Absolutely Bonkers

In which …

*The Nun discovers that randomness is
not all it's cracked up to be,*

*and that the answer might
actually matter – sometimes more than
the statistics,*

but that both can be accommodated.

It was inevitable, perhaps. The subject of systematic samples erupted from the paneled office of the official Statistical Officer. Vi sent a memo around the company, and suggested that such sampling procedures were not acceptable, based on scientific principles [1].

This time, The Nun didn't nip at the heels of OH. She attacked a project by Lem, who had suggested systematic sampling to a group of ecologists, and she brought up the fact that "any valid hypothesis test" would require a random sample - therefore "this unfortunate advice" should not be repeated in the future. In addition, she strongly implied that systematic samples were biased. Lem was grumpy. Another meeting was called. Dr. Smiley stayed home. This time it was just the main players. If she was to be outmaneuvered again, Vi did not want it done in front of the managers. OH had been right. She was able to learn - but not experienced enough to arrange the meeting when OH was out of the building.

Vi arrived with her stack of statistics books. The opposition was empty-handed. So far, everything was going well for her.

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[1] The details were missing from her memo. Presumably this was because the huddled masses would not understand them anyway. She thought it sufficient that divine guidance was provided, and that the answer was revealed.

"I can understand", she said, in as gracious a tone as she could muster, "that the *practitioners* [2] prefer to do systematic sampling. The advantages in cost, time and difficulty are obvious. I even understand that it is so much easier to spot a missing data point on a map. My concern, however, is about the sampling error calculations that are critical to analyzing the data".
"I see", said Lem, "and I feel your pain". She ignored this, and continued.

"My first point, she said, "is that there is a problem with the bias in systematic samples. As you can see from some of the pages I have marked in these texts, this can be a problem and I think we want to avoid it".

"Don't be daft", said Lem. "Systematic samples, just like many other samples that are done correctly, are certainly <u>not</u> biased. All that is required is that the items have the same long-run probability of selection ". The Nun bristled a bit when it was suggested that her near-biblical text references were inappropriate or even incorrect.

OH did her the courtesy of quickly scanning the pages. "I am familiar with the material you are referring to here, Vi", said OH. "They are all examples where something vaguely 'systematic' was done, but done *incorrectly* so that the probabilities of selecting observations were not equal. There is absolutely <u>no</u> doubt that when the probabilities are equal (as in Lem's study) the estimate is unbiased. You have not read these pages carefully enough. If you doubt this, I can give you the phone numbers of the authors and you can ask them directly". This astonished Vi. Were these people still alive ? Who would have thought of just asking them ?

OH continued. "Samples in which some parts of the process are random while other parts are not random have the same problem. The selection probabilities can be unequal, so the *overall* selection probabilities are not correct – and therefore the samples are biased. It happens all the time. It's not a problem with 'randomness'. The discussion here today should assume correct procedures."

I sense thin ice, Vi thought. *Best to keep moving*. "My second point moves into the serious statistical realm", she announced [3]. "With systematic samples we cannot compute valid Standard Errors. That eliminates any valid scientific hypothesis tests. She pronounced the term "scientific" with reverence.

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[2] By this she meant "the little people" who merely went out into the cold and dangerous hinterland to bring back the raw data for her to bless.

[3] Imagine this conceit - as if data was created only to allow complicated and "serious" statistical manipulation, rather than mere averages. Dr. Smiley had done Vi no favors at school, and she had lost sight of the importance of averages.

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"Look, sister", said Lem. "Nobody cares about hypothesis testing. The ecologists are trying to find the average here, and nobody even contemplates computing other statistics. Didn't you read the study plan?". She had not, of course, and she could not imagine stopping the analysis at the point of only having a simple average.

"What's more" said Lem, "the managers *don't want* to see statistics. They all had a miserable time in statistics class at business school and are looking for a dog to kick. If you start spouting that stuff they will start kicking at *you*. They want the answer, and they want someone to say something like '… *and the data is adequate to make decisions with. The details are in this stack of material and it <u>could</u> be put up on the projection screen if you want to spend the time'*. The chairman will <u>not</u> want that. You have done them the courtesy of doing the detailed analysis while sparing them the tedious bits. They want to depend upon your personal credibility to know that they can use the numbers in examining the bigger picture."

Not want to see the statistics?, thought The Nun. *How could anyone feel that way? Best to keep moving* ...but OH interrupted again.

"You might want to read those sections again", said OH. "What they say is that a *single* systematic sample does not offer any estimate of the Standard Error, just as (usually) a single observation of any kind would not. You could perfectly well do a hypothesis test using an <u>assumed</u> Standard Error. You don't require the <u>data</u> Standard Error to do a hypothesis test."

Darn, she thought, *perhaps I should have read all the way through this project material before I shot off the memo*. She vaguely remembered that you could do a hypothesis test with an assumed Standard Deviation (and thereby an assumed Standard Error). It was never done in school, of course. She remembered that a Binomial average implied a Standard Error at the same time, but could not quite see how this applied. Was that estimate for random or systematic samples?[4] *Best to keep moving ....*

"Well in this case we only have a set of measurements from <u>one</u> grid", she announced, "and therefore we have a problem. Technically the answer is a 'cluster' which provides only one observation. I admit that if we had several independent grids on that area we could get a valid sampling error, but that is not the case here".

OH agreed. "It's true that a solitary systematic sample will not provide a valid Sampling Error statistic (that nobody wants) to do hypothesis testing (that nobody wants), but the point is that we are virtually certain to get a *better average* (which everybody <u>does</u> want). A decision <u>will</u> be made

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[4]   It was for random samples – systematic samples typically have better precision. Although exceptions can be constructed, they never seem to occur on the ground.

based upon that average (regardless of the Standard Error), and we want the best estimate possible. If we had cared about the other options, we would have used several grids. At worst, we would compute a Sampling Error estimate that is <u>virtually certain</u> to be too large (and therefore conservative) by using the standard equation for random sampling.

Lem defended his approach. "We took the precaution of doing a simple simulation, and once the bugs were worked out of the computer code we were able to estimate that when we geographically spread out the samples they were 8 times more efficient than when we used a random sample. It would have been 15 times better if we had pre-sorted the data based on rough estimates of the measured characteristics [5] but we used a simple grid because the psychology was so much better". *Psychology*, thought The Nun, *what's that got to do with it?* The point is that everything that we know about the process indicates that we will get a <u>much</u> better answer with this process, and it is clearly unbiased".

"Well, perhaps I was hasty", Vi admitted. "I can see your point. I would like to reread some of this material, and maybe this process is OK. Perhaps I should have asked you directly".

"Too late, I am afraid", suggested OH. "Your Vice-President has already had lunch with the CEO, and the ecologists have been told 'from on high' to take random samples. They are now faced with 8 times the cost per unit of precision that they want to obtain. No doubt they will remember you in their wills."

"This meeting is over", announced OH.

He and Lem then went off to one of their weekday lunches, where they often discussed how things happened in the company.

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[5] As they say – "your results may vary". Check it out.

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"That girl <u>does</u> show promise", said OH, who was actually quite upbeat during lunch. "Did you see how quickly she picked up the fact that you could use several grids and get a valid Standard Error ?. It was poor preparation going in, but a pretty fair recovery on the spot."

"She's an unctuous twit", replied The Kid. He was thinking of the botched project design. At this late stage it couldn't be fixed without embarrassing upper management - and that was <u>not</u> about to happen for the amount of money wasted. He could only hope to make sure that the ecologists were well aware that it was not his own error. Still, it reflected badly on everybody who did statistical work.

"No", suggested OH. "She's not hopeless, just hapless. She's been raised badly (in the professional sense). We all need a little adjustment early in the career when we are young and stupid".

He stared pointedly at Lem for a moment. *Yes*, Lem thought, *I do remember being there not so long ago. Message received*.

"I don't think she will be sending many unseen memos of the same sort. She needs some calibration and she has a way to go yet, but there is always the hope of redemption".

Note to readers ... the next chapter is about adjusting the inventory of land added to the company.