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?

d. \[ p\text{-value} = P \left( |\hat{p}_R - \hat{p}_D| > 0.02 \mid (\hat{p}_R - \hat{p}_D) = 0 \right) \]

\[ = P(\mid z \mid > 0.68) \]

\[ = 2 \times P(z < -0.68) \]

\[ = 2 \times (0.2483) \]

\[ p\text{-value} = 0.4966 \]
Problem 10. A news article reports that “Americans have differing views on two potentially inconvenient and invasive practices that airports could implement to uncover potential terrorist attacks.” This news piece was based on a survey conducted among a random sample of 1,137 adults nationwide, where one of the questions on the survey was “Some airports are now using ‘full-body’ digital x-ray machines to electronically screen passengers in airport security lines. Do you think these new x-ray machines should or should not be used at airports?” Below is a summary of responses based on party affiliation. Conduct an appropriate hypothesis test evaluating whether there is a difference in the proportion of Republicans and Democrats who think the full-body scans should be applied in airports. Assume that all relevant conditions are met.

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a. What are the hypotheses?
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e. $0.4906 > 0.05$
\[ p\text{-value} > \alpha \]

f. The data does not provide statistically significant evidence that the true difference between the proportion of all republicans and the proportion of all democrats who believe the full-body scans should be used in airports is different from zero.
Problem 11. The average cholesterol level in the general US population is 189 mg/dL. A researcher wants to see if the average cholesterol for men in the US is different from 189 mg/dL. She takes a sample of 81 American males and finds a sample mean of 194 mg/dL and a sample standard deviation of 10.4. Create a 96% confidence interval for the true average cholesterol level of the general US male population.

a. What is the 96% confidence interval?

\[
\hat{x} = 194 \\
Z^* = 2.054 \\
S = 10.4 \\
n = 81
\]

\[
\text{CI: } \bar{x} \pm Z^* \left( \frac{S}{\sqrt{n}} \right) = 194 \pm (2.054) \left( \frac{10.4}{\sqrt{81}} \right) = 194 \pm 3.196 = 190.804 \text{ and } 197.196
\]

b. We are 96% confident that the true average cholesterol level of all US men is between 190.804 and 197.196.
Problem 11. The average cholesterol level in the general US population is 189 mg/dL. A researcher wants to see if the average cholesterol for men in the US is different from 189 mg/dL. She takes a sample of 81 American males and finds a sample mean of 194 mg/dL and a sample standard deviation of 10.4. Create a 96% confidence interval for the true average cholesterol level of the general US male population.

a. What is the 96% confidence interval?

b. What is the correct interpretation of the confidence interval?

c. Are the assumptions met? Explain.

d. Based on the confidence interval, what can you say about the researcher’s question?

C. Independent
random? unknown
n < 10% pop'n ✓
pop'n dist'n
we don't know what the
pop'n dist'n looks like
→ n is large, sampling dist'n
is approx normal ✓

96% CI: (190.804, 197.196)

→ 189 is not in the interval,
this supports the idea that
pop'n mean for males is dif. from 189.
Problem 12. The average cholesterol level in the general US population is 189 mg/dL. A researcher wants to see if the average cholesterol for men in the US is different from 189 mg/dL. She takes a sample of 81 American males and finds a sample mean of 194 mg/dL and a sample standard deviation of 10.4. **Conduct a hypothesis test at the 0.01 significance level to test the researcher’s claim.**

a. What are the hypotheses?
b. What is the significance level?
c. What is the value of the test statistic?
d. What is the p-value?
e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?
g. Are the assumptions met? Explain.

\[
\begin{align*}
a. & \quad H_0: \mu = 189 \\
& \quad H_A: \mu \neq 189 \\
\text{b. } & \quad \alpha = 0.01 \\
\end{align*}
\]

\[
\begin{align*}
c. & \quad T_S = \frac{\bar{X} - M_0}{S/\sqrt{n}} \\
& \quad = \frac{194 - 189}{10.4/\sqrt{81}} \\
& \quad = \frac{5}{1.1556} \\
& \quad = 4.33
\end{align*}
\]
Problem 12. The average cholesterol level in the general US population is 189 mg/dL. A researcher wants to see if the average cholesterol for men in the US is different from 189 mg/dL. She takes a sample of 81 American males and finds a sample mean of 194 mg/dL and a sample standard deviation of 10.4. Conduct a hypothesis test at the 0.01 significance level to test the researcher’s claim.

a. What are the hypotheses?
b. What is the significance level?
c. What is the value of the test statistic?
d. What is the p-value?
e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?
g. Are the assumptions met? Explain.

d. \[ P( |z| > 4.33) = 2 \times P(z < -4.33) = 2 \times (0.0002) < 0.0064 \]

E. \[ p-value < 0.0004 < 0.01 \]

\[ p-value < \alpha \]

Reject \( H_0 \)
Problem 12. The average cholesterol level in the general US population is 189 mg/dL. A researcher wants to see if the average cholesterol for men in the US is different from 189 mg/dL. She takes a sample of 81 American males and finds a sample mean of 194 mg/dL and a sample standard deviation of 10.4. Conduct a hypothesis test at the 0.01 significance level to test the researcher’s claim.

a. What are the hypotheses?
b. What is the significance level?
c. What is the value of the test statistic?
d. What is the p-value?
e. What is the correct decision?
f. What is the appropriate conclusion/interpretation?
g. Are the assumptions met? Explain.

f. The data does provide statistically significant evidence that the true average cholesterol level of all US men is different from 189. Based on our sample, we believe it is greater than 189.

g. ① Independent? random? unknown
   \[ n < 0.1 \times \text{pop'}n \]
\[ \checkmark \]

② pop’n dist’n
   - don’t know what pop’n dist’n looks like
   - \( n \) is large, sampling dist’n \( \sim \text{Normal} \)