IMAGE COMPRESSION II:

Run Length Coding,

Predictive Coding and

Digital Pulse Code Modulation

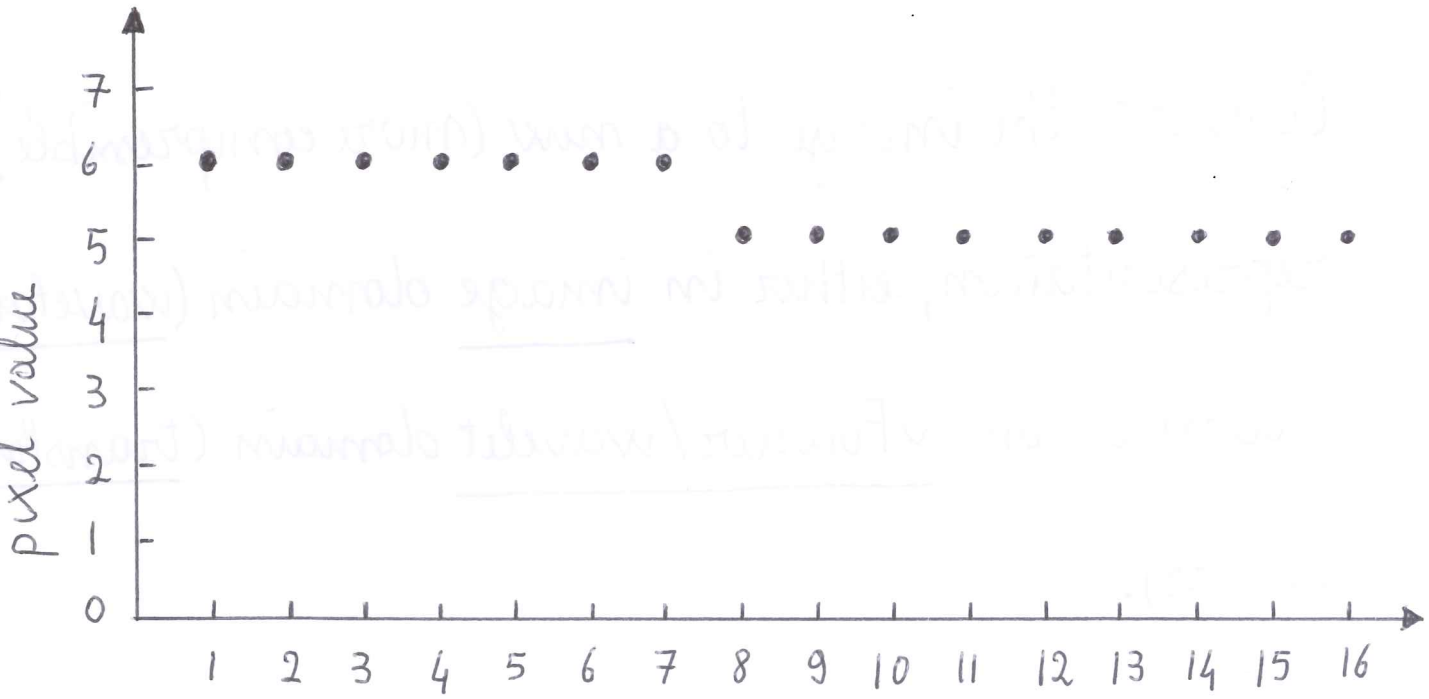
MAPPER

- **The basic idea**

Convert the image to a new (more compressible) representation, either in image domain (waveform coders) or in ~Fourier/wavelet domain (transform coders).

• Run Length Coding

* It exploits interpixel redundancy:



* Plain code: $\underbrace{16}_{\#\text{pixels}} \times \underbrace{3}_{\text{bits/pixel}} = 48$ bits

* Run length code: (6, 7), (5, 9)

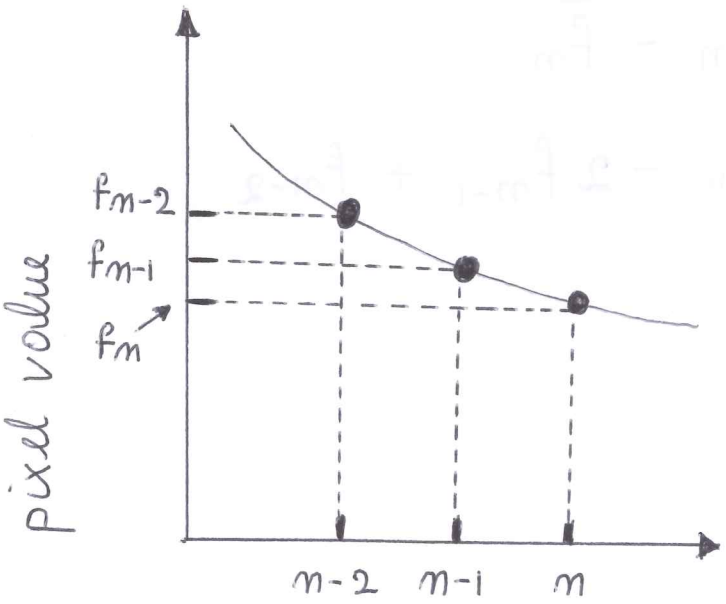
(3 bits + 4 bits) + (3 bits + 4 bits) = 14 bits

→ (Lossless) Compression $= \frac{48}{14} \simeq 3.4$

* Problem E2c

Predictive Coding

* It exploits interpixel redundancy:



* The simplest lossless predictive coding:

Predict: $\bar{f}_n = f_{n-1}$

Transmit: $\underbrace{e_n}_{\text{error}} = f_n - \bar{f}_n$

$= f_n - f_{n-1}$

* Figs 8.34, 8.35

* Gradient-based lossless predictive coding:

Predict: $\bar{f}_n = 2 f_{n-1} - f_{n-2}$ ← Why?

Transmit: $\underbrace{e_n}_{\text{error}} = f_n - \bar{f}_n$

$= f_n - 2 f_{n-1} + f_{n-2}$

* 2D predictors:

. . . . .
. A B C .
. D X . .
. . . . .

* Problem E 2b

+ QUANTIZER = Lossy Predictive Coding

- Intuitive but wrong

* **TRANSMITTER**

Predict: $\bar{f}_n = f_{n-1}$ | Error? $e_n = f_n - \bar{f}_n$ | Quantize e'_n → transmit

* **RECEIVER**

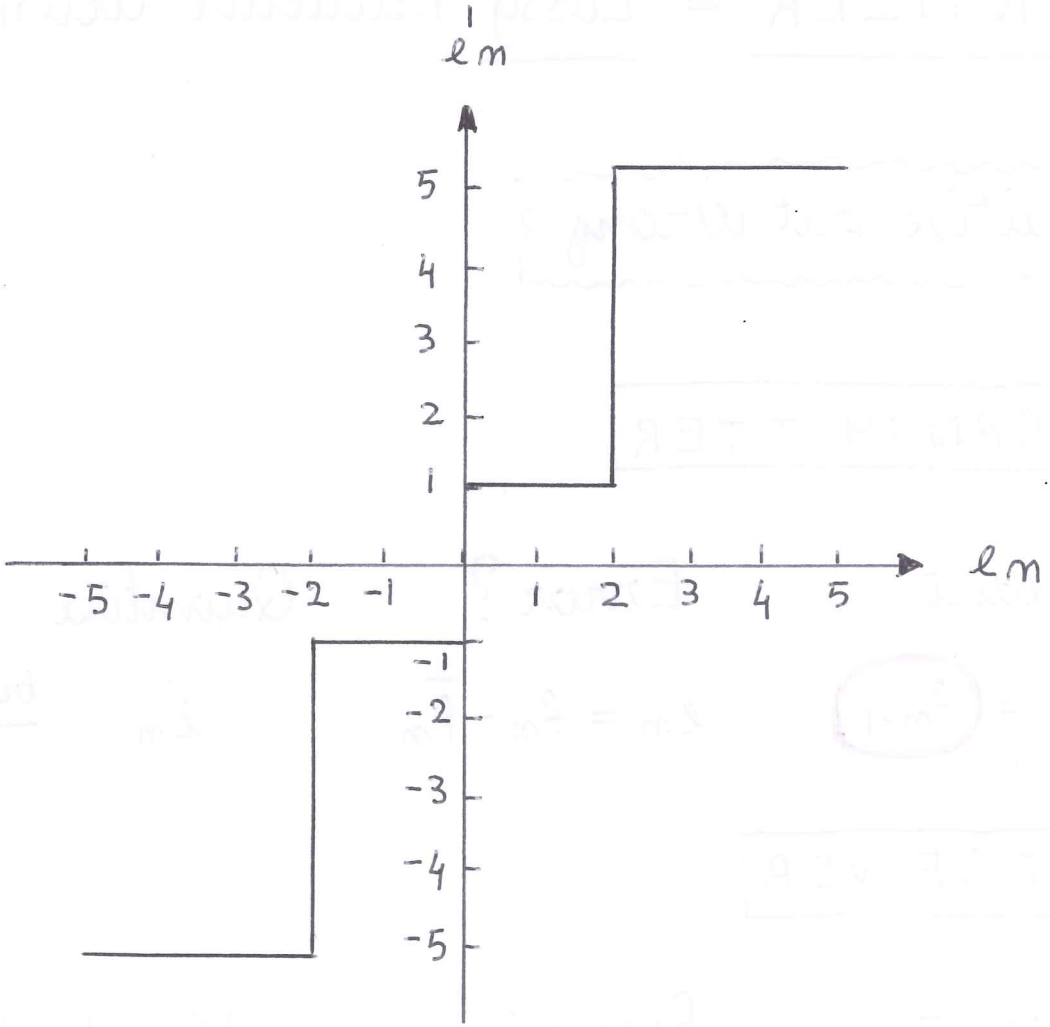
Predict: $\bar{f}'_n = f'_{n-1}$ | Reconstruct: $f'_n = \bar{f}'_n + e'_n$ | What is the error (real)? $\underbrace{f_n - f'_n}_{E_n}$

n	f_n	$\bar{f}_n$	e_n	e'_n *	$\bar{f}'_n$	f'_n	E_n
0	100	–	←	–	–	100	0
1	102	100	2	5	100	105	-3
2	120	102	18	5	105	110	10
3	119	120	-1	-1	110	109	10
4	117	119	-2	-5	109	104	13
5	119	117	2	5	104	109	10

EXAMPLE: a row of an image with an edge

→ The error jumps at the edge, and remains large thereafter!

* See p. 6



Quantizer used in the examples at pp. 5 and 7

Digital Pulse Code Modulation

Compare with p. 5:
DPCM simulates the receiver at the transmitter!

* TRANSMITTER

Predict: $\bar{f}_n = \bar{f}'_n$

Error ?: $e_n = f_n - \bar{f}_n$

Quantize: e'_n → transmit

* RECEIVER

Predict: $\bar{f}'_n = f'_{n-1}$

Reconstruct: $f'_n = \bar{f}'_n + e'_n$

What is the error? (real)

$\underbrace{f_n - f'_n}_{E_n}$

n	f_n	$\bar{f}_n$	e_n	e'_n *	$\bar{f}'_n$	f'_n	E_n
0	100	—	—	—	—	100	0
1	102	100	2	5	100	105	-3
2	120	105	15	5	105	110	10
3	119	110	9	5	110	115	4
4	117	115	2	5	115	120	-3
5	119	120	-1	-1	120	119	0

EXAMPLE: a row of an image with an edge

→ The error jumps at the edge, but decreases thereafter !

* See p. 6

- Studio Exercises 1, 2
- (Problems E2a, E2d)