

Point Space and Interface: A Holistic Approach to Search Result Visualisation

by

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October, 2012

A thesis presented to the
Flinders University of South Australia
in fulfilment of the requirements for the degree of
Doctor of Philosophy

CONTENTS

<i>Abstract</i>	ix
<i>Certification</i>	xi
<i>Acknowledgements</i>	xiii
1. <i>Introduction</i>	1
1.1 Statement of Problem	1
1.2 Contributions of Thesis	2
1.3 Outline of Chapters	3
2. <i>Review of Area</i>	5
2.1 Introduction	5
2.1.1 Information Tools	6
2.1.2 Three Problems	14
2.1.3 Three Explanations	16
2.1.4 A Proposed Solution	23
2.2 Document Attribute Visualisation	32
2.3 Static and Non-Static Attribute Visualisation	37
2.3.1 The Perception of Motion	38
2.3.2 The Dimensions of Motion	39
2.3.3 Studies of Motion	42
2.3.4 A Gap in Understanding - Encoding Data with Motion Frequency	44
2.4 Natural Encoding Paradigms	46
2.4.1 The Principle of Best Foot Forward	46
2.4.2 A Gap in Understanding Semantically Motivated Encoding Paradigms	51
2.5 Visualisation of Inter-Document Relationships	51
2.5.1 The Semantic Relationship	52

2.5.2	Spatial Arrangement	53
2.5.3	Alternative Result Presentation Paradigms	54
2.5.4	The Ranked-list Result Presentation Paradigm	63
2.5.5	Perspectives on Alternative Result Presentation Paradigms	68
2.5.6	Meeting the Advantages of the Current Ranked-list Paradigm	73
2.5.7	The Absence of Guidelines for Spatially-Organised Results	77
2.6	Summary	78
3.	<i>On the Role of Motion in Attribute Visualisation</i>	81
3.1	Introduction	81
3.2	Motivation for Research	82
3.3	The Breadth of Reliable Encoding	83
3.3.1	Use of Perception Research for Encoding	85
3.4	Motion in Encoding	88
3.5	Web-Based Experimentation	92
3.5.1	Experimenter Motivations	92
3.5.2	Online Laboratories	94
3.5.3	Apparatus and Delivery Mechanisms	96
3.5.4	Data Integrity	97
3.5.5	Participation Rewards	97
3.5.6	Ethical Considerations	99
3.5.7	Data Security in Storage and Transmission	100
3.5.8	Weighing Up Web-based Experiment Methodologies	101
3.6	A Web-Based Evaluation of Motion Frequency Encoding	101
3.6.1	Graphical Features for Encoding Paradigm	102
3.6.2	Data Features for Encoding Paradigm	110
3.6.3	Method	111
3.6.4	Results	122
3.6.5	Discussion	152
3.7	Summary	161

4. <i>On the Role of Naturalness in Attribute Visualisation</i>	163
4.1 Introduction	163
4.2 Encoding Paradigms in Attribute Visualisation	165
4.2.1 Diagrams and Pictorial Representation	165
4.2.2 Semantics of Charts and Graphics	167
4.2.3 Encoding by Social Norms and Conventions	168
4.2.4 Encoding by Metaphor	169
4.2.5 Encoding by Data Type	170
4.2.6 Encoding by Perceptual-Cognitive Psychology	171
4.2.7 Encoding by Natural Encoding	175
4.3 A Web-Based Evaluation of Natural Encoding Paradigms	181
4.3.1 Method	181
4.3.2 Results	198
4.3.3 Discussion	216
4.4 Summary	224
5. <i>On the Role of Space and Interface</i>	225
5.1 Introduction	225
5.2 The Concept of Information Space	227
5.3 Formalising Information Space	228
5.4 Models of Navigation in Information Space	229
5.5 Spatial Metaphor	230
5.6 Spatial Configuration	232
5.7 Evaluation Results	233
5.8 Open Research Questions	236
5.9 Deciding on a Spatialisation Construction Approach	238
5.9.1 Document Corpus and Topics	239
5.9.2 Pre-Processing	241
5.9.3 Algorithms	242
5.9.4 Evaluation	246
5.9.5 Selected Approach for Information Space Construction	255
5.10 Summary	257

6.	<i>A Laboratory-Based Evaluation of Information Space Usability</i>	259
6.1	Introduction	259
6.2	Apparatus	260
6.2.1	Document Full-text View	260
6.2.2	Ranked-list Interface	270
6.2.3	Theme Map Interface	272
6.2.4	Theme Cloud Layout Control	290
6.2.5	Search Facilities of the Apparatus	295
6.2.6	Summary of Apparatus Design	298
6.3	Exploratory Hypotheses	299
6.3.1	Hypothesis One - Pop-up Transparency	299
6.3.2	Hypothesis Two - Document Full-text Integration	300
6.3.3	Hypothesis Three - Theme Map Layout Control	301
6.3.4	Exploratory Hypotheses - Summary	301
6.4	Method	303
6.4.1	Participants	303
6.4.2	Materials	303
6.4.3	Procedure	312
6.4.4	Design	314
6.5	Results	316
6.5.1	Analysis One: Analysis of Document Full-text View in Ranked-list Interface	316
6.5.2	Analysis Two: Analysis of Document Full-text View, Pop-up Transparency and Projection Dimension Control in Theme Map	322
6.5.3	Subjective Response	331
6.6	Discussion	333
6.6.1	Relevance Assessment Methodology	333
6.6.2	Analysis One	334
6.6.3	Analysis Two	339
6.7	Summary	344

7. <i>Discussion and Conclusions</i>	347
7.1 Introduction	347
7.2 On the Role of Motion and Natural Encoding in Attribute Visualisation	347
7.3 On the Role of Space and Interface	350
7.4 A Holistic Perspective on Search Result Visualisation	356
7.4.1 The Point: Representing an Individual Search Result	356
7.4.2 The Space: Representing Semantic Relationships	358
7.4.3 The Interface: Facilitating Interaction with Information Space .	359
7.4.4 The User	360
7.4.5 The Evaluation	361
7.5 Future Experimental Work	368
7.6 Contribution of Thesis	372
7.7 Conclusion	374
<i>Appendix</i>	375
A. <i>Motion Encoding Experiment: Instructions</i>	377
B. <i>Natural Encoding Experiment: Instructions I</i>	379
C. <i>Natural Encoding Experiment: Instructions II</i>	381
D. <i>Space and Interface Experiment: Training</i>	384
E. <i>Space and Interface Experiment: Handout for Integrated Full-text Interface</i> .	389
F. <i>Space and Interface Experiment: Handout for Modal Full-text Interface</i> . . .	391
G. <i>Space and Interface Experiment: Spatialisation Qualitative Evaluation</i>	393
H. <i>Statistical Methods</i>	406
H.1 Object Measures	406
H.1.1 Time	406
H.1.2 Accuracy	406
H.2 Statistical Techniques	410
H.2.1 Significance Testing	410
H.2.2 Multiple Comparisons	410
H.2.3 Use of Error Bars	411

<i>I. Select Publications</i>	414
<i>Bibliography</i>	416

LIST OF FIGURES

2.1	A search result visualisation taxonomy derived from Bonnel, Cotarmanac’h, and Morin (2005) and Drori (2000)	24
2.2	A survey of search result interfaces incorporating a visualisation-based component	59
3.1	The size palette	106
3.2	The orientation palette	106
3.3	The hue palette	106
3.4	The saturation palette	106
3.5	The grow palette	108
3.6	The pulse palette	108
3.7	The rotate palette	109
3.8	The shuffle palette	109
3.9	A screen shot of the motion experiment	113
3.10	The two stages of the experiment	116
3.11	Personalised performance report	117
3.12	A graph of preparation time for dimensionality	124
3.13	A graph of answer time for dimensionality	124
3.14	A graph of error for dimensionality	125
3.15	A graph of preparation time for number of motion features and dimensionality	128
3.16	A graph of answer time for number of motion features and dimensionality	128
3.17	A graph of error for number of motion features and dimensionality	129
3.18	A graph of preparation time for one dimensional trials	132
3.19	A graph of answer time for one dimensional trials	132
3.20	A graph of error for one dimensional trials	133
3.21	A graph of preparation time for two dimensional trials	136
3.22	A graph of answer time for two dimensional trials	136

3.23	A graph of error for two dimensional trials	137
3.24	A graph of preparation time for three dimensional trials	141
3.25	A graph of answer time for three dimensional trials	141
3.26	A graph of error for three dimensional trials	142
3.27	A graph of preparation time for four dimensional trials	145
3.28	A graph of answer time for four dimensional trials	146
3.29	A graph of error for four dimensional trials	146
3.30	A graph of participant drop out for experiment stage	149
4.1	A screen shot of the apparatus for naturalness experiment	189
4.2	Hue palette for naturalness experiment	190
4.3	A graph of time for task set	202
4.4	A graph of pop-ups triggered for task set	202
4.5	A graph of time for task set presentation	203
4.6	A graph of pop-ups triggered for task set presentation	203
4.7	A graph of time for task set and naturalness of encoding	204
4.8	A graph of pop-ups triggered for task set and naturalness of encoding .	204
4.9	A graph of time for task set presentation and naturalness of encoding .	205
4.10	A graph of pop-ups triggered for task set presentation and naturalness of encoding	205
4.11	A graph of time for naturalness of encoding	206
4.12	A graph of pop-ups triggered for naturalness of encoding	206
4.13	A graph of time for trial type and naturalness of encoding	207
4.14	A graph of pop-ups triggered for trial type and naturalness of encoding	207
4.15	A graph of participant drop out for experiment stage	216
4.16	A proposal for future encoding legend	219
4.17	A colour mixing guide.	219
5.1	A box plot graph of Spearman Rank Coefficient distributions for three projection techniques for the Hong Kong Hand Over Task Set	253
5.2	A box plot graph of Spearman Rank Coefficient distributions for three projection techniques for the Newspaper Circulation Task Set	253
5.3	A box plot graph of Spearman Rank Coefficient distributions for three projection techniques for the Recycled Materials Task Set	254
5.4	A box plot graph of Spearman Rank Coefficient distributions for three projection techniques for the Space Shuttle Task Set	254

6.1	A screen shot of the ranked-list interface with integrated full-text	263
6.2	A screen shot of the ranked-list interface with modal full-text	264
6.3	A screen shot of the modal full-text view	265
6.4	A screen shot of the theme map interface with integrated full-text, transparent pop-up windows and theme cloud control	266
6.5	A screen shot of the theme map interface with integrated full-text, transparent pop-up windows and theme list control	267
6.6	A screen shot of the theme map interface with modal full-text, transparent pop-up windows and theme cloud control	268
6.7	A screen shot of the theme map interface with modal full-text, non-transparent pop-up windows and theme list control	269
6.8	A screen shot of the ranked-list	271
6.9	A theme map of the <i>Recyclable Materials</i> task set	273
6.10	A theme map of the training task set	274
6.11	Colour set for document icons; colour denotes differences in cluster membership	276
6.12	Five techniques to display message text in a desktop computing application	280
6.13	Non-transparent pop-up windows	287
6.14	Transparent pop-up windows	287
6.15	The theme cloud control consisting of theme tags and descriptor tags . .	293
6.16	The theme list control consisting of horizontal theme tags and descriptor tags and vertical theme tags and descriptor tags.	296
6.17	A screen shot of the relevance judgement task interface	306
6.18	Progression of participant through training stages	313
6.19	Progression of participant through experiment stages	314
6.20	A graph of time (in seconds) for full-text integration	317
6.21	A graph of Bookmaker for full-text integration	318
6.22	A graph of the number of documents opened for full-text integration . .	319
6.23	A graph of the number of ranked-list resort actions for full-text integration	321
6.24	A graph of the average length of the re-sort vector for full-text integration	321
6.25	A graph of time (in seconds) for projection control, pop-up transparency and full-text integration	326
6.26	A graph of Bookmaker score for projection control, pop-up transparency and full-text integration	326
6.27	A graph of the number of documents opened for projection control, pop-up transparency and full-text integration	327

- 6.28 A graph of the number of projection dimension configurations for projection control, pop-up transparency and full-text integration 327
- 6.29 A graph of the proportion of trial time spent with the multi pop-up facility active for projection control, pop-up transparency and full-text integration 328
- 7.1 The Point, Space and Interface of Search Result Visualisation 357

LIST OF TABLES

2.1	The information seeking model adopted in this research	12
2.2	Motion dimensions and expressive capacity	40
2.3	Interpolation functions used in the production of motion	41
2.4	Intuitive and conventional encoding seen across literature	50
2.5	Feature definition and description for survey	57
2.6	A survey of search user interface systems	58
2.7	Desirable characteristics of a ranked-list interface	64
2.8	To what degree do alternative result presentation techniques meet the desirable characteristics of a ranked-list interface	76
3.1	Description of the motion under investigation	107
3.2	Parametrisation of the motion under investigation	107
3.3	Trial conditions from 4 static and 4 motion feature combinations; motion and static features unmixed	119
3.4	Trial conditions from 4 static and 4 motion feature combinations; motion and static features mixed	120
3.5	Trial conditions from 4 static and 4 motion feature combinations; motion and static features mixed	121
3.6	Trial outcome by success category	129
3.7	Success outcome for 1 dimensional trials.	131
3.8	Dependent variables by feature type for 1 dimensional trials.	131
3.9	Success outcome for 2 dimensional trials.	135
3.10	Dependent variables by feature type for 2 dimensional trials.	138
3.11	Success outcome for 3 dimensional trials.	140
3.12	Dependent variables by feature type for 3 dimensional trials.	143
3.13	Success outcome for 4 dimensional trials.	145
3.14	Dependent variables by feature type for 4 dimensional trials.	147
3.15	Subjective questionnaire data	148
3.16	Demographics and drop-out incidence	151

3.17	Preparation time and answer time for unmixed static and dynamic feature trials	152
3.18	Feature ranking based on average answer time	154
3.19	Feature ranking based on average error rate	154
4.1	A natural encoding scheme for use in metadata visualisation	176
4.2	Encoding paradigms based on approaches discussed in chapter	179
4.3	Experiment tasks for the Dog Train Security (DTS) task set	192
4.4	Experiment tasks for the Australian Music Festival (AMF) task set . . .	192
4.5	Experiment condition configuration for cluster icon shape and size . . .	193
4.6	Encoding of icon shape for word count and cardinality	196
4.7	Encoding of icon size for word count and cardinality	196
4.8	Complete cluster colour-coding scheme and interpretation	197
4.9	Objective performance measures for condition and question type	199
4.10	Accuracy over condition and question type	208
4.11	Accuracy for condition, task set and task type	209
4.12	Correct encoding recall for condition	210
4.13	Diversity and frequency of incorrect responses to recall question for condition	210
4.14	Subjective response data sorted by question type	213
4.15	Subjective response data sorted by question type	215
5.1	Topics and queries that form the basis for task sets in experiment	240
5.2	A summary of the qualitative evaluation	248
5.3	Mean Spearman Rank Coefficient for document distance ranks	255
6.1	Interactive capabilities of interface	297
6.2	Search facilities and strategies afforded by the experiment apparatus . .	298
6.3	Dependent variable outcome predictions for manipulated factor and levels in analysis one	302
6.4	Dependent variable outcome predictions for manipulated factors and levels in analysis two	302
6.5	Topics and queries that form the basis for task sets in experiment	304
6.6	Relevance score ranges for relevance calculations	308
6.7	Task set relevance ratings source from experiment population and one expert	308

6.8	Task set relevance ratings for corrected model	308
6.9	Fictitious document ratings contributing to the production of Gold Standard	308
6.10	Agreement between expert and crowd	309
6.11	Correlation calculations for expert and crowd	310
6.12	Schedule of experimental factor randomisation; full-text integration and pop-up transparency are combined in addition to randomisation of the interface presentation order	315
6.13	Descriptive statistics for document full-text view factor in analysis one.	317
6.14	Proportion of participants who did and did not utilise resorting functionality in the ranked list stage	320
6.15	Descriptive statistics for document full-text view, pop-up transparency and projection dimension control factors.	323
6.16	Descriptive statistics for document full-text view factor in analysis two.	323
6.17	Descriptive statistics for projection dimension control factor in analysis two.	323
6.18	Descriptive statistics for pop-up transparency factor in analysis two. . .	330
6.19	Descriptive statistics for pop-up transparency and document full-text view factors in analysis two.	330
6.20	Subjective workload response data for Theme Cloud control for Pop-up Transparency and Full-Text Integration factors	332
6.21	Subjective workload response data for heme list control for pop-up transparency and full-text integration factors	332
6.22	Dependent variable outcome observations for manipulated factors and levels in analysis one	336
6.23	Dependent variable outcome observations for manipulated factors and levels in analysis two	341
7.1	A comparison of online and offline methodological factors influencing search user interface evaluation	367
H.1	Objective performance and behavioural metrics in use across experimental chapters	409
H.2	Statistical techniques in use across experimental chapters	413

ABSTRACT

The research presented in this dissertation centres on the search user interface. The search user interface is the graphical user interface between where a human searcher interacts with a set of search results that a search engine serves in response to a request by the searcher.

We are accustomed to linear, ranked-list interfaces that support information search across pages upon pages of search results. However, whilst ranked-list interfaces have a number of useful and usable characteristics - that for the most part, have served our search activities well - some search is not well supported by such interfaces. Future designers should focus efforts on provisioning an appropriate level of information in appropriate forms to searchers.

Three human-based experiments are proposed and reported; each experiment tackles a different aspect of information display. Two experiments investigate ways that information can be presented in graphical form in an information visualisation tradition. In contrast, a third experiment investigates interface configuration with the intention to optimise the way textual information is presented to the user.

Together, the results form a picture of where future search interface design should move. By nature of the textual documents we search for, our interfaces must provision textual cues to the searcher. However and where possible, attributes of and relationships between documents should be expressed in graphical and spatial forms to facilitate quick and effortless comparison between documents.

Search user interfaces connect digital and cognitive worlds. It is increasingly apparent that building such interfaces necessitates a concerted, interdisciplinary effort of research and development. Accordingly, future search tools will be reliant on both an understanding of the human perceptual-cognitive system, as much as the bits and bytes that make up our search engine tools. Accordingly, perceptual-cognitive systems and phenomena have played a major role in the experimental work presented herein.

CERTIFICATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed

Dated

Kenneth R.F. Treharne

ACKNOWLEDGEMENTS

There are several people that I wish to acknowledge for their indirect though vital contribution to the development and production of this body of research. Foremost, I wish to thank my supervisors Professor David Powers and Dr. Richard Leibbrandt. Professor David Powers has bestowed on to me what it is to do research and I am most richer for this; many number of hours were devoted to a multitude of an idea's permutations and I have come to appreciate that this is a vital part of the process. Moreover, Professor Powers' diverse research interests have at long last provided direction for my own ambition and I can say with certainty that I have settled into my own area of computing where I have complete interest. Dr. Richard Leibbrandt has always been at an arm's length for professorial contribution to the task at hand. Dr. Leibbrandt's collegial and compassionate dedication to his supervision is exemplary.

The AiLab at Flinders University has been a second home for the much of the last decade and as such I would like to acknowledge in particular, Darius Pfiztner, Tom Anderson, Adham Atyabi, and Taskeshi Matsumoto. Darius, in parallel with Professor Powers, was a great source of academic inspiration early on and brought a refreshing collegial feel to the academic environment while Tommy, Adham and Takeshi were highly supportive, cooperative and engaging, and I am particularly grateful for our time together on the robotic competition. AiLab is not alone composed of the above people; accordingly, I extend my appreciation to all AiLab members for their friendly and engaging contribution to this academic life.

Finally, I wish to acknowledge friends and family, past and present who I will endeavour to reconnect with after so long withdrawn. To Tha'is, who has more or less, been there for the entirety of this thesis, thank you. Your support has taken on a multitude of forms and I am very fortunate and grateful to have had you by my side throughout this process, thank you again. To Archer, who has only been here for the finale, yet has strengthened my resolve to finish, thank you. To my parents, who have provided this opportunity, thank you. And finally, to my extended family and close friends who have maintained continued interest in my progress, thank you.

1. INTRODUCTION

1.1 Statement of Problem

Search facilities are increasingly prevalent in many computing applications - both online and offline. Whenever we engage in complex search activities, we are likely to endure a significant number of completely off-topic, or on-topic but irrelevant search results - among those that are actually suitable for our information need. This is a widespread problem in even contemporary search interfaces and more research should be devoted to facilitating the identification of useful results as well as indicating where similarly interesting results will be found subsequently.

When we do find a useful search result, the current methodology of presenting search results - the ranked-list - provides little guarantee that the next search result below will be relevant as well. Many information visualisation-based, alternative presentation techniques have been proposed to make it easier to identify and locate the subset of relevant documents in search result sets. Yet none has received sustained and widespread adoption. While these systems offer some unique advantage for text search, many take an overly literal interpretation of graphical visualisation of search results; subsequently, many search result presentation techniques are incompatible with contemporary search behaviours such as fast text skimming.

We need research that perceives alternative visualisation-based techniques as a specific type of information visualisation that does not engage the full set of analytical facilities that traditional information visualisation affords. More research is required to strike a balance between the visual representation of data and information, such as document metadata and inter-document relationships, and the inclusion of appropriate - but not dominating - textual information like document surrogates that searchers at present, make heavy use of in contemporary search interfaces. This thesis strongly contends that previous alternative search result presentation techniques have leaned more toward the visual aspect and have taken too much text out of the display. This imbalance is evidenced by prior systems in which it may be seen that a document shares a relationship with another document, yet it is difficult to perceive what each document is about and therefore what the semantic relationship actually is; consequently, this impacts on a decision of whether that relationship is useful to the current information need.

Furthermore and generally, search for information using a web-based search engine is not analytical, in the same sense of analytical information visualisation for multi-dimensional datasets. However, there has been an implicit assumption that if we visualise search results, somehow search for information will be improved, given the successes of visualisation-supported data analysis in other application domains. Accordingly, we need a big-picture or holistic approach to search result visualisation that takes into consideration the user's abilities and the tasks and behaviours they engage in, when searching for information.

The envisioned research approach and the approach taken in this thesis, is that of a balanced and holistic approach to search result presentation; it focuses on the point, the space and the interface. The point represents the search results and their attributes, the space represents the semantic space those points are arranged and presented within, and the interface that contains the controls and views that we use to interact and engage with search results.

Although the above perspectives are shared (Dong, 2008; Hoeber, 2012), largely, the field continues to show off visually-impressive though broadly unusable or unsustainable tools for everyday search activities - and few attempts are made by large commercial search companies to offer promising facilities to the mainstream. Therefore, the overall intention of this thesis is to support and facilitate the design of future search tools that are more effective. More effective tools will enable searchers to satisfy their information needs more efficiently and completely and furthermore, will instil greater confidence in the searcher's decision to terminate their search, having found information that satisfies their need.

However, there is no one solution to the problem of search, since our search needs are diverse in nature. Accordingly, improvements to search tools can be made in a range of areas both at the back-end of the search engine, the front-end of the search engine and through greater education of producers and consumers of digitised information. Specifically, the contributions of the present work are limited to improvement of the front-end or interface of the search engine.

1.2 Contributions of Thesis

Core aspects of search user interfaces include: the representation of individual search results, depiction of the relationships between search results, and the interactive capacities afforded to searchers. Succinctly, this is the point, space and interface of search result visualisation. Our search user interfaces contain each of these core aspects in some capacity.

Whilst there is no set formula for the design of search user interfaces, this thesis will attempt a bounding for such a formula - based on the point, space and interface

of search result visualisation. An initial outline and review goes to some lengths, to contextualise and establish each of the core aspects, while a survey of systems highlights a great diversity in prior research. Later and importantly, a series of experiments are reported, with the outcomes anticipated to partially contribute to an inner substance of the prescribed bounding.

The experiments presented in this thesis make a contribution to each core area of the search user interface. Specifically, they investigate the role of motion - vis. animation - to encode metadata attributes of individual search results; they evaluate the idea of using a user's pre-existing ideas, experiences and intuitions to define the data encoding process; and they contrast and compare the usability of user interface configurations for spatialisation-based search tools.

The reported experiments are a concerted effort toward improvement of search user interfaces in a holistic sense, such that all outcomes could feature simultaneously in a subsequent search user interface. They investigate novel but natural ways to convey information to a searcher; they investigate how to convey semantic relationships by way of visually-defined, spatial relationships; and they investigate how best to support exploration of information through usable and optimal information display and user interface design. The anticipated contributions of this research are key for future search user interface design and evaluation.

1.3 Outline of Chapters

The next chapter will establish a context for search user interface research that investigates visualisation-based techniques for the display and organisation of search results. This multifaceted discussion offers a broad snapshot of the user and system issues and includes a small survey of the various approaches evident across the literature.

The third chapter will motivate and report an experiment that investigates the use of motion-based graphical attributes to encode metadata - just as colour, shape or size can encode data. This experiment and subsequently, the experiment of chapter four are conducted online, so significant efforts are taken to explicate the benefits of performing experimental research of this kind over the Internet.

In the fourth chapter, it is argued that a data-encoding paradigm must take into account the affordances of the data. When data is encoded in a way consistent with our perceptual and cognitive expectations, the resulting interfaces should be easier and more natural to interact with, thus improving search outcomes. Later, results are reported for an experiment that explores this idea empirically.

The fifth and six chapters shift the focus away from document representation and toward inter-document relationship visualisation. Namely, the fifth chapter introduces document spatialisation and information spaces as a way to present search results to

searchers. In addition, the latter part of chapter five will define and investigate a set of key criteria to be used in the selection of algorithms for the construction of such spaces. Building on this introduction, the sixth chapter will detail and report an experiment that evaluates interface design components that are specific to search tools which feature spatially-organised search results. Three experimental hypotheses centre on the way searchers access and view document full-text, the way searchers access and view document surrogate information, and the way searchers control the layout of spatialised documents.

Finally, the seventh and final chapter summarises the findings of each experiment, reiterates the significance of the findings and reviews how each of the experimental findings will contribute to future search user interface design.

The studies presented herein are pilot studies of sorts. What is common among these studies is a tendency to be highly and broadly exploratory - in both the subject matter at the heart of the experimental hypotheses, and in the pragmatic methodological aspects, such as how to conduct research in a balanced way. From an original research perspective, the contributions of these studies are two fold; they introduce and develop new and previously unexplored research questions and ideas within the immediate field, whilst also contributing to a pool of methodological considerations made by many researchers situated within the broader human-computer interaction and usability discipline.