Session 6

ANALYSIS OF VARIANCE INTRODUCTION

BASIC CONCEPTS

- Experimental Design

  a plan and a structure to test hypotheses in which the researcher controls or manipulates one or more variables.

- Independent Variables (or Factors)

  Treatment variable -- the one that the experimenter controls or modifies in the experiment.

  Classification variable -- a characteristic of the experimental subjects that was present *prior to* the experiment, and is not a result of the experimenter's manipulations or control.

BASIC CONCEPTS

Each independent variable has two or more *Levels* or *Classifications*:

The subcategories of the independent variable used by the researcher in the experimental design.

- Dependent Variable

The response to the different levels of the independent variables. The measure that is being analyzed.

BASIC CONCEPTS

Example: A product development engineer investigates the tensile strength of a new synthetic fiber. From experience she knows that

- The strength is affected by the *weight percent of cotton* used
- Cotton content should range from 10% – 40%

The engineer suspect that increasing the cotton content may increase the strength and she decides to

- Test specimens at five levels of cotton weight percent: 15%, 20%, 25%, 30% and 35%.
- Test five specimens at each level of cotton content.

$\Rightarrow$ A single-factor experiment with:
- $a = 5$ levels of the factor
- $n = 5$ replicates

BASIC CONCEPTS

The 25 runs should be made in *random order*:

%	Experimental Run Number				
15	1	2	3	4	5
20	6	7	8	9	10
25	11	12	13	14	15
30	16	17	18	19	20
35	21	22	23	24	25

BASIC CONCEPTS

Test Sequence	Run Number	Test Sequence	Run Number
1	8	14	7
2	18	15	1
3	10	16	24
4	23	17	21
5	17	18	11
6	5	19	2
7	14	20	13
8	6	21	22
9	15	22	16
10	20	23	25
11	9	24	19
12	4	25	3
13	12		

BASIC CONCEPTS

Data (in lb/in^2)

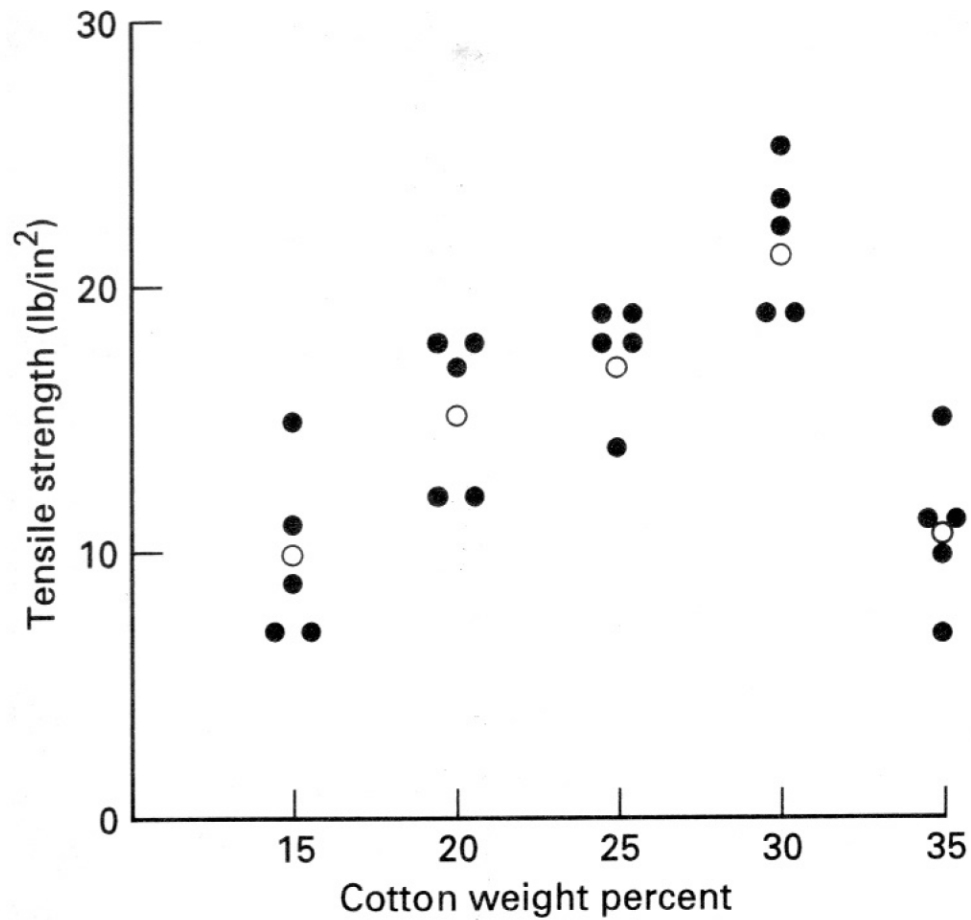| Cotton Weight Percentage	Observations					Total	Average
	1	**2**	**3**	**4**	**5**		
15	7	7	15	11	9	49	9.8
20	12	17	12	18	18	77	15.4
25	14	18	18	19	19	88	17.6
30	19	25	22	19	23	108	21.6
35	7	10	11	15	11	54	10.8
						376	**15.04**

BASIC CONCEPTS

Graphical Representations
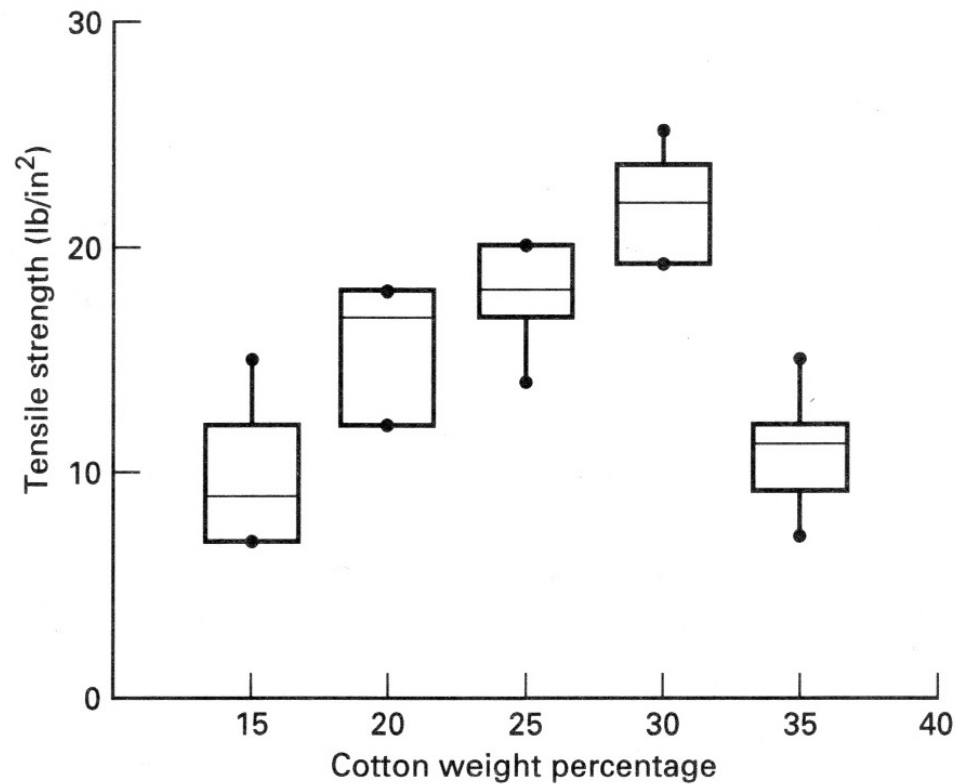
Box Plot of Tensile Strength vs. Cotton Weight Percentage

BASIC CONCEPTS

Scatter Diagram of Tensile Strength vs. Cotton Weight Percentage

BASIC CONCEPTS

It can be suspected that

1. Cotton content affects tensile strength
2. Around 30% percent cotton results in maximum strength

Testing the equality of the five mean:

Comparing pairs of means leads to increasing of Type I error

Ex.: $\alpha = .05 \Rightarrow$ Prob. of correctly accepting the null hypothesis for all 10 tests is $(.95)^{10} = .60 \Rightarrow$ Type I error $= 0.40$

The appropriate procedure: **Analysis of Variance (ANOVA)**