

WEB 3.0 and the Evolution of the World Wide Web

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Abstract

The paper aims to cover the main contributors to the development of Web 3.0 and to explore their different views on the evolution of the World Wide Web by creating a comprising image on the key theories, models, and frameworks in the evolution of Web 3.0. We used a qualitative research method, more precisely we conducted a literature review to identify the main characteristics of Web 3.0. Based on the selected papers we revealed the evolution of Web 3.0 by investigating a large variety of dimensions. Findings unfold to reveal the chronological publication of studies, main journals, and research methodology used in studies, along with future research directions. Furthermore, we performed an in-depth analysis to of the selected paper to discover a taxonomy of studies by key theories, models, and frameworks, features, technologies, main theories on the evolution of Web 3.0. As this is still a nascent topic, future research directions must focus on both qualitative and quantitative studies covering a wide spectrum of Web 3.0 stakeholders. The originality of the research derives not only from stating the evolution of Web 3.0 but also from the comparison between Web 1.0, Web 2.0, Web 3.0, and Web 4.0 we performed in order to hint towards the promise of the future in terms of opportunities and strengths.

Keywords: evolution of web development, Web 4.0, Web 3.0, Web 2.0, Web 1.0

JEL classification: O32, O33

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1. Introduction

The term "Web 3.0" has been attracting considerable attention in recent years both in practice and academic research. However, what does it mean, and how is it different from the current web we know? Web 3.0, referred to as the Semantic Web or Decentralized Web, is considered the next generation of the Internet. It aims to create a web environment where data is interconnected, easily understood by machines, and controlled by users, making a convergence between the real world and the virtual means of communication and information access, enabling an ambient intelligence scenario of pervasive and ubiquitous computing (Silva et al., 2008). Web 3.0 aims to make web content machine readable and understandable, structuring data in such way that allows computers to understand

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the context and meaning, enabling more automation than its predecessors Web 2.0 and Web 1.0. In essence, Web 3.0 represents a significant evolution of the Internet, aiming to create a more intelligent, user-centric, and immersive online environment, which caught our attention.

In this paper, we focus on studying the available literature in order to disclose not only the main stages in the evolution of the World Wide Web, but also other relevant information in each stage. We focused on the following: period, creator, concept, characteristics, main theories, content creation, focus, networks, number of users, portability, types of application, architecture, data, challenges and issues, enabling use patterns, enabling monetization, software development, hardware, enabling technology, used technologies, used sites, and payments. In the next section, we briefly describe the literature review, moving further with research methodology, results interpretations, and discussion and concluding remarks.

2. Literature review

The evolution of World Wide Web

The World Wide Web (known as web) is considered the fastest growing publication medium of all time (Rudman, 2015) and the largest global information media through which user can share, read, and writes data through computers connected with internet (Nath and Iswary, 2015). It acts as an enabler for technological advancement, evolving in its own respective way (Rudman, 2015). Therefore, in recent years internet and media scholars have been confronted with new developments of the Web, that have seen the growth of social networking sites, the extension of mobile technologies and an increase in user participation (Barassi and Treré, 2012), forming ecosystems (Grosu, 2022). As Silva, Mahfujur Rahman, and El Saddik (2008) emphasized that in recent years there was a tendency to have version numbers for the World Wide Web. Initially, there were the static informative characteristics of the early web (Rudman, 2015), the read-only Web 1.0 (Silva et al., 2008), which progressed into the more interactive experience of the read-write Web 2.0. The next phase of web evolution, is the Semantic Web, the Transcendent Web, and the Web of Things – henceforth referred to solely as Web 3.0 (Rudman, 2015; Silva et al., 2008). This will change the way people interact with devices and networks, and how companies use information to market and sell their products, and operate their businesses (Rudman, 2015). Nath and Iswary (2015) describes the future phase, Web 4.0, as a web of intelligence connections.

Web 3.0

Rudman (2015) stated that Web 3.0 is a new concept in the domain of web evolution. Although in the past years there were debates about what technologies drive the third generation of Websites and Web applications experts did not seem to agree on a specific set of characteristics or technologies, or a definition for Web 3.0 (Silva et al., 2008). Rudman (2015) stated that defining Web 3.0 will assist in

classifying new and developing web technologies into the correct evolutionary genre, being Web 1.0, Web 2.0, and Web 3.0, and a robust definition will assist in distinguishing between preexisting and new negative impacts and opportunities that arises.

Furthermore, (Kreps and Kimppa (2015) suggest that definitions of Web 3.0 in the literature fall into reasonably clear categories. First, those focused on the technologies, with regard to the social or theoretical aspects. In this category a definition of Web 3.0 is presented by Hendler (2009) as a „Semantic Web technologies integrated into, or powering, large-scale Web applications” (Kreps and Kimppa, 2015). Second, those focused either positively or negatively on the social meaning of this development. For instance Fuchs and Reich (2019), focusing on the social political ramifications, describe Web 3.0 as a web of cooperation (Kreps and Kimppa, 2015). Third, those who question the entire notion of such theorizing, for instance. Barassi and Treré (2012) criticize the whole idea of “whether concepts such as Web 1.0, 2.0 and 3.0 can be viable and successful theoretical models for social analysis” when they are, in fact, “cultural constructs” in themselves (Kreps and Kimppa, 2015), considering Web 3.0 a more deeply complex than is thus far envisaged in the literature.

Research methodology

Based on the recommendations of Tranfield, Denyer, and Smart (2003), Denyer and Tranfield (2009), and Crişan (2022) our study is constructed as a literature review of the most important and recent sources which analyses the concept and main features of WEB 3.0, and the evolution of the web.

Identification and screening stage: as the high interest in the study topic, and implicitly the existence of many papers, which cover this topic, we have decided to perform a review of existing articles concerning this topic. In our approach, we identified relevant sources regarding WEB 3.0 in google scholar, the most comprehensive online database. The first search of the terms “WEB 3.0”, “WEB 3.0” &” products”, “WEB 3.0” & “technologies”, was performed in August 2022, and has delivered about 37,300 results. The second search of the combination “WEB 3.0” “comparative” led to 6,210 results in Google Scholar as Web of Knowledge returned very few results. After applying filters to include only articles, we resulted with 267 papers referring to Web 3.0. Furthermore, we reviewed the titles and abstracts of these sources guided by our inclusion (publications in English and address our topic) and exclusion (sources with a different/same topic based on title and abstract appraisal, excluding papers that focus solely on technical aspects) criteria. The result of the screening was 48 eligible sources that met our criteria. The full papers analysis led to the acceptance of 26 papers from the sample. We also identified other three relevant papers cited within these sources, which finally equaled 29 papers, representing our sample (Figure 1).

Extracting stage: Each of these 29 articles have been further analyzed considering their contribution to the study’s objectives, respectively all these

studies were analyzed in detail to provide information regarding the period, features, technologies, and main theories of the various stages of the web. All these ideas are mentioned in the findings section.

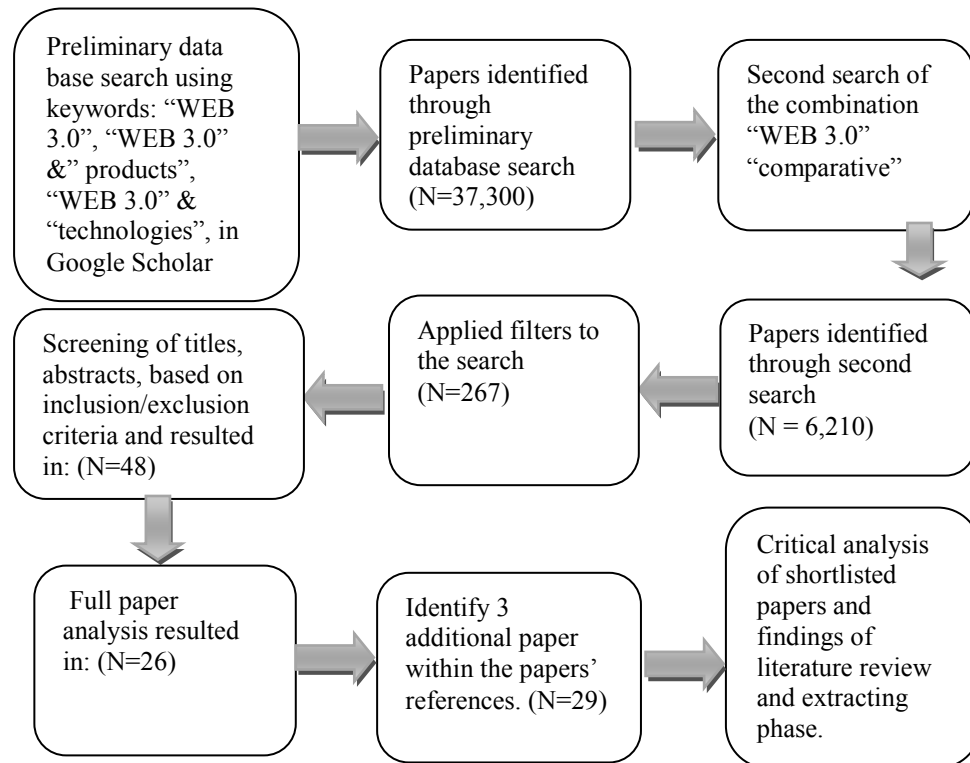


Figure 1. Literature review methodology

Source: authors work

3. Findings and research implications

The identified literature is organized into a number of categories for better analysis of the existing information in a process of recording and analyzing data performed in Microsoft Excel. The various categories identified for this literature review are the following: chronological publication of studies, journals, and research methodology used in studies, future research directions. Furthermore, we performed an in depth analysis to on the selected paper to discover a *taxonomy of studies by key theories, models, and frameworks*, features, technologies, main theories on the evolution of Web 3.0.

Descriptive findings

The selected sources go back to 2007 with the incipient research on Web 3.0, evolving in complexity towards 2022. The very few papers published before 2007 did not meet the inclusion criteria for our study as they only mention Web 3.0 as being built (Markoff, 2006) without much information. It is true though that the term Web 3.0 was first coined around 2006, and academic research into this concept began to emerge shortly thereafter, hence papers dating back to 2007. The early research was largely focused on the idea of the Semantic Web, a concept that was proposed by Tim Berners-Lee (Shivalingaiah and Naik, 2008), the inventor of the World Wide Web. The Semantic Web, which is a key component of Web 3.0, is a vision of the internet where data is structured in such a way that it can be easily understood and processed by machines.

In terms of geographical location we considered the first author affiliation and concluded that research on Web 3.0 emerged in 2007-2008 in USA, Canada and India, but then spread in other continents such as Europe (Sweden, Portugal, Spain, UK, Romania, and Germany), Africa (South Africa) or Australia.

Research approach, methods and technique, future directions

Most of the papers we analyzed are conference papers, IEEE publications being popular, but there are also some journals included, such as: British Medical Journal, Management Decision, New media & society, Journal of Advanced Distributed Learning Technology, Journal of Educational and Instructional Studies in the World, Journal of Applied Business Research, and Information Technology & People.

In our research sample, most studies employ qualitative research methods, only two studies are mentioning quantitative ones. This can be explained through the fact that Web 3.0 is still an emerging field. In the early phases of any technological or conceptual development, there is a great need to define, understand, and conceptualize the fundamental ideas first. Qualitative research is particularly suited for this, as it allows for a deep exploration for new concepts, their implications, and potential applications.

Looking at future research directions, we observed that in our sample there are some common ideas on what should be researched next. These topics range from data sharing (Silva et al., 2008), aggregation techniques to mitigate disagreements among users (Davis and Lin, 2011), Web 3.0 business strategies, Web strategies and Web tactics (Barassi and Treré, 2012). Furthermore, the topics include the synergies between ubiquity and semantics impact (Lassila and Hendler, 2007), impact on the social context (Garrigos-Simon et al., 2012), machine learning methods for pre-classification (Schulz et al., 2012), or gender diversity in ICT (Kreps and Kimppa, 2015). In terms of methods, some of them are qualitative (in the need of more literature reviews), quantitative (large data sets must be used further on). Ideally, longitudinal studies are to be carried on, as they are needed to talk about sustainability in the use of technologies and Web 3.0 used in educational context. Moreover, another suggestion for future directions is to collect data from

all stakeholders and perform a triangulation in terms of methodology and data sources (FIRAT and Firat, 2020).

A taxonomy of studies by key theories, models, frameworks and evolution of Web 3.0

As stated by (Barassi and Treré, 2012) the concept of Web 3.0, as it is described by business models and Web developers, is often associated with the idea of the Semantic Web. The idea being first coined in 1999 by Tim Berners-Lee, the creator of the World Wide Web, who foresaw the possibility of enabling machines to ‘talk to one another’ and to understand and create meaning from semantic data (Berners-Lee in Floridi 2009). In order to understand the evolution of the web and its impact upon organizations, it helps to present the various stages of the web, based on literature (see Annex 1, Table 1).

Web 1.0

Web 1.0 was created by Tim Berners Lee (Shivalingaiah and Naik, 2008) around 1997, as suggested in Table 1. In terms of who the concept works it was meant to be an international web, read-only static web (Nath et al., 2014; Singh and Gulati, 2011) as it did not allow any interaction between the information and the consumer, presenting static information with text and images. Some disadvantages underlined for Web 1.0 refer to the fact that it is based on the client-pull model, meaning that the client can only initiate it. Furthermore, in order to visualize information from multiple sources one should move from one site to another (Silva et al., 2008). Content creation was not an easy task in Web 1.0 as it was only performed by experts, while the focus was company oriented (Singh and Gulati, 2011). Networks were not available (Singh and Gulati, 2011), even if there were millions of users (Shivalingaiah and Naik, 2008) and the portability was low (Nath et al., 2014).

The software part is static HTML page published by web author (Kreps 2015), HTML frames, guest books, e-mail correspondence, newsletters, ‘donate now’ buttons and web directories such as Yahoo and DMOZ or encyclopedia’s such as Encarta (Singh and Gulati, 2011). All these are using HTML, HTTP, URL as core web protocols, some newer protocols are also in used like XML, XHTML and CSS, both server side and client-side scripting are used such as ASP, PHP, JSP, CGI, PERL as server side scripting and JavaScript, VB script, flash as client side (Nath et al., 2014; Nath and Iswary, 2015).

Web 2.0

Web 2.0, created around 2004 (Nath and Iswary, 2015) by Tim O’Reilly (Shivalingaiah and Naik, 2008) is a read-write web (Gulati et al., 2021) presenting user generated content (Kreps and Kimppa, 2015) with dynamic content (Silva et al., 2008) web site. It is not considered a new development of the web, but rather an extension of Web 1.0 (Galvao et al., 2019; Rudman and Bruwer, 2016) of which main objective was to focus to power of the community to generate dynamic

contents and interactive technology (Almeida and Lourenço, 2011). The main advantage of Web 2.0 derives from the fact that it is a read-write networking platform (Nath et al., 2014) defined by the empowerment of users (Silva, 2008). Other advantages include communicating with each other (Nath et al., 2014) to write, modify, update and share the content online, supporting collaboration in gathering collective intelligence (Nath and Iswary, 2015; Rudman and Bruwer, 2016; Silva et al., 2008).

Web 2.0 brings in different stakeholders such as consumers, programmers, service providers, organizations contributing to content creation (Rudman and Bruwer, 2016). In terms of content creation the focus is on sharing (Gulati et al., 2021) as both individuals and organizations that create it (Almeida and Lourenço, 2011) in a community oriented focus (Nath et al., 2014; Singh and Gulati, 2011).

Web 2.0 is used in online social networks (Singh and Gulati, 2011) has millions of worldwide users (Shivalingaiah and Naik, 2008) has medium portability (Nath et al., 2014) is user developed and seen as an open application service-oriented architecture (Nath et al., 2014). The data allowed by Web 2.0 has medium richness (XML) and is light interlinked (Nath et al., 2014). The issues and challenges around Web 2.0 regard different vulnerabilities related to scalability, security, performance and authentication flaws (Nath et al., 2014; Nath and Iswary, 2015). The enabling use patterns are social, mashups Saas/PaaS (Cabage and Zhang, 2013). The enabling monetization is done through ads, selling products (Alabdulwahhab, 2018) or subscription. Collaboration is enabled through social networks, RSS Feeds, weblogs/blogs, and content publishing services (images, text and video), web of services, social bookmarking, wiki, podcasts. RSS feeds (and other forms of many-to-many publishing), social software, web APIs, mashups (hybrid applications which mix various forms of data) and folksonomies (bookmarking/ content sharing sites (Cabage and Zhang, 2013; Shivalingaiah and Naik, 2008; Silva et al., 2008; Singh and Gulati, 2011) through credit cards and Paypal (Alabdulwahhab, 2018) are also permitted. In terms of hardware, the progress from Web 1.0 is marked by Wi-Fi internet. Comparing the software we observed that Web 2.0 implies a separation of form and content of documents (Kreps and Kimppa, 2015). Furthermore it allows database-driven web site creation with content uploaded by users employing HTML, CSS, PHP, Javascript (Kreps and Kimppa, 2015; Silva et al., 2008), AJAX (Almeida and Lourenço, 2011; Silva et al., 2008), XML (Silva et al., 2008). According to Singh and Gulati (2011) Web 2.0 enables technological resources used to create a final product, such as: languages, systems and other tools that allow the professional to develop or adapt application and the final products. These final products are audio, blog pod, bookmarking, e-learning, e-mail, multi-media games, forums, etc.(Shivalingaiah and Naik, 2008) such as Google, Facebook, Wikipedia, eBay, Youtube, Scribd (Almeida and Lourenço, 2011; Shivalingaiah and Naik, 2008).

Web 3.0

Web 3.0, created in 2007 to 2011 (Nath and Iswary, 2015) by Sr Tim Berners Lee (Shivalingaiah and Naik, 2008) is a read-write intelligent web (Nath et al., 2014) “intelligent web” (Almeida and Lourenço, 2011), smart web (FIRAT and Firat, 2020), portable personal web (Singh and Gulati, 2011), and decentralized web (Alabdulwahhab, 2018). It is not considered an emergence of a new web, rather than an extension of Web 2.0 (Rudman and Bruwer, 2016) as the main objective is to link data, devices and people across the web (Almeida and Lourenço, 2011) where the computer, rather than humans, generates new information (Rudman, 2015; Wolfram, 2021).

The novelty resides from the fact that in Web 3.0 the focus is on developing protocols and underlying technologies unnoticeable to the end-user (Alabdulwahhab, 2018) introduction of new programming language (Rudman, 2015; Rudman and Bruwer, 2016) and the possibility to obtain contextual information from a bigger and wider variety of sources (Rudman, 2015; Rudman and Bruwer, 2016). Some key elements of Web 3.0, according to (Nath et al., 2014; Nath and Iswary, 2015; Silva et al., 2008): include the Social Web (in which users can share their feeling, thoughts, ideas through Web 3.0 technologies rather than by solely linking documents). Furthermore, other key elements are the Semantic Web (allowing users to find information in much deeper level), Web 3D (allowing people to live in a virtual world as an avatar). Worth mentioning is also the Media Centric Web (allows taking a media and searching for similar objects), and the Pervasive and Ubiquitous Web (a Web that is virtually everywhere, on every device, and even in common everyday objects such as your clothes furniture, appliances).

Besides individuals and organizations in Web 3.0 we also have machine creating context which can then be reused (Almeida and Lourenço, 2011), while the focus is individually oriented (Nath et al., 2014; Singh and Gulati, 2011) and the networks are semantic social networks (Singh and Gulati, 2011). Web 3.0 allows unlimited number of users (Singh and Gulati, 2011) with high portability in user developed smart applications with a Web oriented architecture (WOA) and internet of things, enabling high data richness and a worldwide database (Nath et al., 2014). Besides all the advancements, Web 3.0 presents certain challenges. Some of them include scalability, security and performance issues from web 1.0 and web2.0 propagated to web3.0 (Nath et al., 2014). Others refer to privacy and legal issues (FIRAT and Firat, 2020; Hussain et al., 2022; Silva et al., 2008). Or social, ethical and cultural issues (Silva et al., 2008) web accessibility, readiness of the users, requirement for further standardization of e-Learning technologies (FIRAT and Firat, 2020; Hussain et al., 2022). The enabling patterns include a multi-screen user, context specific apps, device as a personal assistant (Cabage and Zhang, 2013). In Web 3.0 monetization is done through app store, mobile commerce, geo fencing (Cabage 2013), using a token model through Ethereum and Bitcoin (Alabdulwahhab, 2018), which have been the stars of the last 7-8 years in terms of investments (Marta, 2022).

The enabling technology is represented by a web of devices, native apps (iOS, Android), geolocation (Cabage and Zhang, 2013), big data, connected data, augmented reality applications, machine learning, artificial intelligence, personal avatars, 3D visualization and interaction (FIRAT and Firat, 2020). Artificial intelligence technology is seen as a major revolution transforming mankind in ways that will profoundly improve the way people live, work, and relate to each other and their environments (Sejera and Bocarnea, 2022). Other enabling technology mention intelligent mobile applications, personalized portals and search engines, integrated games, business and education, avatars and 3D role play games, Automated reasoning, Cognitive architecture, Composite applications, Distributed computing, Knowledge representation, Ontology (computer science), Recombinant text, Scalable vector graphics, Semantic Web, Semantic Wiki, and Software agents (Gulati et al., 2021). The hardware part did not change from 2.0, in comparison to the software one, which includes mashup of HTML, CSS, PHP, JavaScript, APIs and public microblogging IM service (Kreps and Kimppa, 2015) ambient intelligence, smart interfaces, intelligent agents (Silva, 2008), and distributed components (Kreps and Kimppa, 2015). The technologies used have evolved significantly, and include: Extensible Mark-up Language (XML), Simple Object Access Protocol (SOAP), Resource Description Framework (RDF), Resource Description Framework Schema (RDFS), Structured Query Language (SQL), Simple Protocol and RDF Query Language (SPARQL). The list can continue with Ontology Web Language (OWL) and Web Ontology Language for Services (OWL-S), Intelligent agents (IA) (Almeida and Lourenço, 2011; Hendler, 2009; Rudman and Bruwer, 2016), while the websites are Dbpedia, sioc-project.org (Almeida and Lourenço, 2011).

Web 4.0

The best is yet to come would be a phase that describes the promises of the future Web 4.0. This is still an idea in progress with suggestive names such as Web of Symbiotic Web, in which human and machine can interact in symbiosis (Nath and Iswary, 2015), connecting intelligences in a ubiquitous web where both people and things reason and communicate together (Davis 2020). Web 4.0 will provide a new model of user interaction with the most comprehensive and personalized, not limited simply to display information, but proposes to behave like an intelligent mirror with concrete solutions to what the user needs (Nath and Iswary, 2015). Its estimated challenges range from the migration of online functionality into the physical world (Gibson, 2021) to issues concerning industry standards such as wireless connections, telecommunication lines doing the actual connection and a language that is understandable by all devices and not only by a few belonging to a certain company, and privacy issues (Gibson, 2021; Nath and Iswary, 2015). The enabling technologies will include some main concepts (Nath and Iswary, 2015) such as: Natural Language Understanding (NLU) Technique, New model of machine to machine (M2M) Communication, New model of interface, but it is still a lot to be said and discovered about Web 4.0. The

succession of the four industrial revolutions shows the increasing rate of change brought by technology (Moldoveanu, 2022) with significant impact in various fields.

Conclusion

Taking a close look at Web 3.0 we can clearly understand the amount of progress was made from Web 1.0 and Web 2.0, but also the hint towards the promise of the future which is represented by Web 4.0. Seen as an extension of Web 2.0, Web 3.0 delivered the promised objectives where computers generate the information within protocols most often not obvious to the end user and the introduction of new programming languages. Web 3.0 connects people in more ways than the previous Web 2.0 and Web 1.0, but also leaves room for exploring the virtual world. According to Nath and Iswary (2015) the future generation of web will be the next great phase of internet, where not only people (Web 1.0 & Web 2.0) or machines (Web3.0) are connected, but these objects could literally be anything from a toaster to a car, our keys, our phone, books, etc, the list is endless. In the present research, we investigated Web 3.0 and the evolution of the World Wide Web according to the available literature. Future research directions may cover qualitative studies on Web 3.0 challenges and risks, but also quantitative ones on large data sets of Web 3.0 stakeholders. The best is yet to come in terms of technology and the sooner businesses and individuals comprise the promise of Web 4.0, the sooner they can benefit from all the advantages and opportunities.

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Annex 1

The evolution of web development: period, features, technologies, main theories

Table 1

Criteria	WEB 1.0	WEB 2.0	WEB 3.0	WEB 4.0
Period	From 1997 to 2003 (Nath and Iswary, 2015; Singh and Gulati, 2011)	From 2004 to 2006(Nath and Iswary, 2015)	From 2007 to (Nath and Iswary, 2015)	Future years
Creator	Tim Berners Lee (Shivalingaiah and Naik, 2008).	Tim O'Reilly (Shivalingaiah and Naik, 2008)	Sir Tim Berners Lee (Shivalingaiah and Naik, 2008)	
Concept	Informational web, read-only static web (Nath and Iswary, 2015; Singh and Gulati, 2011).	Read-write web (Nath and Iswary, 2015; Singh and Gulati, 2011), web site presenting user-generated content (Kreps and Kimppa, 2015) with dynamic content (Silva et al., 2008).	Read-write intelligent web (Nath et al., 2014) “intelligent web” (Almeida and Lourenço, 2011), smart web (FIRAT and Firat, 2020)the portable personal web (Singh and Gulati, 2011) decentralized web (Alabdulwahhab, 2018).	still an idea in progress, with suggested names such as Webos, “Symbiotic” web,
Characteristics and main theories	A web site publishing static information (Kreps and Kimppa, 2015) well designed with text and images, with no interaction between the information and the consumer, and minimal content creators (Rudman, 2015; Rudman and Bruwer, 2016). User can only read information and cannot interact with the content of the pages	Not a new development of the web, but rather an extension of Web 1.0 (Rudman and Bruwer, 2016; Stănescu et al., 2019). Main objective - focus the power of community to create dynamic contents and interaction technology (Almeida and Lourenço, 2011). Read-write networking platform (Nath et al., 2014), defined by the	Not an emergence of a new Web, but rather an extension of Web 2.0 (Rudman and Bruwer, 2016). Main objective - linked data, devices and people across the web (Almeida and Lourenço, 2011) where the computer, rather than humans, generates new information (Rudman and Bruwer, 2016; Wolfram, 2021). Conceived through many different angles: such as, social - refers to the interactions among users as part of a	Implies that once the metadata are organized (Web3.0), human and machine can interact in symbiosis (Nath and Iswary, 2015) connecting intelligences in a ubiquitous web where both people and things reason and communicate together (Davis, 2011). Will be able to give suggestions based on educated studies of how we live and what we want or need (Nath and Iswary,

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	<p>(like comment, answers, etc.) (Nath and Iswary, 2015). Based on client-pull model (HTTP) that can be initiated by client only (Nath and Iswary, 2015). To visualize information from different sources, one should move from one site to the next and loosing sight of information contained in the previous sites (Silva et al., 2008).</p>	<p>empowerment of users (Silva et al., 2008) that can communicate among each other (Nath et al., 2014) not only read the content, but also write, modify, update and share the content online, supporting collaboration and helping to gather collective intelligence (Nath et al., 2014; Rudman and Bruwer, 2016; Silva et al., 2008). Described it as the greater collaboration between consumers, programmers, service providers, and organizations, which enabled them to re-use and contribute information (Rudman and Bruwer, 2016).</p>	<p>virtual society (Chohan, 2022; Keizer et al., 2021; Stănescu et al., 2019), the economic - as a domain of economic value creation (Chohan, 2022, 2021); and cultural - refers to the creative production of cultural artifacts and content (Chohan, 2022, 2021; Rennie et al., 2019). Focused on developing protocols and the underlying technologies that are not noticed by end-users (Alabdulwahhab, 2018). Introduction of new programming languages (Rudman and Bruwer, 2016, 2016) The capability of obtaining contextual information, from a bigger and wider variety of sources (Rudman and Bruwer 2016). Key elements (Nath et al., 2014; Nath and Iswary, 2015; Silva et al., 2008): -the Social Web (users can share their feelings, thoughts, ideas using web3.0 technologies instead of linking documents only, being an efficient and attractive way of connecting people around the glob); -the Semantic Web (an evolving</p>	<p>2015). Provides a new model of user interaction with the most comprehensive and personalized, not limited simply to display information, but proposes to behave like a intelligent mirror that concrete solutions to what the user needs (Nath and Iswary, 2015) The advantages: accessibility, distributed computer-based information agents, improved user experience through personalized agents, more efficient exploitation of the Semantic Web (Nath and Iswary, 2015)</p>

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			<p>extension of the web3.0, that allows users to find the information much deeper level the meaning of the search terms and the context in which they are used);</p> <ul style="list-style-type: none"> - the Web 3D (allows people to live in a virtual world as an avatar and can explore, meet other residents, etc.); - the Media Centric Web (allows taking media such as audio, video, image etc as an input element and can search for similar media objects), - the Pervasive and Ubiquitous Web (refers to a Web that is virtually everywhere, on every device, and even in common everyday objects such as your clothes furniture, appliances etc.). 	
Content creation	Owning (Gulati et al., 2021)- a task performed by experts, not so easy to have personal web pages or post personal content to the Web (Silva et al., 2008).	Sharing (Gulati et al., 2021)- individual and organization create content (Almeida and Lourenço, 2011).	Consolidating/ Syndication (Kreps and Kimppa, 2015)- individual, organization, machine create content which can be reused (Almeida and Lourenço, 2011).	
Focus	Company-oriented (Nath et al., 2014; Singh and Gulati, 2011)	Community-oriented (Nath et al., 2014; Singh and Gulati, 2011).	Individually oriented (Nath et al., 2014; Singh and Gulati, 2011)	
Networks	Not available	Online social	Semantic social	

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	(Singh and Gulati, 2011).	networks (Singh and Gulati, 2011).	networks (Singh and Gulati, 2011).	
Number of users	Millions of users (Shivalingaiah and Naik, 2008; Singh and Gulati, 2011).	Billions of users (Shivalingaiah and Naik, 2008; Singh and Gulati, 2011).	Unlimited number of users (Singh and Gulati, 2011).	
Portability	Low-portability (computing equipment) (Nath et al., 2014).	Medium portability (mobile) (Nath et al., 2014).	High portability (mobile and consumer electronics) (Nath et al., 2014).	
Types of applications	Professionally developed stand-alone applications (Nath et al., 2014).	User-developed open applications (Nath et al., 2014).	User-developed smart applications (Nath et al., 2014).	
Architecture	Point-to-point/hub & spoke architecture (Nath et al., 2014)	Service-oriented architecture (SOA) (Nath et al., 2014)	Web oriented architecture (WOA) and internet of things (Nath et al., 2014)	
Data	Low data richness (HTML), sliced data (Nath et al., 2014)	Medium data richness (XML), light interlinked data (Nath et al., 2014)	High data richness (RDF), worldwide database (Nath et al., 2014)	
Challenges/ Issues	In general, shaped by the limitations of a 56K dial-up connection (Singh and Gulati, 2011) various issues related to scalability, security and performance (Nath et al., 2014; Nath and Iswary, 2015)	Various issues and vulnerabilities related to scalability, security and performance (Nath et al., 2014; Nath and Iswary, 2015), such as Cross Site Scripting, Cross Site Request Forgery, SQL Injection, Authentication and Authorisation Flaws, Information	Scalability, security and performance issues present in web 1.0 and web2.0 are also propagated to web3.0 (Nath et al., 2014), privacy and legal issues (FIRAT and Firat, 2020; Hussain et al., 2022; Silva et al., 2008)- for instance, data privacy is one of most security issue for the IT professional (Nath et al., 2014; Nath and Iswary, 2015), unauthorized access to sensitive	The migration of online functionality into the physical world (Gibson, 2021) issues concerning industry standards such as wireless connections, telecommunication lines doing the actual connection and a language that is understandable by all devices and not only by a few belonging to a certain company, and privacy issues

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		Laekage. (Nath et al., 2014)	information, etc. (Rudman and Bruwer, 2016) social, ethical and cultural issues (Silva et al., 2008)web accessibility, readiness of the users, requirement for further standardization of e-Learning technologies (FIRAT and Firat, 2020; Hussain et al., 2022), etc.	(Gibson, 2021; Nath et al., 2014).
Enabling use patterns	Content, e-commerce (Cabage and Zhang, 2013)	Social, mashups, Saas/PaaS (Cabage and Zhang, 2013)	Multi-screen user, context-specific apps, device as a personal assistant (Cabage and Zhang, 2013)	
Enabling monetization	Ad banners, product sales (Cabage and Zhang, 2013).	Ads, selling goods (Alabdulwahhab, 2018), AdSense/PPC, SaaS/ Subscription (Cabage and Zhang, 2013).	App store, mobile commerce, geo fencing (Cabage and Zhang, 2013), Token model (Alabdulwahhab, 2018).	
Payments	-	Credit Cards, Paypal (Alabdulwahhab, 2018).	Ethereum, Bitcoin (Alabdulwahhab, 2018).	
Enabling technology	Web of documents and web browser (Cabage and Zhang, 2013)	Technologies enabling collaboration such as social networks, RSS Feeds, weblogs/blogs, and content publishing services (images, text and video), web of services, social bookmarking, wiki, podcasts, RSS feeds (and other forms of many-to-many	Web of devices, native apps (iOS, Android), geolocation (Cabage and Zhang, 2013) big data, connected data, augmented reality applications, machine learning, artificial intelligence, personal avatars, 3D visualization and interaction (FIRAT and Firat, 2020), intelligent mobile applications, personalized portals	Based on some main concepts (Nath and Iswary, 2015)such as: Natural Language Understanding (NLU) Technique, New model of machine to machine (M2M) Communication, New model of interface.

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		publishing), social software, web APIs, mashups (hybrid applications which mix various forms of data) and folksonomies (bookmarking/ content sharing sites (Cabage and Zhang, 2013; Gulati et al., 2021; Shivalingaiah and Naik, 2008; Silva et al., 2008).	and search engines (such as iGoogle which can already be personalized to deliver key information to a users' desktop), integrated games, business and education, avatars and 3D role play games, Automated reasoning, Cognitive architecture, Composite applications, Distributed computing, Knowledge representation, Ontology (computer science), Recombinant text, Scalable vector graphics, Semantic Web, Semantic Wiki, Software agents (Singh and Gulati, 2011)	
Hardware	Desktop computer, server, wired internet (Kreps and Kimppa, 2015)	Desktop or laptop computer, server, wired/wifi internet (Kreps and Kimppa, 2015)	Desktop or laptop computer, smartphones, server, wired/ wifi/mobile internet (Kreps and Kimppa, 2015)	
Software	static HTML pages published by web author (Kreps, 2015), HTML frames, guest books, e-mail correspondence, newsletters, 'donate now' buttons and web directories such as Yahoo and DMOZ or encyclopedia's such as Encarta (Gulati, 2011)	Database-driven web site with content uploaded by users employing HTML, CSS, PHP, Javascript (Kreps and Kimppa, 2015; Silva et al., 2008) AJAX (Almeida and Lourenço, 2011; Silva et al., 2008) XML (Silva, 2008). Separation of	Mashup of HTML, CSS, PHP, JavaScript, APIs and public microblogging IM service (Kreps and Kimppa, 2015), ambient intelligence, smart interfaces, intelligent agents (Silva, 2008). Distributed components and services mashup beyond the document model – document that	

Criteria	WEB 1.0	WEB 2.0	WEB 3.0	WEB 4.0
	Integrated single document (Kreps and Kimppa, 2015)	form and content of document (Kreps and Kimppa, 2015)	hits the browser is no longer the centre-piece (Kreps and Kimppa, 2015)	
Used Technologies	HTML, HTTP, URL these are core web protocols, some newer protocol are also in used like XML, XHTML and CSS; both server side and client side scripting are used such as ASP, PHP, JSP, CGI, PERL as server side scripting and JavaScript, VBscript, flash as client side (Nath et al., 2014; Nath and Iswary, 2015)	technological resources used to create a final product: languages, systems and other tools that allow the professional to develop or adapt applications, e.g. Ajax, API, RSS, XML, P2P and Mashup; and the final products, created from technology based on the first level, for e.g. Social networks, blogs, wikis, podcast, social book marks (Singh and Gulati, 2011).	Extensible Mark-up Language (XML), Simple Object Access Protocol (SOAP), Resource Description Framework (RDF), Resource Description Framework Schema (RDFS), Structured Query Language (SQL), Simple Protocol and RDF Query Language (SPARQL), Ontology Web Language (OWL) and Web Ontology Language for Services (OWL-S), Intelligent agents (IA) (Almeida and Lourenço, 2011; Hendler, 2009; Rudman and Bruwer, 2016).	
Websites	Static websites	Audio, blog pod, bookmarking, e-learning, e-mail, multi-media games, forums, etc. (Shivalingaiah and Naik, 2008) such as Google, Facebook, Wikipedia, eBay, Youtube, Scribd (Almeida and Lourenço, 2011; Shivalingaiah and Naik, 2008)	Dbpedia, sioc-project.org (Almeida and Lourenço, 2011).	