Modeling the Web Economy: Web Users and Goods

Michalis Vafopoulos
Aristotle University of Thessaloniki
University Campus, Thessaloniki
54124, Greece
+306945897894

vaf@aegean.gr

ABSTRACT

An increasing amount of research papers is devoted in modeling Web functions. This effort is coming from many diverse disciplines like Computer and Information Science, Economics, Mathematics, Physics, Law, Psychology, Social studies and others. At this stage, a set of definitions concerning the basic Web functions is needed in order to elaborate a more fruitful interdisciplinary dialogue about the Web.

The objective of the present paper is to contribute towards a common understanding of the economic behavior in the Web.

Existing analysis of network goods is insufficient for the Web because does not account for the drastic effects of the Editors' function on the Web network and does not incorporates in the demand and supply of a network good the distinctive characteristics of digital goods. Respectively, digital goods underestimate the network structure of the Web.

Web goods (WGs) are introduced as payoff-relevant bit strings with an assigned URI that affect the utility of Users. Their market value stems from the information they are composed from and a specific part of it, the hyperlinks, which facilitates navigation over a network of WGs. Contrastingly, to information's and knowledge's controversial definitions, WGs qualify as commodities, even according to Debrau's strict definition. In the case of pure WGs, the predominance between search and experience attributes depends on how close these goods are to information goods.

Users are partitioned to Navigators and Editors of WGs. Navigators are consuming information by navigating the Web and Editors are producing WGs by creating, updating or deleting online content and links. Navigation creates traffic streams for Editors, which is transformed to income mainly through advertising. Finally, the economic aspect of User's functions is incorporated into a more general framework of Web functions, which is based on four interconnected networks: Users, Topics, Queries and the Web.

Categories and Subject Descriptors

WSSC: webscience.org/2010/E.1.1.1 Goods in the Web; webscience.org/2010/E.1.1.2 The Web economy; webscience.org/2010/B.3.99 Other in Web Science Theory and Epistemology

Keywords

Web goods, Web's quad-graph, Navigators, Editors, Aggregators, Platforms, Reconstructors

1. INTRODUCTION

The Web has transformed the way we live, communicate, entertain, work, or doing research. Nowadays, more than 2 billions Users, worldwide, accessing some trillion web pages, spending 700 million minutes per month in Facebook, ordering in Amazon 73 items per second and sending 1.3 exabytes from mobile Web devices. During the last decade, the Web has been metamorphosed from an information software system to a major socio-technical ecosystem, which is transformed and transforms human societies.

Web science [1] is taking the Web as its primary object of study. It is focusing in the investigation of the Web in order to spot threats, opportunities and invariants for its development, including issues like excessive market power, privacy [2], net neutrality, non-market mechanisms, self-powered collective production and economic growth policies [3]. To address these issues we need (among others) to build a common understanding of the Web economy. These basic definitions may help us to exploit recent heterogeneous literature emerging in diverse fields. Section 2 introduces the concept of "Web Goods". The next section connects WGs to traditional economy. Particularly, investigates if WGs are commodities, search or experience goods. A taxonomy of Web Users is provided in Section 4. Section 5 describes the fundamental functions of the Web economy. Section 6 summarizes the discussion and proposes issues for further research.

2. WEB GOODS

The general classification of Data, Information, and Knowledge [4] fails to capture the salient features of the information life cycle in a highly connected digital world. Information can be now digitized (if not digital already) and transferred over networks with minimum cost. Data are transformed to information and knowledge in new ways at global scale. There are numerous epistemological approaches to the definition and the study of the concept of "knowledge". We limit our analysis to the economic aspects of knowledge creation as a dynamic human activity. This activity enters in production as four different types of knowledge [5]:

    i.   know- what (facts),

    ii.   know-why (scientific knowledge),

iii.   know-how (skills) and
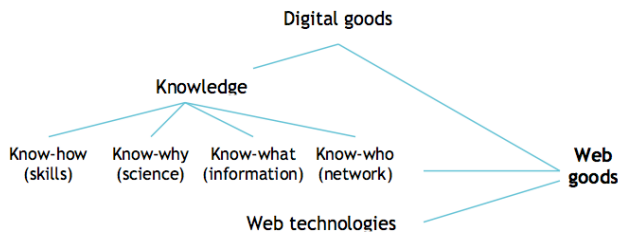
iv.   know-who (networks).

Figure 1: Web goods are networked digital goods assigned with a URI, represented by Web languages and exchanged through protocols in the Web network.

Know-what is information about facts that can be easily represented by symbols. *Know-why* includes scientific knowledge of the laws on how nature, the human mind and society develop. Contrastingly, to the first two types of knowledge, which are observable and can be accumulated through the access in data and information in paper and Web pages, know-how and know-who are tacit or implicit knowledge, usually called human capital, in the sense that is difficult to codify and transfer among humans and can be acquired mainly by education and experience. *Know-how* describes the capacity and skills of participating in the economic activity. *Know-who* refers to the ability of procuring the knowledge that resides in social networks (Figure 1). Social networks, and knowledge flows through them, are becoming partially observable (e.g. social networking, institutional websites etc.) creating new forms of production and consumption.

The concept of digital goods [6] is a more effective attempt to capture this new reality, because it refers to knowledge, which is relevant to the digital economy. Although, it overlooks the transformative power of networks, which is drastically affecting the fundamental characteristics of digital information.

Respectively, the notion of network goods includes all the goods (physical and digital) that exhibit network externalities [7], without taking into consideration in the production, exchange and consumption, the special characteristics of digital goods, namely non-rivalry, infinite expansibility, discreteness, aspatiality and re-combinance. Web technologies provide the technical platform for representing, interconnecting and exchanging addressable digital information over the Internet network (Figure 1). In the proposed research we introduce the concept of goods and services in the Web as follows:

Web goods (WGs) are payoff-relevant bit strings, sequences of binary digits, 0s and 1s with an assigned URI, that affect the utility of or the payoff to some individual in the economy. Their market value stems from the information they are composed from and a specific part of it, the hyperlinks, which facilitates navigation over a network of Web goods.

Technically, WGs are networked digital goods, which are interconnected with links through URI technology, are represented by Web languages (e.g. HTML, PHP, RDF) and exchanged through Web protocols (e.g. HTTP). WGs can be further elaborated in the following categories. *Pure* WGs are the primary focus of the Web science research because they are defined to include goods that are basically exchanged and consumed in the Web and are not tightly connected to an ordinary good or a service that exists in the physical world. For instance, a blog entry about the market of used cars is a pure Web good, but a car sales advertisement is not. If we primarily account for production incentives, WGs can be discriminated in *commercial* (e.g. sponsored search results) and *non-commercial* (e.g. Wikipedia entries). In contrast to commercial, the non-commercial WGs are produced outside the traditional market mechanisms of price and property and are based on openness, peer-production and qualitative ex post reward schemes. Commercial WGs are the basic focus of economic modeling (see for instance see [8], [9] and [10]).

Based on their excludability (since all WGs are non-rival) could be divided to *public* (e.g. Linked Open Data) and *private* WGs (e.g. subscription fee of an online magazine).

There are many different definitions for public goods [11]. In the present article, a Web good is considered to be public if it is non-excludable and is provided by the government, a collective or an individual. A freely available micro-blog entry and the Linked Open Data in data.gov are examples of public WGs. The fundamental importance of public WGs provided by governments (also called PSI) has been recently explored [12].

However, WGs can be excludable and become *purely private goods* through the institutional setting of provision. *Private* WGs could be excludable due to a *financial fee* (e.g. subscription in a Web service), a *"personal data"* fee and a *"social" or "membership"* fee. The "personal data" fee refers to the WGs that are requiring user's personal data (commonly only an email is enough) in order to provide access. This personal information is commonly exploited for marketing reasons and is commonly overcome by users through multiple email accounts. The *"social"* fee was introduced by Kumar [13] in the framework of connected goods. A connected good is defined [13]: "as a conspicuous contribution made by an individual that is available for experiencing by the individual's peers in a social network setting. The following properties are shared by connected goods: (1) The contributions are conspicuous information goods and observable by the contributor's peers, (2) the contributor of the good incurs a cost for making a contribution (monetary, time, effort etc.), (3) the contributor need not get a direct or immediate consumption benefit from the good, i.e. the contributor either does not experience the product or service, or already has access to consume the good without making it a connected good, (4) the contributor's friends or peers obtain a benefit from experiencing or consuming the good, hence we refer to them as experiencers." For instance, a Facebook profile may not be consumed due to the lack of "friendship" permission from its owner. Connected goods differ from club goods because are not market-mediated but through a social network and include the notion of public goods in the case of fully connected social network [13]. Connected goods are also distinguished from gift-giving in social contexts because in the latter case, the contributor anticipates real costs for providing gifts and her motivation has been considered to be altruism effects, signaling of wealth etc. Opposingly, in the case of WGs, the contributor does not obtain marginal costs per peer for producing the connected good [13] and she is basically motived by the exciting experience of navigating into social networks.

3. WEB GOODS AND THE TRADITIONAL ECONOMY
3.1 WGs as commodities

Nowadays, an important part of available information is produced, exchanged and consumed in the Web. The main difference with existing technological platforms is that

information representation and communication could be established in one-to-one, one-to-many and many-to-many forms and in various formats (text, voice, video) and contexts.

WGs can be simplistically considered as hyperlinked digital information in a well-defined technological framework. WGs are the basic commodities of the so-called New Economy. Contrastingly, to information's and knowledge's multiple and controversial definitions and approaches in Economics, WGs qualify as commodities, even according to the strict definition of Debrau [14]. Debrau [14] defines a commodity as a good or a service possessing a stable identity that is completely specified physically, temporally and spatially. Unambiguously, URI technology facilitates a stable identity for every WG, which resides physically in a Web server during a specific period of time. Creation, edit, access and deletion of a WG are recorded in a standardized format under the UTC time measurement.

3.2 Search and experience goods and the Web

Information goods are characterized as experience goods because you can only tell whether you want to consume the information after you have seen it [15]. Historically, Nelson [16] was the first to observe that investigation of monopoly market power never considered consumers' information about products as a determinant. Particularly, he remarked that an asymmetry in consumers' information is an important factor, which facilitates the emergence of monopolies. Nelson, based on the definition of "search goods" as goods whose attributes can be discovered prior to purchase [17], introduced "experience goods" as the opposite of search goods. Experience goods are those which attributes cannot be discovered prior to purchasing or consuming the good. Later, Nelson [16] talked in detail about goods with search and experience attributes using clothes as an example of search good and milk as an example of experience good. Nelson [16] concluded that monopoly is more probable for experience than for search goods and companies pay more for advertising experience goods compared to search goods.

The quality of an experience good is initially unknown, and is determined during the experience of consumption of the good. Generally, experience goods are characterized by low price elasticity, because a low or discounted price signals the perception of low quality.

But how the Web influences the experience and search attributes of information and non-information goods? Are WGs search or experience goods?

In Stigler's economics of information [17] the cost of good that consumer pays is defined as the sum of price plus the cost of searching for it. Since, the Web facilitates the search of relevant information, one can expect that the cost of search is reduced and consequently the total cost of good that consumer anticipates. However, this is not the only benefit. Klein [18] indicates that the ability of the Web to easily offer information about many goods can change also their experience attributes. She talks about the "virtual experience" which allows the consumer to evaluate basic good's characteristics prior to purchase. By doing so, the experience good is turned into a search good. The author identifies three routes in which this transformation is achieved by examining the case of selling software via the Web. The first route provides the information, which the consumer needs to know about the product through the discussions she can have in user forums where she can obtain knowledge from other users that have experienced the program. The second route provides the

information to the customer through third-party reviews. The third route refers to the provision of a free downloadable trial version of the software, which offers the experience to the customer prior to purchase [18]. Klein's [18] research has influenced the posterior research not so much in terms of theoretical aspects, but mainly in terms of practical comparisons between search and experience goods on the Web. Biswas [19] is among the fewest who tests a set of theories concluding that the Web will influence the traditional economics of information research. Huang et al. [20] find that despite the fact consumers spend the same amount of time online for both types of goods in order to gather information, for experience goods spend more time per page but browse less total number of pages than for search goods. They also find that reviews from other consumers prove to be more important for experience than for search goods. Park & Lee [21] find that the effect of word of mouth in the Web, and especially the negative one, is higher for experience goods. On the contrary, Yang & Mai [22] present evidence that online feedback is more possible to influence consumers in favor of a search than of an experience good. Hao et al. [23] conclude that positive reviews have a greater effect on search goods than on experience goods. However, they find no significant difference in terms of the negative reviews. Girard et al. [24] test basic demographic variables and relate them to search and experience products. They find that gender is significantly correlated to both types of goods, because males prefer to buy online search products like books and experience products like cell phones, while females tend to buy online experience products like clothing. Finally, Moon et al. [25] confirm that the Web facilitates selling of search goods.

Navigational ability, collaborative filtering, experts' reviews and multimedia representations enrich the search attributes of any good in the Web. For non-pure WGs, goods that are tightly connected to an ordinary good or a service exist in the physical world, the magnitude of this search effect depends on the properties of the underlying physical good. For instance, as Klein [18] demonstrated, software could be transformed to a search good if it is properly reviewed and demonstrated in the Web. On the contrary, it is much more difficult to affect the experience attributes of a bottle of wine.

In the case of pure WGs the predominance between search and experience attributes depends on how close these goods are to information goods. For instance, a story or an article in the Web remains an experience good, despite the fact that several mechanisms exist to enrich initial experience. Reviews, previews and browsing through part of the information give a first impression but the basic attributes cannot be discovered prior to consuming the whole good. On the other hand, a Web-based service could be considered as a search good because, commonly, sufficient information exists about it like screenshots, technical specifications, reviews and evaluations. In general, search attributes are becoming more significant for pure WGs if they include advanced functionalities beyond informativeness.

4. THE WEB USERS

Discussion about the search and experience characteristics of WGs brings into the foreplay the Users who consume online information. In this article, a simple and comprehensive categorization of Web Users is provided in order to facilitate the comparative investigation of existing literature in Web analysis. The distinction of Users is based on the economic motivations and impact of their actions in the Web ecosystem.
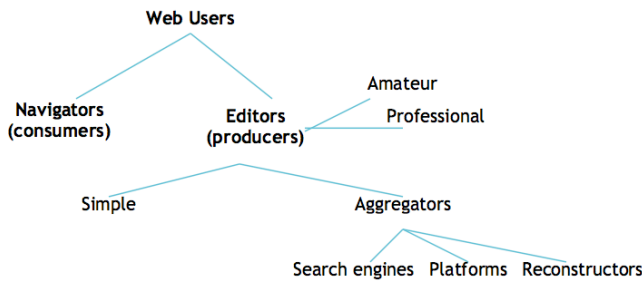
Figure 2: The Web Users are partitioned to Navigators and Editors of WGs.

First, Users are partitioned to Navigators and Editors of WGs (Figure 2). Navigators are consuming information by navigating (browsing, surfing or accessing) the Web network. Editors are producing WGs by creating, updating or deleting digital content and links in the Web network. Editors are categorized to Amateur and Professional based on their production incentives. In contrast to Amateur Editors (e.g. Wikipedia editors), Professional Editors are profit maximizers and take into account direct financial compensations in producing WGs (e.g. Facebook). Amateur Editors in not-for-profit community settings (e.g. Open Source Software) are actuated by individual acclaim and reputation-building, which apart from moral reward and self-confidence, boost their choices to high-paying employment arrangements. This temporal disengagement between effort and reward provide an explanation why Editors may provide knowledge, effort and time for free [6]. Amateur Editors in social networking may be motivated by obtaining a higher relative contribution status compared to their peers and future consumption utility from the connected goods provided by their peers [6]. In such cases, Amateur Editors are the initial producers of WGs that are created, bundled and commercialized by a professional Editor acting as a platform. This massive function in Web 2.0 calls for a function-based distinction among Editors that is economic relevant. Editors can be further divided, in the basis of their aggregation capability, to Simple and Aggregators. Aggregators are characterized by their automated mechanisms for selecting and presenting WGs and are further divided to Search Engines, Platforms and Reconstructors (Figure 2). Their function is more focused on creating content based on linking in existing WGs.

Simple Editors are more like Web 1.0 users, which create content manually and in the case of professionals, monetize their production by advertisement or/and subscription fees. *Search engines* are based on sophisticated algorithms to automatically aggregate, index, classify and (indirectly) commercialize all kinds of existing WGs. *Platforms* are a set of technologies and incentives facilitating peer production and aggregation under common infrastructure of Web goods (e.g. Flickr, Digg). Platforms are the cornerstones of the Web 2.0 era because they enable Users to collaboratively produce complementary WGs. Commonly, are open-access "walled gardens" in the sense that Users do not pay financial fees to use them, but they produce digital content difficult or impossible to be transferred to other platforms (lock-in) and their generic code is not open source [26]. Most of the Platforms are commercialized with advertisements (e.g. Facebook) and/or subscriptions (e.g. LinkedIn), but also exist not-for-profit platforms that operate as Amateur Editors of the Web network. *Reconstructors* are sophisticated technologies that capacitate the deconstruction, filtering, modification and reconstruction of digital (micro) information into more personalized WGs. For instance, last.fm unbundles music tracks

from albums and playlists to reconstruct new playlists based on the collaborative filter matches to user's personal preferences. Reconstructors could be considered as the next generation platforms that are based on semantic processing of WGs (i.e. Semantic Web and Linked Data technologies). Nowadays, most Platforms and Reconstructors try to consolidate horizontally by adding more functionality (e.g. semantic Wikipedia) and fragment vertically (e.g. LinkedIn professional accounts). The dominant players in Web economy strive to consolidate both horizontally and vertically as Editors of the Web network. Advertisers in the Web are Professional Editors that create online content to promote consumption of specific goods and services. They can be Simple or Reconstructors. The difference is that Reconstructors interconnect advertising content to the context of a Web site (e.g. AdSense, Ad Words).

5. THE WEB ECONOMY

In the current Web, most of the Users are navigating and editing online content. How these two fundamental functions are connected by economic incentives to result this massive and dynamic network of online information, people and functionalities?

Navigators explore the Web to acquire utility by consuming WGs (Figure 3). This navigation creates traffic streams for Editors. Amateur Editors are concerned to attract traffic for their content, even if they do not actually own it (e.g. a Web page in Facebook). This function is represented in Figure 3 by the straight line that connects directly traffic to Editors. In contrast, Professional Editors, which own or/and administer WGs can transform some parts of this traffic into income through selling it to third parties, advertising or direct sales of both physical and WGs. The resulting income acts as an incentive for Editors to update existing and create new WGs, producing a new Web network with novel possibilities for Navigators to maximize their utility (Figure 3).
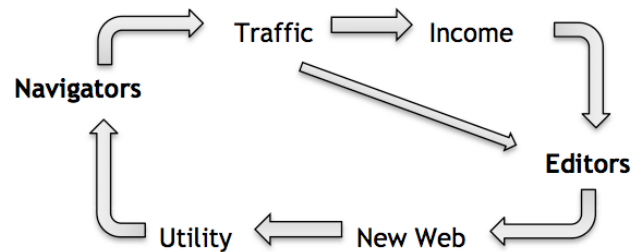

Figure 3: In the Web economy, Navigators explore the Web to acquire utility. This navigation creates exploitable traffic for Editors, which are motivated to update the existing Web.

The next step is to include the economic aspect of User's functions into a more general framework of Web functions. This general framework is captured by the contraction of four interconnected networks: Users, Topics, Queries and the Web (Figure 4). A User can access a WG, either by using a Search Engine (Users-Queries-Web) or directly by typing the URI (Users-Web). Users, as have been defined in Section 4, could be modeled to act independently [8], [27] or to strategically interact [9], [10]. *Query* is the phrasing of a question, usually in terms of a code. The questions are messages expressed as sequences of symbols in the query language. The class of *Queries* has different structures depending upon the interest. A very useful description of the class of queries is in terms of graphs or semantic networks. By this way we can include discussions in term of Topics.
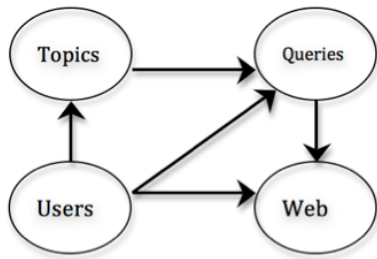
Figure 4: The Web functions quad graph is defined to be a contraction of four interconnected networks: Users, Topics, Queries and Web.

Users are explicitly or implicitly interested in specific Topics to navigate and edit the Web. The concept graph is defined with concepts as nodes and semantic relations as links and includes the Topics used in the assessment of WGs. Additionally to the definition provided in Section 4, Search Engines are also considered to be mechanisms that get as inputs Queries and produce results as collections of WGs. The Web graph is formed by WGs as nodes and hyperlinks as links. The Web network accrues from the Web graph in the case of assigning random variables in order to assess nodes and links. For instance, WGs can be assessed by content (e.g. TF-IDF [28]). Hyperlinks assessment is usually called weight and may be deterministic or random. Modeling and analysis of co-evolution of all four interconnected networks (Users, Topics, Queries and Web) is a difficult task and an important challenge to comprehend and anticipate in a complex network as the Web. There is not yet a model, to the best of our knowledge, which explicitly models all the four interconnected networks and their connections in the Web. An effort in this direction will enable us to design better technologies, experiences and policies in order to exploit the full potential of the Web artifact.

6. DISCUSSION AND FURTHER RESEARCH

The Web is the largest human information construct in history. Web technologies have been proven to be an enormous stimulus for market innovation, economic growth, social discourse and the free flow of ideas. Searching, social networking, video broadcasting, photo sharing and blogging have become part of everyday life whilst the majority of software and business applications have migrated to the Web. At the same time, a growing number of researchers are investigating the incentives and consequences of Web functions. As this effort is coming from many diverse disciplines, there is not, yet a common set of definitions and methodologies about the fundamental aspects of the Web functions. Existing concepts in Economics are not fully fitted for the Web because they do not account for the important effects of the Editors' function. Furthermore, they do not incorporate in the demand and supply of a network good the distinctive characteristics of digital goods. Furthermore, in existing models, the terms "Users", "Topics", "Queries" and "Web" are used with different meanings and connotations. Therefore, a set of definitions concerning the basic Web functions is needed in order to elaborate a more fruitful interdisciplinary dialogue about the Web.

In the present article, the concept of "Web Goods" is introduced and Web Users are divided to Navigators and Editors of the Web network. Editors are categorized to Amateur and Professional based on their production incentives. Alternatively, Editors can be

further elaborated, in the basis of their aggregation capability, to Simple and Aggregators. Aggregators are characterized by their automated mechanisms for selecting and presenting WGs and are further divided to Search Engines, Platforms and Reconstructors. Finally, we include the economic aspect of User's functions into a more general framework of Web functions. This general framework is described by the contraction of four interconnected networks: Users, Topics, Queries and the Web.

Further research in creating common understanding among Web scholars may include a more detailed analysis on how the Web changes the basic characteristics of digital and network goods. Indicatively, Internet infrastructure restrictions (e.g. cost of traffic, traffic congestion) and business practices (e.g. many YouTube videos are not accessible in some developing countries due to low financial incentives for the company) can impose serious practical barriers to non-rivalry. Analysis of WGs will also include issues about the exploitation of network effects, peer production, social commerce and online advertising. For instance, it is interesting to understand how the network effect in "two-sided markets" [29] has resulted an ecosystem with interconnecting multi-sided platform Web businesses (e.g. Google's advertising platform) with excessive market power.

After the hard lesson of the dot-com bubble in early 2000's, the Web economy is now an important part of the real economy, bigger and more robust with new services ranging from search to social networking, virtual entertainment and giant multi-stores. Economic behavior in the Web is motivated by a different mixture of incentives and patterns than in traditional economy. It is time to focus on them in order not to miss the new development opportunities arising from this extension of human functionalities.

7. ACKNOWLEDGMENTS

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