Entrópia alapú adattömörítési algoritmusok

SHANNON-FANO, HUFFMAN, SHANNON-FANO-ELIAS KÓDOK

Shannon – Fano kód

$$p_1 = 0.49;\ p_2 = 0.14;\ p_3 = 0.14;$$
$$p_4 = 0.07;\ p_5 = 0.07;\ p_6 = 0.04;$$
$$p_7 = 0.02;\ p_8 = 0.02;\ p_9 = 0.01$$

Szimb.	Kódszó
X_1	01
X_2	001
X_3	101
X_4	1100
X_5	1101
X_6	11101
X_7	111100
X_8	111101
X_9	1111101

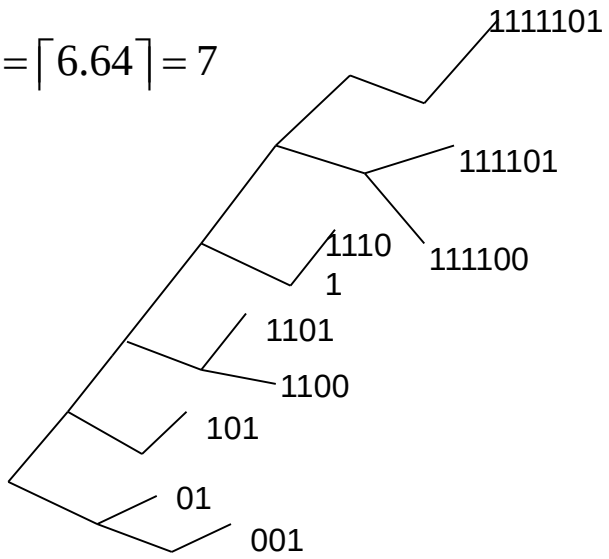
$$l_1 = ld\left\lceil \frac{1}{p_1} \right\rceil = \lceil 1.029 \rceil = 2;\quad l_2 = ld\left\lceil \frac{1}{p_2} \right\rceil = \lceil 2.836 \rceil = 3;$$

$$l_3 = ld\left\lceil \frac{1}{p_3} \right\rceil = \lceil 2.836 \rceil = 3;\ l_4 = ld\left\lceil \frac{1}{p_4} \right\rceil = \lceil 3.836 \rceil = 4;$$

$$l_5 = ld\left\lceil \frac{1}{p_5} \right\rceil = \lceil 3.836 \rceil = 4;\ l_6 = ld\left\lceil \frac{1}{p_6} \right\rceil = \lceil 4.64 \rceil = 5;$$

$$l_7 = ld\left\lceil \frac{1}{p_7} \right\rceil = \lceil 5.64 \rceil = 6;\quad l_8 = ld\left\lceil \frac{1}{p_8} \right\rceil = \lceil 5.64 \rceil = 6;$$

$$l_9 = ld\left\lceil \frac{1}{p_9} \right\rceil = \lceil 6.64 \rceil = 7$$



Hatékonyság

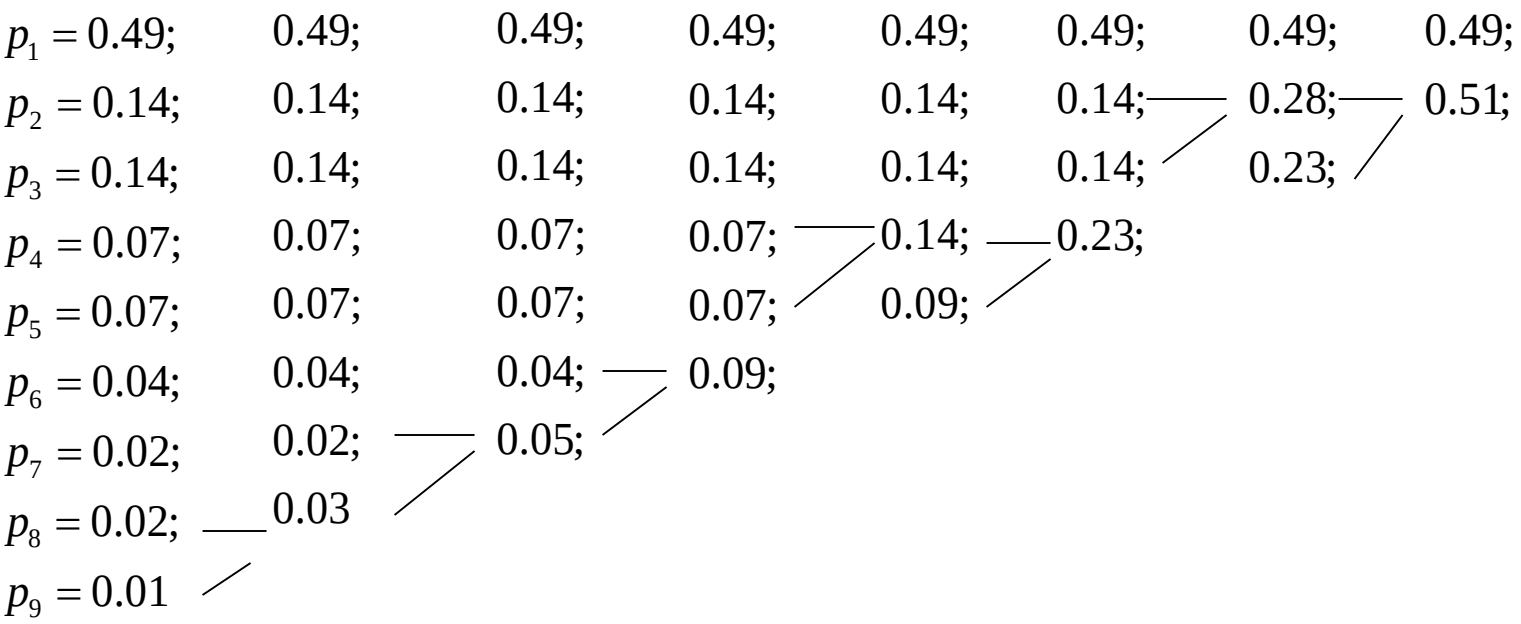
$$L_{SF}(x) = \sum_{i=1}^{N} p(x_i) l(x_i) = 0.49*2 + 0.28*3 + 0.14*4 + 0.04*5 + 0.04*6 + 0.01*7 =$$

$$= 0.98 + 0.84 + 0.56 + 0.2 + 0.24 + 0.07 = 2.89$$

$$H(X) = \sum_{i=1}^{N} p_i ld\left(\frac{1}{p_i}\right) = \ldots = 2.314$$

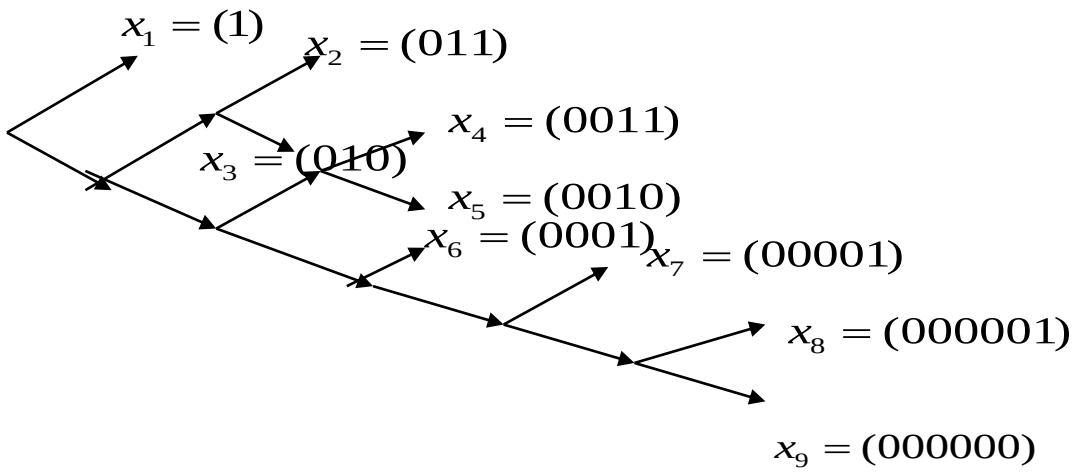
$$Efficiency = \frac{H(x)}{L_{SF}(x)} = \frac{2.314}{2.89} \approx 0.8 \Rightarrow 80\%$$

Megoldás Huffman kóddal

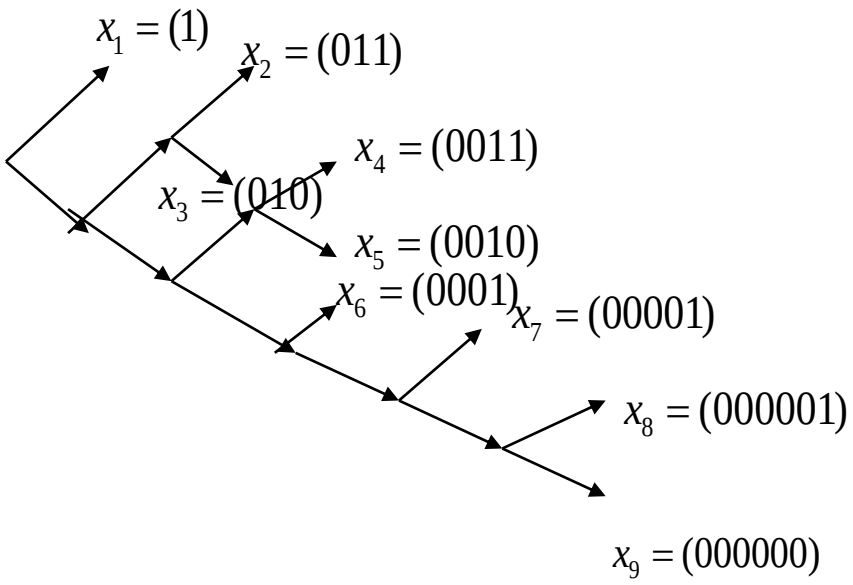


Megoldás Huffman kóddal

$p_1 = 0.49;$	0.49;	0.49;	0.49;	0.49;	0.49;	0.49;	0.49;	1
$p_2 = 0.14;$	0.14;	0.14;	0.14;	0.14;	0.14;	0.28;	0.51;	
$p_3 = 0.14;$	0.14;	0.14;	0.14;	0.14;	0.14;	0.23;		
$p_4 = 0.07;$	0.07;	0.07;	0.07;	0.14;	0.23;			
$p_5 = 0.07;$	0.07;	0.07;	0.07;	0.09;				
$p_6 = 0.04;$	0.04;	0.04;	0.09;					
$p_7 = 0.02;$	0.02;	0.05;						
$p_8 = 0.02;$	0.03							
$p_9 = 0.01$								



Megoldás Huffman kóddal



Szimb.	Kódszó
X_1	1
X_2	011
X_3	010
X_4	0010
X_5	0011
X_6	0001
X_7	00001
X_8	000001
X_9	000000

Hatékonyság

$$L_{HUFF} = 0.49*1+0.14*3+0.14*3+0.07*4+0.07*4+0.04*4+$$
$$+0.02*5+0.02*6+0.01*6=2.33$$

$$Efficiency = \frac{H(x)}{L_{HUFF}(x)} = \frac{2.314}{2.33} \approx 0.99 \Rightarrow 99\%$$

$f_s = 160$ MHz esetén

$$R_{HUFF} = 372,8 \text{ Mbps} \qquad R_{SF} = 462 \text{ Mbps}$$

$$\text{Diff. dataspeed} = 1,6*10^8 (2.89-2.33) = 89,6*10^6 \approx 90 \text{ Mbps}$$

Megoldás Shannon-Fano-Elias kóddal

eloszlás	eloszlás	Mod.eloszlás	Bin. konverzió	Kódszó
$p_1 = 0.49;$	$F(1) = 0;$	$\bar{F}(1) = 0.245;$	$0.001\overline{111101011100001010 00};$	001;
$p_2 = 0.14;$	$F(2) = 0.49;$	$\bar{F}(2) = 0.56;$	$0.1\overline{0001111011011100001 01};$	1000;
$p_3 = 0.14;$	$F(3) = 0.63;$	$\bar{F}(3) = 0.7;$	$0.101\overline{100};$	1011;
$p_4 = 0.07;$	$F(4) = 0.77;$	$\bar{F}(4) = 0.805;$	$0.1100\overline{1110000101000111101};$	11001;
$p_5 = 0.07;$	$F(5) = 0.84;$	$\bar{F}(5) = 0.875;$	$0.1110;$	11100;
$p_6 = 0.04;$	$F(6) = 0.91;$	$\bar{F}(6) = 0.93;$	$0.1110\overline{1110000101000111101};$	111011;
$p_7 = 0.02;$	$F(7) = 0.95;$	$\bar{F}(7) = 0.96;$	$0.\overline{11110101110000101000};$	1111010;
$p_8 = 0.02;$	$F(8) = 0.97;$	$\bar{F}(8) = 0.98;$	$0.1\overline{11110101110000101000};$	1111101;
$p_9 = 0.01$	$F(9) = 0.99;$	$\bar{F}(9) = 0.995;$	$0.111\overline{11110101110000101000};$	11111110;

Megoldás Shannon-Fano-Elias kóddal

Szimb.	Kódszó
X_1	001
X_2	1000
X_3	1011
X_4	11001
X_5	11100
X_6	111011
X_7	1111010
X_8	1111101
X_9	11111110

$$L_{SFE} = 0.49*3 + 0.14*4 + 0.14*4 + 0.07*5 + 0.07*5$$
$$+0.04*6 + 0.02*7 + 0.02*7 + 0.01*8 = 3.89$$

$$L^{SF} = 2.89 \qquad L^{HUFF} = 2.33$$

Hatékonyság

$L_{HUFF} = 2.33$ $L_{SF} = 2.89$ $L_{SFE} = 3.89$

$R_{HUFF} = 372.8$ Mbps $R_{SF} = 462$ Mbps $R_{SFE} = 622.4$ Mbps

Forráskódolás nélkül 640 Mbps !!!!

Konklúzió: „*L*”-ben kis javulás is nagyon sokat számít !!!

Összehasonlító analízis

teljesítőképesség

$f_s = 160$ MHz esetén

Kód	**Telj. kép**	**Átl. hossz**	**Adatátvseb**	**Alg. Kompl.**
Huffman	*L_opt*	2.33	372,8 Mbps	Ker.+ bin. fa
SF	$H(X)<L<H(X)+1$	2.89	462,4 Mbps	bin. fa
SFE	$H(X)<L<H(X)+2$	3.89	622,4 Mbps	Bin. konv.

alg. implementáció