

**Encoding Short Ranges in TCAM Without expansion: Efficient Algorithm and Applications**

**Abstract:**

We present range encoding with no expansion (RENÉ)— a novel encoding scheme for short ranges on *Ternary content addressable memory* (TCAM), which, unlike previous solutions, does not impose *row expansion*, and uses bits proportionally to the maximal range length. We provide theoretical analysis to show that our encoding is the closest to the lower bound of number of bits used. In addition, we show several applications of our technique in the field of packet classification, and also, how the same technique could be used to efficiently solve other hard problems, such as the *nearest-neighbor search* problem and its variants. We show that using TCAM, one could solve such problems in much higher rates than previously suggested solutions, and outperform known lower bounds in traditional memory models. We show by experiments that the translation process of RENÉ on switch hardware induces only a negligible 2*.*5% latency overhead. Our nearest neighbor implementation on a TCAM device provides search rates that are up to four orders of magnitude higher than previous best prior-art solutions.

**Existing System:**

Multi-field packet classification is becoming more and more important in modern network architectures, such as SDN and *network function virtualization* (NFV) [8]. Specifically, recently suggested SDN frameworks perform more network functionalities on switches, such as load balancing [9], DdoS prevention [10], and quality of service (QoS) [11]. The initiative for NFV suggests to implement higher level tasks such as deep packet inspection and caching as virtual software services, and make traffic flow through them using smart classification rules. All such frameworks heavily rely on multifield packet classification. Many of these fields are better expressed as ranges.

**Proposed System:**

We present a database-independent range encoding scheme, called RENÉ - *Range Encoding with No Expansion* - that *eliminates row expansion completely* when ranges are *short enough*. The code produced by RENÉ is *proportional to the maximal range length*, not to the number of ranges, as in database-dependent schemes. In many cases, as we show in this paper, ranges are limited in length. For example, it was shown in that in real-life packet classification tables more than 60% of the TCP port ranges are short. Moreover, packet classification also uses other range fields, where all ranges are short (such as IP ToS or TTL).

On some fields one may apply quantization and categorization to reduce the length of ranges without hurting classification accuracy (e.g. packet length). Nonetheless, RENÉ can be combined with other approaches to represent a wider spectrum of ranges if necessary. In addition to packet-classification, where TCAM has already been selected as de-facto industry standard, we propose in this paper using a TCAM as a co-processor to CPU in order to solve hard problems from other domains in computer science. Specifically, we show how an encoding scheme such as RENÉ, which requires no row expansion, can be used to practically and efficiently solve the *nearest neighbor search* problem and its variants, removing the infamous curse of dimensionality from them.