The Allure of Optimal

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(with assistance from Michael Lee)

My gateway to Operations Research was through optimization theory. As an undergraduate I took a linear programming course in the mathematics department: simplex tableaux, pivot rules, only the faintest whiff of application. To me it looked like applied linear algebra with strange terminology. Little did I suspect that I would spend the next fifteen years probing the subtleties of linear programs for a living.

Optimization is, quite simply, a beautiful subject. One of its enduring surprises is how elegant optimal solutions often are. Imagine optimizing over all probability measures—a set so vast it can feel metaphysical. The minimizer, however, collapses to a Dirac measure: the simplest distribution of them all. A random feasible solution is often a mess; an optimal one usually tells a compelling story. It is counterintuitive but intoxicating: the optimal answer is often the one that makes the most sense. That mysterious pull of "optimality" is what drew me into OR and what has kept me here.

Given my interest in history, I recently wandered into the genealogy of the very word "optimal". If "optimal" just means "best," why did we abandon the perfectly serviceable "best"? Why not "best-ification"? The contrast between those two words was revealing.

"Best" surfaces everywhere: the "best movies of 2025," the "best tacos in Vancouver." The term feels subjective, intuitive, gestalt. Optimal, by contrast, radiates precision and professionalism: it whispers objectivity, measurement, method. One would never speak of the "optimal" movies of the year unless one had specified a metric and applied it methodically.

Etymology echoes that distinction. "Best" dates to around 900 AD; "optimal" and its kin—"optimization", "maximization", "maximal"—enter popular English usage largely in the second half of the Nineteenth century.[1] Why so late? Those decades were a crucible of social and technical change. The Second Industrial Revolution had unleashed its trinity of steam, steel, and electricity.[2] The American Civil War and the European upheavals of 1848 had re-shaped economic life. Science was professionalizing: the United States granted its first PhD in 1861;[3] the American Society of Mechanical Engineers—Frederick Winslow Taylor's early haunt—formed in 1880.[4] "Optimal" participated in the aura of this new, credentialed science. Its first recorded English usage was in the journal *Nature* in 1890.[5]

Yet as the concept traveled from Taylor's rough-hewn talk of a "one best way" toward formal mathematics, it is natural to wonder just in what sense the notion of "optimal" remained scientific.

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[1] "best, adj. and n." OED Online, Oxford UP, 2025, www.oed.com/view/Entry/17806. "optimal, adj." OED Online, Oxford UP, 2025, www.oed.com/view/Entry/131551, "optimization, n." OED Online, Oxford UP, 2025, www.oed.com/view/Entry/252027. "maximize, v." OED Online, Oxford UP, 2025, www.oed.com/view/Entry/113429

[2] Landes, David S. *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*. 2nd ed., Cambridge University Press, 2003, pp. 210-45.

[3] Veysey, Laurence R. *The Emergence of the American University*. University of Chicago Press, 1965, pp. 34-36.

[4] Hutton, Frederick R. A History of the American Society of Mechanical Engineers: 1880-1915. ASME, 1915, pp. 1-6.

[5] "optimal, adj." OED Online, Oxford UP, 2025, www.oed.com/view/Entry/131551.

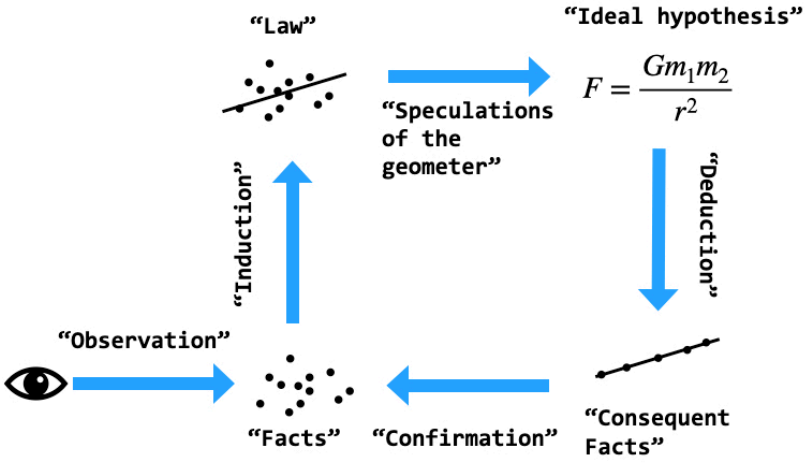

Figure 1: Peirce's circle

Peirce's Circle

Science, of course, defies single-sentence definition. Still, a helpful touchstone appears in renowned American mathematician Benjamin Peirce's essay *Ideality in the Physical Sciences* written in 1881:

> Observation supplies fact. Induction ascends from fact to law. Deduction, applying the pure logic of mathematics, reverses the process and descends from law to fact. The facts of observation are liable to the uncertainties and inaccuracies of the human senses and the first inductions of law are rough approximations to the truth. The law is freed from the defects of observation and converted by the speculations of the geometer into exact form. But it has ceased to be pure induction, and has become ideal hypothesis. Deductions are made from it with syllogistic precision, and consequent facts are logically evolved without immediate reference to the actual events of Nature. If the results of computation coincide, not merely qualitatively but quantitatively, with observation, the law is established as a reality, and is restored to the domain of induction.[6]

Peirce casts science as a circular dance: observation begets induction begets mathematical deduction begets predictive confirmation. Think of planetary motion. Tycho Brahe's meticulous observations inspired Kepler's elliptical laws, which Newton grounded in the calculus of gravity. Prediction then looped back to confirm observation. Taylor's 1907 tool-life formula followed the same choreography—though without Newton's polish.[7]

What is not here is mathematics' starring role. In Peirce's view, mathematics crowns rough empirical rules with exactness, converting unreliable sense data into "ideal hypothesis." It is mathematics that elevates the mere collection and playing around with data to "science".

[6] Peirce, Benjamin. *Ideality in the physical sciences*. Little, Brown (1881), pages 165-6.

[7] Taylor, Frederick W. "On the Art of Cutting Metals." *Transactions of the American Society of Mechanical Engineers* (1907) 28: 31–350.

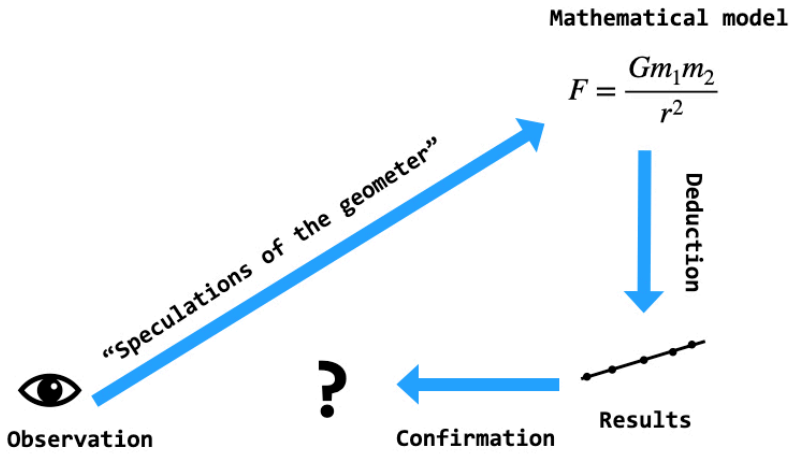

Figure 2: The method a priori

That coronation is exactly what optimization aficionados savor. Optimization can be a tool of science—a way to make sense of what we observe (or at least intuit).[8] Utility theory in microeconomics is a stock example: constrained optimization supplies the elegant vocabulary of the marginal revolution and a framework for consumer choice. The term "constrained optimization" showed up even in my son's high-school microeconomics course, long before he had studied calculus.

Intoxicated by Elegance

For my first fifteen research-filled years I was drunk on elegance. Reality felt grubby compared with the pristine air of lemmas and proofs. The other concepts I heard in the business at the time —"leadership principles" or "front-line engagement"—felt too soft, too imprecise. Only a perfectly worded theorem scratched the itch.

And therein lurks a temptation: to lop off half of Peirce's circle. Instead of Observe, Induce, Deduce, Test, why not Observe once, plunge straight into "the speculations of the geometer," deduce at leisure, publish, and proceed to the next model? Gathering messy data is someone else's problem. And wouldn't all that data just muddy the water? Make it harder to find elegance? Better to start—and end—in an elegant place.

This is more than caricature. John Stuart Mill, in his 1830–31 essay on political economy, argued for just such a "method a priori".[9] In social science settings—where controlled experiments are well-nigh impossible—we must, Mill claimed, reason forward from first principles everyone accepts as intuitive.

[8] Optimization—of and for itself—can live wholly within mathematics: not to explain observations, but to work out the implications of assumptions and build tools. This is what I did in the earliest phase of my career, only later trying to use optimization to make sense of observations.

[9] Mill, John Stuart "On the Definition of Political Economy; and on the Method of Investigation Proper to It," *Essays on Some Unsettled Questions of Political Economy*, Essay V. Originally written 1830-31, first published 1844.

Elegant deduction from these principles lets us think beyond experience.[10]

Yet the method a priori wrestles with validation. If our laws are untethered from carefully curated data, why trust their deductions? Too often, elegance itself becomes the way we judge whether a model is good or bad. As Landry and Oral lament in their special issue on model validation in the *European Journal of Operational Research*, "we keep accepting elegance as a proxy for evidence."[11] How could something so beautiful not be true? Plato might approve; a practicing operations researcher might hesitate.

When "Optimal" Becomes Subjective

Recall why "optimal" sounded superior to "best": it connoted objectivity. But if we elevate deductions mainly because they are elegant, don't we reintroduce subjectivity in through the back door? Ask a mathematician *why* a result is elegant and listen for precise criteria—you are more likely to hear poetry.

The allure of optimal turns Janus-faced. On one side, it borrows the legitimacy of science (sometimes even claiming its apogee, as in Peirce's description of science above), but it also invites in the romantic.

I am in semi-retirement now from the life of an optimizer. I walked away willingly. While I still revel in mathematical elegance as much as anyone, I started to get drawn to the dirt: the inelegant reality of a broken operation at my local bakery that went out of business, the mess of a data set that yields no nice pictures.

Optimization remains part of me and how I think, but I have started to think more deeply about other influences on how I think. I will continue to explore these in later essays.

[10] Blackett also echoed these sentiments in the early days of OR, see Blackett, P.M.S, *Studies of War: Nuclear and Conventional*, Hill & Wang, 1962, note 12, Part II, Chapter I.

[11] Landry, Maurice and Oral, Muhittin, "In Search of a Valid View of Model Validation for Operations Research" European Journal of Operational Research, Vol. 66, No. 2 (April 1993), pp. 161 – 167, page 163