

Preface

The Origins

“All science is information science. All life is computation.”¹—Seth Lloyd

Humanity is in a period of dramatic change, perhaps the most noteworthy in human history. Historically, natural systems did not add much to the challenge, but today we face unprecedented current and near-term impact from environmental degradation. In addition, the networked world, artificial intelligence and the power of widespread computational science creates fantastic opportunities, but also uncertainty and risks that most of the population cannot properly appreciate. All of this manifests in economic, political and social concerns, which are only exacerbated by domestic and foreign bad actors manipulating social media and other means. This complexity requires government officials, academics, non-profit heads and corporate leaders to recognize the uncertainty, anticipate the resultant social change and adapt modern technologies to realize the full benefits of the exciting period ahead.

In about 2009 I started to see a series of factors that prompted me to think that humanity was on the verge of the Second Renaissance. I had just joined a project at MIT, started reading on Complex Adaptive Systems (complexity) and rekindled an interest in artificial intelligence (AI). Since 1982 when I started my first company, I have been involved in technology, first as a founder and then as an operating executive, mentor, college professor and always as a student. Fortunately, that college professor as student took a multidisciplinary approach to studying and understanding the emerging trends in 2009. Influenced by two of the greatest thinkers of the 20th century, economists and Nobel Laureates Friedrich Hayek and Herbert Simon, I studied information theory, quantum mechanics, artificial intelligence, systems thinking, design and innovation to better understand what I was seeing. This science and the related disciplines, as I will show, changed humanity’s metaphysics and epistemology. The fundamental concepts of reality and how we think about knowledge changed. Not only did we push aside the thinking of Descartes that had shaped science and engineering since the 1600s, but we shook the foundations of western thinking provided by Plato and Aristotle.

The range and scale of these changes led me to think the Second Renaissance was emerging. I went back and studied the First Renaissance and discovered the monumental contribution of the Italian Filippo Brunelleschi (1377–1446). He replaced a 2-D perspective in painting with the then new 3-D perspective. This insight allowed for art

¹ Seth Lloyd, *Programming the Universe: A Quantum Computer Scientist Takes on the Cosmos* (Alfred A. Knopf, 2006). The quote expresses Lloyd’s views, but an exact rendering is not available.

to better bridge the gap from the abstract to the tangible, more accurately presenting the observer's (the artist) perception of reality. This was a major achievement in intellectual history because of the realism it inserted into our expression of thought. In modern terminology, Brunelleschi showed a better "synthetic visualization" of the abstract concept of one's perception. AI, modeling and mathematical simulations continue this tradition today.

Significant developments in art characterized the First Renaissance. Initially, I thought a new form of art might explain an emerging Second Renaissance. However, eventually I realized that the key factor was actually a change in perspective, not art itself. This new perspective involves a shift from Descartes' macroscopic, reductionist view to a focus on the atomic and molecular levels of quantum physics, chemistry, and biology. This change in perspective has been facilitated by various tools, with artificial intelligence (AI) playing a crucial role. Brian Arthur, a Stanford economist, suggests that tools are developed to address the problems of their time. For instance, the modern computer was invented during World War II to perform calculations necessary for developing the atomic bomb. Today, our most pressing issue is the environmental crisis. This problem can be broken down into two fundamental components:

Biology: How living things use energy

Chemistry: How substances and matter are affected by energy

To fully understand and address these issues, we need to examine them at the sub-atomic, particle, or molecular level, which is invisible to the naked eye but perfectly suited to analysis by AI. Understanding the role of AI in advancing science, and particularly chemistry and biology, is a foundational concept for the future of science.

Background

I have taught traditional and social entrepreneurship for eighteen years at Florida International University, a Carnegie R1 research university and the fourth largest university in the U.S. Today I am the Director of StartUP FIU. StartUP has served students, faculty and the community to provide traditional and active learning in innovation, entrepreneurship and related topics. I devote most of my time to commercializing faculty research through federal grants, licensing, sponsored research and startups. Supporting faculty researchers has prompted me to become an active student of research, innovation, science, engineering and applied machine learning (ML) (a type of AI). The U.S. military and its research requirements are my latest field of study.

Students are where I get my energy and my particular focus is in preparing them for the scale of change from AI. The renowned mathematics professor George Polya highlighted three areas of fundamental knowledge—philosophy, mathematics and physics. This focus on fundamentals was reinforced at MIT where I taught an IAP

course in social entrepreneurship for seven years. I agree with Polya and MIT and encourage undergraduate students to study math or physics and learn quantitative methods. Failing that, I propose the study of the other natural sciences, any of the fields of computer engineering and computer science or any other engineering field. I have read much economics and hope that economists or sociologists will use AI and systems thinking to address social issues like poverty, which is another domain I encourage for student study. I encourage the students to do graduate degrees to learn and advance their quantitative skills. *I believe that any undergraduate not adept in quantitative methods such as data analytics and ML will be out of date in five years.*

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