EVIDENTIAL STATISTICS

Reforming the Introductory Course in Applied Statistics for Non-Majors

Milo Schield

Augsburg College

schield@augsburg.edu

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Applied introductory statistics

Many say that introductory statistics has problems and must be reformed.

Dr. 'Bob' Hogg

"I am tired of hearing about problems in introductory statistics.

I know there are problems with introductory statistics;

But I defy anyone to identify what is wrong and what we must do to fix it."

JSM-95 Orlando FL.

"The problem is

that introductory statistics is designed

like a human anatomy course --

not like a human physiology course.

So much time is spent trying to get

these students to understand

where the basic organs are

in the Statistical body, that

they never get a chance to understand

how the organs function together

to maintain homeostasis."

From "Testing basic statistical concepts." Posted to sci.stat.edu news-group on 2 June, 1997 by Robert Schilling, MPH at Loma Linda, CA. Email to rschill718@aol.com.

Evidential statistics

uses traditional <u>statistics as evidence</u> in arguments with <u>non-statistical conclusions</u>.

Evidential statistics

is <u>macro-statistics</u>: a mixture of traditional statistics philosophy of science, and critical thinking.

Sciences of Method

	METHOD OF REASONING	
Content	DEDUCTIVE	INDUCTIVE
WORDS	Logic	Critical Thinking
NUMBERS	Mathematics Probability	Evidential Statistics

An example of evidential statistics:

Two hunters were being chased

by a hungry bear

The first hunter shouted to the second,

"It's hopeless!"

This bear runs twice as fast as we can.

The second hunter shouted back:

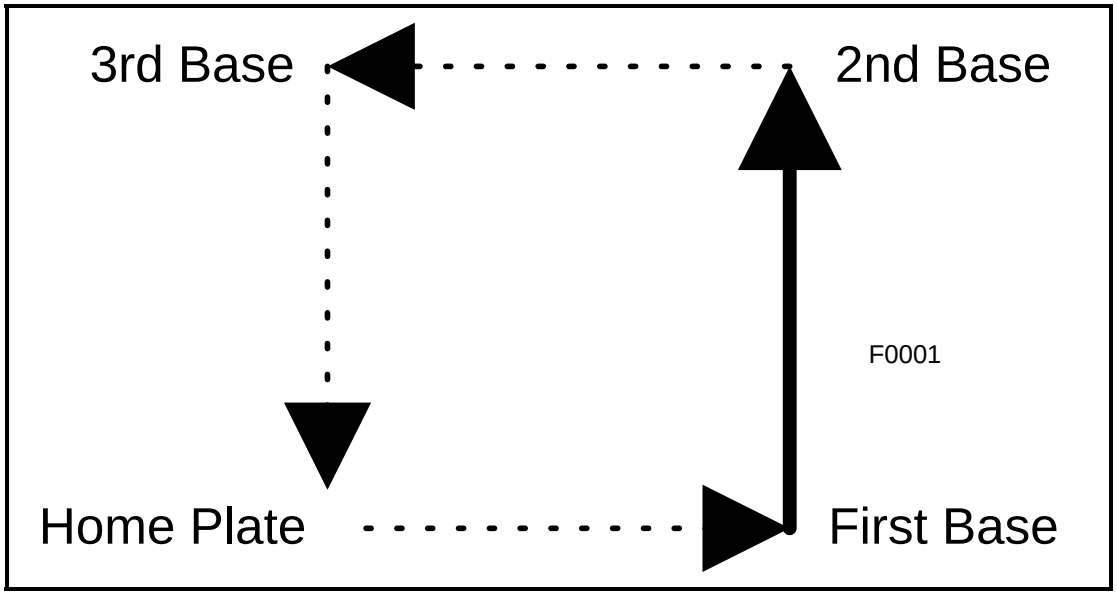
"So what?

I don't have to outrun the bear.

I just have to outrun YOU…!"

Thanks to David Friedman's Intermediate Microeconomics Text for this example.

Statistics is like a baseball game.



Describing and modeling gets one to 1st

Classical Inference gets one to 2nd.

Bayesian Inference gets one to 3rd.

Evidential statistics reviews all these runs and tries to get one back home.

The run to 1st base

Evidential statistics is concerned with
BIAS

"…the most serious threat to the progress of science... comes from bias, not random variation."

John Bailar, Chair, Board of Trustees NISS

[Amstat News, Nov., 1997 p. 5]

What you take into account (control for) can change the magnitude and direction of an association between two variables.

[Simpson's paradox]

The run from 2nd to 3rd

The more unlikely a relationship
***if* due to chance,**
then
the more unlikely the relationship
***is* due to chance and**
the more likely the relationship
is due to some determinate cause.

The smaller the p-value
in a classical test of hypothesis,
the more one is justified
in rejecting the truth of the null.

The run to home plate

Sometimes students cannot distinguish association from causation.

A is positively associated with B

A is riskier than B

A is determined by B

A is explained by B

A is linked to (related to) B

A is a factor in relation to B

A is attributable to B

A can be attributed to B

The run to home plate

Students can't distinguish association from causation.

Suppose A and B are positively associated:

1. **Subjects who have more A are likely to have more B**

2. **As A *increases*, B [tends to] increase**

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3. As A is increased within a subject, we expect that B will increase within that same subject.

The run to home plate

The quality of a statistic depends on the kind of study:
experimental versus observational.

In presenting regression and ANOVA,
we don't dwell on the source of the data
(experimental or observational)
since the kind of study
doesn't affect the statistics

But the kind of study
affects
the value of the statistics
as evidence.

The run to home plate

Good experiments limit arguments.

"Can magnets block pain?"

A recent double-blind experiment

of 50 subjects says "Yes"

75% in treatment group got relief;

19% in control group got relief.

While we may have questions, we do have reason to believe this study could be replicated and something like the observed outcome should result.

The run to home plate

Experiments and observational studies vary in the strength they give to support a conclusion.

Support	Observational	Experiment
Strong	Impossible	Double blind: controlled or repeatable
Moderate	Longitudinal	No-blind and, missing data. Uncontrolled or unrepeatable
Weak	Cross-sectional	

"Statistics: a Guide to Public Policy"

1998 JSM Theme

"Public policy is a series of uncontrolled, [unrepeatable] experiments."

David Pavelchek. JSM-95. Session 172. Orlando, FL

To guide public policy, we must teach Evidential Statistics

Evidential statistics is a key in reforming statistical education!

Seven Reasons Against Teaching Evidential Statistics

1. **Dilutes our discipline**
   - Mathematics is deductive.
2. **Division of labor**
   - causality is discipline specific
3. **Arrogance to try to teach all things**
   - Mathematics and probability
   - Statistical inference and modeling
   - Critical thinking & Phil.of Science
4. **Too much stuff for one semester**

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5. **Lack of texts**
6. **<u>Inability</u> <u>to teach</u>**
7. **<u>Inability</u> <u>to test</u>**

Florence Nightingale

the passionate statistician, used statistics as evidence to support her claim that *improved medical care would save lives.*

Statistic #1

Crimea, 1859: For every soldier killed in battle, seven died after the battle.

Statistic #2

The death rate for young soldiers in peacetime was twice that of the general population.

(Brown, 1988 *People Who Have Helped the World, p. 44)*

Florence Nightingale introduced many techniques designed to take into account (control for) confounding factors. She noted that mortality statistics should be age-specific and that crude death rates can be misleading.

Johnson & Kotz, 1997 *Leading Personalities in Statistical Sciences.*

Statistics began as the queen of the social sciences.

David Moore is right on! Introductory statistics should be taught as a liberal art.

It is time to assert our identity!

We should teach <u>Evidential Statistics</u>: statistics as evidence

Jessica Utts, Univ. Calif, Davis

Seeing Through Statistics

Gary Smith, Pomona College, Calif

Statistical Reasoning

Gudmund Iverson, Swathmore

Statistics:A Conceptual Approach

Donald Macnaughton, Toronto

www.matstat.com/teach

Milo Schield, Augsburg College

www.augsburg.edu/ppages/schield

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