

Statistics is about variation. If data didn't vary, we wouldn't need Statistics.

If random samples didn't vary one from another, we wouldn't have sampling distributions (or inference).

And without standard deviations we can't answer the question at the core of all Statistical inference, "how different?"

But it is fundamentally hard to think in terms of variation, often we forget that our focus should be there.

Key Ideas of Statistics:

always plot your data – make a picture, make a picture, make a picture ...

look for overall patterns and striking deviations from the patterns ... L.O.S.S.

some procedures (both data analytic and inferential) are much more sensitive to anomalies than others ...

mean versus median, range versus interquartile range, robustness of the t-distribution results, ...

the design of data production is the most important part of any statistical study – Randomization!!!

To call in the statistician after the experiment is done may be no more than asking him to

perform a post-mortem examination: he may be able to say what the experiment died of. ~ Sir R. A. Fisher

association doesn't imply causation ...

careful experimentation (beyond observation) is needed to separate causation from correlation/association.

a confidence interval, computed from sample data, reports reasonable values for a parameter of interest.

a confidence level tells you the success rate of the method you used ...

significance tests use this reasoning:

if the null were true, data this extreme would rarely occur; the data are therefore evidence against the null ...

a test of significance is a statistical check to determine whether a difference ...

between “what is observed” and “what is expected” is real or simply due to chance variation ...

if the p-value is low – the null must go ...

statistical significance is not the same thing as practical significance ... importance of context!! ...

is the effect you are seeking visible in plots?

if not, ask yourself if the effect is large enough to be practically important.

report the size of the effect using confidence intervals ...

statistical inference draws conclusions about a population(s) on the basis of sample data ... As in all of statistics, estimates of

model parameters are subject to variation. We must be able to quantify this variation in order to make inferences; tests of

hypotheses and confidence intervals for model parameters. Use probability to indicate how reliable the conclusions are ...

confidence interval estimates an unknown parameter ... significance tests shows how strong the evidence is for some claim

about a parameter {population} ...



Millersville University recognizes excellence in teaching and learning as its reason for being and is committed to offering students a high quality, comprehensive university experience of exceptional value. Dedicated to providing nationally recognized programs that embrace the liberal arts, ...

Consistent with Millersville University's mission to provide a liberal arts-based education, the purpose of General Education is to provide breadth of knowledge as a balance and complement to the depth provided by the major. This is necessary for the holistic development of Millersville graduates as responsible citizens in a diverse and technologically complex, global community.

Students, working with advisers, and taking into consideration prior knowledge and experience, purposefully select courses in the General Education curriculum that meld with required courses, co-curricular and extra-curricular activities, and courses in the major to achieve the following objectives: Foundations for Lifelong Learning, Critical Thinking across the Liberal Arts, and Connections and Exploration.

Statistics is one of the liberal arts¹ ... reasoning about data, variation, and chance is *a flexible and broadly applicable mode of thinking*. That is just what is often meant by a liberal art. Also liberal arts are *intellectual tools that can be applied in any realm*.

- encouraging skeptical, analytical thinking ... methodological ...
- equipping citizens to lead society ... a body of knowledge/standards of civic virtue ...

Statistics is a general intellectual method that applies wherever data, variation, and chance appear. It is a fundamental method because data, variation, and chance are omnipresent in modern life.

However, working with data is an art as well as a science. We learn it not simply by mastering formal methods but by following examples set by our current teachers and by past masters. In this, learning statistics is like learning to perform music, another subject in which students develop practical wisdom and critical evaluation through context and example. We learn in this way because technique alone does not make an outstanding statistician any more than an out-standing musician. Interpretation in the specific context is always important.

Technology is not enough ... technology empowers but thinking enables ...

Reading Arithmetic Writing // Think Show Tell // Recognition Computation Interpretation

¹ Moore, D. S. (1998), "Statistics Among the Liberal Arts," *Journal of the American Statistical Association*, 93, 1253-1259.