Digital Image Processing
Chapter 8:
Image Compression-1

Outline

1 Fundamentals

2 Some basic compression method

- Huffman coding
- Arithmetic coding
- LZW coding
- Block Transform coding
- Predictive coding
- …

Image Compression

Reducing the amount of data required to represent a digital image while keeping information as much as possible

Relative Data Redundancy and Compression Ratio

Relative Data Redundancy

$$R_D = 1 - \frac{1}{C_R}$$

Compression Ratio

$$C_R = \frac{n_1}{n_2}$$

Types of data redundancy

1. Coding redundancy
2. Spatial and temporal redundancy -- Interpixel redundancy
3. Irrelevant information -- Psychovisual redundancy

Coding Redundancy

Different coding methods yield different amount of data needed to represent the same information.

Example of Coding Redundancy : Variable Length Coding vs. Fixed Length Coding

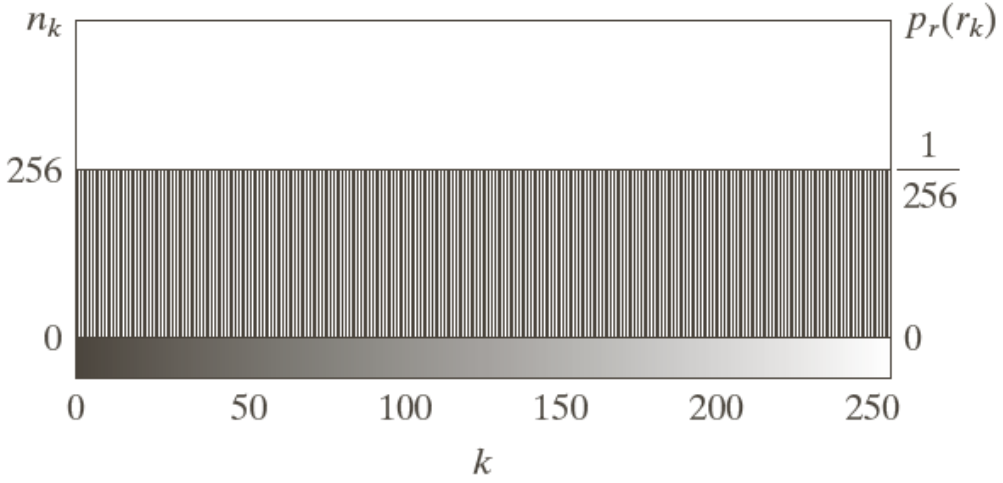
r_k	$p_r(r_k)$	Code 1	$l_1(r_k)$	Code 2	$l_2(r_k)$
$r_{87} = 87$	0.25	01010111	8	01	2
$r_{128} = 128$	0.47	10000000	8	1	1
$r_{186} = 186$	0.25	11000100	8	000	3
$r_{255} = 255$	0.03	11111111	8	001	3
r_k for $k \neq 87, 128, 186, 255$	0	—	8	—	0

L_{avg} 8 bits/symbol

L_{avg} 1.81 bits/symbol

Concept: assign the longest code word to the symbol with the least probability of occurrence.

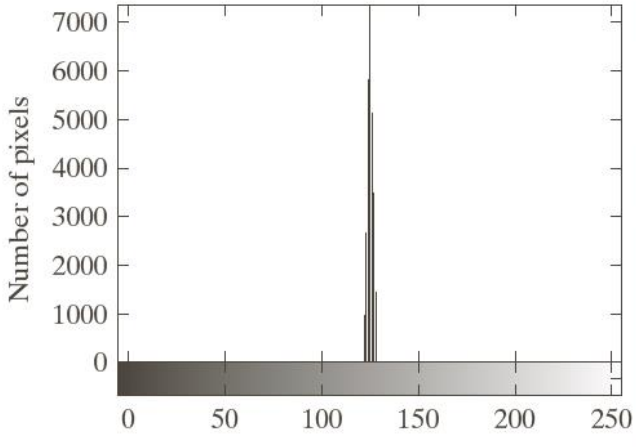
Spatial and temporal Redundancy

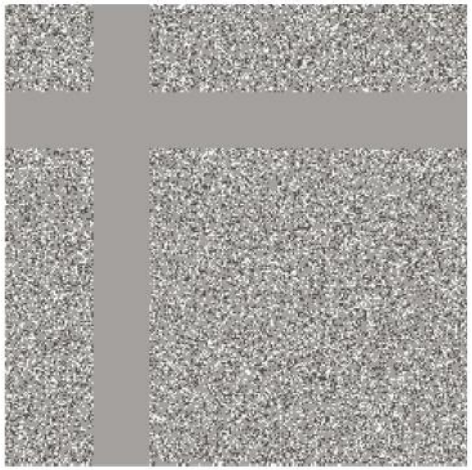


Interpixel redundancy: Parts of an image are highly correlated.

In other words,we can predict a given pixel from its neighbor.

Irrelevant information





Most 2-D intensity arrays contain information that is ignored by the human visual system and/or extraneous to the intended use of the image.

Measuring Image Information

Measuring information

$$I(E) = \log\left(\frac{1}{P(E)}\right) = -\log\left(P(E)\right)$$

Entropy or Uncertainty: Average information per symbol

$$H = -\sum_{j} P(a_j)\log\left(P(a_j)\right)$$

Shanon's first theorem

$$\lim_{n\to\infty}\left(\frac{L_{avg,n}}{n}\right) = H$$

The image can be represented with as few as entropy

Fidelity Criteria: how good is the compression algorithm

-Objective Fidelity Criterion

- RMSE, PSNR

-Subjective Fidelity Criterion:

-Human Rating

Value	Rating	Description
1	Excellent	An image of extremely high quality, as good as you could desire.
2	Fine	An image of high quality, providing enjoyable viewing. Interference is not objectionable.
3	Passable	An image of acceptable quality. Interference is not objectionable.
4	Marginal	An image of poor quality; you wish you could improve it. Interference is somewhat objectionable.
5	Inferior	A very poor image, but you could watch it. Objectionable interference is definitely present.
6	Unusable	An image so bad that you could not watch it.

Source Encoder and Decoder Models

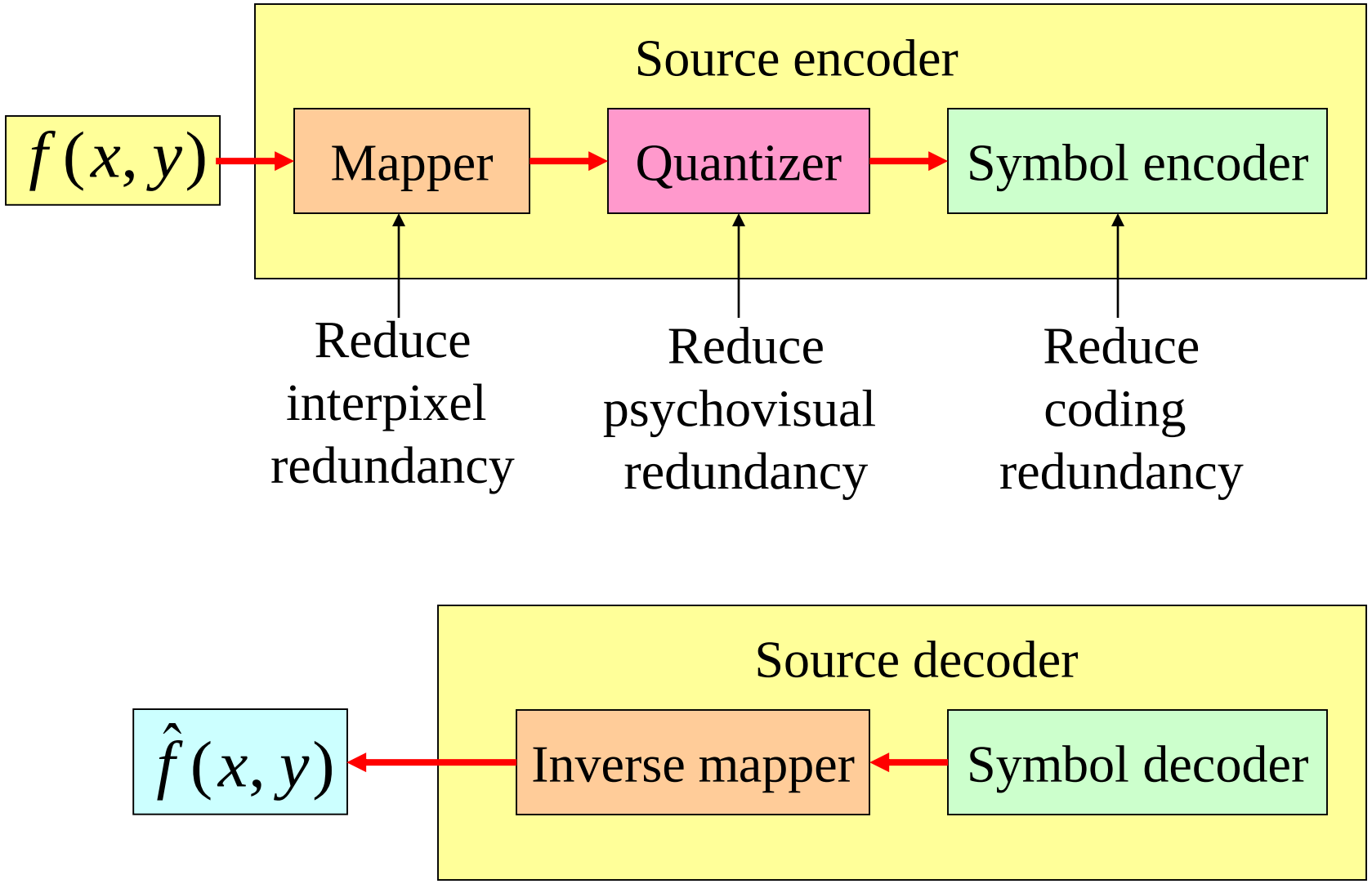


image format, Compress standard

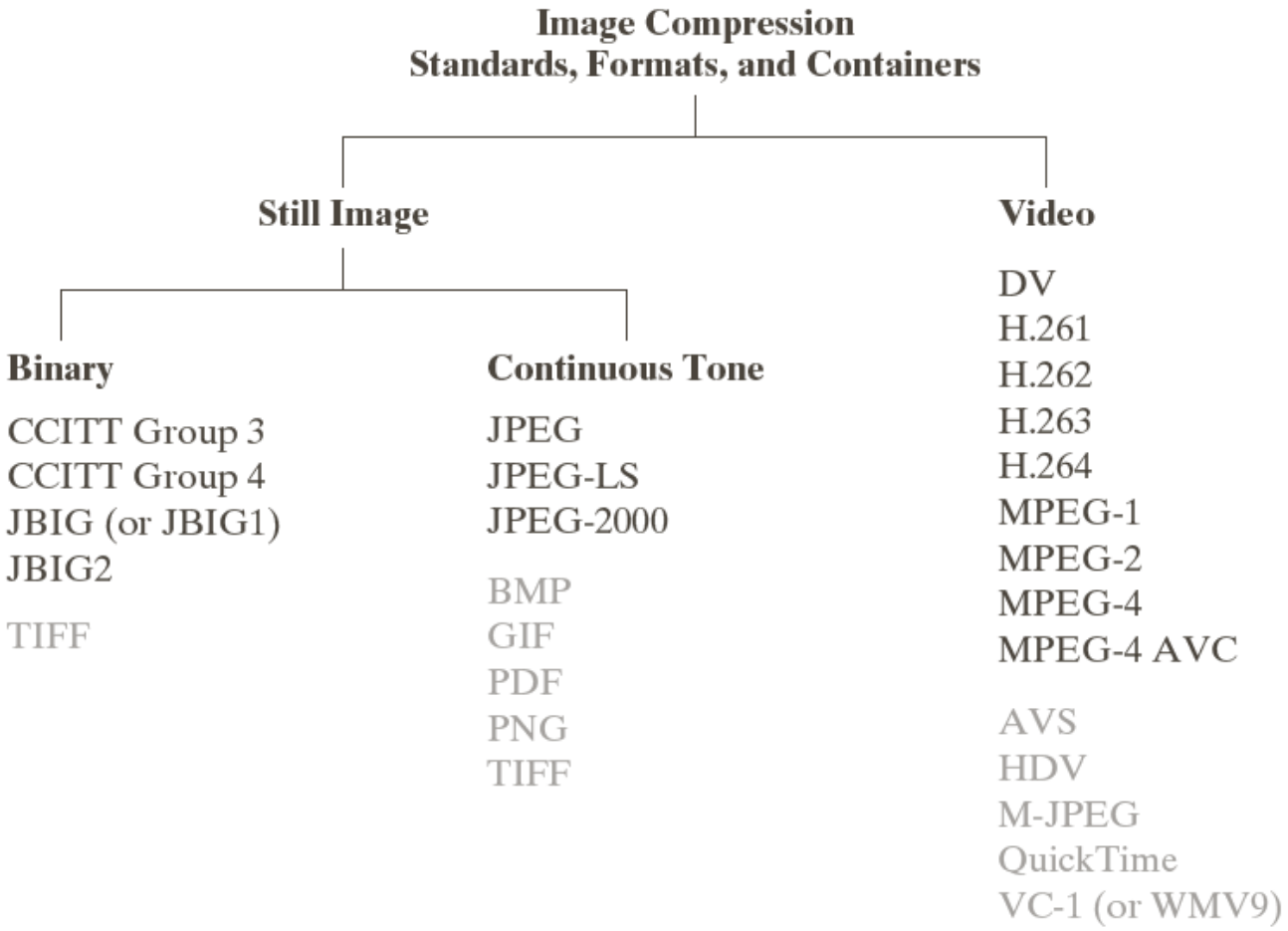


FIGURE 8.6 Some popular image compression standards, file formats, and containers. Internationally sanctioned entries are shown in black; all others are grayed.