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Efficient Contour Match Kernel

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Abstract

We propose a novel concept of asymmetric feature maps (AFM), which allows to evaluate multiple kernels between a query and database entries without increasing the memory requirements. To demonstrate the advantages of the AFM method, we derive an efficient contour match kernel – short vector image representation that, due to asymmetric feature maps, supports efficient scale and translation invariant sketch-based image retrieval. Unlike most of the short-code based retrieval systems, the proposed method provides the query localization in the retrieved image. The efficiency of the search is boosted by approximating a 2D translation search via trigonometric polynomial of scores by 1D projections. The projections are a special case of AFM. An order of magnitude speed-up is achieved compared to traditional trigonometric polynomials. The results are boosted by an image-based average query expansion approach and, without any learning, significantly outperform the state-of-the-art hand-crafted descriptors on standard benchmarks. Our method competes well with recent CNN-based approaches that require large amounts of labeled sketches, images and sketch-image pairs.

Keywords: sketch-based image retrieval, efficient contour matching, kernel descriptors, asymmetric feature maps

1. Introduction

Efficient match kernel [1] is a popular choice in applications evaluating complex similarity measures on large collections of objects, where an object is a set of elements. This includes local feature descriptors [1, 2, 3] and image retrieval with short descriptors [4] .

In efficient match kernel, all elements of the sets are mapped to a finite feature map [5, 6]. An inner product of the feature maps approximates evaluation of a specific kernel, defining similarity of the set elements. We propose an extension to this concept. In the asymmetric feature map, the query uses a different embedding than the database objects. The query embedding defines the kernel that is evaluated between the query and the database entries. Thus, multiple kernels can be evaluated while the memory requirements for the database remains the same (up to a scalar per kernel) as for a single kernel to be evaluated. The embeddings are obtained via joint kernel feature map optimization, which significantly improves the quality of kernel approximation for a fixed dimensionality of the feature map.

The application domain of AFM is wide, in particular many efficient match kernels benefit from AFM. We evaluate the AFM on a sketch-based retrieval application. Sketch-based retrieval has received less attention than image retrieval and still remains challenging. Instead of a real image, the query consists of an abstract binary sketch. This allows the user to quickly outline an object, *e.g.* by a finger on a tablet or smart phone, and search for relevant images (see Figure 1). The progress in this area has more or less followed the footsteps of traditional image retrieval. The first systems employed global descriptors [7]. Then, the Bag-of-Words paradigm with local descriptors and feature quantization [8, 9, 10] was adopted. Geometric constraints are also applied to filter out false positives [11].

Due to the absence of textural cues on the query side, the image representations are shape based. Bridging the representation gap between hand-drawn sketches and real images is one of the challenges making the task difficult. Matching

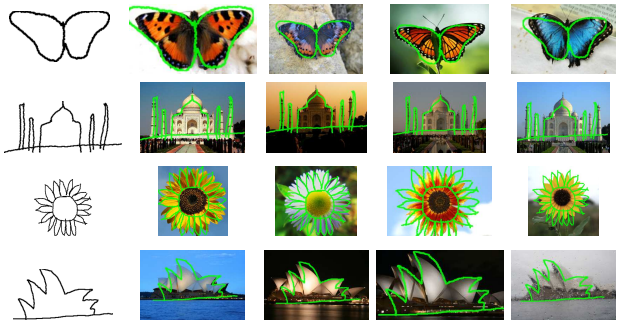

Figure 1: Scale and translation invariant contour matching. Examples of sketch queries which are localized (shown in green) in real images. The images are top-retrieved by the proposed efficient query-by-sketch image retrieval method.

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