TIME-SCALE (WAVELET) ANALYSIS

M2 AI — SIGNAL PROCESSING

CONTINUOUS WAVELET TRANSFORM

Idea: be sensitive to irregularities instead of oscillations

Let OBJ be an admissible wavelet and its dilated and translated versions

OBJ

The continuous wavelet transform is given by:

OBJ

OBJ is called the magnitude scalogram

Properties

- It is a time-scale transform
- It is invertible: OBJ
- We have energy preservation

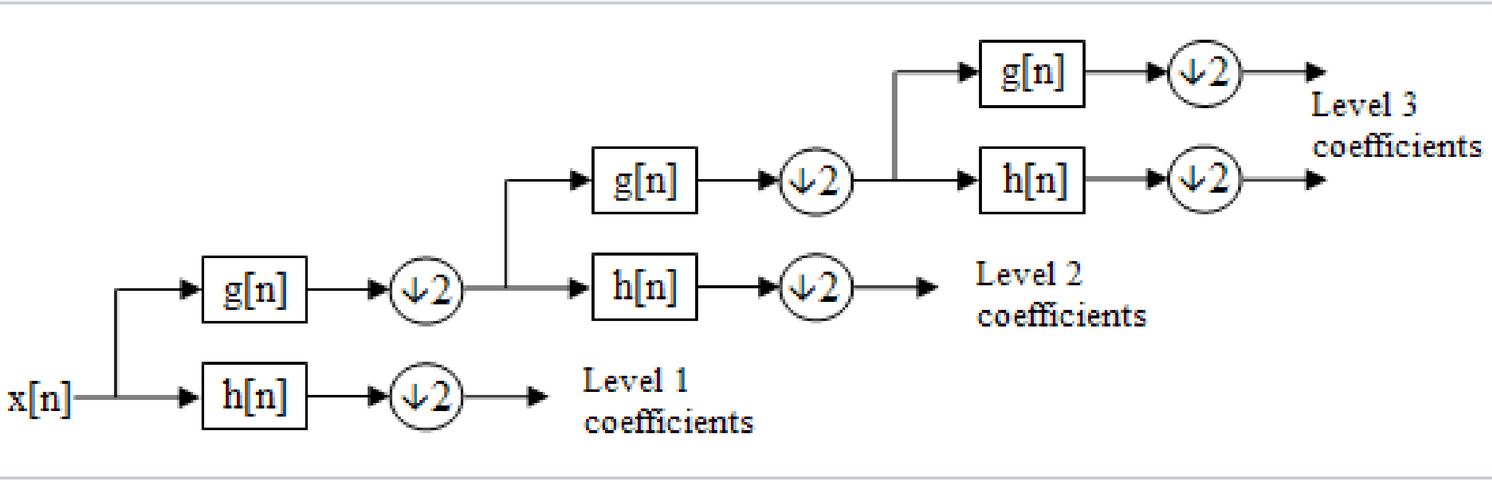
ORTHOGONAL WAVELET TRANSFORM

Comes from “multiresolution” analysis on a dyadic scale

In practice, a Fast (orthogonal) Wavelet Transform can be computed thanks to filter bank and subsampling

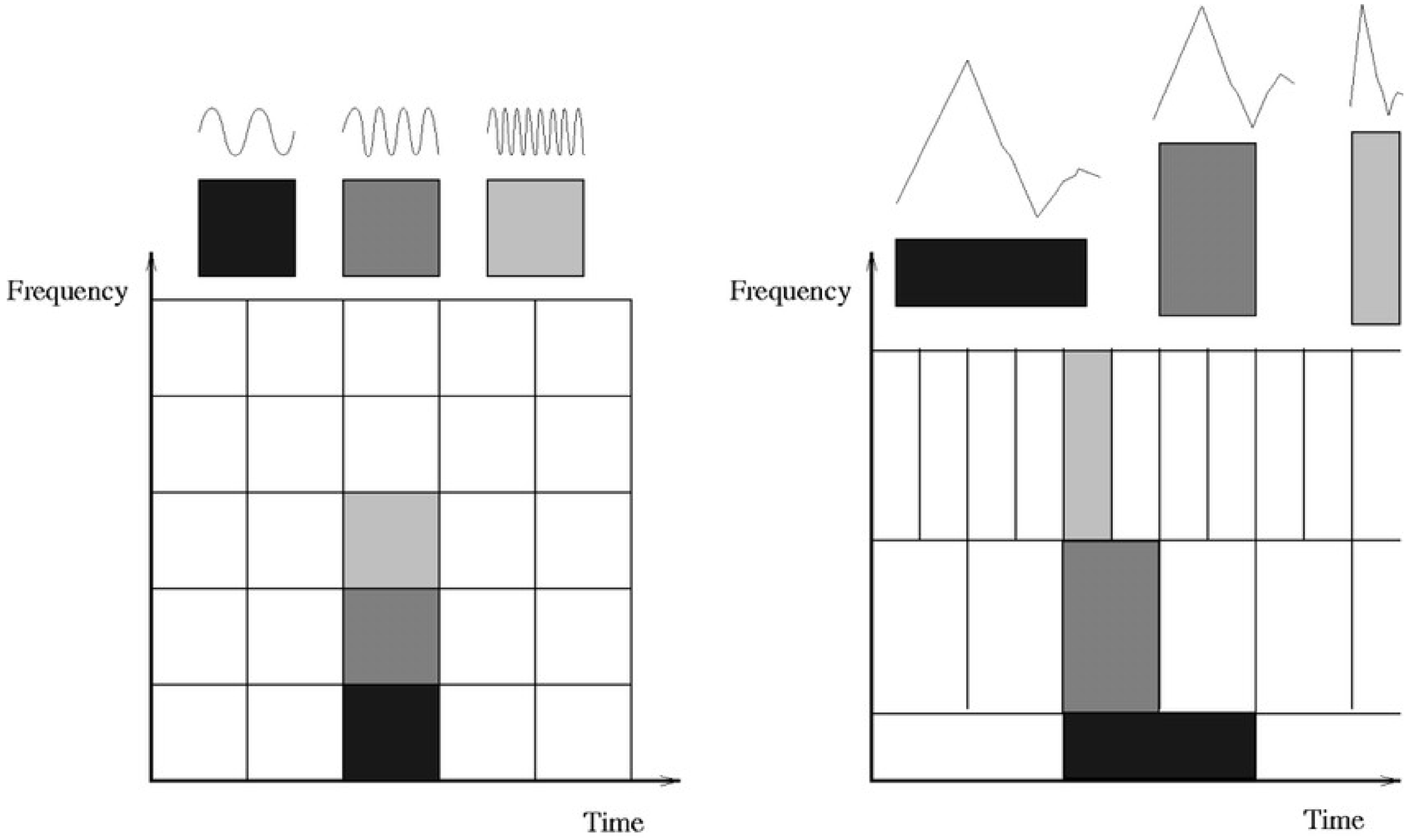
The same filter bank can be used to reconstruct the signal from the wavelet coefficients

A wavelet is then fully determined by two filters (which must fulfill certain conditions): a low pass filter and a high pass filter

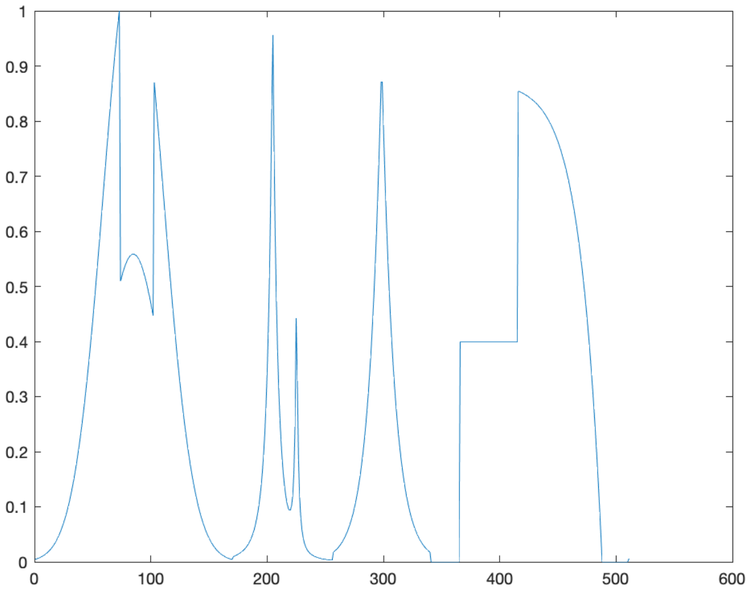


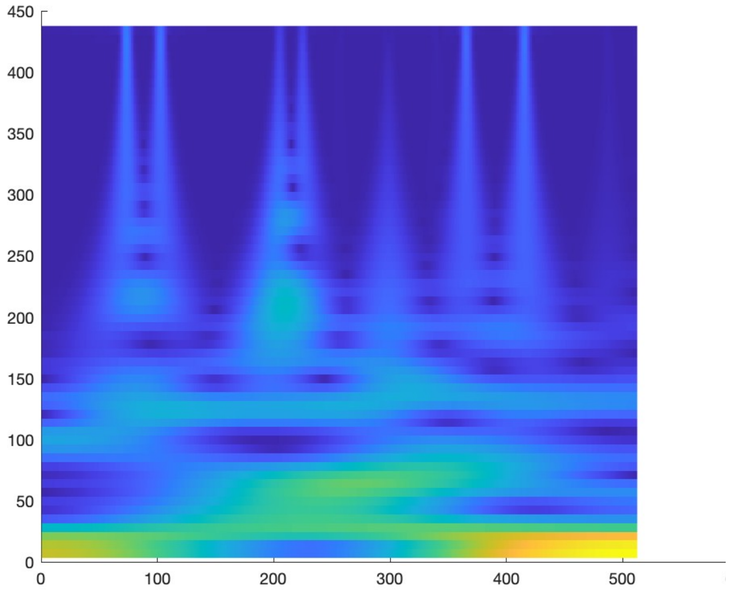
A 3 level filter bank

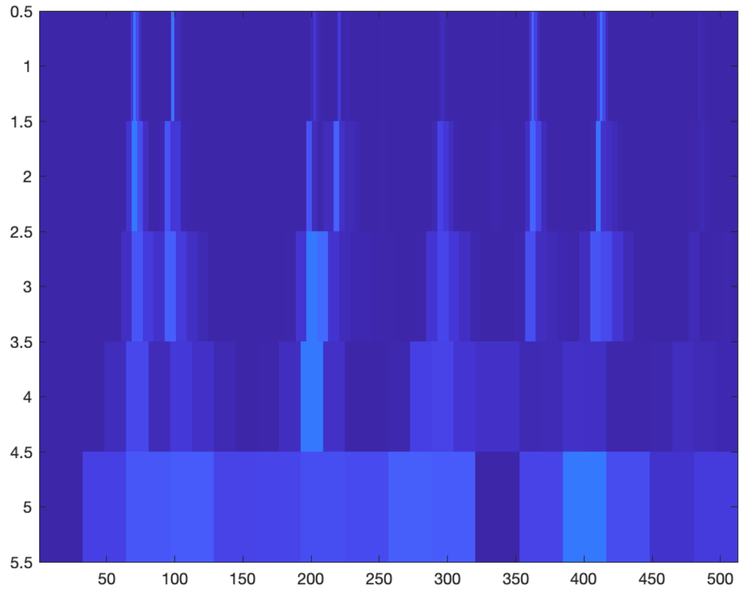
TIME-FREQUENCY TILING



SCALOGRAM: CONTINUOUS VS ORTHOGONAL



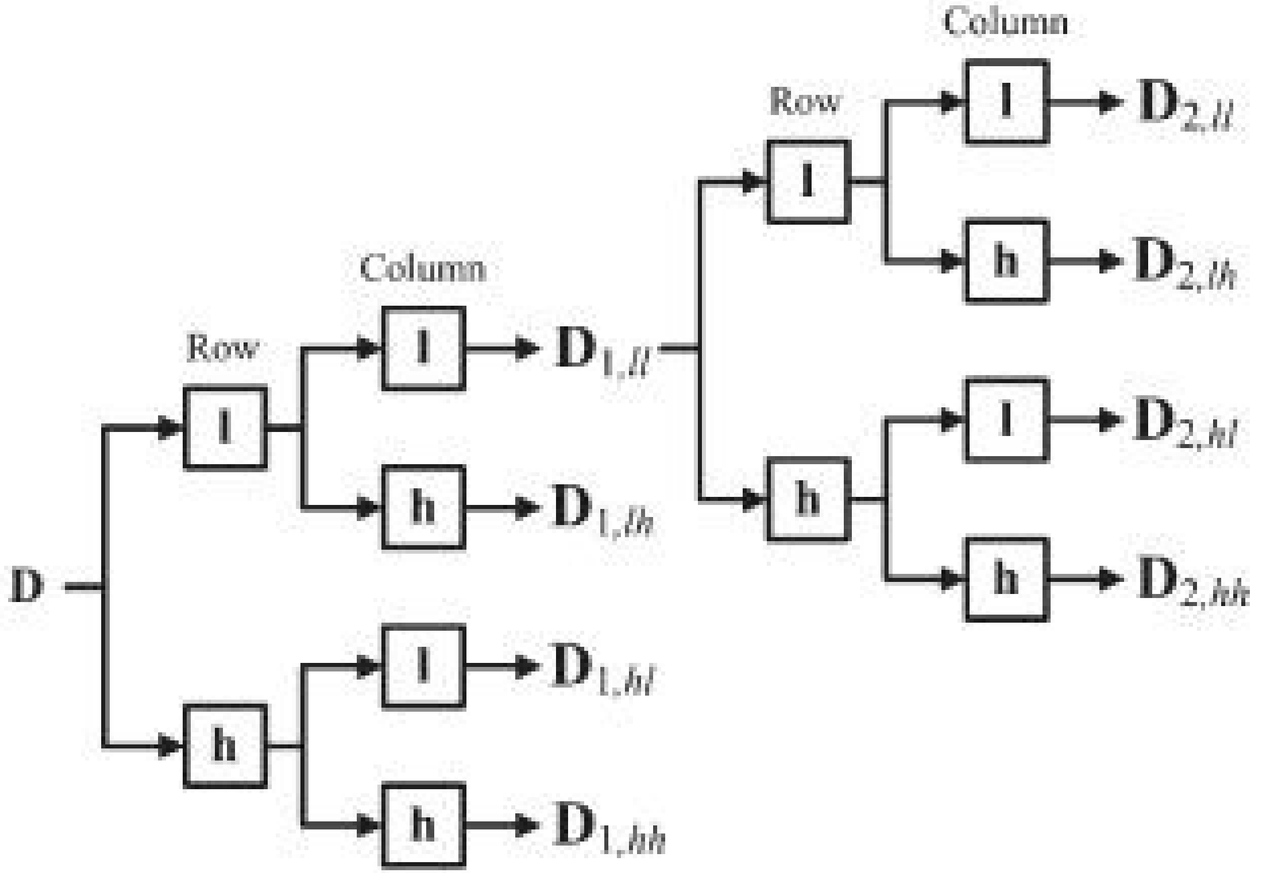




2D FWT

For images, we need a 2D FWT

It is constructed by using a separable filter bank (we first filter the row, then the column with the same filters)



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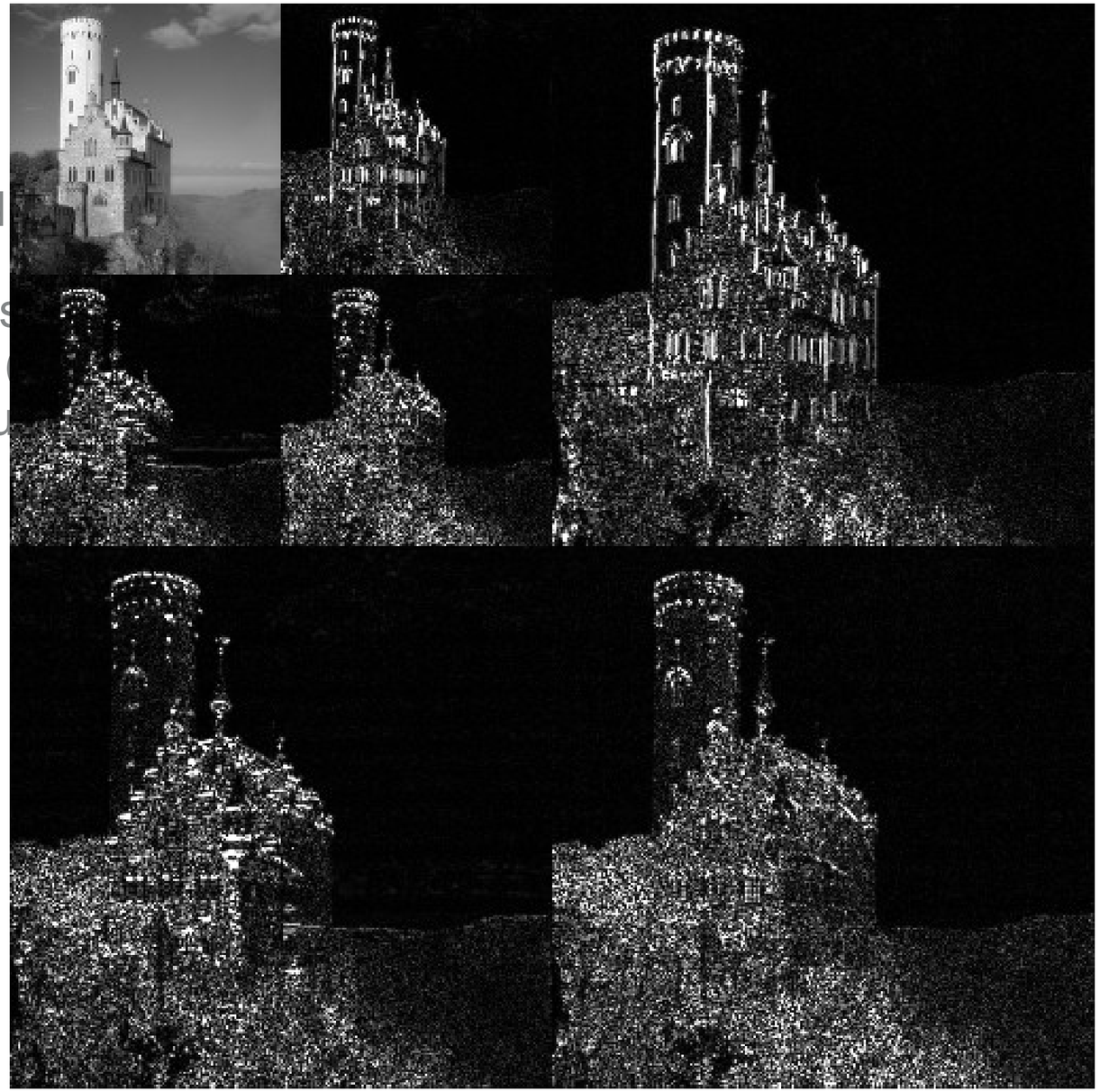

TO DO: DENOISING IN THE WAVELET DOMAIN

Data

Image you want

Todo

Simulate a noisy version of the image using the noises at various SNR Level (0 db, 10 dB and 20 dB)

Denoise the image by performing hard thresholding and soft thresholding in the wavelet domain

Discuss the parameters (wavelet type, number of level, type of thresholding)

Denoise the image by implementing translation invariant wavelet transform (see the numerical tour on image wavelet denoising)