

CALL TO ADVENTURE

DESIGNING FOR ONLINE SERENDIPITY

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ABSTRACT

This investigation explores the concept of serendipity and its possible applications in digital interactions as a means for finding uncommon, unexpected and relevant information, and the capacity to gather insight from it. To do so, we explore the topics of creativity, the personalization of the Web and the potential of randomness and unconscious browsing as tools for discovery. We gather a series systems that enable the discovery of digital content and analyzed their potential for serendipitous discoveries. This allowed for the creation of a typology of traits for serendipity that enabled the creation of a prototype hypothesis of a dedicated serendipitous system.

RESUMO

Este estudo explora o conceito de serendipidade e a sua potencial utilização em interacções no âmbito digital com o objectivo de encontrar informações invulgares, inesperadas e relevantes, bem como a capacidade para adquirir conhecimento através das mesmas. Para o conseguir, exploraram-se os tópicos da criatividade, da personalização da Web e do potencial da aleatoriedade e da navegação inconsciente como ferramentas de descoberta. Reunimos um conjunto de sistemas que possibilitam a descoberta de conteúdos digitais e analisámos o seu potencial para descobertas ocasionais. Isto permitiu a criação de uma topologia de características de serendipidade que servem de base à construção de um protótipo de uma hipótese de sistema dedicado às descobertas serendipitosas.

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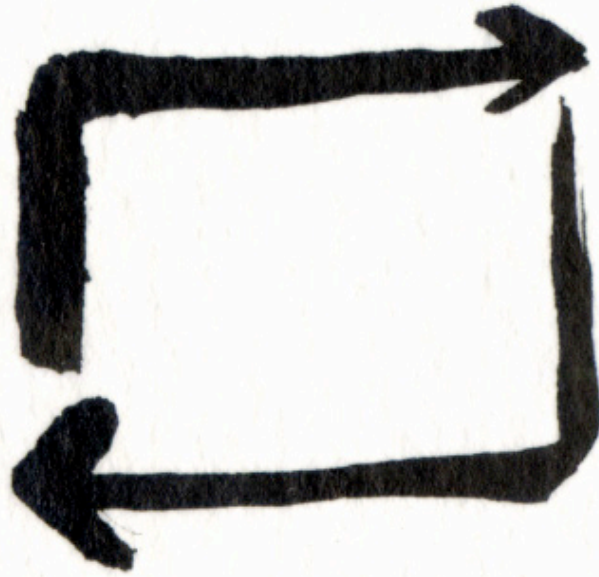
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[Computers] are useless. They can only give you answers.

Pablo Picasso



I INTRODUCTION

1.1 A need for surprise

This investigation was born from an apparent incapacity to discover something new on the Web. Everything seemed familiar, predictable. There was nothing surprising to be discovered: recommendation engines gave more of the same suggestions and search engines required beforehand to know what one wanted to search. The Web felt constrained and limited, and that didn't feel right.

It is now common knowledge that through the Web we have access to the world's knowledge. If that is so, why this seeming feeling of being restricted and pigeonholed towards the familiar content?

While researching this subject, we discovered that this feeling is now a rising phenomenon that more web users share. Marshall Van Alstyne and Erik Brynjolfsson (1997) describes it as "cyberbalkanization" and Eli Pariser (2011) simply calls it "The Filter Bubble".

It was with the gradual substitution of traditional methods of access to information and entertainment, such as television and newspapers, for the Web, that this need for a form of surprise arose. While beginning to rely on the internet as an information source, a certain narrowing of availability of content started to become visible. Not that

the internet lacks diversity of information, quite the contrary, as nowadays we have at our disposal what appears to be an endless source of it, as well as remarkable tools to access it. Between search engines and social networks, it has never been easier to learn more about a specific subject or to be recommended an interesting book or movie.

1.2 A broken Web

However, an unexpected side effect of the increased development of the search and recommendation technologies is emerging, as these tools become increasingly targeted, in order to provide us with more relevant content to our own preferences and interests, they prevent us from being exposed to completely new, original and unexpected content. While trying to cater for what they perceive are our intentions, they prevent us from broadening our horizons and being genuinely surprised.

The result of these efforts is, to quote Aleks Krotoski, a “broken web” (Krotoski 2010). A Web where we no longer have access to infinite possibilities of information, but rather a personalized stream of content that the systems perceive to be relevant not to us, but to a constructed persona that represents us, with or without our consent.

Besides this effect of a narrowing capacity of discovery due to a *personalized and broken Web*, we may also consider how this current web helps to not just discover information but actual creativity. With an increased optimization and perceived efficiency of search mechanisms and recommendations, we start to lose casual occurrences, accidents that happen in the course of web browsing. These unexpected, unusual situations, created by chance, are the privileged vehicle for the creation of ideas. In the words of Umberto Eco, in *Serendipities: Language and Lunacy*: “Even the most lunatic experiments can produce strange side effects” (Eco 2002).

It is with these concerns in mind that we propose the concept of *Serendipity* as a tool for information discovery and idea generation. To experience *serendipity* is to run across a happy accident, a surprising event that brings with it something new and pertinent, and to have the creative capacity of making insightful connections due to this accidental discovery of meaningful information. It is the objective of this investigation to attempt to understand how this concept can be applied on the Web, as well as how we can hope to facilitate and/or induce it.

1.3 Current Constraints and Concerns

This investigation was motivated by a perceived limitation of discovery of content regarding the prevalent methods of discovery of content on the Web. We encounter these constraints within our daily interaction with the Web and Web content, through the most commonly used tools for it. We summarized these tools into three different categories: search, recommendation engines and social networks.

1.3.1 Constraints of Search

Search is nowadays the foremost method of information seeking on the Web.

The problem with search: it is direct, the user makes a query and is confronted with a series of results, where the topmost is (usually) the most likely correct one. While this is efficient, it does not allow for many ‘left-turns’.

Search also needs the user to have a predefined notion of what she wants to find. The system works best when the user is as specific as she can and does not easily accommodate for ambiguity or indefiniteness. If the user does not know what to search for, the search engine can’t help.

Finally, modern search engines optimize their results in regards to what it perceives the user may be interested in. It allows a series of methods for this, from geo-localization of the user, to their search history, stored information or even operating system of choice.

While the methods used aren’t made available to the public¹, they all contribute to the creation of a persona of what the search engine perceives as the user, and try to cater to that persona. While this may be a good method to predict the users’ behaviors and intentions, it doesn’t help the discovery of surprising results that may not directly relate to the search intentions of the user but may yield interesting results and help to access the limitless of the Web.

1.3.2 Constraints of Recommendation Engines

Recommendation Engines, commonly used in shopping websites, are a good tool for finding new information that relates to previous viewed content. They generally work by analyzing users’ viewing and purchasing history and then inferring other possible items similar to those that the user has previously expressed interest in.

¹ On December 4th, 2009, Google, on their official blog, published a post announcing “Personalized search for everyone”, where it would use fifty-seven signals so it could make better guesses about the person making the search and what types of websites they most visited, in order to customize, and hopefully improve, the search results. This, even if you weren’t logged in a Google account. (Google, 2009)

However, this dependency on the previously viewed information by the user can limit the scope of interesting, and valuable, results. While recommendation engines can be a positive means to discover related information, the same can't be said for unrelated, peripheral and tangential but otherwise relevant information. If these do not relate to what is present in the users' browsing history, they end up not being recommended and thus not shown to the user, reducing the variety of the content that is made available.

With this reducing of variety and consequential consumption of content that closely relates to past browsing history, as well as recommendations based on what the system perceives to be the users interests, we enter a into a continuous validation by the tools that we use of an increasingly narrow field of interests. This may, in turn, lead to a 'personality loop', in which, through the gradual but regular consumption of the same type or genre of information, user's tastes are made gradually more exclusive and discriminating, which in turn feedback into the user's own personality, making it more extreme.

1.3.3 Constraints of Social Networks

Social Networks are an emerging method of discovery of information.

The concerns about social networks are that these networks are formed from the users' own relationships and interests: as such, the informations made available on these networks usually share the common interests of the users that make them. This in turn can contribute to the personality loop described earlier.

We create our social networks based on our real-life connections or interests. While doing so, we might exclude those whose opinions differ from us. However, when we are not confronted with conflicting ideas and arguments, how can we grow? Isn't the intention of the Web to create a global village? Why then are we applying limitations to the connections that we make by excluding the thoughts and ideas of those who have little in common with us?

Also, some social networks such as Facebook filter the content that is shown to the user according to what they perceive that user may be interested in, as a method to optimize the results. This is generally made without the users' knowledge and perpetuates this narrowing specter of opinions and content, like sunlight focused through a magnifying glass: it can be concentrated and strong, but loses the capacity to enlighten.

1.4 Problems and Hypotheses

When considering the question of serendipity, we are able to envision a series of questions that will guide the following research. It is by attempting to understand and give response to these problems that we can start to create a theory of how we are able to design towards serendipity.

1.4.1 Is serendipity an observable phenomenon?

The first step on the path to understand how serendipity works is to know if it can, actually, be observed and documented. While examples of serendipitous connections are commonly available in the form of anecdotes and *a posteriori* reflections, in order to fully understand the phenomenon we must first see if it is one that can be observed in a controlled environment. To do this we will observe the attempts of recording serendipity, as it happens, available in the literature.

1.4.2 Is serendipity designable?

After understanding the concept of serendipity, we need to apprehend how it is applicable to user experience design, what are its inherent characteristics and how they can be explored. For this we will consider the known attempts to induce serendipity, what methods were used and what were (if any) the observable results.

1.4.3 Is designing for serendipity an oxymoron?

Do we destroy serendipity when we attempt to *design* it? Various authors are of the opinion that it is not possible to induce serendipity in any way. That doing it would defeat the purpose and the result would be anything *but* serendipity. In this investigation, we will attempt to start without preconceived notions of our capacity to induce serendipitous insight. We will look to it as a natural process of discovery that, as such, can be analyzed and perhaps even encouraged. It will be our goal to understand how.

1.5 Methodology

The study of serendipitous experiences is one of varied interdisciplinary relationships. It applies to cognitive processes and to the nature of creativity and idea-generation. This study will focus on the possible applications of these concepts, and their relationship to digital interactions.

As such, we will begin by reviewing available literature regarding the definition of serendipity both in offline and online applications, so we are able to reach a working definition that can serve as the basis for this study.

Afterwards we will examine the various attempts that have been made to both observe and induce serendipity, in particular regard to that as a result of digital and online interactions. This will help us gather a series of inherent characteristics that describe what are the necessary conditions for a serendipitous experience.

After establishing a working notion of serendipity, how it occurs and what is involved in it, we will explore the problem of the personalized Web, the implications that derive from it and what is serendipity's contribution to the Web and user's experience. We will also explore the relationships between randomness, browsing and creativity as integral parts of the online serendipitous experience.

Having established a working model of what constitutes serendipitous findings, we will proceed to collect and observe popular and available systems and platforms on the Web that allow the discovery of content, for their potential for serendipitous experiences, as well as systems that were explicitly created with serendipity in mind.

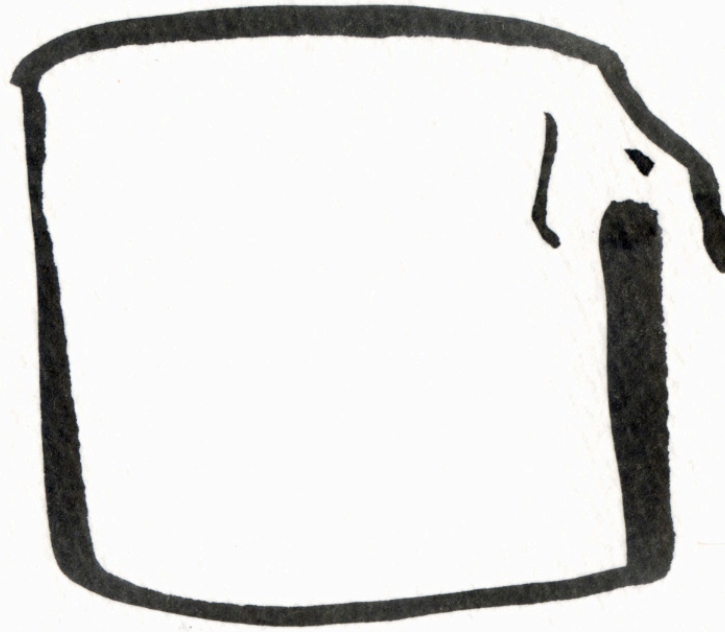
Through the analysis of these systems, we will propose a set of reference traits that can enable the development of online platforms with the intention of promoting serendipitous discoveries.

Finally we will hypothesize what such a platform could be, with a prototype of a serendipitous system.

1.6 Goals

It is our goal to begin to understand the fundamentals of the serendipitous process, and how they can be applied as methods and tools in order to facilitate the discovery of content as well as the development of insight gathered from that content. For this we shall also examine the concept of creativity and its possible implementations in online interactions.

We also intend to establish a series of recommendations for the development of systems that help the discovery of new, uncommon information that might promote serendipitous discoveries.



2 SERENDIPITY, CYBERBALKANIZATION AND CREATIVITY

2.1 Defining Serendipity

In order to understand how serendipity works, we first need to define it. This, however, is not an easy task, as although the concept that serendipity describes is as old as human thought, the terms' origin dates from 1754, and is vaguely explained, as different authors give it different interpretations, generally defining it as to better suit their needs. We will attempt to gather a common description of serendipity, one that attempts to be consensual across the diverse authors, as well as its applications regarding the physical and the digital world.

2.1.1 The Three Princes of Serendip

The origin of the term, and its first known use in the English language, dates to January 28th 1754, when Horace Walpole, 4th Earl of Orford, recalls, in a letter to his cousin Horace Mann, a "silly fairy tale" he once read called "The three Princes of Serendip",² as a means to illustrate a recent discovery he had made:

² An english version of *Peregrinaggio di tre giovani figliuoli del re di Serendippo*, published by Michele Tramezzino in Venice in 1557, who claimed to learn the story from Christophero Armeno who had translated the Persian fairy tale while adapting Book One of Amir Khusrow's *Hasbt-Bibisht*.

This discovery I made by a talisman, which Mr. Chute calls the *sortes Walpolianae*, by which I find everything I want, *à pointe nommée*, wherever I dip for it. This discovery, indeed, is almost of that kind which I call *serendipity*, a very expressive word, which, as I have nothing better to tell you, I shall endeavor to explain to you[...]. I once read a silly fairy tale called: the *three Princes of Serendip*: as their Highnesses travelled, they were always making discoveries, by accidents and sagacity, of things which they were not in quest of: for instance, one of them discovered that a mule blind of the right eye had travelled the same road lately, because the grass was eaten only on the left side, where it was worse than on the right— now do you understand *serendipity*? One of the most remarkable instances of this *accidental sagacity* (for you must observe that *no* discovery of a thing you *are* looking for comes under this description) was of my Lord Shaftsbury, who happening to dine at Lord Chancellor Clarendon's, found out the marriage of the Duke of York and Mrs. Hyde, by the respect with which her mother treated her at table. (Merton & Barber 2006)

It is apparent from this letter that Walpole regularly finds himself as the benefactor of this extraordinary luck, this “*sortes Walpolianes*” that he describes as it.

What is most germane in this initial description of the concept of serendipity is the emphasis given to its *accidental* characteristic. Walpole himself notes that the discovery must come from a thing that is *not* looked after, but is puzzled together through the *sagacity* of the observer. It is with the combination of these two key characteristics: *accidental* and *sagacity*, that we begin to construct a meaningful, applicable definition of serendipity.

The concept of serendipity has since evolved, as attention to the phenomenon increased, be it its relationship with creativity and problem solving (Bawden 1986; Erdelez 1999), applications in medical (Meyers, 2007) and scientific research (Roberts, 1989) or even in corporate environments (Pinha e Cunha, 2005).

With this observable increase of interest, so did the literature available, which in turn led to a growing number of definitions and conceptualizations of what exactly is serendipity.

For this study we will resort to a number of research made on the subject, with an emphasis on those that concern serendipity in digital interactions, which have contributed with varying opinions and viewpoints on what can be described as serendipity and what constitutes it.

Daniel Liestman (1992), for example, defines “intuitive sagacity” as a skill where “a random juxtaposition of ideas in which loose pieces of information frequently undergo a period of incubation in the mind and are brought together by the demands of some external

event, such as a reference query, which serves as a catalyst.” This view of the process, that can be described as a serendipitous one, focuses on the pattern building aspect.

In a similar vein, Allen Foster and Nigel Ford (2003) describe the discovery of hidden connections or analogies, through serendipitous links between sources of information and its inter-disciplinary nature: “Serendipity would seem to be important across disciplinary areas for its role in connection building, discovery and creativity. The literature presents serendipity as being in some way both passive and yet capable of “efficiency”, or techniques by which hidden knowledge may be retrieved” (Foster and Ford 2003).

Sanda Erdelez, on the other hand, defines serendipity as a chance encountering of information (Erdelez, 2004), which gives emphasis to chance as the main drive for serendipity discovery, which in turn can lead towards a fortuitous outcome or new insight.

Gary Fine and James Deegan (1996) offer a definition of serendipity inline with Erdelez’s. In their words: “[serendipity is] the unique and contingent mix of insight coupled with chance. It is conclusions that are defined as surprising, yet obvious, that contribute to the presentation of ‘interesting’ research.”

The complex nature of the serendipitous process, however, has led to discussions on the very nature of serendipity and how, and if, it can be explored. As Abigail McBirnie (2008) argues, the relationship between control and serendipity is unclear: “great care must be taken over the inclusion of the concept of control, either intentionally or unintentionally in the definition of serendipity”, an opposing view to Rhode’s (2003) declaration that “serendipity is too important to be left to chance”.

Roberts (1989), however, brings an interesting, and often forgotten point of view on the serendipitous discovery: serendipity “arises not from random accidents but from circumstances brought about by unconscious motives which lead ultimately to the serendipitous event”. This emphasis on an underlying unconscious process that can trigger a discovery is something we will return to. Roberts also makes a distinction between serendipity and what he refers to as “pseudoserendipity”, which he defines as a description of accidental discoveries as a way to achieve an end that is sought for, as opposed to *true* serendipity, which describes accidental discoveries *not* sought for.

With Elizabeth Cooksey’s (2004) illustration of serendipity, comparing it to how a metaphor is constructed, we have an excellent example on how serendipity can be employed as process for creative thinking and help to unlock unexpected relationships:

Employing metaphor, a poet might write, ‘My love is a rose.’ Here some implicit properties connected with the rose are compared with implicit qualities of the beloved.

The metaphor does not tell us how to interpret itself, but it does suggest a range of possibilities. The poet probably does not mean to say that the beloved is covered with rose petals, but rather that the beloved has a quality of delicacy, or softness, or fragrance. On the other hand, a wag might play with the implication of rose thorns, not the poet's original intention, but an interesting new way to look at the situation. The point is that the linking of concepts in the metaphor stimulates the reader to make connections. Some of these connections may have been expected, but the real power of a good metaphor is its ability to open the possibility of connections that have not previously been anticipated (Cooksey 2004).

The analogy to a metaphor relegates, in a way, the role that chance has on serendipity, but it does call attention to the ability to make original and distinct interpretations, the availability of the observer to recognize a new pattern and with it, gather new information.

Regardless of some differing interpretations on how to define and achieve serendipity, we can start to understand some of the inherent mechanics of the serendipitous process as well as establishing a common ground that can accommodate most applications of the term, creating a working, provisional definition of serendipity as something that is both:

- 1 - the *accidental* discovery of *meaningful* information;
- 2 - the *creative* capacity of making *insightful* connections with the discovered information.

2.2 Understanding Serendipity

2.2.1 Studying Serendipity

Serendipity is, by its very nature, rare and evasive. As such, it is with difficulty that researchers seek to observe and induce it in a controlled environment. Even so, various attempts have been made to understand it and, in some cases, to create serendipitous processes. In the following section we shall examine some of these studies, their focuses, successes or lack-there-off.

Erdelez (1999), when questioning users about their past experiences of “bumping into information”, in an effort to understand “information encountering”, defined four elements that were useful in understanding that experience: First, the user who encounters the information; second, the environment where the information encountering occurred; third, the characteristics of the information encountered; and fourth, the characteristics of the information needs that the encountering addresses.

A similar inference was made by Foster and Ford (2003), in a study based on naturalistic enquiries, where they found that serendipity, in some regard, was widely experienced by interdisciplinary researchers. They categorized the findings in two possible fields. In regards to the findings themselves: they either (1) reinforced an existing problem; or (2) took the researcher into a new direction.

Regarding the location the findings were made, they could be either known valued information in an unexpected location; or unexpected finding of information that also proved to be of unexpected value.

André et al. (2009), conducted a small study in order to gain some insight on the frequency of serendipitous encounters in a common task, in this case a task-focused web search where the participants were asked to review their search history and examine clicked results on search result pages and report any clicked results that they deemed to be not directly task related. Within the eight participants, although they considered themselves rather “serendipitous” (as having made common serendipitous discoveries), only two reported encountering something unexpected and none gained any particular new insight.

The findings of André et al. are in line with the elusive nature of serendipity. One can even argue that serendipity itself is a foregone conclusion: a romantic memory of what was, in fact, a series of naturally occurring events that lead to a particular discovery³ (Roberts, 1989). While there may be some truth to this point of view when considering

3 techcrunch.com/2010/11/27/myth-serendipity

scientific discoveries, when exploring the field of creativity, one might argue that there is power within the unexpected as a tool for problem-solving and overcoming roadblocks. As we shall develop on the following chapters, while one can argue the relative value of serendipity as a tool for scientific research, the processes that define it can be themselves of value when considering the problem of creativity and discovery of information. As such, this study will focus on what and how serendipitous moments occur, in an effort to better understand them and if they can be encouraged.

To this end, we must first analyze the attempts made so far at replicating serendipity.

2.2.2 Inducing Serendipity

Although few in number, there have been some studies that have tried, in some fashion or another, to induce serendipity in an observable fashion.

Elaine Toms (2000), for instance, experimentally manipulated the purpose with which users approached a digital newspaper and the tools used to facilitate use. For this she asked a group of 47 readers for two purposes and two methods of information access:

The first purpose was one with a specific goal, operationalized as “find the answer to a set of questions”, while the second had no pre-defined goal asked to “read/browse the newspaper for the next 20 minutes”.

The first method of information access was a search tool which prompted for keywords, while the second was a dynamic list of ten suggested news articles that were somewhat similar to the article that was being displayed.

The “no goal” purpose was devised as a way to simulate a type of browsing, while also creating the best potential for a serendipitous encounter. In this way, Toms attempted to trigger serendipity.

The participants that were asked for a goal, even if only partially understood, searched through the paper and examined the contents with the clear intention of only extracting the appropriate piece of information, and moving on. Those without a goal were more interested in “coverage and exploration”. Toms concluded that “when the interaction was not guided by an objective, user decisions seemed less definitive and less predictable.” There isn’t, however, any indication by the authors that any serendipity occurrences existed.

Elderez (2004), in an explicit and targeted study to induce serendipity, gave 10 participants (eight females and two males) from a class of 25 library and information science students a common coursework task, and a new search task was reverse-engineered,

in an effort to reveal one relevant result in regards to the coursework task. Although 9 out of 10 participants noticed the relevant result, none changed their task to look at it, this highlighting the evasive nature of serendipity and its difficulty of facilitating it.

Overall, there aren't a lot of experiments that specifically try to facilitate serendipity, and many that do try do not elaborate on the results. There is an overall lack of observational testing or conclusive findings to this question, which can lead us to deduce the following:

Serendipity is, by definition, rare. It is elusive and capricious, showing up unexpectedly and without warning. This is why we can even doubt its existence as a confined phenomenon rather than a natural consequence of the thought-process. To observe it in controlled environments is an exercise in frustration and the only successes being made are those that try to register when it occurs 'in the field', like those of Foster and Ford (2003). To our knowledge, no such experiment has been done specifically in regards to digital-occurring serendipity.

Secondly, we are just starting out. Although research on the matter is scarce, it is rapidly growing. Websites⁴ and conferences dedicated to the topic of serendipity, and digital serendipity in particular, have been growing regularly and incrementally, as is the number of papers on the matter in recent years. It is the hope of this research to add to the conversation and, hopefully, provide an unique perspective on the matter that might add some value.

2.3 Characteristics of Serendipitous discoveries

We have now analyzed various explorations of what defines serendipity. Some authors prefer to focus on its accidental—apparently random—nature, while others emphasize the part the user has on the discovery, while even others prefer to explore the conditions that enable these discoveries to happen. Ever since Horace Walpole first wrote to his cousin, serendipity had as many different definitions as it had people writing about it. In an attempt to provide common ground that could accommodate the different interpretations

4 *SerenA - Understanding and designing to support serendipitous research* <www.serena.ac.uk> is an UK Research Council funded project that aims to understand what constitutes serendipity and how it can be used in order to promote connections between people, information and ideas.

The *SerenA project* also features a "Serendipity Stories" section <serendipitystories.net> with a series of examples of serendipitous experiences.

Aleks Krotoski, co-author of *The Serendipity Engine* <theserendipityengine.tumblr.com> regularly discusses the topic of serendipity in *The Observer* <www.guardian.co.uk/technology/2011/aug/21/google-serendipity-profiling-aleks-krotoski#_jmp0_> or the *BBC* <www.bbc.co.uk/programmes/p00lmpfq and www.bbc.co.uk/programmes/b01jqfk8>

of the concept, as well as create an overall illustration of it, we have identified four inherent characteristics to serendipitous discoveries that define the different aspects of the process: Nature, Mind, Context and Value. We have purposely left these broad since it is our intention to encompass different interpretations of this process.

2.3.1 Nature

The first and immediate characteristic of serendipity is the *accidental* nature of a serendipitous event. For an experience to be described as serendipitous it must occur from unexpected and, in some sense, random situations. Chance is the driving force for the serendipitous discovery.

2.3.2 Context

The *context* of a serendipitous event can be described as the necessary physical conditions for it to occur: the necessary mindset by the serendipitous experiencer as well as the time and place that it happens. It is the context of the serendipitous event, as well as its accidental characteristic, that will serve as the two *actionable* characteristics in the development of this research, as opposed to the upcoming characteristics of mind and value, of which we can't directly influence or intervene.

2.3.3 Mind

The third characteristic can be described as the capacity to be in the correct mindset to recognize the discovery and its underlying value. Walpoole described this as *sagacity*: the capacity of the one who experiences the serendipitous event to acknowledge the occurrence of it. In other words: Without a mind that is capable to create a new insight, there is no serendipity, just random events. This describes the pre-disposal of the observer to accept a new idea as well as his own capacity to create the necessary connections between different inputs.

2.3.4 Value

Value is the direct outcome of a serendipitous event. If it isn't valuable, it's because it is meaningless and as such, it's not serendipity. While this may seem rather obvious, we must keep in mind that valueless connections are, by and large, the most common form of relationships that are created between random pieces of information. It is the goal of designing for serendipity to transform useless connections into valuable ones.

2.4 The Personalized Web

Having defined and started to understand the process of serendipity, we begin to look into *why* and *if* there is a preoccupation regarding the lack of it on the Web.

The Web is, arguably, a privileged means for serendipity. Steven Johnson, author of *Where Good Ideas Come From*, describes the Web as “the greatest serendipity engine in the history of culture” (Johnson, 2010). Taking aside the nostalgic thoughts of wandering through a library and *serendipitously* finding a book, or making a wonderful new discovery at the music store, we have access to more and more varied information as ever with the internet. It is a serendipity perfect storm.

Then, why bother to *design* for serendipity?

While it’s true that, when online, we have remarkable access to information, in recent years there has been a phenomenon that might have an advert affect to our capacity to discover new things, things that we don’t yet know that we might have an interest on them: new interests, new experiences and new thoughts. This is the problem of Cyberbalkanization induced through an increasingly Personalized Web.

2.4.1 Cyberbalkanization

The concept of cyberbalkanization was first introduced in 1996, on an MIT paper by Marshall Van Alstyne and Erik Brynjolfsson (1996) and referred specifically to specific interest groups that tend to use the internet as a means to exclude views that are contradictory to their personal beliefs, creating in that way sub-groups and communities where different points of view are discouraged. The authors alert to the dangers of a “voluntary balkanization” that can lead to a “loss of shared experiences and values” which can reveal to “be harmful to the structure of democratic societies as well as decentralized organizations” (Alstyne and Brynjolfsson 1997).

While Alstyne and Brynjolfsson focused on the active creation and adoption of these groups, we can also observe the creation of these segregating communities through a more subtle, and subsequently more disruptive process: the one that happens as a consequence of the personalization of the Web.

2.4.2 The Filter Bubble

Eli Pariser on his book *The Filter Bubble*, illustrates the various consequences of

an increase tailoring of the content that we, as Internet users, have access to. With the advances of recommendation engines such as the ones on amazon.com, or the search engines like Google, these are increasingly more precise on predicting what we might be interested in buying or searching.

While this might be good when we are looking for things of similar nature, we cannot say the same for searching new information, or information that is incongruent to our previous browsing history. These optimized search and recommendation engines are built upon our browsing history, and create a virtual persona of an user, representing what they believe are the users interests. To quote Pariser:

It's a cozy place, populated by our favorite people and things and ideas. If we never want to hear about reality TV (or a more serious issue like gun violence) again, we don't have to—and if we want to hear about every movement of Reese Witherspoon, we can. ... We're never bored. We're never annoyed. Our media is a perfect reflection of our interests and desires (Pariser 2011, 12)

The problem is, as Pariser puts it, that while our identity shapes our media, our media also shape our identity. The results that these services provide us end up reinforcing the perceived image that the system has of us and, in turn and gradually, shape our own identities. As we continually consume the same, increasingly narrowing, field of interests, this results into a sort of personality loop where we only search for what we only know about, and the results are a perpetuation of what we are (or the system perceives as such) already interested in knowing about. New information, uncommon information to our browsing habits, is filtered away. As Pariser succinctly describes it: “If we don't erase our web histories, in other words, we may be doomed to repeat them” (Pariser 2011, 136).

This echo is worsened due to the pervasive ways that it happens, invisibly to the user. Contrary to popular belief, there is not one, single, Google search. The search engine, as of December 2009, no longer relies solely on PageRank, its link analysis algorithm, but also on a series of indicators, that haven't been divulged by Google, that customize google searches in order to better represent what it perceives are the users intentions. This personalization of the Web happens without the users' knowledge or, even, their consent. As such, we are constrained—or boxed— into a summary of link and click history of things that we tend to agree, while being made unaware of what we are missing, limiting our explore to opposing information.

It is our opinion, however, that there is a method that we can apply in order to escape this *filter bubble*: the introduction of an element of chance into our regular web experience. By using unfiltered randomness as a means to be confronted with unexpected content, we might be able to circumvent the personalization of web services, help induce

serendipity and at the same time, promote creativity.

2.5 Randomness and Coincidence

What distinguishes serendipity from simple coincidence?

In her study of the creative process and the role chance and randomness have in it, Margaret Boden defines coincidence as a “co-occurrence of events having independent casual histories, where one or more of the events is improbable and their (even less probable) co-occurrence leads directly or indirectly to some other, significant, event” (Boden 2004, 235).

While serendipity can, indeed, happen due to coincidence, it does not depend on the improbability of the event to happen for it to exist. It wouldn't be a coincidence if one had an insight into the nature of underwater exploration while listening to “Yellow Submarine”, if one listened regularly to the Beatles, nor it was a coincidence that the water level of Archimedes's bath rose, in the famous anecdote. As such we can equate coincidence as a possible factor for insightful discoveries, and could be what makes a serendipitous experience possible, but serendipity itself is an independent process that might occur due or irregardless of simple coincidence.

Serendipity and coincidence, however, have inherently a certain degree of randomness. We have already described chance, or randomness, as a prerequisite for serendipity: it is the accidental nature of discovering something valuable while not specifically searching for it. This assumes a degree of randomness to the event itself, unsought and uncontrolled.

When considering chance events we associate them with chaotic processes: a singularity that arises from chaos, or unpredictability. Chaos, having in mind to the greek origin of the term *hkaos*, can be described as the shape of all matter before it was reduced to order (*kosmos*). Chaos is, in this sense, the precursor to creation: the state of thought before systematization.

Art, and creative practices in general, have realized for sometime the potential for idea generation that chaos, chance and coincidence can bring to the creative process, resulting in serendipity. A paradigmatic example is that of Mozart's *Musikalisches Würfelspiel im C K516f*⁵ which employed a pair of dice and a set of 176 measures of prepared music in order to determine the music to perform. In the twentieth century, music composer

5 Written in 1787 and published in 1793.

and theorist Iannis Xenakis would take this approach further in the development of his ‘stochastic music’. Founding father of Dadaism Tristan Tzara used a cut-up technique consisting of a random arrangement of pieces of text and words to create the “dada manifesto on feeble love and bitter love” as well as various poems. A similar technique later used by the writer William S. Burroughs and that can be observed in his book collaboration with Brion Gysin entitled *The Third Mind*.

Randomness can also be used to promote problem-solving and creative thinking, as with the random events of the computer game *SimCity*⁶ where there was always the

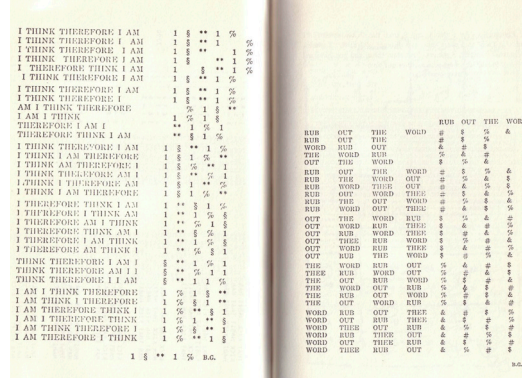


Fig.1: *The Third Mind* (Burroughs and Gysin 1977). Fig. 2: *SimCity 2000*.

probability that a random ‘catastrophe’ could decimate the city the player created, adding challenge and improvisation to a game that rewarded order and careful planning.

Chaotic processes are often associated to creativity. This association can be made not only to the usage of chaotic processes as a tool to induce creative thinking, but also to the though process itself. Boden (2004, 252) makes reference to the possibility that chaotic neutral activity in the brain can help prevent cell-networks from being trapped into certain patterns of activity and are used to our learning ability as well as to recall sensory patterns, such as sound and smells. Neuronal chaos, therefore, would act as a “randomizing device” in order to expand the capacity of pattern-learning of cell-networks. This theory, however, isn’t consensual in the field of the neurosciences (Boden 2004, 253), but if it’s possible that randomness is employed as “patterns of activation”, this could mean new ideas are generated accordingly. The possibilities of these “new ideas” turning out to be creative ideas is, however, highly doubtful.

6 *SimCity* is city-building simulation video game developed by Maxis and first released in October 1989. Examples of the ‘disasters’ that could be triggered in the game included earthquake, fires, floods, monsters and nuclear meltdowns. The video game *Sid Meier’s Alpha Centauri*, released 10 years after the first *SimCity* would utilize the same concept of random events

2.6 Browsing and Free Association towards Creativity

When we start exploring the mechanics of creativity and discoverability, there is one key-aspect into idea-creation that is common and can also be relevant to digital interactions: the need to wander or, to put it how many authors do, to “go for a walk”.

This type of creative breakthrough can also be described as allowing for a period of incubation, when research is paused and the researcher focuses on a different type of activity, usually physical in nature.

The physicist Hermann von Helmholtz, as reported by Graham Wallas (1926), described this idea during a speech delivered in 1891, when he said that ideas came unexpectedly and without effort and that rather than occurring at his “working table ... They came particularly readily during the slow ascent of wooden hills on a sunny day”.

Csikszentmihályi and Sawyer (1995) interviewed nine “creative” individuals, 60 years or older and still actively involved in creative work. All mentioned the importance of “idle time” where insights usually occurred, and several commented that these happened when they were doing a “repetitive, physical activity”, such as gardening, taking a walk or a bath. Some of their interviewees actually scheduled “a period of solitary idle time” in order to be creative, following a period of hard work.

There are numerous examples of these types of gestation of ideas in creative fields, from Archimedes’s famed bath to the fictitious detective Sherlock Holmes playing the violin. What is relevant to this investigation is how and if we can draw a parallel between the physical activities associated with these idle times and digital interactions with systems that may allow for idea associations.

The term ‘surf the Web’ has become part of our everyday language. The concept that underlies it is a sort of exploratory move through content as one would move through waves in the ocean, with minimal control. Although we could argue that our interactions with the Web nowadays are mainly started through a web search (this isn’t so much as ‘surf the Internet’ as rather to ferry across it), there are services where one can engage in this online wandering. Wikipedia comes to mind as a good example, where its users regularly describe the act of aimlessly going from article to article, in a kind of *wiki-surf*. Most social networks, such as Facebook, also potentiate this kind of behavior.

This ‘wandering’ browsing opposes a traditional, purposive-driven and conscious browsing that one might engage in when, for example, one views an online newspaper with the intention to learn the current events, or goes shopping online with a clear intention. We will distinct this purposive browsing from a non-purposive browsing of which

we can describe, in concurrence with Oscar De Bruijn and Robert Spence (2008) as “serendipitous browsing”.

De Bruijn and Spence have examined this “serendipitous browsing” and have distinguished between two possible classes of browsing that do not possess a particular goal in mind. The first is *Opportunistic Browsing*, an intentional action but one where the user has no particular goal in mind. The overall goal by the user is to “see what’s there”. The second class is an *Involuntary Browsing*, also without goal but unintentional in nature. It can happen when a user’s gaze naturally moves between a “series of fixations, serendipitously fixates on an information item that may lead to the answer to a longstanding query.” (De Bruijn and Spence 2008).

This aimless, goal-less browsing is reminiscent of the free association technique developed by Sigmund Freud and used in psychoanalysis and psychoanalytical psychotherapy. With free association, patients are encouraged to freely verbalize their thoughts and feelings, ignoring their perceived importance or potential for embarrassment. Traditionally, the patient lies on a couch, their back towards the psychoanalyst, in order to help induce a state of relaxation and trust, by removing from thought the image of the recipient, and letting the patient dwell on their own thoughts. The purpose of this method is to help surface repressed thoughts and feelings, so that the patient can be made conscious of them. As Deborah Britzman (2003) paradoxically describes it, free association is both a “particular narrative and the resistance to making narrative particular”.

Can we, then, make the association between a goal-less, purposive-less, wandering browsing state to that of free association? And can this lead to the uncovering of unexpected insights as free association can lead to the discovery of repressed memories? As we have explored in the previous chapter, there is the possibility that chaotic brain activity might lead to creative thinking and that specific states of mind (particularly those that oppose the direct activity of research, such as physical labour or recreational activities) often lead to serendipitous discoveries. The interconnectivity of these processes is only now being explored but, at least on the surface these connections appear to be there. Still, there is yet much work to be done in the fields of understanding creative processes. To quote Boden:

Our ignorance of our own creativity is very great. We are not aware of all the structural constraints involved in particular domains, still less of the ways in which they can be creatively transformed. (Boden 2004, p. 246)



3 SYSTEMS FOR SERENDIPITY

3.1 Classification and Methods

When we consider the *possibility* of serendipity through exposure to new and uncommon information, the Web stands among others as a privileged medium. While online, we are in constant contact with sources of information and entertainment, of varying degrees of noteworthiness. Although, to attempt to precise *when* and *where* digital serendipity might occur is a pointless effort since, as per its meaning and nature, serendipity is unexpected and can happen at anytime.

We can, however, consider the premise of serendipity: the creation of insight due to a chance occurrence. As we have proposed, we can summarize the innate characteristics of serendipity into four main areas: its *Nature* (accidental), its *Context*, *Mind* and *Value*. We have also suggested that only the two first of these characteristics can be actively acted on, on the premisses of this investigation. It is by observing this accidental nature and understanding in what context these serendipitous discoveries are made, that we may look for systems that might induce serendipity.

We consider that it is by exposure to new information, and as such by increasing the chances of finding something uncommon and of value, that we can hope to achieve true serendipitous discoveries. As such, we have focused our analysis of available systems on the Web to those that promote the discovery, and sharing, of content. We realise that

serendipity is not, at all, exclusive to these kinds of system, however we argue that these have a potential for surprise discoveries which, in turn, often lead to equally surprising insights.

To do so, we have recollected a series of popular web tools and platforms being in use, at the moment of this investigation, and have examined what is the most common method of interaction that could lead to serendipity. In order to simplify our description and analysis, we have separated these systems by their specific methods for information interaction.

This categorization is done *a posteriori* of the compilation and is a simplification of these complex systems. More complex tools and platforms may use various and distinct methods simultaneously or implement these in different ways. In such cases we will try to individualize how and when the different methods take place.

In addition, we have also created an *Outliers* group where we try to group the examples that are distinct to the focus of this investigation but that we have, nonetheless, identified as of possible interest to future research in this area.

3.1.1 Collections

We consider Collections as a category when serendipity is mainly achieved by presenting the user with aggregations — or collections — of content, where the user is presented with a substantial quantity of information, possibly from a varied number of sources that the platform collects, and generally collected in one central location.

3.1.2 Filtering

The Filtering method functions by the targeted collection of various bits of information through the use of a common theme or trait. With the use of filtering systems, as with the example of social bookmarking services, the user can collect and visualize varied data gathered from diverse locations which, when asynchronously juxtaposed, may yield new connections.

3.1.3 Randomness

This method relies on the degree of chance and random input or output of information as a way to trigger serendipitous connections. Chance is one of the distinct, inherent, characteristic of serendipity, as first described by Walpole and ever since in the following definitions of the concept. It is with the confrontation with unexpected information, that we allow for surprise, for new discoveries and the possibility for serendipity.

3.1.4 Recommendations (Curated or Algorithmic)

Recommendations are a commonly used method for the discovery of new information. In this category we make the distinction between what we design as “Curated” and “Algorithmic”, the former describing the recommendations that are made by a human intermediary while the latter the recommendations made through computer processes and are usually based on the users’ patterns.

3.1.5 Search

The last category describes the occasions where the principal method of serendipitous discoveries happen through an user-made search. In this case, the serendipitous process begins with the results of the input of a query into a search engine.

3.2 Intentions, Assets and Perks

The systems that we have gathered vary also in their relationship with serendipity itself.

As we have seen, serendipity can happen anywhere and at anytime in digital media, and the Web is a privileged medium for it to happen, as users have easy access to different forms of stimuli and information that can trigger serendipitous processes. However, in spite of this very nature of the Web and the digital medium (or perhaps due to it), there has been a series of attempts to directly and explicitly provoke or induce serendipity. In our analysis of the various systems of serendipity, we will examine these attempts, which we describe as *Serendipity as Intention (I-Serendipity)*, and their possible successes.

Besides the various tools that have serendipitous experiences as their direct intention, we have also identified a series of platforms or tools where, while serendipity isn't the goal *per se*, one could argue that it is an implicit characteristic of the tool itself and a method that is explored by it. We will explore these various examples of *Serendipity as an Asset (A-Serendipity)*.

Finally, we can also identify a series of tools and platforms where serendipity is neither an intention or an asset but can be observed as a causality of using the tool or platform itself, and although we could argue that every aspect of existence is a possible means to achieve serendipity, in the particulars of this investigation, we can observe that there are some platforms that, due to their advantageous position as a means to discover *new and uncommon information*, could be possible tools to commonly induce serendipitous experiences. This category we describe as *Serendipity as a Perk (P-Serendipity)*.

P-Serendipity is also of a particular interest to this research since if we can identify particular characteristics of the process that can lead to the finding of new and fortunate information or connections as a by-product of the usage of a specific platform, those same principles could be applied to different tools, regardless of their main goal, and thus increasing the overall potential of the Web as a means for serendipity.

Before we dwell into the exploration of these systems, we should premise that, due to the liquid nature of the Web, some of the examples we cite may no longer be available to the public, while new and interesting ones may appear everyday. In fact, some platforms were discontinued during the process of this research.

Although the project is still in development, the authors have been extremely vocal regarding the issue of serendipity on the Web. On her IAB Engage 2010 presentation, entitled “The web is broken: supercharge with serendipity” (Krotoski 2010), Krotoski identified various common subjects of this investigation, particularly the *cyberbalkanization* effect, as as such it is a relevant example of what is being made on the subject.

3.3.2 *Oblique Strategies: Over One Hundred Worthwhile Dilemmas*

Oblique Strategies, published by Peter Schmidt and Brian Eno in 1975 is a deck of printed cards in a black box with a series of aphorisms intended to help problem solving and creative blocks. They were later revised by Brian Eno and Peter Norton in 1996 and by Eno in 2010. These cards have phrases that would offer a possible new direction or solution when facing a dilemma during the creative process. Some examples included: “Use an old idea.”, “What to increase? What to reduce?” or “Try faking it!”.



Fig. 4: *Oblique Strategies* (Eno and Schmidt 1975))

The Serendipity Engine and *Oblique Strategies* bring forth the question of serendipity (although in the case of *Oblique Strategies* in a subjacent way) in novel representations and solutions. These approach the subject from a particular view point that enrich the discussion of serendipitous findings and provide a valuable example of alternative methods to the exploration of the concept.

3.4 Collections

A-Serendipity:

Explore <exp.lore.com>;
Gimme Bar <gimmebar.com>;
iTunes <www.apple.com/itunes>.

P-Serendipity:

Foursquare <foursquare.com>;
Facebook <www.facebook.com>;
Flickr <www.flickr.com>;
Flipboard <flipboard.com>;
Online Newspapers (e.g. *Google News*, *nytimes.com*, *publico.pt*);
Pinterest <pinterest.com>;
SoundCloud <soundcloud.com>;
Tumblr <www.tumblr.com>;
Twitter <twitter.com>;
Web Portals (e.g. *AOL*, *sapo.pt*, *MSN*, *Yahoo!*).

3.4.1 *Explore*

Explore, a website with curated content, edited by Maria Popova, is an attempt to create a “discovery engine for meaningful knowledge, fueled by cross-disciplinary curiosity” (Popova 2012). It aggregates content from a variety of sources for, in the words of the author: “cultivating your interests, and a discovery engine for things you didn’t know you were interested in, until you are.”

Explore is a good example of the type of curation of content that the Web allows that may yield surprising discoveries to visiting users, without utilizing any method of recommendation system, relying instead on the choices made by the curator. The level of interest of the possible audience is dependable on the choices of curation that are made. It is by the use of comparison and engagement of this type of curated content that novel experiences might occur.



Fig. 5: *Explore* (Popova 2012)

3.4.2 *Gimme Bar*

Gimme Bar is similar in principle to *Explore* but the curation is made not by a single curator but by its users. It is a visual bookmarking service that allows to clip various types of information into pages, reminiscing of a scrapbook, and usually organized by topic which user's can then follow. The tool privileges the visual aggregation of information from different sources and displays it in a grid or timeline view, allowing for visualization of a varied amount of information, an important characteristic of the process of promoting serendipitous experience.

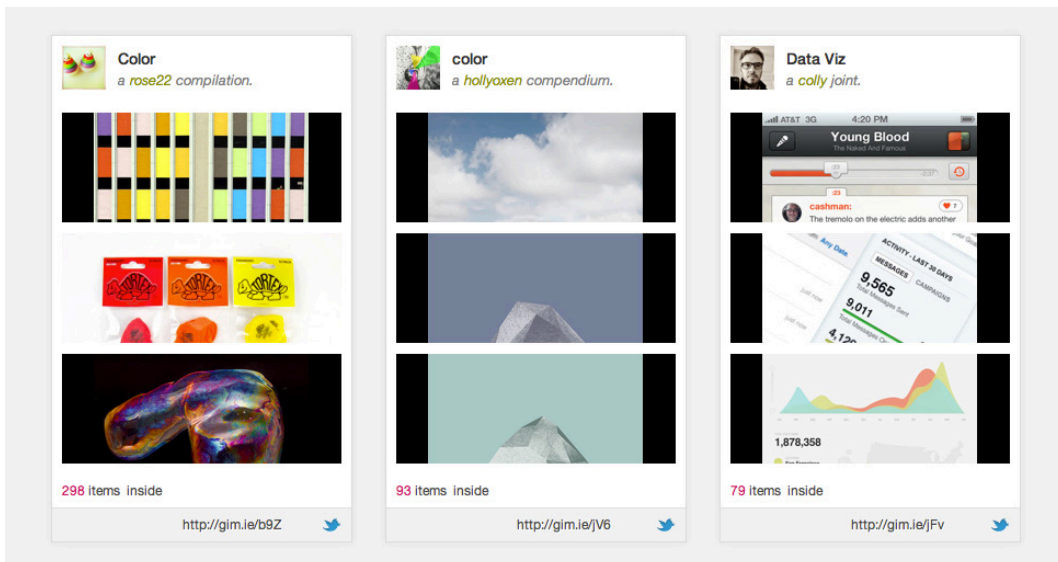


Fig. 6: *Gimme Bar*.

3.4.3 *iTunes*

iTunes, a media player and manager by Apple, while complex in nature, is an example of a system where serendipity is a crucial component to its functionality, be it in discovering new media in its store, or the one the user already owns. Due to its complexity, it is cross-methodological, and we will explore it on other methods for serendipity, but *Collection* is a core one, since it is the privileged method of organization and exploration of ones' personal library of media, and, through this overview of content, can help one discover content that, at the moment, would be unexpected.

3.4.4 *Foursquare (also Gowalla)*

Foursquare (as well *Gowalla*⁸) is a location-based social networking app where users 'check-in' at specific venues using a GPS enabled mobile device, earning "badges" and points. It is through the possibility for real-life connections that this type of localization-enabled check-in applications allows for serendipitous experiences.

3.4.5 *Facebook (also Google+⁹)*

Facebook aggregates on its users' 'wall' the numerous and varied bits of information that the users' network shares. Due to the ubiquitous and simple to use methods of sharing online content on *Facebook*, as well as the varied types of information that can be shared, it has an enormous potential to help uncover new content. However, due to the previously discussed filtering and personalization methods employed by *Facebook*, as well as the sources of information that are available to a *Facebook* user are limited by their user-created network, the capacity for increasing the breadth of varied information ends up being limited, despite *Facebook's* potential.

3.4.6 *Flickr (also Dribbble)*

Flickr is an image hosting and sharing website with an online community. It offers various ways to browse and search for images. *Flickr* offers various methods of discovering images: through search, tags, 'relevant', 'recent' and 'interesting' images, as well as image sets (collections of images made by users) or image groups, generally dedicated to a particular theme or topic. The serendipitous potential in Flickr, and similar image sharing and hosting websites, lies in the juxtaposition of its content, originated from various sources.

8 *Gowalla* was acquired by *Facebook* on December, 2011.

9 plus.google.com

Dribbble is similar in execution, but is dedicated to the design community, where users can share small screens of the designs they are working on.

3.4.7 *Flipboard*

Flipboard is a social magazine application for iOS and Android. The application collects the content of social networks and other websites and presents them in magazine format. The distinguishing factor of *Flipboard* is its capacity for aggregation of content from diverse sources: from an user's social networks (such as Twitter or Facebook), image and video sharing services (like Flickr, Instagram and YouTube) and *traditional* content providers such as newspapers. This blend of personalized and curated content is conducive for serendipitous discoveries.

3.4.8 *Online Newspapers (e.g. Google News¹⁰, nytimes.com, publico.pt)*

Newspapers are a classical and often cited example for serendipitous findings. The leisurely browsing of a newspaper and stumbling across an unexpected but valuable article is a defining example of serendipity, and this is true both in the paper and digital formats of newspapers. However, due to the limitless potential for content that a digital newspaper has, its readers are less likely to browse through one than to search for the content that their interested in, thus reducing the potential for surprise.

3.4.9 *Pinterest*

The pinboard-style photo-sharing social network *Pinterest* is a good example of *Collections*. *Pinterest* gathers content (or 'pins') uploaded by its users and displays them in a familiar grid-like manner. These pins are generally themed so they can be easily categorized by its users based on theme or content. Users are able to browse and search their own collections as well as others. They can also save their favorite pins to their own boards (using the 'Pin It' button) as well as content from other websites through the use of a bookmarklet.

It is in the visualization of these user-selected, unconnected 'pins' that the serendipitous potential lie, and by the interaction between user and content: saving those that interest them and browsing other users' choices, that discovery on relevant content is promoted. It is also highly pertinent the fast adoption of this platform, as evidence in the growing number of users¹¹ of *Pinterest*, which is also indicative of the possible need for such tools on the Web.

¹⁰ news.google.com

¹¹ For January 2012 comScore reported the site had 11.7 million unique U.S. visitors, making it the fastest site ever to break through the 10 million unique visitor mark. (<<http://techcrunch.com/2012/02/07/pinterest-monthly-uniques>>)

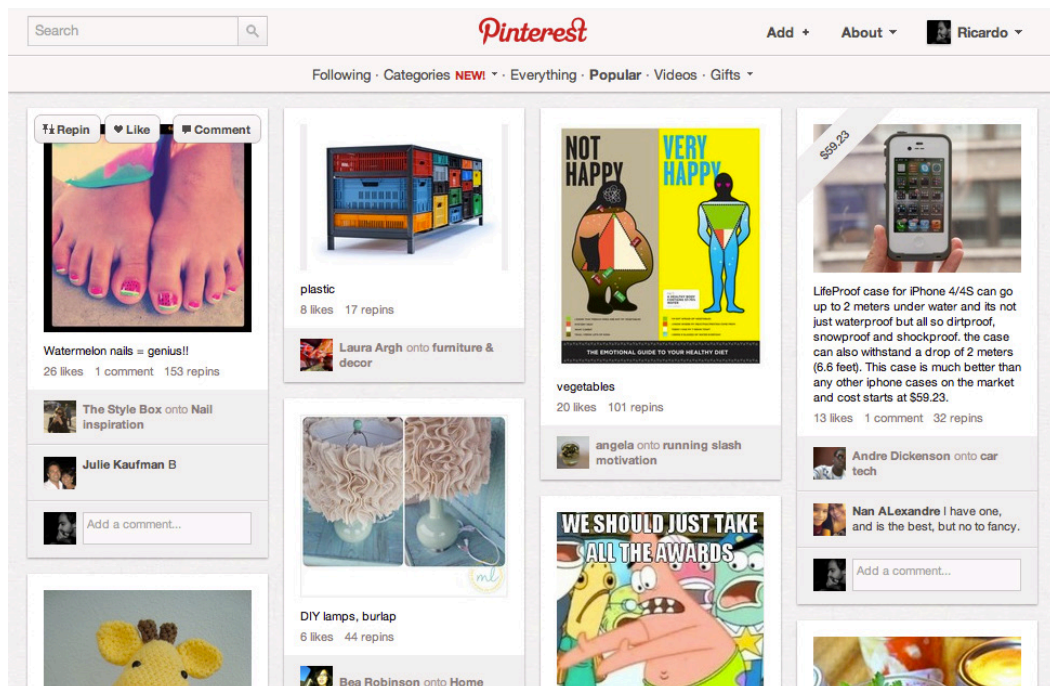


Fig. 7: Pinterest

3.4.10 Tumblr

Tumblr is a microblogging platform and social networking website. Emphasizing its ease of use, the service allows users to post content to a short-form blog, named a “tumblelog.” Users can follow other users’ blogs, as well as make their blogs private. In each users ‘dashboard’ is presented the most recent posts from creators the user is following, as well as access to Tumblr’s suggested posts. Tumblr also features an ‘Explore’ section with various categories, popular tags ranked by ‘feedback’, ‘activity’ and ‘top editor’, all possible methods for experiencing serendipity.

3.4.11 Twitter

Twitter, an online social network created in 2006 by Jack Dorsey, allows its users to create and read ‘posts’ of up to 140 characters. The user can also choose to follow others users’ posts (or ‘tweets’), which will then appear, in reverse chronological order, on the following users’ main page, or ‘timeline’.

Due to the possible diverse nature of the content of these tweets, and depending on whom the user chooses to follow, it is with this cluster of information that we believe Twitter could be a good vehicle for serendipitous discoveries.

3.4.12 *SoundCloud*

SoundCloud, an online audio distribution platform, allows for users to share audio recordings on the internet. Through the creation of an online community or the exploration of popular tracks, this system can help the fortunate discovery of new sounds.

3.4.13 *Web Portals (e.g. AOL, sapo.pt,¹² MSN¹³, Yahoo!¹⁴)*

A web portal is one of the earlier examples of online aggregation of content. Web portals generally compile information from diverse sources in a unified way, in some cases under a specific branding, with a common set of functionalities such as search engines, e-mail, news, weather and general entertainment. Due to the diverse nature of these systems, the serendipitous potential is immense, as well as untraceable, since *Web Portal* are capable (and often do) of encompassing most of the methods described in this research. Still, as evidenced by their popularities (they frequently appear at the top of the most visited websites in the Web), they are a prime source of discovery of content and, as such, of possible serendipitous occurrences.

12 www.sapo.pt

13 www.msn.com

14 yahoo.com

3.5 Filters

I-Serendipity:

The Bohemian Bookshelf.

P-Serendipity:

Delicious <delicious.com> and *Pinboard* <pinboard.in>;

Twitter (tags);

Universe <number27.org/universe.html¹⁵>;

We Feel Fine <wefeelfine.org>.

3.5.1 *The Bohemian Bookshelf: Supporting Serendipitous Discoveries through Visualization*¹⁶

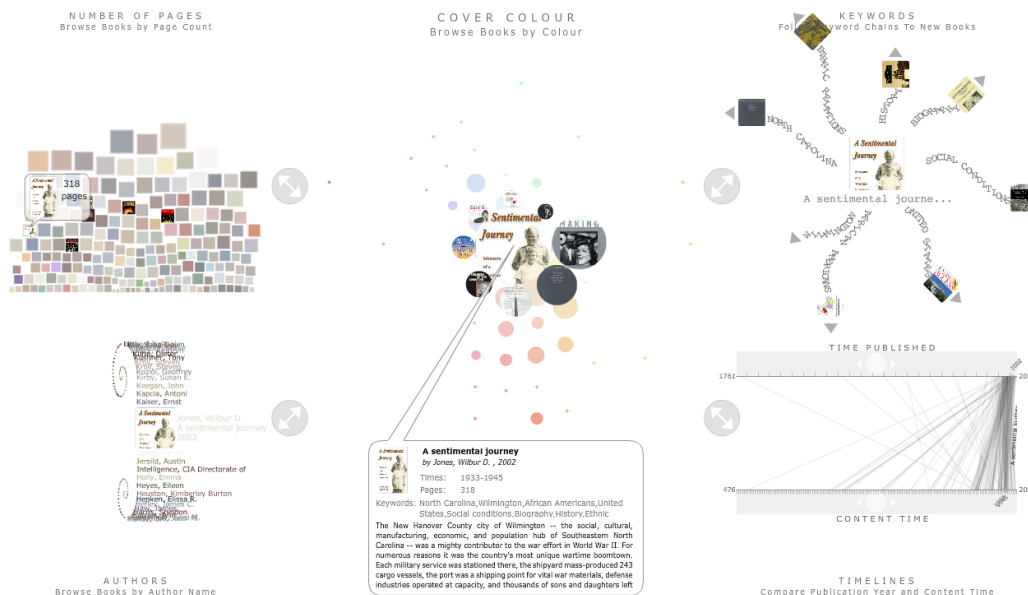


Fig. 8: *The Bohemian Bookshelf* prototype.

The Bohemian Bookshelf, a project developed by Alice Thud, Uta Hinrichs and Sheelagh Carpendale from the InnoVis Group of the University of Calgary is a good example of this type of exploratory browsing as a method to achieve serendipity. This project employs information visualization as a means to discover books in digital library catalogues. Its main concerns are: to provide multiple access points to the collection through the use of different visualizations; to entice curiosity through distinct representations of

15 Unavailable at the time of this writing

16 An early prototype is available at www.alicethudt.de/BohemianBookshelf/Program/BB.swf

the collection; to highlight alternate adjacencies between books; to provide multiple pathways for exploring the data; to support the immediate preview of books and to enable a playful approach to information exploration. Through the use of five different, interlinked types of visualization, *The Bohemian Bookshelf* hopes to incite a playful, exploratory state of browsing that is reminiscent of wandering through a library or bookstore, while providing solutions that are unique to digital interactions.

3.5.2 *Delicious and Pinboard*

Delicious and *Pinboard* are online, and social, bookmarking services, where users can save links to web pages by the use of a bookmarklet service and categorize these links by the use of ‘tags’, which can then be used to filter the saved bookmarks by a common tag.

With the continuing use of these services, the user can collect and visualize varied data gathered from diverse locations which, when asynchronously juxtaposed, or filtered through a specific tag, may yield surprising and intriguing connections.

3.5.3 *Twitter (tags)*

Twitter is a complex system that can be a method for serendipity in various forms, as described previously. One of these methods is the use of tags, or hashtags: words or phrases that were prefixed with a hash (#) sign. With the aid of these hashtags, topics can be grouped and viewed together. This led to the creation of ‘trending topics’ that list the most used tags at any given time. This may be an engrossing glimpse into the collective mind.

3.5.4 *Universe*

Universe, a project by Jonathan Harris and commissioned by Daylife, presents an interactive night sky, with thousands of stars that form constellations. These constellations are created from information that is gathered from online news sites and can represent stories, persons, quotes, images, etc. Any constellation can be activated, making it the centre of the users’ *universe*, or perspective. With this, Harris poses the question of what defines our modern mythologies and what are our contemporary heroes, gods or goddesses (Harris 2010).

3.5.5 *We Feel Fine*

We Feel Fine, a collaboration between Jonathan Harris and Sep Kamvar, collects from the Internet sentences that contain the phrases “I feel” or “I am feeling”, saving them in a database that it displays in an interactive Java applet, where each person’s feeling is represented by a single dot. The color of each dot corresponds to the type of feeling manifested on the phrase itself (bright dots represent happiness, while dark represent sadness). Also available is the demographic characterization of the writers: their age, gender, location and weather.

Both *Universe*, and *We Feel Fine* allow the user to, in a playful manner, interact with the content, creating unique narratives with it, and what distinguishes them from other *Filtering* systems is that, contrary to other examples where the user creates a categorization, here it’s the system itself that arranges the content.



Fig. 9: *We Feel Fine*

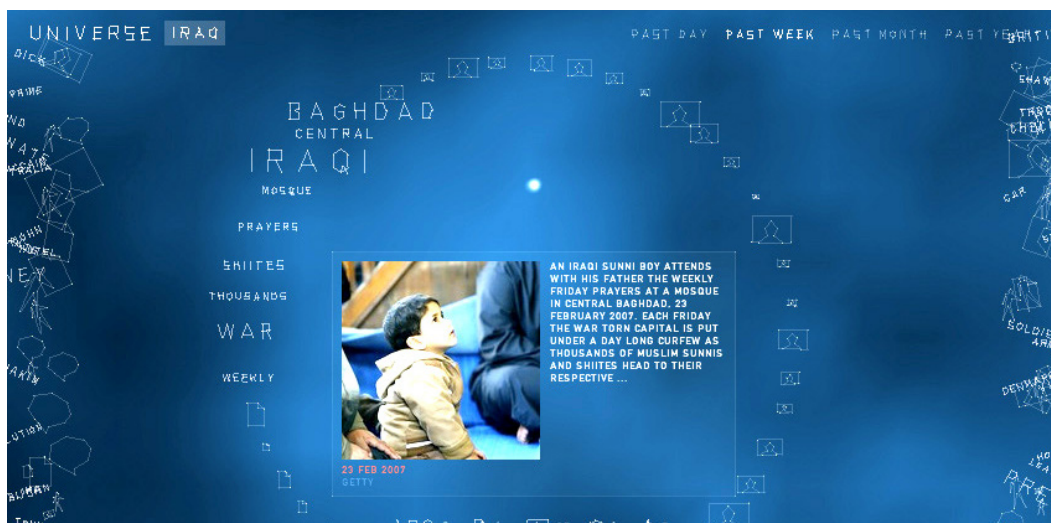


Fig. 10: *Universe*

3.6 Randomness

A-Serendipity:

iTunes Shuffle;
StumbleUpon <stumbleupon.com>.

P-Serendipity:

Twitter (*retweet*).

3.6.1 *iTunes Shuffle*

A paramount example of chance is the *Shuffle* function that exists on media players such as *iTunes*.¹⁷ By removing the control from the user, and the knowledge of what that content will be, *Shuffle* allows the user to be surprised, to discover something new and, as Leong et al. (2008), argue, to abdicate choice, which can in turn lead to a better user-experience and encourage “encounters with serendipity”.

Although it has been argued that the shuffle in iTunes uses isn't truly random but employs an algorithm that encourages deeper connections between certain songs¹⁸, however, this is pure conjecture and could be due to coincidence or perception.

3.6.2 *StumbleUpon*

Another example of Randomness is the discovery engine *StumbleUpon*. With the use of a collaborative filtering system that combines human opinions with machine learning, it allows users to ‘stumble upon’ web pages that relate to their expressed interests. The users can then give the ‘stumbled upon’ web page a ‘thumb up’ or ‘thumb down’ in order to fine-tune the possible results. *StumbleUpon* has expanded its services to *StumbleUpon Video*, dedicated exclusively to video websites, and *StumbleThru*, which allows users to stumble on pages within a specific website, making this system a curious experiment into the possibilities of random discovery and, taking into consideration its 25 million registered users (as of April 2012),¹⁹ a good example of the need for tools.

17 The shuffle functionality predates *iTunes* or other digital media players and much earlier examples can be found in CD players but, with the intention of focusing in the digital experience, *iTunes* will serve as an example for the purposes of this research.

18 www.cnet.com.au/itunes-just-how-random-is-random-339274094.htm

19 Announced by *StumbledUpon* in April 2012.

3.6.3 *Twitter (retweet)*

Due to the nature of Twitter, the incoming flow of apparent random information might be an useful tool for serendipity discoveries. Lacking built-in filtering of content²⁰ (contrary to Facebook) and with the help of ‘retweets’²¹ can help to overcome the problems of the personalized Web. It still depends, however, on the user-created networks.

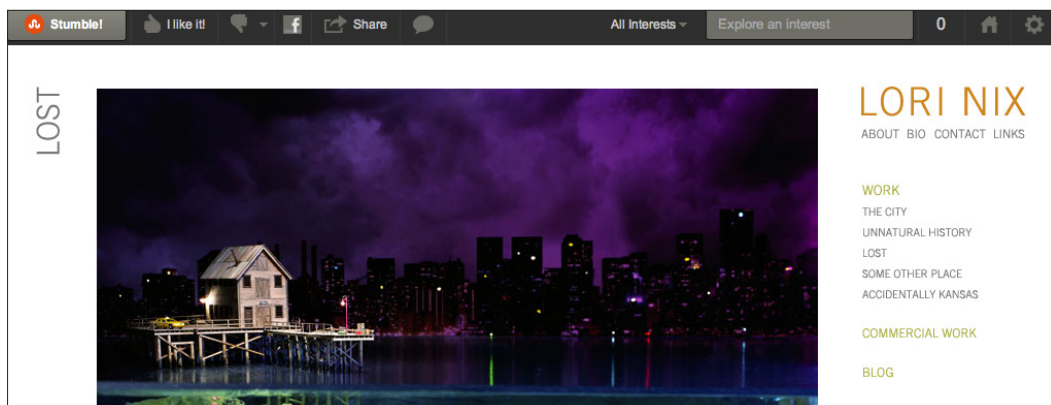


Fig. 11: *StumbleUpon*



Fig. 12: *Retweet* example in *twitter.com*

²⁰ Although we have previously described hashtags as a filtering method, this is an optional functionality that can be easily ignored or circumvented and does not limit the access to content.

²¹ A ‘retweet’ is a *Twitter* feature that allows a user to re-post someone else’s tweet in their own timeline. This is usually done by typing ‘RT’ at the beginning of a tweet to indicate they’re re-posting someone else’s content. This allows to easily quote and share content on *Twitter*.

3.7 Recommendations

Algorithmic

I-Serendipity:

Mitsikeru;

Serendipitor <serendipitor.net>;

The Accidental News Explorer <accidentalnewsexplorer.com>.

A-Serendipity:

Amazon <www.amazon.com>, *iTunes and eBay*;

DEVONthink <www.devontechnologies.com/products/devonthink>;

FriendFeed <friendfeed.com>;

Hunch <hunch.com>;

iTunes genius <www.apple.com/itunes/features/#genius>;

Last.fm <www.last.fm>;

Netflix <www.netflix.com>;

Pandora <www.pandora.com>;

YouTube <www.youtube.com>.

3.7.1 *Mitsikeru*

Mitsikeru, a project developed by Russell Beale, tries to determine the possible relevance of webpages linked to the one the user is currently interacting with, by analyzing the user's behaviors. The system does this by incrementally creating a 'master' table for each browsing session based on word frequencies found in pages. This table, after the removal of very common words, is a representation of the "current browsing context" (Beale 2007) for the session, one that can vary in theme or topic, as the user is free to wander through different threads of interest. It then colors the links on the page according to what it suggests may be more relevant to the user's intent.

During the evaluation of the system, the coloring method was seen as successful (Beale 2007), as users tended to follow the strongly advised links most of the time, although there are no references to any interesting discoveries being made.

In similar fashion to *Mitsikeru*, although not specifically mentioning serendipity, *Letizia*, by Henry Lieberman, is one of the first attempts to anticipate items that may of interest to the user, by searching linked documents and tracking the user's behavior, it attempts to provide valuable recommendations.

Both *The Bohemian Bookshelf* as *Mitsikeru* tackle the problem of serendipity face-on, although through different methods. Both of them rely on the act of browsing by the user as the preferred method of interaction, but use very different approaches to help make discoveries and unintentional connections. *The Bohemian Bookshelf* focuses on the visual experience, on different methods of visualization and interaction, while not directly conditioning the user's navigation, *Mitsikeru* actively recommends possible paths for browsing. This can be both *Mitsikeru*'s strength and weakness, as the recommendation engine it uses can be a valuable tool for finding information that mirrors the users' expectations, it may also reduce the probability for 'detours' and playful wandering that can often lead to new discoveries.

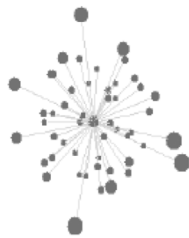


Fig. 13: Visualizing the result of one query



Fig. 14: Three unrelated queries



Fig. 15: A sequence of four queries, showing the inter-relationships.

3.7.2 *Serendipitor*

Serendipitor is a navigation application for the iPhone developed by Mark Shepard at the V2_Institute for the Unstable Media and is part of the "Sentient City Survival Kit", a project by Creative Capital. Its goal is to provide alternate routes between an origin and a destination, with varied complexity according to the intention of the user, that may allow for interesting detours and discoveries along the way. The application also suggests different actions the user might make during the route, such as "follow a cloud" or walk along an edge for a few minutes.

3.7.3 *The Accidental News Explorer*

An iPhone application that encourages chance discoveries of information, *The Accidental News Explorer* prompts its users to search for a subject by finding a series of articles relating to that search and then presenting a series of related subjects to the previous article. This, according to the application's authors, allows for "chance encounters and serendipity". (The Accidental News Explorer 2012)

3.7.4 *Amazon (also iTunes²², eBay²³)*

Algorithmic Recommendations are commonly employed by online stores as Amazon, iTunes or eBay, as a means to help clients discover new products. This is usually done by observing and tracking the users' behavior, such as previous purchases or browsing history, and by comparing this with similar data by other users. Amazon, for example, changes what items are displayed in its home page according to what information it has about the user accessing it. An user visiting amazon.com is presented with a list of items that were previously viewed by her, items that are recommendations based in what she has already viewed as well as items that other users' with a similar shopping history to the her, have viewed. It is through the diversity and variety of recommendations, particularly those that diverge from the users' regular viewing habits, that may allow for new discoveries, which in turn may lead to serendipity.

DEVONthink

DEVONthink is a Mac OS X program for intelligent document management and associative search. The user can store varied types of documents in *DEVONthink* which, by analyzing specific keywords within a document and associated words within it, can then provide a best-match result to a search, as well as interesting, and not obvious relationships between documents.

DEVONthink is featured in Steven Johnson's "Where Good Ideas Come From" specifically as a serendipity-enabling software, where he describes his usage of the software (Johnson 2010, 114). Johnson uses the software to save different of documents such as quotes, articles and books, as well as his own texts. This allows him not only to easily access information but through *DEVONthink*'s search system, be surprised by connections between files. Johnson sums the serendipitous potential of *DEVONthink* thus:

The serendipity of the system emerges out of two disinct forces. First, there is the connective power of the semantic algorithm, which is smart but also slightly unpredictable, thus creating a small amount of randomizing noise that makes the results more surprising. But that randomizing force is held in check by the fact that I have curated all these passages myself, which makes each individual connection far more likely to be useful to me in some way. (Johnson 2010, 116)

Other applications made by DEVONtechnologies, such as *DEVONsphere Express*, apply the same artificial intelligence principles for document or internet-search.

22 www.apple.com/itunes

23 www.ebay.com

3.7.5 *FriendFeed*

FriendFeed, according to their website, attempts at helping discover new and relevant content on the Web, by using social networks. To do this, it allows its users to aggregate, in real-time, updates from social media and social networking websites, as well as social bookmarking and blogs, allowing these feeds to be shared as well as discussed.

3.7.6 *Hunch*

Hunch is a website designed for helping decision-making through a collective-intelligence method. It uses decision trees based on users' interests in order to give responses to their queries. To do this, the system asks users a series of questions regarding a specific topic and afterwards it provides with a possible result, which the user can agree or disagree with. This helps to train the system in order to provide with increasingly better answers.

3.7.7 *iTunes Genius*

The *Genius* feature of iTunes, introduced in version 8, uses a ratings and collaborative filtering systems to recommend music and generate "Genius playlists" of songs from the user's library that are, in some way, related to the selected song. The system anonymously sends information about the user's music library, which then relates to other users' libraries, correlating information regarding musical preferences. As such, the larger the data set, the more accurate Genius becomes. This same system is used for recommending music for purchase at the iTunes Store.

3.7.8 *Last.fm*

Last.fm is a music website where users can create a profile with their music preferences and history of played tracks. The website can then provide information regarding similar artists or users with similar tastes. It also provides an Internet radio system that plays a personalized playlist of music according to the users' preferences.

By using a music recommendation system called "Audioscrobbler", Last.fm can register information from various online music players (e.g. *Rdio*²⁴ and *Spotify*²⁵), or via a *plugin* installed on the user's music player. This data is then displayed on the user's profile page and is used to create a more detailed and accurate classification of the user's musical taste and preferences.

24 www.rdio.com

25 www.spotify.com

3.7.9 Netflix

Netflix is a digital video distribution platform that employs recommendations as a means to help its users discover new content.

A good recommendation algorithm is, nowadays, a key concern to online stores, as it is a privileged method of knowing the users' interests and what they are more likely to purchase. We can observe this degree of valuation with the example of the *Netflix Prize* competition, held originally in 2006 by the American provider of on-demand Internet streaming media *Netflix*. The purpose of this contest was to find a better recommendation algorithm than the one it currently had, known as Cinematch.

The contest, and the respective US\$50,000 prize, was won by Team BellKor— comprised of a group of scientists of AT&T Labs— with an 8.43% improvement over Cinematch. The same contest was repeated in 2007, 2008 and 2009, where after an improvement of 10.09%, the joint team BellKor's Pragmatic Chaos won the grand prize of US\$1,000,000.

3.7.10 Pandora

The *Pandora Internet Radio* is an automated music recommendation service that, using the Music Genome Project²⁶ for classifying music, creates a personalized musical selection according to the user's preference. The user can give positive or negative feedback that influences future selections. As with Netflix, at the time of this writing, Pandora isn't available in Portugal.

3.7.11 YouTube

YouTube is the most popular online video sharing website that allows users to upload, view and share videos. It features a prominent recommendation system for similar videos related to those that the user is watching at the moment. The website also features a recommendation page²⁷ that offers recommended videos according to the user's viewing history, as well as popular (most viewed) videos in various categories.

26 Created by Will Glaser and Tim Westergren in late 1999, The Music Genome Project is an effort to create a taxonomy of musical information. See more at www.pandora.com/about/mgp

27 www.youtube.com/recommended

Curated

A-Serendipity:

FFFFFOUND! <fffffound.com>;

Stamped <www.stamped.com>;

Vimeo <vimeo.com>;

Yelp <www.yelp.com>.

3.7.12 *FFFFFOUND!*

FFFFFOUND!, a web service and image bookmarking site where registered users can share images found on the Web, is an compelling example of curation of content and how it can lead to serendipity. The website, besides allowing to share images, also recommends images according to the user's tastes or to those images currently being viewed: the website, through a manual system of editorial suggestions, accompanies each image with three others that may be in some way related to the image being viewed, even if the relationship between images is not immediately made clear. It is from the comparison with these three images, sometimes of unknown relation, that new connections and discoveries can arise.



The screenshot shows the FFFFOUND! website interface. At the top left is a logo featuring a silhouette of a person bending over to pick up a small object, with the text "FFFFFOUND!" below it. To the right of the logo, the site name "FFFFFOUND!" is displayed in a large, bold, black font, followed by the tagline "image bookmarking" in a smaller font. Below the tagline, there is a blue link: "iFOUND! | iPhone application for FFFFOUND comes back to App Store!!!". In the top right corner, there are navigation links: "tile(x) | top(h) | prev(k) | next(j)".

On the left side, there is a vertical navigation menu with links: "Top", "About", "Sign in", "Screensaver", "iPhone", "Register", "Privacy Policy", "Terms of Service", "Contact", "Change Log", and "Feed".

The main content area features a quote from "Josh Cochran: PROJECTS" with the URL "www.joshcochran.net/site_admin/portfolio_fullsize/BDoDBA_fullsize.JPG" and the text "23 minutes ago saved by 16 people". Below the quote is a large, colorful illustration of a busy, surreal scene with various figures and objects. To the right of the main illustration, there are three smaller, square images stacked vertically, each showing a different abstract or surreal scene.

At the bottom left, there is a section titled "recent active users" with a list of usernames and their respective user counts: "zichy (97)", "nikolay (12029)", "blacknapkin (1320)", "thijustin (1593)", "molesteez (635)", "chamosan (1763)", "aulku (709)", and "shominavel (1212)".

At the bottom center, there is a blue link that says "FLAG THIS IMAGE".

Fig. 16: *FFFFFOUND!*

3.7.13 *Stamped*

An iOS application, *Stamped* is a global-recommendation system where users can “stamp” their approval on anything they choose, and doing so they recommend it to whom is following them. The system gives each user a limited number of ‘stamps’ to use for recommendations, at a particular time. This limitation, and the need to actively choose to follow a specific user, makes for a very targeted, curated method of recommendations, where you value the individual making each recommendation rather than the aggregated number of reviewers on similar system.

3.7.14 *Vimeo*

A video sharing website with similar characteristics to *YouTube* although with less focus on recommendations based on watched videos but on what is referred to “staff picks”: videos that are individually chosen for promotion on the web site, focusing on curation rather than algorithmic recommendation.

3.7.15 *Yelp*

Yelp, a local-search, social networking and user review website. This service provides online local search for businesses listings, that are accompanied by a 5-star rating, reviews from users and detailed information regarding the location.

Yelp, as well as similar products like *Urbanspoon*²⁸ (which focuses on restaurants) and *Localscope*,²⁹ offers opportunities for serendipitous discoveries of real-life places and venues, and the capacity for new discoveries is one of its main attractions. While this does not immediately relate to discovery of new, digital content, it is a curious method of use of serendipity as a tool for discovery.

28 www.urbanspoon.com

29 www.cynapse.com/localscope

3.8 Search

I-Serendipity:

Max — Searching the Unsearchable: Inducing Serendipitous Insights

P-Serendipity:

DEVONAgent Pro <devontechnologies.com/products/devonagent>;

Google Search <www.google.com>; also *Bing*; *DuckDuckGo* and *Yahoo! Search*.

3.8.1 *Max — Searching the Unsearchable: Inducing Serendipitous Insights*

Max, a software engine developed by José Campos and António Dias de Figueiredo (2001) is an explicit attempt at “inducing serendipitous insights”. The system uses information retrieval techniques and heuristic search in order to discover “useful, and not sought for,” information in an attempt to stimulate serendipitous insights.

Quoting lateral thinking (De Bono 1990) and the possibilities of cross-domain connections, the system seeks to provoke insight. To do this, *Max* is informed of websites that are of interest to the user and then submits queries to a search engine, with randomly chosen words, and the results are e-mailed to the user. In a two-month evaluation, 100 messages were sent, of which 7 were considered of interest.

Max combines recommendations with randomness for an intriguing result. Although *Max* is “invisible” in its interactions with the user, it does successfully help in finding new and unknown information and while its 7% success rate may seem low, it actually is an encouraging number, when considering the fleeting nature of serendipitous experiences.

3.8.2 *DEVONagent Pro*

A Mac OS X application from the same creators of DEVONthink, DEVONagent Pro is a search application that connects with a series of online systems and search engines in order to discover relevant results to users’ queries. The application features an artificial intelligence system that strongly filters all returned results in an effort to provide the most accurate results, as well as a unique ‘See Also’ system that contains related pages to those presented in the search results.

3.8.3 *Google (also Bing³⁰; DuckDuckGo³¹; Yahoo! Search³²)*

An unexpected search result can lead to serendipity, however, as we go deeper into the personalized Web, the likelihood of this happening is less and less. Notable exception: *DuckDuckGo* was designed to not personalize search results or to characterize its users according to their search history or click patterns.³³

30 www.bing.com

31 duckduckgo.com

32 search.yahoo.com

33 Read more about *DuckDuckGo*'s attempts to break the "filter bubble" at <dontbubble.us>



4 EVALUATION AND HYPOTHESIS

4.1 Traits for Serendipity

During the analysis of the available literature as well as of the collected systems, and in an attempt to discover patterns that may contribute to serendipitous discoveries, we gathered a series of common traits that recurrently appear in the various studies of the matter, as well as complementary research in other areas of interest.

These traits, while generalist in nature, will serve as a qualitative metric of analysis to the selected State of the Art. Due to restraints of time and available research of the topic in study, as of the date of this study we are unable to perform a rigorous quantitative evaluation of the potential for serendipity in these tools and platforms and will only be able to do in future work. However, by applying these criteria we can begin to understand the potential in each of these processes for serendipitous discoveries.

4.1.1 Purposelessness

We can also describe this trait as a non-goal driven interaction. As we have explored in “Browsing and Free Association towards Creativity”, this argues that we are more receptive to new ideas and to create unexpected relationships between data when our usage of a system has no specific goal in mind, and we enter into a ‘wander’ state of browsing, disengaging from active thought, an experience akin to going for a walk in a well

know path, or driving home after work. This routine behavior encourages the mind to drift which in turn may lead to insightful discoveries.

We are able to observe this same state of aimless direction being applied within social networks such as Twitter and Facebook, when a user visits these websites without a particular intention or objective but rather to be entertained or, in many cases, as a reflex due to repeated usage.

These purposeless actions allows the user to disengage from active thought and enter a period of incubation of ideas. A system that is propitious for this state while presenting the user with new information, can uncover insightful connections by the formation of patterns between the sub-conscious process of thought and the visualization of new content.

4.1.2 **Immediateness**

Information should be readily accessible, requiring minimum interaction by part of the user.

The intention is to allow the user, in combination with a purposelessness browsing state, to enter the serendipitous browsing referenced in chapter 2.6, where one wanders through information. If the user is required to be active in order to access content, it engages the mind in a way that is counter-productive to serendipitous discoveries.

As such, content should be visible immediately or nearly so. This could be observed on Facebook, where videos, images and text are all visible with minimum interaction. Twitter, due to the majority of the information being text also allows for this immediate access, however, the usage of links within an individual ‘tweet’ can break minimal interaction.³⁴

4.1.3 **Diversity**

In order to increase the exponential probability of a connection or discovery between objects being made, the information that we have access to should be abundant and diverse. It is through the contact with new, unexpected and unknown information that we are able to break free of the “filter bubble” (Periser 2011) and create new relationships between juxtaposed content. This is part of the reason for the popularity of such websites as *Facebook*, *Pinterest* and *Twitter*, that continuously offer new content during the day.

³⁴ Some *Twitter* third party clients, as well as *Twitter*’s own web interface are starting to implement previews of some contents in an attempt to increase immediateness.

4.1.4 Curiosity and Playfulness

In order to be able to achieve a state of engagement with a system, to the point of entering the aforementioned state of purposeless browsing, the user needs to be enticed to use it. Interactions that favor a playful attitude and entice curiosity on the part of the user, have a better chance to grab the users' attention for a longer period of time, which in turn enhances the probability of a serendipitous experience.

As serendipity is recurrently associated with curiosity, creativity and ideation, by creating a playful experience, we encourage a state of mind that is permissive for discovery.

Jonathan Harris's previously mentioned projects *Universe* and *We Feel Fine* are good examples of how a system can use playfulness in order to engage its users, as is the *Bohemian Bookshelf*, that was specifically designed so it offers a diverse and engaging method of interaction with its contents.

4.1.5 Randomness

This corresponds to the ability of the system to provide access to truly unexpected information in order to surprise the user.

As previously established, chance is paramount to the serendipitous mechanism, as such, the capacity of a system for randomness and chance encounters is key to induce serendipity. Here we define randomness as the capacity of a system to be able to surprise its users with content that is unrelated with what the user is currently observing or expecting. An interesting example of this is the use of the "retweet" functionality, which introduces a degree of different information into an users' defined network. The shuffle functionality of various music players is also a particular example of this effect, as it often offers a more relaxed experience of music, by freeing the user from the "burden" of choice (Leong, Vetere & Howard 2008).

4.2 Hypothesis

During the whole process of investigation—from the development of a notion of serendipity as it relates to the digital context, to the review of the literature, of the state-of-the-art and the defining of the five traits for designing towards serendipity—came the necessity to experiment these discoveries, of how a serendipitous system could look like and how the traits hypothesised could be implemented.

As such, we began to develop a working hypothesis of a serendipitous system (named *Horacle*), that would try and give response to each of the five traits, and have as a main goal the discovery of information.

Being developed in tangent with the research, this prototype reflected our own insights of the matter, as they happened, and its evolution is also a representation of the unfolding of this same research. An evolution that will continue as will our understudying of phenomenon of serendipity.

4.2.1 Linear or Aggregated browsing

After the analysis of the selected systems that, in some fashion, help the serendipity problem, we started to observe a pattern of choices: all of these systems, besides the methods used for discovery of information or to induce serendipity, could as well be grouped in two different approaches, that, for lack of better descriptions, we can call *Linear* and *Aggregated* browsing.

Linear browsing is when a user is prompted to travel from one object to the next in a linear fashion. This is the case with *StumbleUpon*, *Max* and the *Accidental News Explorer*.

Aggregated browsing is when the user is confronted with a series of objects aggregated in one main area, as can be observed on *Pinterest*, *Facebook* and several other examples.

While both have advantages of their own, when developing our working hypothesis, we constructed it with the concept of “idle time” (Csikszentmihályi 1996) in mind: we wanted to digitally recreate the notion of wandering around, without a goal or even much attention, in an attempt to let the user enter a state of relaxation and playful interaction, as described in the chapter 2.6. As such, we adopted an initial *Aggregated* approach, since it allows for less focus on the task than the *Linear* one.

These two methods do not, however, need to be mutually exclusive and during the development of the prototype hypothesis, we have experimented with methods to introduce a *Linear* browsing without compromising the *Aggregated* approach.

4.2.2 Intentions of the Serendipitous System

Our goal for this prototype hypothesis for the serendipity system is to provide the user with access to relevant information that they can access when in need for an *overview* state, that they can browse without a specific goal, in the non-purposive, wandering state described in Chapter 2.6 and as a trait for serendipitous discoveries.

The system should enable access to various degrees of information and content. When considering the various systems analyzed, we observed three types of content that relates to the user: (1) Content that the user has marked as being as relevant (*Pinboard*, *Pinterest*, *Delicious*); (2) Content that is recommended to the user based on their demonstrated interests (*Amazon*, *iTunes Genius*, *Last.fm*), and (3) Random information (*Stumbleupon*, *iTunes shuffle*)³⁵.

We believe that these three approaches don't need to be mutually exclusive and can work well together, as well as provide interesting connections between different kinds of content: that which is familiar to the user, juxtaposed with completely unexpected information.

As such, we start with a blank canvas. This will aggregate content that the user has herself collected from various sources on the Web, in similar fashion to social bookmarking services. From this content, the system will recommend other content that is similar in nature. These two categories will represent the users' tastes and interests. To these the system will provide, pulled randomly from what is recorded onto it, assorted bits of information that do not relate directly to the users' interests or to saved content, but is in true sense *random*.

It is the intent of the system to provide a playful platform where the user can freely interact with the content. To do this, it should implement a method of free, endless browsing, as to engage the user in an unperturbed manner.

The system should, as well, allow the user to have direct access to the content with minimum interaction, as when introducing interaction, we break the state of free browsing. As such, the content should be able to visually and fully represent the content itself when possible, without the need for an action by part of the user. If a specific content is of interest to the user, and possibly to induce a surprising discovery, it should be possible for a focus on the particular content that allowed for this insight to happen, as well as discover new information related to it.

³⁵ The shuffle functionality of *iTunes* and most media players, however, differs from complete randomness since it is developed in a space of possibilities controlled through the user in *iTunes* library. A shuffle in a foreign library, or one provided from other users would be a very different experience

4.3 Prototyping a Serendipity System

“Even the most lunatic experiments can produce strange side effects” (Eco, 2000).

The system gathers information from the Web in two distinct ways: by the user herself directly saving content that she’s interested in (in a similar fashion to online bookmarking services), and randomly saved content that the system gathers through a series of different providers of content.

The content then is presented to the user with the same distinctions, as well as a third one: a recommended category pulled from the larger database of content and that relates to the content that the user has defined relevant.

Horacle defaults at presenting an aggregation of equal amount of saved, recommended and random objects. This value can be modified by the user through a controller.

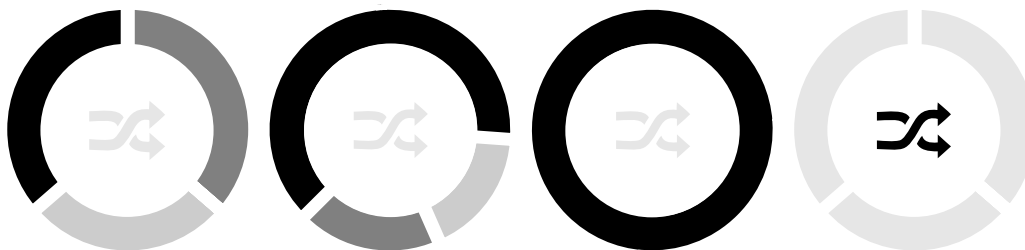


Fig. 17: *Horacle* controller: 1/3, 2/3 and 3/3s, as well as the unstructured mode.

Individual categories can increase or decrease by thirds and by changing a value the other two would change as well. The system could be configured so it would present from equal variation, to more saved and less recommended and random; more recommended and less saved and random; more random and less recommended and saved, as well as being totally dedicated to one of the three variables, excluding the other two.

The controller also incorporates a ‘shuffle’ mode that removes the visually indicators of to what category each object belongs to and randomizes the amount of content displayed regarding each specific category.

HORACLE

saved
recommended
random

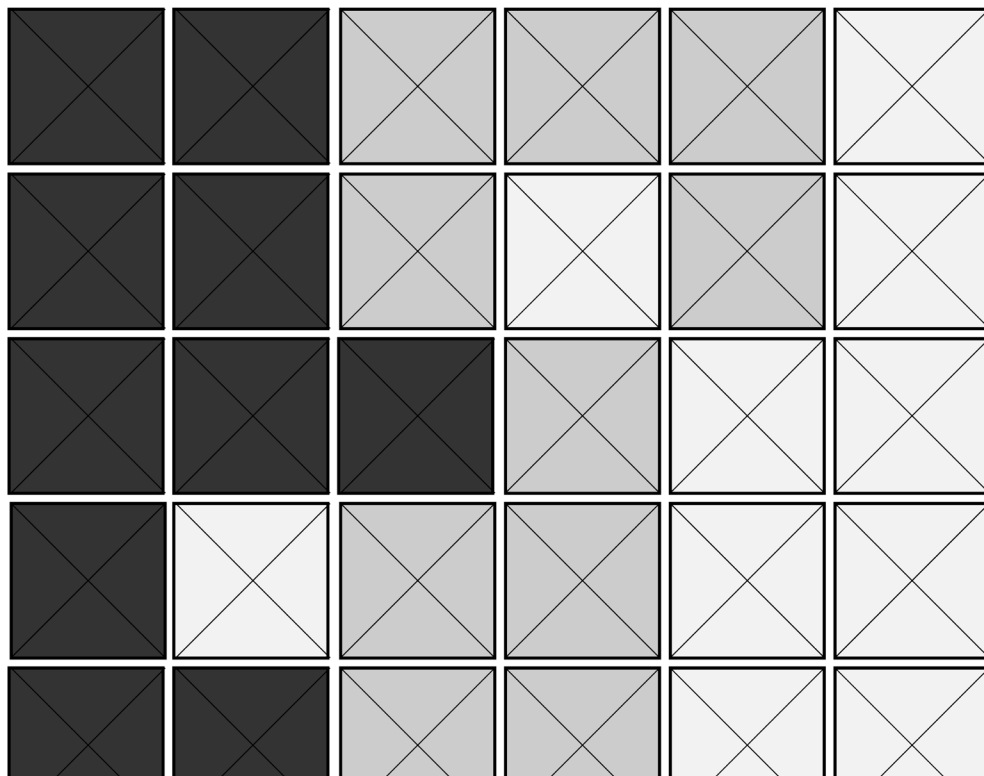


Fig. 18: *Horacle wireframe with equal distribution of content*

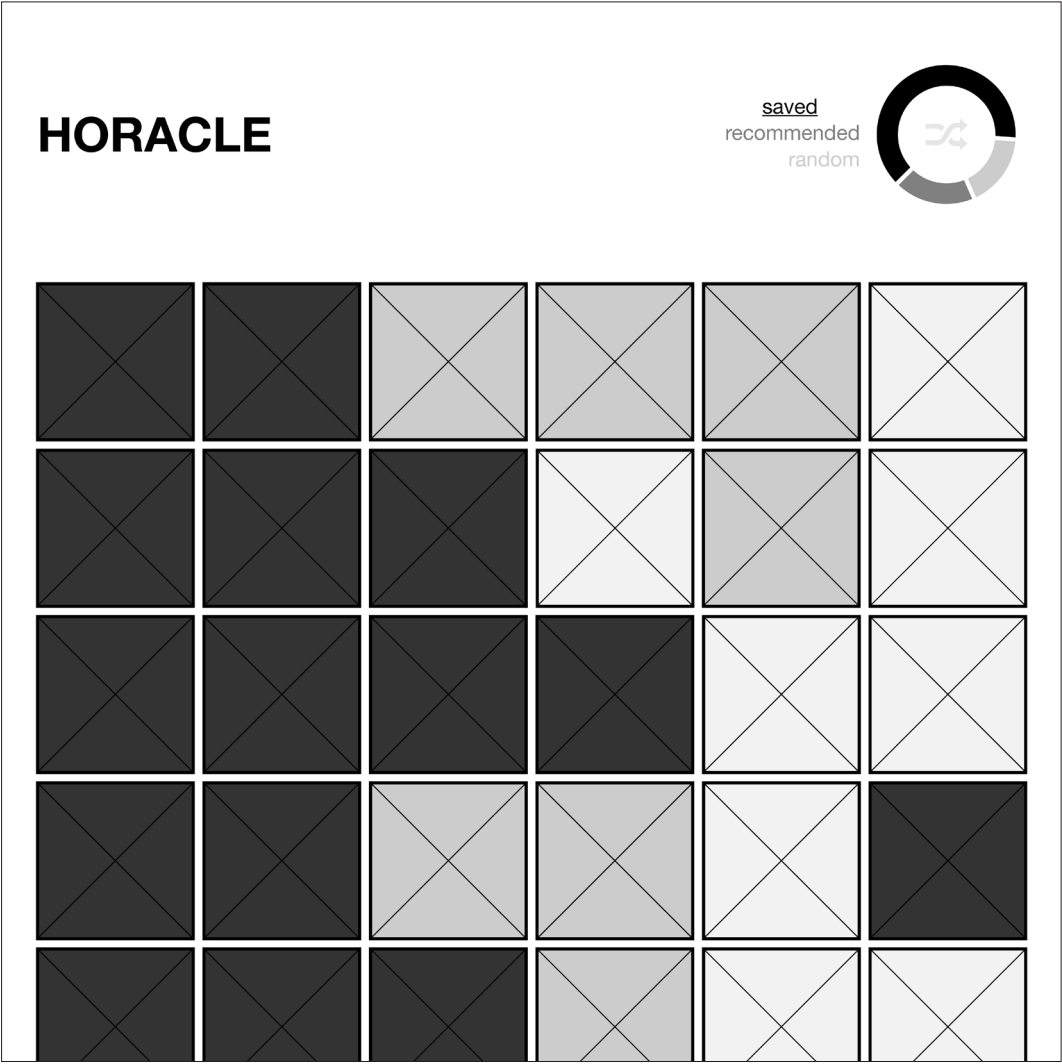


Fig. 19: Horacle wireframe with more saved content

HORACLE

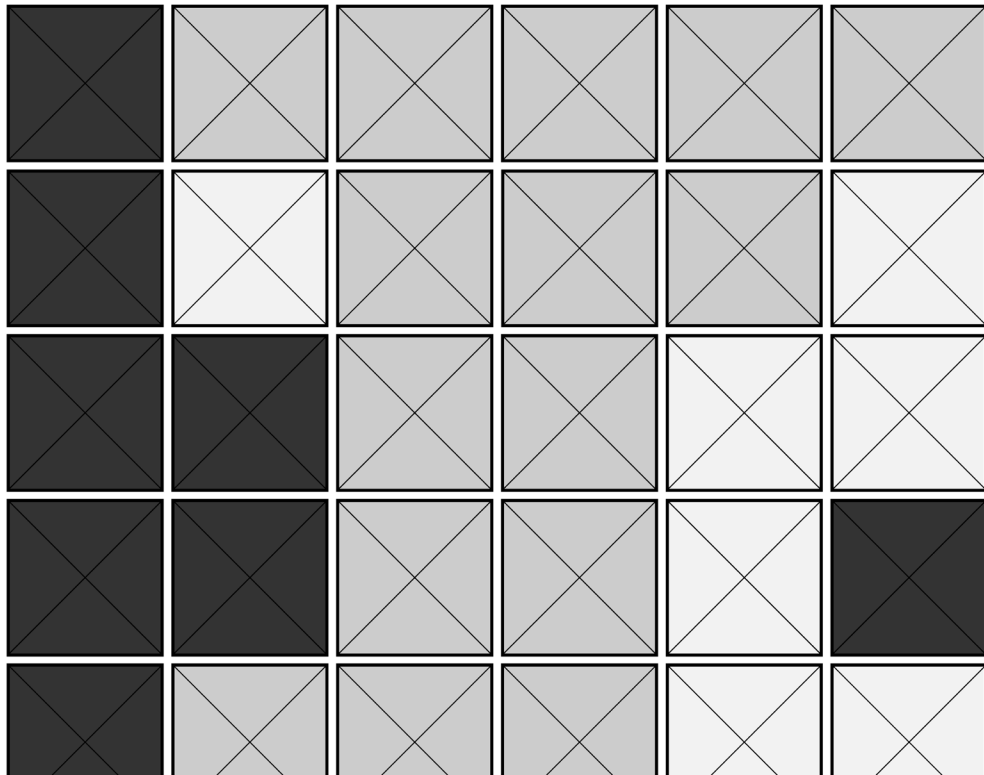


Fig. 20: *Horacle wireframe with more recommended*

HORACLE

saved
recommended
random

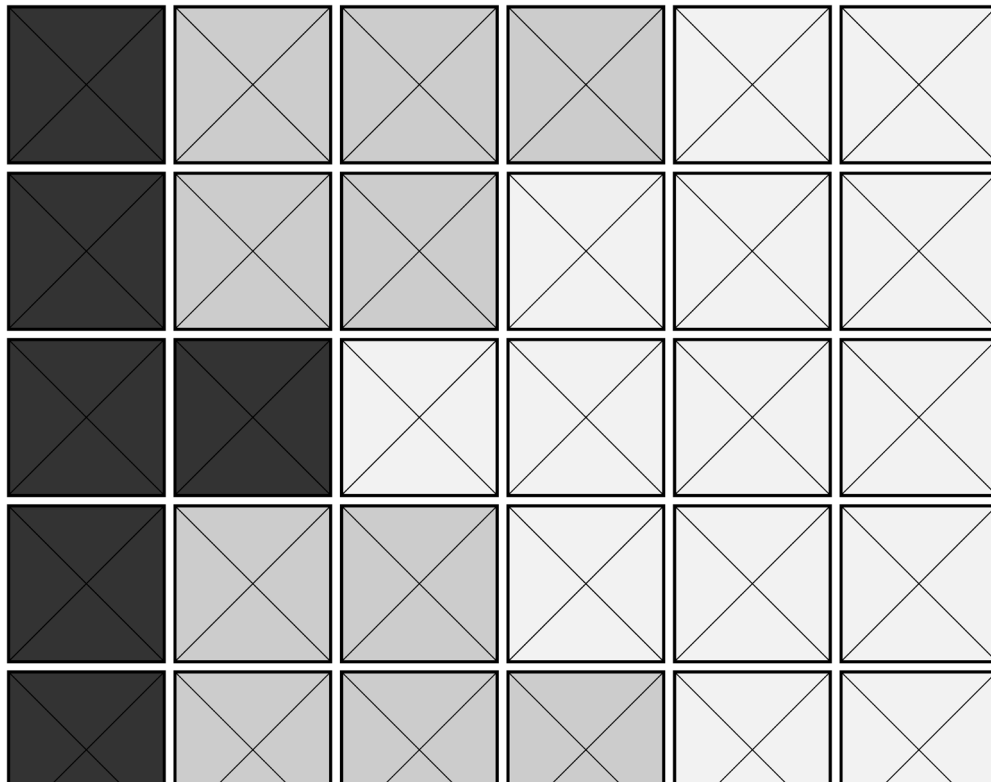


Fig. 21: *Horacle wireframe with more random content*

HORACLE

saved
recommended
random

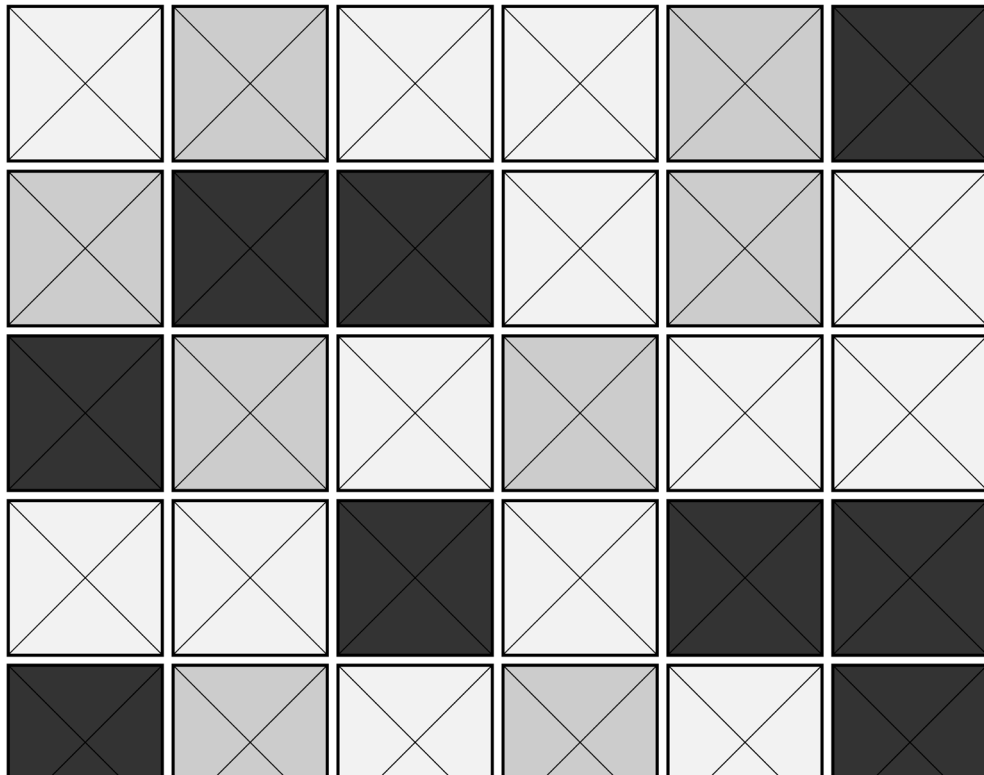


Fig. 22: *Horacle wireframe, unstructured mode.*

When selecting a specific object, this would grow to almost the full size of the window, presenting more information and hiding the rest, leaving the *aggregation* mode and *entering* a linear one, as described in 4.2.1. This would allow for an increase of information displayed, or to show the full amount when it is cropped in the aggregated mode, as well as provide a link to the origin of the content. While in this linear mode, the user can, through the use of on-screen directional arrows, or through the keyboard, browse the content present in *Horacle*.



Fig. 23: *Horacle* wireframe , *linear* mode.

Horacle is a work-in-progress in continuing development and with regular chances that encompass new insights regarding designing for serendipity. Within this hypothesis we attempted to accommodate our five traits of serendipity, allowing for constraints of implementation and time available, and while the construction of the system might change due to future development, the goals that it responds to are clear: to provide access to new information in a playful manner and that does not require a specific goal for usage.



Fig. 24: *Horacle* high-fidelity layout, aggregation mode.

Euismod Risus Nullam



<http://www.pellentesque.com>

Morbi leo risus, porta ac consectetur ac, vestibulum at eros. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Sed posuere consectetur est at lobortis. Nullam quis risus eget urna mollis ornare vel eu leo. Etiam porta sem malesuada magna mollis euismod. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.



Fig. 26: Horacle high-fidelity layout, linear mode.



5 CONCLUSION

5.1 Summary

We discussed the possible definitions of the concept of serendipity and what its inherent characteristics are. This led us to a consensual, working definition of serendipitous experience, as (1) the accidental discovery of meaningful information, and (2) the creative capacity of making insightful connections with the discovered information.

We have examined how serendipity can be applied in digital interactions, how (or if) we are able to observe or induce it, and observed that some attempts have been made to both fronts, but with disparate results: while there were instances of observed records of serendipity being acknowledged by participants (Foster and Ford 2003), attempts to reproduce it in a controlled environment did not yield conclusive results (Erdelez 2004) or resulted in rare instances of it occurring, which is concurrent due to the very nature of the subject.

We have also explored how serendipity and its inherent mechanisms, such as chance and idle exploration, could influence discovery and creativity, as well as break through the balkanization and personalization effect of Web, through the usage of chance and randomness.

We then analyzed popular online systems for content discovery for their serendipitous potential, as well as projects that were designed with serendipity as an explicitly intention, and through what methods these possible serendipitous experiences could occur.

From what was observed we could create an introductory set of traits (Purposeless; Immediateness; Diverseness; Curiosity and Playfulness; Randomness) that could be applied when developing a system that has serendipity as an aim or intention.

With these traits in mind, we proceeded to create a prototype hypothesis of a system dedicated to serendipity and content discovery. One that would apply the principles proposed and the best-practices observed on the previously observed systems.

5.2 Results

With our research we hope to have been able to alert for the question of serendipity on the Web, as well and observe the different opinions on the subject of inducing serendipity and in what cases we are now able to observe good practices of designing towards it.

It has also become apparent the uncertainty regarding the whole concept of serendipity as a mechanism and tool for discoverability and insight. As a phenomenon, it touches on a series of different topics, such as information discovery, perception, cognitive processes, problem solving and creativity. Interdisciplinary subjects that raise important questions when we speak of *design* with serendipity in mind. This investigation focused on the comprehension of what it means to speak of serendipity in the digital context and how it can enable one to discover new and useful information, regardless of content filters, and gather creative insight from it. Yet, we recognize that a different approach could (and can) also be made: a detailed analysis of the inherent phenomena of discovery and the whole serendipitous experience, of creativity, of insight and the process that lead to it: incubation, chance, randomness and pattern recognition. It was through the process of this investigation that it became apparent that these questions have yet to be resolved in a cross-disciplinary manner, and it is through it that this deeper understating of what it means when we talk about *serendipity*, that we are able to work towards it.

We believe, however, that this research was an important first step into what will be a continuous effort of understanding serendipity.

5.3 Limitations

We were unable to fully develop the working hypothesis of the serendipitous system, as well as to realize some early user-testing. However, this attempt illustrates an example of the direction towards designing with a serendipity mindset, through an user-interface perspective and is an observable example of an application of the various traits that characterize a system that privileges the discovery of new information, be it related to what are the users' interests of completely random.

We were as well unable to user-test the analyzed systems in regards to their serendipitous potential, due to time restraints and to a decision to concentrate our efforts in the comprehension of serendipity as a useful mechanism.

5.3.1 Future Work

Our analysis was focused on the serendipitous potentials of the existing systems and what can be inferred in regards to the possible creation of a model for designing towards serendipity, although, as we have acknowledged, for a better understanding of the phenomenon of serendipity it is desirable to develop a deeper understanding of the process of insight, creative thinking and problem solving in regard to digital systems for information search and discovery. This is our intention going forward.

To that end, we have created the website *www.designingforserendipity.net* which gathers information regarding new discoveries and developments about the themes discussed in this investigation, and is a project that will harbour future research.

To fully understand how content discovery is made on the Web, we will also need to user-test the analyzed systems in order to understand exactly how users gather new information through them, particularly uncommon information, as well as cross-confront these systems with our serendipity traits, to how and if, they are implemented and what can be observed by their usage.

And finally, we will continue the work on the "Horacle" prototype, in order to make it fully functional and eventually to be able to user test it in regards to its serendipitous potential.

5.4 Return

We began this investigation with the intention to introduce serendipitous discoveries into our daily online interactions. Motivated by an increasing feeling of limitation on what was available on the internet, due to an increase personalization of the Web, we proposed that through the exploration of the concept of serendipity, and the mechanics inherited to it, we could discover how to overcome these constraints and, possibly, help to induce not only the uncovering of new and uncommon information, but also to promote the generation of insight and creative ideas.

The subject of digital serendipity is gradually becoming a concern on the internet, as the creators of online distribution platforms realize that the next step of providing content to their users is through surprise, showing them what they not yet knew they were searching for. Google's executive chairman Eric Schmidt, at the 2010 TechCrunch Disrupt conference, said that their company hopes to "one day tell people things they may want to know as they are walking down the street, without having to type in any search queries" (Krotoski 2011). Schmidt called this a "Serendipity Engine".

A less positive view of the capacities of the internet for serendipitous discoveries is Damon Darlin's, that can be found on the NYTimes.com article entitled "Serendipity, Lost in the Digital Deluge" (Darlin 2009). In this article, Darlin alerts to the possible loss of serendipity on the Web, even though we are being constantly recommended new content by our online social networks. In Darlin's words, these recommendations are not serendipity: "It's really group-think. Everything we need to know comes filtered and vetted. We are discovering what everyone else is learning, and usually from people we have selected because they share our tastes" (Darlin 2009). The article also refers the overwhelming quantity of information we encounter online everyday, making it extremely difficult to wave through it all in the hopes of a fruitful discovery.

Steven Johnson, author of the book "Where Good Ideas Come From", dedicated a chapter to the subject of serendipity and its influence on creativity, is of a different opinion regarding the value of the internet for serendipitous discoveries. In an article published on his website, Johnson shares an example of a series of coincidences and discoveries that were made possible by the internet (and particularly Twitter) that led into new insight and ideas for Johnson. This was for the author a good example of the power of internet tools and platforms for serendipity, making him proclaim that "people who think the Web is killing off serendipity are not using it correctly" (Johnson 2011).

Regardless of the proper usages of the internet, and while it is debatable if what Johnson experienced is indeed serendipity or rather the natural evolution of an idea or underlined thought combined with a cognitive bias, it was not the intention of this research to point out the limitations of the Web for serendipity but rather to focus on how we can better design online systems with serendipity in mind, complementing existing online tools.

Search and recommendation engines, despite their possible shortcomings, do make our (digital) lives easier and allow us to learn new things or be entertained by new experiences. But we shouldn't be satisfied with what is possible at the moment, rather strive for better and deeper tools, that do not limit our growth into predictable patterns of interests and choices, that do not cater to what are our perceived intentions, but rather help us to grow as human beings, to increase the scope of our attention and be closer to what World Wide Web's inventor Tim Berners-Lee envisioned: "to support and improve our weblike existence in the world" (Berners-Lee 2000). Designing Web services with serendipity in mind might be a step towards that.

6 BIBLIOGRAPHY

- Alstyne, Marshall.V. and Brynjolfsson, Erik.** *Electronic Communities: Global Village or Cyberbalkans?* MIT Sloan School, Cambridge, MA, 1997
- André, Paul and Schrafel, M.C.** *Computing and chance: designing for (un)serendipity.* The Biochemist E-Volution, 2009.
- Barabási, Albert-László. Linked.** *How Everything Is Connected to Everything Else and What It Means.* Plume Books, Cambridge, MA, 2003. Kindle Edition.
- Bawden, David.** *Information systems and the stimulation of creativity.* Journal of Information Science, 1986.
- Beale, Russell.** *Supporting serendipity: Using ambient intelligence to augment user exploration for data mining and web browsing.* Int. J. Human-Computer Studies 65, Birmingham, 2007.
- Berners-Lee, Tim.** *Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web.* HarperBusiness, New York, 2000.
- Benkler, Yochai.** *The Wealth of Networks: How Social Production Transforms Markets and Freedom.* Yale University Press, New Haven and London, 2007.
- Boden, Margaret A.** *The Creative Mind: Myths and Mechanisms.* 1990. Second Ed. London: Routledge, 2004.
- De Bono, Edward.** *Lateral Thinking: Creativity Step by Step.* Harper Colophon, New York, 1973.
— — —. *Lateral Thinking for Management: A Handbook.* Penguin Books, London, 1990
- Britzman, Deborah.** *Five Excursions into Free Association, or Just Take the A Train.* Journal of the Canadian Association for Curriculum Studies 1(1), 25-37, 2003.
- Bruijn, Oscar De. & Spence, Robert.** *A new framework for theory-based interaction design applied to serendipitous information retrieval.* 2008.

- Campos, José. & Figueiredo, A. Dias.** *Searching the unsearchable: Inducing serendipitous insights.* In R. Weber, & C. G. von Wangenheim (Eds.), *Case-based reasoning: Workshop program at ICCBR-2001.*
- Cooksey, Elizabeth B.** *Too important to be left to chance – serendipity and the digital library.* Science and Technology Libraries, 2004.
- Csikszentmihályi, Mihály.** *Creativity: Flow and the Psychology of Discovery and Invention.* Harper, Perennial, New York, 1996
- Csikszentmihalyi, Mihály. & Sawyer, K.** *Creative insight: The social dimension of a solitary moment.* In R. J. Sternberg & J. E. Davidson (Eds.), *The nature of insight* 329363. Cambridge, MA: MIT Press. 1995.
- Danzico, Liz.** *The design of serendipity is not by chance.* Interactions 17(5), 16-18, 2010.
- Darlin, Damon.** *Serendipity, Ping - The Digital Age Is Stamping Out Serendipity, Lost in the Digital Deluge,* NYTimes.com, 2009. <<http://www.nytimes.com/2009/08/02/business/02ping.html>>
- Eco, Umberto.** *Serendipities. Language and Lunacy.* New York: Phoenix, 1999.
- Erdelez, Sanda.** *Information encountering: A conceptual framework for accidental information discovery.* 1997
 ———. *Information encountering: It's more than just bumping into information.* Bulletin of the American Society for Information Science, 25(3), 25–29, 1999.
 ———. *Investigation of Information encountering in the controlled research environment.* Information Processing and Management, 40, 1013-1024. 2004
- Fifield, William.** *In Search of Genius,* Morrow, New York, 1982.
- Fine, Gary A. and Deegan, James G.** *Three principles of serendipity: insight, chance, and discovery in qualitative research.* Qualitative Studies in Education 9(4): 434-447, 1996.
- Foster, Allen and Ford, Nigel.** *Serendipity and information seeking: an empirical study.* Journal of Documentation, 2003.
- Johnson, Steven.** *Anatomy of an Idea,* 2011. <stevenberlinjohnson.com/2011/12/anatomy-of-an-idea.html>
 ———. *Where Good Ideas Come From: The Natural History of Innovation,* Riverhead, New York. 2010
- Harris, Jonathan.** *Universe,* 2010. <www.number27.org/universe.html>
- Krotoski, Aleks.** *The web is broken: supercharge with serendipity.* IAB Engage 2010. <<http://youtu.be/EPnTihFluKU>>
 ———. *Digital serendipity: be careful what you don't wish for.* The Observer, The Guardian 2011. <www.guardian.co.uk/technology/2011/aug/21/google-serendipity-profiling-aleks-krotoski#_jmp0_>
- Leong, Tuck, Vetere, Frank, & Howard, Steve.** *Abdicating choice: the rewards of letting go.* Journal of Digital Creativity, 19(4), 233-243, 2008.
- Leong, Tuck.** *Understanding Serendipitous Experiences when Interacting with Personal Digital Content,* 2009.
- Liestman, Daniel.** *Chance in the midst of design: Approaches to library research serendipity.* RQ, 31(4), 524–532. 1992.
- McBirnie, Abigail.** *Seeking serendipity: the paradox of control.* Aslib Proceedings, 60(6), 600–618. 2008
- Merton, Robert K. and Barber, Elinor.** *The Travels and Adventures of Serendipity: A Study in Sociological Semantics and the Sociology of Science.* Princeton University Press. 2006.
- Meyers, Morton A.** *Happy Accidents: Serendipity in Modern Medical Breakthroughs* Arcade Publishing, New York 2007
- Nothhaft, Henry Jr.** *The Myth Of Serendipity.* 2010. <<http://techcrunch.com/2010/11/27/myth-serendipity/>>

- Official Google Blog.** *Personalized Search for everyone*, 2009. <<http://googleblog.blogspot.pt/2009/12/personalized-search-for-everyone.html>>
- O'Brien, Chris.** *How I Find Serendipity In The Digital Age*, 2009. <<http://www.siliconbeat.com/2009/08/03/how-i-find-serendipity-in-the-digital-age/>>
- Pariser, Eli.** *The Filter Bubble: How the New Personalized Web Is Changing What We Read and How We Think*. Penguin Books, New York 2011. Kindle Edition
- Pinha e Cunha, Miguel.** *Serendipity: Why Some Organizations Are Luckier Than Others*, Lisbon: Universidade Nova de Lisboa. 2005.
- Popova, Maria.** *Explore*, 2012. <<http://exp.lore.com>>
- Roberts, Royston M.** *Serendipity: Accidental Discoveries in Science*. New York: John Wiley and sons, 1989.
- Russell, Beale.** *Supporting serendipity: using ambient intelligence to augment user exploration for data mining and web browsing*. 2007.
- Rhodes, B.** *Opportunity. E-knowledge*, 2003. <<http://www.e-knowledge.ca/wisdom/opportunity.html>>
- Quan-Haase, Anabel and Martin Kim.** *Rethinking Tradition: The loss of serendipity and the impact of technology on the historical research process*. 2011.
- Siegler, M.G.** *Eric Schmidt On The Future Of Search — A Move Towards A “Serendipity Engine”*, 2010. <techcrunch.com/2010/09/28/eric-schmidt-future-of-search/>
- Sun, Xu., Sharples, Sarah. and Makri, Stephann.** *A user-centred mobile diary study approach to understanding serendipity in information research*, 2011
- Thudt, Alice, Hinrichs Uta and Carpendale Sheelagh.** *The Bohemian Bookshelf Supporting Serendipitous Discoveries through Visualization*. 2011.
- Toms, Elaine G.** *Serendipitous Information Retrieval*. DELOS Workshop: Information Seeking, Searching and Querying in Digital Libraries, 2000.
- Toms, Elaine G. and McCay-Peet, Lori.** *Chance encounters in the digital library*. 192-202, 2009.
- Toms, Elaine G.** *Serendipitous Information Retrieval*. In Proceedings of the First DELOS Network of Excellence Workshop on Information Seeking, Searching and Querying in Digital Libraries, Zurich, Switzerland: European Research Consortium for Informatics and Mathematics. 2000.
- Van Andel, Pek.** *Anatomy of the Unsought Finding. Serendipity: Origin, history, domains, traditions, appearances, patterns and programmability*, The British Journal for the Philosophy of Science. 1994.
- Wallas, Graham.** *The Art of Thought*, New York: Harcourt, Brace, and World, 1926.
- YouTube** *Web 2.0 Expo NY 09: Chris Brogan, “The Serendipity Engine”*, 2009 <<http://www.youtube.com/watch?v=XIRD5oosqIU>>

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