

# ***A Simulation and Critique of Asimov's Foundation Series: What Works and Fails***

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## **Introduction**

Science fiction author Isaac Asimov wrote several fictional stories and books known as the *Foundation* series which involved a science of human history that could also predict the future course of humanity. The title “Foundation” refers to a fictional scientific association in those stories.

Why is the Foundation even worth discussing among serious social scientists? The Foundation series is one of the most prominent works of fiction to describe a science of human history and futurism. It has influenced many people including societal leaders, such as Industrialist Elon Musk and Nobel Prize-winning economist Paul Krugman. Krugman tells “The ‘Foundation’ trilogy had a huge impact on my teenage self ... I wanted to be the brilliant mathematician who leads the effort; this economics thing was as close as I could get.”

What about other folks? Here are some quotes taken from Reddit:

“The message in the Foundation series was pretty unique: that major problems in society could be solved with intelligence and technology, and even politics, not violence” (Technical-Platypus-9, 2021).

“As a kid the Foundation series placed an idea in my mind: that competence, intelligence, and original thinking can occasionally triumph” (Traditional\_Mud\_1241, 2021).

“They made me look at the big picture, think of consequences of long-term movements.” (SinnerP, 2021).

Since this series is being portrayed on Apple TV starting in September 2021, a scientific understanding and critique is especially timely. However, this paper chiefly refers to the books. The earliest Foundation stories are about eighty years old, so I will spare you from spoiler alerts. Discussing the books will disclose nothing of significance regarding the television series.

## **What Is The Foundation series?**

The Foundation series began as several short stories written in the 1940s for a science fiction magazine. Science fiction author Isaac Asimov read Edward Gibbon's entire *Decline and Fall of the Roman Empire*. Consequently, he decided to write a short story about the fall of a Galaxy-wide empire.

The Foundation describes a group of university mathematicians led by a Dr. Hari Seldon who live on the capital planet Trantor of a Galactic Empire. This Empire takes place in our own Milky Way galaxy, over 12,000 years into the future. The mathematicians develop a hybrid science of mathematical history and futurism called psychohistory and foretell that the 12,000-year-old empire will unavoidably completely collapse in just three centuries. The mathematicians manage to get 100,000 of their followers, chiefly physical scientists and their families, sent to the edge of the galaxy on a planet called Terminus.

The imperial collapse is gradual, but it begins at the edges. Hence, this settlement of scientists find themselves cut off and surrounded by newly-independent, but technologically-backward and hostile kingdoms who would like to annex Terminus and its Foundation of scientists.

However, Seldon has foreseen this crisis, and that a political class would arise who would be able to leverage the Foundation's scientific advanced know-how into gaining power over the surrounding kingdoms. The Foundation then goes through a series of foreseen crises. In each crisis, the source of power over surrounding territories changes, as does the nature of governance of the Foundation itself.

## **Social and Historical Context of Original Series**

Foundation author Isaac Asimov was born in Russia to Jewish parents in 1920. He emigrated to Brooklyn with his family at the age of 3. He received a PhD from Columbia and became a professor of biochemistry at Boston University Medical School. (Sagan 1992).

The Foundation stories were written towards the end of World War II. The wake of World War Two was a time of optimism and hope. Despite the upcoming Korean War, the USA was full of elan and rapid economic growth. The late 1940s and much of the 1950s was a time of unparalleled prosperity for many blue collar workers and other Americans. It certainly must have felt that way compared to the great Depression and early years of the World War II. University life in the USA was rapidly growing.

Technical technological advances continued at the fast pace seen earlier during the industrial revolution. Technology was a major factor in winning World War Two. Yet, at that time, there were no personal computers or satellites or people in space. The European colonial empires were falling, and economic liberalism was in theory the nature of the new US global empire. Most people were horrified by the destruction, death and carnage of the world wars, so it was natural to look for a better approach. Such was the environment in which the Foundation stories were conceived and written.

### **A Few Comments on the Fictional Science**

Let's begin with perhaps the most fictional aspect of this work: the science. This series takes place in our own Milky Way galaxy which is 104 million light years in diameter. That means it would take 104 million years for communications from one end of the galaxy to reach the other end. In the series, the capital planet of the empire, Trantor, is in the galactic center. So even communications from the capitol would take 52 million years to reach the edges, and another 52 million years to get back.

That wouldn't make for either a pragmatic empire or for a good story, so it is assumed "space jumps" exist that can skip across many millions of light years in a few seconds. There is no other way the book works. Hence, a galaxy-wide empire is not likely to exist, or else we might already be paying it taxes. But let's give Asimov this one, so we can continue with our analysis.

Another problem is that some entities in the books have been using fossil fuels for long periods of time. Even in the 1940s, forward-thinking scientists knew about potential climate change and that fossil fuels were not renewable. While metals are valuable and sometimes scarce in this series, both fossil fuels and nuclear fuels appear to be available in perpetuity and without consequences. The neglect of these issues may have been emblematic of the times in which the stories were written.

### **More Comments On The Fictional Social Science**

Let us now delve into the social science.

The author clearly applies some of his chemistry training to the fictional science of history portrayed in the stories, which discusses modeling large populations of humans in a similar manner to a large collection of particles in a gas.

A well-mixed gas will have certain overall characteristics such as temperature and pressure. Forces applied to that gas will generally have predictable effects on those quantities.

In thermodynamics, larger quantities of particles tend to be easier to model because individual particles become increasingly less significant.

Also, changing the state of a very large quantity of particles requires much more force or energy than doing so for a small quantity of particles.

What if this same approach could be used to model the progression of human history and future society?

Asimov's psychohistory assumes that humans in society can be modeled in a similar nature to particles of gas. Psychohistory asserts that the behavior of a collection of larger quantities of humans is more difficult to change. In general, this is true. This is why such big advertising budgets are often required to get large quantities of people to buy a lot of a new product.

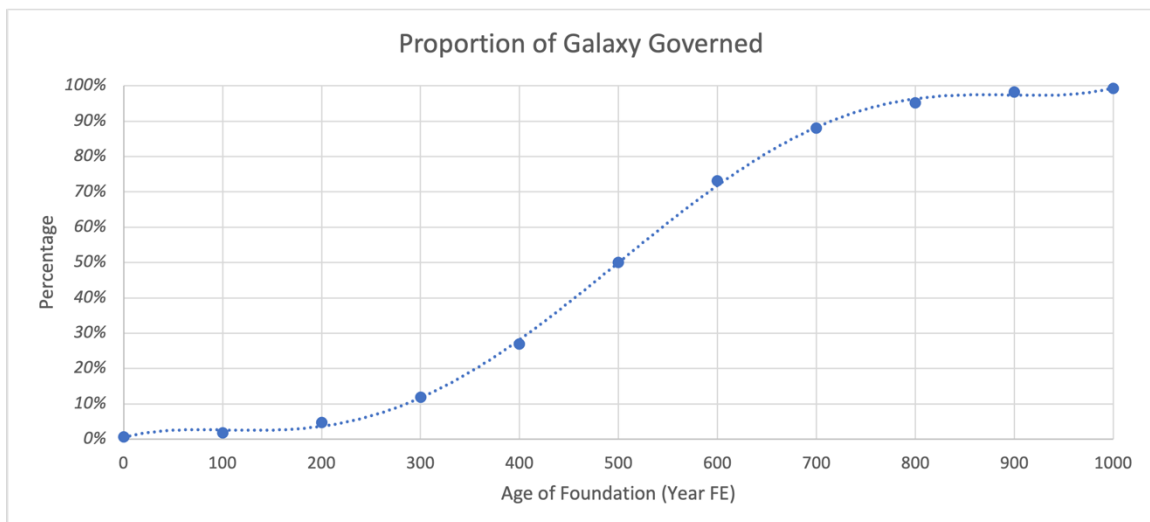
Is this always true? Perhaps not. Especially with new social technologies, sometimes behavior can be quickly changed, at least in the short run, such as after the publicizing of the George Floyd killing, although the long-term effects of those changes remain to be seen. Arguable, there needs to be a pre-existing potential for rapid change to occur, and the build-up of such a potential might be foreseeable and subject to modelling.

### Simulations of Asimov's Foundations

Asimov provides enough information to run several rough simulations.

#### Growth of the Foundation

According to early stories in the Foundation book series, the Foundation would start with governing just one planet and then, over the next thousand years, grow to govern one hundred percent of the galaxy (25 million worlds). Without much more information than that, a standard logistic curve is traditionally used to model growth where there is a limit. Here, the limit is the habitable planets contained in our galaxy. There is nothing in those early stories to either reject this model or categorically adopt it.



## Accuracy

First, let's examine the claims for the accuracy of psychohistory. These stories are intended as social science fiction, and the accuracy of this fictional social science would probably be just that: fiction. However, let's play along for the sake of a simulation.

Hari Seldon, the founding mathematician of psychohistory, claims that:

- 'my figures show a ninety-eight point four percent probability there is to be no significant deviation from the Plan in the first eighty years.' (Foundation, P 167).
- "For the first three centuries the percentage probability of nondeviation is ninety-four point two." (Foundation and Empire, p. 162)
- It "can predict it fifteen hundred years into the future." (Foundation, p.28)

So we are given three data points for accuracy in the books. We don't know exactly what the accuracy is based upon, aside from the needs of storytelling. Nevertheless, this allows us to project out a few models to the implied 1000-year lifespan of the plan until the ubiquity of the new empire, and all the way to the 1500 years mentioned in the first story. The first point is presented as being a deterministic event. Note that since the given data points are carried out to one decimal place, so too will be our projected figures. Years (FE) refer to the age of the Foundation.

Year (FE)	Claimed Accuracy
50	99.9%
80	98.4%
300	94.2%

First, we notice that the data could visually fit an exponential decay function, so let's first model that.

Year (FE)	Claimed Accuracy
400	93.5%
500	92.8%
600	92.2%
700	91.7%
800	91.3%
900	91.0%
100	90.7%
1100	90.4%
1200	90.1%



Foundation:

- Year 0            100,000 people
- Year 50           1,000,000 people

Next, we consult a standard textbook on thermodynamics. This is not a paper on thermodynamics, so the terminology and principles are simplified. Thermodynamics models a gas as a collection of particles, where each individual particle can be at any speed and moving in any direction. However, generally speaking, the more particles there are, then the overall distribution of speeds is likely to be increasingly predictable. This predicted state can be called the peak state.

Physicist Schroeder provides a formula for the portion of system that is in its most common state. This proportion can be called “peak width” and expressed as:

$$\text{Width} = (V/N)^{1/2},$$

where V is volume and N is quantity of particles. (Schroeder 2000).

For psychohistory, volume V is represented by the number of planets and quantity of particles N is represented by the overall human population

$$\begin{aligned}\text{Width} &= (25,000,000 / 10^{18})^{1/2}. \\ &= 0.0000025.\end{aligned}$$

When taken over the “area” of all possible states, this peak represents a mere probability  $1 \times 10^{-14}$ , that the system could be in a non-peak state. This peak is quite narrow compared to the overall possibilities of different states. This means that the probability that the system will be found in the configuration represented by the peak is quite high. Thermodynamically-speaking, this system is essentially deterministic. Although this exercise does not prove anything, it uses the thermodynamic analogy to produce a result that is consistent with the high probabilities of accuracy claimed for psychohistory in the Foundation novel.

It is possible that with really high populations, individual differences may matter less and less, and a statistical approach may be increasingly valid. There is not a galaxy full of people upon which to test this hypothesis, but with advances in machine learning and data science, it may be possible to test this hypothesis with smaller quantities of people. Data science can capture and analyze many actions per human.

## **Commentary on The Television Series**

Currently, Apple is broadcasting a series to its TV+ platform. The content of the series was not known when the proposal for this paper was submitted.

Quoting Krugman, “So how does the Apple TV+ series turn this into a visually compelling tale? It doesn’t. What it does instead is remake “Star Wars” under another name. There are indispensable heroes, mystical powers, even a Death Star. These aren’t necessarily bad things to include in a TV series, but they’re completely antithetical to the spirit of Asimov’s writing. Pretending that this series has anything to do with the “Foundation” novels is fraudulent marketing, and I’ve stopped watching” (Krugman, 2021).

The television series provides significant casting opportunities for people of color. The television show series uses this casting to represent the Foundation as a feminist, anti-colonial struggle and resistance against a white-male dominated imperial government. What may be controversial is how the white males who created the show also portray this struggle as resistance by females, especially Black females, against mathematics and STEM. The heroine, despite being a mathematical prodigy, reportedly rejects mathematics and social science in favor of decision-making via intuition. The author’s acquaintances who are female BIPOC mathematicians celebrate and revel in mathematics. The television series, by placing racial overtones on the validity of math and science may be doing a great disservice to mathematicians of color and other folks who may aspire towards vocations in STEM.

## **Conclusions**

The book series of stories is intended to be science fiction and social fiction. It does contain several ideas that can be explored. Quantitative models can be produced and analyzed to see if they are consistent with the assertions made in the stories. Any consistency of these historical social models with the stories does not prove anything, but it suggests that some of the ideas may be conceivable and worth further exploration.

The television series (as viewed up to episode 6) does not contain any historical assertions that can be meaningfully analyzed from a mathematical perspective, in part due to the supernatural qualities of several of the leading characters as well as lack of intellectual content.



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