Parallel Hashing

Program for Undergraduate Research

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1 Introduction

Hash functions are

2 Intel SIMD Instructions

SIMD is an instruction set available mostly on all current processors. In this project we used AVX(Advanced Vector Extension) and AVX2 instructions which are available for Intel processors since Sandy Bridge architecture. With AVX instructions, it is possible to process 128 bits of data in registers on parallel, with AVX2 this increased to 256 bits. The SIMD instructions we used on this project and their descriptions could be found in the following paragraph.

__m256i _mm256_add_epi32 (__m256i a, __m256i b)

Add 8 packed to 256-bit side by side 32-bit integers in a and b, and store the results in dst.

__m256i _mm256_add_epi64 (__m256i a, __m256i b)

Add 4 packed to 256-bit side by side 64-bit integers in a and b, and store the results in dst.

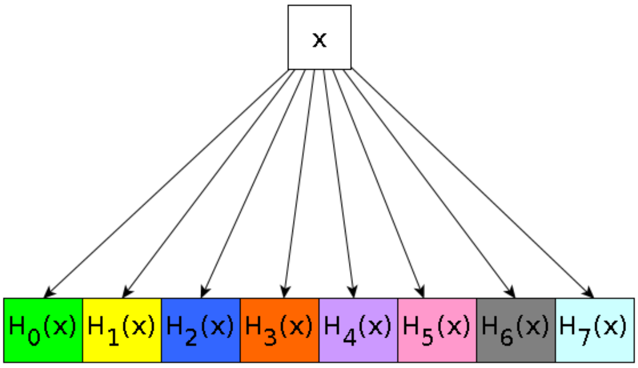
__int32 _mm256_extract_epi32 (__m256i a, const int b)

Add 4 packed to 256-bit side by side 64-bit integers in a and b, and store the results in dst.

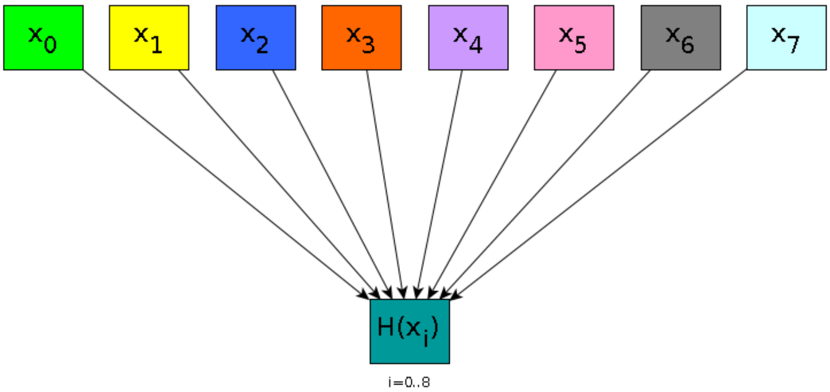
3 Hashing Functions

We have developed our work under 2 models; Model 1, one data multiple hash, where we generate multiple hash values from a single data sample, and Model 2, one data one hash, where we generate only one hash value using the same random seed for a single data sample. As our hash functions, we used Multiply-Shift Hash, MurMurHash3 and Tabular Hash.

3.1 Model 1



3.2 Model 2



3.3 Multiply-Shift Hash

1: **function** MULTIPLY-HASH(x)
2: 2 randomly sampled 64 bit integers m_a,m_b ;
return $(m_a * (uint\_64) * x + m_b) >> 32$

3.4 MurMurHash3

```
function Murmur3(key, len, seed)
    c1 = 0xcc9e2d51
    c2 = 0x1b873593
    r1 = 15
    r2 = 13
    m = 5
    n = 0xe6546b64
    hash = seed
    for each fourByteChunk of key do
        k ← fourByteChunk
        k = k * c1
        k = (k ROL r1)
        k = k * c2
        hash = hash XOR k
        hash = (hash ROL r2)
        hash = hash * m + n
                                ▷ Endian swapping is only necessary on big-endian machines.
    for each remaining byte in key do
        remainingBytes = SwapEndianOrderOf(remainingBytesInKey)
        remainingBytes = remainingBytes * c1
        remainingBytes = (remainingBytes ROL r1)
        remainingBytes = remainingBytes * c2
        hash = hash XOR remainingBytes
    hash = hash XOR len
    hash = hash XOR (hash SHR 16)
    hash = hash * 0x85ebca6b
    hash = hash XOR (hash SRH 13)
    hash = hash * 0xc2b2ae35
    hash = hash XOR (hash SHR 16)
```

3.5 Tabular Hash

4 Experiment and Results

5 Future Work

5.1 HyperLogLog

5.2 Bloom Filter

5.3 Count-Min Sketch

6 Conclusions