

# Uporaba diskretne kosinusne transformacije pri kompresiji slik v formatu JPEG

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Zagovor diplomske naloge  
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# Uvod

- Diskretna kosinusna transformacija
- Kodiranje bloka v JPEG
- Primeri slik v JPEG

# Diskretna kosinusna transformacija (DCT)

- enodimenzionalna DCT

$$C(u) = \alpha(u) \sum_{x=0}^{N-1} f(x) \cos \left[ \frac{\pi(2x+1)u}{2N} \right], u = 0, 1, 2, \dots, N-1$$

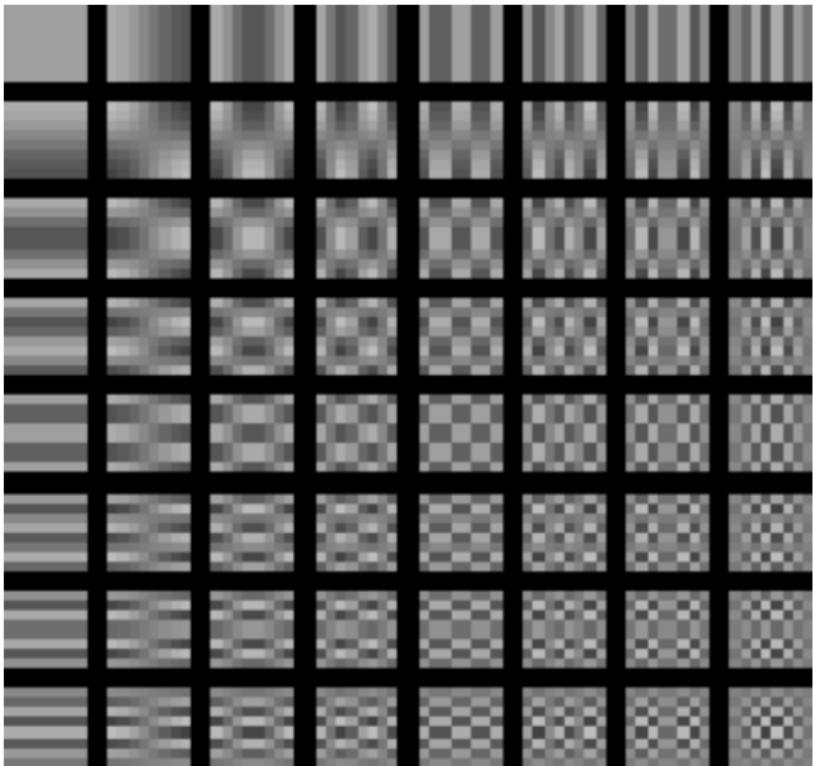
$$\alpha(u) = \begin{cases} \sqrt{\frac{1}{N}}, & u = 0 \\ \sqrt{\frac{2}{N}}, & u \neq 0 \end{cases}$$

- dvodimenzionalna DCT

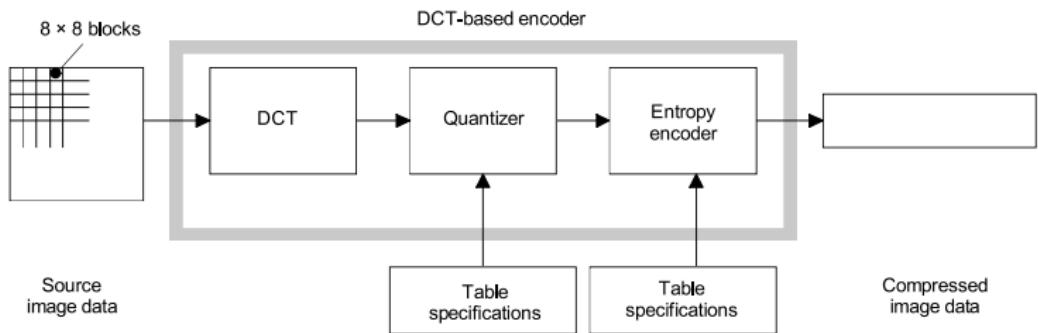
$$C(u, v) = \alpha(u)\alpha(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x, y) \cos \left[ \frac{\pi(2x+1)u}{2N} \right] \cos \left[ \frac{\pi(2y+1)v}{2N} \right],$$
$$u, v = 0, 1, 2, \dots, N-1$$

# Kosinusne bazne funkcije DCT

- koeficient DC
- koeficienti AC

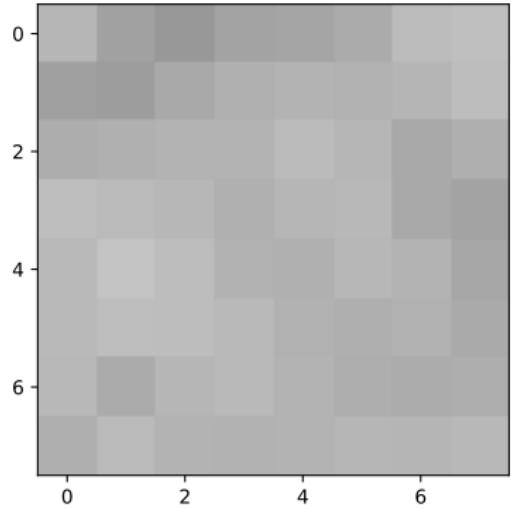


# Shema kodiranja JPEG



# Blok slike

$$I = \begin{bmatrix} 182 & 161 & 152 & 164 & 165 & 171 & 188 & 191 \\ 160 & 157 & 169 & 176 & 179 & 177 & 181 & 189 \\ 173 & 176 & 179 & 180 & 187 & 182 & 169 & 175 \\ 190 & 186 & 183 & 176 & 182 & 184 & 169 & 164 \\ 185 & 195 & 189 & 178 & 176 & 183 & 180 & 167 \\ 185 & 190 & 189 & 185 & 177 & 175 & 177 & 170 \\ 184 & 171 & 182 & 185 & 180 & 174 & 172 & 174 \\ 175 & 186 & 179 & 178 & 180 & 182 & 181 & 184 \end{bmatrix}$$



# Zamaknjen blok

$$I' = I - 128 = \begin{bmatrix} 54 & 33 & 24 & 36 & 37 & 43 & 60 & 63 \\ 32 & 29 & 41 & 48 & 51 & 49 & 53 & 61 \\ 45 & 48 & 51 & 52 & 59 & 54 & 41 & 47 \\ 62 & 58 & 55 & 48 & 54 & 56 & 41 & 36 \\ 57 & 67 & 61 & 50 & 48 & 55 & 52 & 39 \\ 57 & 62 & 61 & 57 & 49 & 47 & 49 & 42 \\ 56 & 43 & 54 & 57 & 52 & 46 & 44 & 46 \\ 47 & 58 & 51 & 50 & 52 & 54 & 53 & 56 \end{bmatrix}$$

# Izračun DCT bloka

$$C(u, v) = \alpha(u)\alpha(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x, y) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right]$$

$$C(I') = \begin{bmatrix} 399,1 & 3,5 & -0,7 & 4,2 & 0,9 & 0,3 & 1,8 & 0 \\ -20,6 & -27,3 & 9,3 & 6,1 & 9,8 & 2,3 & 1,1 & 1 \\ -15,1 & -35 & 15,4 & -4,2 & 14,7 & 5,6 & -3,1 & -0,5 \\ -2,7 & 3,8 & 15,3 & -0,6 & -0,9 & 12 & -5,2 & 0,3 \\ 3,4 & 4,7 & 16,6 & 10 & -8,9 & -1,9 & -4 & -2,8 \\ -4,8 & 10,9 & 3,4 & 9,1 & 10,1 & 4,1 & 4,1 & 1,1 \\ 5 & 5,7 & 3,9 & 0,3 & -3,3 & -4,4 & -4,6 & -2,5 \\ 0,2 & -0,4 & 0 & 0,3 & -0,2 & 0 & 0 & -0,3 \end{bmatrix}$$

# Pomen DCT

399,1	3,5	-0,7	4,2	0,9	0,3	1,8	0
-20,6	-27,3	9,3	6,1	9,8	2,3	1,1	1
-15,1	-35	15,4	-4,2	14,7	5,6	-3,1	-0,5
-2,7	3,8	15,3	-0,6	-0,9	12	-5,2	0,3
3,4	4,7	16,6	10	-8,9	-1,9	-4	-2,8
-4,8	10,9	3,4	9,1	10,1	4,1	4,1	1,1
5	5,7	3,9	0,3	-3,3	-4,4	-4,6	-2,5
0,2	-0,4	0	0,3	-0,2	0	0	-0,3

# Kvantizacija

- Kompresija z izgubo

$$C^Q(u, v) = \text{Integer round} \left( \frac{C(u, v)}{Q(u, v)} \right)$$

399,1	3,5	-0,7	4,2	0,9	0,3	1,8	0
-20,6	-27,3	9,3	6,1	9,8	2,3	1,1	1
-15,1	-35	15,4	-4,2	14,7	5,6	-3,1	-0,5
-2,7	3,8	15,3	-0,6	-0,9	12	-5,2	0,3
3,4	4,7	16,6	10	-8,9	-1,9	-4	-2,8
-4,8	10,9	3,4	9,1	10,1	4,1	4,1	1,1
5	5,7	3,9	0,3	-3,3	-4,4	-4,6	-2,5
0,2	-0,4	0	0,3	-0,2	0	0	-0,3

$C(u, v)$

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	12
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

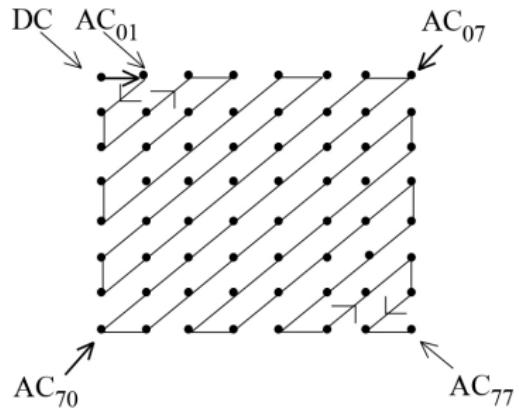
$Q(u, v)$

# Zapis v vrstici

$$C^Q(I') = \begin{bmatrix} 25 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -2 & -2 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & -3 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

# Zapis v vrstici

$$C^Q(I') = \begin{bmatrix} 25 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -2 & -2 & 1 & 0 & 0 & 0 & 0 & 0 \\ -1 & -3 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

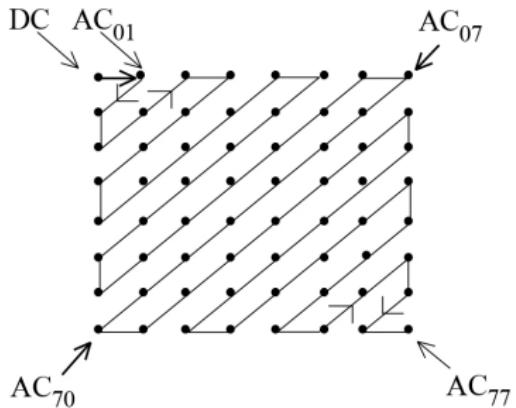


# Zapis v vrstici

$$C^Q(I') = \begin{bmatrix} 25 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -2 & -2 & 1 & 0 & 0 & 0 & 0 & 0 \\ -1 & -3 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

DC = 25

$$AC = \begin{bmatrix} 0, & -2, & -1, & -2, & 0, & 0, & 1, & -3, & 0, & 0, & 0, & 1, & 0, & 0, & 0, & 0, & 0, \\ 0, & 1, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, \\ 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, \\ 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0, & 0 \end{bmatrix}$$



# Vmesna predstavitev

DC = 25 —→ (5)(25)

## Vmesna predstavitev

$$DC = 25 \rightarrow (5)(25)$$

$$(1, 2)(-2)$$

## Vmesna predstavitev

$$DC = 25 \rightarrow (5)(25)$$

$$(1,2)(-2), (0,1)(-1)$$

## Vmesna predstavitev

$$DC = 25 \rightarrow (5)(25)$$

$$(1, 2)(-2), (0, 1)(-1), (0, 2)(-2), (2, 1)(1), \\ (0, 2)(-3), (3, 1)(1), (5, 1)(1),$$

## Vmesna predstavitev

$$DC = 25 \rightarrow (5)(25)$$

$$(1, 2)(-2), (0, 1)(-1), (0, 2)(-2), (2, 1)(1), \\ (0, 2)(-3), (3, 1)(1), (5, 1)(1), (0, 0)$$

# Kodiranje

## Huffmanova kodirna tabela koeficientov DC

(5)

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

(5)

110

Huffmanova kodirna tabela  
koeficientov DC

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

Variable-length integer(VLI)

(5)(25) 110

Huffmanova kodirna tabela  
koeficientov DC

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

Variable-length integer(VLI)

(5)(25) 110 11001

Huffmanova kodirna tabela  
koeficientov DC

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

Variable-length integer(VLI)

(5)(25) 110 11001

(1, 2)

(0, 1)

(0, 2)

(2, 1)

(0, 2)

(3, 1)

(5, 1)

(0, 0)

Huffmanova kodirna tabela  
koeficientov DC

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

## Variable-length integer(VLI)

(5)(25)	110 11001
(1, 2)	11011
(0, 1)	00
(0, 2)	01
(2, 1)	11100
(0, 2)	01
(3, 1)	111010
(5, 1)	1111010
(0, 0)	1010

## Huffmanova kodirna tabela koeficientov DC

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

## Variable-length integer(VLI)

(5)(25)	110 11001
(1, 2)(-2)	11011
(0, 1)(-1)	00
(0, 2)(-2)	01
(2, 1)(1)	11100
(0, 2)(-3)	01
(3, 1)(1)	111010
(5, 1)(1)	1111010
(0, 0)	1010

## Huffmanova kodirna tabela koeficientov DC

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

## Variable-length integer(VLI)

(5)(25)	110 11001
(1, 2)(-2)	11011 01
(0, 1)(-1)	00 0
(0, 2)(-2)	01 01
(2, 1)(1)	11100 1
(0, 2)(-3)	01 00
(3, 1)(1)	111010 1
(5, 1)(1)	1111010 1
(0, 0)	1010

## Huffmanova kodirna tabela koeficientov DC

$S$	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

# Kodiranje

## Variable-length integer(VLI)

(5)(25)	110 11001
(1, 2)(-2)	11011 01
(0, 1)(-1)	00 0
(0, 2)(-2)	01 01
(2, 1)(1)	11100 1
(0, 2)(-3)	01 00
(3, 1)(1)	111010 1
(5, 1)(1)	1111010 1
(0, 0)	1010

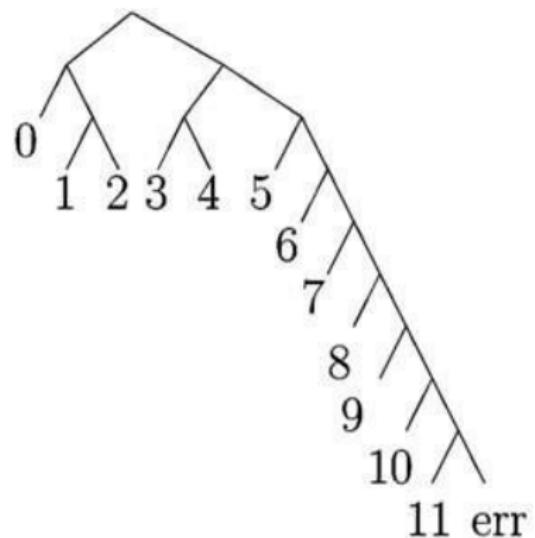
## Huffmanova kodirna tabela koeficientov DC

<i>S</i>	Kodna beseda
0	00
1	010
2	011
3	100
4	101
5	110
6	1110
7	11110
8	111110
9	1111110
10	11111110
11	111111110

11011001 11011010 00010111 10010100 11101011 11101011 010

# Dekodiranje

110111001 11011010 00010111 10010100 11101011 11101011 010

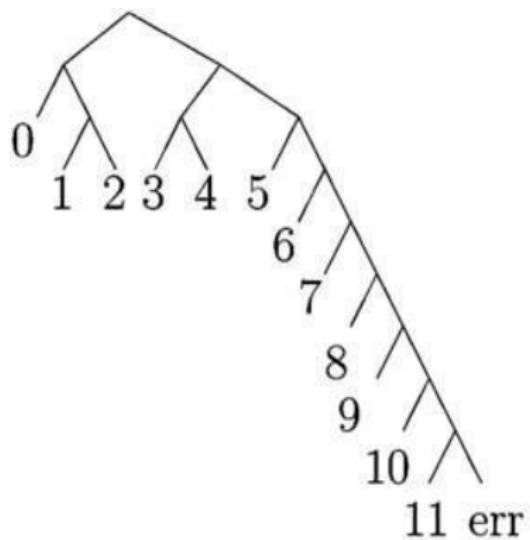


# Dekodiranje

110111001 11011010 00010111 10010100 11101011 11101011 010

(5)

110

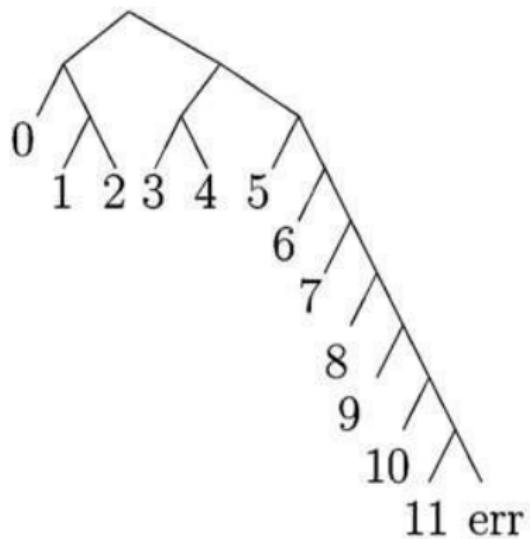


# Dekodiranje

11011001 11011010 00010111 10010100 11101011 11101011 010

(5)

110 11001

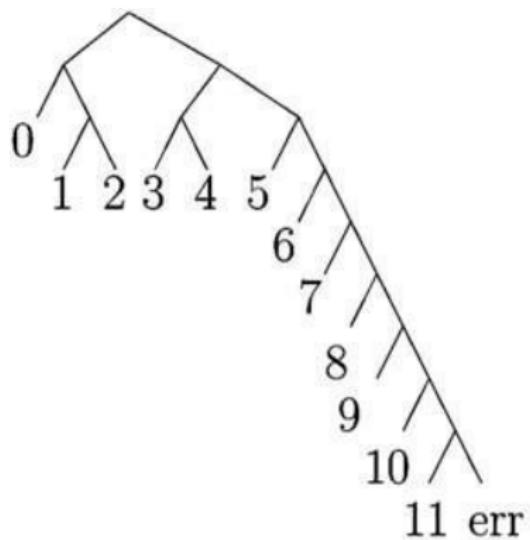


# Dekodiranje

11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)

110 11001



DC = 25

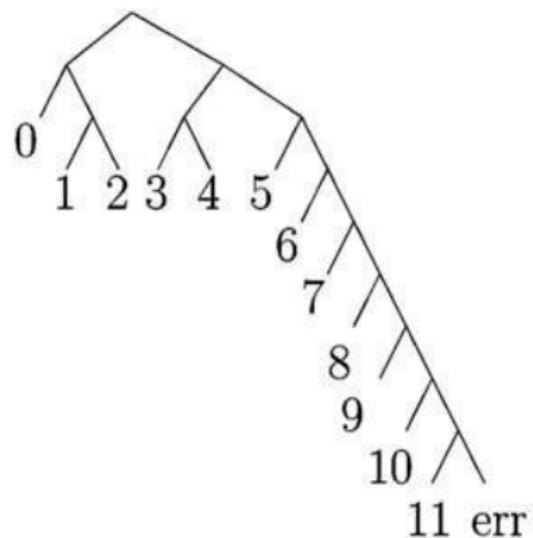
# Dekodiranje

11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)

110 11001

11011



DC = 25

# Dekodiranje

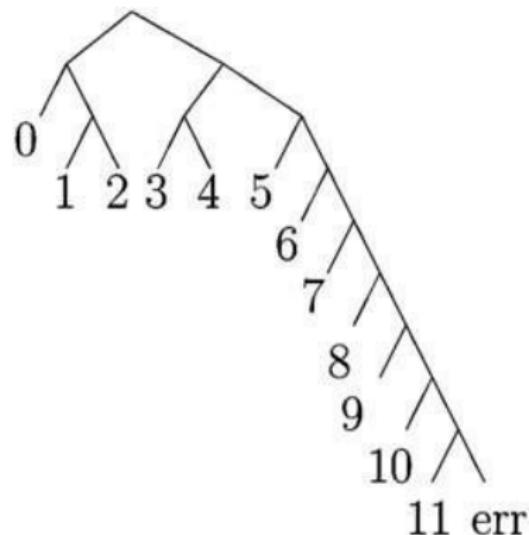
11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)

(1,2)

110 11001

11011



DC = 25

# Dekodiranje

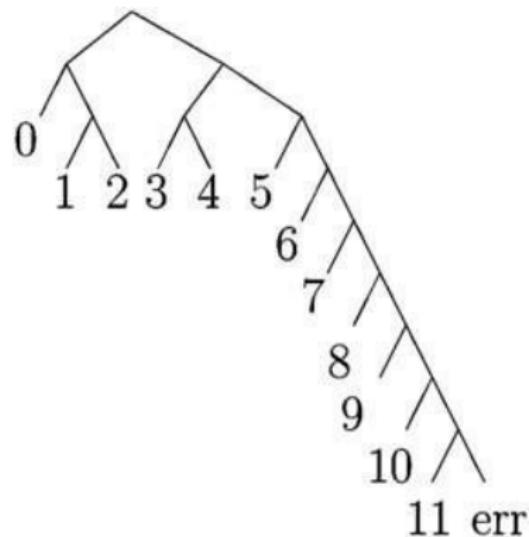
11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)

(1,2)

110 11001

11011 01



DC = 25

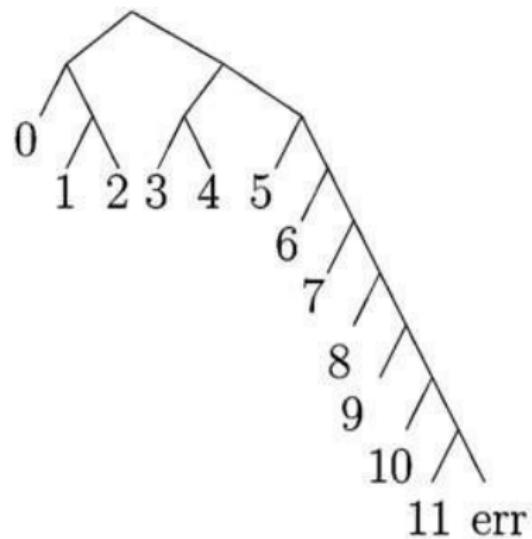
[0

AC =

# Dekodiranje

11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)      110 11001  
(1, 2)(-2)    11011 01



DC = 25

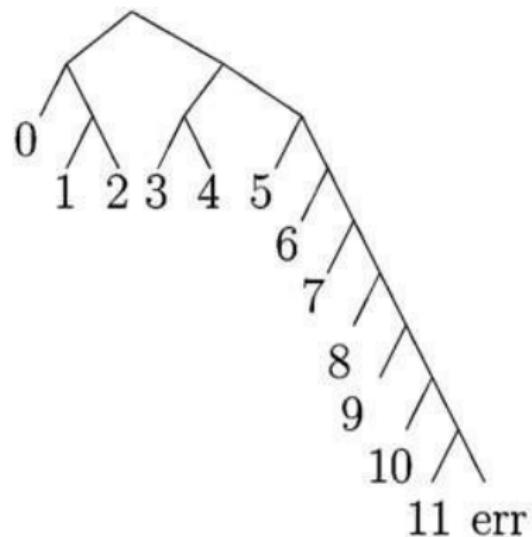
[0, -2

AC =

# Dekodiranje

11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)	110 11001
(1, 2)(-2)	11011 01
(0, 1)(-1)	00 0
(0, 2)(-2)	01 01
(2, 1)(1)	11100 1
(0, 2)(-3)	01 00
(3, 1)(1)	111010 1
(5, 1)(1)	1111010 1



DC = 25

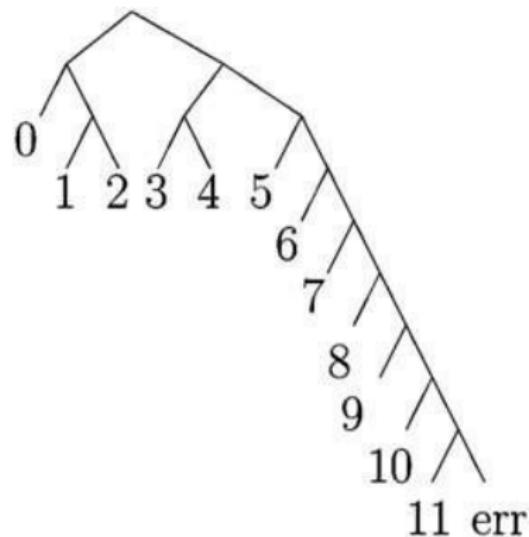
[0, -2, -1, -2, 0, 0, 1, -3, 0, 0, 0, 1, 0, 0, 0, 0, 0,  
0, 1,

AC =

# Dekodiranje

11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)	110 11001
(1, 2)(-2)	11011 01
(0, 1)(-1)	00 0
(0, 2)(-2)	01 01
(2, 1)(1)	11100 1
(0, 2)(-3)	01 00
(3, 1)(1)	111010 1
(5, 1)(1)	1111010 1
(0, 0)	1010



DC = 25

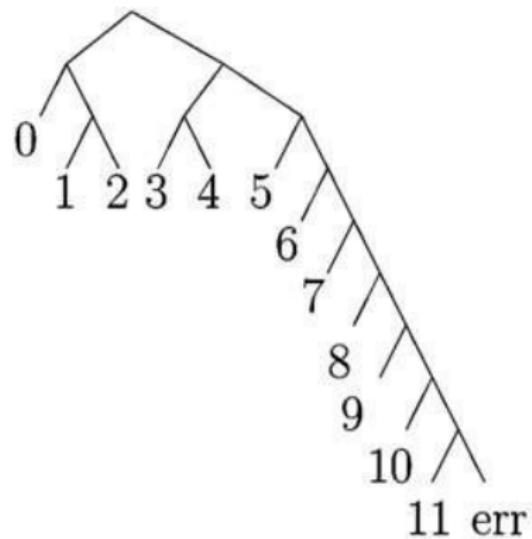
[0, -2, -1, -2, 0, 0, 1, -3, 0, 0, 0, 1, 0, 0, 0, 0, 0,  
0, 1,

AC =

# Dekodiranje

11011001 11011010 00010111 10010100 11101011 11101011 010

(5)(25)	110	11001
(1, 2)(-2)	11011	01
(0, 1)(-1)	00	0
(0, 2)(-2)	01	01
(2, 1)(1)	11100	1
(0, 2)(-3)	01	00
(3, 1)(1)	111010	1
(5, 1)(1)	1111010	1
(0, 0)	1010	



DC = 25

# Dekvantizacija

$$C^Q(\tilde{I}') = \begin{bmatrix} 25 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -2 & -2 & 1 & 0 & 0 & 0 & 0 & 0 \\ -1 & -3 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

# Dekvantizacija

$$C(u, v) = C^Q(u, v) \cdot Q(u, v)$$

$$C^Q(\tilde{I}') = \begin{bmatrix} 25 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -2 & -2 & 1 & 0 & 0 & 0 & 0 & 0 \\ -1 & -3 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad C(\tilde{I}') = \begin{bmatrix} 400 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -24 & -24 & 14 & 0 & 0 & 0 & 0 & 0 \\ -14 & -39 & 16 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 22 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

# Inverzni DCT

$$f(x, y) = \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} \alpha(u)\alpha(v)C(u, v) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right],$$

$$x, y = 0, 1, 2, \dots, N - 1$$

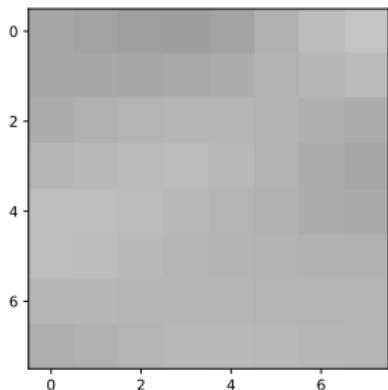
$$C(\tilde{l}') = \begin{bmatrix} 400 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -24 & -24 & 14 & 0 & 0 & 0 & 0 & 0 \\ -14 & -39 & 16 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 22 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\tilde{l}' = \begin{bmatrix} 40 & 36 & 31 & 30 & 36 & 47 & 60 & 69 \\ 40 & 40 & 39 & 41 & 44 & 49 & 54 & 57 \\ 44 & 47 & 51 & 53 & 53 & 50 & 46 & 44 \\ 54 & 56 & 58 & 59 & 56 & 49 & 43 & 38 \\ 62 & 61 & 59 & 56 & 52 & 48 & 44 & 42 \\ 62 & 60 & 56 & 53 & 50 & 49 & 48 & 48 \\ 54 & 54 & 53 & 53 & 53 & 52 & 51 & 51 \\ 45 & 48 & 52 & 55 & 56 & 55 & 53 & 51 \end{bmatrix}$$

# Primerjava blokov

Približek originalnemu bloku

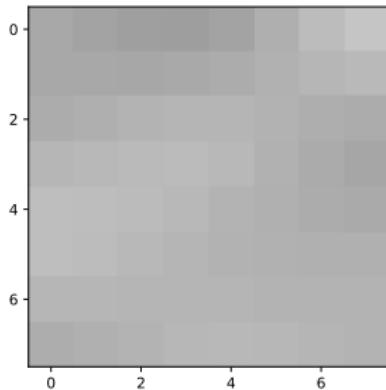
$$\tilde{I} = \begin{bmatrix} 168 & 164 & 159 & 158 & 164 & 175 & 188 & 197 \\ 168 & 168 & 167 & 169 & 172 & 177 & 182 & 185 \\ 172 & 175 & 179 & 181 & 181 & 178 & 174 & 172 \\ 182 & 184 & 186 & 187 & 184 & 177 & 171 & 166 \\ 190 & 189 & 187 & 184 & 180 & 176 & 172 & 170 \\ 190 & 188 & 184 & 181 & 178 & 177 & 176 & 176 \\ 182 & 182 & 181 & 181 & 181 & 180 & 179 & 179 \\ 173 & 176 & 180 & 183 & 184 & 183 & 181 & 179 \end{bmatrix}$$



# Primerjava blokov

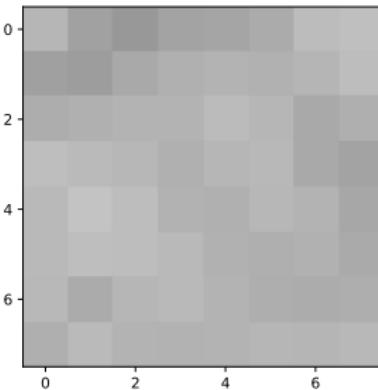
Približek originalnemu bloku

$$\tilde{I} = \begin{bmatrix} 168 & 164 & 159 & 158 & 164 & 175 & 188 & 197 \\ 168 & 168 & 167 & 169 & 172 & 177 & 182 & 185 \\ 172 & 175 & 179 & 181 & 181 & 178 & 174 & 172 \\ 182 & 184 & 186 & 187 & 184 & 177 & 171 & 166 \\ 190 & 189 & 187 & 184 & 180 & 176 & 172 & 170 \\ 190 & 188 & 184 & 181 & 178 & 177 & 176 & 176 \\ 182 & 182 & 181 & 181 & 181 & 180 & 179 & 179 \\ 173 & 176 & 180 & 183 & 184 & 183 & 181 & 179 \end{bmatrix}$$



Originalen blok

$$I = \begin{bmatrix} 182 & 161 & 152 & 164 & 165 & 171 & 188 & 191 \\ 160 & 157 & 169 & 176 & 179 & 177 & 181 & 189 \\ 173 & 176 & 179 & 180 & 187 & 182 & 169 & 175 \\ 190 & 186 & 183 & 176 & 182 & 184 & 169 & 164 \\ 185 & 195 & 189 & 178 & 176 & 183 & 180 & 167 \\ 185 & 190 & 189 & 185 & 177 & 175 & 177 & 170 \\ 184 & 171 & 182 & 185 & 180 & 174 & 172 & 174 \\ 175 & 186 & 179 & 178 & 180 & 182 & 181 & 184 \end{bmatrix}$$



# Primer slike v JPEG



peppers



peppers 5



peppers 25



peppers 50



peppers 75



peppers 95

Ime slike	velikost
peppers	769 kB
peppers 5	8 kB
peppers 25	17 kB
peppers 50	26 kB
peppers 75	41 kB
peppers 95	122 kB

## Problematičen primer

A large square grid composed of 100 smaller squares arranged in a 10x10 pattern. Each of the smaller squares is a perfect copy of the entire 10x10 grid, creating a recursive, infinite-loop visual effect.

text

A large grid of 100 small, identical JPEG images arranged in a 10x10 pattern. Each individual image is a standard JPEG file, showing a white background with a few small, dark specks.

text 50

A large grid of 100 small, identical images arranged in a 10x10 pattern. Each image is a thumbnail of a JPEG file, showing a white square with a black border.

text 5

text 75

A large grid of 100 small images arranged in a 10x10 pattern. Each individual image is labeled 'JPEG' in the top-left corner and shows a different scene from a video frame, likely a sequence of frames from a video file.

text 25

A large grid of 100 small, identical JPEG images arranged in a 10x10 pattern. Each individual image is a standard JPEG file, showing a white background with a few small, dark specks.

text 95

Ime slike	velikost
text	18 kB
text 5	22 kB
text 25	44 kB
text 50	63 kB
text 75	85 kB
text 95	151 kB

# Problematičen primer

JPEG

text

JPEG

text 5

JPEG

text 25

JPEG

text 50

JPEG

text 75

JPEG

text 95

Hvala za vašo pozornost