

0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

#include <stdio.h>

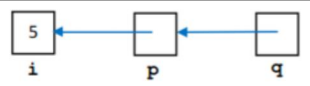
```
int a;
extern int b;
const int c;
```

Úttak:
1
2

```
int f() {
    static int t = 0;
    t++;
    return t;
}
```

```
int main() {
    printf("%d\n", f());
    printf("%d\n", f());
    return 0;
}
```

```
int i = 5;
int *p = &i;
int **q = &p;
```



```
a[0] = 4;
*a = 4;
```

```
char litur[] = "blár";
char *litp = "gulur";
```

```
a[2] = 8;
*(a+2) = 8;
```

```
01101001
^ 01010101
00111100
```

– Segðir með signed int og unsigned int:
• int er kastað yfir í unsigned!!

	8	16	32	64
UMax	255	65,535	4,294,967,295	18,446,744,073,709,551,615
TMax	127	32,767	2,147,483,647	9,223,372,036,854,775,807
TMin	-128	-32,768	-2,147,483,648	-9,223,372,036,854,775,808

Gagnatag	32-bit	64-bit	printf
char	1	1	%c
short int	2	2	%hd
int	4	4	%d
long int	4	8	%ld
long long int	8	8	%lld
float	4	4	%f
double	8	8	%lf

```
sum = 0;
for (i=0; i<100; i++)
    sum += a[i];
```

```
sum = 0;
for (i=0; i<100; i++)
    sum += *(a+i);
```

```
sum = 0;
for (p=a; p<&a[100]; p++)
    sum += *p;
```

- Utfærir í raun mátreikning
 $s = UAdd_w(u, v) = u + v \bmod 2^w$

unsigned char	1110 1001	E9	223
+	1101 0101	+ D5	+ 213
	1 1011 1110	1BE	446
	1011 1110	BE	190

– Samlagning með/án formerkis í C:

```
int s, t, u, v;
s = (int) ((unsigned) u + (unsigned) v);
t = u + v
```

– Mun gefa s == t

	1110 1001	E9	-23
+	1101 0101	+ D5	+ -43
	1 1011 1110	1BE	-66
	1011 1110	BE	-66

HÁSKÓLI ÍSLANDS
IDNADARVERKFRÆÐI, VÉLAVERKFRÆÐI
OG TÖLVUNARFRÆÐI

Útfærir mátreikning:

$UMult_w(u, v) = u \cdot v \bmod 2^w$

	1110 1001	E9	223
*	1101 0101	* D5	* 213
	1100 0001 1101 1101	C1DD	47499
	1101 1101	DD	221

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	Division	Computed	Hex	Binary
x	15213	15213	3B 6D	00111011 01101101
x >> 1	7606.5	7606	1D B6	00011101 10110110
x >> 4	950.8125	950	03 B6	00000011 10110110
x >> 8	59.4257813	59	00 3B	00000000 00111011

Deiling neikvæðrar tölu með heilu veldi af 2

– Viljum $\lceil x / 2^k \rceil$ (rúnnað $\lceil \cdot \rceil$)

– Reiknum $\lfloor (x+2^k-1) / 2^k \rfloor$

• Í C: $(x + (1<<k) - 1) >> k$

• Bjöðum deilistofn (teljara) að 0

Sérstök gildi

Tilvik 1: $exp = 111...1$, $frac = 000...0$

– Táknar gildið ∞ (óendanlegt)

Tilvik 2: $exp = 111...1$, $frac \neq 000...0$

– Not-a-Number (NaN)

Heiltölureikningur: Helstu reglur

Samlagning:

– Með/án formerki: Venjuleg samlagning og svo stýfing, sama aðgerð á bita-lagi

– Án formerkis: samlagning $\bmod 2^w$

– Með formerki: breytt samlagning $\bmod 2^w$ (útkoma á réttu bili)

Margföldun:

– Með/án formerki: Venjuleg margföldun og svo stýfing, sama aðgerð á bita-lagi

– Án formerkis: margföldun $\bmod 2^w$

– Með formerki: breytt margföldun $\bmod 2^w$ (útkoma á réttu bili)

Viljum reikna $-13/4$ (eða $-13/2^2$)

–13: 1111 0011₂

–13 >> 2 = 1111 1100₂ = -4

Rúnnast í átt að $-\infty$ í stað 0

Bætum við bjögun (bias): $2^2 - 1 = 3$

Reiknum þá $(-13+3) >> 2$

eða $-10 >> 2 = 1111 0110_2 >> 2 = 1111 1101_2 = -3$

Fáum nú rétta útkomu

Einföld nákvæmni:

$s=1$, $exp=8$,

$frac=23$

Tvöföld

nákvæmni:

$S=1$, $exp=11$,

$frac=52$

Háenda

0x100	0x101	0x102	0x103
01	23	45	67

Lágenda

0x100	0x101	0x102	0x103
67	45	23	01

00...00	exp ≠ 0 og exp ≠ 11...11	11...11
óstaðlaðar (denormalized)	staðlaðar (normalized)	sérstakar (special)

$bias = 2^{k-1} - 1$

Gildi: float F = 15213.0;

– $15213_{10} = 11101101101101_2$
 $= 1.1101101101101_2 \times 2^{13}$

Brothluti

$M = 1.1101101101101_2$

$frac = 11011011011010000000000_2$

Veldishluti

$E = 13$

$bias = 127$

$exp = 140 = 10001100_2$

STAÐLAÐ

Útkoma:

0	10001100	11011011011010000000000
s	exp	frac

Brothluti hefur nú falið 0 fremst: $M = 0.xxx...x_2$

– $xxx...x$: bitar í frac

Veldisgildi: $E = 1 - bias$ (í stað $exp - Bias$)

Tvö undirtílvik:

ÓSTAÐLAÐ

– $exp = 000...0$, $frac = 000...0$

• Táknar gildið núll

• Athugið að það eru tvö núll: +0 og -0 (af hverju?)

– $exp = 000...0$, $frac \neq 000...0$

• Tölurnar sem eru næstar 0.0

• Jafnt bil á milli þeirra

Gildissvið (s=0)

$v = (-1)^s M 2^E$
staðl: $E = exp - Bias$
óstaðl: $E = 1 - Bias$

s	exp	frac	E	Gildi
0	0000	000	-6	0
0	0000	001	-6	$1/8 \cdot 1/64 = 1/512$
0	0000	010	-6	$2/8 \cdot 1/64 = 2/512$
...
0	0000	110	-6	$6/8 \cdot 1/64 = 6/512$
0	0000	111	-6	$7/8 \cdot 1/64 = 7/512$
0	0001	000	-6	$8/8 \cdot 1/64 = 8/512$
0	0001	001	-6	$9/8 \cdot 1/64 = 9/512$
...
0	0110	110	-1	$14/8 \cdot 1/2 = 14/16$
0	0110	111	-1	$15/8 \cdot 1/2 = 15/16$
0	0111	000	0	$8/8 \cdot 1 = 1$
0	0111	001	0	$9/8 \cdot 1 = 9/8$
0	0111	010	0	$10/8 \cdot 1 = 10/8$
...
0	1110	110	7	$14/8 \cdot 128 = 224$
0	1110	111	7	$15/8 \cdot 128 = 240$
0	1111	000	n/a	inf

næst núlli

$(-1)^0 (0+1/4) \cdot 2^{-6}$

stærsta óstaðlaða

minnsta staðlaða

$(-1)^0 (1+1/8) \cdot 2^{-6}$

næst 1 neðanfrá

næst 1 ofanfrá

stærsta staðlaða

Table with 4 columns: 8-byte register, Bytes 0-3, Bytes 0-1, Byte 0. Rows include registers like %rax, %rcx, %rdx, %rbx, %rsi, %rdi, %rsp, %rbp, %r8, %r9, %r10, %r11, %r12, %r13, %r14, %r15 and their corresponding bit fields.

Table with 4 columns: cmpq b, a, eins og að reikna a-b, skilagildis, %rdx, 0xf000, %rcx, 0x0100. Rows include instructions like jmp, je, jne, js, jns, jg, jge, jle, ja, jb and their corresponding bit fields.

Table with 3 columns: Segð, Vistfangsútreikningur, Vistfang. Rows include instructions like movb, movw, movl, movq, movzsd, movssd and their corresponding bit fields.

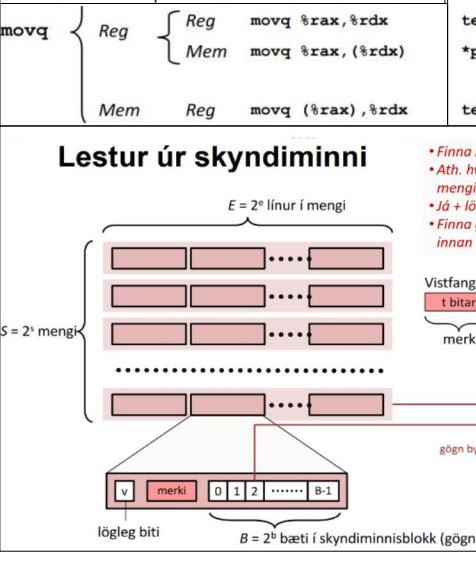


Table with 2 columns: int (*p)[13] p er 13 staka fylki af bendum á int, int (*p)[13] p er 13 staka fylki af bendum á int. Rows include instructions like movq, movzsd, movssd and their corresponding bit fields.

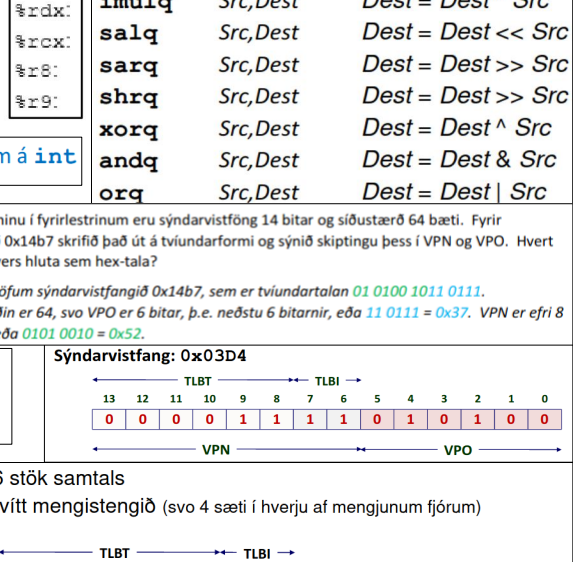


Table with 2 columns: Mengi 0 (002), Mengi 1 (012), Mengi 2 (102), Mengi 3 (112). Rows include instructions like movq, movzsd, movssd and their corresponding bit fields.

Table with 2 columns: int (*p)[13] p er 13 staka fylki af bendum á int, int (*p)[13] p er 13 staka fylki af bendum á int. Rows include instructions like movq, movzsd, movssd and their corresponding bit fields.

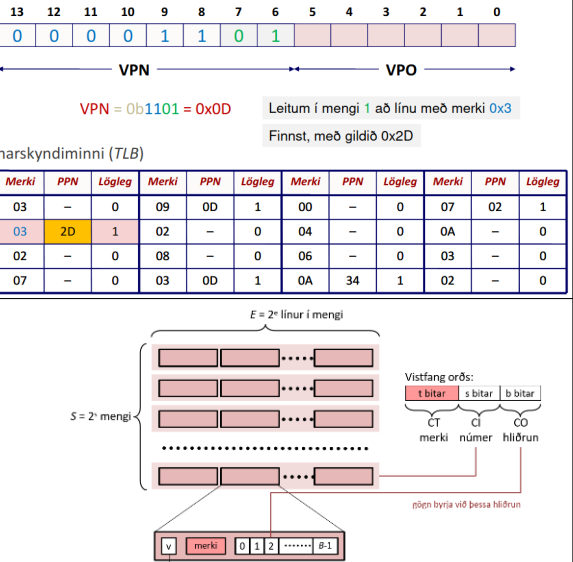


Table with 2 columns: Mengi 0 (002), Mengi 1 (012), Mengi 2 (102), Mengi 3 (112). Rows include instructions like movq, movzsd, movssd and their corresponding bit fields.

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