Confidence interval

Exercises:
1. How can I visualise by a drawing a confidence interval?
2. What is the meaning of a confidence interval?
3. What elements can influence the width of a confidence interval?
4. What is the difference between the confidence interval of the mean and the confidence interval for each of data points?
5. Can I compute a confidence interval of a proportion?
6. Can I compute a confidence interval of a variance?
7. If I compute a confidence interval with 50 of set of 200 data, and then a confidence interval with the 200 data; which one will be the narrower?
8. If I compute a confidence interval at alpha=5% and another at alpha=1%; which will be the largest?
9. What will be the effect of removing a data which is very different from the others on the confidence interval of the mean?

Usually our results are obtained after examination of a given number of plants/seeds from a given lot under known controlled conditions.

From the data we have we estimate a value for the result (% pure seeds, number of foreign seeds, % germination, % healthy seeds…)

A confidence interval is a range of values in which our result is likely to be.

In the following figure, the horizontal line figures the range, and the vertical bar figures the result. The result does not change, but (going from the

The narrower, the smaller is the expected range
top) from the first confidence interval to the fourth
the range is narrower.

Example:
We found that for a lot the moisture content was 5.5%,
and we were able to compute a confidence interval. The moisture content is between 4% 
and 6% (alpha risk 5%)

What tells a confidence interval of a mean of 10 measures at alpha = 5%?. It tells:
If we were able to make hundreds times such sets of 10 measures in the same conditions on 
the same type of seeds, only in 5 per cent of the sets the mean obtained from the 10 measures 
would fall out of the range computed.

This does not tell my means are good estimates of the true value I want to know. 
If my growing conditions differ the potential of germination will not express the same. 
If I do not see always the difference between two proximate species, I can count as pure 
seed a proximate species.
The confidence interval take into account the variability, but it does not take into account 
a bias.

The basis to compute confidence interval is:
• use an estimation to obtain the result (this will give the place of the vertical line figured 
here by a diamond)
• use the variability of the observations to compute the expected range (the horizontal line)
The confidence interval is linked to our observations:
• The more « able » we are, the better will be the estimate of the result
• The more variable will be our data, the bigger will be the range
• The less data we have, the bigger will be the range.

Example:
We observe the time before seeds « fully germinate » according to a defined protocol.
We have for a lot a sample of 12 seeds, and the observations are summarised below in example 1.
Our estimation for the time for full germination will be the mean of our 12 observations (27.7 days).

The variability of the time to germinate can be computed by the variance of the 12 observations
(variance=9.65, standard deviation is 3.11 days).
If we wish to compute the confidence interval of the time for full germination we find
27.7 ± 1.97 days (a range from 25.73 to 29.67 days).
This computation is done for alpha=5% which means that
- assuming the observed variability is a good basis;
- if we were able to repeat a great number of observations on samples of 12 seeds (same
lot, same conditions),
- then only 5% of the results obtained from 12 seeds will fall out of the range.

Example 1:

<table>
<thead>
<tr>
<th>For a given sample of 12 seeds</th>
<th>time to fully germinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>plant 1</td>
<td>20.4</td>
</tr>
<tr>
<td>plant 2</td>
<td>25.4</td>
</tr>
<tr>
<td>plant 3</td>
<td>25.6</td>
</tr>
<tr>
<td>plant 4</td>
<td>25.6</td>
</tr>
<tr>
<td>plant 5</td>
<td>26.6</td>
</tr>
<tr>
<td>plant 6</td>
<td>28.6</td>
</tr>
<tr>
<td>plant 7</td>
<td>28.7</td>
</tr>
<tr>
<td>plant 8</td>
<td>29</td>
</tr>
<tr>
<td>plant 9</td>
<td>29.8</td>
</tr>
<tr>
<td>plant 10</td>
<td>30.5</td>
</tr>
<tr>
<td>plant 11</td>
<td>30.9</td>
</tr>
<tr>
<td>plant 12</td>
<td>31.1</td>
</tr>
<tr>
<td>mean</td>
<td>27.68</td>
</tr>
<tr>
<td>variance</td>
<td>9.65</td>
</tr>
<tr>
<td>confidence around mean alpha=5%</td>
<td>1.76 using excel (1.96)</td>
</tr>
<tr>
<td>confidence around mean alpha=5%</td>
<td>1.97 using correct T value (2.201)</td>
</tr>
</tbody>
</table>
NB: This is an example where the use of a commercial program might not give a correct result. In the version used, the function to compute confidence intervals always use the same value for the T coefficient (« infinite » number of observations), instead of using the correct T value in accordance with the number of observations.

**Effect of the number of observations and the alpha level on the ½ range:**

![Graph](image1)

Example with alpha=10% std dev 1.2 or 5

![Graph](image2)

Example std dev = 3.5
Série 1 alpha 5%
Série 2 alpha 1%
Série 3 alpha 1 per 1000
Examples from the excel demo:

Same as above with bar chart instead of curves

NB: The confidence interval of a mean correspond to the number of times the mean will fall into the range, not the number of times the observations will fall into the range. See other document influence of the number of values on the mean.

<table>
<thead>
<tr>
<th>result =27.7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>half-range= 1.97 days</td>
</tr>
<tr>
<td>total range is from (27.7 -1.97) days to (27.7 + 1.97) days</td>
</tr>
<tr>
<td>from 25.73 days to 29.67 days</td>
</tr>
</tbody>
</table>

The ½ range is not a commonly used statistical notion. It is the length to put on each side of the result to draw the confidence interval.

NB:
- If we have only one observation, it is impossible to compute a confidence interval.
- For a given alpha, the ½ range is proportional to the standard deviation
- Above 30 observations the ½ range are « fewly » influenced by the increase of observations
- From 2 to 10 observations, the addition of observations « greatly » reduce the ½ range
The interval of confidence can be computed for a set of observations, usually we compute confidence interval for the means, but we can also compute confidence intervals for variances for instance.

In statistics, the confidence interval of a data point does not exist, because we need variability to compute it.

From a common sense point of view, we often have the equivalent of a confidence interval for a data point (= an observation) in mind. We use our knowledge of possible errors, precision of the equipment, expected values,…to imagine in which range should lay the value. The idea behind is the same as in statistics, we use variability of past experience to evaluate a range.

In ISTA certificate we report the result without confidence intervals.

The precision of this result reported can be affected by many factors;

• The quality of the sampling
• The sample size
• The conditions of the test
• The ability of the seed analyst to recognise correctly
• …

In principle the follow of ISTA rules should enhance that the results from different labs have a similar precision (similar range of the confidence interval)
- The sampling should be made by appropriate persons and apparatus, the goal is to obtain a representative sample.
- The sample size (number of plants for instance) is part of the rules, the goal is to assess the result with the same amount of data in different labs.
- The conditions of the test are described, the goal is to obtain data in similar conditions in the different labs.
- The tests are conducted or checked by experienced seed analysts, the goal is to obtain good and precise observations according to the technical definitions of the rules.

In practice the follow of ISTA rules does not fully guarantee that two labs will give similar results.
For instance in germination or pathology, there are sometimes more than one “method + conditions”. The result itself might be different, due to the method used. If the number of seeds vary depending on the method used, the confidence interval will vary.

Nevertheless, from experienced gained in some comparative studies between labs, it has been often felt by analysts that the use of the routine method of the lab is usually more precise and accurate than the use of a “method which they are not used to”. This make think that the effect of different agreed methods might be limited.

_**Linking J Van Bilsen presentation and confidence interval:**_