Inferential Summary

<table>
<thead>
<tr>
<th>unknown pop. Quantities of main interest</th>
<th>( \mu = \text{pop. mean annual family income in 2009} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>estimate of ( \mu )</td>
<td>( \bar{x} = $82.9 ) k</td>
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<tr>
<td>size or take ( \bar{x} ) as ( \hat{\mu} ) for ( \mu )</td>
<td>( SE(\bar{x}) = \frac{s}{\sqrt{n}} = 8.35k )</td>
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<tr>
<td>99.9% CI for ( \mu )</td>
<td>( ($71.5k, 894.2k) )</td>
</tr>
</tbody>
</table>

\( \text{pop.} \) \( \longrightarrow \) \( \text{sample} \)

\( \text{random} \) [ ] \( \text{if} \) \( \longrightarrow \) ? \( \text{if} \)

\( \text{known} \) \( \text{statistical based on inference} \) [ ]

\( \text{pop.} \) \( \rightarrow \) ? \( \text{probability} \)
on the basis of this IID sample of size \( n = 842 \), we think that \( \mu \) is around \( \hat{\mu} = 882.9k \), give or take about \( \hat{SE}(\hat{\mu}) = 83.5k \), and we're 99.9% confident (given that our assumptions are correct) that \( \mu \) is between $71.5k and $92.5k.

how measure how accurate \( \hat{\mu} \) is as an estimate of \( \mu \) ?

\[
p\left( \left| \frac{\hat{\mu} - \mu}{\epsilon} \right| \leq \text{small} \right) = \text{big} \text{ (close to 1)}
\]

\[\text{Frequentist (Mr. Neyman)}\]
Estimate \( \mu \) using

use a different ten for \( \sigma(\bar{X}) \):

\[
\text{Estimated Standard Error of } \bar{X} = \frac{\tilde{X}^4}{\sqrt{\mu}} = \frac{8.5}{\sqrt{84.2}} = 8100.1 \text{ k} < 83.45 \text{ k}
\]

\( \tilde{SE} \) $3.5k

\[ P \left( 3.29 \tilde{SE} < \bar{X} < 3.29 \tilde{SE} \right) = 0.999 \]

\( P \left( \frac{\bar{X} - \mu}{3.29 \tilde{SE}} < Z < \frac{\bar{X} + \mu}{3.29 \tilde{SE}} \right) = 0.999 \]

\( \mu \approx 99.9\% \)

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Mr. Ni's proposal

We use \( \bar{x} \pm 3.29 \frac{s}{\sqrt{n}} (\bar{x}) \) as a \( 100(1-\alpha)% \) confidence interval for \( \mu \) (\( \alpha = 0.001 \)).

\[
\bar{x} \pm \left( 1 - \frac{1}{2} \right) \frac{5}{\sqrt{n}}
\]

99.9% CI for \( \mu \)

\[
71.5 \text{ } 88.2 \text{ } 84.2
\]

Person 1:

I think P's annual net pay was \$70,000

P_2 (I think \( \mu \) was \$100k)

P_3 (I think \( \mu \) was \$50k)

Data does not support that theory.
but we think that \( \mu \) is close to \( \$83K \) or \( \$90K \)

\[ \mu \neq \$90K \]

\[ \pm \$3.5K \]

\[ 99.9\% \text{ CI} \]

\[ 871.5K \pm 82.9K \]

\[ 894.2K \]

Since \( \$70K \) is not in our 99.9\% CI for \( \mu \), the difference between \( \bar{X} = \$82.9K \) (statistically significant) \( \mu_0 = \$70K \) is statistically significant (at the 99.9\% confidence level)

\[ P_3: \mu = \$90K \]

no statistically significant difference between \( \bar{X} \) and \( \mu_0 \)

\( \text{diff. is probably real} \)

\( \text{diff. is likely due to unlucky random sampling} \)
\[ P \left( 87.5k < \mu < 94.2k \right) \geq 0.999 \]

Fixed unknown constant

Neyman:

\[ \text{you will achieve about a 99.9\% hit rate with my method} \]