QuestionnaireGroup1

Thank you for taking part in this study which aims to understand the influence that visualization can have on the understanding of software behavior. You are kindly requested to answer 12 questions whose answers range from automatic completions to some calculations that you can do mentally. You can also use a calculator or an Excel spreadsheet. If you wish, you can answer this questionnaire anonymously by providing a pseudonym instead of your name. This study has received ethical certification from the Ethics Committee for Research with Human Beings of TELUQ University (CER-TELUQ) number 2022-08 of April 12, 2022.

A- Personal information, start date and start time of filling out the questionnaire

Q1- Name or pseudonym
Abdul

Q2-Date :
2022-05-21

Q3-Start time:
4:09 PM

C- Understanding the behavior of the vector instructions _mm512_mask_add_ps and _mm_shuffle_epi32

1- Vector instruction _mm512_mask_add_ps

Carefully read the explanation of this instruction on the figure below. You can also find this explanation on Intel © web site. Make sure you read and understand the explanation before answering questions Q7 and Q8. You can also watch this short video where the instruction is explained; the video is an explanation made by an expert in the field of vector programming. You should only use the explanations provided (you can of course consult the Intel © web site), but do not use other resources (for example search on Google, other documents, etc.).

__m512 _mm512_mask_add_ps (__m512 src, __mmask16 k, __m512 a, __m512 b) vaddps

Synopsis

```
__m512 _mm512_mask_add_ps (__m512 src, __mmask16 k, __m512 a, __m512 b)
#include <immintrin.h>
Instruction: vaddps zmm {k}, zmm, zmm
CPUID Flags: AVX512F
```

Description

Add packed single-precision (32-bit) floating-point elements in a and b, and store the results in dst using writemask k (elements are copied from src when the corresponding mask bit is not set).

Operation

```
FOR j := 0 to 15
        i := j*32
        IF k[j]
                dst[i+31:i] := a[i+31:i] + b[i+31:i]
        ELSE
                dst[i+31:i] := src[i+31:i]
        FI
ENDFOR
dst[MAX:512] := 0
```

Performance

Architecture	Latency	Throughput (CPI)
Icelake	4	1
Skylake	4	0.5

Q7- After reading the description and the explanation above, say what the _mm512_mask_add_ps instruction does by performing the following calculation: given src=(1, 3, 4, 1, 2, 5, 4, 1, 2, 3 , 4, 1, 1, 3, 4, 1); k=(1, 0, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0); a=(6, 1, 2, 3, 1, 4, 5, 1, 2, 3, 4, 1, 3,1, 2, 1); b=(6, 1, 2, 3, 1, 4, 5, 1, 2, 3, 4, 1, 3,1, 2, 1) . Calculate r = _mm512_mask_add_ps(src, k, a, b)
r = (12, 2, 4, 6, 2, 8, 10, 2, 4, 6, 8, 2, 6, 2, 4, 0)

Q8- Using the description and the explanation above again, give a general formula for calculating the coordinates of r(ri) as function of those of src(srci), k(ki), a(ai) and b(bi)). ri=?
ri=(1-ki) x srci+ai+bi

2-Vector instruction _mm_shuffle_epi32

Carefully read the explanation of this instruction on the figure below. You can find this explanation on[Intel © web site.](#) Make sure you read and understand the explanation before answering questions Q9 and Q10. You can also watch [this short video](#) where the instruction is explained; the video is an explanation made by an expert in the field of vector programming. You should only use the explanations provided (you can naturally consult the Intel © site by following the link given above), but do not use other
resources (for example search on Google, other documents, etc.).

__m128i _mm_shuffle_epi32 (__m128i a, int imm8) pshufd

Synopsis

```
__m128i _mm_shuffle_epi32 (__m128i a, int imm8)
#include <emmintrin.h>
Instruction: pshufd xmm, xmm, imm8
CPUID Flags: SSE2
```

Description

Shuffle 32-bit integers in a using the control in imm8, and store the results in dst.

Operation

```
DEFINE SELECT4(src, control) {
        CASE(control[1:0]) OF
        0:      tmp[31:0] := src[31:0]
        1:      tmp[31:0] := src[63:32]
        2:      tmp[31:0] := src[95:64]
        3:      tmp[31:0] := src[127:96]
        ESAC
        RETURN tmp[31:0]
}
dst[31:0] := SELECT4(a[127:0], imm8[1:0])
dst[63:32] := SELECT4(a[127:0], imm8[3:2])
dst[95:64] := SELECT4(a[127:0], imm8[5:4])
dst[127:96] := SELECT4(a[127:0], imm8[7:6])
```

Performance

Architecture	Latency	Throughput (CPI)
Skylake	1	1
Broadwell	1	1
Haswell	1	1
Ivy Bridge	1	0.5

Q9- After reading the description and the explanation above, say what the _mm_shuffle_epi32 instruction does by performing the following calculation: given a=(6, 7, 4, 3); imm8=(0, 1, 2, 3) . Calculate r = _mm_shuffle_epi32(a, imm8)
r = (3, 4, 7, 6)

Q10- Usingthe description and the explanation above again, give a general formula for calculating the coordinates of r(ri) as function of those of a(ai) and imm8(imm8i). ri=?
ri=aij, where j=imm8i

B- Preliminary knowledge

I- Knowledge of algebra and vector space

Consider the real vector space R3. For A, B, C, Res1, Res2, five vectors of R3 such that A=(a1, a2, a3), B=(b1, b2, b3), C=(c1, c2, c3), Res1=(x1, x2, x3), Res2=(y1, y2, y3) we define vectSum(A,B,C)=Res1 and vectProd(A,B,C)=Res2 by

$$\begin{cases} x_1 = a_1 - b_1 + c_1 \\ x_2 = a_2 - b_2 + c_2 \\ x_3 = a_3 - b_3 + c_3 \end{cases} \text{ and } \begin{cases} y_1 = b_1 \times (a_1 - c_1) + c_1 \\ y_2 = b_2 \times (a_2 - c_2) + c_2 \\ y_3 = b_3 \times (a_3 - c_3) + c_3 \end{cases}$$

Now let's assume that A=(1, 0,1) ; B=(1,1,0) ; C=(0,1, 1).

Q4- Calculate each of the Res1 and Res2 vectors: Res1= ?
Res2=?
Res1=(0,0,2); Res2=(1,0,1).

Q5- Give a general formula for calculating the coordinates of Res1(xi) and Res2(yi) as a function of those of A (ai), B (bi) and C (ci). xi=? yi=?
xi= ; yi=ai-bi+ci ; biai-bici+ci

II- Knowledge of the C language

Consider the following function f in C: int f (int x, int y) {return x-y;}.

Q6- Choose the two instructions in C (that is, instruction1 and instruction2) which allow you to declare three integer variables a, b, c and to place in c the difference between a and b using the function f. instruction1: ? instruction2: ?
Instruction1: int c, a, b; Instruction2: c=f(a,b);

D- End time of the questionnaire completion and comments

Q11- End time:
4:45 PM

Q12- Other comments and remarks: