From Algorithms to AI: A Comprehensive Review of Core Concepts in Computer Science

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Abstract

The review delves into the very ideas of Computer Science and constantly-developing fields, thoroughly reviewing the theoretical basis and the most modern technologies. The theory is started with basic concepts like algorithms, data structures and models of computation then moves to programming paradigms, architecture of computation, and operating systems. The explanations are carried out to its practical fields such as databases, networking, software engineering and artificial intelligence. Emerging fields like quantum computing, human-computer interaction, cloud and edge computing and ethical considerations are also outlined. Through the combination of fundamental knowledge and its application in the real world, the review highlights the cross-disciplinary purpose of Computer Science and its central role in innovation of the present times. The goal of this synthesis is to help learners, educators, and professionals learn the depth and relevance, as well as the future development direction of the field.

Key words

Algorithms, artificial intelligence, computer architecture, operating systems, programming paradigms, quantum computing, and software engineering.

Introduction

Computer Science is an innovative domain which encompasses a wide range of activities that represent the core of the current technological development. It supports design, development and implementation of systems that define all spheres of our life, including communication, healthcare, finance and education. In the last few decades, Computer Science has transformed into one of the least focused academic fields to a wide and interdisciplinary field that cuts across fields like mathematics, engineering, cognitive science, and biology [1].

Computer Science is interested in the causes of computation, the formulation of effective algorithms, the construction of software and hardware, and the manner in which cleverness can be simulated by computers. It is a combination of theories and practical expertise to understand that practitioners can identify complicated problems in the real world and transform them into computational problems which can be solved after abstraction and create systems which can implement the solutions to the problems efficiently and reliably [2].

This is a review paper with the title, From Algorithms to AI: a Comprehensive Review of Core Concepts in Computer Science, which seeks to delve in the cornerstone concepts that encompass the field. It will provide a step by step progression along the topics which serve as the foundation of Computer Science; beginning with theoretical concepts and going all the way to the current thrusts in the field; artificial intelligence. The mission is to provide a comprehensive and unified perspective of the area which relates historical changes to modern technologies and growing problems [3]. The choice to write this article was driven by the consideration of the necessity to tie numerous subfields of Computer Science into the same story.

Most people specialize in a certain field of study in an academic or professional context including software, machine learning, cybersecurity, or database systems. This specialisation is a necessity in the journey towards innovation, but it is also important to have a holistic mindset in the relation of such areas. As another example, a good machine learning model will usually as well be built on well-tuned algorithms, good data structure and strong software architecture all of which are based on basic Computer Science knowledge [4].

The review is organized in such a way that it could interest a wide range of readers: students who just start their path in this field, teachers who want to have the opportunity to get a concise synthesis of previous works, and practitioners who need an opportunity to go back to the basics. It originates in theoretical foundations like computational theory, algorithms and data structures, which are the foundation blocks of Computer Science [5]. Then it enters into systems-oriented subjects such as computer architecture, computer networks, and programming paradigms. Lastly; it discusses the current frontiers such as artificial intelligence, quantum computing, and technological ethics [6].

The necessity to know basics of Computer Science cannot be overestimated. With the development of technology still in motion like never before and better understanding its lexicon; i.e. the fundamentals of the discipline in question, one will be prepared intellectually to adjust and best adapt accordingly and make better and strategically thought out decisions. Hints about how to design a good AI application, learn more about data compression algorithms, or create a responsible AI application are just a few of the examples of the knowledge that is described in this article and that are essential in such ways [7].

Foundations of Computer Science

Computer Science is based on its theoretical foundation, a collection of abstract concepts, logical frameworks and methodologies, and tools of mathematics which characterise what is meant by computation. Such basic areas form the basis of computer algorithm design, computer programming language design, analysis of computational problems and the nature of the capabilities and limitations of computers [8]. The practical applications of computing would be shallow, ad hoc and inaccurate without the existence of such fundamental principles. Computer Science, on basic level, is based very much on mathematics and logic of sets. A large variety of reasoning such as correctness proofs of algorithms to artificial intelligence rely on propositional and predicate logic. The formal means of handling set is set theory [9].

Functions, relations and more discrete structures like graphs and trees are crucial in describing and solving computational problems. Knowledge of the abstract models enables computer scientists to put reality in a manner that can be solved as logic. Of the most striking questions in Computer Science is the following: What can be computed? Computability theory tackles this in setting the bounds of solvable problems using algorithms [10]. These limits have been prepared through the work of Alan Turing, in particular the development of the idea of the Turing Machine. Not all problems are solvable and depending on the ability to be solved by an algorithm they are classified as decidable and undecidable [11].

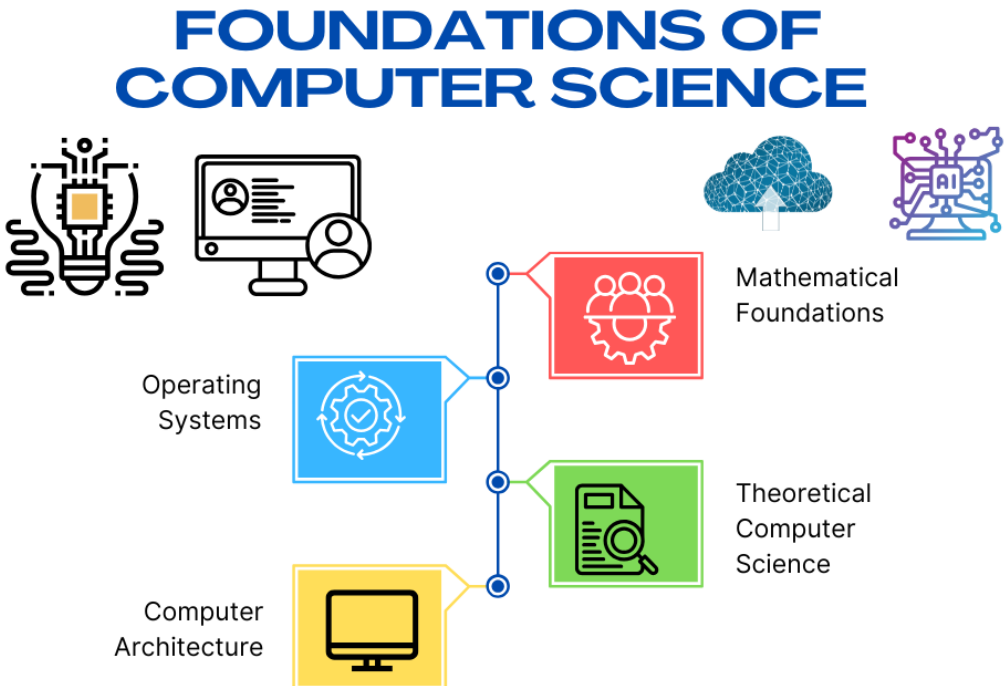

Figure: 1 showing foundations of Computer Science

The concepts are not abstract; they assist software engineers and designers on what systems to build and prevent developers and system designers from wasting resources trying to solve intractable problems, as well as in the design of programming languages and compilers. Computability gives us the definite answers of what is computable but what the complexity theory deals with is how efficiently, computationally, it can be solved. It classifies issues in terms of resources needed that are often time and space [12]. The best known is the classes P (polynomial-time solvable), NP (polynomial-time verifiable), and NP-complete (optimization problems lying at the heart of cryptography). Getting to the bottom of the renowned P vs NP problem, which remains to be unsolved, has tremendous implications in areas of cybersecurity, logistics, and artificial intelligence. Knowledge about the computational complexity enables the designers and researchers to select the best appropriate algorithms and data structures suitable to various kind of problems [13].

Formal languages Formal languages and automata theory can be used as models to design compilers and interpreters. Programming languages are described using finite automata, regular expressions and context-free grammars. The models also act as the foundations of syntax analytics, lexical analytics, and pattern recognition systems of artificial intelligence. On the whole, the theoretical basis of Computer Science acts as the prototype of every created system, language, or algorithm [14]. These notions have made the study accurate, accurate and innovative in every aspect of computation by basing computational science in areas of formal logic, maths rigor and abstract computation.

Data Structures and Algorithms

Computer Science consists of algorithms and data structures. Jointly they characterize the extent of efficiency in solving the problems and data management. It may be an algorithm which searches through a file, sorts user records, analyses social networks or trains a machine learning system, but performance, scalability and reliability are all determined by algorithms and data structures. The simplest algorithmic operations in the center of algorithmic thinking are sorting and searching [15]. Readily available classic algorithms such as Quicksort, Merge Sort and Heap Sort provide various trade-offs between speed and memory consumption. On the same note, the search algorithms like Breadth-First Search (BFS) and Depth-First Search (DFS) or Binary Search are extremely crucial in many applications including databases and path finding in AI [16].

Learning Algorithms is not just remembering algorithms, it is understanding its efficiency in terms of Big-O notation where one can explain the performance of an algorithm with a change in its input size: that method will introduce the term Big-O and give a mathematical form to describe the efficiency of algorithms. This analysis assists developers to select the correct strategy towards a given problem. Data structures define means and manner in which data is organized and stored enabling accessibility and modification of the data in an efficient manner [17]. Simple List Besides arrays, linked lists, stacks, and queues are used in the majority of software systems. Even more sophisticated structures e.g. trees, heaps, hash tables, graphs will enable us to manipulate data and solve problems in even more complicated ways [18].

As an example, the trees allow hierarchical organization of data, which is necessary in databases and file systems. Hash tables enable quick search, with which caching of data and big data manipulation are highly important. Networks can be modeled by graphs: a set of social ties, transportation, wires or dependencies. Graphs are instrumental in the solution of numerous real problems. To construct fast, responsive and scalable software, excellent data structures and algorithms are crucial [19]. The strength are the power of search engines, real-time systems, mobile applications and AI engines. These concepts are not simply learned, but are practically required in developing systems that are strong.

Paradigms and Languages Programming

There are paradigms and languages of programming; these are the focuses of a software conception, design and implementation. They offer a developer the techniques and means of stating solutions of computational problems. Effective software structure, performance, maintainability and scalability tends to depend on the paradigm and the programming language chosen. A paradigm of programming is a form or pattern of programming [20]. The various paradigms provide different methods of coding and thinking of a code. The greatest paradigms are:

Procedural Programming: It is extended on the basis of a sequence of instructions that act on data, and focuses on routine, loop, and conditional. C and Pascal languages are grounded on this approach. It is simple and is extensively used on a system-level programming [21].

Object-oriented programming (OOP): In this paradigm, objects are used to describe the real world entities and contain both data and actions or behavior. Such central terms are classes, inheritance, polymorphism and encapsulation. Using OOP, one enables code reusability and module development. Well known OOP languages are Java, C++, and Python [22].

Functional Programming: based on mathematical functions, this paradigm does not modify state and mutable data. It focuses on pure functions, immutability and recursions. Other languages such as Haskell, Lisp or functional features of the Scala or JavaScript language encourage cleaner and more predictable programming, particularly in concurrent and parallel processing [23].

Logic Programming: This is the paradigm that is founded on formal logic and declaratives. Programs are composed of a group of logical relations and rules. The most well-known language out of the category is Prolog that frequently appears in the tasks of AI and symbolic reasoning [24].

Declarative Programming: Declarative programming contrasts with the procedural programming in which they are interested, it is what to be performed, rather than how to be performed. A well-used example is SQL, a language used to query databases; concentrating on the result desired rather than the process to get it [25].

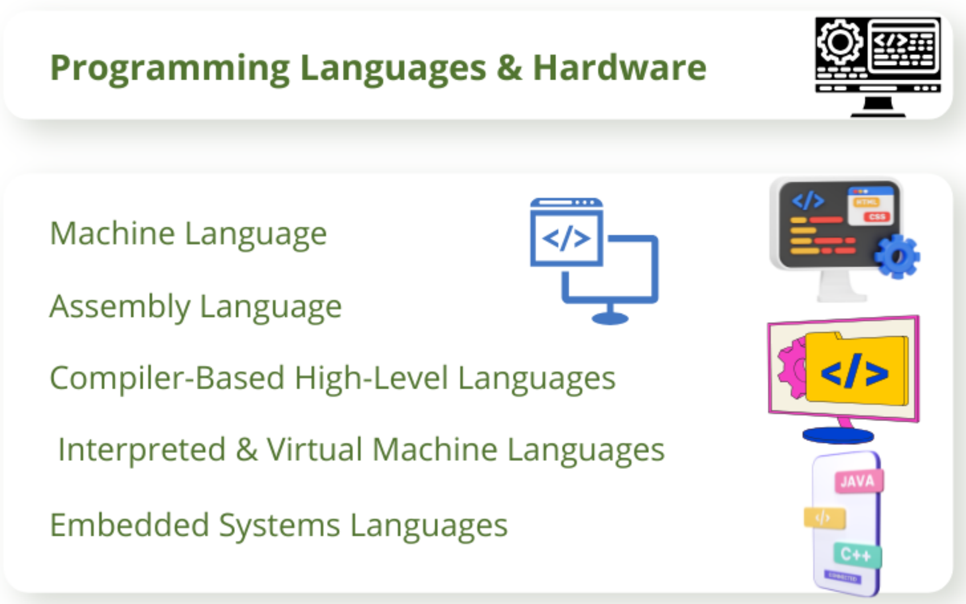

Figure: 2 showing foundations of programming languages and hardware

The art of programming has progressed tremendously, with its early beginnings of low-level assembly language to state-of-the-art high level programming languages, with strong abstractions. The first languages to be developed such as FORTRAN and COBOL defined business and scientific purposes. Languages such as C that later provided control of memory and resulted in development of operating systems and embedded systems [26]. New programming languages like Python, JavaScript, and Go focus on simple readability, fast code, and the popularity of the language. They also promote various paradigms, which provide versatility to the developers. The languages are either compiled (translated and then executed, e.g. C++) or interpreted (executed line-by-line e.g. Python). Another option is a hybrid approach, which uses a just-in-time (JIT) compilation (e.g. Java, JavaScript) [27]. These mechanisms are useful with debugging, performance tuning and cross-platform development. The programming paradigms and languages determine the form in which we really pose and solve problems. This will allow developers to acquire the best techniques in performing any task because they will have mastered the various paradigms and learnt how language is designed [28].

Operating Systems and Computer Architecture

Computer Architecture and Operating systems (OS) have been major building blocks that makes the connection between hardware and software. They decide how computers can perform instructions, handle resources, and to add to user and application requirements. This knowledge of these systems is crucial in designing effective software, resolving performance-related problems, and resource maximization [29]. Computer Architecture means the structure and layout of computer systems. It describes the processing, storing and transferring of data in a machine. There are three major parts of architecture:

Central Processing Unit (CPU): This is commonly referred to as the brain of the computer and it undertakes the arithmetic and logic functions. It is composed of parts such as the Arithmetic Logic Unit (ALU), control unit and register [30].

Memory Hierarchy: The computer memory system is a tiered application divided into registers, cache, main memory (RAM), and secondary storage in order to achieve the balance between performance and price. To access data stored in caches L1, L2, and L3, high speed access is obtained [31].

Instruction Set Architecture (ISA): The ISA describes what the set of operations of the processor consists of load instruction, store instruction, add instruction, jump instruction etc. Various performance, power, and cost trade-offs are supported by different architectures (e.g., x86, ARM and RISC-V). The architectural design affects the low-level programming, compilers, the performance of mobile devices and energy efficiency of data centers. System software is called an

Operating System (OS), which controls a computer as regards hardware and software resources [31]. It serves as a translator between the users and the hardware allowing the applications to perform safely and effectively.

An operating system has some key functions, which involve:

Process Management: The OS takes care of creation and termination of processes as well as their scheduling. It assigns CPU time using scheduling algorithms Round Robin or Priority Scheduling [32].

Memory Management: The OS controls the task of using RAM and assigns memory to each process, and this involves the concept of virtual memory so that it may appear to have more memory than physically recorded [33].

File Systems: Operating systems allow logical methods of storing, retrieving and arranging data on the storage devices through file systems such as NTFS, FAT32 and ext4 [34].

Device Management: Device drivers are used by the OS to manage the input/output devices (e.g. keyboards printer's spring disk drives etc.) [35].

Access Control and Security: It uses controls to define permissions, authenticate users as well as isolating processes to ensure system integrity. Embedded systems to cloud infrastructure is an architecture and operating system that is imperative to comprehend. High performance systems are based on proper hardware software interrelation design, and expertise in this field will enable the developer to create speedier, more stable, and safer programs [36].

Databases and Information Systems

The information system and databases form the core of the modern computing resource making available to the various users the possible chilling of information in large volumes as well as execution of storage, retrieval and management functions. Due to the predominance of data in almost all sectors, including healthcare and financial, education, and e-commerce, the scope of databases in these areas has grown colossally. To develop scalable, secure, and smart applications, it is essential to get acquainted with the principles of creation and technologies of these systems [37]. Data modeling is central to any database and is the act of defining the data structure and relationships. The relational model which is the most popular one was demonstrated by E.F. Codd in the 1970s. Data in this model is stored in tables (relations) composed of rows (tuples) and columns (attributes), whereby each table contains information about a definite entity or concept. The diagrams of relation between the different entities (e.g. customers, products, or transaction) often applied at the stage of designing a database are called the Entity-relationship (ER) diagrams. These models are then converted into relational models with the help of which actual databases are implemented [38].

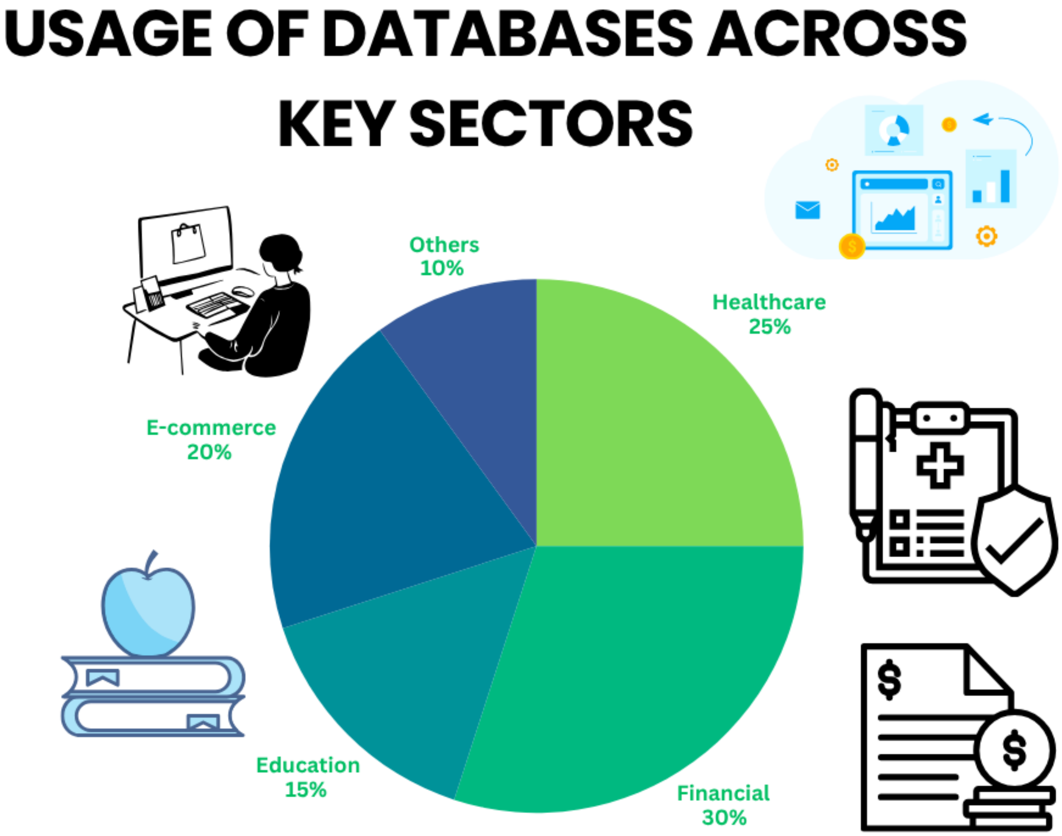

Figure: 3 showing usage of databases across key sectors

The common language to discuss relational databases is called SQL (Structured Query Language). It enables one to create tables, insert data, and make complex inquiries, e.g., filter, sort, as well as join documents and several tables. Examples: To serve a multi-user scenario where the integrity and consistency of the data has to be guaranteed by databases. This is realized under transactions; series of activities that are carried out as one [39]. Transactions obey the ACID features:

- **Atomicity:** All the operations either succeed to the end or not at all.
- **Consistency:** The database is in a good state.
- **Isolation:** There are no other interferences of transactions.
- **Durability:** Even when the system fails some changes are persistent.

Locking-based, timestamp-ordering based and multisession based concurrency control (MVCC) are implemented to avoid conflicts and sustain the performance of the system in its heavy traffic. Although the relational databases continue to dominate, other categories of databases, denoted together as NoSQL, have emerged to solve the problem of scalability and flexibility of modern applications. These models are found in the NoSQL databases and they are particularly adaptable in dealing with unstructured or semi-structured kinds of data, and also in distributed architectures as well as real time web applications [40]. Information systems cover more than databases to involve the software, the individuals and activities that exist to handle information. Enterprise resource planning (ERP) systems, customer relationship management (CRM) systems and decision support systems are all dependent on sound database infrastructures. To create smart data-oriented applications and make business decisions, knowledge of working with databases and information systems is required. They underlie everything ranging up to big cloud-based platforms and simple websites [41].

Internet and Computer Networks

The Internet is the main frame through which the world communicates and shares information. They facilitate all forms of web surfing, emailing, online banking, online video conferences and cloud computing among others. Knowledge of data transmission, routing, and security on interconnected systems is a necessity in anyone pursing computing career either at software development, cybersecurity, or even systems engineering. A computer network is simply the group of devices that are joined together sharing any resources and information [42]. These devices interact in terms of protocols, that is, set rules of data transmission. OSI (Open Systems Interconnection) model can be conceptualized as a model which subdivides the communication of networks into 7 layers:

- **Physical Layer:** Sends out its raw bits through the physical media (e.g. cables, fiber optic).
- **Data Link Layer:** Wide spread coverage of error detection and frame synchronization (e.g., Ethernet).
- **Network Layer:** Pats data amongst networks with logical addressing (i.e., IP).
- **Transport Layer:** Secures unreliable data transfer (For e.g. TCP, UDP.)
- **Session Layer:** This session layer controls application sessions.
- **Presentation Layer:** Converts data formats (such as encryption, and compression).
- **Application Layer:** Accesses user programs (e.g. http, ftp, domain, name server).

Despite being theoretical, the OSI model assists in describing how the protocols in TCP/IP stack are implemented and how they interact in real life. The Internet is a huge uncentralized system of systems [43]. It is based on TCP/IP protocol suite, in which:

- Addressing and routing is dealt with by IP (Internet Protocol).
- TP serves reliably and orderly transmission of data.
- The higher level protocols are:
- Web communication via HTTP / HTTPS.
- Email SMTP.
- Domain name resolution using DNS (Domain Name Server).

Every device on the Internet has its own IP address and domains names (e.g. google.com) are resolved to IP addresses through DNS. Wireless technologies have been added to the modern types of networks (e.g., Wi-Fi, Bluetooth, 5G), which makes them mobile and remote-accessible. Cloud networking Cloud networking enables scalable sharing of computing resources on the Internet, where Amazon Web Services (AWS), Google Cloud, and Microsoft Azure services are built [44]. As online activities increase, there arises a need of network security. To prevent intrusion of data and attacks on the data by any hacker, they are safeguarded through encryption (e.g., SSL/TLS), firewalls, intrusion detection systems, and VPNs. Common risks are phishing, denial of service (DoS) attacks and man-in-the-middle attack. Charles has changed the interaction of people and systems with the advent of Computer networks and the Internet. The establishment of applications that are efficient, secure and scalable in a richly networked environment requires sound knowledge of networking concepts [45].

Software Principles Engineering

Software engineering can be defined as the systematic approach of engineering parameters into the creation, running, and maintenance of the software systems. It links the theoretical computer science with practical software development involving both the concept of structure, quality, scalability and collaboration. With increasing complexity of software and integration into daily living conditions, the need to employ good engineering principles when developing software to create reliable, maintainable, and efficient systems becomes very important [46]. Software Development Life Cycle (SDLC) is a regulated paradigm of software development. It normally comprises the following stages:

- **Requirement Analysis:** Subconscious knowledge of what software has to do.
- **Design:** Definition of the software large-scale structure, architecture and components.
- **Implementation (Coding):** A code is written, according to the design.
- **Testing:** Making sure the software acts according to how it should and eliminating bugs.
- **Deployment:** The Act of software release to users.
- **Maintenance:** Enhancement through time and revision of the software.

All the phases are very vital in enhancing reduction of errors, quality and the ability to have the final product that meets the needs of the user. Old development methodologies such as water fall are linear and inflexible, and current ones such as Agile are cyclical and responsive. Design patterns are solutions to recurrent design problems that are common to software design [47]. Some such examples are the Singleton, Factory, Observer and Model-View-Controller (MVC) patterns. These patterns would help in providing consistency, maintainability, and readability of code.

Proper software engineering design principles result in software that is functional, maintainable, and scalable as well as user focused. These are the main principles of the success of modern software projects both in the academic and industrial environment [48].

Artificial intelligence and machine learning

Artificial Intelligence (AI) and Machine Learning (ML) can be defined as two of several most influential areas of the modern Computer Science. They are concerned with developing systems capable of learning, adaptation and decision making and thus behave intelligently but their behavior required a mind previously found only in a human brain. Since voice agents and recommender systems to diagnostic machines and self-driving cars, AI and ML are making a difference in almost every sector [49]. Artificial intelligence is a science whose origins date back to the 1950s when such scientific pioneers as Alan Turing and John McCarthy established the theoretical basis of this science. Initial ones were concerned with symbolic representation and rule-based systems, with the encoded knowledge created manually. Such good old-fashioned AI worked well with complex but structured, logic-based tasks but faltered when uncertainty was involved [50].

A subfield of AI related to machine learning concerns algorithms that allow computers to learn based on data as opposed to programming them. ML systems can recognize patterns and can predict the future and make decisions using past data. The important paradigms of learning are:

Supervised Learning: These models are trained with labeled exploratory information that teaches the models. Typical uses are spam classification and image classification [51].

Reinforcement Learning: The agent adapts through trial and error, through its environment through rewards or punishment. It is applied to robotics, gaming (e.g., AlphaGo) and autonomous systems [52].

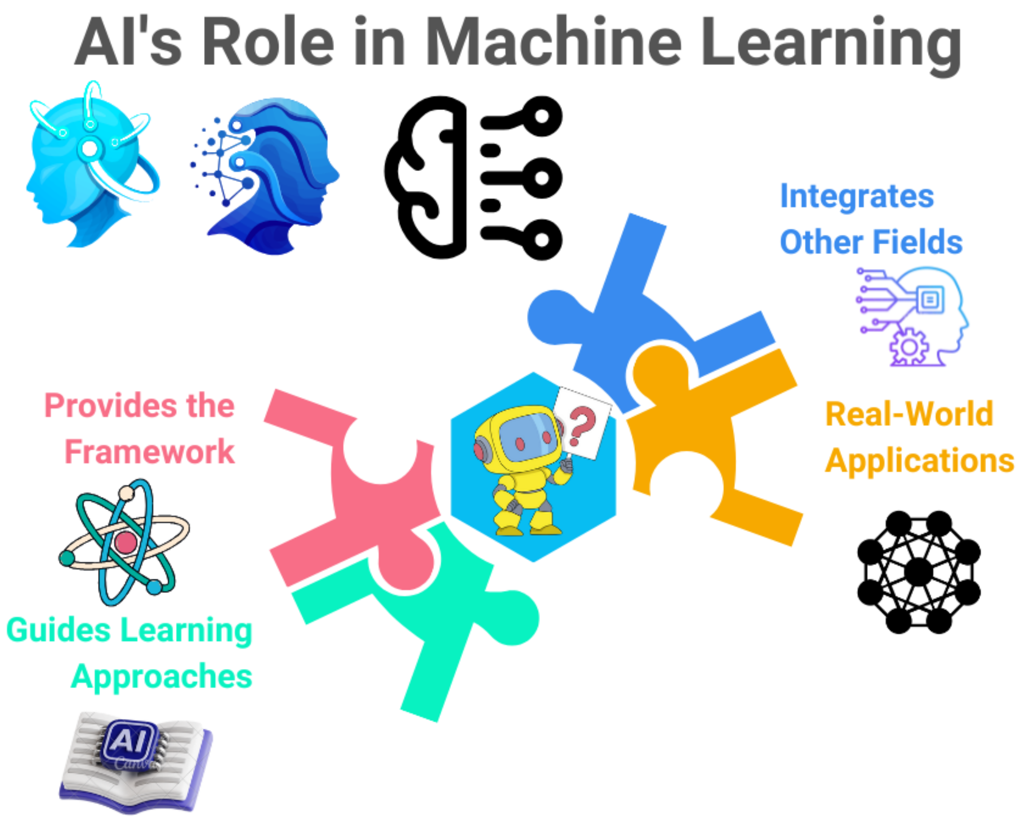

Figure: 4 showing Role of AI in machine learning

Some of the popular algorithms are linear regression, decision tree, support vector machines (SVMs), k-means clustering and neural networks. Artificial Intelligence and Machine Learning are hastily defining the future. To master such technologies, one really needs to understand algorithms, data, and the real world, as well as be limber in the fundamentals of Computer Science [53].

Newfield's within Computer Science

With technology growing, Computer Science gets smarter, and the realm has come up with a number of up-and-coming fields, which have stretched the limits of computer capabilities. Not just changing the industry, these fast-growing industries are also changing the industry, influencing the society, economy and the research, in many ways. Quantum computing is a type of computing that takes advantages of the quantum mechanics to compute functionalities that cannot be performed by classical computers [54].

Computer Science (CS) can be effectively applied to the optimization of controlled release organogels using Quality by Design (QbD), Phytosomes as the delivery system of anticancer phytochemicals, Supersaturable self-microemulsifying drug delivery system (SMEDDS) as itraconazole, Oral organogels as the controlled drug delivery system and Cubosomes as the next-generation nanocarriers used as a delivery system of anticancer therapeutics and other biomedical applications [55]. Molecular modeling, simulation and machine learning are computational tools that enable prediction of drug-carrier interactions, release kinetics, and stability, which are especially applicable in QbD-based optimization of organogels [56].

The Anticancer phytochemicals can be screened using the data mining and AI algorithm to design phytosomes and predict their bioavailability. Likewise, it is possible to use CS-based modeling of solubility and supersaturation profiles to enhance SMEDDS formulations of poorly soluble drugs such as itraconazole [57]. In the case of oral organogels, digital simulations and predictive analytics may inform formulation decisions about controlled release, and cubosomes may be studied with the help of computational docking, bioinformatics, and nanoinformatics tools to determine their suitability in cancer therapy [58]. These new drug delivery systems can be developed, optimized, and translated into clinical utilization more effectively using the CS techniques of big data analytics, AI, cloud-based platforms, and digital twins [59].

Technology is so deeply rooted in the society that the ethical issues are increased. Algorithmic bias, data privacy, ethical AI, and environmental sustainability are now the focus of a socially responsible tech development. Sustainable computing is also about the reduction in the carbon footprint of data centers and devices [60]. The branches of emerging finders can define the pandemic experience in the world of Computer Science and reflect on a world where an interdisciplinary apprehension, moral obligation as well as innovation will exist more than ever before.

Conclusion

Computer Science is a very huge, dynamic and continuously growing industry that defines the digital era. The practical to the theoretical, the fundamentals influence the technologies we live by, industries we operate in and communities we form. In this review, the authors have seen the range of topics in Computer Science and how each of these sub disciplines is linked together and each contributes in its own way to solving hard real-world problems. We started by reading the underpinnings of Computer Science that give one a theoretical grasp of computation itself. The discipline has intellectual pillars like logic, theory of sets and computability. The complexity theory and formal machines such as Turing Machines assist in defining what can, and cannot be computationally achieved.

In addition to it, data structures and algorithms allow to solve problems and operate data economically. They form the core of any software because, besides desktop applications, they are also used in large-scale cloud systems. The algorithm and data structure that will be used also affects the system performance, scalability, and user-friendliness directly. Alongside this, paradigms and languages of programming offer the philosophy and tools of adequately expressing a solution. Starting with procedural and object-oriented all the way through to functional and declarative paradigms, these styles help developers think and code. The knowledge on the interpretation or compilation mechanism of a programming language makes the developer more capable of creating what is enabled to be optimized and be portable.

It proceeded to computer architecture and operating systems, those that control the physical and logical substrates of computing environments. They are vital in the allocation of resources, memory managements, multitasking and serving as the interface between hardware and software. Databases and information systems are the vehicle of information in this era of information where there are many organizations and companies requiring storage, retrieval, and management of information efficiently. In one way or another, data management is a key task in virtually any field, whether it is a legacy relational database system, or a new and exciting NoSQL system. Computer networks and the Internet that makes us have a connection over the globe were also discussed.

Livelihood in the distributed and dependable systems development, necessitates the importance of knowing network protocols, communication layers as well as the security apparatus in our hyper-connected world.

Doctrine in software engineering introduces order and regulations on software engineering. Best practices in design, testing and deployment enables developers to assure robust, scalable and maintainable software. Agile and DevOps methodology have changed the collaboration and software delivery of teams. An insight overview into artificial intelligence and machine learning emphasized how machines have become capable of learning information, deciding and evolving with time. It is transforming the areas of healthcare, finance, and transportation and, at the same time, prompting critical ethical questions. We discussed new fields of quantum computing, human-computer interaction, cloud, and edge computing, and renewable technology development. These fields are the playground of Computer Science and suggest the future with lots of promising opportunities and pivotal challenges.

Computer Science is fundamental as well as progressive. Its values give us the power to grasp the inner mechanics of systems, create the latest technologies, and morally control the future of the digital world. Understanding of fundamental ideas, such as algorithms or AI is a key aspect both to the practitioners and to all individuals who are interested in moving around and contributing to our work-driven society, which is becoming more and more technologically equipped.

References

[1]. S. Secinaro, D. Calandra, A. Secinaro, V. Muthurangu, and P. Biancone, "The role of artificial intelligence in healthcare: a structured literature review," BMC Med. Inform. Decis. Mak. vol. 21, no. 1, 2021.

[2]. Y. Guo, Y. Liu, A. Oerlemans, S. Lao, S. Wu, and M. S. Lew, "Deep learning for visual understanding: A review," Neurocomputing, vol. 187, pp. 27–48, 2016.

[3]. S. Chung, S. Moon, J. Kim, J. Kim, S. Lim, and S. Chi, "Comparing natural language processing (NLP) applications in construction and computer science using preferred

reporting items for systematic reviews (PRISMA),” Autom. Constr., vol. 154, no. 105020, p. 105020, 2023.

[4]. Y. Kang, Z. Cai, C.-W. Tan, Q. Huang, and H. Liu, “Natural language processing (NLP) in management research: A literature review,” J. Manag. Anal., vol. 7, no. 2, pp. 139–172, 2020.

[5]. T. Ige, A. Kolade, and O. Kolade, “Enhancing border security and countering terrorism through computer vision: A field of artificial intelligence,” arXiv [cs.CV], 2023.

[6]. Jadhav, B., Kulkarni, A., Khang, A., Kulkarni, P., & Kulkarni, S. (2025). Beyond the Horizon: Exploring the Future of Artificial Intelligence (AI) Powered Sustainable Mobility in Public Transportation System. In Driving Green Transportation System through Artificial Intelligence and Automation: Approaches, Technologies and Applications (pp. 397-409). Cham: Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-72617-0_21

[7]. Adhikary, S., Sau, S., Debnath, S., & Ghosh, D. (2025). Advancing bioenergy: leveraging artificial intelligence for efficient production and optimization. In Computer Vision and Machine Intelligence for Renewable Energy Systems (pp. 177-186). Elsevier. https://www.sciencedirect.com/science/article/abs/pii/B9780443289477000100

[8]. Nweje, U., & Taiwo, M. (2025). Leveraging Artificial Intelligence for predictive supply chain management, focus on how AI-driven tools are revolutionizing demand forecasting and inventory optimization. International Journal of Science and Research Archive, 14(1), 230-250. https://journalijsra.com/sites/default/files/fulltext_pdf/IJSRA-2025-0027.pdf

[9]. Das, S., Mutsuddi, I., & Ray, N. (2025). Artificial Intelligence in Adaptive Education: A Transformative Approach. In Advancing Adaptive Education: Technological Innovations for Disability Support (pp. 21-50). IGI Global Scientific Publishing. https://www.igi-global.com/chapter/artificial-intelligence-in-adaptive-education/367292

[10]. Arsad, A. Z., Azhar, A. D., Arsad, S. R., Zuhdi, A. W. M., Chau, C. F., & Ghazali, A. (2025). Towards artificial intelligence for solar charge controller: an analytical study of

recent status, optimization and module development. Energy Systems, 1-54. https://link.springer.com/article/10.1007/s12667-024-00721-4

[11]. Vijay Kumar, V., & Shahin, K. (2025). Artificial Intelligence and Machine Learning for Sustainable Manufacturing: Current Trends and Future Prospects. Intelligent and Sustainable Manufacturing, 2(1), 10002. https://www.sciepublish.com/article/pii/400

[12]. Rawat, P. S., & Kumar, N. (2025). Cost Optimization Model for Cloud Using Machine Learning and Artificial Intelligence. In Advanced Computing Techniques for Optimization in Cloud (pp. 170-179). Chapman and Hall/CRC. https://www.taylorfrancis.com/chapters/edit/10.1201/9781003457152-9/cost-optimization-model-cloud-using-machine-learning-artificialintelligence-pradeep-singh-rawat-narendra-kumar

[13]. Ogunseye, O. O., Ajayi, O. T., Fabusoro, A., Abba, A. O., & Adepoju, B. (2025). Leveraging Artificial Intelligence for Advancing Key Sectors of National Growth and Development. Asian Journal of Current Research, 10(1), 45-55. http://article.ths100.in/id/eprint/1968/

[14]. Kasim S, Malek S, Cheen S et al (2022) In-hospital risk stratifcation algorithm of Asian elderly patients. Sci Rep 12:17592. https://doi.org/10.1038/s41598-022-18839-9

[15]. Wang W, Peng J, Hou J et al (2023) Predicting mild cognitive impairment progression to Alzheimer's disease based on machine learning analysis of cortical morphological features. Aging Clin Exp Res 35:1721–1730. https://doi.org/10.1007/s40520-023-02456-1

[16]. Ribeiro, M.T., Singh, S., & Guestrin C. (2016). "Why should I trust you?": Explaining the predictions of any classifier. In Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 1135-1144).

[17]. OpenAI (2020). "GPT-3: Language Models are Few-Shot Learners." Retrieved from Rudin C., & Radin J. (2019). Why Are We Using Black Box Models in AI When We Don't Need To? A Lesson from an Explainable AI Competition. Harvard Data Science Review, 1(2). https://doi.org/10.1162/99608f92.f6b3a8c5

[18]. Ribeiro, M.T., Singh, S., & Guestrin C. (2016). "Why Should I Trust You?" Explaining the Predictions of Any Classifier. In Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 1135-1144).

[19]. Smith-Creasey, M., & Kulkarni-Knight, A. (2020). Open-Source Artificial Intelligence: Ethical Considerations for Transparency and Accountability in Machine Learning Algorithms Used by Public Entities (Doctoral dissertation). University of California Irvine School of Law.

[20]. Abadi M., et al., (2016). TensorFlow: A system for large-scale machine learning. Retrieved from https://arxiv.org/abs/1605.08695

[21]. Zeb S, Lodhi SK. AI and Cybersecurity in Smart Manufacturing: Protecting Industrial Systems. American Journal of Artificial Intelligence and Computing. 2025 Apr 7;1(1):1-23.

[22]. Smithers P., & Smithers R.L (2019). The Role of Regulatory Frameworks in Balancing Transparency and Proprietary Concerns. Journal of Business Ethics, 145(2), 345-358. Doi: 10.1007/s10551-017-3655-6

[23]. Doshi-Velez F., Kim B.(2017). Towards A Rigorous Science of Interpretable Machine Learning. arXiv:1702.08608 [cs.LG]

[24]. Bacha A, Shah HH. AI-Enhanced Liquid Biopsy: Advancements in Early Detection and Monitoring of Cancer through Blood-based Markers. Global Journal of Universal Studies.;1(2):68-86.

[25]. Damiano C, Onder G, Zazzara MB et al (2022) Frailty, multimorbidity patterns and mortality in institutionalized older adults in Italy. Aging Clin Exp Res 34:3123–3130. https://doi.org/10.1007/s40520-022-02269-8

[26]. Mirniaharikandehei S, Heidari M, Danala G et al (2021) Applying a random projection algorithm to optimize machine learning model for predicting peritoneal metastasis in gastric cancer patients using CT images. Comput Methods Programs Biomed 200:105937. https://doi.org/10.1016/j.cmpb.2021.105937

[27]. Mitchell-Heggs R, Prado S, Gava GP et al (2023) neural manifold analysis of brain circuit dynamics in health and disease. J Comput Neurosci 51:1–21. https://doi.org/10.1007/s10827022-00839-3

[28]. Ghojogh B, Ghodsi A, Karray F, et al (2021) Uniform manifold approximation and projection (UMAP) and its variants: tutorial and survey. ArXiv abs/2109.02508.

[29]. Nizamullah F, Fahad M, Abbasi N, Qayyum MU, Zeb S. Ethical and legal challenges in AI-driven healthcare: patient privacy, data security, legal framework, and compliance. Int. J. Innov. Res. Sci. Eng. Technol. 2024; 13:15216-23.

[30]. Abid N, Neoaz N, Amin MH. AI-Driven Approaches to Overcoming Tumor Heterogeneity in Breast Cancer: Modelling Resistance and Therapy Outcomes. Global Journal of Universal Studies.;1(2):591050.

[31]. Bacha A, Zainab H. AI for Remote Patient Monitoring: Enabling Continuous Healthcare outside the Hospital. Global Journal of Computer Sciences and Artificial Intelligence. 2025 Jan 23;1(1):1-6.

[32]. Liang, J. (2025). Artificial Intelligence Empowered Teaching Reform and Exploration of Python Programming Course. Open Access Library Journal, 12(1), 1-14. https://www.scirp.org/journal/paperinformation?paperid=140313

[33]. L. Kaiyue, L. Lei "Research and application of artificial intelligence in the field of vision system and network," in 2019 5th International Conference on Advanced Computing, Networking and Security (ADCONS 2019), 2019.

[34]. P. Abichandani, C. Iaboni, D. Lobo, and T. Kelly, "Artificial intelligence and computer vision education: Codifying student learning gains and attitudes," Computers and Education: Artificial Intelligence, vol. 5, no. 100159, p. 100159, 2023.

[35]. G.-J. Hwang, H. Xie, B. W. Wah, and D. Gašević, "Vision, challenges, roles and research issues of Artificial Intelligence in Education," Computers and Education: Artificial Intelligence, vol. 1, no. 100001, p. 100001, 2020.

[36]. S. B. Rajasekaran and NVIDIA, "Literature review: Recent advances in computer vision and language AI," J Arti Inte & Cloud Comp, pp. 1–3, 2023.

[37]. Neoaz N. Role of Artificial Intelligence in Enhancing Information Assurance. BULLET: Jurnal Multidisiplin Ilmu. 2024;3(5):749-58.

[38]. Z. Jiang, "Representation and reasoning of empirical engineering knowledge," Int. J. Knowl. Eng., vol. 5, no. 2, pp. 53–56, 2019.

[39]. Lan, Y., Wang, L., Ding, L., and Zhou, Y. (2016). Full-order and reduced-order observer design for a class of fractional-order nonlinear systems. Asian J. Control 18, 1467–1477. doi: 10.1002/asjc.1230

[40]. Goksel N, Bozkurt A. Artificial intelligence in education: Current insights and future perspectives. Handbook of Research on Learning in the Age of Transhumanism, IGI Global; 2019, p. 224–36.

[41]. Neoaz N, Amin MH. Advanced AI Paradigms in Mental Health: An In-depth Exploration of Detection, Therapy, and Computational Efficacy. Global Insights in Artificial Intelligence and Computing. 2025 Jan 25;1(1):40-6.

[42]. Zeb S, Lodhi SK. AI for predictive maintenance: Reducing downtime and enhancing efficiency. Enrichment: Journal of Multidisciplinary Research and Development. 2025 May 13; 3(1):135-50.

[43]. Bacha A, Shah HH. AI-Enhanced Liquid Biopsy: Advancements in Early Detection and Monitoring of Cancer through Blood-based Markers. Global Journal of Universal Studies.;1(2):68-86.

[44]. Guàrdia L, Clougher D, Anderson T, Maina M. IDEAS for transforming higher education: an overview of ongoing trends and challenges. International Review of Research in Open and Distributed Learning 2021; 22:166– 84.

[45]. Selwyn N. The future of AI and education: Some cautionary notes. European Journal of Education 2022; 57:620–31.

[46]. Gupta A, Christie R, Manjula PR (2017) Scalability in internet of things: features, techniques and research challenges. Int J Comput Intell Res 13(7):1617–1627

[47]. Srivastava G, Parizi RM, Dehghantanha A, Choo KKR (2019) Data sharing and privacy for patient iot devices using blockchain. International Conference on Smart City and Informatization. Springer, Singapore, pp 334–348

[48]. Shaw RN, Walde P, Ghosh A (2020) IOT based MPPT for performance improvement of solar PV arrays operating under partial shade dispersion. In: 2020 IEEE 9th Power India International Conference (PIICON). IEEE, pp 1–4

[49]. Song F, Zhu M, Zhou Y, You I, Zhang H (2019) smart collaborative tracking for ubiquitous power IoT in edge-cloud interplay domain. IEEE Int Things J 7(7):6046–6055

[50]. Abbasi N, Nizamullah FN, Zeb S. Ai in healthcare: Using cutting-edge technologies to revolutionize vaccine development and distribution. JURIHUM: Jurnal Inovasi dan Humaniora. 2023 Jun 14;1(1):17-29.

[51]. H. Dhillon, P. K. Chaudhari, K. Dhingra et al., "Current applications of artificial intelligence in cleft care: a scoping review," Frontiers in Medicine, vol. 8, article 676490, 2021

[52]. M. Mohamed, D. J. Ferguson, A. Venugopal, M. K. Alam, L. Makki, and N. R. Vaid, "An artificial intelligence based referral application to optimize orthodontic referrals in a public oral healthcare system," Seminars in Orthodontics, vol. 27, no. 2, pp. 157–163, 2021.

[53]. Abbasi N, Nizamullah FN, Zeb S, Fahad M, Qayyum MU. Machine learning models for predicting susceptibility to infectious diseases based on microbiome profiles. Journal of Knowledge Learning and Science Technology ISSN: 2959-6386 (online). 2024 Aug 25; 3(4):35-47.

[54]. N. Ahmed, M. S. Abbasi, F. Zuberi et al., "Artificial intelligence techniques: analysis, application, and outcome in dentistry—a systematic review," BioMed Research International, vol. 2021, Article ID 9751564, 15 pages, 2021.

[55]. Dave P, Kariya S, Dudhat K. Tailoring and optimization of nifedipine controlled release organogel via quality by design approach. Journal of Pharmaceutical Innovation. 2024 Aug; 19(4):47.

[56]. Dave P, Jani R, Chakraborthy GS, Jani KJ, Upadhye V, Kahrizi D, Mir MA, Siddiqui S, Saeed M, Upadhyay TK. Phytosomes: A promising delivery system for anticancer agents by using phytochemicals in cancer therapy. Cellular and Molecular Biology. 2023 Dec 20; 69(14):1-8.

[57]. Dave P, Raval B, Pujara N, Gohil T. FORMULATION AND EVALUATION OF ORAL SUPERSATURABLE SELF MICRO EMULSIFYING DRUG DELIVERY SYSTEM ITRACONAZOLE.

[58]. Dave P, Patel D, Raval B. An oral organogel-novel approach for controlled drug delivery system. International Journal of Drug Delivery Technology. 2022; 12(1):437-45.

[59]. Dave P, Raval B, Dudhat K. Cubosomes: Next-Generation Nanocarriers for Versatile Drug Delivery System for Cancer Therapy and Other Applications. Biomedical Materials & Devices. 2025 Jun 5:1-32

[60]. G. V. Bulatova, B. Kusnoto, V. Grace, T. P. Tsay, D. M. Avenetti, and F. J. C. Sanchez, "Assessment of automatic cephalometric landmark identification using artificial intelligence," Orthodontics & Craniofacial Research, vol. 24, no. S2, pp. 37– 42, 2021.