

Henry Rouanet, Jean-Marc Bernard,
Marie-Claude Bert, Bruno Lecoutre,
Marie-Paule Lecoutre, Brigitte Le Roux

New Ways
in Statistical Methodology
From Significance Tests
to Bayesian Inference

Preamble

Dialogue on the Great Systems of Statistics

Sagredo, an opinion pollster, consults his old friend Simplicio, Professor of Statistics, at the Mathematics Department of Lampione University, where Salviati, from Zanzara University, is visiting.

Sagredo (joyful) – I've got good news about the forthcoming election in our city. In my random sample of 1,000 electors, 545 people, i.e. 54.5%, support our friend Antonio. To be on the safe side, I have performed a statistical test. The departure of 54.5% from 50% is highly significant. So, although we can't be certain that our candidate is in the lead — after all, these are only sample data — the chances are on our side. Incidentally, my computer program gives me the exact significance level: $p = .002$ (one-sided), i.e. $1 - p = .998$.

The local media are outside waiting for us to make an announcement. How about telling them that our friend Antonio has 998 chances in 1000 of winning the election?

Simplicio (troubled) – Which statistical school do you belong to?

Sagredo (misunderstanding) – Have you forgotten? I studied at the Lampione School of Psychology, in the Hayes building on the

campus just opposite the Maths Department where you're now a professor.

Simplicio (*mezza voce, a parte*) – He must have been taught classical statistics.

(*to Sagredo, coldly*) – Remember what you were taught, my dear Sagredo: you don't have the right to talk about probabilities of hypotheses...

Salviati (*intervening*) – ... within the Neyman-Pearson framework...

Simplicio (*to Salviati*) – Sure, within the Neyman-Pearson framework.

Sagredo (*disappointed*) – I've also computed an interval at confidence .95 and found the limits (51.4%, 57.6%). I'm doubtless correct in saying that there are 95 chances in 100 that the percentage of people who support Antonio lies between those two limits, am I not?

Simplicio (*colder and colder*) – Excuse me for saying this, but — most definitely not! Again, remember that to speak of probabilities on parameters is not correct...

Salviati – ... within the Neyman-Pearson framework...

Simplicio (*nervous*) – ... within the Neyman-Pearson framework, of course.

Sagredo (*tenacious*) – All right, let me try another tack. Suppose I now randomly sample one further elector. Isn't the probability that that elector will support Antonio .545?

Simplicio (*impervious to argument*) – Not really, since probabilities cannot be calculated for single events...

Salviati – ... within the Neyman-Pearson framework...

Simplicio (*more and more nervous*) – ... within the Neyman-Pearson framework, naturally.

Sagredo (*baffled*) – That's weird! But then what the devil are the probabilities that we *can* talk about?

Simplicio (*loftily*) – Well, for instance, you may safely state in line with the accepted interpretation of confidence intervals that, using your method of calculating confidence limits, the probability that those limits will cover the unknown parameter value is .95.

Sagredo (quickly) – I don't see the difference between that and what I said earlier.

Simplicio (loftily) – Let me please expand on what I said. Suppose you carry out a huge number of polls, each time drawing a random sample and computing an interval at the same confidence level of .95, then, in the long run, about 95% of your intervals will cover the true value of the parameter (i.e. here the percentage of people who support Antonio.)

Sagredo (astounded) – Here is a sentence that surely sounds statistically correct! But are you counting on making an announcement to that effect to the media?

Besides — mind you — it seems to me to be irrelevant. I haven't carried out a huge number of polls on the forthcoming election, and I am certainly not going to do so. All I want, given what I do know, i.e. the data of the opinion poll I have carried out, is to assess the probability of what I don't know, i.e. the event that in the population of interest to us, more than 50% of people — or more than 51.4%, or whatever — support our candidate!

Simplicio – I'm very sorry — but probabilities of epistemic statements are forbidden — within the Neyman–Pearson framework, needless to say.

Sagredo (with resignation) – I didn't know I was that inclined to epistemics! At least I've learnt something — even though it doesn't help very much.

Simplicio –?

Salviati (smiling engagingly at Sagredo) –?

Sagredo (pensively) – I just can't remember the names of my statistics teachers at Hayes — presumably neither Professor Neyman nor Professor Pearson. Are you sure there were no other teachers of Statistics?

Salviati (quietly) – Dear Dr Sagredo, do you know that if you changed your “system of world”... I mean, if you went over to the Bayesian viewpoint, you would be in a position to make those epistemic statements that come naturally to you?

Sagredo (brightening up) – Oh! That sounds great! Tell me about this wonderful Bayesian system, quickly, before we tell the media.
Salviati – The story began in the Century of Enlightenment, with Bayes and Laplace. . .

Unfortunately, at this point, our friends are told that due to more pressing events elsewhere, the media have departed.

★

The present book is just the continuation of this dialogue. . .

Table of Contents

Foreword	
<i>Patrick Suppes</i>	v
Preface	vii
Preamble	xiii
Table of Contents	xvii
1. Statistics for Researchers	
<i>Henry Rouanet</i>	1
2. Statistical Practice Revisited	
<i>Henry Rouanet</i>	29
3. And... What about the Researcher's Point of View?	
<i>Marie-Paule Lecoutre</i>	65
4. Introduction to Combinatorial Inference	
<i>Henry Rouanet and Marie-Claude Bert</i>	97
5. From Significance Test to Fiducial Bayesian Inference	
<i>Bruno Lecoutre</i>	123
6. Bayesian Inference for Categorized Data	
<i>Jean-Marc Bernard</i>	159
7. Geometric Data: From Euclidean Clouds to Bayesian MANOVA	
<i>Henry Rouanet, Brigitte Le Roux, Jean-Marc Bernard</i> <i>and Bruno Lecoutre</i>	227
References	255
Index	271