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A Thousand Years Before the Emergence of Artificial Intelligence: Arab and Muslim Scholars Laid the Foundations for Algorithms, Robots, Automation, Intelligent Machines and Cryptography

قبل ألف عامٍ من ظهور الذّكاء الاصْطناعي: عُـلماء عـَـرب و مُـسلمون وضَـعـوا الأسُـسَ الأولى للخوارزْميات، الرّوبُـوتات، الأتْـمَـتَـة، الآلات الـذّكية والتّـشْـفِيـر

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Abstract.
Practically Arab and Muslim scholars did not invent artificial intelligence in its modern form, yet historical evidence demonstrates that they laid its conceptual foundations centuries before the digital age. Artificial Intelligence should therefore, not be regarded as a purely Western achievement. Instead, it is the product of cross-civilizational interaction, in which Arabs and Muslims played an early and foundational role — long underacknowledged in conventional historical narratives.
This paper offers a historical reading, doing justice to the undervalued legacy of Arab and Muslim scholars —long before *Silicon Valley*— when *Baghdad*, the beacon of science and the heart of Arab and Muslim civilization, was experiencing the dawn of Artificial Intelligence in all its facets: Building intelligent machines, developing programming, working with algorithms, analyzing codes, and processing data. This was more than 1000 years before the birth of the British computer science theorist *Alan Mathison Turing* (1912-1954) recognized today as the first to lay the foundations of Artificial Intelligence.
Keywords: Artificial Intelligence; Algorithms; *House of Wisdom* (*Bayt al-Hikma*); Scientific translation movement; Arab and Muslim scholars.

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1. Introduction

This study adopts a historical-analytical methodology to examine the contributions of Arab and Muslim scholars to the intellectual foundations of modern artificial intelligence. This is achieved through a critical analysis of their scientific ideas, inventions, and theoretical achievements within their historical context. The analysis relies on primary sources, including original Arabic and Islamic texts and classical treatises, and secondary sources such as peer-reviewed scientific publications, historical studies, and contemporary research in the history of science, technology, and artificial intelligence. It also incorporates testimonies from some Western thinkers and Orientalists regarding the role and contributions of Arab and Muslim scholars in disseminating science and culture in the Western world. The study focuses on a select group of scholars whose documented contributions are directly linked to the conceptual foundations of algorithms, robotics, automation, intelligent machines, and cryptography. The study does not aim to provide a comprehensive history of all scientific developments during the Islamic Golden Age, as that would exceed its scope.

The following is a detailed account of the article's topic:

Arab and Muslim scientists had a major impact on the intellectual renaissance scientific progress of Western societies during the Middle Ages[1,2], when most Westerners lived in agricultural societies governed by the feudal system, with limited education, widespread illiteracy, and rampant epidemics. This period represented the peak of the Golden Age of Islam (the period extending from the middle of the eighth century AD to the fourteenth century AD). Several historical studies and academic research confirm the profound (and undeniable) influence of Arab and Muslim scholars on the Christian West during this period[3,4], in various fields such as philosophy, mathematics, medicine, navigation, astronomy, optics, engineering, chemistry, history, literature, etc...[5].

Using historical methods, the pivotal role played by Arab-Islamic civilization in shaping the development of scientific discourse in the West since the eleventh century CE becomes clear. The cities of *Toledo* and *Sicily* served as key gateways for the translation of Arabic texts and manuscripts into Latin[6,7] (particularly in centers such as the *Toledo* School of Translation and the Norman School of *Palermo*). This subsequently sparked a genuine revolution in the emerging European universities, which was the primary catalyst for the European Renaissance. Thus, *Toledo* and *Sicily* became conduits through which Arabic knowledge flowed. Islamic and other initiatives that arose during the Abbasid Caliphate in the 8th century CE and

thereafter, particularly those related to the translation of Greek texts into Arabic[4].

The British historian *Bertrand Russell* (1872-1970) stated in his famous book[8] : **"Islamic civilization not only preserved the Greek heritage, but also added to it and contributed to its transmission to *Europe*, and this had an impact on the European scientific renaissance"**. At that time, the *House of Wisdom* (*Bayt al-Hikma*) (the first scientific institution established in the Islamic Golden Age, a massive edifice whose foundation was laid by Caliph *Abu Ja'far al-Mansur* (713-775), and which was officially established during the reign of Caliph *Harun al-Rashid* (766-809) in the eighth century CE in *Baghdad*) played a major role in preserving books (especially the precious ones). This included authorship, copying, binding, and the purchase of valuable and rare manuscripts at their weight in gold, as well as the flourishing of the translation movement (which reached its peak during the reign of *Al-Ma'mun ibn Harun al-Rashid* (786-833)), where tens of thousands of pages were translated into Arabic from Greek, Persian, Syriac, and Hindi[4]. The translation was not literal; a group of philosophers and scientists, such as *Ibn Rushd*, *Ibn Sina*, *Al-Farabi*, and *Al-Khwarizmi*, critiqued the ideas contained in those pages, explained and modified them, and reformulated them into eloquent and precise Arabic, thus enriching them further. With original additions and contributions, the group laid the foundations for many modern sciences[9].

The American-Lebanese historian *Philip Khuri Hitti* (1886-1978), in his book[10], described the *House of Wisdom* as **"the greatest scientific center for translation and research in the world at that time"**, and noted that thanks to the *House of Wisdom*, *Baghdad* became a global capital of science and knowledge during the Abbasid era.

In this context, the fact emerges that the Arab-Islamic civilization powerfully strengthened the march of scientific and intellectual progress. The Arab-Islamic influence was a fundamental factor in understanding the process of transferring ideas and sciences to the other side (the West) through cultural contact[11]. The Arab-Islamic civilization became one of the main tributaries that nourished the European Renaissance, which led to expanding the circle of human knowledge, intellectual continuity, encouraging the pursuit of knowledge, pushing its wheel forward, and saving the world heritage from loss through the translation and publication of manuscripts and texts that were brought (with enormous sums of money) from various parts of the world to the Arab-Islamic *House of Wisdom*[12,13].

In[14], in the context of discussing scientific institutions in *Baghdad* and the flourishing of translation and authorship, it is stated:

"For several centuries, the Arabs remained the world's masters in science and the arts, and Europe only came to know civilization through them". In his famous book[15], the "Father of the History of Science", the American-Belgian historian *George Sarton* (1884-1956), said of the scholars of the Arab-Islamic civilization (such as *Ibn Sina*, *Al-Biruni*, *Al-Farabi*, *Ibn al-Haytham*, *Al-Khwarizmi*, and others) that they represent pivotal figures in the history of science, describing them as: **"A magnificent array of names"**.
Among his most famous quotes in this context are:
"The scientific books written in Arabic during the Middle Ages were, for a few centuries, the main vehicle of the living science".
He also described the era Al-Dhahabi defined Islam as **"the period in which scientific activity in the world was primarily written in Arabic"**.
He said of Abbasid *Baghdad* and the intellectual environment that flourished there: **"The ninth century was essentially a Muslim century"**.

Jonathan Lyons said in his book[16] that while the best European libraries contained only a few dozen books, the *House of Wisdom* library held over four hundred thousand volumes. The German orientalist and philosopher *Sigrid Hunke* (1913-1999) described *Baghdad* as[17] : **"the greatest scientific center the world had known at that time"**, directly linking this to the translation movement and scientific research that flourished at the *House of Wisdom*. The *House of Wisdom* was thus the scientific starting point and reference point for Arab-Islamic civilization, which influenced the flourishing of sciences for centuries. The works of Muslim scholars such as *Ibn Sina*, *Al-Farabi*, *Al-Biruni*, and *Ibn Rushd* were even studied in European scientific centers after the Middle Ages[13]. Thus, the *House of Wisdom* was not just an ordinary library, but the philosophical and mathematical incubator in which the triad (algorithms, formal logic, self-propelled machines) was born, without which neither the intelligent computer nor artificial intelligence would have ever existed.

The research article[18] proved with evidence that the conceptual roots of artificial intelligence extend to the scholars of the *House of Wisdom* who formulated formal logic and probabilistic mathematics and laid the basic cognitive building blocks on which today's machine learning models are built. The *House of Wisdom* included an elite group of the greatest scholars of the Middle Ages who led (thanks to their brilliant minds and sound ideas) the movement of translation, authorship, innovation, industry, etc., including: *Al-Khwarizmi*, the three brothers *Banu Musa* (the sons of *Shakir*), *Al-Kindi* (*Abu Yusuf Yaqub*), *Al-Farabi*, and many others. In this article, we will discuss the achievements of some of them and their contributions to the emergence of artificial intelligence technology.

2. The First Foundations of Artificial Intelligence (According to the Western Narrative)

The term "Artificial Intelligence" refers to the field (of computer science) that focuses on creating technological systems and automated devices capable of mimicking human cognitive processes, such as: learning, reasoning, recognizing emotions, and understanding languages[19,20,21,22]. The main goal of artificial intelligence is to enable automated devices or robots to perform tasks that usually require human intelligence, but in an efficient, automated way.

2.1. The British scientist *Alan Matheson Turing* caused a global sensation because of his famous article (1950)

Alan Matheson Turing (1912-1954) was an inspiring British mathematician and computer science theorist[23], born in *London*. He worked at the Government Cryptography and Code School in *Bletchley Park*, located in central *England*. During World War II (1939-1945), he participated in deciphering the secret naval messages of the German High Command (which used a machine called "*Enigma*" to encrypt messages to protect military communications), thus contributing to the defeat of the German submarines in the *Atlantic* Ocean and the victory of *Britain* and its allies over *Germany* during World War II, which led to shortening this war from four years to two years (according to some historians)[24].

Thus, *Turing* was very distinguished among his generation, and he was considered the first (from a purely Western perspective) to lay the foundations of artificial intelligence after publishing his famous article[25]:
A. M. Turing (1950) "**Computing Machinery and Intelligence",** *Mind* 49: 433-460, in which he posed the question: Can machines think?

This article has garnered over 33,440 citations as of this writing. *Turing* proposed a test that has become a criterion for determining whether a machine is capable of thought. He also formulated the concept of the *Turing* machine, a theoretical computational model (which forms the basis of computer logic) used to model what a computer can and cannot compute. This concept was proposed by *Alan Turing* in 1937 in a paper on computable numbers titled[26,27,28] :
"On Computable Numbers, with an Application to the Entscheidungs problem". This article has garnered over 16,526 citations as of the writing of this article.

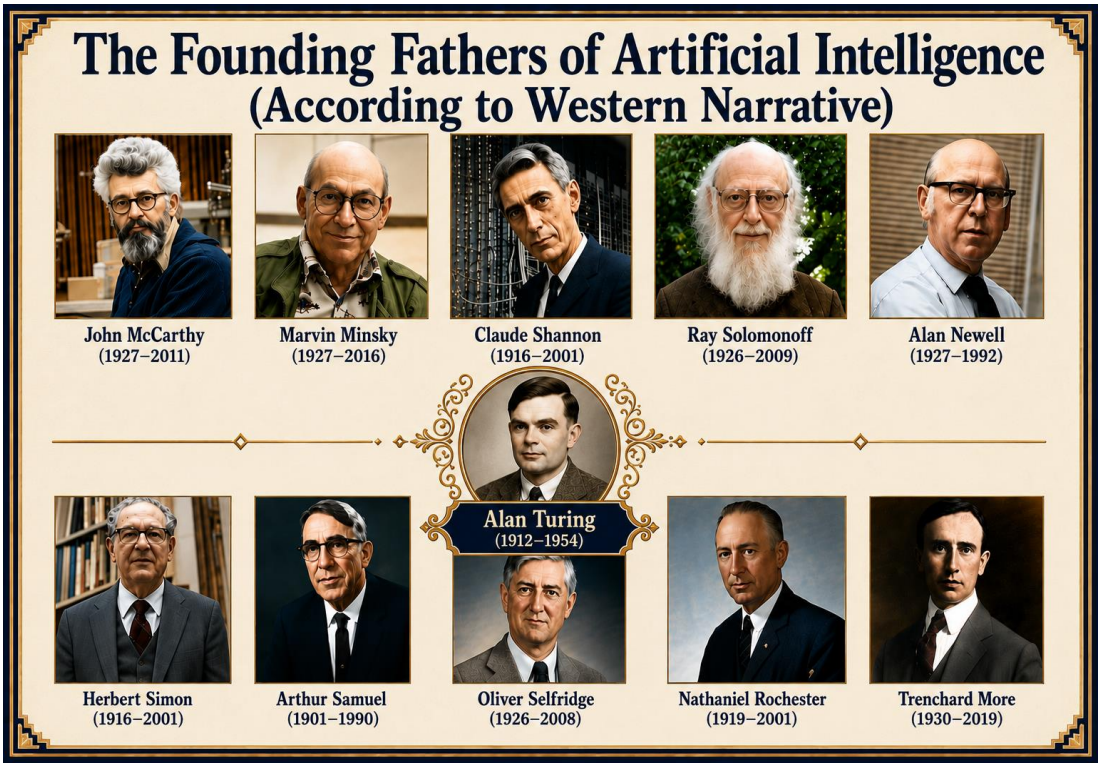
2.2. The birth of the term "Artificial Intelligence" (1956)

The work of *Alan Matheson Turing* in algorithmic modeling and computing contributed to providing a theoretical basis on which researchers later relied to develop this emerging field. In this context, the *Dartmouth* Summer Research Project on Artificial Intelligence[29] emerged to transform these ideas into a structured scientific project and the beginning of a new phase of systematic research into designing machines capable of mimicking human cognitive abilities.

The term "Artificial Intelligence" was officially introduced during this conference, held in the summer of 1956 at *Dartmouth* College (a private university located in the northeastern *United States*). It brought together a select group of the brightest minds in the fields of computing and cognitive science—twenty American researchers, all of whom were scientists working at American universities and research centers during the 1950s. Among them were: *Ray Solomonoff* (1926–2009), *Alan Newell* (1927–1992), and *Herbert Simon* (1916–2001). This conference (which was not the beginning of the journey, but rather a milestone in a long intellectual path, one in which multiple civilizations converged) was organized by a research team consisting of *John McCarthy* (1927–2011), *Marvin Minsky* (1927–2016), *Nathaniel Rochester* (1919–2001), and *Claude Shannon* (1916–2001). During this conference, this team proposed formulating and implementing "human thought processes" using automated devices.

In Western literature, this event is considered the official beginning of Artificial Intelligence research as a distinct academic field and an independent area of scientific research[29]. At this conference, *John McCarthy* presented a paper on the alpha-beta filtering principle, an evaluation algorithm that plays a key role in artificial intelligence programming, and is used in particular by the vast majority of chess programs.

Artwork 1.



Panorama of AI Pioneers "According to the Western Narrative":
A Group Portrait
(Designed by the *Gemini* AI Assistant and Reviewed by the *ChatGPT* AI Assistant)

3. The Contributions of a constellation of Arab and Muslim Scientists to the Emergence of Artificial Intelligence Technology

The intellectual journey that led to that pivotal moment (the convening of the *Dartmouth* Conference in 1956) did not begin in American universities at all. Rather, its intellectual roots extend deep into the scientific heritage of Arab-Islamic civilization, where scholars in *Baghdad*, *Andalusia*, and *Cairo* were laying the foundations of the digital mind a thousand years ago, which have now become the basis for Artificial Intelligence systems.

In what follows, we will begin by reviewing historical glimpses of some Arab and Muslim scholars, in which we will explore aspects of their scientific careers, and reveal the gems of their immortal works that fueled an intellectual renaissance whose echoes still resonate today[30]:

3.1. *Muhammad ibn Musa al-Khwarizmi* (781-847)

Abu Abdullah Muhammad ibn Musa al-Khwarizmi was a mathematician, astronomer, and geographer. He was born in *Khwarazm* in the Islamic region of *Khorasan* and died in *Baghdad*. *Al-Khwarizmi* developed systematic mathematical methods for solving problems step by step, which are known today as "Algorithms". Contemporary academic studies confirm that the concept of "Algorithm" is linguistically derived from "Algoritmi": The Latinized name of *Al-Khwarizmi*, a direct historical link between the legacy of Muslim scholars and computer science. He is one of the most brilliant minds and prominent Muslim scientists who paved the way for modern computer science[31]. In his famous book: "*Al-Kitāb al-Mukhtaṣar fī Ḥisāb al-Jabr wa-l-Muqābala* (The Compendious Book on Calculation by Completion and Balancing)", he laid the foundations for the development of algebra[32] and systematic arithmetic, which became the cornerstone of modern computing, programming principles, and the mathematical heart of artificial intelligence[33,34].

Al-Khwarizmi also played a prominent role in disseminating the Hindu-Arabic numeral system and introducing the use of zero to the Islamic world (and later to *Europe*), until it became an essential part of modern mathematics. This revolutionized arithmetic operations and paved the way for the later emergence of digital computers. Contemporary researchers believe that the algorithmic thinking established by "*Al-Khwarizmi*" represents the intellectual core upon which modern machine learning techniques depend[33].

3.2. The three brothers *Banu Musa* (c. 800-873)

They are three brothers who were scholars: *Muhammad ibn Musa ibn Shakir*, *Ahmad ibn Musa ibn Shakir*, and *Al-Hasan ibn Musa ibn Shakir*, who lived in *Baghdad* during the ninth century AD (the Abbasid era) and worked in the *House of Wisdom*, and they excelled and became famous for their work in mathematics[35], engineering, mechanics, astronomy, and machine manufacturing[36]. Among their most famous books is "Kitāb al-Ḥiyal (The Book of Ingenious Devices)", which was the first scientific document (in the history of mechanical engineering and self-propelled machines) to describe systems operating with automatic and automated control, and to describe engineering devices and self-propelled mechanical machines resembling modern robotic concepts[37,38]. "The Book of Ingenious Devices" contains 100 innovative mechanical devices, hydraulic (water-powered) devices, lifting machines, self-igniting lamps, fountains, musical instruments, and intelligent valves and pipes. It cames in[39] that: **"The *Banu Musa*, who worked in the**

bio-environment of the *House of Wisdom* (*Bayt al-Hikma*) in *Baghdad*, were not merely collectors of Hellenistic ideas (philosophical, scientific, and cultural concepts that emerged during the Hellenistic period from 323 to 31 BC), but were pioneers in the use of automatic control systems, failure-safety mechanisms, sequential programming, which are the direct ancestors of cybernetics (direction and control) and modern automation".

3.3. *Yaqub ibn Ishaq al-Kindi* (801-873)

Abu Yusuf Yaqub ibn Ishaq al-Kindi, known in the West as *Alkindus* was born in *Kufa* (an Iraqi city) and died in *Baghdad*. He was a multi-talented Arab Muslim scholar who excelled in astronomy, philosophy, chemistry, physics, medicine, mathematics, music, psychology, and logic[40]. *Al-Kindi* was interested in mathematics, logic, and cryptography, and is considered one of the first to use statistical analysis in codebreaking[41], a principle similar to data processing and pattern analysis in intelligent systems. He laid the foundations for statistical frequency analysis for cryptanalysis (a field now linked to data processing, digital security, natural language processing, and artificial intelligence)[42,43]. *Al-Kindi* is known in the West as "The Philosopher of the Arabs", and the book[44] offers a comprehensive and in-depth analysis of his metaphysical, medical, and philosophical ideas.

3.4. *Muhammad ibn Muhammad ibn Tarkhan al-Farabi* (870-950)

Abu Nasr Muhammad ibn Muhammad ibn Tarkhan al-Farabi, a Muslim polymath born in *Farab* (*Turkestan*, in present-day *Kazakhstan*) and died in *Damascus*. He greatly developed the science of logic after Aristotle. He discussed the nature of the mind and knowledge, logic, the idea of organizing thought and logical reasoning[40], topics that have resurfaced strongly with the development of artificial intelligence and today form a philosophical basis for contemporary artificial intelligence systems based on logic. *Al-Farabi* was known in scholarly circles as the "Second Teacher" after *Aristotle*, and he was distinguished by his integration of Greek philosophy and Islamic thought[45]. He authored some of the most profound works on music theory, combining mathematics, acoustics, and aesthetics. He wrote more than 100 treatises and books.

3.5. Al-Hasan Ibn Al-Haytham (965-1040)

Abu Ali al-Hasan ibn al-Hasan ibn al-Haytham, an Arab Muslim scholar born in *Basra* and died in *Cairo*. He contributed to the establishment of the scientific method based on meticulous observation, experimentation, and

rational deduction or mathematical analysis. This is the method upon which artificial intelligence research relies today for testing models and analyzing data. It is also considered a cornerstone of all subsequent experimental sciences, including computer science. His research in optics and visual perception revolutionized the understanding of human vision[46], topics directly related to modern computer vision. Studies indicate that his work represented a shift from philosophical speculation to a systematic experimental method[47]. *Ibn al-Haytham* was also a renowned mathematician, physicist, and astronomer. His most influential book, Optics, demonstrated through various experiments that vision first reflects off an object before reaching the eyes[47]. He authored over 200 valuable manuscripts on diverse subjects, including astronomy, theology, music, politics, and geometry. He is known in Latin as the "Father of Optics".

3.6. *Al-Husayn ibn Abd Allah ibn Sina* (980- 1037)

Abu Ali al-Husayn ibn Abdullah ibn al-Hasan ibn Ali ibn Sina al-Balkhi, known in the West as *Avicenna*, Father of Modern Medicine, and Princeps Medicorum (In Latin), was a brilliant scholar and physician of Persian origin. He was a memorizer of the Quran and a renowned scholar of both medicine and philosophy, and is considered one of the greatest scientists and philosophers of Islamic civilization[48]. *Ibn Sina* was born in the village of *Afshana*, near *Bukhara* (in present-day *Uzbekistan*), to a father from *Balkh* (in present-day *Afghanistan*) and a mother from a rural area. He died in *Hamadan* (*Iran*). The philosophical and logical concepts developed by scholars like *Ibn Sina* are used today as effective research tools in advanced fields such as Natural Language Processing (NLP) and Deep Learning[49]. He was known as "The Chief Sheikh" and called "The Prince of Physicians" by Westerners. He presented advanced conceptions of perception, thought, and logic[43]. His exceptional works (which reached great heights) have had a profound impact on the sciences of mind and knowledge, which are now linked to cognitive artificial intelligence[43,50]. His writings exceed 450 books and treatises.

3.7. Badi' al-Zaman Abu al-'Izz ibn Isma'il al-Jazari (1136-1206)

Badi' al-Zaman Abu al-'Izz ibn Isma'il ibn al-Razzaz nicknamed *al-Jazari* after the region of *al-Jazira* (located between the *Tigris* and *Euphrates* rivers in *Iraq*) where he was born. He was an Arab Muslim scholar considered one of the greatest engineers, mechanics, and inventors in history. The invention of the "Elephant Clock" is attributed to him. *Al-Jazari* designed self-moving mechanical machines (automatas)[36], which can be considered prototypes of modern robots. He contributed to the field of mechanics[51], and among his

most famous and impressive inventions are: the automatic servant (a device that dispenses water or beverages automatically), complex mechanical clocks powered by water and weights, water-drawing devices used by farmers for centuries, and automated control systems. He is considered one of the first to conceive the idea of "machines that execute commands automatically" (self-service machines), an early precursor to the concept of the "intelligent machine" or "programmable robot." In fact, some modern studies have dubbed him "the father of robotics, hydraulics, and modern engineering." *Al-Jazari*'s designs are considered part of the historical development of global engineering[52,43], and they are also regarded as the missing link that paved the way for the Industrial Revolution in *Europe*[53].

In his book: "The Book of Knowledge of Ingenious Mechanical Devices", he described more than fifty complex mechanical devices (with precise and detailed drawings) based on gears, valves, hydraulics, and mechanical programming. Among his most famous inventions are: water pumps, complex locks, complex water clocks, fountains or garden fountains of the palaces of his time in northern *Iraq*, and the "floating music band", which is a boat that operated according to a reprogrammable system using mechanical pegs that controlled the rhythm and movement, which is similar to the principle of modern programming, as well as the "automatic handwashing machine", which is a mechanical doll that automatically provides soap and a towel to the user when water is poured[54].

3.8. *Nasir al-Din al-Tusi* (1201-1274)

Nasir al-Din Abu Ja'far Muhammad ibn Muhammad ibn al-Hasan al-Tusi, an exceptional Muslim philosopher, astronomer, biologist, chemist, mathematician, physician, and physicist[55]. He was born in the city of *Tus* in *Khorasan* and died in *Baghdad*. *Al-Tusi* wrote on trigonometry and is considered the independent founder of spherical trigonometry[56]. He also wrote on astronomy, geometry, arithmetic, medicine, and music, and played a prominent role in developing astronomical models and astrology[57,58], among other subjects. He produced works in logic and systematic mathematics, which are among the theoretical foundations of modern computing. His writings exceed 150 books and treatises on astronomy, mathematics, philosophy, ethics, logic, and theology.

4. An objective comparison between the output of Arab and Muslim scholars (from the 8th to the 14th centuries) and the

output of computer science theorist *Alan Matheson Turing* in the field of Artificial Intelligence

The objective comparison between the output of Arab and Muslim scientists (from the 8th to the 14th century) and the output of the British scientist *Alan Matheson Turing* in the field of Artificial Intelligence is based on understanding the sequential historical development as an integrative relationship and not a competitive one. Arab and Muslim scholars laid the cognitive frameworks and the procedural, mechanical, and logical foundations (inputs and self-propelled machines), while *Turing* transformed these foundations and frameworks, along with other (global) scientific accumulations, into a computational framework and a direct theoretical (then applied) model that led to the emergence of modern artificial intelligence[59,23]. In summary, Arab and Muslim scholars paved the way (the necessary cognitive background for *Turing*'s work), while *Turing* designed the vehicle that travels on that road.

The following (Table 1.) is a detailed analysis comparing the nature and level of contribution of each party:

Table 1.

Comparison Criterion	Arab and Muslim Scholars	Alan Mathison Turing
Historical Period	Approximately from the 8th to the 14th century CE	20th century
Historical Context	The Age of Translation and Scientific Flourishing in *Baghdad*, *Al-Andalus*, and *Sicily* under the Islamic Caliphates	The period between the World Wars and the Cold War
Technologies Used	Mechanical and optical instruments	Theoretical tools and early electronic computers (Colossus, ACE)
Nature of their Work	Philosophy, mathematics, and mechanical engineering	Mathematics, computer science, and digital computation
Primary Objective	Understanding the mind, logic, and constructing intelligent machines	Developing a mathematical model of computation and machine intelligence

Concept of the Algorithm	Established by *Al-Khwarizmi*	Incorporated into modern computational models
Programming	Primitive mechanical programming	Theoretical digital programming
Types of Machines	Mécanisa devices and automata	General-purpose programmable computers
Automation	Clearly demonstrated, especially by *Al-Jazari*	Associated with computation and mathematical logic
Logic	Developed by *Al-Farabi* and *Ibn Sina*	Converted into a mathematical computational model
Concept of Intelligence	Philosophical and cognitive	Computational and digital
Fundamental Question	Nature of reason and cognition	Can machines think?
Autonomous Machines	Self-operating mechanical devices	Computers executing algorithms
Electronic Computer	Did not exist	Foundation of *Turing*'s work
Intelligence Test	None	*Turing* Test
Symbolic AI	Philosophical and logical foundations	Direct mathematical foundation
Mathematical Model	Not formulated in modern form	*Turing* Machine
Mode of Operation	Manual and mechanical	Electronic and algorithmic
Use of Electricity	No	Yes
Theory of Computation	Not formally established	Founded by *Alan Turing*
Modern Computer Science	Indirect foundation	Direct foundation
Relationship to AI	Foundational and indirect contribution	Direct contribution
Global Impact	Intellectual and historical influence	Direct scientific and technological impact
Closest Modern Fields	Logic, mathematics, automation	Computing, algorithms, AI
Did They Use the Term AI?	No, but they laid its foundations	No, the term was coined after his lifetime

Linguistic Legacy	Algorithm and Algebra derive from Arabic	*Turing* Machine and *Turing* Test bear his name

An objective comparison between the output of Arab and Muslim scholars and that of computer science theorist *Alan Matheson Turing* in the field of Artificial Intelligence

5. Study Recommendations

This article concludes with a set of actionable recommendations aimed at rehabilitating and institutionalizing the scientific legacy of Arab-Islamic civilization within contemporary academic and technological discourse. We advocate for a critical return to primary sources over secondary literature, and call for the establishment of an interdisciplinary research field provisionally termed "The Cultural History of Artificial Intelligence Technology", bringing together historians, computer scientists, and philosophers. At the institutional level, the recommendations include producing a peer-reviewed multilingual encyclopedia of Arab-Islamic contributions to logic, mathematics, and computing; integrating this heritage into artificial intelligence curricula; and allocating dedicated resources for the digitization of manuscript collections. We further propose the creation of a "Digital House of Wisdom" as a conceptual model merging classical scholarly tradition with modern technology, supported by international conferences, interactive museums, and immersive educational tools leveraging virtual and augmented reality. On the ethical dimension, an AI development charter grounded in humanistic and Arab-Islamic values is proposed. The article closes with a caution against Western reductive narratives of the history of science, affirming that a rigorous, balanced, and inclusive historiographical approach remains the only scholarly path toward an accurate account of civilization's intellectual heritage.

6. Future Prospects

As part of the age of Artificial Intelligence, we should aspire to:

- Developing AI systems based on human and ethical values.
- Developing AI applications for analyzing and cataloging ancient scientific manuscripts that serve the Arabic language and Islamic culture.
- Creating digital libraries containing Islamic scientific manuscripts with AI tools for research and analysis.
- Collaborating between different cultures and civilizations to develop ethical and responsible technology.
- Encouraging dialogue between religious scholars and technologists on the future of AI.

• Utilizing Islamic principles in establishing ethical guidelines for technology.
• Building bridges between civilizations in the field of developing responsible AI.
• Promoting interdisciplinary research between heritage and technology.
• Establishing research centers specializing in "Artificial Intelligence and Islamic Civilization". Creating digital platforms for preserving and disseminating Islamic scientific heritage.

7. Conclusion..... From the "*House of Wisdom*" to the Intelligent Computer: A Thousand-Year Journey of Ideas that Gave Birth to Artificial Intelligence

This article has shown that Artificial Intelligence technology did not emerge suddenly in the twentieth century, nor was it the fruit of individual efforts or a single civilization. Rather, it is the result of a cumulative knowledge path that extended for more than a thousand years, during which the contributions of different nations and civilizations succeeded one another in building the scientific and methodological concepts that paved the way for the emergence of artificial intelligence technology. In this context, this article reveals that Arab-Islamic civilization, particularly during its golden age, had a profound and lasting influence on the development of the ideas that constitute artificial intelligence today[60]. It also made an original contribution to this trajectory by developing numerous sciences such as mathematics, logic, astronomy, optics, engineering, and mechanics, as well as by establishing the experimental method and initiating a widespread translation movement that began in the *House of Wisdom* in *Baghdad*. Hence, the spread of scientific centers was prevalent like in *Toledo* and *Sicily* to *Europe*, where human knowledge continued its journey toward the modern scientific renaissance. As this article demonstrates, a number of Arab and Muslim scholars, such as *Al-Khwarizmi*, *Ibn al-Haytham*, *Al-Jazari*, *Al-Tusi*, *Al-Farabi*, *Ibn Sina*, and others, made significant scientific and intellectual contributions that had a far-reaching impact on shaping the knowledge base upon which modern computing and artificial intelligence are founded[33,44,45,48,54,55,61]. However, these contributions must be understood within their proper historical context[62]. They did not directly establish Artificial Intelligence in its modern sense, but rather laid the foundations for knowledge and methodological concepts that contributed to the development of ideas leading to Artificial Intelligence over centuries of scientific accumulation. These findings underscore the importance of a comprehensive and objective re-examination of the history of science, one that acknowledges the

contributions of diverse civilizations and transcends narratives that confine the origins of scientific knowledge to a single environment or specific historical period. It also calls for strengthening interdisciplinary studies that link the history of science with computing and Artificial Intelligence, contributing to a more balanced understanding of the evolution of human knowledge and highlighting that true innovation is the fruit of continuous cultural interaction, not the product of rupture or discontinuity.

The Future Needs the "Wisdom" of the *House of Wisdom* (*Bayt al-Hikma*) and the "Intelligence" of the Smart Computer Together, to Build a More Just, Knowledgeable and Humane World

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Artwork 2.



Eight Visionaries of Islamic Civilization: Architects of the Foundations of Artificial Intelligence
(An artwork designed and created by the AI tool *ChatGPT*)

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