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In your calculations please use at most three decimal points. For brief explanations, two or three sentences is enough.

A survey is done by a news agency for presidential elections. The agency reported that the Reds are leading Blues by 11%, because 48% of the participants supported Red Party's candidate while 37% supported Blue Party's candidate. Note that 400 people participated in the survey and the population size is significantly larger than 400.

- a) What margin of error should be reported for each candidate's estimated vote rate?
- b) What margin of error should be reported for the estimated lead?
- c) Which candidate's margin of error is larger than the other? Explain the reason.
- d) How would margin of errors change if there were 1800 participants in the survey? Briefly explain.

NOTE: Use 95% confidence interval for calculating margin of errors.

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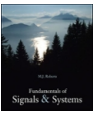
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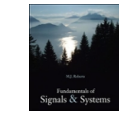
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In population proportion,
Margin of error (M.E)

$$M.E = Z^* \sqrt{\frac{P(1-P)}{n}}$$

$P \rightarrow$ Sample Proportion.

$Z^* \rightarrow$ Value of Z^* for selected Confidence level

For 95% of Confidence level

$$Z^* = 1.96$$

(a) For red party's Candidate

Sample proportion $P = 48\% = \underline{0.48}$

Sample size $n = 400$
 $Z^* = 1.96$

Margin of Error (M.E) = $Z^* \sqrt{\frac{P(1-P)}{n}}$

$$M.E = 1.96 \times \sqrt{\frac{0.48(1-0.48)}{400}}$$

$$M.E = 1.96 \times \sqrt{\frac{(0.48) \times (0.52)}{400}}$$

$$= 1.96 \times \sqrt{0.000624}$$

$$= 1.96 \times 0.025 = \underline{0.049}$$

For red Party's Candidate
margin of error = 0.049

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For Blue Party Candidate

Sample proportion, $P = 37\% = \underline{0.37}$

Sample size $n = 400$

Table value of Z corresponding to
Confidence level 95% is $Z^* = 1.96$

Margin of error (M.E) = $Z^* \sqrt{\frac{P(1-P)}{n}}$

$$P = 0.37, 1-P = 1-0.37 = 0.63$$

$$Z^* = 1.96$$

$$M.E = 1.96 \times \sqrt{\frac{0.37 \times 0.63}{400}}$$

$$= 1.96 \times \sqrt{0.00058}$$

$$= 1.96 \times 0.0241 = \underline{0.0472}$$

For Blue Party Candidate

margin of error = 0.0472

(b) For estimated lead

Sample proportion $P = 11\% = \underline{0.11}$

Sample size, $n = 400$

Margin of error (M.E) = $Z^* \sqrt{\frac{P(1-P)}{n}}$

$$P = 0.11, 1-P = 1-0.11 = \underline{0.89}$$

$$Z^* \text{ (from table)} = 1.96, n = 400$$

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$$\begin{aligned} M.E &= 1.96 \times \sqrt{\frac{0.11 \times 0.89}{400}} \\ &= 1.96 \times \sqrt{0.000245} \\ &= 1.96 \times 0.0157 = \underline{\underline{0.031}} \end{aligned}$$

For estimated lead,
margin of error = 0.031

② Margin of error for Red = 0.049
Margin of error for Blue = 0.0472
Margin of error is larger for
Red party.

Here sample size n and
confidence level are same,
margin of error of Red party
increases due to increase
in proportion.

As variability in the
proportion increases, margin
of error increases.
So the margin of error of
Red party is higher than
the Blue party

④ If there were 1800 participants in the survey, $n = 1800$.

Then, Margin of error of Red.

$$(M.E)_{Red} = Z^* \sqrt{\frac{P(1-P)}{n}}$$

here $n = 1800$

$$\begin{aligned}(M.E)_{Red} &= 1.96 \sqrt{\frac{(0.48) \times (0.52)}{1800}} \\ &= 1.96 \times \sqrt{0.000139} \\ &= 1.96 \times 0.0118 \\ &= \underline{\underline{0.023}}\end{aligned}$$

Margin of error of Red when $n = 1800$ is 0.023

Margin of error of Blue when $n = 1800$

$$\begin{aligned}(M.E)_{Blue} &= Z^* \sqrt{\frac{P(1-P)}{1800}} \\ &= 1.96 \sqrt{\frac{0.37 \times 0.63}{1800}} \\ &= 1.96 \times \sqrt{0.000129} \\ &= 1.96 \times 0.0114 \\ &= \underline{\underline{0.022}}\end{aligned}$$

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⑤

Margin of error of Blue party when $n = 1800$ is 0.022.

Margin of error of estimated lead, when $n = 1800$

$$\begin{aligned}(M.E)_{lead} &= Z^* \sqrt{\frac{P(1-P)}{n}} \\ &= 1.96 \sqrt{\frac{(0.11) \times (0.89)}{1800}} \\ &= 1.96 \times \sqrt{0.0000544} \\ &= 1.96 \times 0.00738\end{aligned}$$

$$(M.E)_{lead} = \underline{\underline{0.0145}}$$

Margin of error of estimated lead, when $n = 1800$ is 0.0145

As the Sample size increases
margin of error decreases.

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