You have 25 minutes. Take your time!
Note that this page has TWO sides! Name: A. Student

ONE: The statistic $\overline{x}$ is a measure of centre, and $s$ and $s_{\overline{x}}$ are both measures of spread or variability.

1) name each statistic, and indicate which parameter each statistic is an estimator of:

a) $\overline{x}$ is called the __________ and is an estimator of ________
   sample mean
   $\mu$

b) $s$ is called the __________ and is an estimator of ________
   sample standard deviation
   $\sigma$

c) $s_{\overline{x}}$ is called the __________ and is an estimator of ________
   std. error of the mean
   $\sigma_{\overline{x}}$

2) According to the Central Limit Theorem, $s$ and $s_{\overline{x}}$ are related. How?

\[ s_{\overline{x}} = \frac{s}{\sqrt{n}} \]

TWO: In your textbook (Avery and Burkhart 2002, p. 11-12) and in lecture we discussed the concept of accuracy, which comprises two parts: bias and precision.

Three groups of students took samples of soil bulk density (in kg m$^{-1}$) from randomly selected points on skid trails in a block after a timber sale on the school forest. Here is a data summary:

<table>
<thead>
<tr>
<th>group</th>
<th>mean</th>
<th>st.dev.</th>
<th>n</th>
<th>std.err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.95444421</td>
<td>0.3065313</td>
<td>10</td>
<td>0.0969337</td>
</tr>
<tr>
<td>2</td>
<td>0.9090369</td>
<td>0.1698814</td>
<td>10</td>
<td>0.0537212</td>
</tr>
<tr>
<td>3</td>
<td>0.8859976</td>
<td>0.2202800</td>
<td>20</td>
<td>0.0492561</td>
</tr>
</tbody>
</table>

a) Which group's estimate of $\mu$ has the greatest precision? Why?

3 because $s_{\overline{x}}$ is smallest

b) The true $\mu$ bulk density is 0.892 kg m$^{-1}$. Which group's estimate is the least biased? Why?

3 because 0.892 is closest to 0.886 than to 0.909

THREE: Two ways of expressing a confidence interval are:

a) $\overline{x} \pm t_{1-\alpha/2, n-1} \cdot s_{\overline{x}}$

b) $\overline{x} \pm z_{1-\alpha/2} \cdot s_{\overline{x}}$

What is the difference between them? Explain.

use a) when $N > 230$ (textbook rule)

$N > 100$ (Robert's rule)

b) when you know $\sigma$
FOUR: I flip two fair coins, and count the number of heads and tails. Order doesn't matter.

a) What are the possible outcomes?
   1. 2 heads
   2. 2 tails
   3. 1 head, 1 tail

b) Draw a probability density histogram. Label it fully.

Write nothing below this line.