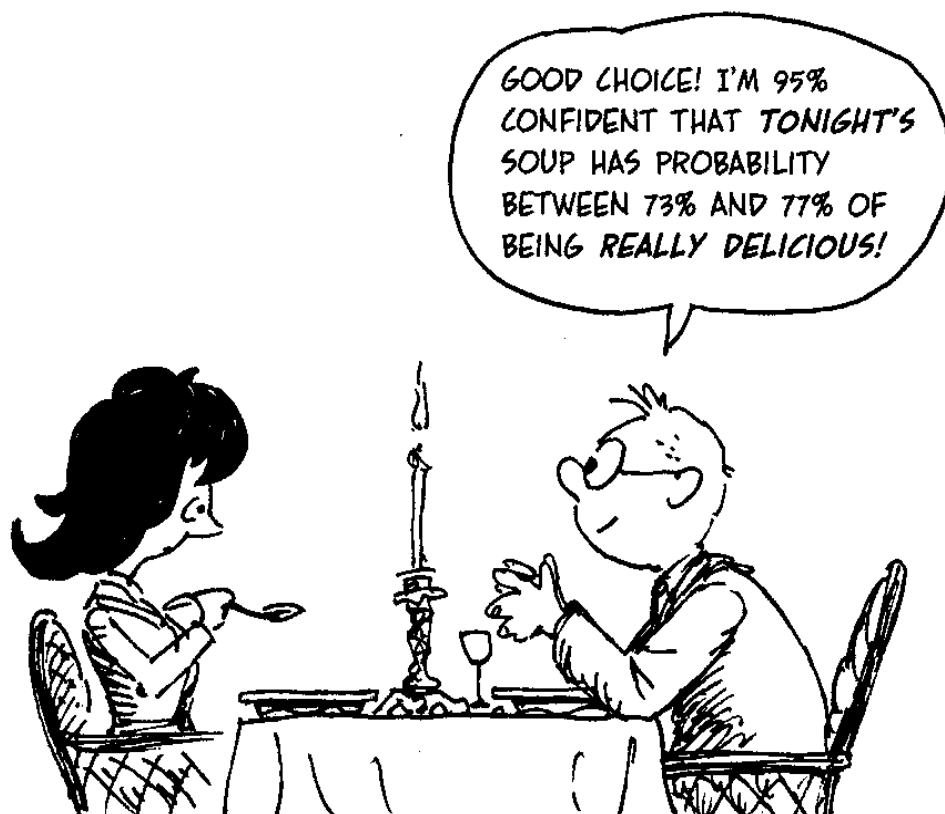


Cartoon Statistics

Introduction

The following cartoons have been taken, under the [right to quote](#), from the book *The Cartoon Guide to Statistics*, by Larry Gonick and Woolcott Smith. With this selection (the book, completely written in this style, has more than two hundred pages), I have built a brief and informal introduction to Statistics and Probability – a sort of handrail without formulas, to show students with no background in Science the kind of tasks they have to face (for them to have a smile before the possible puffs). Nevertheless, the book has a good theoretical level and a quite appropriate way of presenting the ideas underlying these subjects, something that is no easy to achieve with figures only...

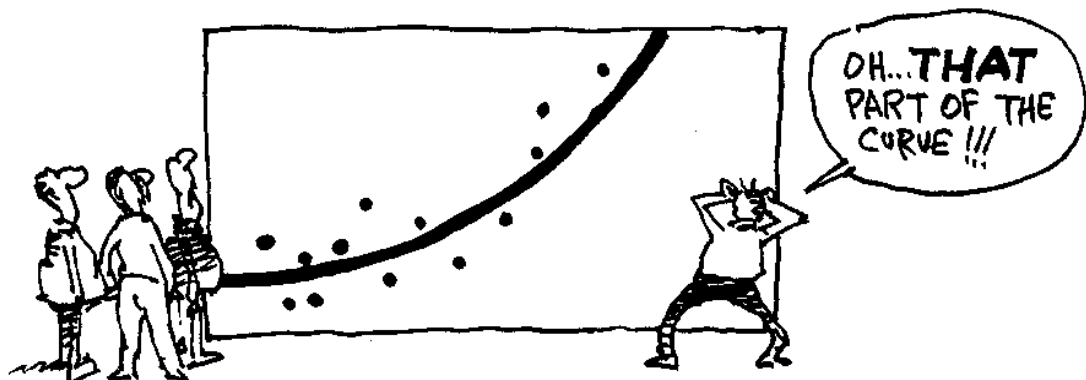
WHAT MAKES STATISTICS UNIQUE IS ITS ABILITY TO QUANTIFY UNCERTAINTY, TO MAKE IT PRECISE. THIS ALLOWS STATISTICIANS TO MAKE CATEGORICAL STATEMENTS, WITH COMPLETE ASSURANCE—ABOUT THEIR LEVEL OF UNCERTAINTY!



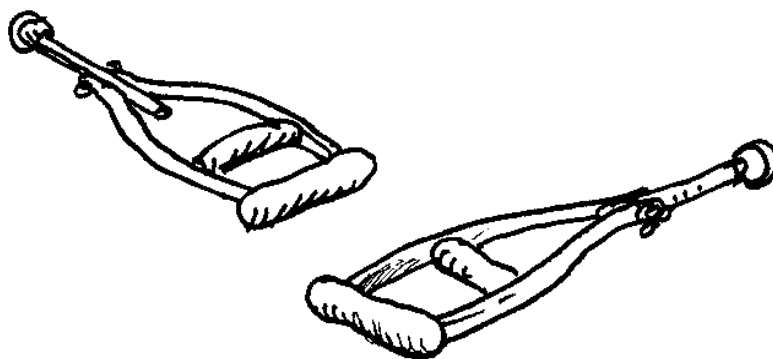
THIS IS NOT JUST A MATTER OF ORDERING SOUP! STATISTICS ALSO INVOLVES MATTERS OF LIFE AND DEATH...



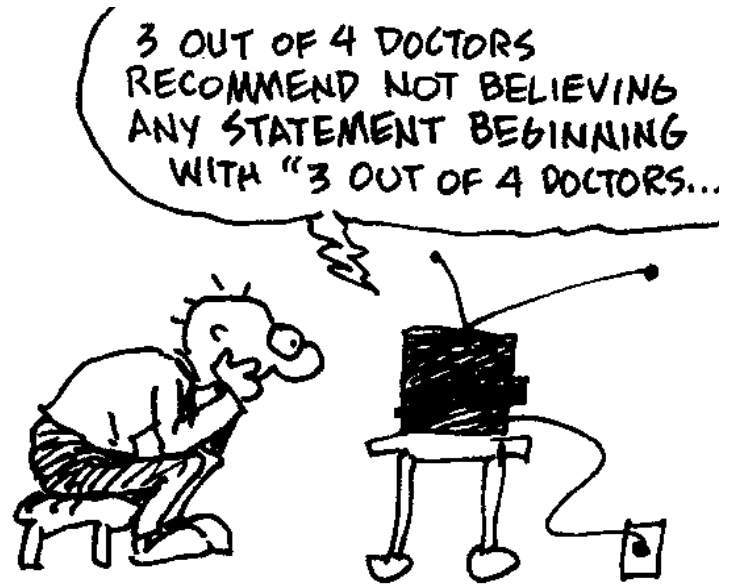
FOR EXAMPLE, IN 1986, THE SPACE SHUTTLE *CHALLENGER* EXPLODED, KILLING SEVEN ASTRONAUTS. THE DECISION TO LAUNCH IN 29-DEGREE WEATHER HAD BEEN MADE WITHOUT DOING A SIMPLE ANALYSIS OF PERFORMANCE DATA AT LOW TEMPERATURE.



A MORE POSITIVE EXAMPLE IS THE *SALK POLIO VACCINE*. IN 1954, VACCINE TRIALS WERE PERFORMED ON SOME 400,000 CHILDREN, WITH STRICT CONTROLS TO ELIMINATE BIASED RESULTS. GOOD STATISTICAL ANALYSIS OF THE RESULTS FIRMLY ESTABLISHED THE VACCINE'S EFFECTIVENESS, AND TODAY POLIO IS ALMOST UNKNOWN.



FINALLY, IN DISCUSSING STATISTICS, IT'S HARD TO AVOID MENTIONING ONE OTHER THING: THE WIDESPREAD MISTRUST OF STATISTICS IN THE WORLD TODAY. EVERYONE KNOWS ABOUT "LYING WITH STATISTICS," WHILE GOOD STATISTICAL ANALYSIS IS NEARLY IMPOSSIBLE TO FIND IN DAILY LIFE. WHAT'S ONE TO DO?



In statistical work, the following related areas are usually involved:

Data analysis

THE GATHERING, DISPLAY, AND SUMMARY OF DATA;

Probability

THE LAWS OF CHANCE, IN AND OUT OF THE CASINO;

Statistical inference

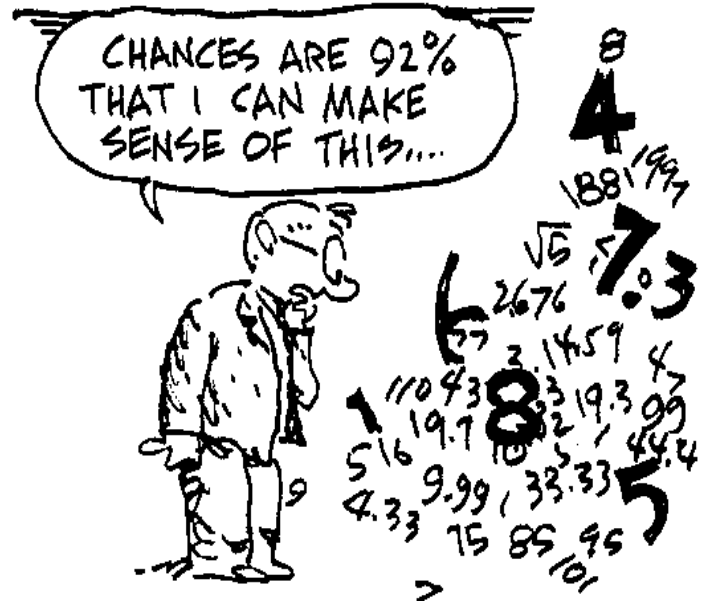
THE SCIENCE OF DRAWING STATISTICAL CONCLUSIONS FROM SPECIFIC DATA, USING A KNOWLEDGE OF PROBABILITY.



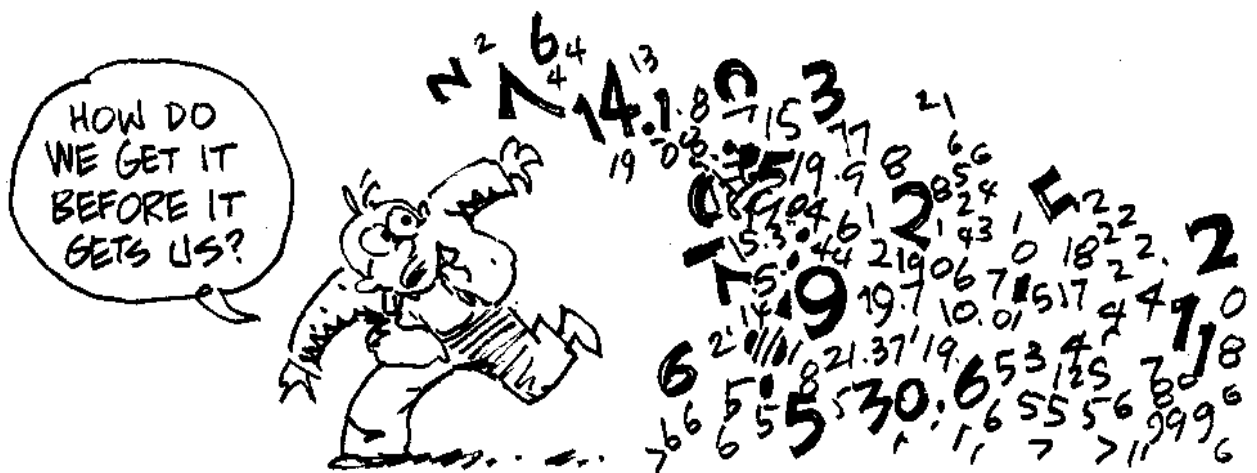
If you have a look at the index of many books and subjects, they usually have a similar structure of contents. First of all, it is considered how to gather and interpret data; after this, how to fit a mathematical model to them (a "suit"); and, finally, how to deduce or infer new information.

Data Analysis

DATA ARE THE STATISTICIAN'S RAW MATERIAL, THE NUMBERS WE USE TO INTERPRET REALITY. ALL STATISTICAL PROBLEMS INVOLVE EITHER THE COLLECTION, DESCRIPTION, AND ANALYSIS OF DATA, OR THINKING ABOUT THE COLLECTION, DESCRIPTION, AND ANALYSIS OF DATA.

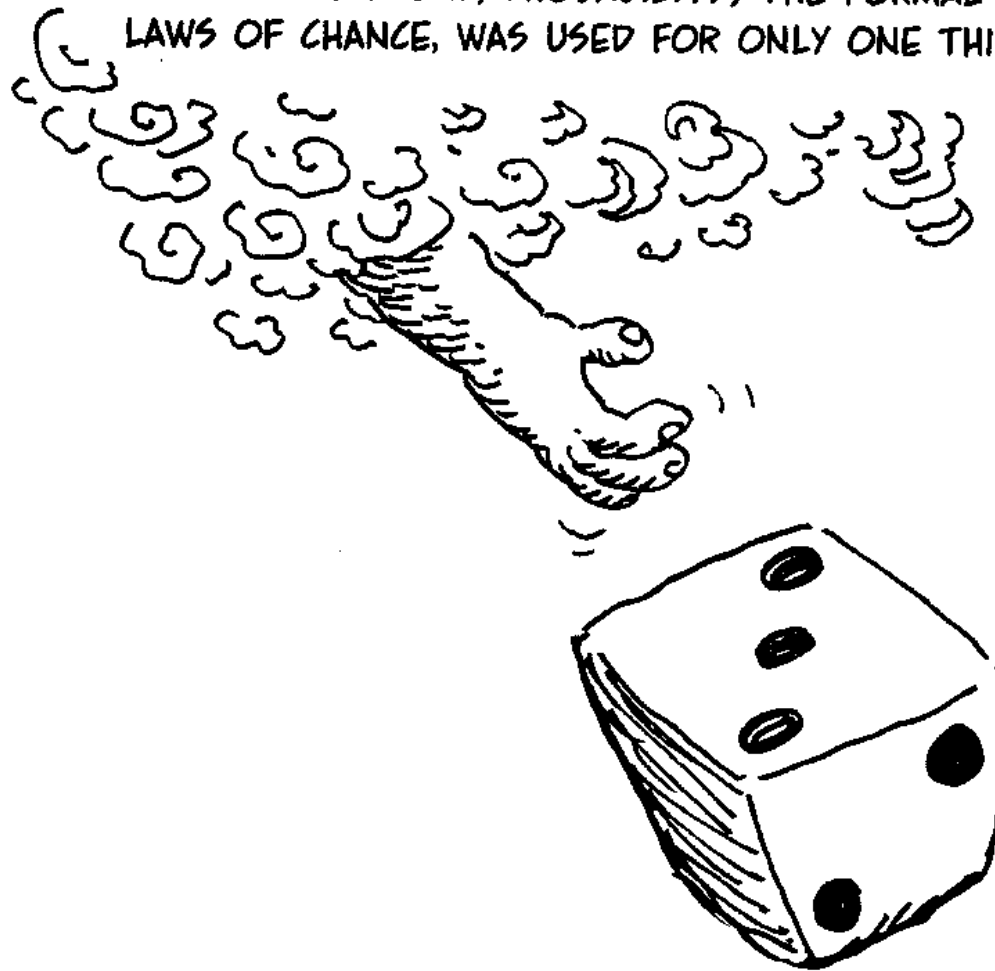


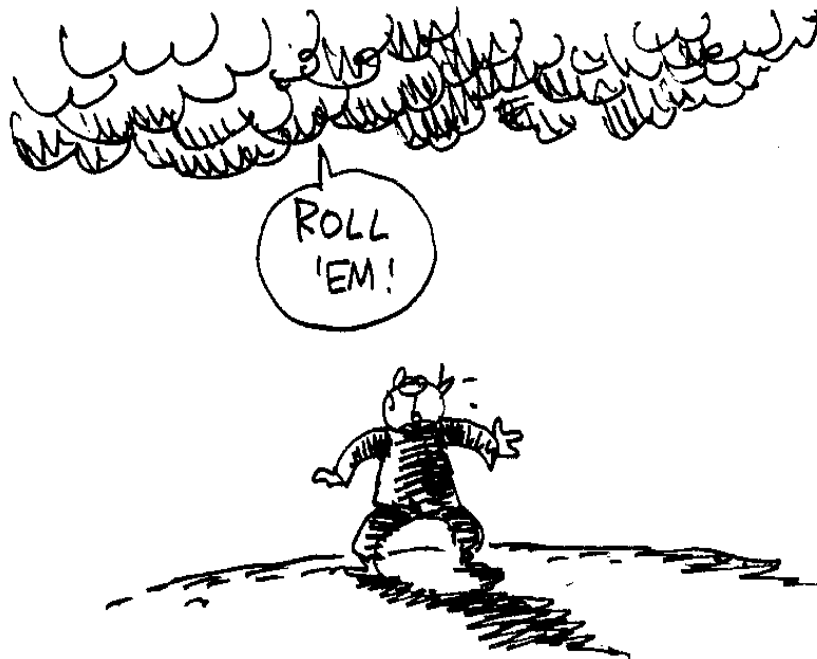
THIS CHAPTER CONCENTRATES ON DATA DESCRIPTION. HOW CAN WE REPRESENT DATA IN USEFUL WAYS? HOW CAN WE SEE UNDERLYING PATTERNS IN A HEAP OF NAKED NUMBERS? HOW CAN WE SUMMARIZE THE DATA'S BASIC SHAPE?



Probability

NOTHING IN LIFE IS CERTAIN. IN EVERYTHING WE DO, WE GAUGE THE CHANCES OF SUCCESSFUL OUTCOMES, FROM BUSINESS TO MEDICINE TO THE WEATHER. BUT FOR MOST OF HUMAN HISTORY, **PROBABILITY**, THE FORMAL STUDY OF THE LAWS OF CHANCE, WAS USED FOR ONLY ONE THING: **GAMBLING**.





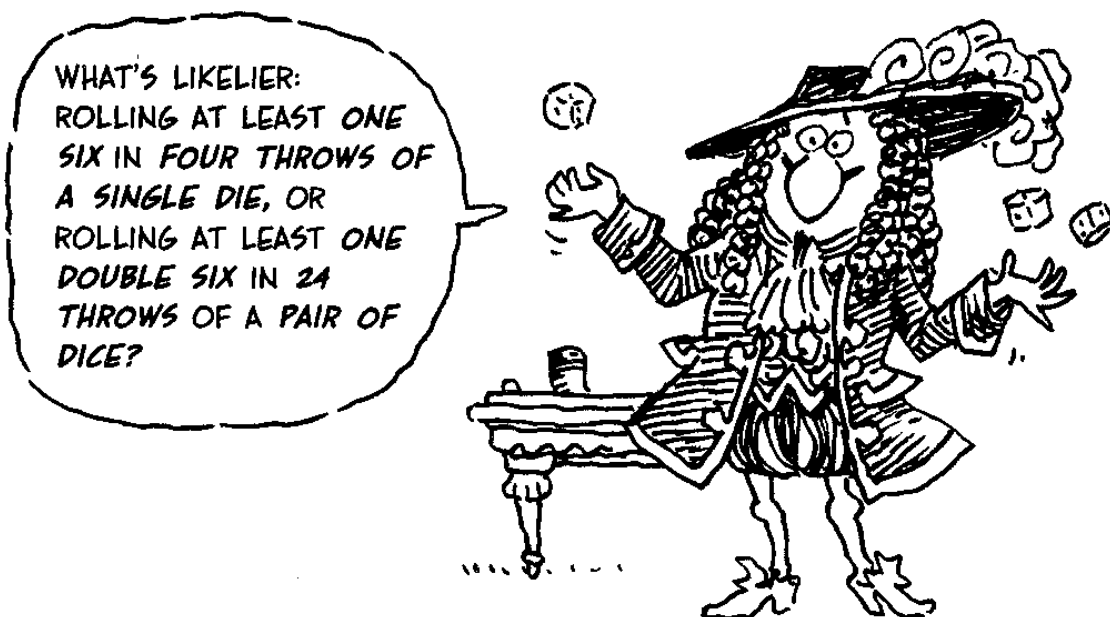
NOBODY KNOWS WHEN GAMBLING BEGAN. IT GOES BACK AT LEAST AS FAR AS ANCIENT EGYPT, WHERE SPORTING MEN AND WOMEN USED FOUR-SIDED "ASTRAGALI" MADE FROM ANIMAL HEELBONES.



THE ROMAN EMPEROR *CLAUDIUS* (10 BCE-54 CE) WROTE THE FIRST KNOWN TREATISE ON GAMBLING. UNFORTUNATELY, THIS BOOK, "HOW TO WIN AT DICE," WAS LOST.



MODERN DICE GREW POPULAR IN THE MIDDLE AGES, IN TIME FOR A RENAISSANCE RAKE, THE *CHEVALIER DE MERE*, TO POSE A MATHEMATICAL PUZZLER:

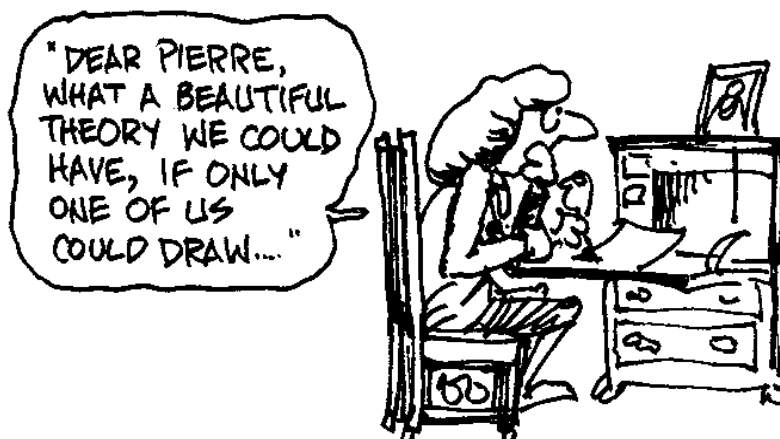


DE MERE PUT THE QUESTION TO HIS FRIEND, THE GENIUS *BLAISE PASCAL* (1623-1666).



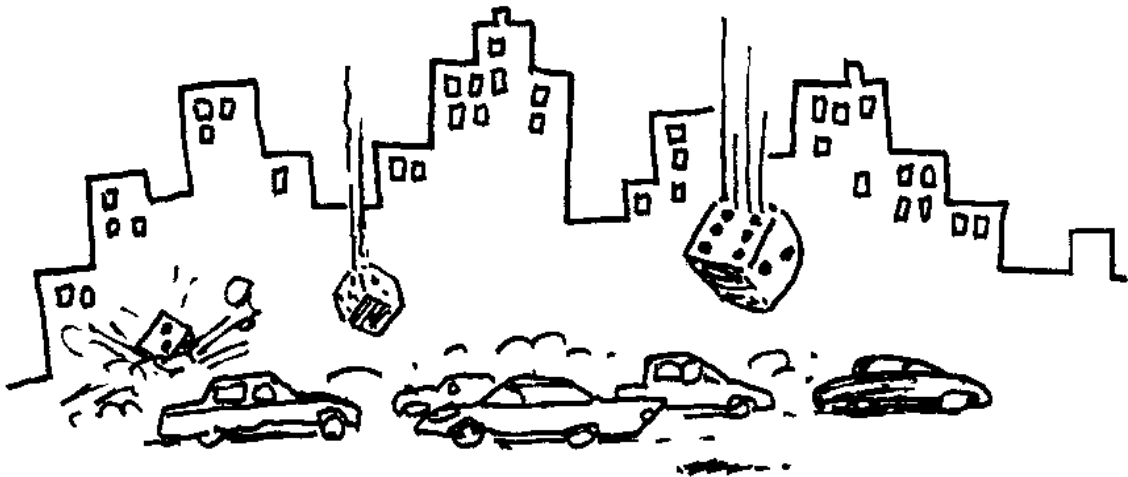
ALTHOUGH PASCAL HAD EARLIER GIVEN UP MATHEMATICS AS A FORM OF SEXUAL INDULGENCE (!), HE AGREED TO TACKLE DE MERE'S PROBLEM.

PASCAL WROTE HIS FELLOW GENIUS *PIERRE DE FERMAT*, AND WITHIN A FEW LETTERS, THE TWO HAD WORKED OUT THE THEORY OF PROBABILITY IN ITS MODERN FORM—EXCEPT, OF COURSE, FOR THE CARTOONS.

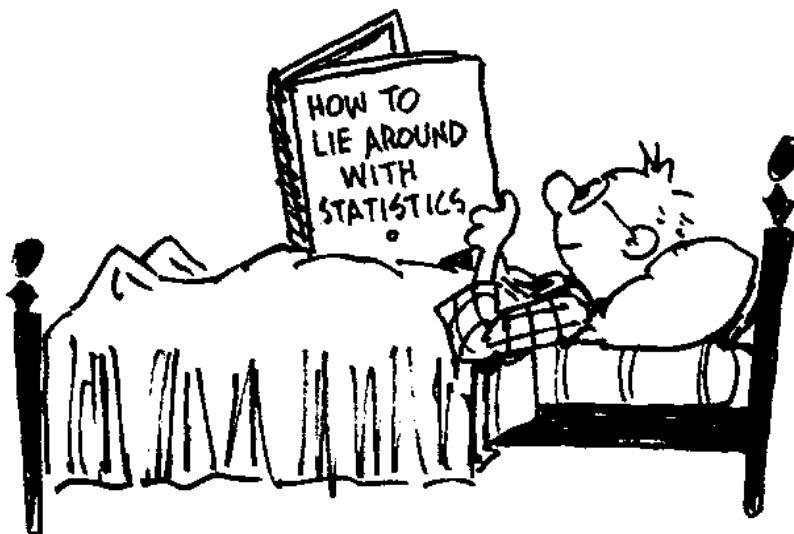


Statistical Inference

BY NOW, AFTER A STEADY DIET OF COINS, DICE, AND ABSTRACT IDEAS, YOU MAY BE WONDERING WHAT ALL THIS STATISTICAL EQUIPMENT WE'VE BEEN BUILDING HAS TO DO WITH THE REAL WORLD. WELL, NOW WE'RE FINALLY GOING TO FIND OUT...



IN THIS CHAPTER, WE BEGIN LOOKING AT THE REAL BUSINESS OF STATISTICS, WHICH IS, AFTER ALL, TO SAVE PEOPLE TIME AND MONEY. PEOPLE HATE TO WASTE TIME DOING UNNECESSARY WORK, AND ONE THING STATISTICS CAN DO IS TELL US EXACTLY HOW LAZY WE CAN AFFORD TO BE.



IN **DEDUCTIVE REASONING**, WE REASON FROM A HYPOTHESIS TO A CONCLUSION: "IF LORD FASTBACK COMMITTED MURDER, THEN HE WOULD WIPE THE FINGER-PRINTS OFF THE GUN."

INDUCTIVE REASONING, BY CONTRAST, ARGUES BACKWARD FROM A SET OF OBSERVATIONS TO A REASONABLE HYPOTHESIS:



IN MANY WAYS, SCIENCE, INCLUDING STATISTICS, IS LIKE DETECTIVE WORK. BEGINNING WITH A SET OF OBSERVATIONS, WE ASK WHAT CAN BE SAID ABOUT THE SYSTEMS THAT GENERATED THEM.



LIKE A CLEVER POLITICIAN, WE HAVE AVOIDED CERTAIN **UNPLEASANT QUESTIONS**, SUCH AS A) WHAT DOES PROBABILITY *MEAN*? AND B) HOW DO WE ASSIGN PROBABILITIES TO OUTCOMES?

B-DUH, B-DUH... LET'S DISCUSS SOMETHING EASIER, LIKE GAYS IN THE MILITARY...



HERE ARE SOME APPROACHES THAT HAVE BEEN TAKEN:

Classical

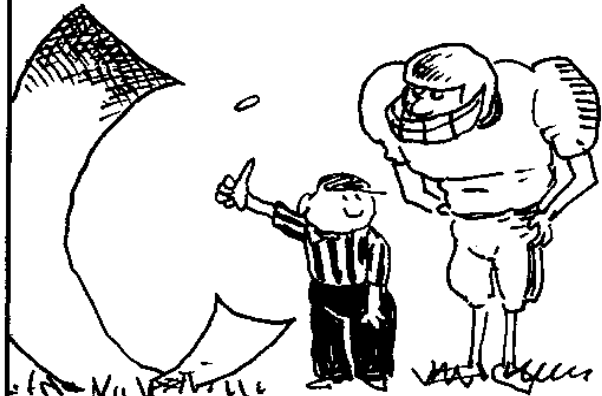
PROBABILITY: BASED ON GAMBLING IDEAS, THE FUNDAMENTAL ASSUMPTION IS THAT THE GAME IS FAIR AND ALL ELEMENTARY OUTCOMES HAVE THE SAME PROBABILITY.



C'MON! DADDY NEEDS A NEW THEORY!

Relative Frequency:

WHEN AN EXPERIMENT CAN BE REPEATED, THEN AN EVENT'S PROBABILITY IS THE PROPORTION OF TIMES THE EVENT OCCURS IN THE LONG RUN.



Personal

PROBABILITY: MOST OF LIFE'S EVENTS ARE **NOT REPEATABLE**. PERSONAL PROBABILITY IS AN INDIVIDUAL'S **PERSONAL ASSESSMENT** OF AN OUTCOME'S LIKELIHOOD. IF A GAMBLER BELIEVES THAT A HORSE HAS MORE THAN A 50% CHANCE OF WINNING, HE'LL TAKE AN EVEN BET ON THAT HORSE.



HOW DO YOU KNOW?

DA WISDOM OF DA TRACK...



AN **OBJECTIVIST** USES EITHER THE CLASSICAL OR FREQUENCY DEFINITION OF PROBABILITY. A **SUBJECTIVIST** OR **BAYESIAN** APPLIES FORMAL LAWS OF CHANCE TO HIS OWN, OR YOUR, PERSONAL PROBABILITIES.

HOW DO YOU KNOW THE ELEMENTARY OUTCOMES ARE EQUALLY LIKELY WITHOUT ROLLING THE DICE A BILLION TIMES?

WANNA BET?



OBJECTIVIST

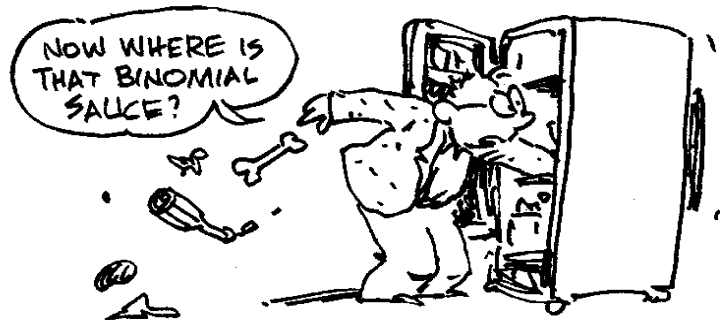


BAYESIAN

BUT WHAT MAKES STATISTICS ALMOST AS CHALLENGING AS COOKING IS THE VARIETY. LIKE AN EXPERT COOK, THE STATISTICIAN CAN "TASTE" THE INGREDIENTS IN A PROBLEM AND THEN FIND THE MOST EFFECTIVE WAY TO COMBINE THEM INTO A STATISTICAL RECIPE.



(THE REASON COOKBOOKS AND STATISTICAL METHODS TEXTS ARE SO HEAVY IS THAT THEY BOTH PROVIDE SOLUTIONS IN A GREAT VARIETY OF SITUATIONS!)

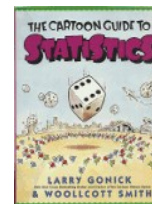


Now, you have a *good* knowledge of Statistics and Probability... Apply it!



Reference

The Cartoon Guide to Statistics
Larry Gonick and Woollcott Smith
Collins, 2005



Complutense University of Madrid

└ Faculty of Economic and Business Sciences

└ Department of Statistics and Operational Research II

└ David Casado de Lucas

15th February 2012



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