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Experimentation
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Causation
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Vocabulary

Using a
Random
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Matched Pairs

Experimental
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Diagrams

Area of
Squares

Math 1710 Class 24

Sampling and Experimentation
Dr. Back

Oct. 23, 2009

Polio Vaccine

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NFIP Vaccine Trials

	Size	Rate (cases/100K)
Grade 2 Vaccine	125K	25
Grade 2 No Consent	125K	44
Grade 1,3 Control	725K	54

Polio Vaccine

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NFIP Vaccine Trials

	Size	Rate (cases/100K)
Grade 2 Vaccine	125K	25
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Grade 1,3 Control	725K	54

PHS Double Blind Vaccine Trials

	Size	Rate (cases/100K)
Treatment	200K	28
Control	200K	71
No Consent	350K	46

Polio Vaccine

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NFIP result confusing, but PHS not.

Polio Vaccine

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NFIP result confusing, but PHS not.

Randomized control groups help a lot with unanticipated issues!

Portacaval Shunt Studies

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51 Studies

Enthusiasm:

Design	Marked	Moderate	None
No Controls	24	7	1
Controls, not randomized	10	3	2
Randomized controls	0	1	3

28 Social and Medical Interventions

++ 21%

+ 21%

0 46%

- 7%

- 4%

36 Surgical and Anaesthetic Innovations

innovation highly preferred 14%

innovation preferred 19%

innovation a success but not much better 11%

innovation a disappointment but not much worse 28%

standard preferred 6%

standard highly preferred 11%

Establishing Causation Without Experimentation

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(Attempts)

Association strong.

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Area of
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(Attempts)

Association strong.

Association consistent.

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Area of
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Higher doses give stronger responses.

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Alleged cause precedes effect.

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Alleged cause precedes effect.

Alleged cause is plausible.

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Alleged cause is plausible.

Rule out other plausible explanations.

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This is hard to do reliably.

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Experimentation is much clearer!

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Basic Strategies

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**Experimental
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1) **Control** extraneous sources of variation.

Basic Strategies

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Area of
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- 1) **Control** extraneous sources of variation.
- 2) **Randomize** to deal with uncontrollable sources of variation.

Basic Strategies

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- 1) **Control** extraneous sources of variation.
- 2) **Randomize** to deal with uncontrollable sources of variation.
- 3) **Replicate** to increase accuracy and gain greater confidence in the scope of your conclusions.

Basic Strategies

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- 1) **Control** extraneous sources of variation.
- 2) **Randomize** to deal with uncontrollable sources of variation.
- 3) **Replicate** to increase accuracy and gain greater confidence in the scope of your conclusions.
- 4) **Block** when possible to increase accuracy/sensitivity and better control variability.

Sampling Words

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Area of
Squares

- Sample vs. Population
- Sample Statistic vs. Population Parameter
- Sampling Frame
- Voluntary Response Sample
- Convenience Sample
- Biased Sample
- Simple Random Sample (SRS)

Sampling Words

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Area of
Squares

- Census
- Strata
- Stratified Random Sample
- Cluster Sample
- Systematic Sampling
- Multistage Sample Design

Sampling Words

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Area of
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- Matching in an observational study
- Undercoverage
- Non-Response Bias
- Response Bias
- Leading Questions
- Sampling Variability

Stratification

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Area of
Squares

- Strata – groups of homogeneous individuals.
- Stratified Random Sample – same probability of choice within each group.

Stratification

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- Strata – groups of homogeneous individuals.
- Stratified Random Sample – same probability of choice within each group.

Advantages include:

- Every stratum well represented.
- Can be more accurate for a given sample size.
Strata with greater variability should be better represented.

Types of Bias

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Response bias vs. voluntary response bias vs. non-response bias?

Types of Bias

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Response bias vs. voluntary response bias vs. non-response bias?

Response Bias: problems in the questions or how they are asked.

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Response bias vs. voluntary response bias vs. non-response bias?

Voluntary Response Bias: problems in surveys where only volunteers participate.

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Response bias vs. voluntary response bias vs. non-response bias?

Non-Response Bias: problems associated with which people are missing in the final results.

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Response bias vs. voluntary response bias vs. non-response bias?

Undercoverage: groups somewhat missing from the sampling frame.

Experiments

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Area of
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- Observational Study vs. Experiment
- Prospective vs Retrospective Study
- Factor in an experiment
- Level
- Treatment

Experiments

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- Control Group
- Single-Blind vs. Double-Blind Experiment
- One Factor vs. Two Factor Experiment
- Placebo
- Placebo Effect
- Hidden Bias

Experiments

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- Block
- Completely Randomized Design
- Block Design
- Matched Pairs Design
- Confounding Variables
- Statistically Significant Effect

Factors and Levels

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Factors vs. Levels vs. Treatments?

Factors and Levels

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Factors vs. Levels vs. Treatments?

Factor in an Experiment: Variable being manipulated.

Factors and Levels

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Factors vs. Levels vs. Treatments?

Levels: Values of a factor.

Factors and Levels

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Factors vs. Levels vs. Treatments?

Treatment: What is actively done to the experimental units.

Block Related

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Block vs. Completely Randomized Design vs. Block Design vs.
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Block vs. Completely Randomized Design vs. Block Design vs. Matched Pairs Design

Block: homogenous group similar in some important way.

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Block vs. Completely Randomized Design vs. Block Design vs.
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Block Design: random within each block.

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Block vs. Completely Randomized Design vs. Block Design vs. Matched Pairs Design

Completely Randomized Design: Every subject an equal chance of every treatment.

Block Related

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Block vs. Completely Randomized Design vs. Block Design vs.
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Matched Pairs Design: block size of 2.

Lurking and Confounding

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Lurking: Mostly used in observational situations; a variable (not directly studied) which actually accounts for an association.

Lurking and Confounding

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Confounding Variables: Mostly used in experiments; variables whose effects are difficult or impossible to separate from what you are observing.

Choose an SRS of size 5 from 30 people

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Step 1: Assign ID numbers 01,02,...,29,30.
all 2-digit!

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Step 1: Assign ID numbers 01,02,...,29,30.
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Step 2: Pick a random place to start in the table.
(e.g. row 12, col 3) You might use a wristwatch.

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69167 38894 00172 02999 97377 33305

Choose an SRS of size 5 from 30 people

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Step 3: Read off pairs of ID digits, selecting those that
correspond to real units, rejecting others.

Choose an SRS of size 5 from 30 people

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69 16 73 88 94 00 17 20 29 99 97 37 73 33 05

Choose an SRS of size 5 from 30 people

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correspond to real units, rejecting others.

69 16 73 88 94 00 17 20 29 99 97 37 73 33 05

Our SRS is units 16 17 20 29 and 05.

Matched Pairs

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Coke/Pepsi Taste Test - matched pairs (50 people)

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Coke/Pepsi Taste Test - matched pairs (50 people)

Method 1: Have half the people rate pepsi on a 1-7 scale and the other half rate coke.

1 is bad, 7 is good.

Matched Pairs

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Coke/Pepsi Taste Test - matched pairs (50 people)

Method 1: Have half the people rate pepsi on a 1-7 scale and the other half rate coke.

1 is bad, 7 is good.

Problem: One person's 6 might be another person's 5.

Matched Pairs

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Coke/Pepsi Taste Test - matched pairs (50 people)

Method 1: Have half the people rate pepsi on a 1-7 scale and the other half rate coke.

1 is bad, 7 is good.

Problem: One person's 6 might be another person's 5.

Would still work if sample size big enough.

Matched Pairs

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Coke/Pepsi Taste Test - matched pairs (50 people)

Method 2: Have each person taste both coke and pepsi.

Matched Pairs

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Coke/Pepsi Taste Test - matched pairs (50 people)

Method 2: Have each person taste both coke and pepsi.
Half try pepsi first, half try coke first.

Matched Pairs

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Coke/Pepsi Taste Test - matched pairs (50 people)

Method 2: Have each person taste both coke and pepsi.

Half try pepsi first, half try coke first.

Look for each person at the difference between their coke and pepsi scores.

Matched Pairs

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Coke/Pepsi Taste Test - matched pairs (50 people)

Method 2: Have each person taste both coke and pepsi.
Half try pepsi first, half try coke first.

Look for each person at the difference between their coke and pepsi scores.

Still some problems, e.g. how thirsty someone is when they start.

That's why we randomize which soda goes first.

Matched Pairs

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Squares

Coke/Pepsi Taste Test - matched pairs (50 people)

Method 2: Have each person taste both coke and pepsi.
Half try pepsi first, half try coke first.

Look for each person at the difference between their coke and pepsi scores.

This is Matched Pairs.

Experimental Design Diagrams

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Causation
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**Experimental
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Diagrams**

Area of
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Basic Pattern: Units \longrightarrow Treatments \longrightarrow Results

Experimental Design Diagrams

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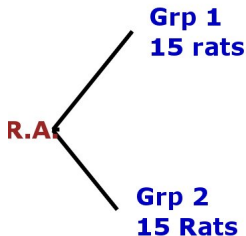
Area of
Squares

Basic Pattern: Units \longrightarrow Treatments \longrightarrow Results
Rat experiment - diet to increase weight. (30 rats)

Experimental Design Diagrams

Basic Pattern: Units \longrightarrow Treatments \longrightarrow Results

Rat experiment - diet to increase weight. (30 rats)



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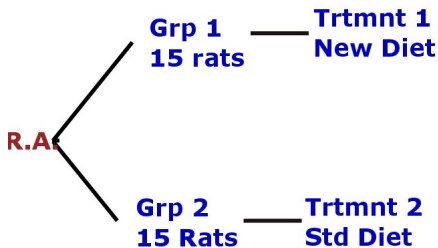
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Experimental Design Diagrams

Basic Pattern: Units \longrightarrow Treatments \longrightarrow Results

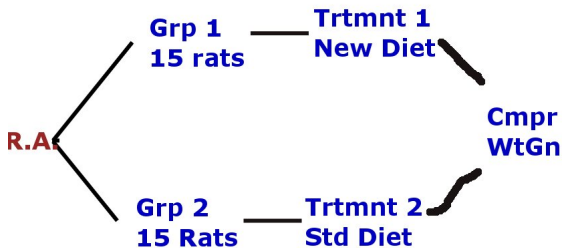
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Experimental Design Diagrams

Basic Pattern: Units \longrightarrow Treatments \longrightarrow Results

Rat experiment - diet to increase weight. (30 rats)



Experimental Design Diagrams

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Area of
Squares

Basic Pattern: Units \longrightarrow Treatments \longrightarrow Results
Rat experiment - diet to increase weight. (30 rats)
Reduce Electrical Usage - meter/chart/control. (60 houses)

Experimental Design Diagrams

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Treatment of a Serious Disease - Men vs. Women, 3
Alternatives

Experimental Design Diagrams

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Treatment of a Serious Disease - Men vs. Women, 3

Alternatives

Coke/Pepsi Taste Test - matched pairs (20 people)

Average Area?

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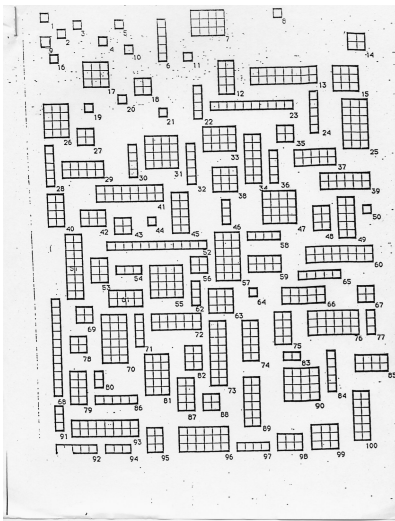
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Eyeball Estimate: Take a 5 second look and make a guess:

Average Area?

Eyeball Estimate: Take a 5 second look and make a guess:



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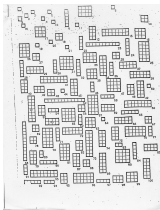
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Judgement Sample: Each person picks 5 representative rectangles, and computes their average area.

Average Area?

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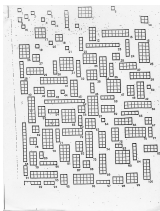
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SRS: Each person uses a table of random numbers to choose 5 random rectangles, and computes their average area.

Average Area?

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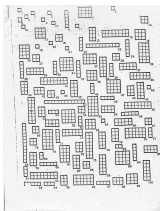
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Stratified Random Sample: Call a rectangle **big** if its area is above 5; **small** otherwise.

Average Area?

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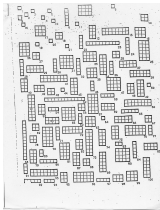
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Stratified Random Sample: Call a rectangle **big** if its area is above 5; **small** otherwise.

Have 70% of people find averages of big rectangles and 30% study small ones.

Average Area?

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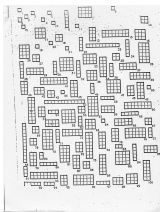
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Our overall estimate will be

$$.48\bar{x}_{small} + .52\bar{x}_{large}$$

Average Area?

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$$.48\bar{x}_{small} + .52\bar{x}_{large}$$

The numbers .48 and .52 come from the fact that there are 48 small and 52 big rectangles.

Average Area?

Stratified Random Sample: Call a rectangle **big** if its area is above 5; **small** otherwise.

Have 70% of people find averages of big rectangles and 30% study small ones.

The fractions 70% and 30% come from the following calculation:

Type	n_i	σ_i	$n_i\sigma_i$
small rectangles	48	1.557	74.74
big rectangles	52	3.847	200.04

$$\frac{200.04}{200.04 + 74.74} = .73 \sim 70\%$$

$$\frac{74.74}{200.04 + 74.74} = .27 \sim 30\%$$

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These proportions give the stratified random sample with smallest variance for a given sample size.

Average Area?

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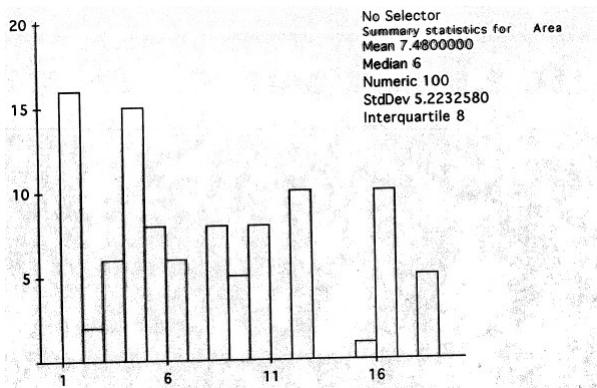
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Histogram of Actual Areas



Average Area?

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Area of
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Frequency Breakdown of Actual Areas

Area

Frequency breakdown of Area
No Selector

Group	Count	Cumulative Count	%	Cumulative %
1	16	16	16	16
2	2	18	2	18
3	6	24	6	24
4	15	39	15.0	39
5	8	47	8	47
6	6	53	6	53.0
8	8	61	8	61
9	5	66	5	66
10	8	74	8	74
12	10	84	10	84
15	1	85	1	85
16	10	95	10	95
18	5	100	5	100
total	100			