

Video compression

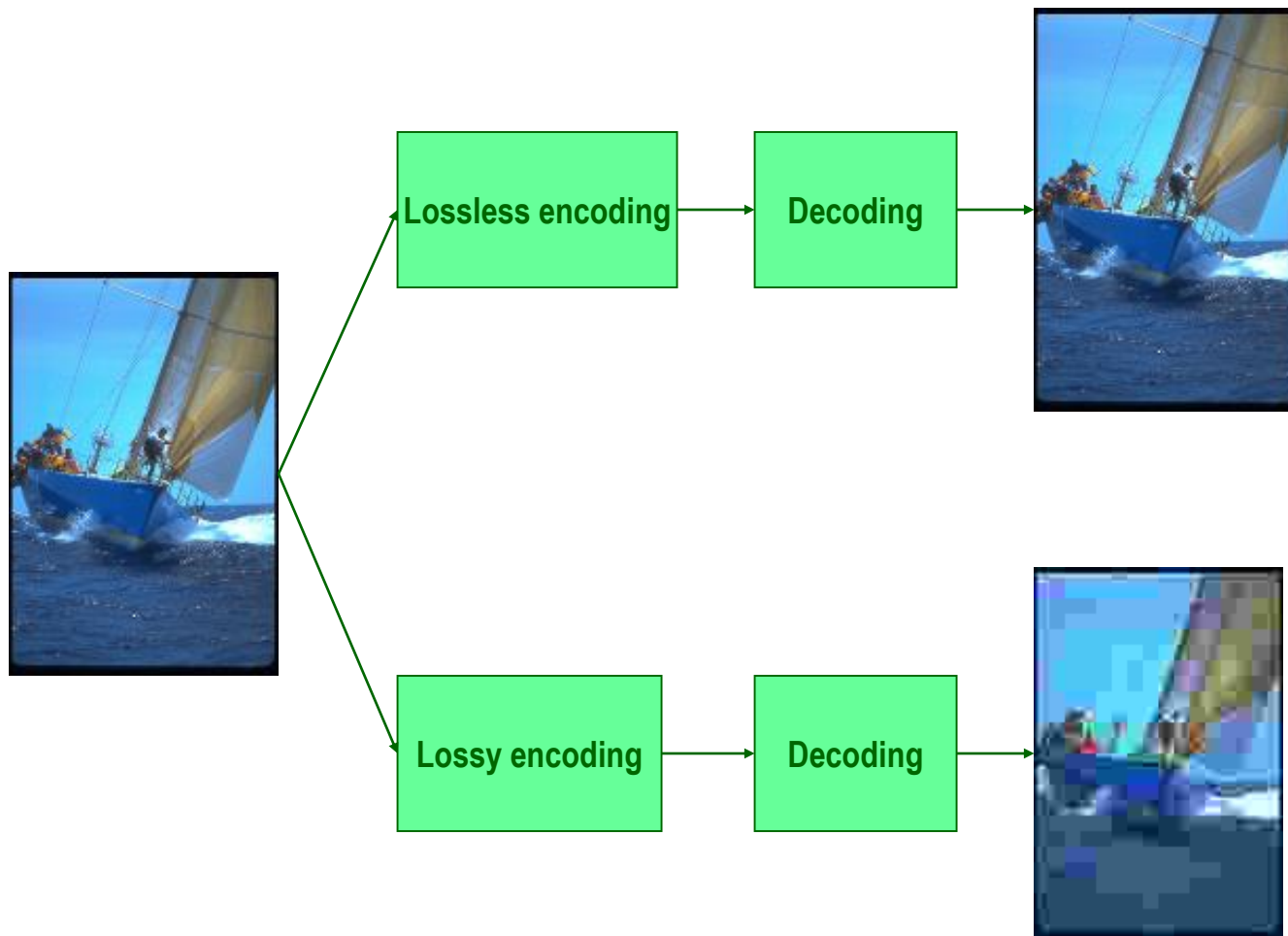
Image compression

JPEG

MPEG

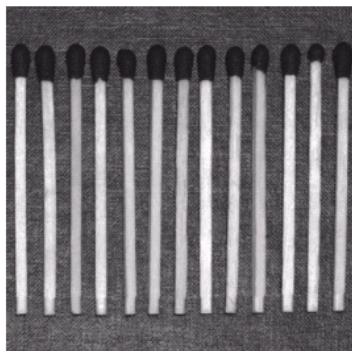
Compression

Compression

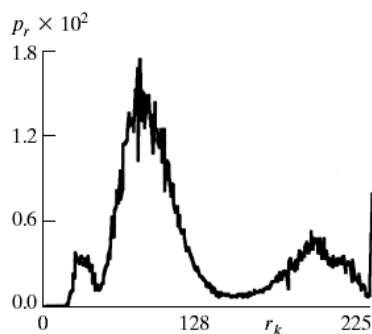
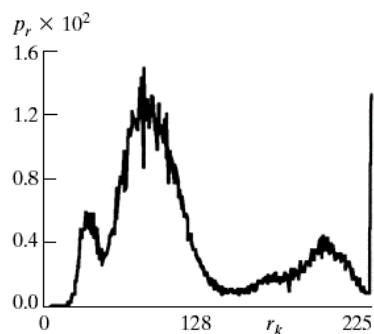


Lossless encoding

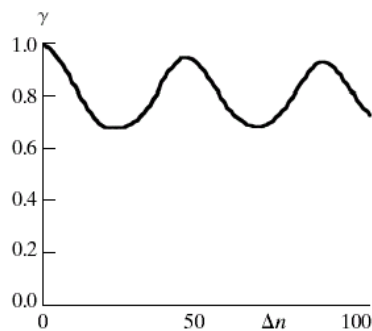
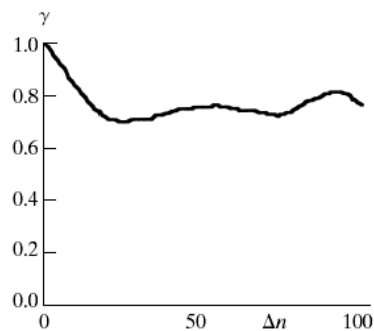
Compression



Why can we compress?



The values do not have the same frequency



Values are correlated

Run-length encoding

- ◆ Repeated values are replaced with their multiplicity

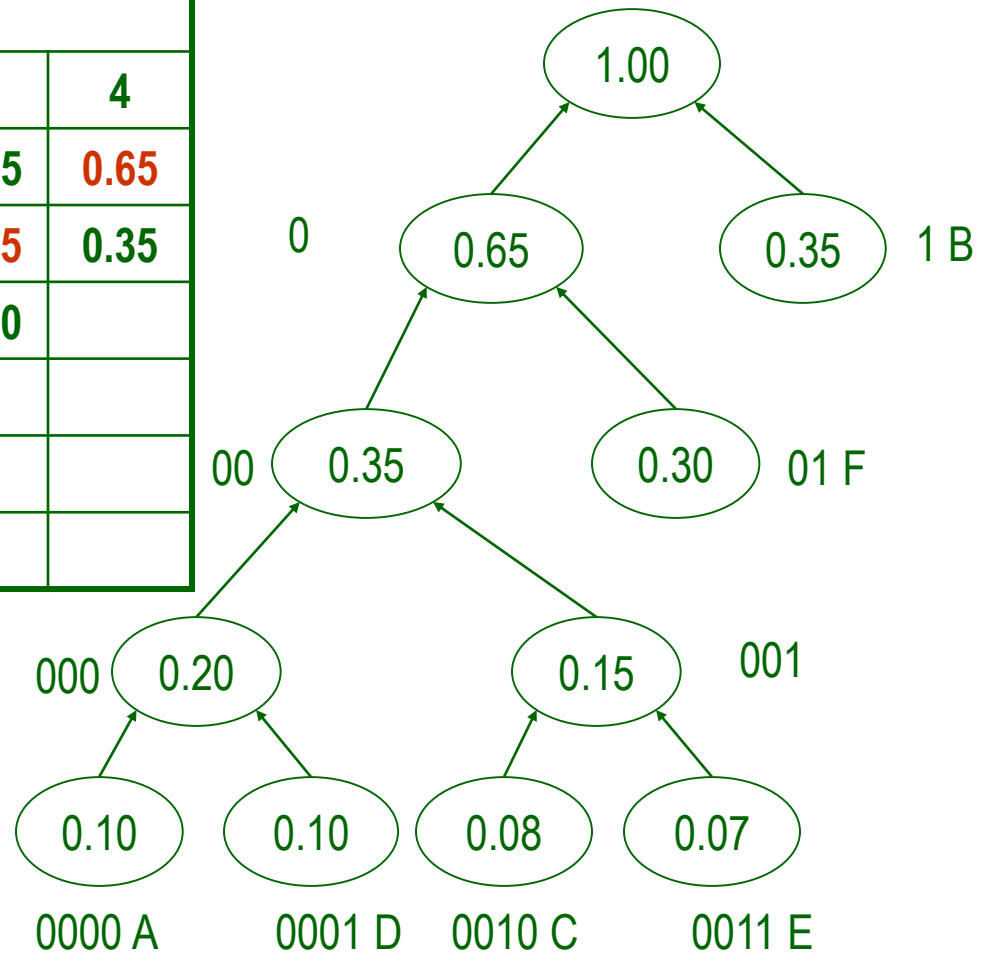
WWWWWWWWWWWWWBWWWWWWWWWWWWWWWWBBBWW
 WWWWWWWWWWWWWWWWWWWWWWWWWWWBWWWWWWWW
 WWWWWWW ... → 12W1B12W3B24W1B14W ...

Variable length encoding

Symbols	Frequency	Standard coding	VL	Needed bits
A	70%	00	0	0.7
B	20%	01	10	0.4
C	5%	10	110	0.15
D	5%	11	111	0.15
Total				1.4

Huffman code

Source		Steps			
Simbolo	Prob.	1	2	3	4
B	0.35	0.35	0.35	0.35	0.65
F	0.30	0.30	0.30	0.35	0.35
A	0.10	0.15	0.20	0.30	
D	0.10	0.10	0.15		
C	0.08	0.10			
E	0.07				



The Huffman algorithm allows us to obtain the optimal VL code, which minimizes the number of bits

Lempel-Ziv-Welch Algorithm

- ◆ It does not require a priori knowledge of the probability distribution of the symbols of the alphabet It is the base of gzip, pkzip, winzip, compress ...
- ◆ It was covered by patent

Test image			
39	39	126	126
39	39	126	126
39	39	126	126
39	39	126	126

Currently Recognized Sequence	Pixel Being Processed	Encoded Output	Dictionary Location (Code Word)	Dictionary Entry
	39			
39	39	39	256	39-39
39	126	39	257	39-126
126	126	126	258	126-126
126	39	126	259	126-39
39	39			
39-39	126	256	260	39-39-126
126	126			
126-126	39	258	261	126-126-39
39	39			
39-39	126			
39-39-126	126	260	262	39-39-126-126
126	39			
126-39	39	259	263	126-39-39
39	126			
39-126	126	257	264	39-126-126
126		126		

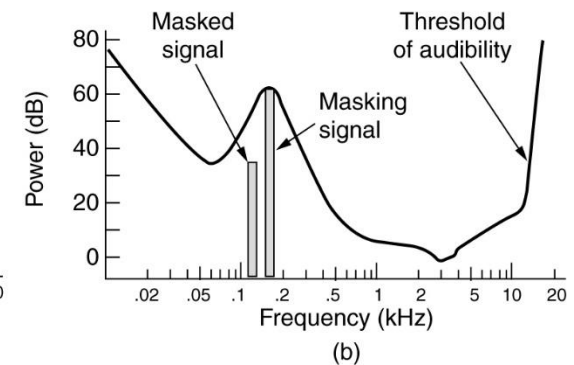
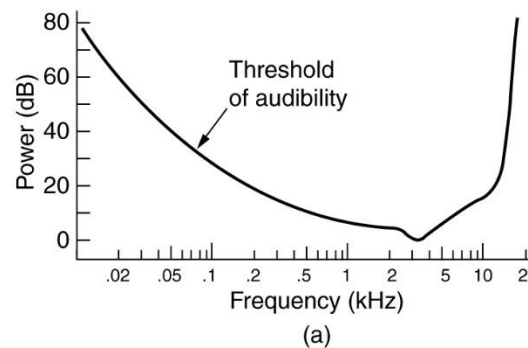
Lossy encoding

Why can it be compressed?

The visual human system cannot perceive small differences

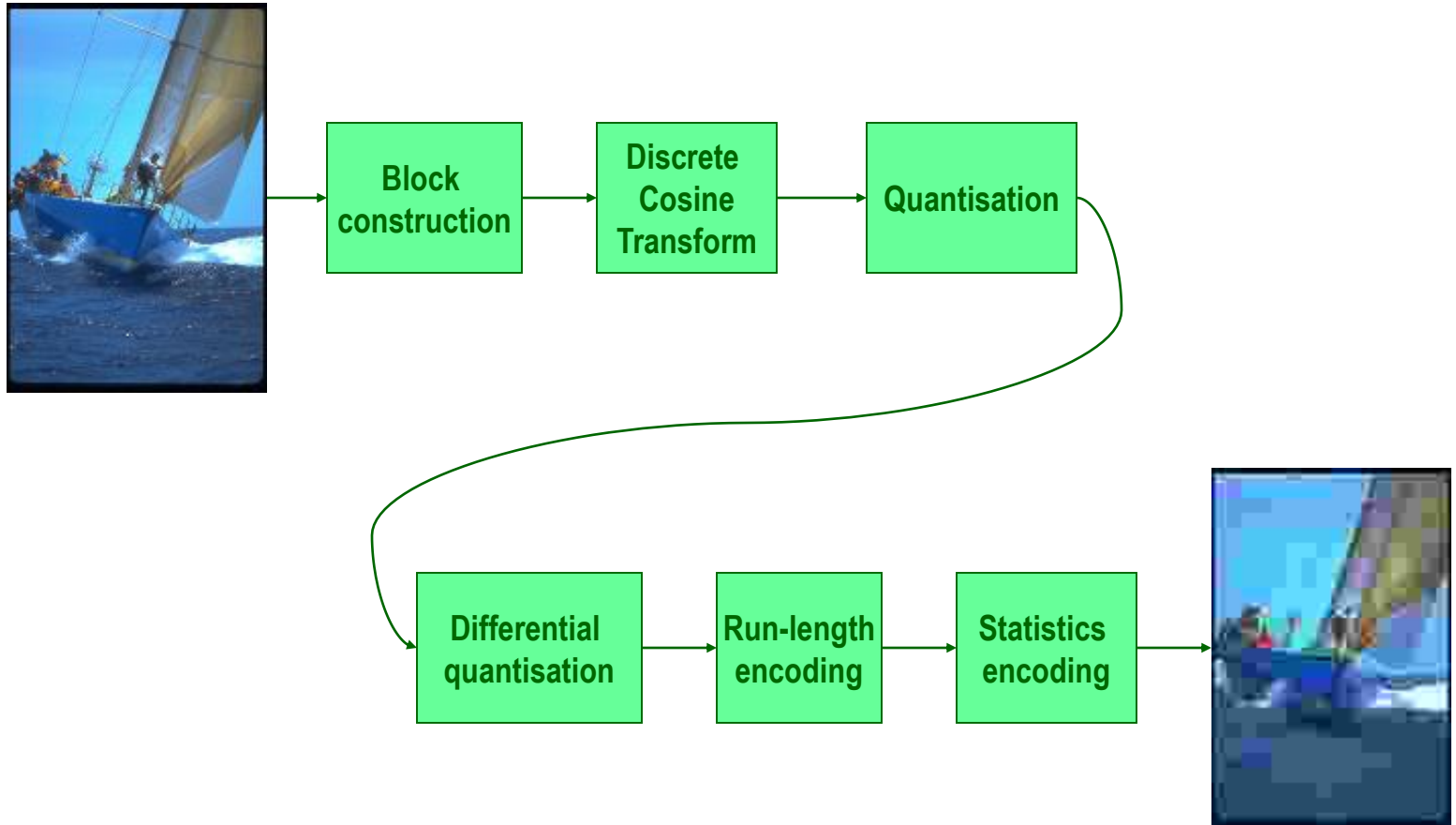


The same for audio signal → MP3



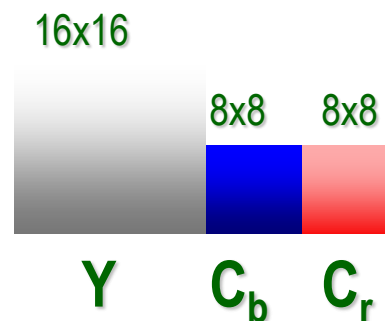
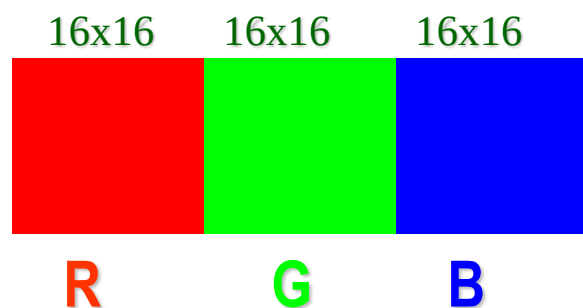
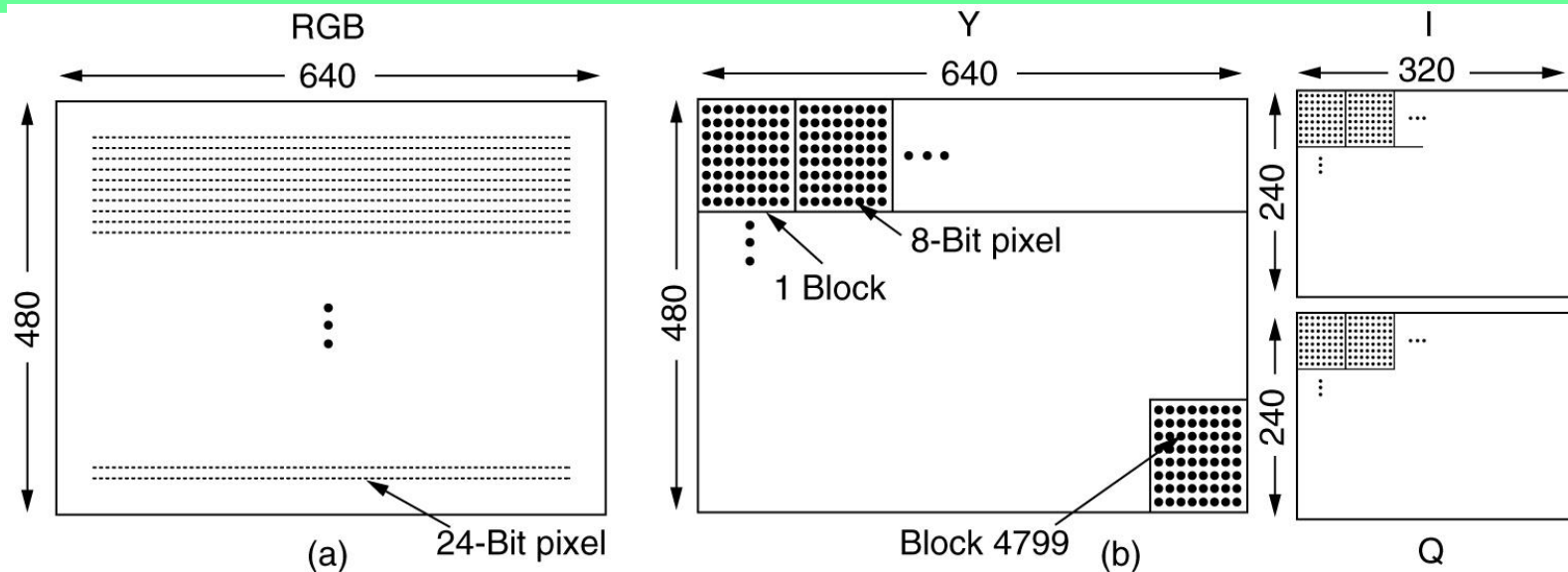
JPEG Encoding

The JPEG sequence of operations



JPEG– Block construction

Compression



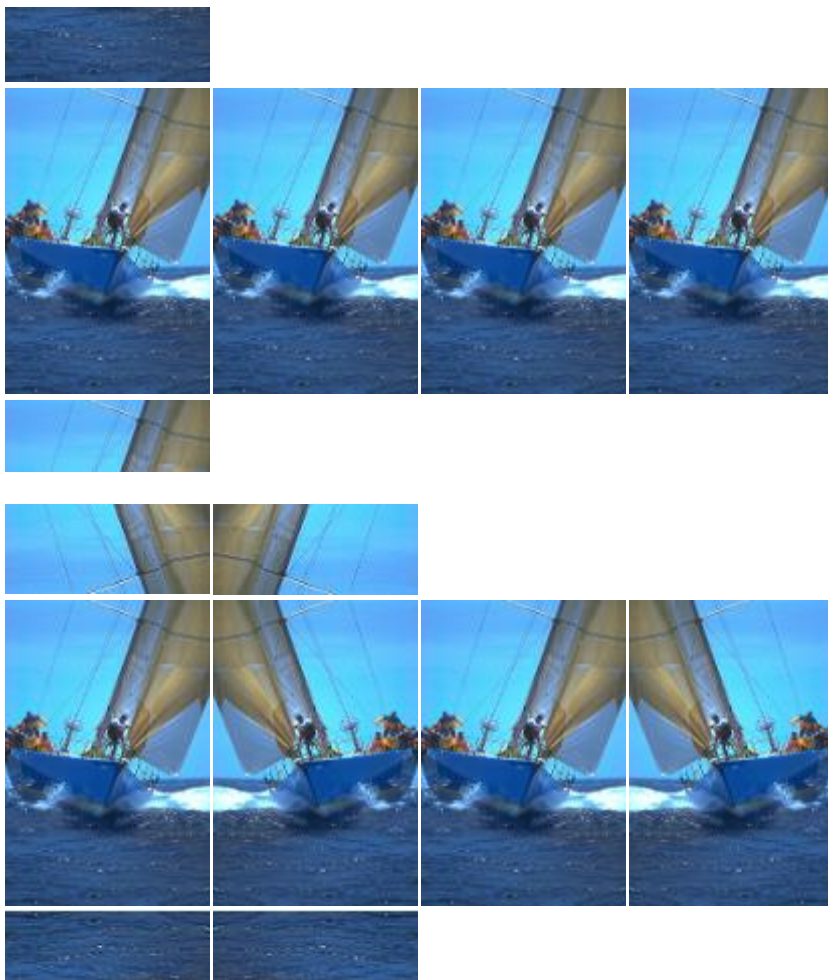
YC_bC_r 4:2:0

$C_r \propto R - Y$

$C_b \propto B - Y$

Discrete Cosine Transform

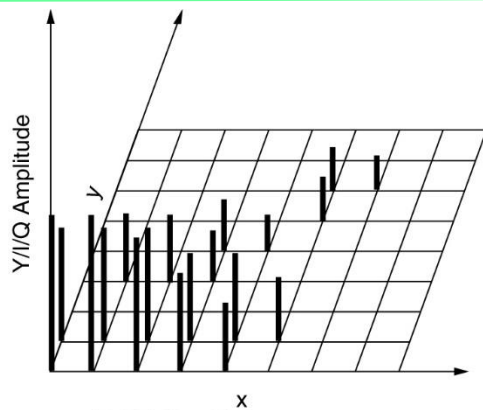
Compression



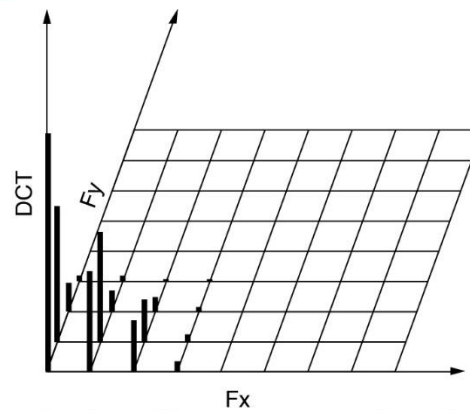
- Fourier transform
 - there are discontinuities at the borders

- DCT
 - Borders are continuous

JPEG – DCT



DCT Coefficients



Quantization table

Quantized coefficients

150	80	40	14	4	2	1	0
92	75	36	10	6	1	0	0
52	38	26	8	7	4	0	0
12	8	6	4	2	1	0	0
4	3	2	0	0	0	0	0
2	2	1	1	0	0	0	0
1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0

1	1	2	4	8	16	32	64
1	1	2	4	8	16	32	64
2	2	2	4	8	16	32	64
4	4	4	4	8	16	32	64
8	8	8	8	8	16	32	64
16	16	16	16	16	16	32	64
32	32	32	32	32	32	32	64
64	64	64	64	64	64	64	64

150	80	20	4	1	0	0	0
92	75	18	3	1	0	0	0
26	19	13	2	1	0	0	0
3	2	2	1	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

150	80	20	4	1	0	0	0
92	75	18	3	1	0	0	0
26	19	13	2	1	0	0	0
3	2	2	1	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

Data reordering

JPEG

Compression



128x192 RGB 72.0 K



quality 80% 6.4 K



quality 60% 4.2 K



quality 40% 3.1 K



quality 20% 2.0 K



quality 5% 0.8 K

Lossy Compression

Compression



perceived quality



Memory
space



Computer
power

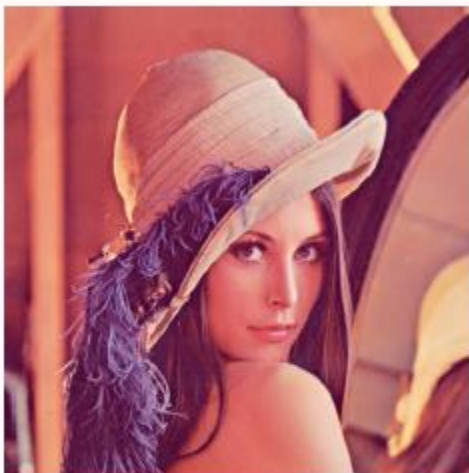
JPEG performances

Compression	perceived quality
64:1	poor
32:1	good
24:1	very good
12:1	high
Lower than 8:1	indistinguishable

Compression

JPEG2000

- ◆ It uses Wavelet instead of DCT
- ◆ It is better with high compression
- ◆ It is possible to define ROI
- ◆ It uses multiresolution



(a) Original Lena (769Kb)



(b) JPEG Compressed (6Kb)



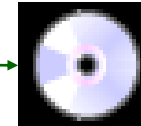
(c) JPEG2000 Compressed (6Kb)

Video compression: only JPEG

Compression



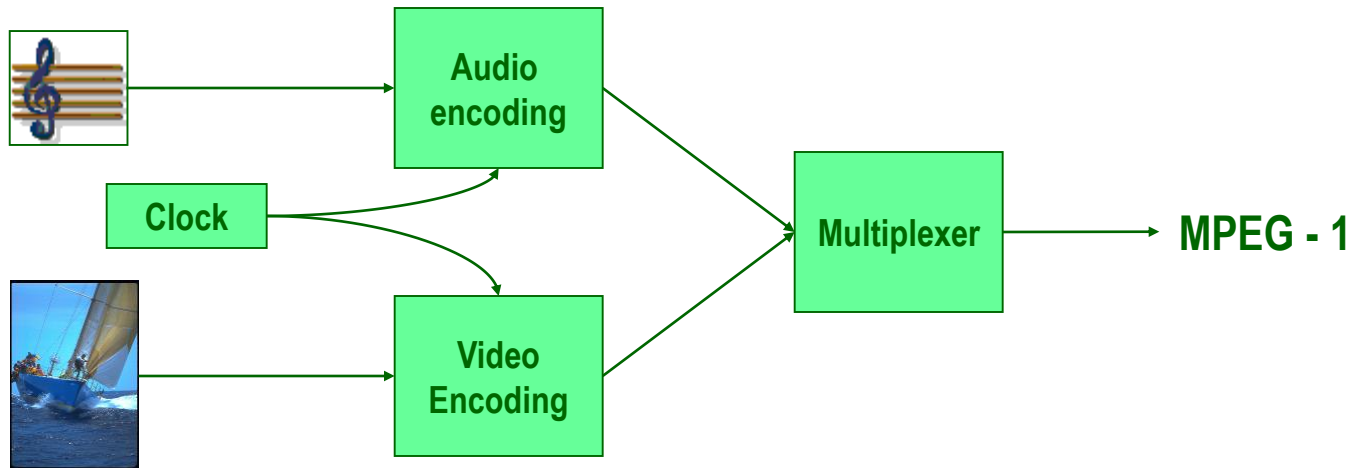
JPEG
encoding



insufficient compression:
temporal redundancy is not
exploited: consecutive frames are
often very similar to each other

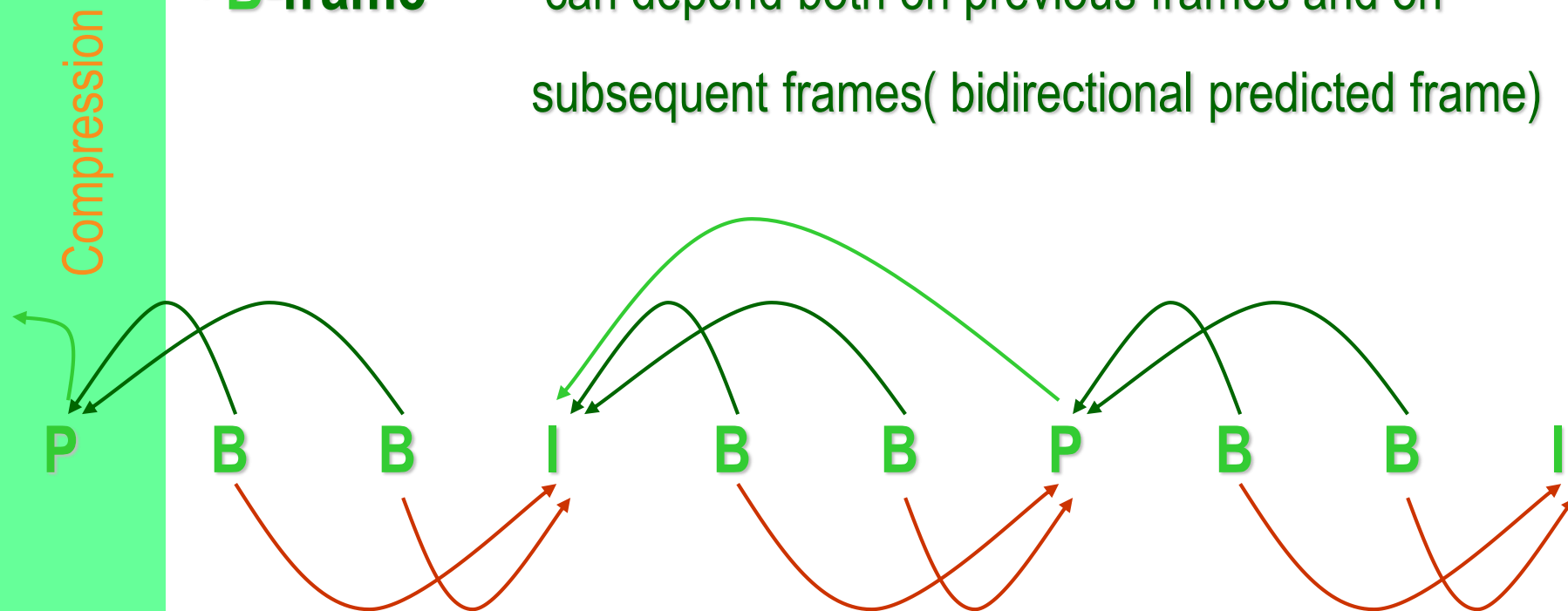
MPEG

Audio and video synchronisation MPEG-1.



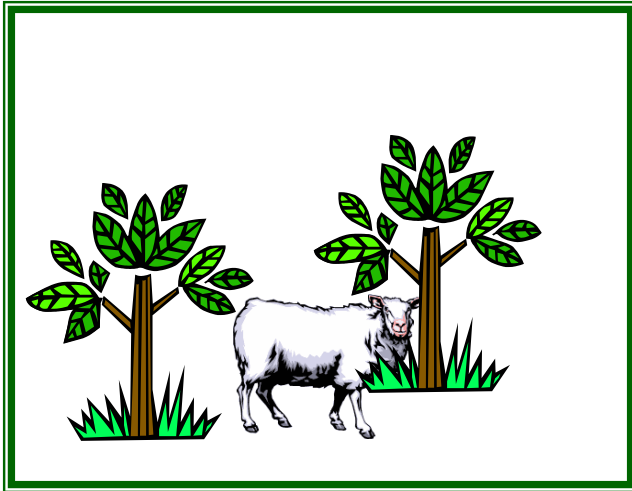
Frame types

- **I-frame** is a complete image (JPEG encoding)
- **P-frame** uses a previous frame (predicted frame)
- **B-frame** can depend both on previous frames and on subsequent frames (bidirectional predicted frame)

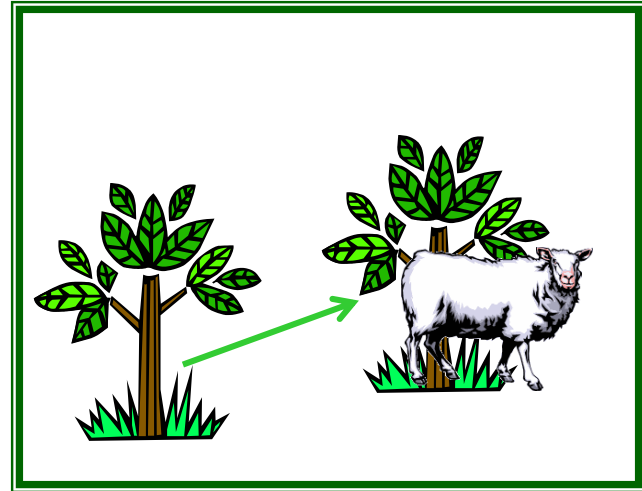


Time prediction

Compression



I-frame



P-frame

Video Compression

MPEG = **M**oving **P**icture **E**xperts **G**roup (www.mpeg.org)

Evolution:

MPEG-1 video from CD-ROM (~ 1.2 Mbps)

MPEG-2 large video for HDTV

MPEG-4 transmission on low band media(< 64Kbps)

MPEG-7 high-level description of the contents

MPEG Levels

- ◆ Low level: 352 x 288 – 4Mb/s
- ◆ Main level: 720 x 576 – 15Mb/s
 - TV Standard (HD Ready 1280 x 720)
- ◆ High 1440: 1440 x 1152 – 60Mb/s
- ◆ High level: 1920 x 1080: – 80Mb/s
 - Full HD