Kenichi Morita

[30 March 1949 – 19 July 2025]

We are shocked and deeply saddened by the heartbreaking and devastating news that our beloved colleague Professor Kenichi Morita is no longer with us. He was not only a pioneering figure in cellular automata and theoretical computer science, but also a cherished member of *Cellular Automata India* from its inception.

We, the community of cellular automata, will eternally honor the extraordinary contributions of Kenichi Morita. The world of reversibility owes him an everlasting debt, for he illuminated the timeless beauty and intricate harmony of cellular automata (CAs) within its reversible realm. Morita resolved the long-standing open question of whether a one-dimensional reversible cellular automaton (CA) can be computationally universal. Building on his earlier result that a 1-tape reversible Turing machine is universal, he devised a method to construct a reversible CA capable of simulating such a machine. This was achieved through the introduction of the one-dimensional partitioned cellular automaton (1-PCA), a model where local reversibility directly ensures global reversibility, greatly simplifying the design of reversible CAs.

Morita used reversible cellular automata as abstract models to explore how computation and information processing occur in reversible spaces. Recognizing the difficulty of designing such systems within the classical CA framework, he adopted partitioned cellular automata,

enabling the creation of various reversible models with notable features and computational universality. This approach also provided a means to study how complex behaviors can emerge from simple reversible local functions, including methods for simulating irreversible CAs with reversible ones and constructing PCAs from reversible logic elements. He demonstrated that the simple rotary element, a reversible logic unit with one-bit memory, can be systematically realized in very simple two-dimensional reversible cellular automata. Through this, he proved that any reversible Turing machine can be constructed within such a framework, showing the power and elegance of minimal reversible systems.

Equally significant is his revelation that even extremely simple reversible partitioned cellular automata possess the ability to generate rich patterns and achieve universal computation. By systematically building reversible Turing machines from minimal reversible logic elements such as the rotary element, he established a clear pathway from fundamental reversible microscopic laws to fully functional reversible computers. Despite their simplicity, Morita's models are computationally universal, capable of embedding any reversible Turing machine built from Fredkin gates. His work opens the door to energy-efficient, fault-tolerant, and sustainable computing architectures for the next generation of nano-computing systems through these reversible models. This advancement is vital for the evolution of future nano-scaled and quantum systems. His elegant yet universal designs offer scalable, fault-tolerant architectures that simplify the creation of reversible systems.

As a tribute to Kenichi Morita's ideas and achievements in theoretical computer science, reversibility and computationally universal mathematical machines, his colleagues, collaborators, students and friends presented over 20 essays on the occasion of his 70th birthday, which was published as the book "Reversibility and Universality", an indispensable book for computer scientists, mathematicians, physicists and engineers. His most recent works "Before and after Big Crunch in a Reversible Discrete Cellular Universe" and "REVERSIBLE WORLD OF CELLULAR AUTOMATA: Fantastic Phenomena and Computing in Artificial Reversible Universe" will remain as invaluable resources to understand the unlimited potential and universal computational capabilities of reversible cellular automata.

Prof. Kenichi Morita had been a whole-hearted advocate of the *Cellular Automata India* community and Asian Symposium on Cellular Automata Technology (ASCAT). He supported and guided us in different phases of our struggle in starting this new conference series on cellular automata, focusing on cellular automata technology. Every time we have approached him with any request, he has always responded positively and enthusiastically and encouraged us in each endeavor. We were always awestruck by his teaching, his way of explaining the most difficult theories in an extremely simplified manner, developing the complex models step by step from scratch so that even a naive can follow, his sense of beauty reflected in each of the slides of his talk and the well-planned simulations he had shown us in Golly, and his depth of knowledge. His kind words, patience, participation in each of our programs, and professionalism were a source of inspiration for us.

During the pandemic, when *Cellular Automata India* was just born, we approached him to give a talk in the first webinar series on cellular automata. He agreed and gave the first talk to *Cellular Automata India* about "Simulating Turing machines in a simple reversible cellular automaton" on 5th December 2020. Since then, he had indulged us with our several requests - from giving talks in first ASCAT 2022, to writing invited articles for the book "The

Mathematical Artist: A Tribute To John Horton Conway", for proceedings of ASCAT 2022, ASCAT 2024, to serving as a general co-chair and guiding us in every aspect of the conferences in ASCAT 2023 and ASCAT 2024 and giving the welcome address in ASCAT 2023 - he was always available for us, motivating us to do more. Last year in April 2024, we conducted a lecture series on understanding reversibility, and obviously, it cannot be complete without a talk by Kenichi. Little did we know that the talk, "Time-reversal symmetries in reversible cellular automata and their applications", on 27th April, 2024, which once again mesmerized us, will be his last public talk.

In October 2024, while finalizing the speakers for ASCAT 2025, when we contacted him with an invitation to visit us, we got to know the terrible news that he had been diagnosed with a rare form of cancer. But we were in touch with him, hoping and praying for his complete recovery. Unfortunately, last week we were informed by Dr. Katsunobu Imai, his former doctoral student and brilliant coresearcher, that Prof. Morita has passed away from us. This is an irreplaceable loss to us, *Cellular Automata India*, as well as the cellular automata community as a whole.

As we are mourning this loss, we shall be forever indebted to Kenichi for his life-long contributions to cellular automata and for the existence of *Cellular Automata India* in its current form. As a person, he will always be remembered as an ideal epitome of knowledge, strength, professionalism, and humility throughout his life. From *Cellular Automata India,* we express our utmost respect, reverence and heartfelt gratitude to him and our deepest condolences are with his family.