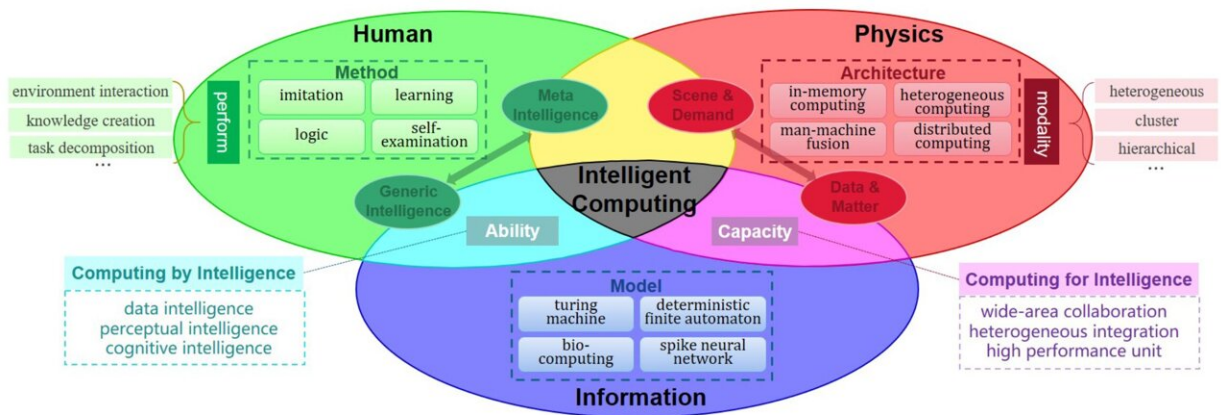# Intelligent computing: Examining the state of the art

January 17 2023

An overview of intelligent computing based on the fusion of human social space, physicalspace, and information space. Credit: *Intelligent Computing* (2023). DOI: 10.34133/icomputing.0006

Human society is on the verge of transforming from an information society to an intelligent society, where optimized computing can autonomously solve practical, real-world problems. Critically, this transition is dependent on the continued development of advanced computing theories and algorithms that impart varying degrees of intelligence to computing systems through autonomous perception, information gathering, analysis and reasoning—functions once reserved only for living organisms.

Several of the world's top computing experts recently completed the first comprehensive literature survey of the intelligent computing field, a relatively new discipline dedicated to complex problem solving using artificial intelligence (AI). The review focuses not only on the theory behind intelligent computing, but also the fusion of intelligence and computing and its potential real-world applications.

An international team led by Shiqiang Zhu, a professor from the Zhejiang Lab in Hangzhou, China, published the review paper in the journal *Intelligent Computing* on Jan. 3 to serve as a timely reference for researchers and practitioners and foster further technological and theoretical innovations in the field.

Intelligent computing will eventually transition human society from an information to an intelligence era, where advanced computation will facilitate breakthroughs in scientific knowledge and the transition of humanity into a digital and sustainable society.

"Intelligent computing targets computational tasks with the minimum cost according to the specific [task requirements], matching adequate computational power, invoking the finest algorithm and obtaining optimal results," said the authors. "Its ultimate goal is to provide universal, efficient, secure, autonomous, reliable and transparent computing services to support large-scale and complex computational tasks."

"Various intelligent methods and high-performance computational architectures have been developed independently for years," the authors said. "The biggest hurdle for intelligent computing is … the fusion of intelligence abilities and computation capabilities and innovating the paradigm of 'computing by intelligence' and 'computing for intelligence.'"

More specifically, AI that uses [deep learning](#), or learning by example, faces major hurdles in interpretability, generality, evolvability and autonomy before it can gain a stronger foothold in society. Most current AI technologies are not as dynamic or integrative as human intelligence and are only capable of performing very specialized tasks.

"There are also major theoretical and [technical challenges](#) to upgrading from data-based intelligence to a more diverse form of intelligence, including perceptual intelligence, cognitive intelligence, autonomous intelligence and human-machine fusion intelligence, to name a few," the authors said.

Researchers will need to further explore the fundamentals of human-like intelligence to better simulate more diverse forms of intelligence through computing. Knowledge, and the way it is created, stored and retrieved must also be better understood to develop more flexible systems that can accommodate data and models that will ultimately lead to self-learning systems capable of independently perceiving the environment.

Incredibly, the amount of computing capacity necessary to power AI applications is doubling every 100 days and is predicted to exceed one million times in the next five years. The digitalization of existing processes requires an enormous amount of computational power, and keeping pace with increasing volume requirements will be a continuing challenge. Software and hardware will also need to be designed in parallel to move toward more human-like data processing and facilitate these forms of non-linear, large-scale computing.

Despite these hurdles, the field of intelligent computing is at the cusp of forever changing human society. "[Intelligent computing] will provide universal, efficient, secure, autonomous, reliable and transparent computing services to support large-scale and complex computational tasks in today's smart society," the authors said.

These researchers and others across the world are developing the new theoretical computing methods, architecture systems and technical capabilities that will usher in an era of digital civilization and interconnect the entire world.

Provided by Intelligent Computing