

# Computational Optical Imaging - Optique Numerique

-- Compression, Signal Processing --

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- Course webpage at <http://giana.mmci.uni-saarland.de/>
  - Teaching -> Introduction to Image Processing and Computer Vision

# Compression

- Lossless

- reproduces exact copy of bit signals
- Popular example: zip/gzip (used in png format)
- Example Algorithm: Huffmann coding

- Lossy

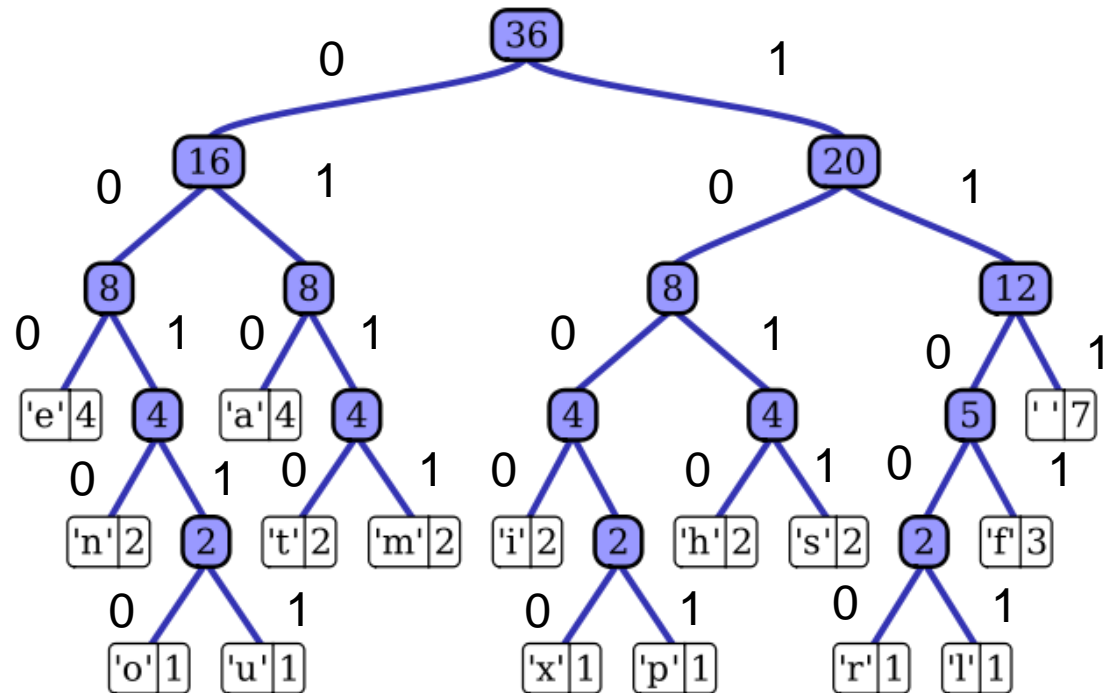
- Takes advantage of the fact that information is an image (removes “inperceptual” data)
- Popular example: jpeg

- Idea:
  - Analyze statistics of data
  - Assign short bit strings to frequent data
  - Assign long bit strings to rare data

# Huffman Coding

- "this is an example of a huffman tree"

Char	Freq	Code
space	7	111
a	4	010
e	4	000
f	3	1101
h	2	1010
i	2	1000
m	2	0111
n	2	0010
s	2	1011
t	2	0110
l	1	11001
o	1	00110
p	1	10011
r	1	11000
u	1	00111
x	1	10010



- Decomposition is not unique!

# Huffman example

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"j'aime aller sur le bord de l'eau les jeudis ou les jours impairs"

File :

b	p	'	m	j	o	d	a	i	r	u	l	s	e	
1	1	2	2	3	3	3	4	4	5	5	6	6	8	12

- Lossless
  - reproduces exact copy of bit signals
  - Popular example: zip/gzip (used in png format)
  - Example Algorithm: Huffmann coding
- Lossy
  - Takes advantage of the fact that information is an image (removes “inperceptual” data)
  - Popular example: jpeg



# Lossy Compression

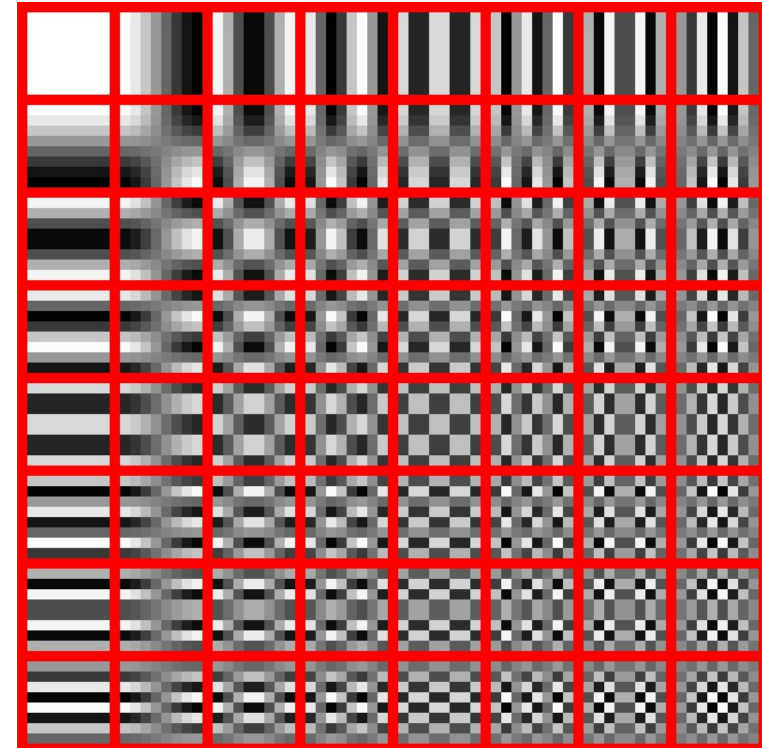
- Example: Jpeg
  - Selectable compression ratio
  - Picture: gradually varying compression ratio from left to right



[Wikipedia]

## ■ JPEG:

- Convert image to YCbCr
- Subsample chroma channels (Cb,Cr)
- Split into 8x8 blocks  $b$
- Apply discrete cosine transform
- Remove small coefficients
- Huffman code the result
- Color channels are treated independently

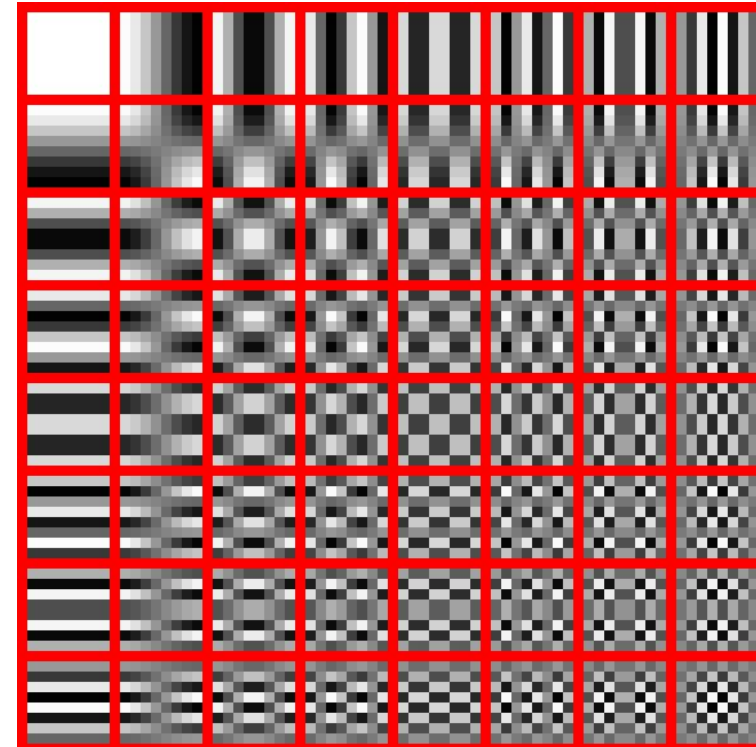


$\phi_i \Rightarrow$  8x8 DCT basis

$a_i = \langle b, \phi_i \rangle$

- JPEG:
  - For each color channel YCbCr:
    - Decode Huffman
    - Perform basis expansion for all 8x8 blocks

$$\hat{b} = \sum_i a_i \phi_i$$



8x8 DCT basis

- Upsample Chroma channels
- Convert to RGB

- Holst, G. *CCD Arrays, Cameras, and Displays*. SPIE Optical Engineering Press, Bellingham, Washington, 1998.
- Theuwissen, A. *Solid-State Imaging with Charge-Coupled Devices*. Kluwer Academic Publishers, Boston, 1995.
- Curless, CSE558 lecture notes (UW, Spring 01).
- El Gamal et al., EE392b lecture notes (Spring 01).
- Several Kodak Application Notes at <http://www.kodak.com/global/en/digital/ccd/publications/applicationNotes.jhtml>
- Reibel et al., *CCD or CMOS camera noise characterization*, Eur. Phys. J. AP 21, 2003