OMASS: One Memory Access Set Separation

In many applications, there is a need to identify to which of a group of sets an element $x$ belongs, if any. For example, in a router, this functionality can be used to determine the next hop of an incoming packet. This problem is generally known as set separation and has been widely studied. Most existing solutions make use of hash-based algorithms, particularly when a small percentage of false positives is allowed. A known approach is to use a collection of Bloom filters in parallel. Such schemes can require several memory accesses, a significant limitation for some implementations. We propose an approach using Block Bloom Filters, where each element is first hashed to a single memory block that stores a small Bloom filter that tracks the element and the set or sets the element belongs to. In a naïve solution, when an element $x$ in a set $S$ is stored, it necessarily increases the false positive probability for finding that $x$ is in another set $T$. In this paper, we introduce our One Memory Access Set Separation (OMASS) scheme to avoid this problem. OMASS is designed so that for a given element $x$, the corresponding Bloom filter bits for each set map to different positions in the memory word. This ensures that the false positive rates for the Bloom filters for element $x$ under other sets are not affected. In addition, OMASS requires fewer hash functions compared to the naïve solution.