Statistics 516

Probability and Statistics for the Physical Sciences

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Course home page:
http://www.stat.ncsu.edu/people/bloomfield/courses/ST516/
# Outline

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<td>Blocked designs</td>
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<td>Introduction to factorial designs</td>
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<td>$2^k$ factorial designs</td>
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See [reading schedule](#) for details.
Prerequisites

Random variable, distribution, expected value, variance, standard deviation.

Sample and population; statistic and parameter.

Inference about the population based on the sample:
- point estimate;
- interval estimate;
- hypothesis test.
Experiments

E.g. strength of paper:

sample from a process to characterize average and variability of strength;

sample from alternative processes to decide which, if either, gives stronger product;

vary a factor such as pH to determine its effect on strength.
Guidelines for Designing Experiments

1. Recognition and statement of problem:
   Getting all concerned parties on board.

2. Response variable:
   How to measure the quantity of interest.
3. Factors, levels, and range

Potential design factors:
- design factors;
- held-constant factors;
- allowed-to-vary factors;

Nuisance factors:
- controllable factors;
- uncontrollable factors;
- noise factors.
4. Design:
Factorial: all combinations of levels of design factors (each combination is a *treatment*);

Randomized: order of runs, assignment of materials to treatments;

Blocking: controllable nuisance factors;

Covariates: measure uncontrollable nuisance factors;

Sample size: replication, including *fractional* replication.
5. Perform:
use pilot run(s) to identify problems, and *follow the protocol*.

6. Statistical analysis:
calculations follow from design.

7. Conclusions and recommendations:
*Practical* meaning of the results, in context.
“The successful integration of good experimental design practice into engineering and science is a key factor in future industrial competitiveness.”