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Searching the Enterprise

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Abstract

Search has become ubiquitous but that does not mean that search has been solved. Enterprise search, which is broadly speaking the use of information retrieval technology to find information within organisations, is a good example to illustrate this. It is an area that is of huge importance for businesses, yet has attracted relatively little academic interest. This monograph will explore the main issues involved in enterprise search both from a research as well as a practical point of view. We will first plot the landscape of enterprise search and its links to related areas. This will allow us to identify key features before we survey the field in more detail. Throughout the monograph we will discuss the topic as part of the wider information retrieval research field, and we use Web search as a common reference point as this is likely the search application area that the average reader is most familiar with.

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1

Introduction

"Enterprise Search doesn't work". Does that sound familiar? Well, it is a view commonly held by employees trying to find information within their organisation. On the other hand, an information retrieval (IR) researcher or student might never have heard this or even thought about it.

Given the wide-spread sentiment among users and search practitioners that enterprise search does not deliver on its promises, the question arises as to what is it that causes these perceptions and do they properly reflect the reality? One of the fundamental issues underlying the overall discussion is the question of how does enterprise search relate to search in general and Web search in particular. This monograph will provide a thorough discussion of the topic and outline implications and guidance resulting from this. We will focus on both theoretical and practical issues as well as their interplay.

We expect our main audience to be researchers and PhD students with some background in information retrieval who want to learn something about enterprise search. Apart from that, we do hope that practitioners facing the challenge of having to implement an enterprise search system and those that need to understand the technical and user in-

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terface problems associated with enterprise search will also find the monograph valuable.

There are at least two ways of approaching this topic academically. One approach might be to review the refereed literature and provide a contextualisation of enterprise search by comparing and contrasting it with related work. A second approach could do this by highlighting research gaps in enterprise search and providing a research agenda in the spirit of the *Strategic Workshops on Information Retrieval (SWIRL)* in Lorne.[1] Given the relatively limited academic interest that enterprise search has attracted, in particular a lack of detailed comparison with other search areas, we opted for the first approach as the first step. We do however need to note that due to the applied nature of the field the refereed literature will only be able to paint a partial picture and not necessarily represent where the technology is at the present time. We therefore complement the analysis with appropriate references to studies and surveys from the practitioners' community. In concluding the review we will also provide a number of interesting future research directions.

1.1 Overview

Web search is a relatively recent development that has attracted much attention and for many it has become a synonym for 'search' in general. But Web search is just one – perhaps the most prominent – search context. There are many other application areas, enterprise search being one of them, which require fundamentally different solutions. Note that we do not simply want to reduce our discussion to a comparison of searching the Web with searching within an organisation – other types of search include Web site search, database search, and desktop search among others. Identifying the key features of each search type allows a systematic comparison and these features can be characterised by investigating a number of dimensions that reflect, for example:

- Generic properties characterising the document collection (e.g., scale of the collection, document formats)

[1] `http://www.cs.rmit.edu.au/swirl12/`

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- Specific structural and organisational differences (e.g., link structure, internal document structure, distribution of documents across data silos)
- Individual document properties (e.g., time stamp, version number, metadata)
- Different types of information needs (e.g., navigational search *versus* attempting to find an expert in a particular subject)
- Differences between the target users (e.g., a heterogeneous set of Web searchers on the one hand and on the other a clearly defined user population whose members have different information needs, interests and access rights according to their role within the enterprise)
- The level of support needed (e.g., working out of the box *versus* requiring continuous support).

Unpacking these differences results in a fairly complex picture with equally complex implications. To choose just one way of contrasting enterprise search with related areas, we will see that while Web search is aimed at high *precision*, in enterprise search *recall* is often at least as important as precision.

Comparing and contrasting enterprise search with other search applications allows us to work out exactly what the fundamental features of enterprise search are and, following from that, what needs to be done in order to make enterprise search work. In short, we will identify the importance of 'putting the user in control', and present customisation and continous tuning as *essential* requirements for those wishing to maximise the value of their investment in a practical search solution – in other words to avoid failure.

The survey aims to be a thoroughly compiled resource and a primer for a range of interested readers as outlined earlier. References that offer a more general entry point into enterprise search include [Mukherjee and Mao, 2004] and [Hawking, 2010]. White approaches the problem from the perspective of a manager who has been put in charge of enterprise search [White, 2007, 2015b]. Any publication on enterprise search

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exemplifies a particular characteristic of the area, the fact that it is difficult to separate the fundamental technical challenges from organisational and pragmatic considerations.

1.2 Examples

Enterprise search tools must provide support for many more functions than simply indexing and query processing so that a basic search tool will not be enough [Hawking, 2010]. To illustrate this we present some introductory examples, all drawn from real applications in industry and academia. Each of these highlights a number of core issues that enterprise search has to deal with, including different types of data structures, access to data silos, the need for manual customisation, the application of domain-specific taxonomies, the varying user needs that need to be catered for etc. One could also argue that none of the examples might be seen as *traditional* enterprise search implementations which just shows what variety of problems need to be considered in any specific use case.

Some of the key concepts that we will encounter again are *emphasized*.

1.2.1 Reed

Reed Specialist Recruitment is part of Reed Global, which also includes Europe's biggest jobs Web site[2] receiving more than 1.5 million job applications per month.[3] Founded in 1960, Reed is a specialist provider of permanent, contract, temporary and outsourced recruitment solutions, and IT and HR consulting, with more than 3,000 permanent employees working out of 350 offices worldwide. As part of a major IT development programme the company moved to a new search framework, accessible to staff in local offices and centrally, that had to deal with a mix of document *repositories* of varying structure including a complex database consisting of millions of records (i.e. *structured* data)

[2] `http://www.reed.co.uk`

[3] `http://www.flax.co.uk/wp-content/uploads/2015/07/reed_case_study_oct2011.pdf`

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as well as a database of CVs represented as flat files in a multiplicity of different formats such as Microsoft Word and PDF (i.e. *unstructured / semi-structured* content). Most of the files are in English, but other languages include Polish, Arabic and Chinese. The *open-source* Apache Lucene/Solr platform was chosen as the new search framework which provides *faceted search* and geospatial filtering and ranking based on complex business rules as well as custom *boost* options. A custom-built performance tester was built for *continuous monitoring* of the system's performance.

1.2.2 Australian National University

An example from academia is reported by Li et al. [2013] who investigate methods for *federated search* at the Australian National University. Information at this university is available in a variety of formats including *structured* databases such as a telephone directory, a course catalogue, and a library catalogue. Furthermore, *semi-structured* documents are sourced from more than 500 different Web servers. *Email lists*, *file shares*, local Web servers and other resources add further internal repositories. The university also makes use of external services such as Twitter, Facebook and YouTube. The individual sources *vary in size* ranging 'from quite small to more than a million documents', in subject matter, and in language among other characteristics. In this setting the creation of a central index is impossible due to the range of sources and *restrictions on access*. Instead, different repositories need to be accessed individually and then results *aggregated*. The authors conclude that this setting is not just realistic for the chosen institution but also for many others.

1.2.3 IBM

A number of studies looking at different aspects of search within IBM[4] have been published illustrating yet again the specific problems aris-

[4]Obviously, it needs to be appreciated that many of the studies being published by the research teams of large companies such as Microsoft and IBM might represent experimental applications and might never be the core engines underlying the organisation's enterprise search application.

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ing in enterprise search. We will look into a number of these studies throughout the survey but here we only focus on one aspect which is people-focussed searches.[5]

Guy and colleagues investigate *expertise finding* as a central information need within an enterprise, i.e. finding people knowledgeable in a given topic [Guy et al., 2013]. They explore enterprise social media applications and what makes this another typical enterprise setting is the multitude of sources including blogs, wikis, forums, bookmarks, microblogs, communities, shared files, and people tags. Each of the different data sources turns out to cover a different fraction of the 400,000 employees within the organisation, ranging from around 20,000 to about 290,000 with the overlap among the individuals retrieved based on each application being very low so that each social media application tends to identify different people.

Another *people-searching* study using the internal tool 'Faces' demonstrates that enterprise people search should be considered a very important tool for the workforce in a large enterprise [Guy et al., 2012]. Faces goes beyond expertise search and offers searching the name, organisation unit, management chain, phone number, email, office location etc. A rapid adoption was reported within the organisation gaining tens of thousands of users per month.

1.2.4 GOV.UK

As a last example, we would like to introduce GOV.UK[6], the Web site of the UK government which offers a single access point to information and services for citizens and businesses, guidance for professionals as well as information on government and policy. This is an example of *site search* rather than *enterprise search* and it illustrates the point that

[5] We would like to refer to a concern raised by Treem and Leonardi who review the use of social media in organisations and who observed that a disproportionate number of studies referenced in their review are the result of research conducted at IBM and involving that organisation's employees simply because they are among the most active in publishing work on social media use in organisations [Treem and Leonardi, 2012]. We note the same is true for research published on enterprise search developments.

[6] `http://www.gov.uk`

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different search areas, such as site search, Web search and enterprise search, share some properties but differ in others. GOV.UK indexes about 300,000 items of content and about 250,000 downloadable files[7] all driven by Elasticsearch[8]. These documents are reported to originate from 870 different organisations[9] covering 140 different *formats*[10]. Issues to be tackled include *duplicated* pages which might be identical or older *versions*[11]. The difficulty in finding the right information has led to the conclusion that a *taxonomy* covering the entire content of GOV.UK needs to be developed[12] and that *tagging*[13] content needs to be an integral part of the publishing process. The use of *'best bets'* makes sure that some fixed results will always be at the top of the result list for certain queries.[14]

This example demonstrates clear differences to Web search (e.g., the size of the collection, the use of hard-coded matching, control over the publishing process), and close similarity with many of the features observed in the three enterprise search examples. Nevertheless, in contrast to enterprise search, it is also worth pointing out that there was no mention of *email* search, or of *access control* issues. In addition to that, all the content on GOV.UK is actually intended for publishing rather than just being *deposited*.

[7] https://insidegovuk.blog.gov.uk/2016/12/05/gov-uks-content-operating-model-whats-next-after-discovery/

[8] https://insidegovuk.blog.gov.uk/2014/06/13/how-gov-uk-site-search-works/

[9] https://insidegovuk.blog.gov.uk/2014/05/12/new-search-results-page-design-unified-search/

[10] https://insidegovuk.blog.gov.uk/2017/01/09/formats-and-templates-whats-the-difference/

[11] https://insidegovuk.blog.gov.uk/2013/06/12/duplicate-titles-in-site-search/

[12] https://insidegovuk.blog.gov.uk/2017/03/21/presenting-our-new-taxonomy-beta/

[13] https://insidegovuk.blog.gov.uk/2017/04/18/making-tagging-part-of-publishing/

[14] https://insidegovuk.blog.gov.uk/2014/06/13/how-gov-uk-site-search-works/

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1.3 Perception and Reality

The heterogeneous structure and variety of formats of underlying data sources turns out to be a particularly prominent feature of enterprise search but there are other such features that make searching in an enterprise stand out. For example, a 'typical' non-enterprise search scenario might be characterised by a user trying to find a document that contains some relevant information, but a more common use case in an enterprise is the search for people who have the right expertise and a simple reason for that might be to avoid spending time and resources on work that has already been conducted within the organisation [Hertzum and Pejtersen, 2000].

With these motivating examples in mind let us step back a bit and look at the extent to which search and findability actually affect an everyday worker within an organisation. According to the most recent 'Enterprise Search and Findability Survey'[15], two thirds of responding organisations state that more than half of their employees depend upon good findability of information in their *daily work* [Findwise, 2016]. We conclude that enterprise search is not a *nice-to-have* but an essential requirement to work effectively within an enterprise context. Note that this need is in contrast to the perception of actual enterprise search users, as in the same survey almost half of the respondents expressed they are *dissatisfied* or *very dissatisfied* with existing search applications within their organisation. This discrepancy is also highlighted by another major enterprise search survey conducted by the Association for Information and Image Management (AIIM)[16] which found that while almost three quarters of organisations polled expressed that search is vital or essential, hardly more than ten percent actually have an enterprise search capability in place that allows search across the organisation, a number that is consistent across different sizes of organ-

[15]The *Enterprise Search and Findability Survey* is an annual survey of enterprises conducted by Findwise focussing on the state of play of search and findability within enterprises. While the overall objective is to observe trends across years the questions asked are not identical every year. This is also the reason why we reference three different surveys as they each provide insight into different aspects in addition to the overall picture.

[16]`http://www.aiim.org/`

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isations [Miles, 2014]. Obviously, not much has changed then in more than 15 years [Feldman and Sherman, 2001].

1.4 Recent Developments

Despite this monograph approaching the topic from an academic perspective, we do want to offer a glimpse into the enterprise search market. What is remarkable is the rapid change in the enterprise search landscape in recent years. To illustrate the point, David Hawking's milestone publication [Hawking, 2010] lists a broad range of enterprise search software systems but hardly any of them are still available, most prominently Google's Search Appliance (GSA) is now being retired[17], FAST Search & Transfer has disappeared once acquired by Microsoft, Autonomy was taken over by HP, Vivisimo was acquired by IBM and so on. Companies like Funnelback[18] on the other hand have become more prominent providers of enterprise search solutions, and a number of new vendors such as Sinequa[19], Coveo[20] and Mindbreeze[21] have appeared. The biggest shift has however been the rise in open source solutions. Elasticsearch[22] and Apache Lucene/Solr[23], both based on the Apache Lucene[24] library, have developed into powerful tools that are widely applied. Bloomberg, for example, does not just deploy Apache Lucene/Solr in over 100 of its applications but the company also actively engages in the community by committing code.[25] Enterprise search is a core part of these applications.[26] More broadly speaking, the deployment of open source code has become mainstream. For example, in an attempt to create a level playing field between pro-

[17] http://fortune.com/2016/02/04/google-ends-search-appliance/
[18] https://www.funnelback.com
[19] https://www.sinequa.com
[20] http://www.coveo.com
[21] https://www.mindbreeze.com
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[25] http://www.bloomberg.com/company/announcements/open-source-at-bloomberg-expanding-our-engagement-with-solr/
[26] http://www.bloomberg.com/company/announcements/open-source-bloomberg-solr-work-enhance-enterprise-search/

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prietary and open source software, the UK Government IT strategy[27] explicitly states that government will procure open source solutions where appropriate given that "open source presents significant opportunities for the design and delivery of interoperable solutions" [Cabinet Office, 2011].

1.5 Outline

As part of plotting the landscape we will first look at the changing face of search in Chapter 2 before defining enterprise search and then contextualising it with many other common search applications, such as general Web search and more specialised applications like patent search. This analysis should offer useful insights into the different types of search areas and goes beyond enterprise search. As such the mapping of the search landscape into some form of 'feature vector of search applications' should be a self-contained chapter which can be used as an easy reference and overview of where enterprise search fits within the bigger picture.

The second part will be dedicated entirely to enterprise search. We decided to split the discussion into four main chapters.

Chapter 3 starts by providing a systematic overview of what defines enterprise search. We drill down into the actual characteristics by adopting a topical structure that should allow the reader to easily refer back to the discussion that contextualises enterprise search within the broader world of other search applications in Chapter 2. This chapter is meant to be a survey of the academic literature providing a solid account of the state of the art in the field while also highlighting issues around enterprise search that need to be addressed properly in order to make it work successfully.

Chapter 4 is devoted to the discussion of how to evaluate enterprise search. We present commonly applied metrics and evaluation approaches and contrast them with other areas of search. In line with the previous chapter, we will again highlight the fundamental difficulties emerging from evaluating enterprise search applications.

[27] `https://www.gov.uk/service-manual/making-software/open-source.html`

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Chapter 5 then picks up the issues and difficulties identified in Chapters 3 and 4 in a less theoretical and more practical discussion of what can and needs to be done to fully exploit the potential of enterprise search. This is the chapter that we expect to be of most interest to the practitioners among our readers while at the same time offering our academic readership an understanding of why enterprise search so often fails to perform.

Chapter 6 will look at current and future developments in this exciting application area and also identify a number of research directions that are emerging from the survey. We conclude in Chapter 7.

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