Generating 2-Dimensional Overviews from a Bi-Partite Classification of Images

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Classification

Major categories: Complex Networks, Image Science, Art History.
Minor categories: image search, classification network, bi-partite network, bi-cliques, matrix visualization, image comparison.

Introduction

Recently a number of projects classify and annotate massive numbers of images and image segments with tags and other classifcation criteria. The work in these projects is either done manually by human editors (Russell, 2008: http://labelme.csail.mit.edu/; Schich, 2007; more examples see Obrenovic, 2007), automatically with the help of pattern recognition algorithms (see for e.g. http://www.definiens.com) or most promising by human computation, i.e. in a collaborative effort in the form of games such as Peekaboom (Ahn, 2006: http://www.peekaboom.org/).

The data produced by these efforts can be understood as a bi-partite network with image documents in one partition and (visual) classification criteria in the other. Typically in addition, the image documents as well as the classification criteria in each partition may feature more structure in the form of trees or ontologies.
Fig. 1 shows a simple example of this structure, where a painting and its classified segments (a) can be represented as a simple tree (b), which is connected to the partition of classifications via the classification link.

As shown in at least two studies (Russell, 2008; Schich, 2007), bi-partite classification networks such as this usually contain complex network properties such as long tail degree distributions. As a consequence network science methods can be used to process the data in a desired way.

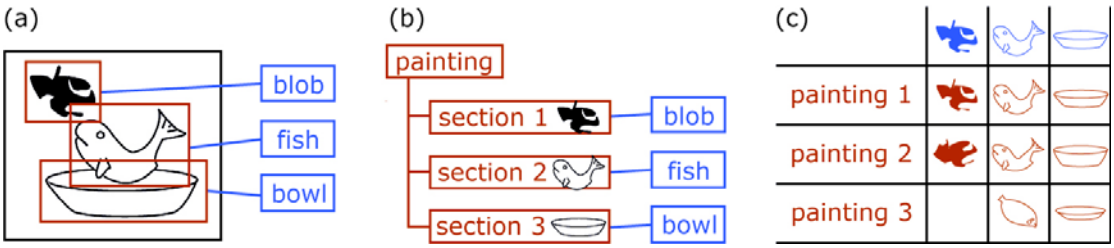

Fig.1. Node informtion of a bi-partite classification network is placed in the location of the links in the adjacency matrix in order to produce a two-dimensional image-matrix (c).

Results

Starting from a classified/annotated image dataset, we propose a method, which combines a community finding algorithm and a method for the production of scalable image matrices in order to construct 2-dimensional overviews.

In order to find interesting areas in the matrix of the whole network we apply the community detecting algorithm for overlapping bi-cliques introduced by Lehmann et. Al. (2008). In a second step these communities are then visualized using the method for the production of scalable image matrices introduced by Schich (2007; see also http://tinyurl.com/29rb9l).

Discussion

Our approach augments the usual one-dimensional result of an image search by placing the found image segments in a two-dimensional matrix of the image classification network. It enables the comparison of multiple classification criteria in multiple images within the context of the network structure.

By using a bi-clique community finding algorithm our method overcomes the problem of picking the right area in the network, containing a large amount of information while still being useful to the human eye. Given multilevel trees in one of the partitions of the bipartite network, our approach can also be used explore the ambivalent nature of superordinate entities.

The approach discovers hidden relationships in the data in a reproducable manner, which otherwise can only be deduced by individual cognitive efforts and which up until now could not be visualized in an objective form.

Acknowledgements

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