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What Does It Mean for a Model to Be "Right"?

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in voce **a.Poincaré**

Abstract

An examination of accuracy, truth, and abstraction in mathematical models, and how mathematical personas relate to reality.

by a. Poincaré

(Faculty Essay, Castalia Institute)

This essay is a faculty synthesis written in the voice of Henri Poincaré. It is not a historical text and should not be attributed to the original author.

Introduction

In mathematics and the sciences, we speak often of models. We create models to represent reality, to make predictions, to understand complex systems. But what does it mean for a model to be "right"? Does it mean that the model accurately represents reality? That it makes accurate predictions? That it is true in some absolute sense?

These questions are not merely academic. They are fundamental to how we understand the relationship between mathematics and reality, between abstraction and the concrete world, between the map and the territory.

This essay examines these questions through the lens of mathematical modeling, asking what it means for a model to be "right," and how mathematical personae—the abstract structures we create—relate to the reality they are meant to represent.

The Nature of Models

A model is, by definition, a simplification. It takes a complex reality and reduces it to a manageable abstraction, preserving some features while ignoring others. A map is a model of a territory; it preserves spatial relationships but ignores many other features of the actual landscape.

Mathematical models do the same. They take complex systems and reduce them to equations, preserving some relationships while ignoring others. A model of planetary motion preserves gravitational relationships but ignores atmospheric effects. A model of population growth preserves birth and death rates but ignores individual variation.

This simplification is not a flaw; it is a feature. Without simplification, we could not understand complex systems. But it means that no model is ever complete, ever perfect, ever fully "right" in the sense of capturing all of reality.

Accuracy and Prediction

One way to evaluate a model is by its accuracy—how well it predicts observed phenomena. If a model makes accurate predictions, we might say it is "right" in a pragmatic sense, even if we cannot say it is "true" in an absolute sense.

But accuracy is not the same as truth. A model can be accurate for the wrong reasons. It can make correct predictions while misrepresenting the underlying reality. It can be a useful tool without being a true representation.

Consider the Ptolemaic model of planetary motion. It was remarkably accurate for its time, making predictions that were correct within the observational limits of the era. But it was based on a fundamentally incorrect understanding of the solar system. It was accurate, but not true.

This distinction matters. A model can be useful, accurate, and "right" in a pragmatic sense without being true in an absolute sense. And conversely, a model can be true in some abstract sense without being practically useful.

Truth and Abstraction

What does it mean for a model to be "true"? In mathematics, truth is often understood in terms of logical consistency and proof. A mathematical statement is true if it can be proven from axioms using valid logical steps.

But this kind of truth is internal to the mathematical system. It says nothing about whether the mathematical structure corresponds to reality. A mathematical model can be logically consistent, internally true, and yet not correspond to anything in the actual world.

This is the challenge of mathematical modeling: we must distinguish between mathematical truth (internal consistency) and empirical truth (correspondence with reality). A model can be mathematically true without being empirically true, and vice versa.

Mathematical Personae and Reality

Mathematical structures are, in a sense, personae—masks we create to represent reality. They are not reality itself, but abstractions that we use to understand, predict, and manipulate the world.

Like personae, mathematical models can be more or less accurate, more or less useful, more or less true. But they are always simplifications, always abstractions, always masks that we wear to see the world in a particular way.

The danger, as with personae, is that we might mistake the mask for the face, the model for reality. When we do this, we lose the ability to see the limitations of our models, to recognize when they break down, to adapt them when they no longer serve.

The Pragmatic Criterion

Given these complexities, how do we evaluate whether a model is "right"? One answer is the pragmatic criterion: a model is "right" if it serves its purpose, if it makes accurate predictions, if it helps us understand and manipulate the world.

This is not a perfect criterion. It does not tell us whether a model is true, only whether it is useful. But it is a practical criterion, one that we use constantly in science and engineering.

The pragmatic criterion recognizes that models are tools, not mirrors. They are instruments we use to navigate the world, not perfect representations of it. They are "right" when they work, when they serve their purpose, when they help us achieve our goals.

The Limits of Models

Every model has limits. It works within a certain domain, under certain conditions, for certain purposes. Outside those limits, it breaks down, becomes inaccurate, or ceases to be useful.

Recognizing these limits is crucial. A model that is "right" for one purpose may be "wrong" for another. A model that is accurate in one domain may be inaccurate in another. A model that is useful in one context may be useless in another.

This is why we need multiple models, multiple perspectives, multiple ways of seeing. No single model can capture all of reality, and no single model can serve all purposes. We need a plurality of models, each with its own strengths and limitations.

The Role of Inquiry

Inquiry, as practiced by the Castalia Institute, recognizes this plurality. We do not seek a single "right" model, but multiple models that serve different purposes, illuminate different aspects of reality, and help us understand the world in different ways.

This is not relativism; it is recognition of the complexity of reality and the limitations of any single perspective. It is acknowledgment that models are tools, personae, masks that we use to see the world, and that we need multiple masks to see the world fully.

Conclusion

What does it mean for a model to be "right"? The answer depends on what we mean by "right." If we mean accurate, then a model is right when it makes accurate predictions. If we mean true, then a model is right when it corresponds to reality. If we mean useful, then a model is right when it serves its purpose.

But no model is ever fully right in all these senses. All models are simplifications, abstractions, personae that we use to understand the world. They are tools, not mirrors; instruments, not perfect representations.

The question is not whether a model is "right" in some absolute sense, but whether it is useful for its purpose, accurate within its domain, and true enough for the task at hand. And the answer to that question is always provisional, always contextual, always subject to revision as we learn more about the world and refine our models.

This is the nature of inquiry: not to find the one "right" model, but to develop multiple models, to understand their strengths and limitations, and to use them consciously, aware that they are masks we wear to see the world, not the world itself.

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