

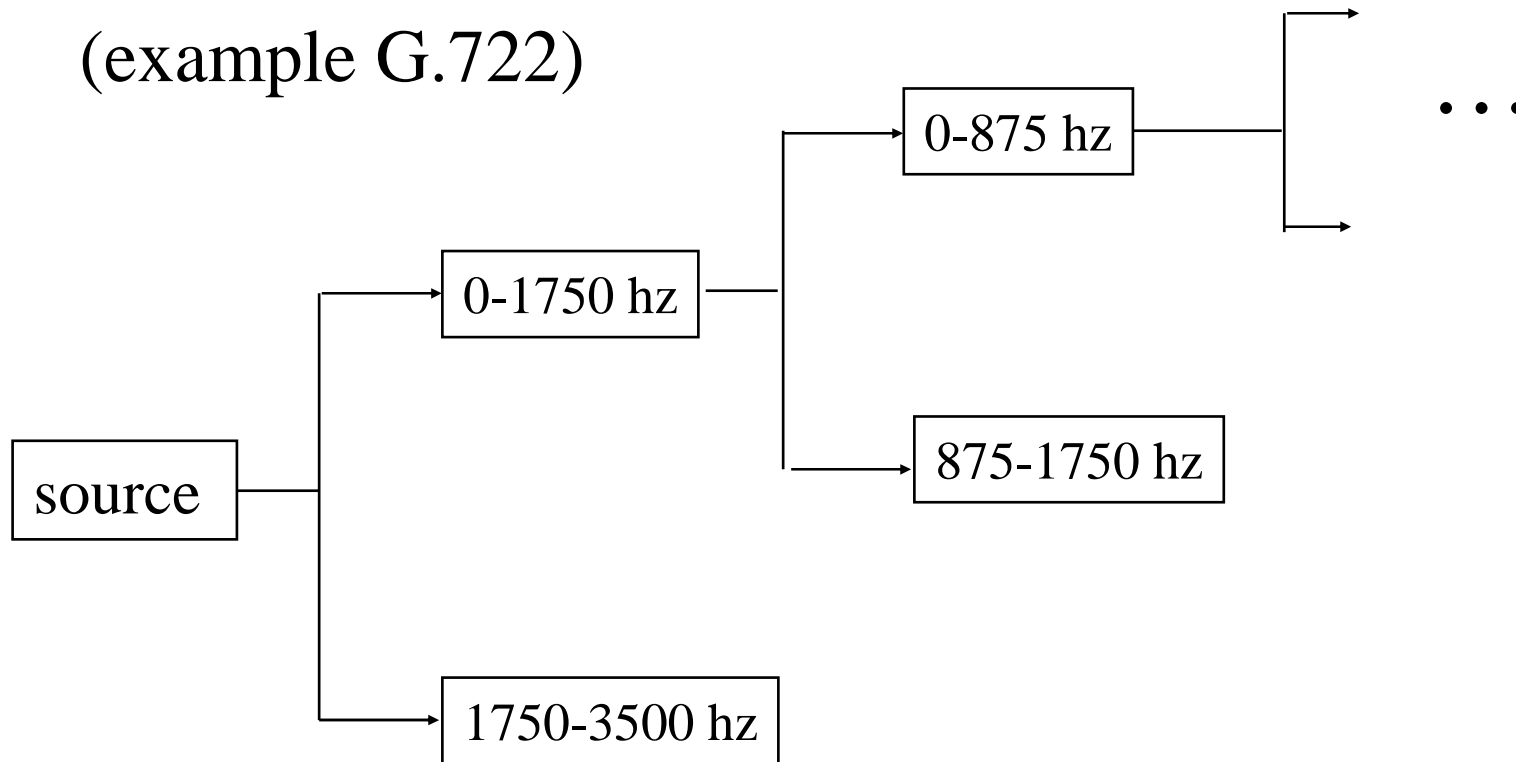
Outline

- Introduction
- Lossless compression
- Lossy compression
 - metrics
 - general methods
 - scalar
 - vector
 - differential
 - transform
 - Haar
 - JPEG
 - wavelet
 - MPEG



General Methods -Audio Subband Encoding

(example G.722)



- assumes low frequencies have more information

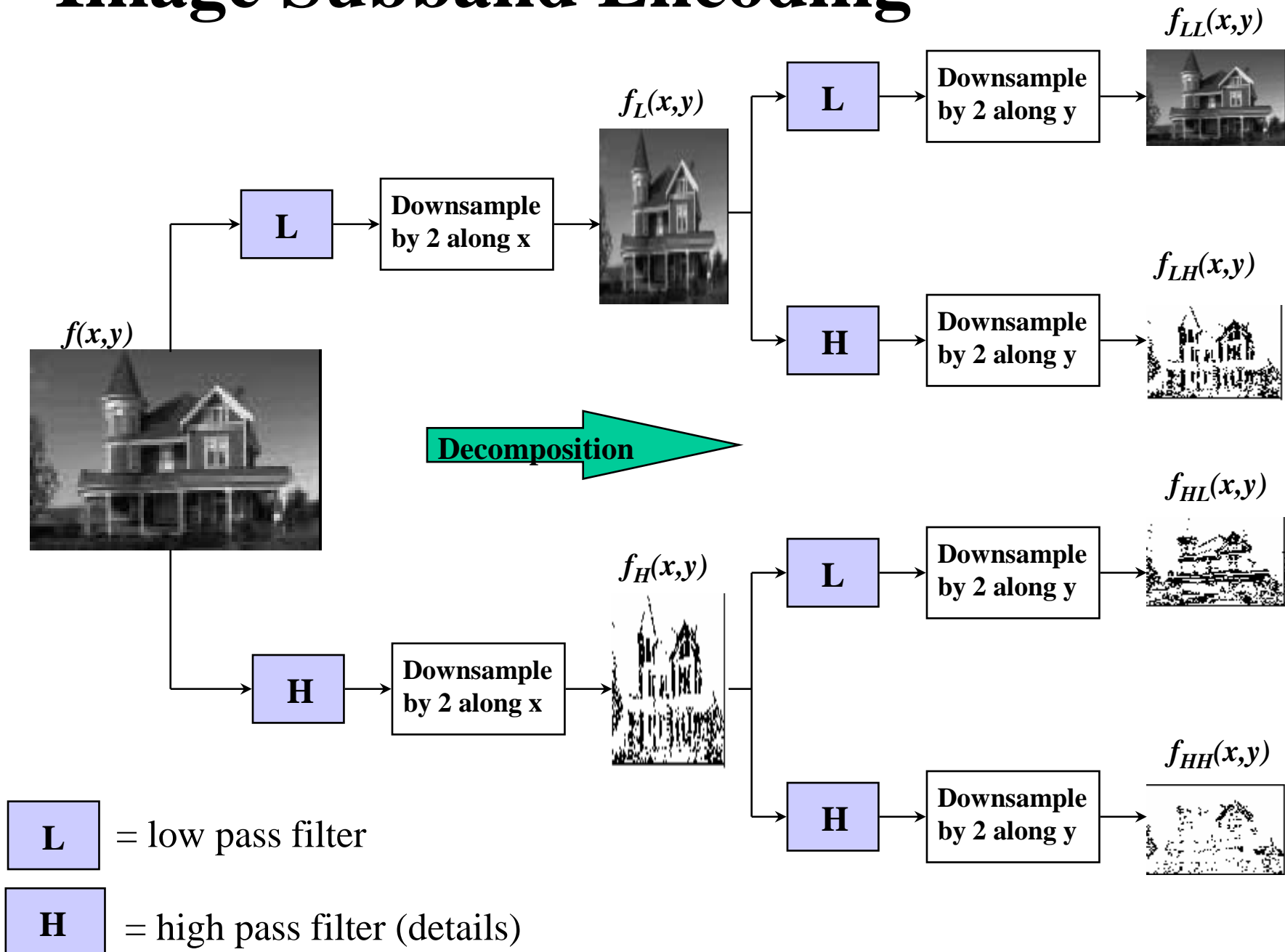
Image Subband Encoding: Wavelets

- 1807 Fourier Analysis by *Joseph Fourier*
- 1909 First mention of the term “wavelet” by *Alfred Haar*
- 1930s Representation of functions using scale-varying basis functions by several independent research groups
- 1960-1980 Mathematicians *Weiss* and *Coifman* studied atoms
- 1980s Studies of *Mallat*, *Meyer*, and *Daubechies*

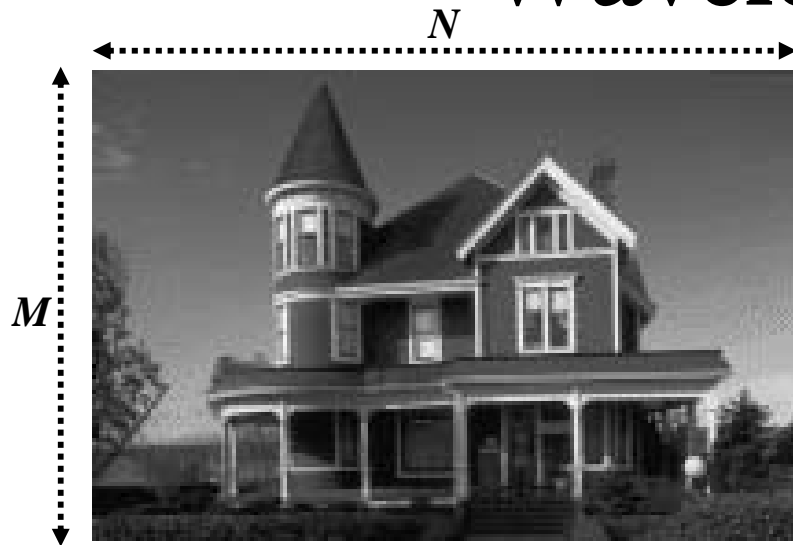
Applications of Wavelets

Signal and image processing, astronomy, acoustics, nuclear engineering, sub-band coding, music, optics, fractals, earthquake-prediction, radar, human vision, etc.

Image Subband Encoding



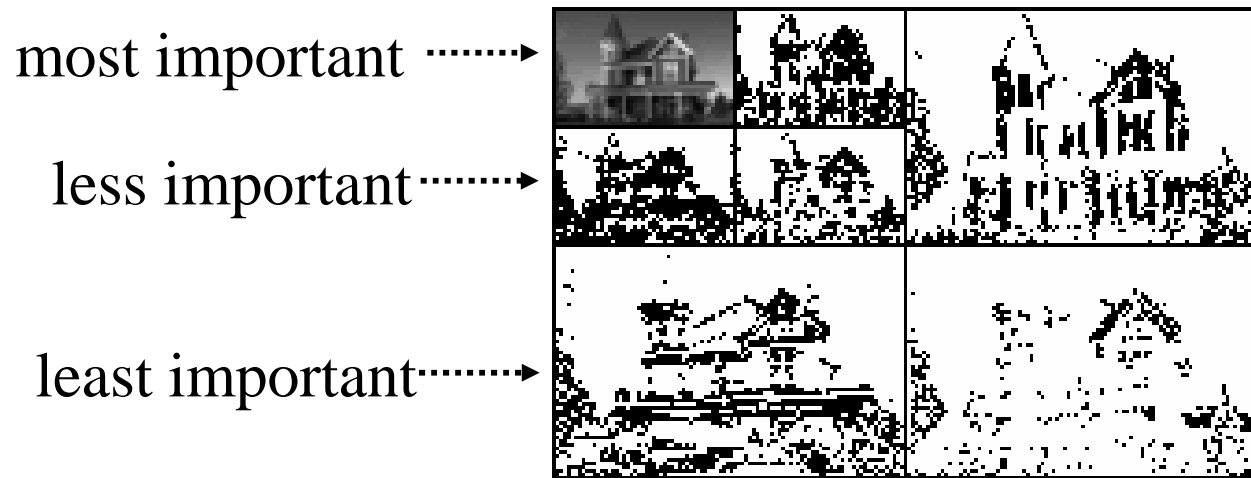
Wavelet Images



original



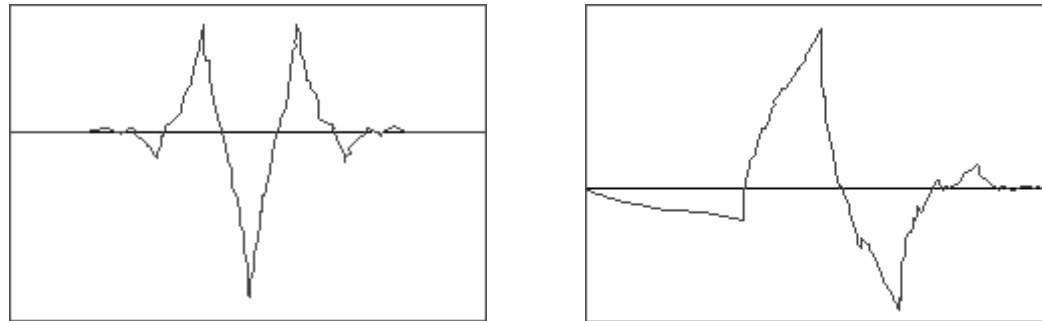
level 1



level 2

What is a Wavelet?

- A mathematical function that cuts up data into different frequency components, and studies each component with a resolution matched to its scale.
- A way of representing a signal $f(x)$ as a weighted sum of simple building blocks (mother wavelets).

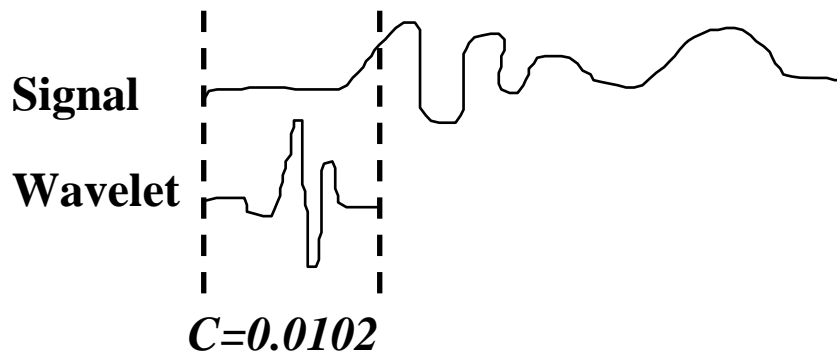


Example mother wavelets

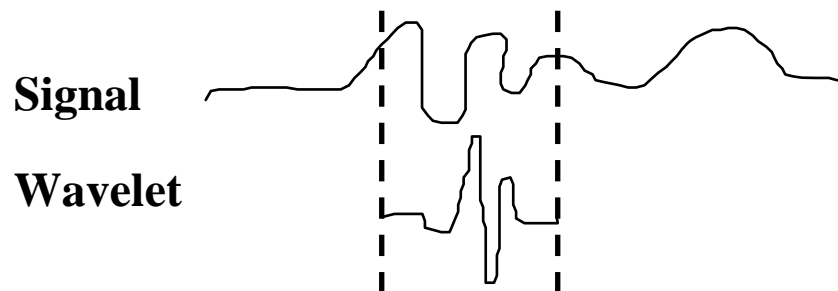
Continuous Wavelet Transform

Step 1: Take a wavelet and compare it to a section at the start of the original signal.

Step 2: Calculate the number C .

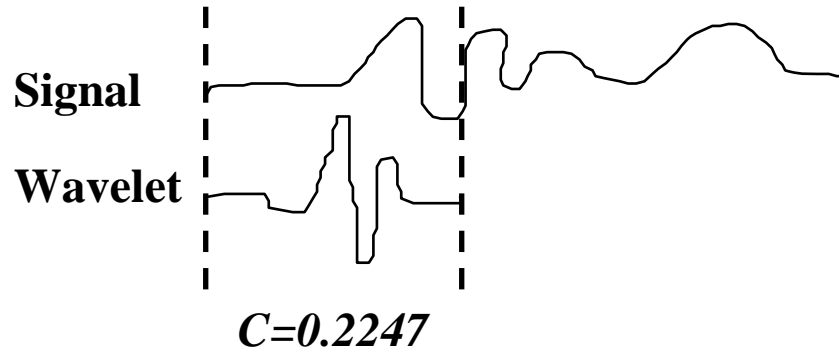


Step 3: *Shift* the wavelet to the right and repeat steps 1 and 2 until you've covered the whole signal.



Continuous Wavelet Transform (cont'd)

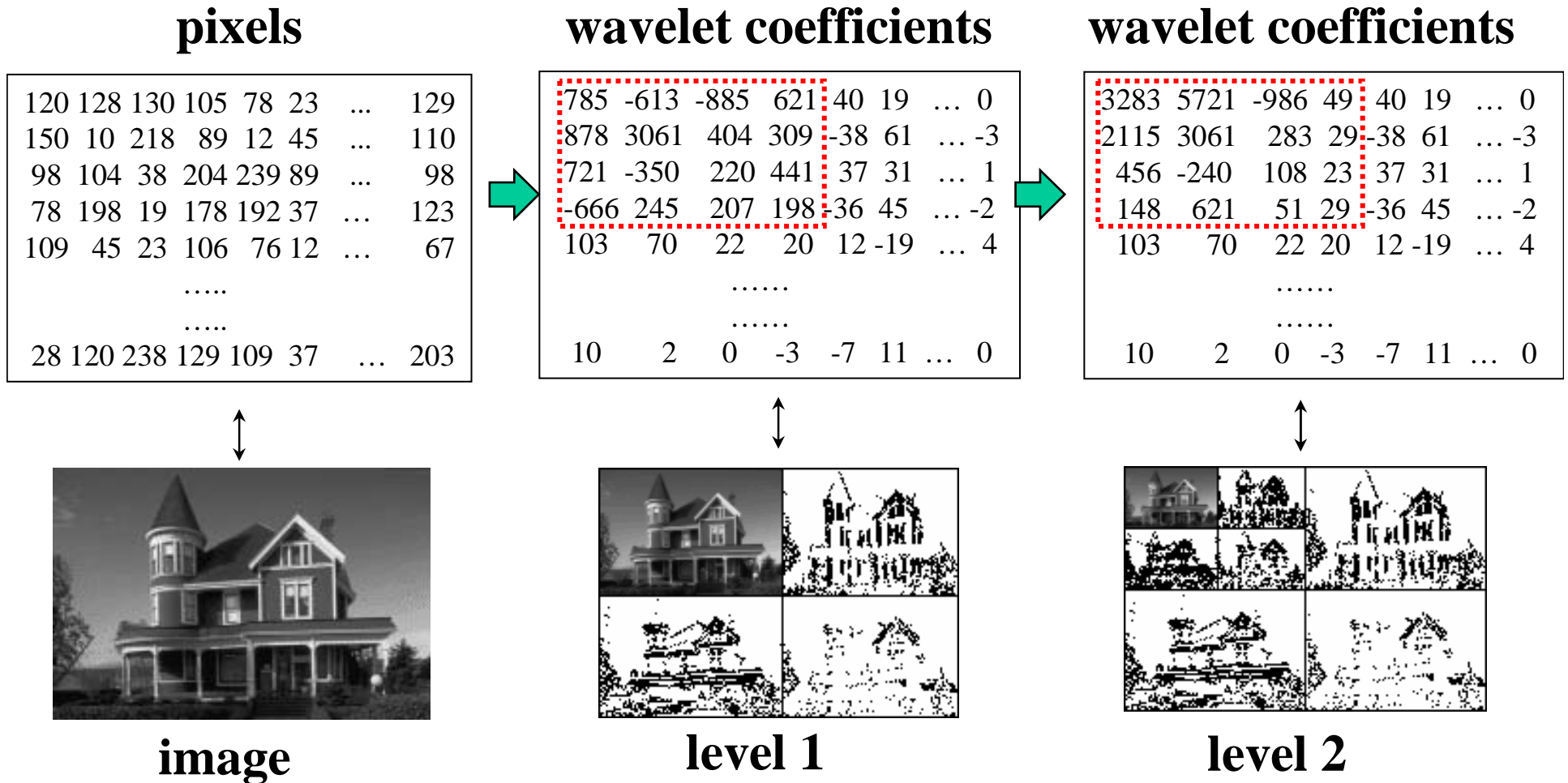
Step 4: *Scale* (stretch) the wavelet and repeat steps 1 through 3.



Step 5: Repeat steps 1 through 4 for all scales.

Result: Coefficients produced at different scales by different sections of the signal.

Wavelet Images (cont'd)



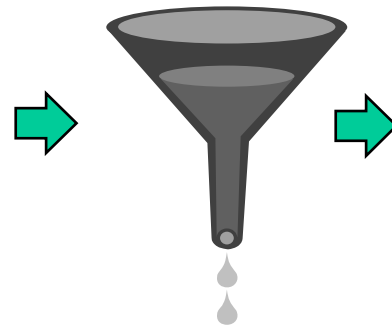
➡ = Forward Wavelet Transform

Wavelet Images (cont'd)

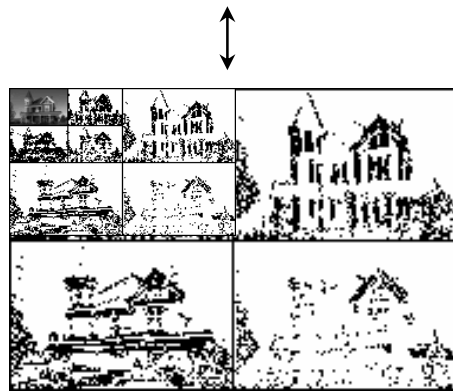
wavelet coefficients

thresholding

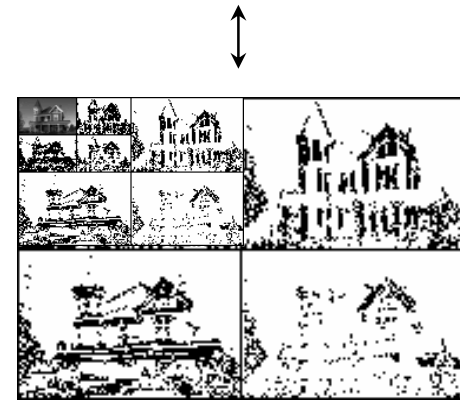
9266	5721	-986	49	40	19	...	0
2115	3061	283	29	-38	61	...	-3
456	-240	108	23	37	31	...	1
148	621	51	29	-36	45	...	-2
103	70	22	20	12	-19	...	4
						
						
10	2	0	-3	-7	11	...	0



9266	5721	-986	49	40	0	...	0
2115	3061	283	0	0	61	...	0
456	-240	108	0	0	0	...	0
148	621	51	0	0	45	...	0
103	70	0	0	0	0	...	0
						
						
0	0	0	0	0	0	...	0



level 3

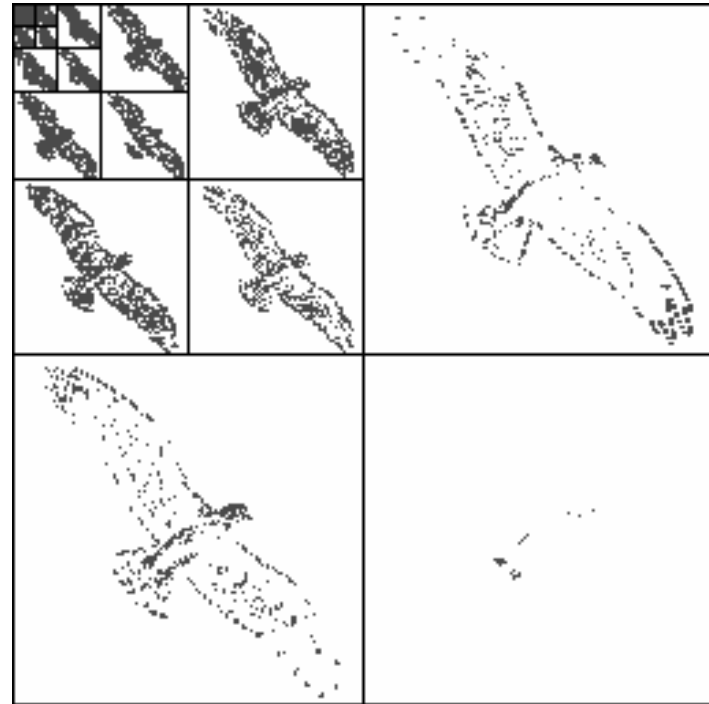


thresholded wavelet image

Wavelet Images



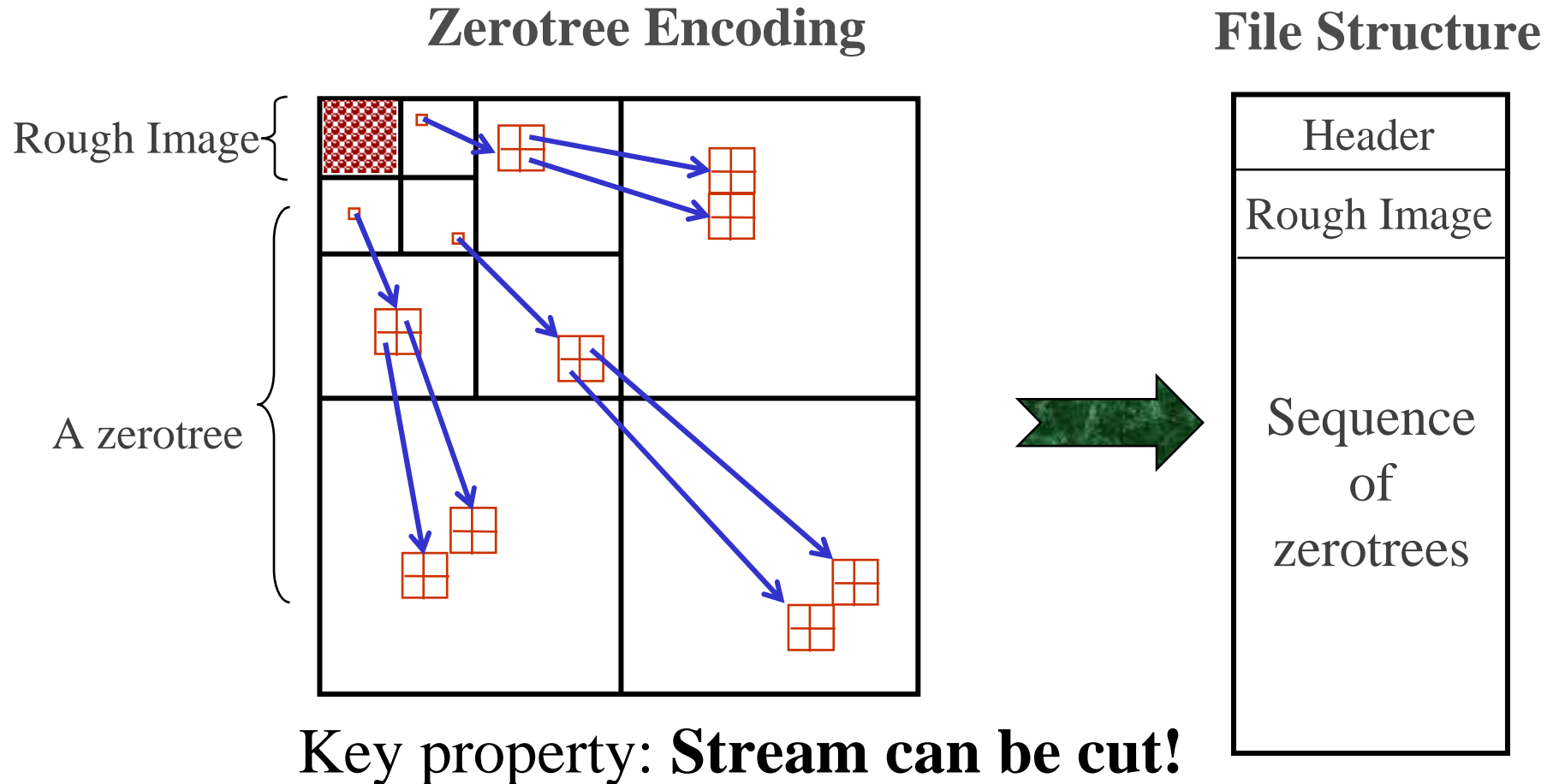
Original Image



Non-zero coefficients

SPIHT algorithm for wavelet compression

Ref: Said & Perlman



JPEG2000 uses:

EBCOT - Embedded Block Encoding with Optimized Truncation - D. Taubman

JPEG vs JPEG2000



Original
(600x480x24)
844KB

JPEG
6220 bytes

JPEG2000
5922 bytes



~ 130:1



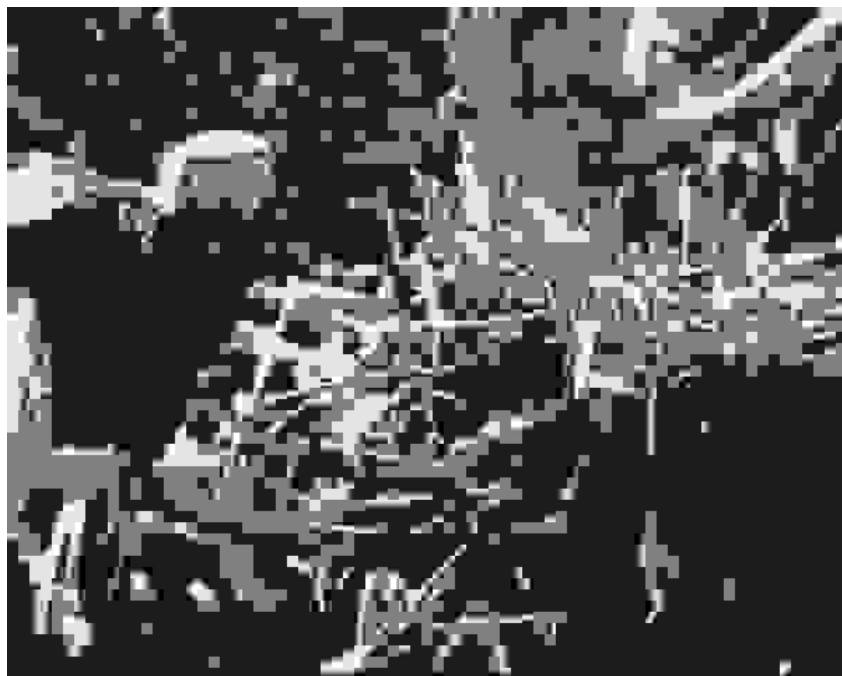
JPEG vs JPEG2000



Original
(600x480x24)
864000 bytes

JPEG
2751 bytes

JPEG2000
2781 bytes



~ 310:1



JPEG vs JPEG2000



Lena
Original
(256x256x24)
192Kbytes

JPEG



JPEG2000



~ 43:1