The Organism Is a Theory

Giuseppe Longo on Biology, Mathematics, and AI

Giuseppe Longo and Adam Nocek

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Chapter 2

A Conversation with Giuseppe Longo

GIUSEPPE LONGO AND ADAM NOCEK

Preface

This conversation took place over the course of four days in June 2022 at Giuseppe Longo's house, just outside of Paris. As to be expected, the discussion covers a wide range of topics, never leaving us wanting for conceptual rigor: From foundational questions in mathematics and the latest research in computing and artificial intelligence to the importance of Italian Renaissance painting and aesthetics for theoretical biology and contemporary mathematics—these and other topics are covered with the clarity and precision one now comes to expect from a scientist who has made significant contributions to so many fields. Some of the conversation has been minimally edited to allow the reader to trace clear throughlines between topics and also permit new seeds of thought to take root. Along these lines, I tried to follow a rough itinerary through the four-day adventure of thinking and, when necessary, make interventions that steer the conversation in directions that are reader friendly and legible to diverse audiences.

At other times, however, I deliberately let the discussion follow its own path. This is for two main reasons. The first is that in conversation, we get the rare opportunity of being led through a history of scientific and mathematical thought, spanning thousands of years, by someone who doesn't shy away from making connections between seemingly distant fields and eras of thought. For instance, we catch sight of how the "scientism" of David Hilbert's turn to completeness might be related to what's happening in

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contemporary biotechnology; or again, how the mathematics of heterogenesis and topos theory may have an aesthetic sensibility, which finds connections to Renaissance painting. It's just this capaciousness of thought that comes into sharp focus during some of the more unstructured portions of the conversation; and it gives us a taste of what it means for thinking to be given space to roam and imagine new possibilities for genealogical and conceptual development.

The second reason, which is related to the first, is that too often academic discourse is so heavily edited—whether in publication, professional presentation, or in email and now social-media soundbites—that we forget how thought actually takes shape. In other words, rarely do we let unrehearsed ideas see the light of day and instead opt to keep them hidden from view until they're already well formulated. And yet, what's remarkable about our conversation is that rigorously developed scientific theories mingle freely with hypotheses and intuitions that demand further investigation. What's more, we also get a sense of how scientific thought is not a private affair—the experimental nature of theory construction does not happen in isolation and does not happen without debate and contestation. Longo is trained as a mathematician and worked for years on foundational problems in computer science. Vigorous debate and objection are ways of showing respect not only for an author's work but also for the practice of science itself. As we come to appreciate, what worries Longo is that scientists are too willing to accept off-the-shelf theories without debate and opposition. This is dramatized throughout the conversation, especially when Giuseppe makes reference to science needing a community of interlocutors, but it's also clear in practice: The past, present, and future of scientific and mathematical thought are in conversation with us over the course of four days. And it becomes clear that certain contemporaries and collaborators of Giuseppe (Maël Montévil, Matteo Mossio, Alessandro Sarti, Ana Soto, and a few others) are there with us, even if in absentia: They're provoking, challenging, and conditioning new possibilities for science.

A final note: I felt that the relatively informal nature of the conversation was necessary to preserve. Of course, part of the reason for doing so is to showcase the ease with which Giuseppe moves from one idea to the next

and does so with total certainty and humility—a truly rare combination. Still, and perhaps more provocatively, the informality also gives us a rare glimpse into how scientific and mathematical thought has a ***style.*** The rhetorical shape of the conversation—the metaphors, the repetitions, the associations, the elisions, and so on—significantly contribute to ***how*** ideas get their shape and texture. For instance, Turing's papers from 1950 and 1952 are alluded to numerous times throughout the four-day conversation, and in both technical and nontechnical ways. But because of this return to Turing throughout, as well as the overall tone of the discussion, these papers—what they say, for instance, about what Turing was thinking vis-à-vis dynamical systems and the limits of computing—become a kind of refrain that manage to hold various episodes in the history of mathematics, computing, and biology together. Such repetitions and allusions are generative, which is why we have decided to keep the informality of the conversation intact, with hope of spurring other possibilities for thought.

June 16, 2022: From Mathematical Foundations to Today's Challenges Between Science and Technoscience

Adam Nocek: Thanks so much for taking the time to talk with me, Giuseppe. I want to start by asking you to think about one of the throughlines in your work, which passes through your research in computation and information theories, biology, philosophy of science, and so forth. It has to do with a sort of crisis in the mathematical foundations in the nineteenth century, and it's the response to this crisis that's in some ways foundational for your work. And so, I'm wondering if you could paint a picture for us, showing us what this crisis is all about, and how we need to go back to the ancient Greeks, to Pythagoras and Euclidean geometry, and through Gauss and Riemann, to get a sense of it. I think this will give us a better sense of how your work takes shape, and what's at stake in it.

Giuseppe Longo: Sure. Now, yes, I think we can understand the modern role of numbers, say integer numbers and the arithmetic and the arithmetical machine, the logical arithmetical machine, which is changing

the world, also because it is projected on the world. And by going back to what is fair to consider the origin of our tradition in mathematics, there were some other traditions in mathematics, of course. There are other paths, but I work on and know ours, and at least it's ours that has been leading recently with advances due to this fantastic arithmetic machine.

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