Search Engines:
Past, Present, and Future

Patrick Reid
University of Warwick, UK

Des Laffey
University of Kent, UK

INTRODUCTION

Search engines are fundamental to modern life, with Google stating that it dealt with 1.2 trillion searches in 146 languages in 2012 (Google, 2012). Google has not updated this figure since 2012 only stating that it is higher (Sullivan, 2015).

The use of the term Google as a verb is perhaps the strongest evidence of the impact of search and of Google's status as the dominant provider. Search has a key role in modern society and as Rangaswamy et al. (2009, p49) write "search results can influence important decisions about someone's life, health, or a major purchase, or an entrepreneur's quest for an acquisition target". The innovation of search enabled Google to offer advertising connected to search results and achieve a market capitalisation of $392 Billion in 2015.

This article makes a contribution to the Encyclopaedia by outlining the key issues regarding search. It does this by integrating ideas from academic and practitioner audiences to offer an integrated perspective on this important topic. The article firstly covers the key definitions, explains how search engines work and discusses the challenges of Web search. The competitive environment of search is then outlined which stresses Google's dominance but notes markets where it is not the market leader. The essential topic of search engine optimization (SEO) is then analysed. The article then covers the evolution of paid search, the use of text based advertisements which are triggered by the terms in a search. The dramatic growth of mobile search in the last few years is then covered. Finally, before it concludes emerging issues in the search engine field are considered in the areas of the Semantic Web, rich media, and the challenges of privacy.

BACKGROUND

What is Search?

Search capabilities are required for any information system, and the need grows in importance as the volume of data grows (Frana, 2004). There are key differences in the methods of how the search challenge is addressed:

- A directory is a human generated index (database) of websites, with the most well known examples being Yahoo and the Open Directory.

- Organic search refers to computer generated search results which appear based on how relevant the pages are to the user's search, an early example being Excite with Google the obvious current example.
- Meta-search in turn describes search engines which present aggregated results they have taken from other search engines.
- Paid search, also known as sponsored search, refers to payment on a per click basis for text advertisements which are triggered by a search term (Laffey, 2007). Paid search provides the revenue model for organic search and in the United States in 2013 was a market worth over $18 billion (IAB, 2014).

The Mechanics of Organic Search

The key reference for how search engines work is the seminal paper by Brin and Page (1998). Other authors such as Tassabehji (2003) or Schneider (2007) also cover the mechanics of organic search. A search engine has three essential aspects: the *crawler or spider*, which retrieves information from webpages, and other documents, it finds as it follows the link structure of the Web; the *index*, which stores relevant information about the document; and finally, the *search engine software* which contains algorithms, or rules, which decide how relevant a document is to a user search.

The Surface Web and the Deep Web

The Surface Web refers to pages that can be indexed by search engines. Google stated in 2008 that their systems were aware of 1 trillion unique pages (Google 2008). To place this in context when Google's prototype search engine was available in 1998, it indexed 24 million pages (Brin and Page, 1998). Estimating the size of the Web is very difficult as crawlers only become aware of new URLs either when they are informed by a webmaster or when they come across a link.

The Deep Web describes pages that cannot be accessed by crawlers, for example, pages which require password access or have been made inaccessible to crawlers. The Deep Web is believed to be many times greater than the surface Web (He et al, 2007).

Challenges of Search

Being able to present relevant results to users from a vast pool of possible results on the basis of unstructured queries presents a major challenge. Google's key software innovation was seen as its PageRank™ system which ranked pages on the basis of the volume and nature of websites which linked to them, with higher quality websites being seen as of greater importance (Rangaswamy et al., 2009). The size of the Web and the volume of searches present further challenges, with Google using over 1 million customised computers to deliver results in fractions of a second.

The Search Market

In most markets organic search is dominated by Google. In the United States in November 2014 Google had 67% of desktop searches with Microsoft sites (powered by Bing) having 19.6% and Yahoo third with 10.2% (comScore, 2014). Interestingly since November 2008 Google's share has marginally risen,

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