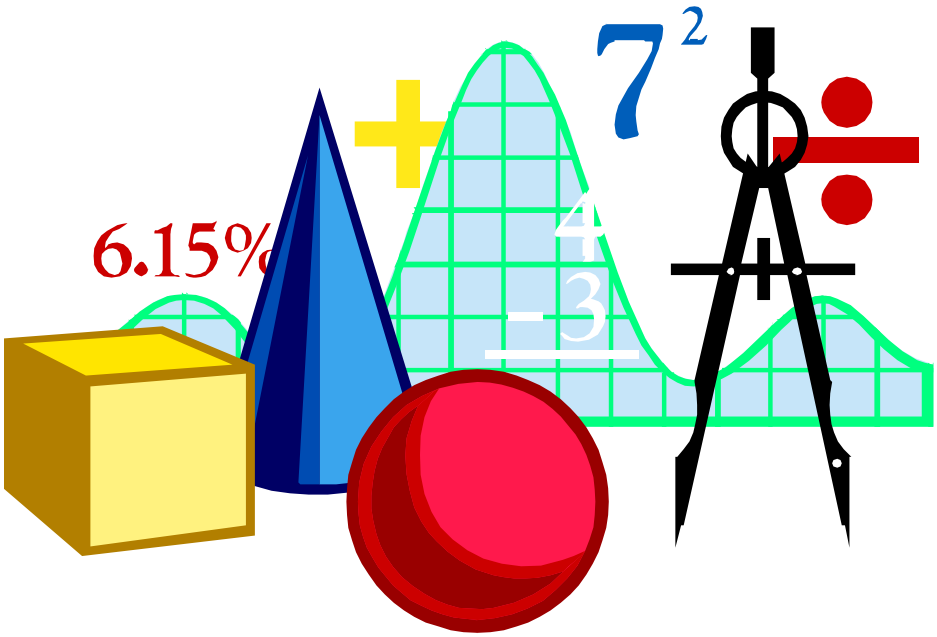

EVIDENTIAL STATISTICS

Milo Schield

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DEDICATION

to Aristotle, Aquinas,

Ayn Rand, and Julian Simon.

MISSION

To help students

evaluate statistics

as evidence in arguments

TO CONSUMERS OF STATISTICS:

Primary Goal

Our goal is to read and interpret statistics.

1. *Statistics are important.* We live in an age of statistics; most arguments involving social issues and public policy involve statistics. Politicians quote statistics to uphold opposing positions. But statistics are a real problem.
2. *Statistics are more than just numbers.* Statistics look like numbers and generally numbers are facts. But statistics are more than just numbers or facts.
3. *Statistics are claims -- claims about reality.* Statistics make claims just like sentences and claims can be quite difficult to understand. In this sense, statistics is a language. As humans, we must learn to read and interpret statistics. If we don't we are liable to make more mistakes. And when we make mistakes, we often pay for our mistakes.

People who cannot interpret claims are more easily manipulated and mislead. People who can interpret claims are more likely to be independent -- to think for themselves. People who are independent are more likely to be clear in their views and their values. They know why they have chosen their values; they know why they hold their beliefs.

Science of Method

As a discipline, Statistics is a science of method – as are mathematics, logic and critical thinking. Sciences of method are fundamental; they are used in all disciplines. There are many ways to classify things. The easiest way is to classify by what is most obvious: their content -- numbers or words. But what is most obvious may not be what is most fundamental. Table 1 classifies these four sciences of method according to both their content and their particular method of reasoning.

Table 1

Sciences of Method	--------- **METHOD OF REASONING** ------	
CONTENT	FORMAL (Deductive)	INFORMAL (Inductive)
WORDS	Logic	Critical Thinking
NUMBERS	Mathematics; Probability	Evidential Statistics

Methods of reasoning

There are two methods of reasoning: formal and informal. Formal reasoning is often called categorical reasoning -- the kind we learn in logic All X are Y; all Y are Z. Therefore, all X are Z. Informal reasoning is often called practical reasoning -- the kind we do most often in making a decision: Many X are Y; many Y are Z. Thus, there is reason to believe that X is a Z. For more details on critical thinking (constructing plausible explanations and evaluating the strength of inductive arguments).

Applicability of Methods

Logic, mathematics and probability are powerful because they rely on formal logic. But they are quite limited because they don't apply to most situations. Critical thinking and evidential statistics are less powerful because they rely on informal reasoning. But they have a broader scope because we use informal reasoning in our day-to-day living.
History, literature, law, journalism, communications and philosophy rely heavily on informal reasoning involving words. Epidemiology, quantitative journalism and quantitative history rely heavily on informal reasoning using numbers.

Content versus method

Most students view the distinction between words and numbers (rows) as more important than the distinction between the methods of reasoning (columns). The row-distinction is easier to recognize (numbers versus words). The row-distinction explains how these four courses are related to academic departments. Critical thinking and logic are part of Philosophy, statistics and probability are typically part of Mathematics.

Method is more fundamental than content

This book argues that method is more important than content; the distinction between deduction and induction (columns) is more fundamental than the distinction between words and numbers (rows). This book views statistics as being closer to critical thinking than to mathematics.
As human beings, inductive reasoning is our primary method of thought. We are not omniscient; we need to choose knowing our choice may be in error. We need to act knowing out actions may have consequences that were unforeseen and perhaps unforeseeable. Thus, our method of thinking is primary; the content of our thinking is secondary. Most statistics texts focus on deductive statistics based on mathematical probability. This text focuses primarily on inductive statistics as a branch of critical thinking.

Challenge

This approach may be challenging for

- *those who like the certainty of mathematics or logic,*
- *those who have difficulty with language -- in this case English.*

Both groups will need time toread and interpret statistics as evidence.

This book is different -- radically different! This book is dedicated to helping you learn to think more effectively by using statistics as evidence. This is not a course where students memorize, regurgitate and forget mathematical statistics and then say "I just didn't get it." This course focuses on the thinking we do every day. The principles learned in this book can help you think with more clarity and certainty. If you can master these principles, you will have an insight that many people lack. And with this insight you can work more effectively toward achieving wisdom in all areas of your life.

THE AUTHOR

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Publications involving Statistical Education	1994 *Random versus Representative.* ASA-JSM, Toronto, Canada. 1995 *Correlation, Determination & Causality.* ASA, Orlando, FL. 1996 *Goals of Introductory Statistics.* Conference on Making Statistics More Effective in Schools of Business. Anchorage, Alaska. 1996 *Selecting Alpha in Tests of Significance using Bayesian Reasoning,* SISCO-96, Sydney, Australia: 1996 *Using Bayesian Inference in Teaching Classical Hypothesis Testing*. ASA-JSM, Chicago, Illinois. 1997 *Interpreting Confidence*. ASA-JSM, Anaheim, California. 1998 *Evidential Statistics*: ASA-JSM, Dallas Texas. ASA papers are published by the Section on Statistical Education:

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I invite comments, criticisms and ideas on how to improve this book.

TO TEACHERS OF EVIDENTIAL STATISTICS

This book is different because it has a different goal. The goal is not to help students appreciate the truth and power of inferential statistics. The goal is to help students think critically about the support that statistics give to non-statistical conclusions. This book can be used as a supplement -- or as a text -- in a college-level course.

Teaching this material requires different skills. It took me many years to become half as good at teaching evidential statistics as I was at teaching traditional descriptive and inferential statistics. But, being able to help students evaluate statistics as evidence is a most worthy and satisfying goal.

I am tired of hearing students say, "Statistics -- the worst course I ever had." I understood that statistics was hard, but to hear students say it wasn't very relevant was most disheartening. Now I understand why my students were right. In teaching traditional statistics, I focused on the glass being half full; my students saw the glass as being half empty.

Not everyone who teaches traditional descriptive and inferential statistics will be good at teaching evidential statistics. Fortunately, our discipline needs both kinds of teachers. Your job is to see how well you can teach this material and then decide whether that is something you want to do.

Best wishes and a satisfying journey of personal and professional discovery.

25 26 Keywords: evidential statistics; error statistics: Bayesian statistics, information criteria; likelihoodism; statistical inference 27 28 29 Introduction 30 We were very pleased when we were invited to present at the â€œStatistics in Population 31 Ecologyâ€ symposium. The use of statistics in science is a topic dear to both of our hearts 32 and has been the focus of both of our research programs for years. We were humbled and 33 In linguistics, evidentiality is, broadly, the indication of the nature of evidence for a given statement; that is, whether evidence exists for the statement and if so, what kind. An evidential (also verificational or validational) is the particular grammatical element (affix, clitic, or particle) that indicates evidentiality. Languages with only a single evidential have had terms such as mediative, mÃ©diatif, mÃ©diaphorique, and indirective used instead of evidential. Evidential is a meaning of nature Evidential statistics is an important advance in model and theory testing, and scientific reasoning in general, combining and extending key insights from other philosophies of statistics. A key desiderata in evidential statistics is the rigorous and objective comparison of alternative models against data. Scientific theories help to define the range of models