Generating research websites using summarisation techniques

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Abstract

We describe an application that generates web pages for research institutions by summarising terms extracted from individual researchers' publication titles. Our online demo covers all researchers and research groups in the Computer Laboratory, University of Cambridge. We also present a novel visualisation interface for browsing collaborations.

1 Introduction

Many research organisations organise their websites as a tree (e.g., department pages → research group pages → researcher pages). Individual researchers take responsibility for maintaining their own web pages and, in addition, researchers are organised into research groups that also maintain a web page. In this framework, information easily gets outdated, and publications lists generally stay more up-to-date than research summaries. Also, as individuals maintain their own web pages, connections between researchers in the organisation are often hard to find; a surfer then needs to move up and down the tree hierarchy to browse the profiles of different people. Browsing is also diffcult because individual web pages are organised differently, since standardised stylesheets are often considered inappropriate for diverse organisations.

Research summary pages using stylesheets can offer alternative methods of information access and browsing, aiding navigation and providing different views for different user needs, but these are time-consuming to create and maintain by hand. We are exploring the idea of automatically generated and updated web pages that accurately reflect the research interests being pursued within a research institution. We take as input existing personal pages from the Computer Laboratory, University of Cambridge, that contain publication lists in html. In our automatically generated pages, content (a research summary) is extracted from publication titles, and hence stays up-to-date provided individual researchers maintain their publication lists. Note that publication information is increasingly available through other sources, such as Google Scholar.

We aim to format information in a way that facilitates browsing; a screen shot is shown in Figure 1 for the researcher *Frank Stajano*, who is a member of the *Security* and *DTG* research groups. The left of the page contains links to researchers of the same research groups and the middle contains a research profile in the form of lists of key phrases presented in five year intervals (by publication date). In addition, the right of the page contains a list of recommendations: other researchers with similar research interests. Web pages for research groups are created by summarising the research profiles of individual members. In addition, we present a novel interactive visualisation that we have developed for displaying collaborations with the rest of the world.

In this paper we describe our methodology for identifying terms, clustering them and then creating research summaries (§2) and a generative summariser of collaborations (§4) that plugs into a novel visualisation (§3). An online demo is available at:
http://www.cl.cam.ac.uk/research/nl/webpage-demo/NLIP.html

2 Summarising research output

Our program starts with a list of publications extracted from researcher web pages; for example:

- S. Teufel. 2007. *An Overview of evaluation methods in TREC Ad-hoc Information Retrieval and TREC Question Answering.* In Evaluation of Text and Speech Systems. L. Dybkjaer, H. Hemsen, W. Minker (Eds.) Springer, Dordrecht (The Netherlands).

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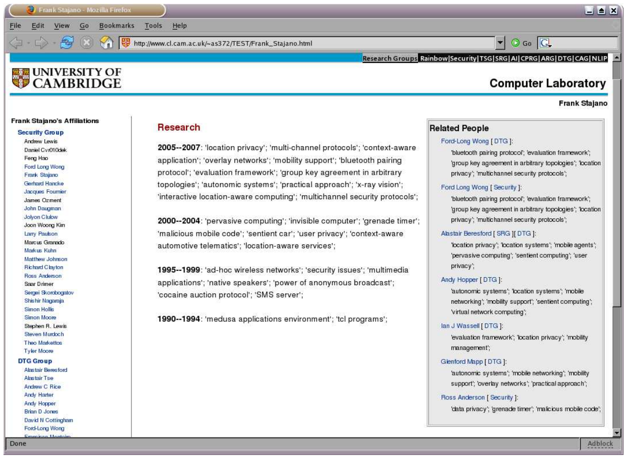
Columbus, June 2008. ©2008 Association for Computational Linguistics

From each publication entry such as that above, the program extracts *author names*, *title* and *year of publication*. This is the only information used. We do not use the full paper, as pdfs are not available for all papers in publication pages (due to copyright and other issues). The titles are then parsed using the RASP parser (Briscoe and Carroll, 2002) and key-phrases are extracted by pattern matching. From the publication entry above, the extracted title:

> "An overview of evaluation methods in TREC ad-hoc information retrieval and TREC question answering"

produces five key-phrases:

> 'evaluation methods', 'evaluation methods in TREC ad-hoc information retrieval', 'TREC ad-hoc information retrieval', 'TREC question answering', 'information retrieval'


Frank Stajano - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://www.cl.cam.ac.uk/~as372/TEST/Frank_Stajano.html
Go
Research Groups Rainbow|Security|TSG|SRG|AI|CPRG|ARG|DTG|CAG|NLIP
UNIVERSITY OF CAMBRIDGE
Computer Laboratory
Done
Adblock

Frank Stajano

Frank Stajano's Affiliations

Security Group
Andrew Lewis
Daniel Cvr010dek
Feng Hao
Ford Long Wong
Frank Stajano
Gerhard Hancke
Jacques Fournier
James Ozment
John Daugman
Jolyon Clulow
Joon Woong Kim
Larry Paulson
Marcus Granado
Markus Kuhn
Matthew Johnson
Richard Clayton
Ross Anderson
Saar Drimer
Sergei Skorobogatov
Shishir Nagaraja
Simon Hollis
Simon Moore
Stephen R. Lewis
Steven Murdoch
Theo Markettos
Tyler Moore

DTG Group
Alastair Beresford
Alastair Tse
Andrew C Rice
Andy Harter
Andy Hopper
Brian D Jones
David N Cottingham
Ford-Long Wong

Research

2005--2007: 'location privacy'; 'multi-channel protocols'; 'context-aware application'; 'overlay networks'; 'mobility support'; 'bluetooth pairing protocol'; 'evaluation framework'; 'group key agreement in arbitrary topologies'; 'autonomic systems'; 'practical approach'; 'x-ray vision'; 'interactive location-aware computing'; 'multichannel security protocols';

2000--2004: 'pervasive computing'; 'invisible computer'; 'grenade timer'; 'malicious mobile code'; 'sentient car'; 'user privacy'; 'context-aware automotive telematics'; 'location-aware services';

1995--1999: 'ad-hoc wireless networks'; 'security issues'; 'multimedia applications'; 'native speakers'; 'power of anonymous broadcast'; 'cocaine auction protocol'; 'SMS server';

1990--1994: 'medusa applications environment'; 'tcl programs';

Related People

Ford-Long Wong [DTG]:
'bluetooth pairing protocol'; 'evaluation framework'; 'group key agreement in arbitrary topologies'; 'location privacy'; 'multichannel security protocols';

Ford Long Wong [Security]:
'bluetooth pairing protocol'; 'evaluation framework'; 'group key agreement in arbitrary topologies'; 'location privacy'; 'multichannel security protocols';

Alastair Beresford [SRG][DTG]:
'location privacy'; 'location systems'; 'mobile agents'; 'pervasive computing'; 'sentient computing'; 'user privacy';

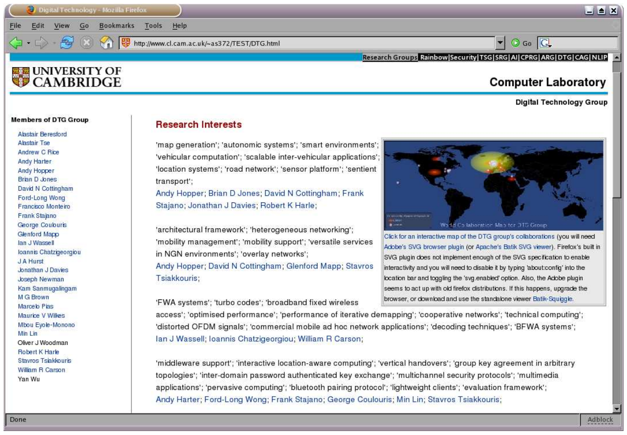
Andy Hopper [DTG]:
'autonomic systems'; 'location systems'; 'mobile networking'; 'mobility support'; 'sentient computing'; 'virtual network computing';

Ian J Wassell [DTG]:
'evaluation framework'; 'location privacy'; 'mobility management';

Glenford Mapp [DTG]:
'autonomic systems'; 'mobile networking'; 'mobility support'; 'overlay networks'; 'practical approach';

Ross Anderson [Security]:
'data privacy'; 'grenade timer'; 'malicious mobile code';

Figure 1: Screenshot: researcher web page.
http://www.cl.cam.ac.uk/research/nl/webpage-demo/Frank_Stajano.html


Digital Technology - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://www.cl.cam.ac.uk/~as372/TEST/DTG.html
Go
Research Groups Rainbow|Security|TSG|SRG|AI|CPRG|ARG|DTG|CAG|NLIP
UNIVERSITY OF CAMBRIDGE
Computer Laboratory
World Collaboration Map for DTG Group
Done
Adblock

Digital Technology Group

Members of DTG Group
Alastair Beresford
Alastair Tse
Andrew C Rice
Andy Harter
Andy Hopper
Brian D Jones
David N Cottingham
Ford-Long Wong
Francisco Monteiro
Frank Stajano
George Coulouris
Glenford Mapp
Ian J Wassell
Ioannis Chatzigeorgiou
J A Hurst
Jonathan J Davies
Joseph Newman
Kam Sanmugalingam
M G Brown
Marcelo Pias
Maurice V Wilkes
Mbou Eyole-Monono
Min Lin
Oliver J Woodman
Robert K Harle
Stavros Tsiakkouris
William R Carson
Yan Wu

Research Interests

'map generation'; 'autonomic systems'; 'smart environments'; 'vehicular computation'; 'scalable inter-vehicular applications'; 'location systems'; 'road network'; 'sensor platform'; 'sentient transport';
Andy Hopper; Brian D Jones; David N Cottingham; Frank Stajano; Jonathan J Davies; Robert K Harle;

'architectural framework'; 'heterogeneous networking'; 'mobility management'; 'mobility support'; 'versatile services in NGN environments'; 'overlay networks';
Andy Hopper; David N Cottingham; Glenford Mapp; Stavros Tsiakkouris;

'FWA systems'; 'turbo codes'; 'broadband fixed wireless access'; 'optimised performance'; 'performance of iterative demapping'; 'cooperative networks'; 'technical computing'; 'distorted OFDM signals'; 'commercial mobile ad hoc network applications'; 'decoding techniques'; 'BFWA systems';
Ian J Wassell; Ioannis Chatzigeorgiou; William R Carson;

'middleware support'; 'interactive location-aware computing'; 'vertical handovers'; 'group key agreement in arbitrary topologies'; 'inter-domain password authenticated key exchange'; 'multichannel security protocols'; 'multimedia applications'; 'pervasive computing'; 'bluetooth pairing protocol'; 'lightweight clients'; 'evaluation framework';
Andy Harter; Ford-Long Wong; Frank Stajano; George Coulouris; Min Lin; Stavros Tsiakkouris;

Click for an interactive map of the DTG group's collaborations (you will need Adobe's SVG browser plugin (or Apache's Batik SVG viewer). Firefox's built in SVG plugin does not implement enough of the SVG specification to enable interactivity and you will need to disable it by typing 'about:config' into the location bar and toggling the 'svg.enabled' option. Also, the Adobe plugin seems to act up with old firefox distributions. If this happens, upgrade the browser, or download and use the standalone viewer Batik-Squiggle.

Figure 2: Screenshot: research group web page.
http://www.cl.cam.ac.uk/research/nl/webpage-demo/DTG.html

2.1 Individual researcher summaries

To create a web page for an individual researcher, the key-phrases extracted from all the paper titles authored by that researcher are clustered together based on similarity - an example cluster is shown below (from Karen Sparck Jones' profile):

> 'automatic classification for information retrieval', 'intelligent automatic information retrieval', 'information retrieval test collections', 'information retrieval system', 'automatic classification', 'intelligent retrieval', 'information retrieval', 'information science', 'test collections', 'mail retrieval', 'trec ad-hoc information retrieval'

A representative phrase (most similar to others in the cluster) is selected from each cluster (*'information retrieval'* from the above) and this phrase is linked with all the publication dates for papers the terms in the cluster come from. These extracted key-phrases are enumerated as lists in five year intervals; for example (from Karen Sparck Jones' profile):

> **1990–1994:** 'information retrieval'; 'document retrieval'; 'video mail retrieval'; 'automatic summarisation'; 'belief revision'; 'discourse structure'; 'cambridge/olivetti retrieval system'; 'system architecture'; 'agent interaction'; 'better NLP system evaluation'; 'early classification work'; 'text retrieval'; 'discourse modelling'...;

2.2 Recommendations (related people)

Recommendations for related people are generated by comparing the terms extracted between 2000 and 2008 for each researcher in the Computer Laboratory. The (at most) seven most similar researchers are shown in tabular form along with a list of terms from their profiles that are relevant to the researcher being viewed. These term lists inform the user as to why they might find the related people relevant.

2.3 Research Group Pages

Group pages are produced by summarising the pages of members of the group. Terms from individual research profiles are clustered according to who is working on them (gleaned from the author lists of the the associated paper title). The group page is presented as a list of clusters. This presentation shows how group members collaborate, and for each term shows the relevant researchers, making navigation easier. Two clusters for the Graphics and Interaction (Rainbow) Group are show below to illustrate:

> ‘histogram warping’; ‘non-uniform b-spline subdivision’; ‘stylised rendering’; ‘multiresolution image representation’; ‘human behaviour’; ‘subdivision schemes’; ‘minimising gaussian curvature variation near extraordinary vertices’; ‘sampled cp surfaces’; ‘bounded curvature variants’: **Neil Dodgson; Thomas Cashman; Ursula Augsdorfer;**
>
> ‘text for multiprojector tiled displays’; ‘tabletop interface’; ‘high-resolution tabletop applications’; ‘distributed tabletops’; ‘remote review meetings’; ‘rapid prototyping’: **Peter Robinson; Philip Tuddenham;**

3 Visualisation

Scalable Vector Graphics (SVG)[1] is a language for describing two-dimensional graphics and graphical applications in XML. Interactive images such as those in Figure 3 are produced by an XSLT script that transforms an input XML data file containing information about collaborations and latitudes and longitudes of cities and countries into an SVG representation[2]. This can be viewed through an Adobe Browser Plugin[3]. In the map, circles indicate the locations of co-authors of members of the NLIP research group, their size being proportional to the number of co-authors at that location. The map can be zoomed into, and at sufficient zoom, place names are made visible. Clicking on a location (circle) provides a summary of the collaboration (the summarisation is described in §4), while clicking on a country (oval) provides a contrywise overview such as:

> In the Netherlands, the NLIP Group has collaborators in Philips Research (Eindhoven), University of Twente (Enschede), Vrije Universiteit (VU) (Amsterdam) and University of Nijmegen.

4 Summarising collaborations

Our summarisation module slots into the visualisation interface; an example is shown in Figure 4. The aim is to summarise the topics that members of the research group collaborate with the researchers in each location on. The space constraints are dictated by the interface. To keep the visualisation clean, we enforce a four sentence limit for the summaries. There are four elements that each sentence contains— names of researchers in research group, names of researchers at location, terms that summarise the collaboration, and years of collaboration.

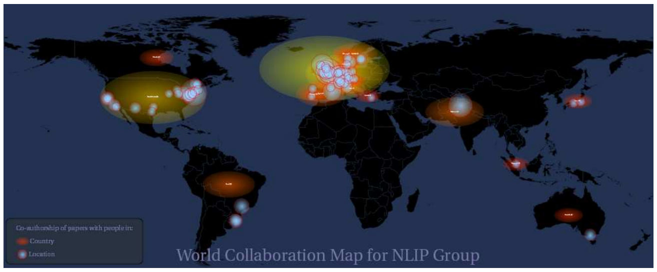
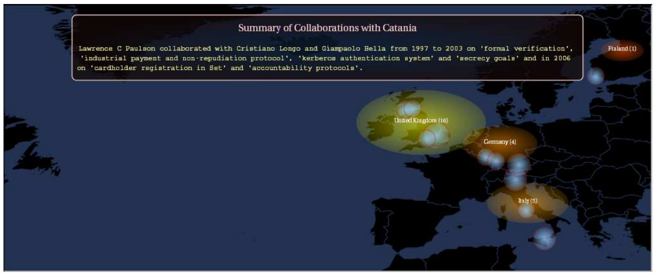

Co-authorship of papers with people in:
Country
Location
World Collaboration Map for NLIP Group

Figure 3: Screenshot: Visualisation of Collaboration between the NLIP Group and the rest of the world



Summary of Collaborations with Catania

Lawrence C Paulson collaborated with Cristiano Longo and Giampaolo Bella from 1997 to 2003 on 'formal verification', 'industrial payment and non-repudiation protocol', 'kerberos authentication system' and 'secrecy goals' and in 2006 on 'cardholder registration in Set' and 'accountability protocols'.

Figure 4: Screenshot: Visualisation of Collaborations of ARG Group; zoomed into Europe and having clicked on Catonia (Italy) for a popup summary

Our summaries are produced by an iterative process of clustering and summarising. In the first step, terms (key phrases) are extracted from all the papers that have co-authors in the location. Each term is tagged with the year(s) of publication and the names of researchers involved. These terms are then clustered based on the similarity of words in the terms and the similarity of their authors. Each such cluster contributes one sentence to the summary. The clustering process is pragmatic; the four sentence per summary limit means that at most four clusters should be formed. This means coarser clustering (fewer and larger clusters) for locations with many collaborations and finer-grained (more and smaller clusters) for locations with fewer collaborations.

The next step is to generate a sentence from each cluster. In this step, the terms in a sentence cluster are reclustered according to their date tag. then each time period is realised separately within the sentence, for example:

[1] http://www.w3.org/Graphics/SVG/

[2] Author Affiliations and Latitudes/Longitudes are semi-automatically extracted from the internet and hand corrected. The visualisation is only available for some research groups.

[3] http://www.adobe.com/svg/viewer/install/main.html

> Lawrence C Paulson collaborated with Cristiano Longo and Giampaolo Bella from 1997 to 2003 on 'formal verification', 'industrial payment and non-repudiation protocol', 'kerberos authentication system' and 'secrecy goals' and in 2006 on 'cardholder registration in Set' and 'accountability protocols'.

To make the summaries more readable, lists of conjunctions are restricted to a maximum length of four. Terms are incorporated into the list in decreasing order of frequency of occurrence. Splitting the sentence above into two time periods allows for the inclusion of more terms, without violating the restriction on list length. This form of sentence splitting is also pragmatic and is performed more aggressively in summaries with fewer sentences, having the effect of making short summaries slightly longer. Another method for increasing the number of terms is by aggregating similar terms. In the example below, three terms (*video mail retrieval*, *information retrieval* and *document retrieval*) are aggregated into one term. Thus six terms have made it to the clause, while keeping to the four terms per list limit.

> In the mid 1990s, K Sparck Jones, S J Young and M G Brown collaborated with J T Foote on 'video mail, information and document retrieval', 'cambridge/olivetti retrieval system', 'multimedia documents' and 'broadcast news'.

The four word limit is also enforced on lists of people. If there are too many people, the program refers to them by affiliation; for example:

> Joe Hurd collaborated with University of Utah on 'theorem proving', 'encryption algorithms', 'functional correctness proofs' and 'Arm verification'.

5 Discussion and Conclusions

Our summarisation strategy mirrors the multi-document summarisation strategy of Barzilay (2003), where sentences in the input documents are clustered according to their similarity. Larger clusters represent information that is repeated more often; hence the size of a cluster is indicative of importance. The novelty of our application is that this strategy has been used at a sub-sentential level, to summarise terms that are then used to generate sentences. While there has been research on generative summarisation, much of this has been focused on sentence extraction followed by some rewrite operation (e.g., sentence shortening (Vanderwende et al., 2007; Zajic et al., 2006; Conroy et al., 2004), aggregation (Barzilay, 2003) or reference regeneration (Siddharthan et al., 2004; Nenkova and McKeown, 2003)). In contrast, our system does not extract sentences at all; rather, it extracts terms from paper titles and our summaries are produced by clustering, summarising, aggregating and generalising over sets of terms and people. Our space constraints are dictated by by our visualisation interface, and our program employs pragmatic clustering and generalisation based on the amount of information it needs to summarise.

Acknowledgements

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