Chapter VIII

Interaction Models and Relevance Feedback in Image Retrieval

Daniel Heesch, Imperial College London, UK

Stefan Rüger, Imperial College London, UK

Abstract

Human-computer interaction is increasingly recognized as an indispensable component of image retrieval systems. A typical form of interaction is relevance feedback in which users supply relevance information on the retrieved images. This information can subsequently be used to optimize retrieval parameters. The first part of the chapter provides a comprehensive review of existing relevance feedback techniques and also discusses a number of limitations that can be addressed more successfully in a browsing framework. Browsing models form the focus of the second part of this chapter in which we will evaluate the merit of hierarchical structures and networks for interactive image search. This exposition aims to provide enough detail to enable the practitioner to implement many of the techniques and to find numerous pointers to the relevant literature otherwise.
Introduction

Similarity in appearance often is revealing about other and, potentially, much deeper functional and causal commonalities among objects, events, and situations. Things that are similar in some respect are likely to behave in similar ways and to owe their existence to similar causes. It is because of this regularity that similarity is fundamental to many cognitive tasks such as concept learning, object recognition, and inductive inference.

Similarity-based reasoning requires efficient modes of retrieval. It is perhaps only in experimental settings that subjects have direct sensory access to the patterns that they are asked to compare. In most situations, an observed pattern is evaluated by comparing it with patterns stored in memory. The efficiency with which we can classify and recognize objects suggests that the retrieval process itself is based on similarity. According to Steven Wolfram (2004), the use of memory “underlies almost every major aspect of human thinking. Capabilities such as generalization, analogy and intuition immediately seem very closely related to the ability to retrieve data from memory on the basis of similarity.” He extends the ambit of similarity-based retrieval to the domain of logical reasoning, which ultimately involves little more than “retrieving patterns of logical argument that we have learned from experience” (p. 627).

The notion of similarity clearly is not without problems. Objects may be similar on account of factors that are merely accidental and that, in fact, shed no light on the relationship that one potentially could unveil. The problem of measuring similarity largely reduces, therefore, to one of defining the set of features that matter. The problem of estimating the relative significance of various features is one of information retrieval in general. However, it is greatly compounded in the case of image retrieval in two significant ways. First, documents readily suggest a representation in terms of their constituent words. Images do not suggest such a natural decomposition into semantic atoms with the effect that image representations, to some extent, are arbitrary. Second, images typically admit to a multitude of different meanings. Each semantic facet has its own set of supporting visual features, and a user may be interested in any one of them.

These challenges traditionally have been studied in the context of the query-by-example paradigm (QBE). In this setting, the primary role of users is to formulate a query; the actual search is taken care of by the computer. This division of roles has its justification in the observation that the search is the computationally most intensive part of the process but is questionable on the grounds that the task of recognizing relevance still is solved best by the human user. The introduction of relevance feedback into QBE systems turns the problem of parameter learning into a supervised learning problem. Feedback on retrieved images can help to find relevant features or better query representations. Although the incorporation of relevance feedback techniques can result in substantial performance gains, it does not overcome the more fundamental limitations of the QBE framework in which they have been formulated. Often, users may not have an information need in the first place and may wish to explore an image collection. Moreover, the presence of an information need does not mean that a query image is readily at hand to describe it. Also, brute force nearest neighbor search is linear in the collection size, and the sublinear performance achieved through hierarchical indexing schemes does not extend to high-dimensional feature spaces with more than 10 dimensions.
Related Content

Support Networks for Rural and Regional Communities
[www.irma-international.org/chapter/support-networks-rural-regional-communities/29299/](www.irma-international.org/chapter/support-networks-rural-regional-communities/29299/)

Emergent Ontologies by Collaborative Tagging for Knowledge Management
Weena Jimenez, César Luís Álvargonzález, Pablo Abella Vallina, Jose Maria Álvarez Gutiérrez, Patricia Ordóñez de Pablos and Jose Emilio Labra Gayo (2013). *Advancing Information Management through Semantic Web Concepts and Ontologies* (pp. 54-69).
[www.irma-international.org/chapter/emergent-ontologies-collaborative-tagging-knowledge/71848/](www.irma-international.org/chapter/emergent-ontologies-collaborative-tagging-knowledge/71848/)

Recent Advances in the Evaluation of Ontology Quality
[www.irma-international.org/chapter/recent-advances-in-the-evaluation-of-ontology-quality/215071/](www.irma-international.org/chapter/recent-advances-in-the-evaluation-of-ontology-quality/215071/)

Overview of MERA: An Architecture to Perform Record Linkage in Music-Related Databases
[www.irma-international.org/chapter/overview-of-mera/215067/](www.irma-international.org/chapter/overview-of-mera/215067/)

A Core Ontological Model for Semantic Sensor Web Infrastructures
[www.irma-international.org/article/core-ontological-model-semantic-sensor/70585/](www.irma-international.org/article/core-ontological-model-semantic-sensor/70585/)