

Image compression

Georgios Tziritas
Computer Science Department
<http://www.csd.uoc.gr/~tziritas>

Spring 2018

JPEG



Colour system YCbCr / RGB
Subsampling chromaticities

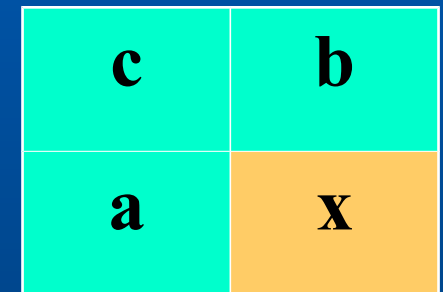
Lossless : predictive coding
Lossy : transform coding (DCT)
Huffman coding

Lossless JPEG compression



Predictive coding

Option	Prediction
0	no
1	$x = a$
2	$x = b$
3	$x = c$
4	$x = a + b - c$
5	$x = a + (b - c)/2$
6	$x = b + (a - c)/2$
7	$x = (a + b)/2$



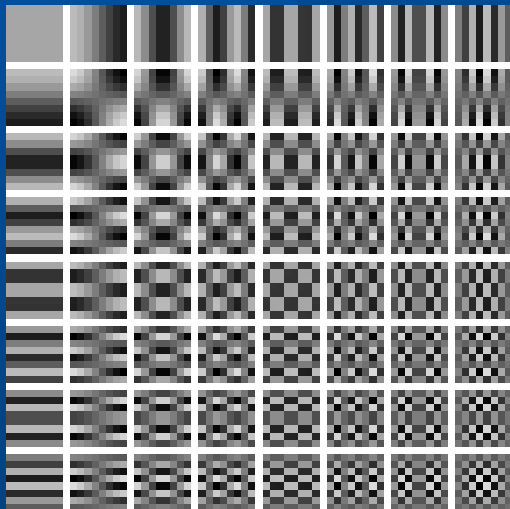
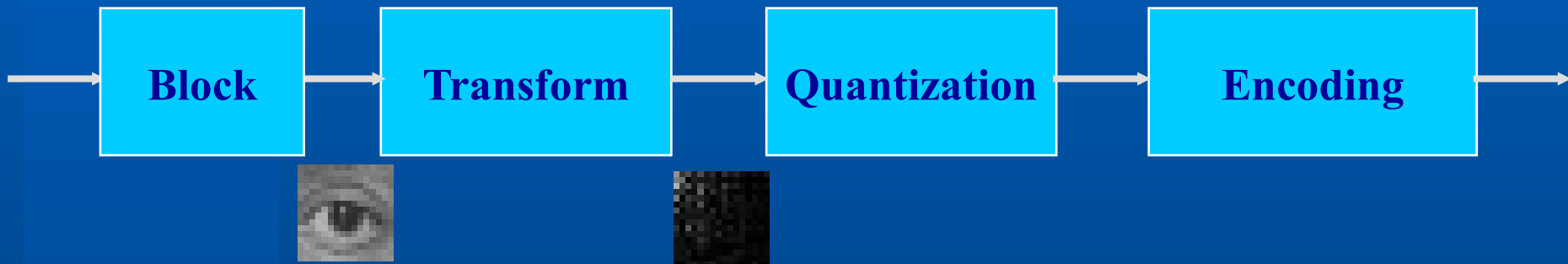
Linear filter prediction

Huffman code

	Prediction error
0	0
1	-1,1
2	-3,-2,2,3
3	-7,-4,4,7
4	-15,-8,8,15
5	-31,-16,16,31
6	-63,-32,32,63
7	-127,-64,64,127
8	-255,-128,128,255
9	-511,-256,256,511
10	-1 023,-512,512,1 023
11	-2 047,-1 024,1 024,2 047
12	-4 095,-2 048,2 048,4 095
13	-8 191,-4 096,4 096,8 191
14	-16 383,-8 192,8 192,16 383
15	-32 767,-16 384,16 384,32 767
16	32 768



Transform coding



Discrete Cosine Transform

$$t(m, n; i, k) = \frac{c(m)c(n)}{N} \cos \frac{(2i+1)m\pi}{2N} \cos \frac{(2k+1)n\pi}{2N}$$

$$Y = T X T^T \text{ και } X = T^T Y T$$

Quantization



Variable bitrate

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	62
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

**Uniform quantizer with
variable step**

0	1	5	6	14	15	27	28
2	4	7	13	16	26	29	42
3	8	12	17	25	30	41	43
9	11	18	24	31	40	44	53
10	19	23	32	39	45	52	54
20	22	33	38	46	51	55	60
21	34	37	47	50	56	59	61
35	36	48	49	57	58	62	63

Zigzag scanning



DC coefficient coding

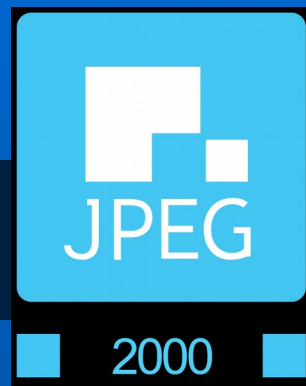
	Codeword	Prediction error
0	00	0
1	010	-1,1
2	011	-3,-2,2,3
3	100	-7..-4,4..7
4	101	-15..-8,8..15
5	110	-31..-16,16..31
6	1110	-63..-32,32..63
7	11110	-127..-64,64..127
8	111110	-255..-128,128..255
9	1111110	-511..-256,256..511
10	11111110	-1 023..-512,512..1 023
11	111111110	-2 047..-1 024,1 024..2 047

AC coefficient coding



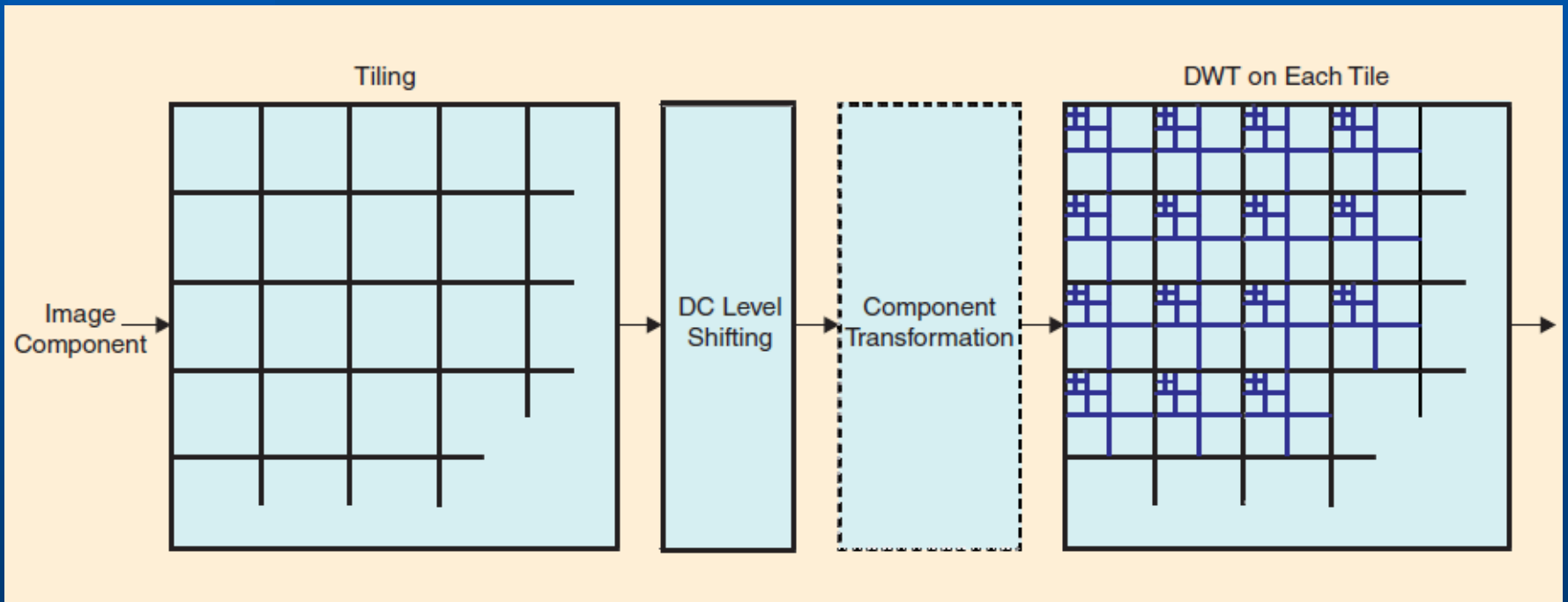
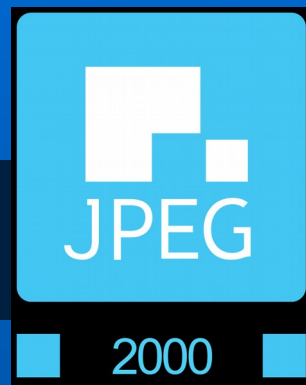
"0" / "S"	Codeword
0/0 (EOB)	1010
0/1	00
0/2	01
0/3	100
0/4	1011
0/5	11010
1/1	1100
1/2	11011
1/3	1111001
1/4	111110110
2/1	11100
2/2	11111001
2/3	1111110111

JPEG 2000



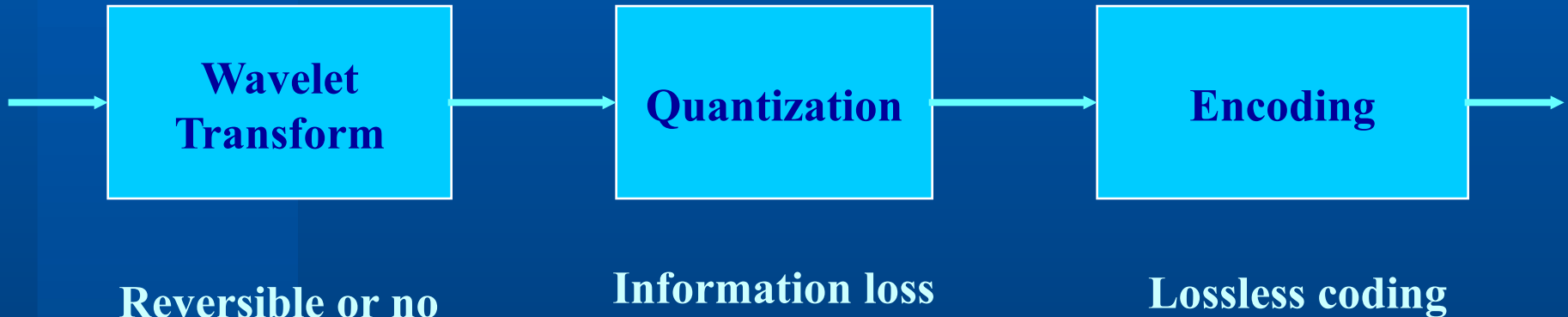
- **Rate-distortion improvement**
- **Quality scaling**
- **Multiresolution**
- **Progressive decoding**
- **Tiling**
- **Region of interest coding**
- **Transmission error resilience**

JPEG 2000 : image processing



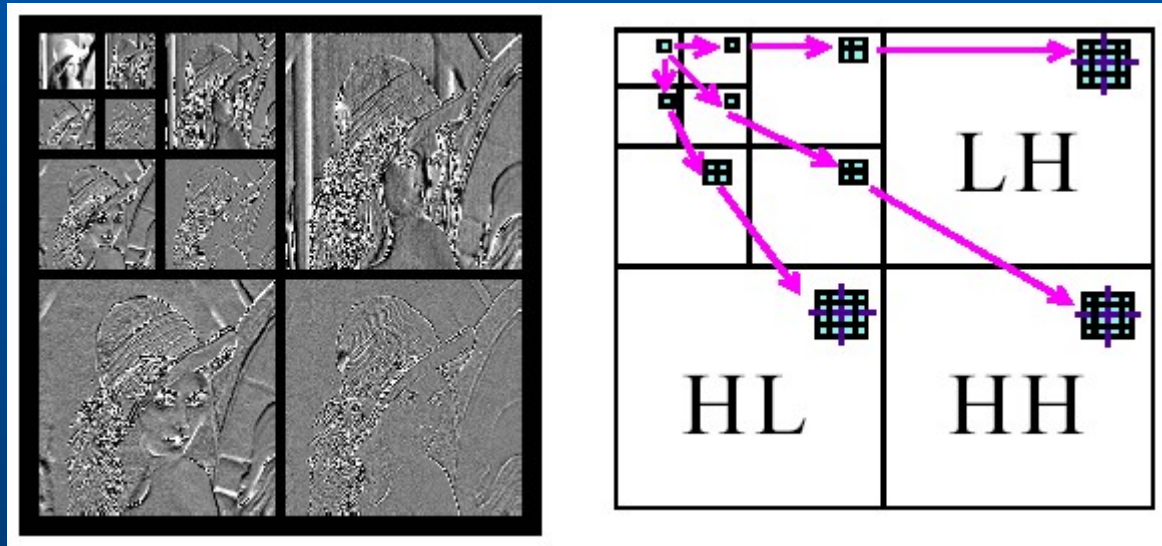


Discrete Wavelet Transform



Colour system $Y C_B C_R$ or $(0.25 R + 0.5 G + 0.25 B, B - G, R - G)$
Chromaticity components subsampling
Arithmetic coding

Discrete Wavelet Transform



Comparison

JPEG

JPEG

JPEG

2000



JPEG
 $\beta=20.80$



JPEG
2000
 $\beta=20.41$

Comparison



JPEG
 $\beta=40.14$



JPEG
2000
 $\beta=41.49$