Theory versus Practice, Intangibles, Intuition, and the Usefulness of Imperfection

Tallys Yunes, March 2018

Theory versus Practice: A Challenge

It was a rainy Saturday afternoon...

"Ready? Go!"

As she reached for her pencil and began scribbling, I opened an empty Excel spreadsheet and started typing in the data and thinking out loud.

"Eight integer variables, three constraints, plus lower and upper bounds. How is it going over there?"

"I'm doing OK. Let me think."

A minute later, I click "Solve" and declare victory.

"There you go: \$2.80. Can't beat that!"

"Five buns? Do you expect people to eat a burger with five buns?"

"Hmm...you're right. One more constraint... voilà \$2.62. The best burger on the market! What did you get?"

"Mine costs \$2.61."

"I win! Ha, ha!"

"But look at your burger! Nobody would ever want to eat this crap. Mine is much more appetizing."

As I reluctantly examined the two solutions, there was no denying the obvious.

That was me and my wife solving the Good Burger puzzle [1]. The challenge is to create the most expensive burger out of a given set of ingredients such as beef patties, cheese, lettuce, tomato, etc., while keeping sodium, fat, and calorie counts in check. Her hand-calculated solution was suboptimal by one cent. It was technically worse than mine, but what does optimality really mean in practice?

Optimality or Bust?

Once upon a time, at the board meeting of a for-profit company...

"Today, I'm excited to report the results from the cost-cutting initiative that my team of analytics experts developed over the last six months. We managed to produce a solution to our problem that improves profits by 6%."

"But is this solution optimal?"

Said no one ever after hearing "improves profits by 6%."

Intangibles and Intuition

The two anecdotes above illustrate an important idea that I emphatically stress to my students every spring semester: models aren't perfect, and that's perfectly OK. There's a reason why business analytics is known as "the science of better" rather than "the science of provably optimal." More often than not, it is impossible to capture all nuances of a real-life problem into a mathematical model. Therefore, solutions produced by such a model are to be taken with a grain of salt and cautious optimism. Do these numbers still make sense after the omitted intangibles are brought back into the picture? If so, great. If not, can we slightly modify the solution? Do we need to revise the model? When building my burger, I ignored flavor considerations and overall gastronomic appeal, whereas my wife didn't.

Another matter with which non-experts struggle is keeping their intuition from negatively affecting their modeling choices. Or, as I like to say in class, "don't try to *solve* the problem; focus on *representing* the problem." A mathematical model is a translation, say, from English to formulas, of the story that warrants investigation. Letting your understanding of the story bias you into thinking the solution should/shouldn't look a certain way, and adding that assumption into your model, can be detrimental. As humans, we tend to think intuitively, which in turn limits the universe of possibilities we look at. Good solutions to complex problems can be, at least at first sight, counterintuitive. Make sure your model has the freedom to consider "weird" courses of action as well.

The Usefulness of Imperfection

Imperfect models create imperfect solutions that can still be useful. Having a solution in the ballpark of good answers is better than looking at a blank slate and not knowing where to begin. Solving a model many times with a range of input values improves your understanding of how certain numbers relate to others. As your understanding of the problem improves, that (initially) counterintuitive solution starts to make sense. Improved understanding leads to revising your initial assumptions and even realizing that what you thought mattered is secondary. What really matters is this other number to which you didn't pay much attention to begin with. In extreme cases, this first model may lead you to conclude that you need to create a completely different model to solve a completely different problem, and that's OK too! You are *learning* about your problem in the process of trying to solve your problem. Finally, it may very well be that your problem, as originally stated, has no solution. This would have been difficult to detect by hand because complex problems have several moving parts with intricate relationships of cause and effect. Having a model whose output says "infeasible" can be a valuable tool in a meeting. It is concrete proof that the original question and/or assumptions are inconsistent in some way.[1] From there, it will be a much shorter path to convincing people to revise the question/assumptions than it would have been otherwise. Who would have thought? Modeling also makes your meetings more efficient!

References

[1] John Toczek. "Good Burger." *The PuzzlOR: Decision Support Puzzles for the Applied Mathematician*. August, 2014. http://www.puzzlor.com/2014-08_GoodBurger.html.

[1] Assuming there's no mistake in the model, of course.