

COMPUTER SCIENCE

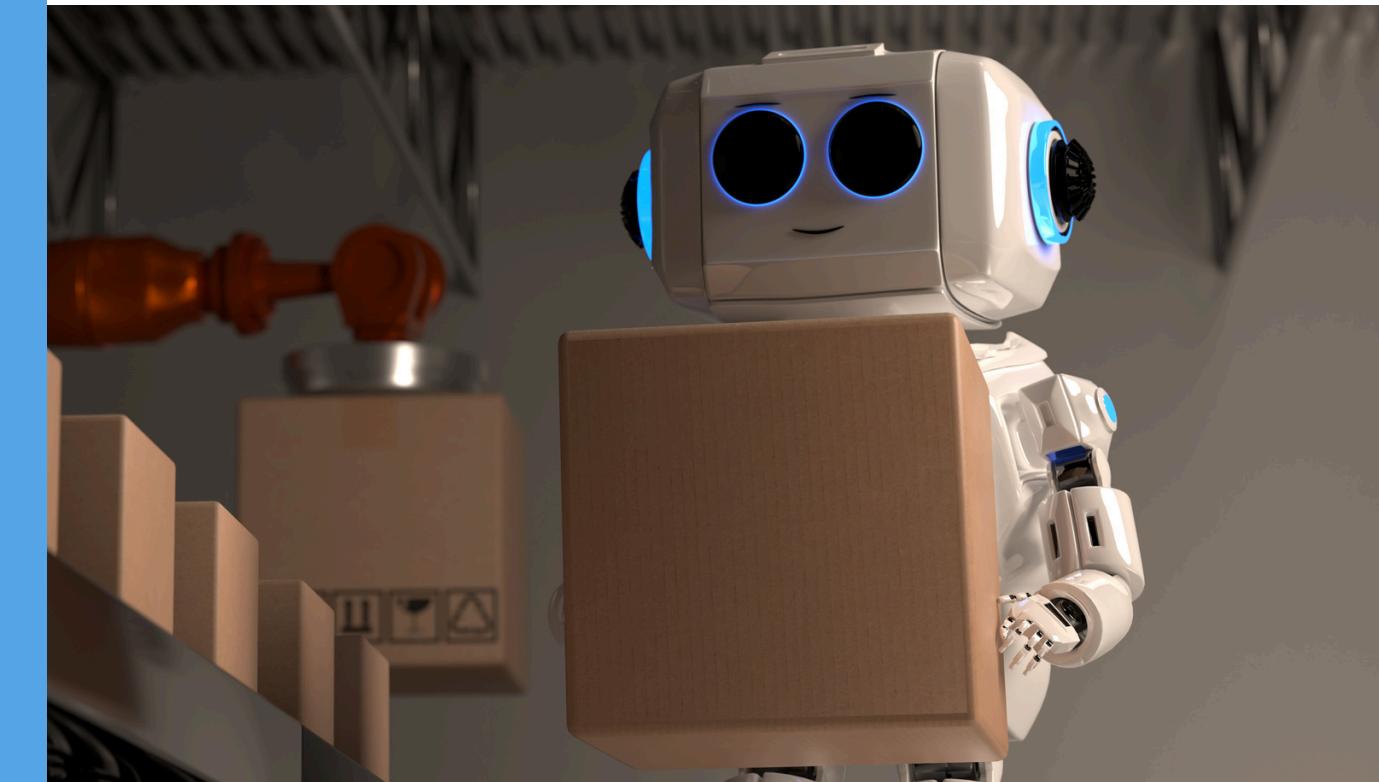
as discipline



Hardware



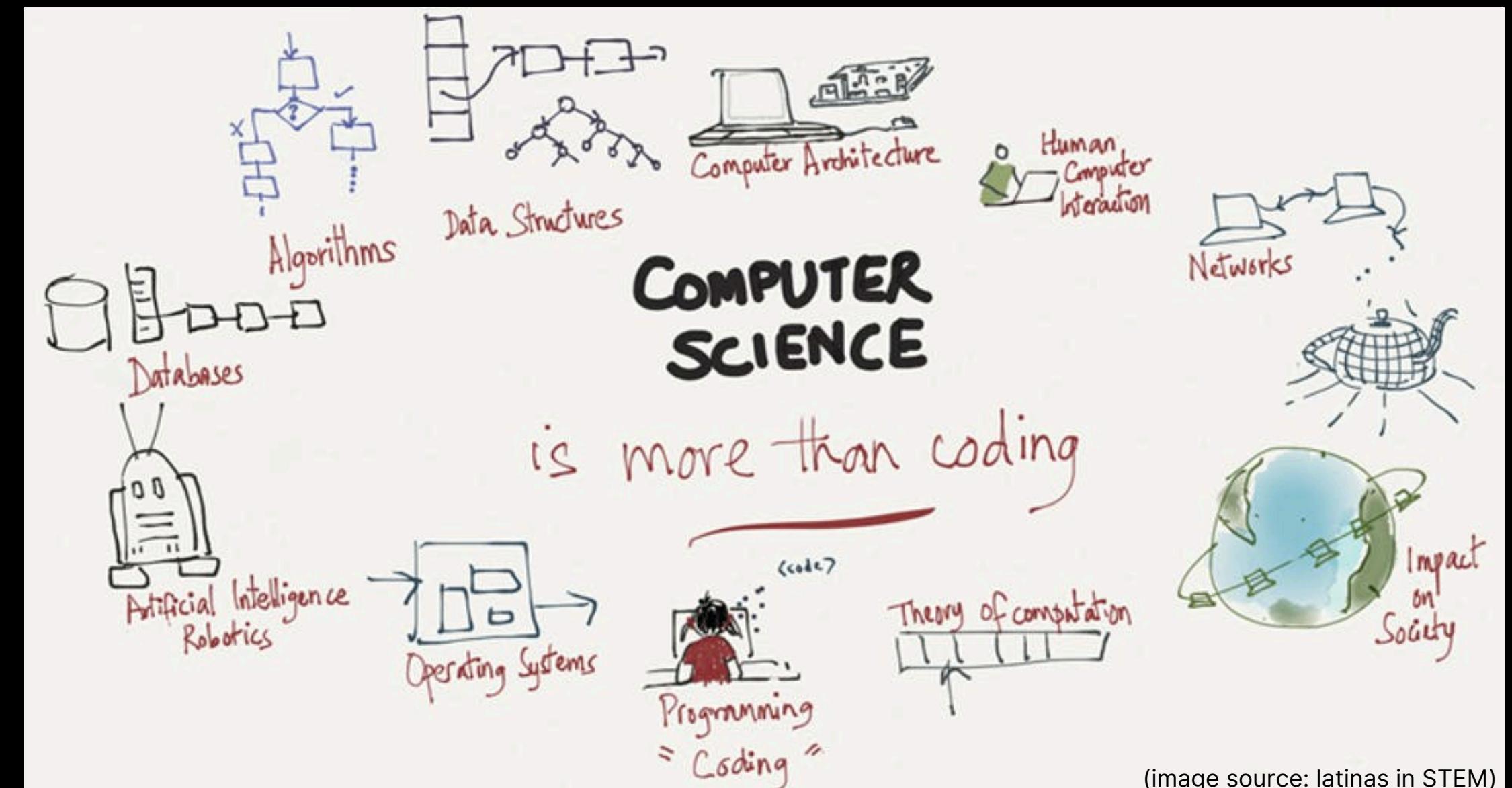
Software



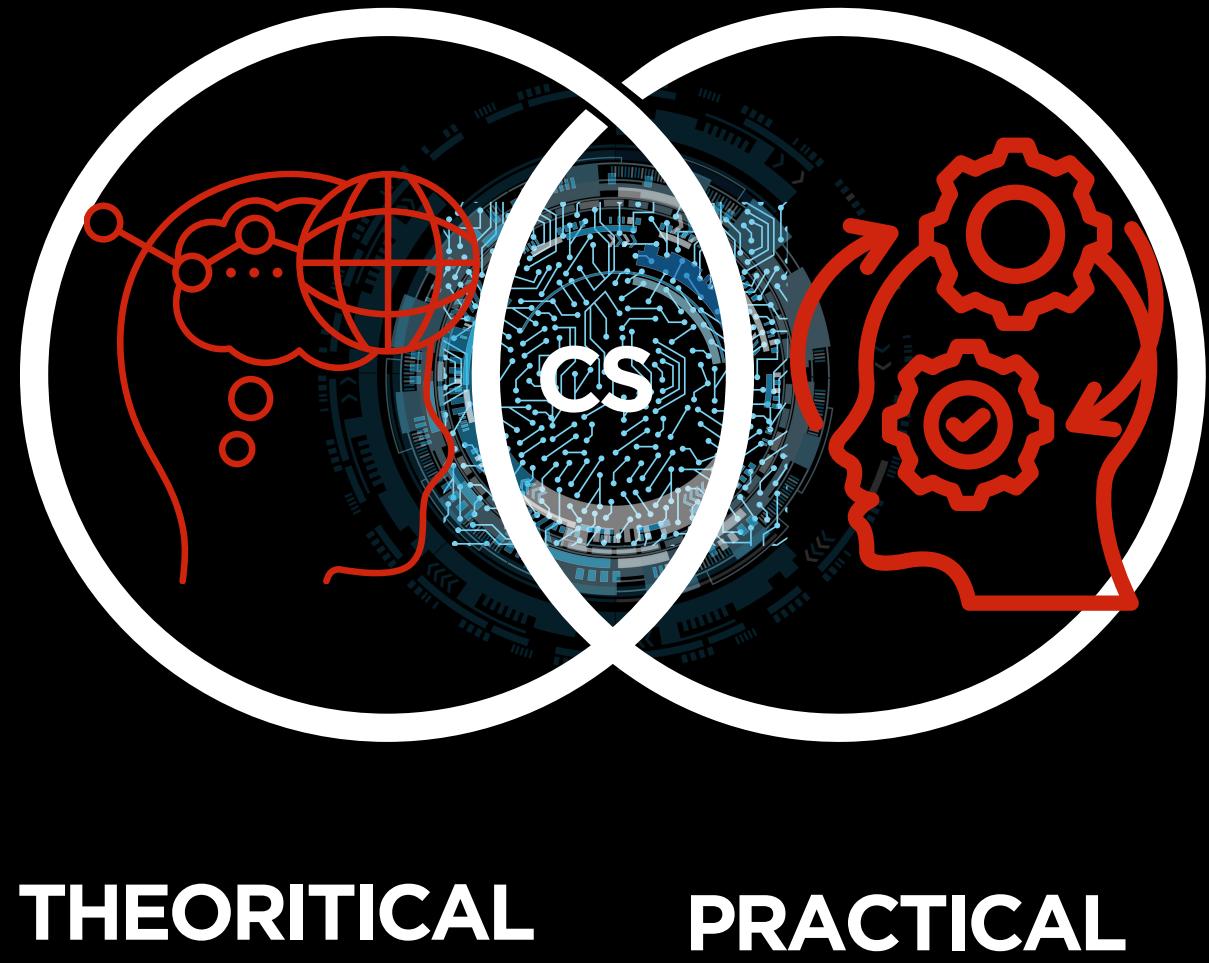
Computer science encompasses the study of computer hardware and software design, bridging the gap between theoretical algorithms and their practical implementation using computer hardware and software (Denning, 2005).

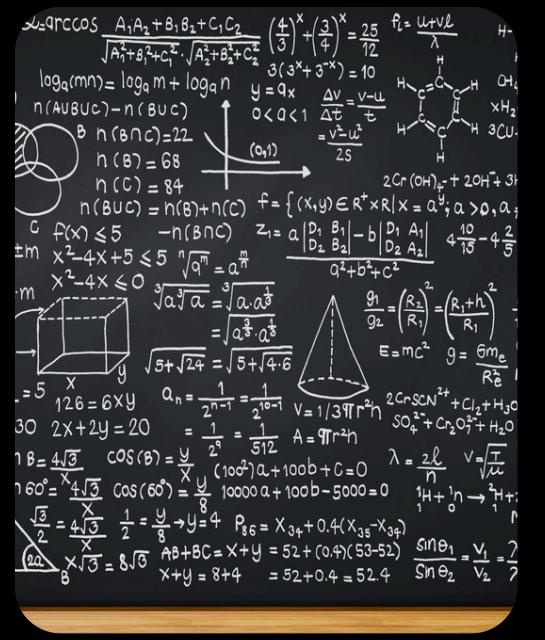
Definition AND SCOPE

- Computer science is defined as "the foundation of all computing disciplines" (Michigan Tech, n.d.), covering a broad range of subareas, including:



- The foundations of computer science are deeply rooted in the adjacent disciplines of mathematics, electrical engineering, physics, and management information systems (Belford & Tucker, 2019).
- Computer science is a comprehensive field that encompasses both theoretical and practical aspects of computing systems (Guide to 5 Computing Disciplines: Key Subjects and Skills, n.d.).
- As Nasution et al. (2022) noted, citing Sabin and Sabin (1994), computer science involves "the study of data, information and knowledge at different levels of complexity or abstraction, and from which other fields of scientific discipline can be developed" (Sabin & Sabin, 1994).





- This involves theory, analysis, design, efficiency, implementation, and application that describe and transform information (Denning et al., 1989)

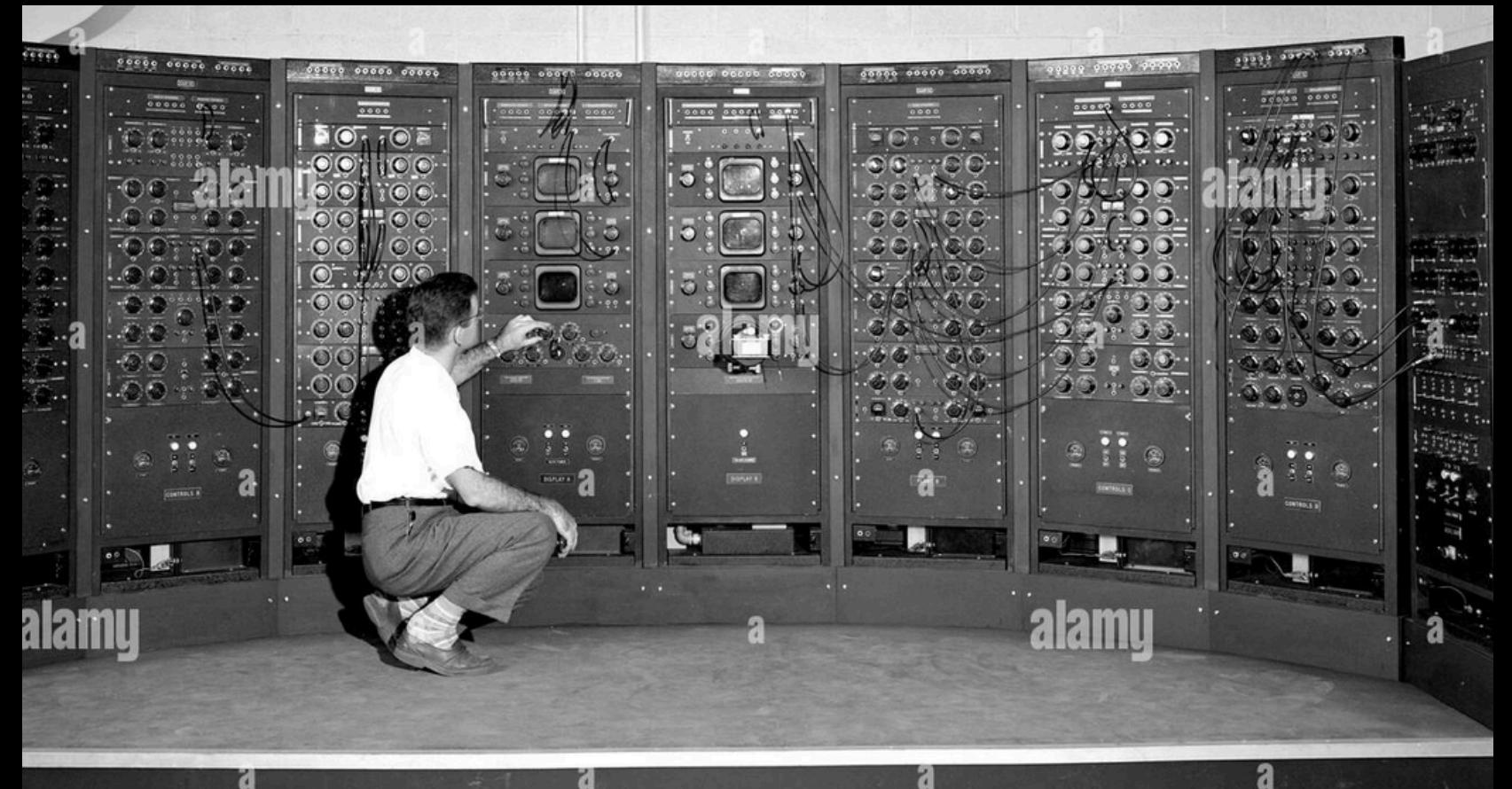
- At its core, computer science seeks to answer a fundamental question:

**What can be (efficiently) automated?
(Denning, 1985).**

History of **COMPUTER SCIENCE**

► This discipline was born in the early 1940s with the joining together of algorithm theory, mathematical logic, and the invention of the stored-program electronic computer (Denning et al., 1989).

- The 1960s marked a significant milestone in the development of computer science as a standalone field of study.
- The term "computer science" was coined by George Forsythe, a renowned numerical analyst (Hassan & Jubaer, 2021).



Great Contributors of COMPUTER SCIENCE



- Alan Turing
- “Father of Modern Computing”
 - Formalized Turing Machine (a model of a general-purpose computer)
- (Aron, 2021)



- Lady Ada Lovelace
- “First Computer Programmer”
 - Worked with Charles Babbage on Mechanical general-purpose computer (Difference Engine or Analytical Engine)
 - Published the first algorithm

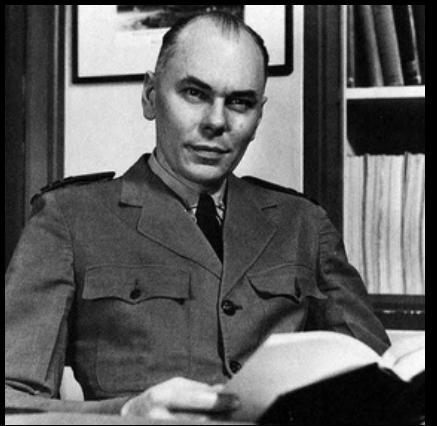


- Kurt Friedrich Gödel
- Proved the incompleteness of axioms for arithmetic (Kennedy, 2015).
 - Showed the relative consistency of:
 - Axiom of choice
 - Continuum hypothesis with other axioms of set theory

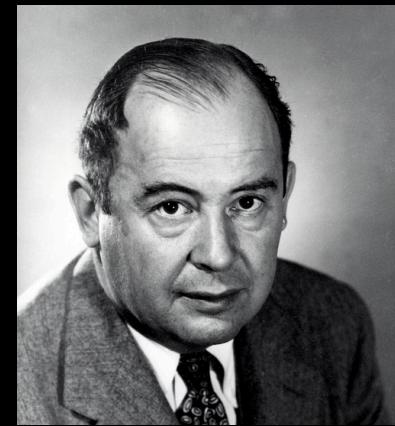


- Vannevar Bush
- Known for engineering work on analog computers and the memex.
 - Invented the differential analyzer, an analog computer with digital components (Dennis, 2019).

Great Contributors of COMPUTER SCIENCE



- Howard Hathaway Aiken
- “Forerunner of the Modern Electronic Digital Computer” (The Editors of Encyclopedia Britannica, 2019)
 - Harvard Mark I (general-purpose electromechanical computer used in war effort) (The Editors of Encyclopedia Britannica, 2019)



- John von Neumann
- Pioneer of the application of Operator Theory to quantum mechanics and functional analysis. (Full Scale, 2024; Cosker, 2015)
 - Developed concepts of cellular automata, universal constructor, and digital computer (Full Scale, 2024; (Cosker, 2015)).
 - Key figure in developing Game Theory (Full Scale, 2024; (Cosker, 2015)).



- Konrad Zuse
- “Inventor of the Modern Computer”
 - Invented Z3 (World’s First Programmable Computer) (IEEE Computer Society, n.d.)
 - Inventor of Modern Computer (IEEE Computer Society, n.d.)

Analysis/Reaction

When I think about Computer Science, I am struck by how vast and intricate it is. It is a field that spans a wide range of issues, from algorithms to artificial intelligence, and from human-computer interaction to machine learning. It takes more than just coding or system development to understand the underlying ideas that control the behavior of computers and computational systems.

What is fascinating about Computer Science is its foundation in scientific principles. It's not just about getting things to function but it is about understanding the core rules and theories that influence how technology behaves. This deep understanding allows Computer Science to expand the limits of what technology can do.

Think about pioneers like Ada Lovelace, Alan Turing, and John von Neumann. Their groundbreaking work set the stage for the algorithms, programming languages, and computers we rely on today. Because of their contributions, we can now develop sophisticated systems that analyze huge amounts of data, spot and identify patterns, and make decisions on their own. To gain a deeper understanding of computer systems and their operation, it is necessary to move beyond coding and development and explore the underlying principles that drive them.

One of the biggest challenges in computer science today is the need for continuous learning. With new technologies and techniques emerg-

ing at such a rapid pace, computer scientists must be adaptable and willing to constantly update their skills. This requires a deep understanding of the core concepts of computer science, along with the ability to think critically and creatively.

Even with the challenges, it's clear that computer science has made a huge impact on our lives. It has sparked innovations in areas like finance, healthcare, and transportation, and the way we work, communicate, and entertain ourselves has been completely transformed by computers and mobile devices. We can now automate tasks, connect with people all over the world, and access more information than we ever thought possible.

With the ongoing expansion of Computer Science, it is important to acknowledge and tackle the obstacles it brings forth. By taking this approach, we can leverage the possibilities it offers to create a more positive future. This necessitates a comprehensive grasp of Computer Science's social and ethical consequences in addition to technical knowledge. Through collaboration, we can build a future in which technology benefits humanity, instead of the other way around.

COMPUTING:

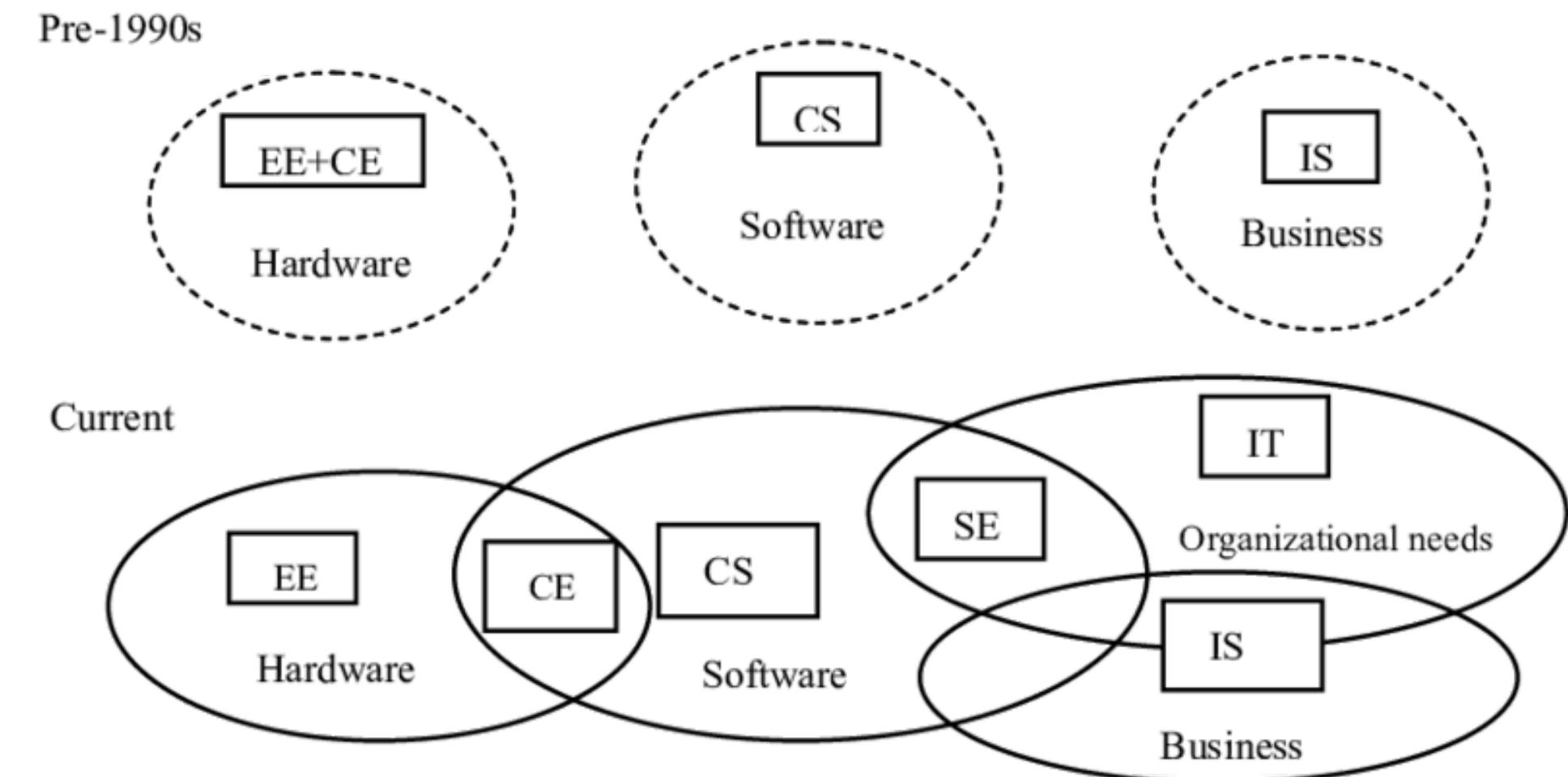
a family of disciplines

► **Pre-1990s:**

- Computer Science was on the technical side
- Information Systems were on the business side

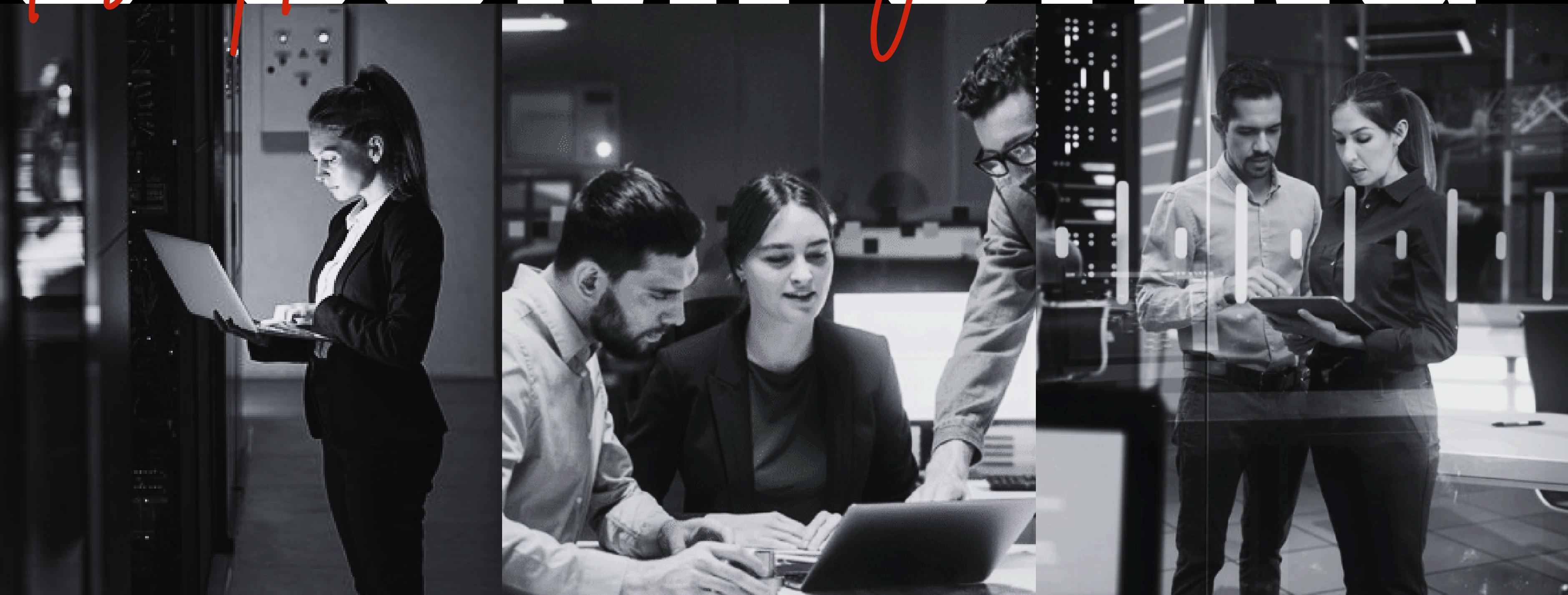
► **During the 1990s:**

- Computer Engineering became a strong discipline
- Software Engineering was sometimes thought as an area within CS and began its own identity
- Information Technology program was common worldwide but began emerging in the 1990s



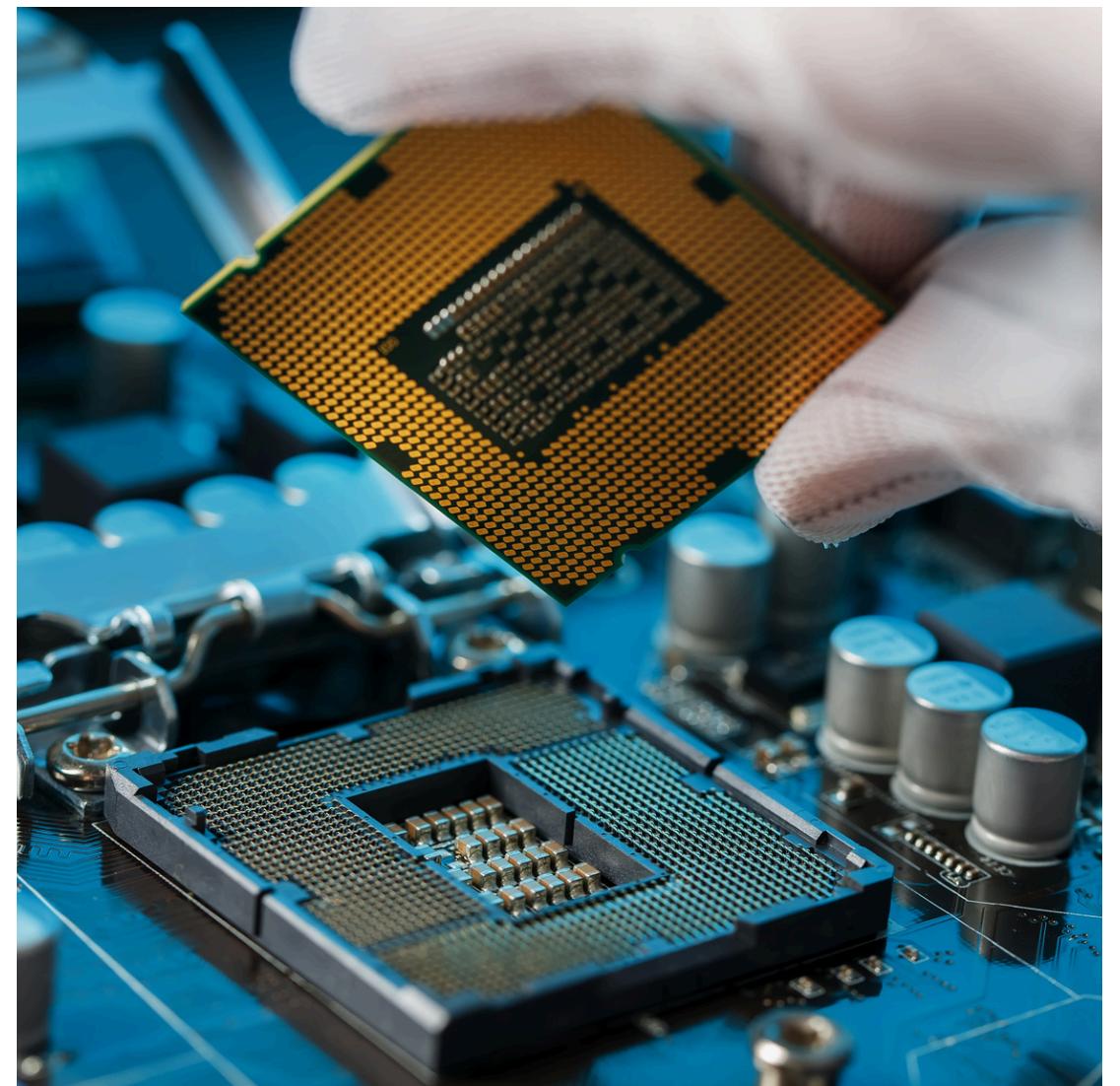
50 COMPUTING

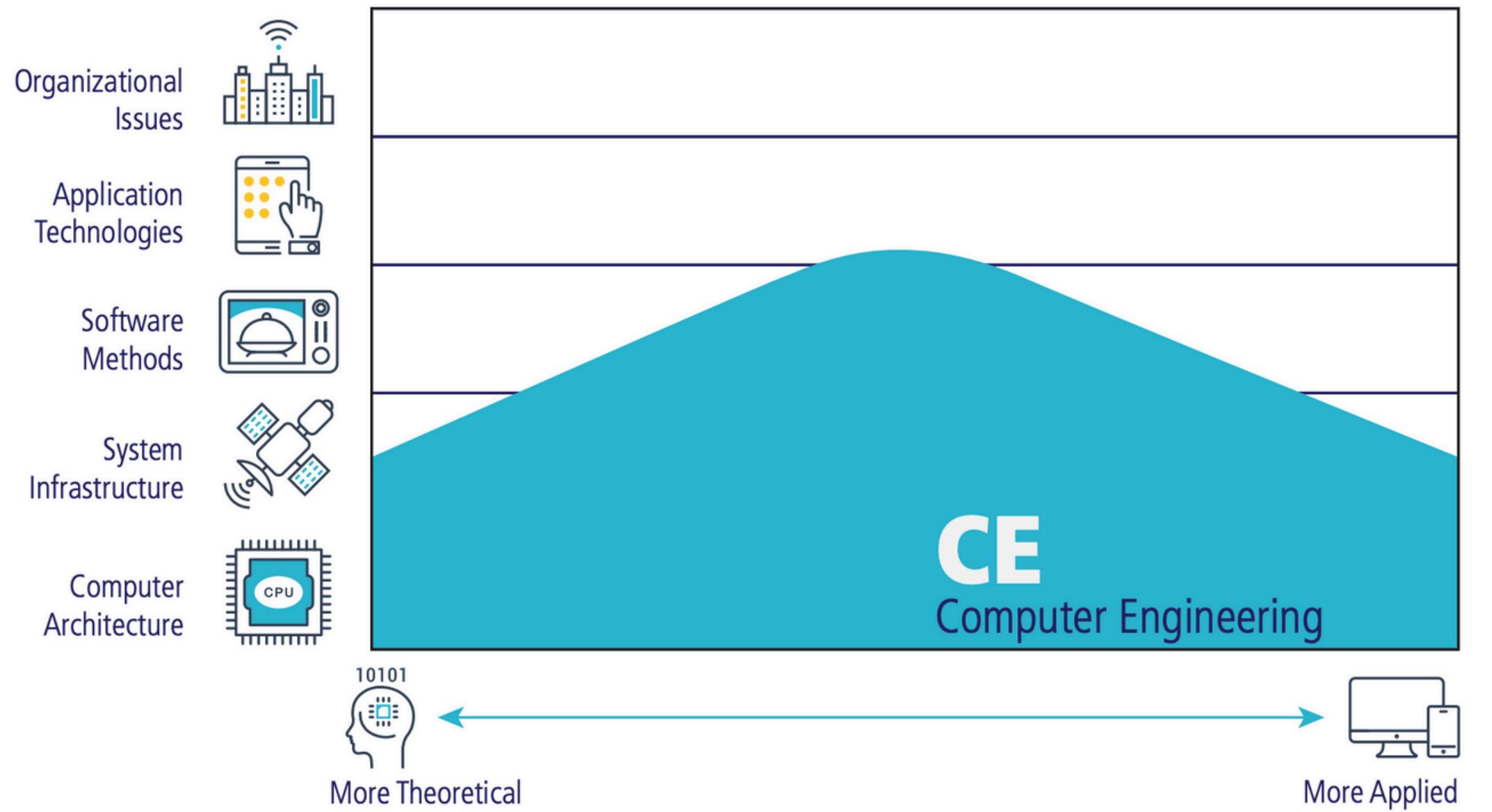
disciplines and majors



engineering COMPUTER

- ▶▶ Computer engineering is a discipline that combines science and technology to design, construct, implement, and maintain software and hardware components of modern computing systems and computer-controlled equipment (Chapter 2 Computer Engineering as a Discipline, 2016).
- ▶▶ It is a combination of computer science (CS) and electrical engineering (EE), but has evolved as a separate discipline over the past three decades (Computer Engineering - ACM CCECC, n.d.).
- ▶▶ Computer engineering is grounded in theories and principles of:
 - Computing
 - Mathematics
 - Science
 - Engineering



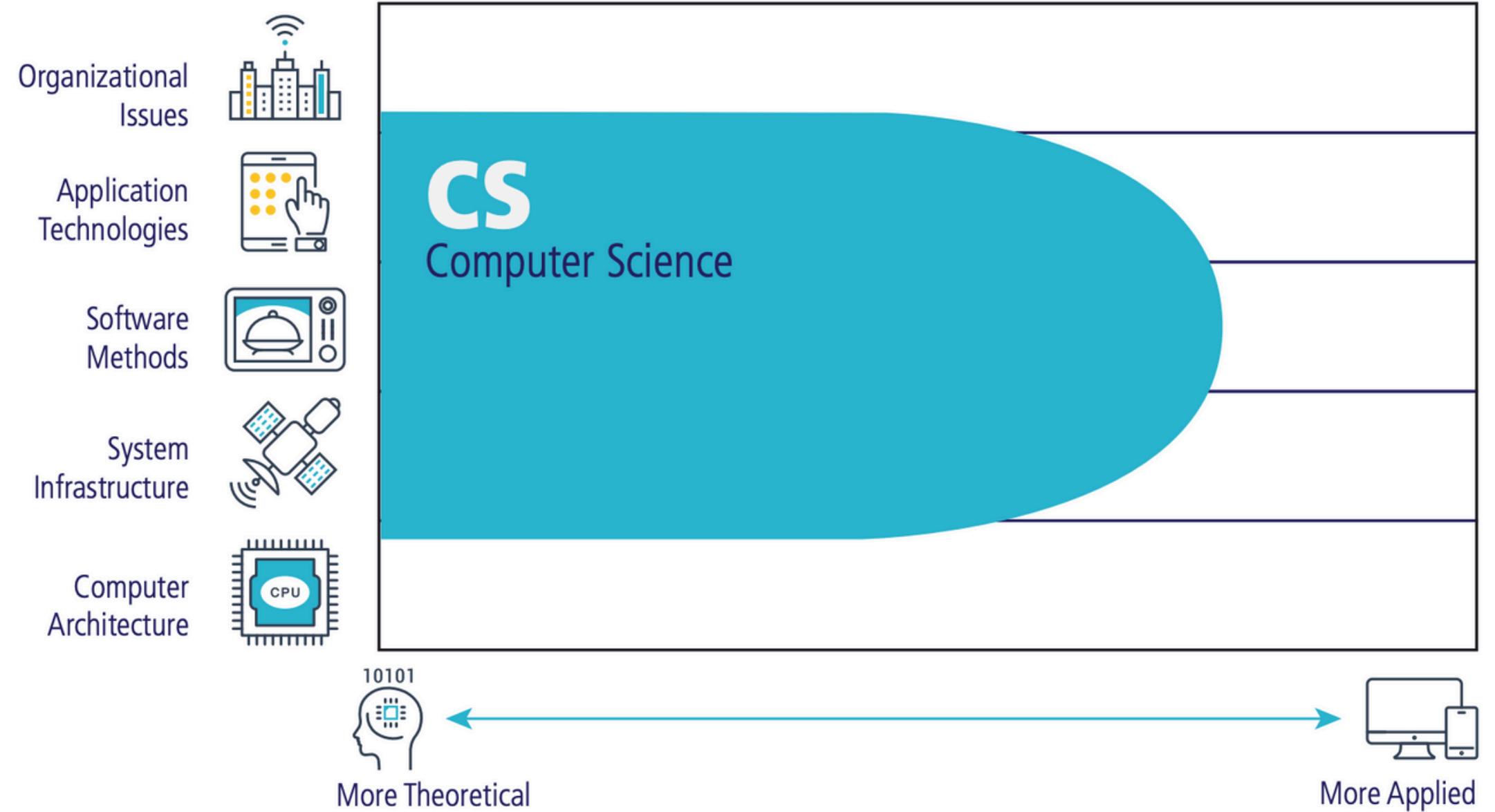


- Computer engineers work in many industries, including healthcare, robotics, cybersecurity, and artificial intelligence. In their daily work, they may create information security tools, design new power grids, develop faster processors, or build biomedical devices (Capella, 2022).
- The shaded area in the figure represents the computer engineering discipline.
- The discipline spans a wide range of topics from theoretical principles to practical applications.
- It is broad at the base, encompassing both hardware and software aspects.
- The discipline narrows as it moves upwards, focusing more on hardware and less on software.
- By the time it reaches the level of software development, the computer engineer's interest is primarily focused on how software supports the development of integrated devices.

science COMPUTER

- ▶ Computer Science is the study of computers and computational systems, focusing on software and software systems (Belford & Tucker, 2019a).
- ▶ Principal areas of study include (Michigan Tech, n.d.):
 - Artificial intelligence
 - Computer systems and networks
 - Security
 - Database systems
 - Human-computer interaction
 - Programming languages
 - Software engineering
 - Theory of computing



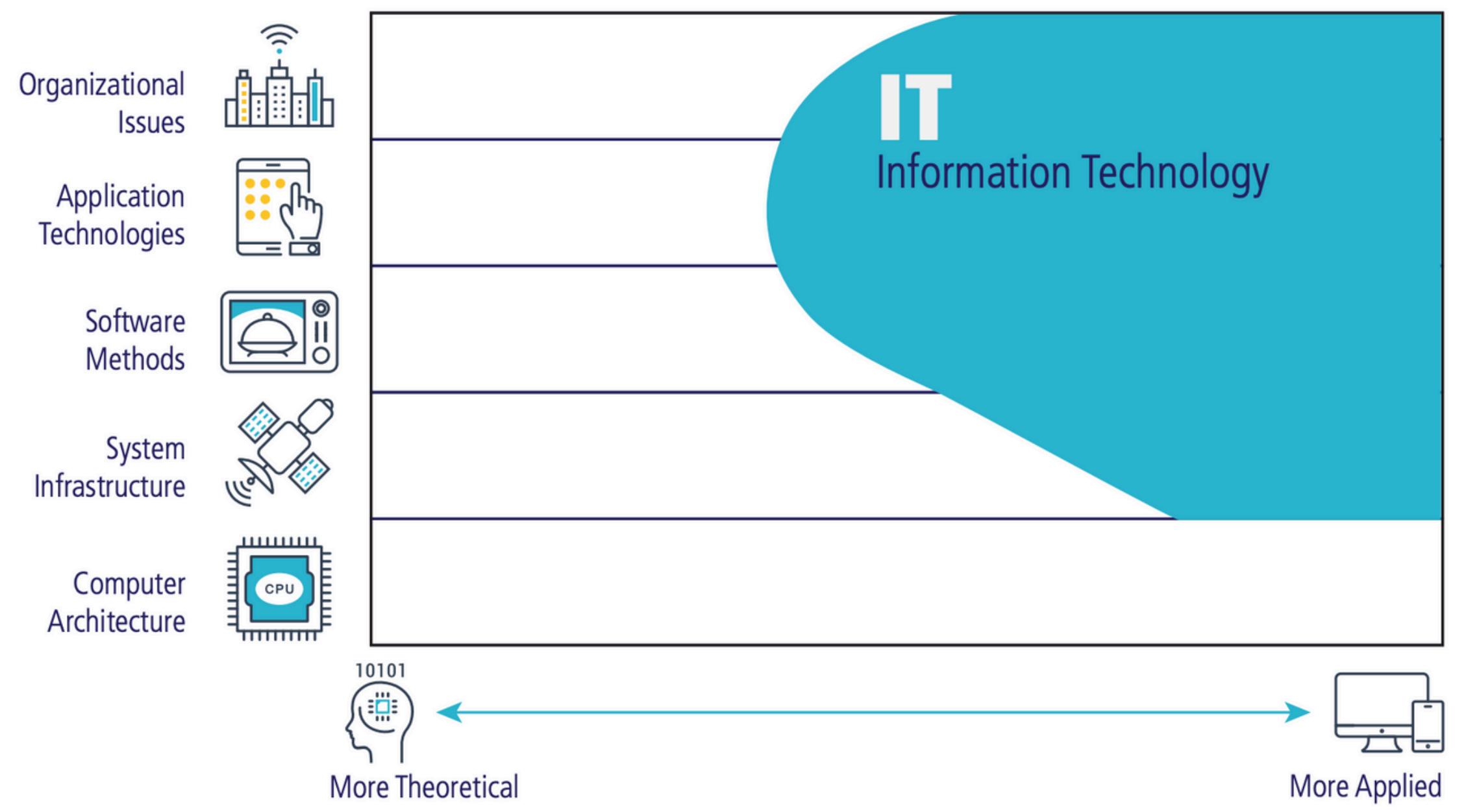


- ▶ The shaded area represents the computer science discipline.
- ▶ Computer science spans almost the entire vertical space, covering everything from software that enables devices to work to information systems that help organizations operate.
- ▶ Computer scientists design and develop various types of software, including systems infrastructure and application technologies. They create software capabilities, but do not manage their deployment.
- ▶ The discipline narrows and stops as it moves to the right, as computer scientists do not involve in selecting, tailoring, or teaching the use of computing products.

Technology INFORMATION

- ▶ Information Technology involves maintaining computers and their operations, including hardware, software, networks, cloud services, data processing, and cybersecurity (DeVry University, 2023).



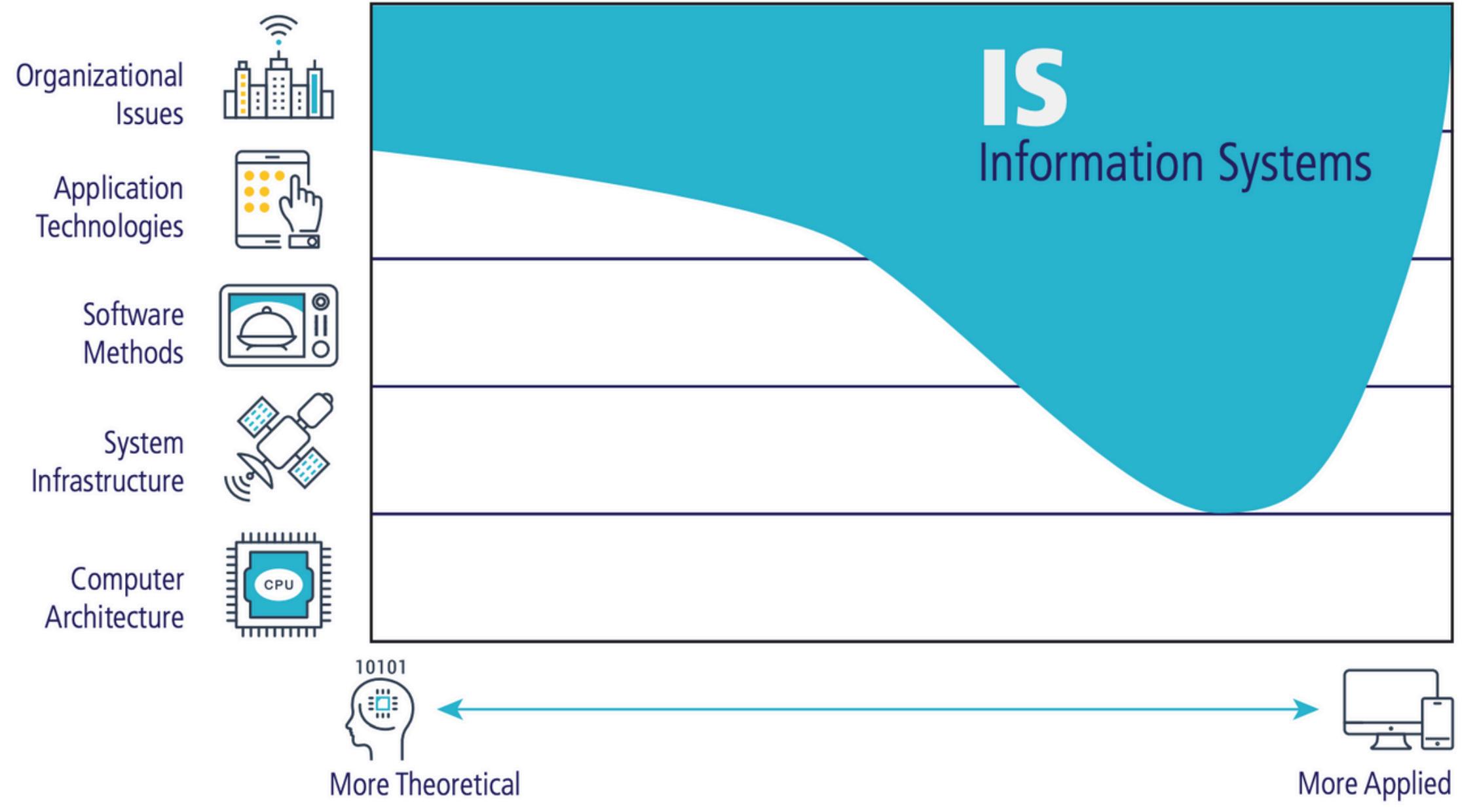


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~~systems~~ INFORMATION

- ▶ An information system is a set of components that collect, store, and process data to provide information, knowledge, and digital products (Zwass, 2022).



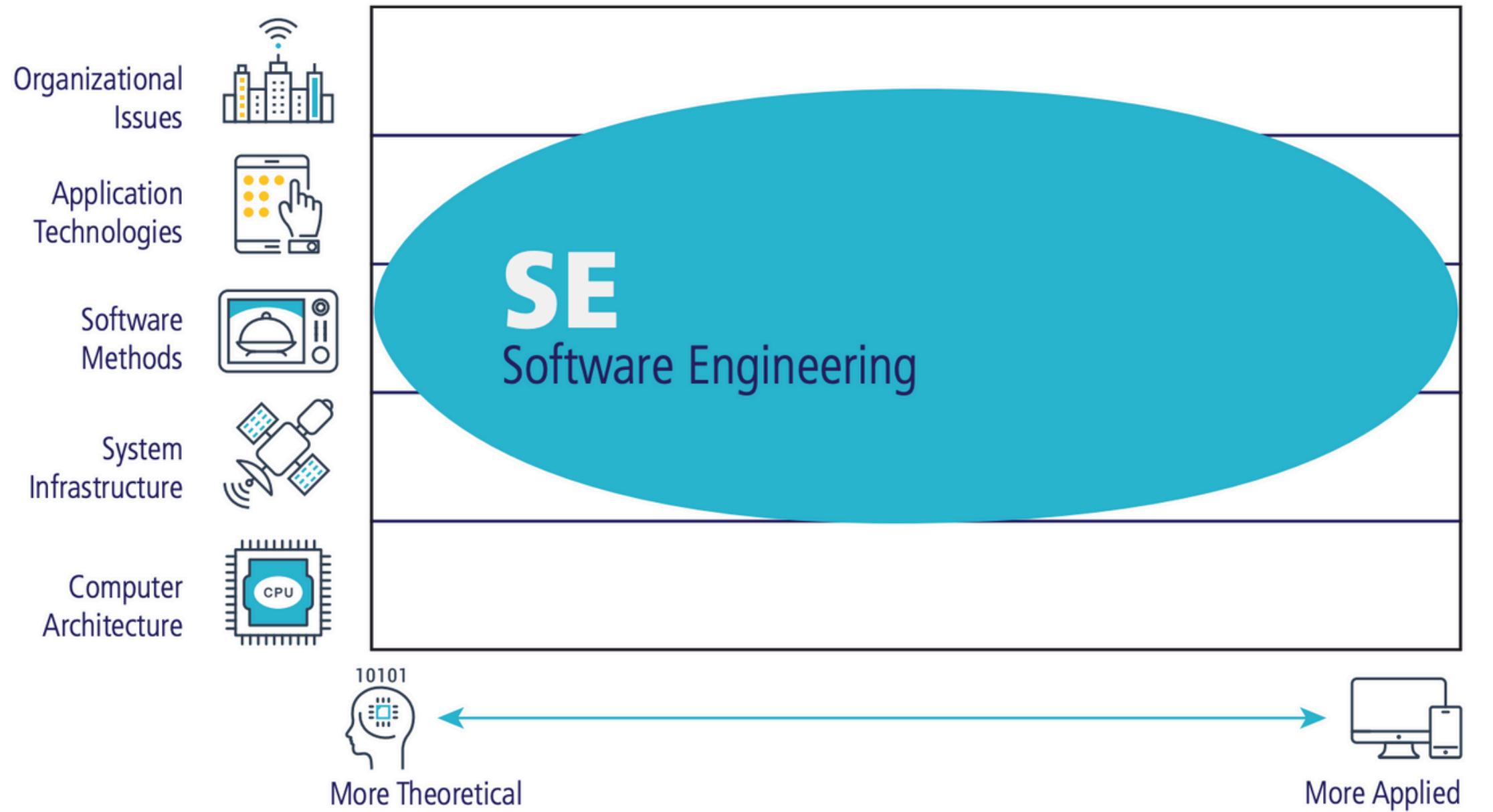


- ▶ The shaded area represents the information systems (IS) discipline.
- ▶ IS spans across most of the top-most level, covering the relationship between information systems and organizations, from theory to application and development.
- ▶ IS professionals are involved in system deployment, configuration, and user training.
- ▶ The discipline extends downward, covering software development and systems infrastructure, as IS specialists tailor application technologies (e.g., databases) and develop systems to meet organizational needs for information.

engineering SOFTWARE

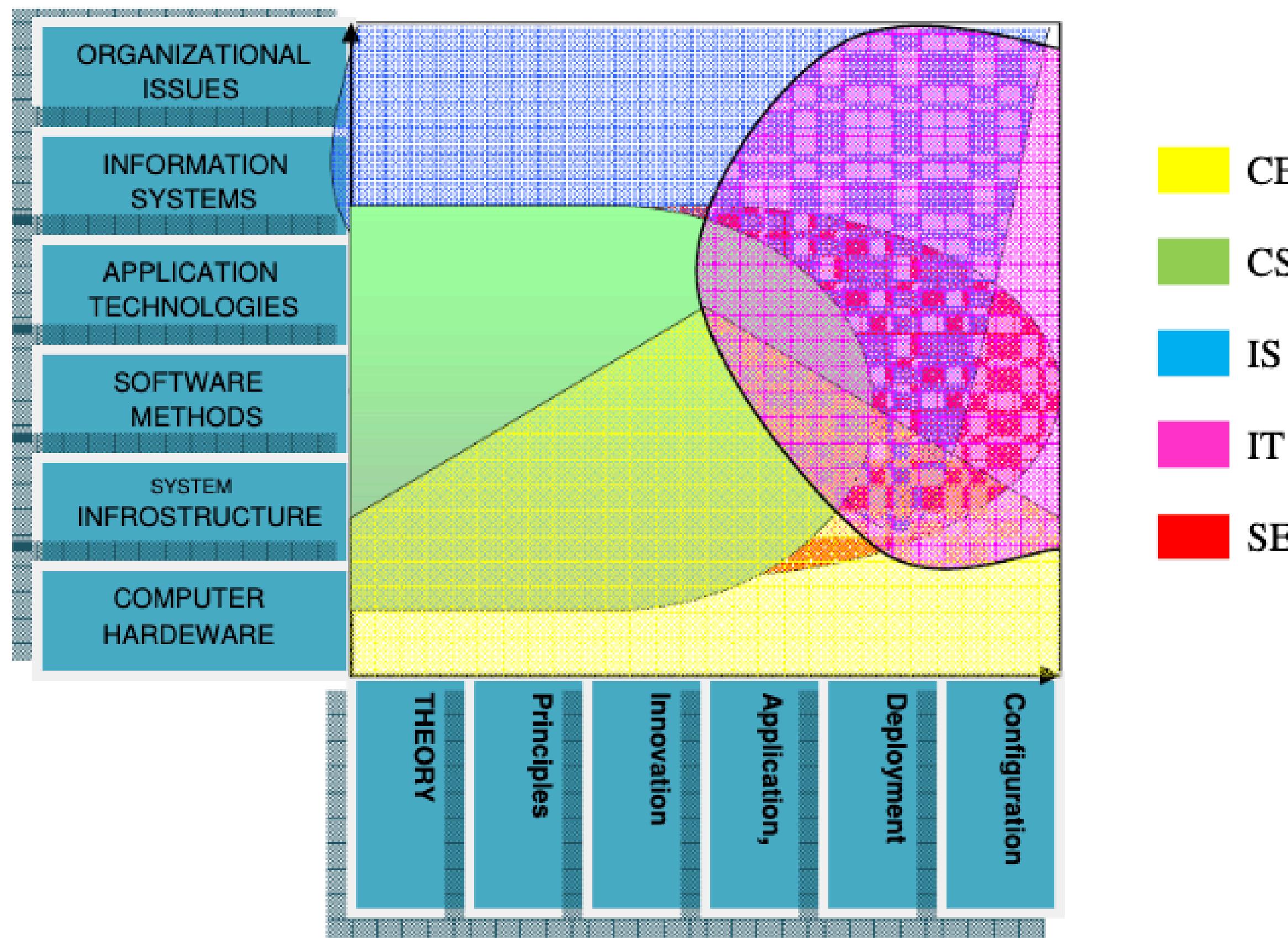
- ▶ Software engineering involves designing, developing, testing, and maintaining software applications (Michigan Tech, n.d.).
- ▶ Software engineers apply engineering principles and knowledge of programming languages to build software solutions for end users (Michigan Tech, n.d.).





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Figure 1: The problem space of computing



Analysis/Reaction

The field of technology is wide and diverse with a range of specializations that play a role in shaping our digital world today. Delving into the five areas within technology – Computer Engineering, Computer Science, Information Technology, Information Systems, and Software Engineering – provides valuable knowledge, on how these disciplines impact our daily lives and the expertise required to excel in these professions.

Every field mentioned here contributes significantly to the progress of technology. Each has its unique focus within the realm of digital innovation. Consider Computer Engineering—it revolves around creating and assembling the parts of computers to ensure hardware aligns with the requirements of contemporary software. On the side is Software Engineering—an area that prioritizes crafting dependable and effective software, by underlining the value of a methodical coding and testing process. In the world of technology management and innovation lies a group of professionals who oversee the operation of organizations by tending to the systems and equipment that drive them forward; at the same time exists another set of experts who delve into the intricate ways technology can support business objectives and enhance strategic decision making processes. These two fields collaborate to harmonize our tools – from hardware to software – making sure they are finely tuned to meet user's needs and align, with organizational goals seamlessly.

While delving into computing domains I realized the strong interconnection among the core five disciplines. Computer Science, Information Technology, Software Engineering, Computer Engineering and Information Systems may appear paths at first glance. Yet they converge in their shared goal of problem solving and, in crafting and executing solutions. What stood out to me the most was how these fields intertwine than exist in isolation.

Computer Science, which is all about creating software, is deeply connected to Information Technology, which deals with setting up and maintaining computer systems. On the other hand, Information Systems brings a business perspective, looking at how to make systems work better. Computer Engineering focuses on building the hardware, and Software Engineering ensures that the software is reliable and maintainable, tying everything together.

These fields overlap in more than just problem-solving. They also share common approaches, like design principles and development methods, which show how important it is to work together and share knowledge in the computing world.
