

Korrutusalgoritmid

Arvud on otsekoodis (positiivsed)

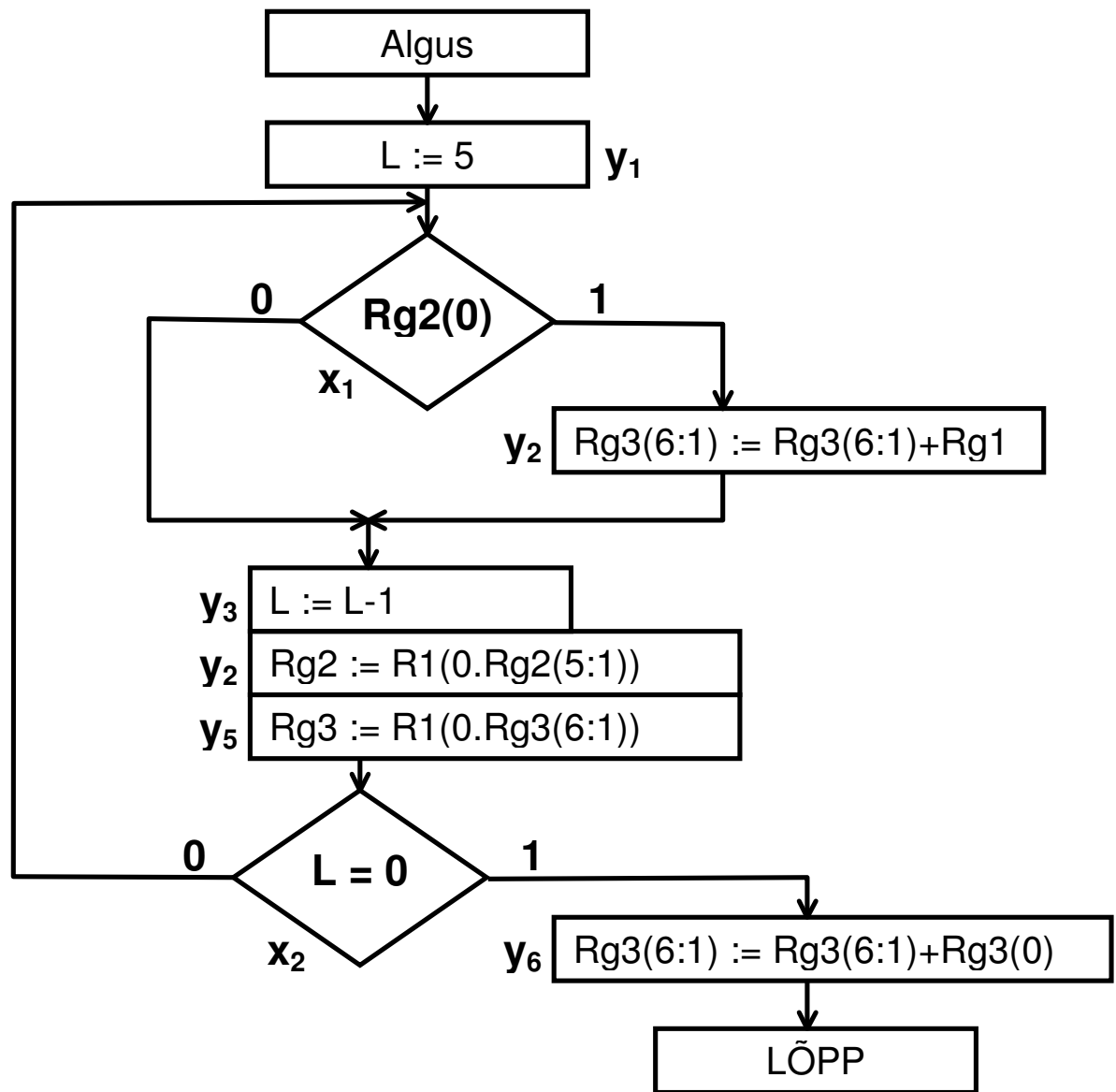
Vaatleme murdarve ($0 < A, B < 1$)

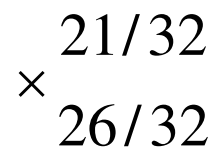
Lihtsaimad korrutamisalgoritmid

- Alates madalamatest järkudest.

Rg1 ja Rg2 : tegurid

Rg3 = 0 ; resultaadi jaoks





Algoritmi modelleerimine:

Rg1: 0,10101

Rg2: 0,11010

L := 5 (y₁)

Rg2 := 0,01101 (y₄)

L := 4 (y₃)

Rg3 := 0,101010 (y₂)

L := 3 (y₃)

Rg2 := 0,00110 (y₄)

Rg3 := 0,010101 (y₅)

L := 2 (y₃)

Rg2 := 0,00011 (y₄)

Rg3 := 0,001010 (y₅)

Rg3 := 0,110100 (y₂)

L := 1 (y₃)

Rg2 := 0,00001 (y₄)

Rg3 := 0,011010 (y₅)

Rg3 := 1,000100 (y₂)

L := 0

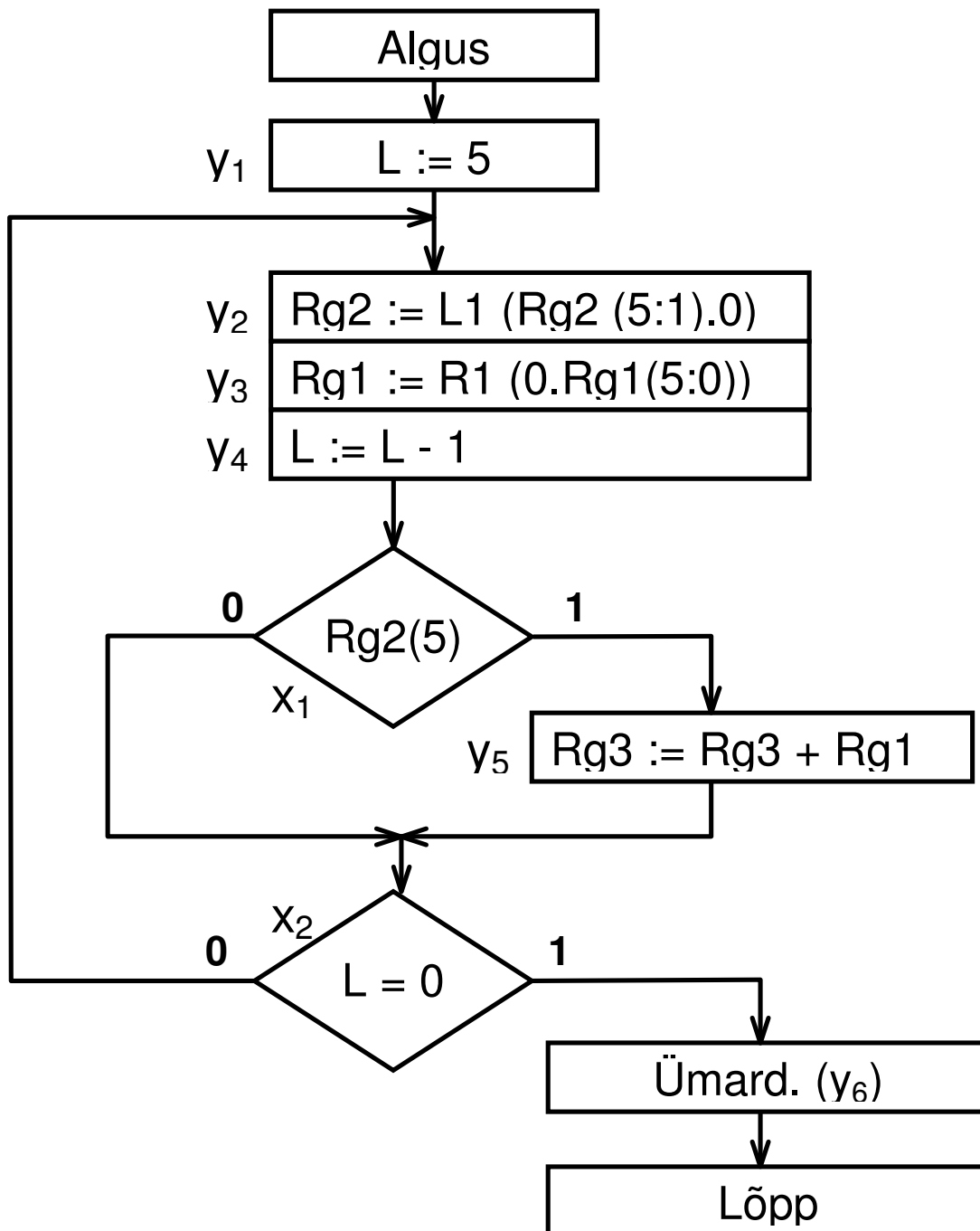
Rg2 := 0,00000 (y₄)

Rg3 := 0,100010 (y₅)

Rg3 := 0,100010 (y₆)

NB! Muutused täisarvude korral

Korrutamine alates kõrgematest järkudest



Koostame paralleelselt op.skeemi

Rg1: 0,10101(0)

Rg2: 0,11010

L:=5

Rg2:= 1,10100 (y2)

Rg1:= 0,010101 (y3)

L:=4

Rg3:= 0,010101 (y5)

Rg2:= 1,01000 (y2)

Rg1:= 0,001010 (y3)

L:=3

Rg3:= 0,011111 (y5)

Rg2:= 0,10000 (y2)

Rg1:= 0,000101 (y3)

L:=2

Rg2:= 1,00000 (y2)

Rg1:= 0,000010 (y3)

L:=1

Rg3:= 0,100001 (y5)

Rg2:= 0,00000 (y2)

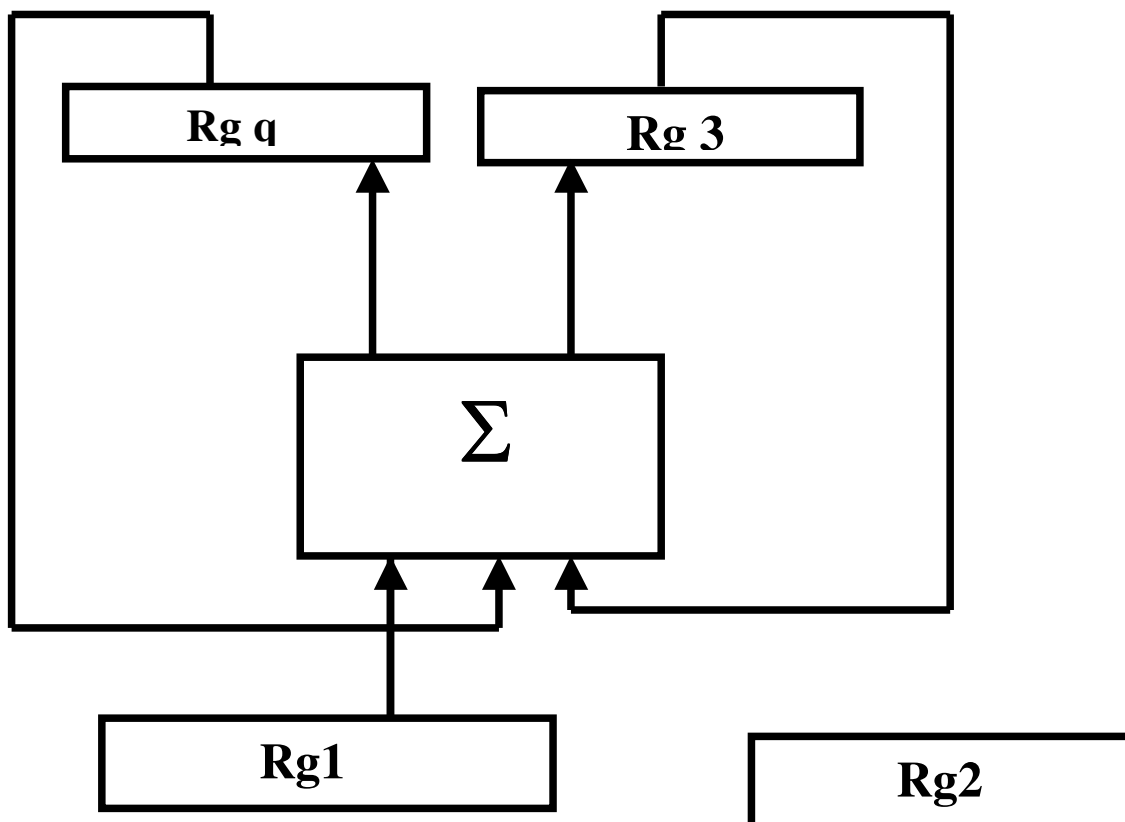
Rg1:= 0,000001 (y3)

L:= 0

Rg3:= 0,10001(0) (y6)

Korrutamise kiirendamine

- Tegurite teisendus $0111110 \rightarrow 10000\bar{1}0$
- Ülekannete vahesalvestus



Rg1: 0,10101(0)

Rg2: 0,11010

L:=5

Rg2:= 1,10100 (y2)

Rg1:= 0,010101 (y3)

L:=4

Rg3:= 0,010101 (y5) Rgq:=0,000000

Rg2:= 1,01000 (y2)

Rg1:= 0,001010 (y3)

L:=3

Rg3:= 0,011111 (y5) Rgq:=0,000000

Rg2:= 0,10000 (y2)

Rg1:= 0,000101 (y3)

L:=2

Rg2:= 1,00000 (y2)

Rg1:= 0,000010 (y3)

L:=1

Rg3:= 0,011101 (y5) Rgq:=0,000010

Rg2:= 0,00000 (y2)

Rg1:= 0,000001 (y3)

L:= 0

Rg3:= 0,10001(0) (y6: Rg3+Rgq+1)

Korrutamine 2 kohaga

00 - blok.

01 - $1 \cdot Rg1$

10 - $2 \cdot Rg1$ ($L1(Rg1)$)

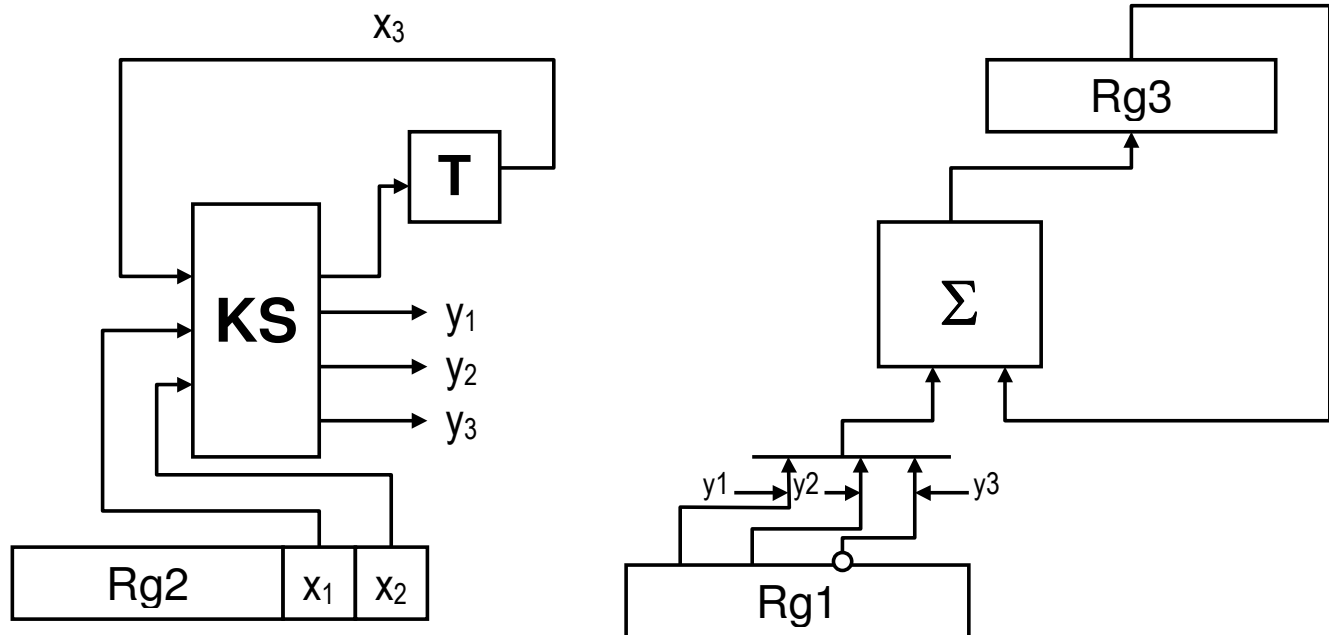
11 - $- Rg1$; +1 järgmisesse järku

$$11_2 = 100 - 1 = 10\bar{1}$$

N: 0,01101101



0,10010101



$y_1: Rg3 := Rg3 + Rg1$

$y_2: Rg3 := Rg3 + L1(Rg1)$

$y_3: Rg3 := Rg3 + \overline{Rg1}$

Korrutamine 3 kohaga

$x_1x_2x_3$	V1	V2	V3
000	-	-	-
001	+ Rg1	+ Rg1	+ Rg1
010	+ 2 (Rg1)	+ 2 (Rg1)	+ 2 (Rg1)
011	+ Rg3	+ Rg3	+Rg1+2(Rg1)
100	+ 4 (Rg1)	+ 4 (Rg1)	+ 4 (Rg1)
101	+ Rg5	-Rg3; +1	+4 (Rg1)+Rg1
110	+ 2 (Rg3)	+ 2 (Rg3)	+2 (Rg1)+4(Rg1)
111	+ Rg7	-Rg1; +1	-Rg1; +1
Lisa:	Rg3; Rg5 Rg7	Rg3	keerukas Σ

Maatrikskorrutamine

N:

$$\begin{array}{r}
 \begin{array}{cc}
 a_1 & a_0 \\
 b_1 & b_0 \\
 \hline
 a_1b_0 & a_0b_0 \\
 a_1b_1 & a_0b_1 \\
 \hline
 c_3 & c_2 & c_1 & a_0b_0 \\
 & & & || \\
 & & & c_0
 \end{array}
 \end{array}$$

$$\begin{aligned}
 c_0 &= a_0b_0 \\
 c_1 &= a_0b_1 + a_1b_0 \\
 c_2 &= q_2 + a_1b_1 \\
 c_3 &= q_3
 \end{aligned}$$

Negatiivsete arvude vahetu korrutamine

$$\begin{aligned} \text{N: } \quad 19_{10} &\Rightarrow 0 \ 1 \ 0 \ 0 \ 1 \ 1 \\ -19_{10} &\Rightarrow 1 \ 0 \ 1 \ 1 \ 0 \ 1 \Rightarrow \\ &\Rightarrow -2^5 + 2^3 + 2^2 + 2^0 \end{aligned}$$

- nihetel arvestatakse märki
- korrektsioon märgibitiga:

$$\text{N: } \quad A > 0 \quad B < 0$$

$$B_t = 2 - |B|$$

$$A * B \Rightarrow 2 - |B| \cdot A$$

$$A \cdot (2 - |B|) = 2A - |B| \cdot A$$

$$B_t = 1, b_{-1}b_{-2} \dots b_{-m} = 1 + B' = 2 - |B|$$

$$B' = 1 - |B|$$

$$A * B' = A - |B| \cdot A$$

$$A - |B| \cdot A + (2 - |A|) = 2 - |B| \cdot A$$

N: A = 011001 (+25)
B = 101101 (-19)

t₁ : Σ + A 000000011001

t₂ : -

t₃ : Σ + 4A 000001111101

t₄ : Σ + 8A 000101000101

t₅ : -

t₆ : Σ - 32A 111000100101

-19A

$$- 2^{11} + 2^{10} + 2^9 + 2^5 + 2^2 + 2^0 = - 475$$

Booth's algorithm

$$\begin{aligned}
 B_t &= (-32) \cdot B_5 + 16 \cdot B_4 + 8 \cdot B_3 + 4 \cdot B_2 + 2 \cdot B_1 + 1 \cdot B_0 = \\
 &= (-32) \cdot B_5 + (32 - 16) \cdot B_4 + (16 - 8) \cdot B_3 + (8 - 4) \cdot B_2 + \\
 &\quad (4 - 2) \cdot B_1 + (2 - 1) \cdot B_0 = \\
 &= (-32)(B_5 - B_4) - 16(B_4 - B_3) - 8(B_3 - B_2) - 4(B_2 - B_1) - \\
 &\quad - 2(B_1 - B_0) - 1(B_0) = \\
 &= 32(B_4 - B_5) + 16(B_3 - B_4) + 8(B_2 - B_3) + 4(B_1 - B_2) + \\
 &\quad + 2(B_0 - B_1) + 1(0 - B_0) =
 \end{aligned}$$

$$(B_i - B_j) \Rightarrow +1, 0, -1$$

$$A = 011001 \quad (25_{10})$$

$$B = 101101 \quad (-19_{10})$$

$B_0 = 1$	$0 - B_0 = -1$	$\Rightarrow -1 * A$
$B_1 = 0$	$B_0 - B_1 = 1$	$\Rightarrow 2 * A$
$B_2 = 1$	$B_1 - B_2 = -1$	$\Rightarrow -4 * A$
$B_3 = 1$	$B_2 - B_3 = 0$	$\Rightarrow \text{—}$
$B_4 = 0$	$B_3 - B_4 = 1$	$\Rightarrow 16 * A$
$B_5 = 1$	$B_4 - B_5 = -1$	$\Rightarrow -32 * A$
		$-19 * A$

1. Σ : 111111100111	$P_0 = -A$
2. Σ : 000000011001	$P_1 = P_0 + 2A$
3. Σ : 111110110101	$P_2 = P_1 - 4A$
4. Σ : —	$P_3 = P_2$
5. Σ : 000101000101	$P_4 = P_3 + 16A$
6. Σ : 111000100101	$P_5 = P_4 - 32A$

$$-19 * A = -475_{10}$$