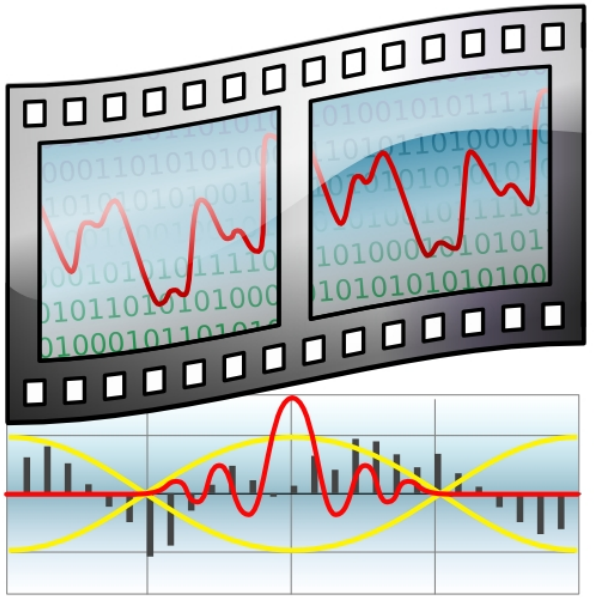
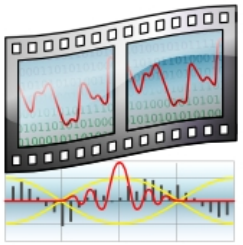
Video encoding: basic principles



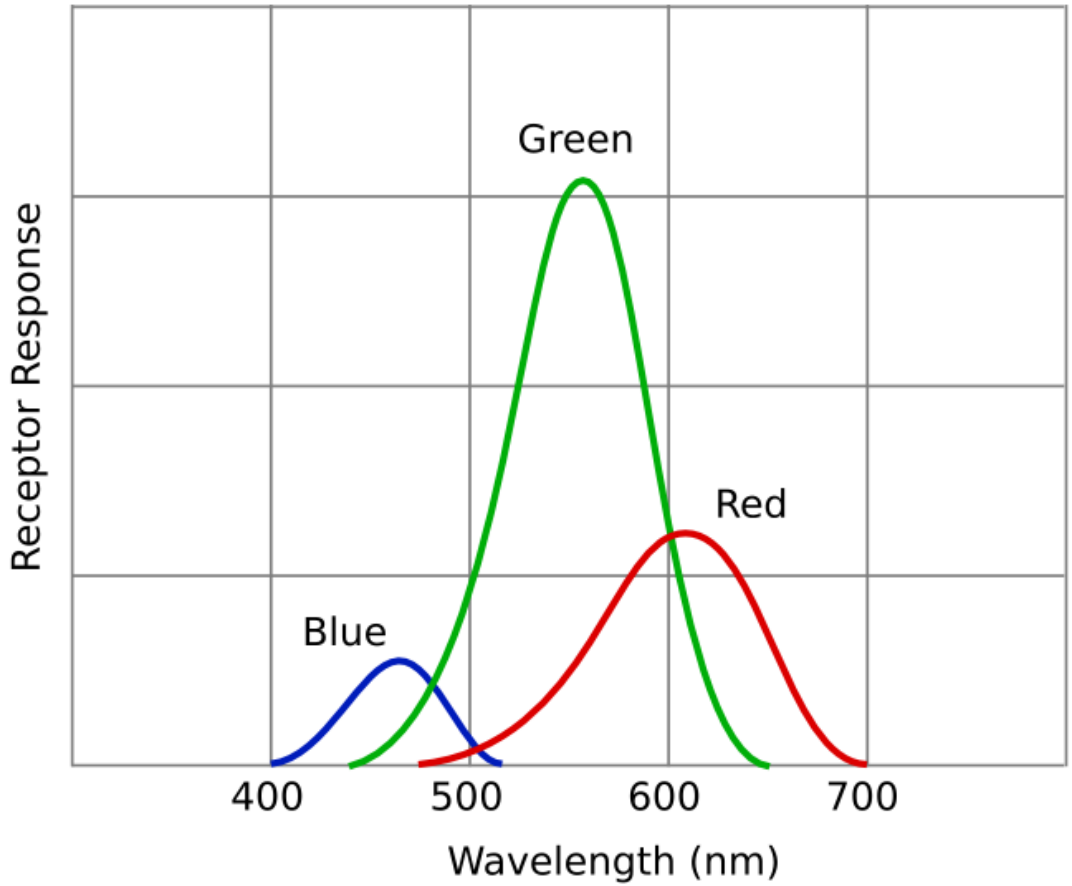
Felipe Portavales Goldstein
portavales@gmail.com

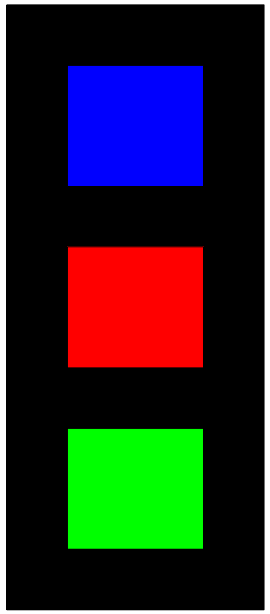


Color coding

Color coding

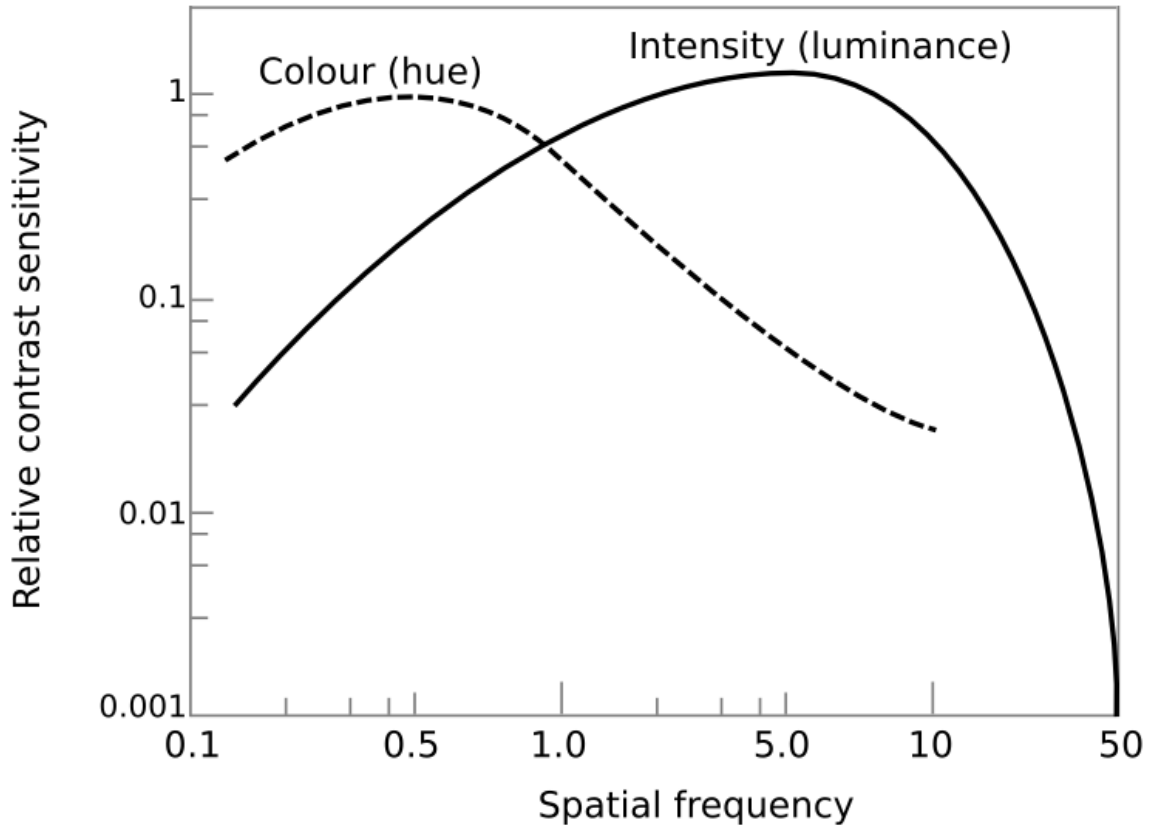
Human eye color perception

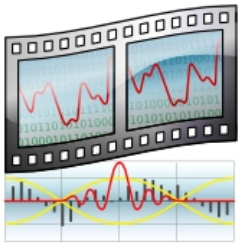




Color coding

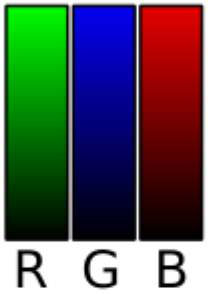
Human eye Colour x Luminance perception





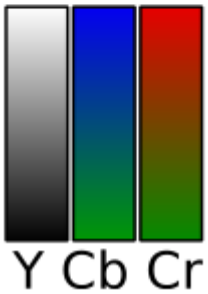
Color coding

Human eye Colour x Luminance perception



R (8 bits) G (8 bits) B (8 bits)

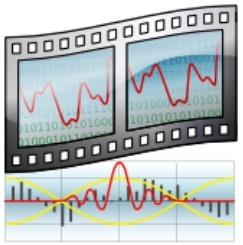
Each color is coded separately



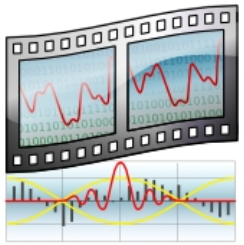
Y (8 bits) Cb (4 bits) Cr (4 bits)

Y : Luminance
Cb : Blue color
Cr : Red color

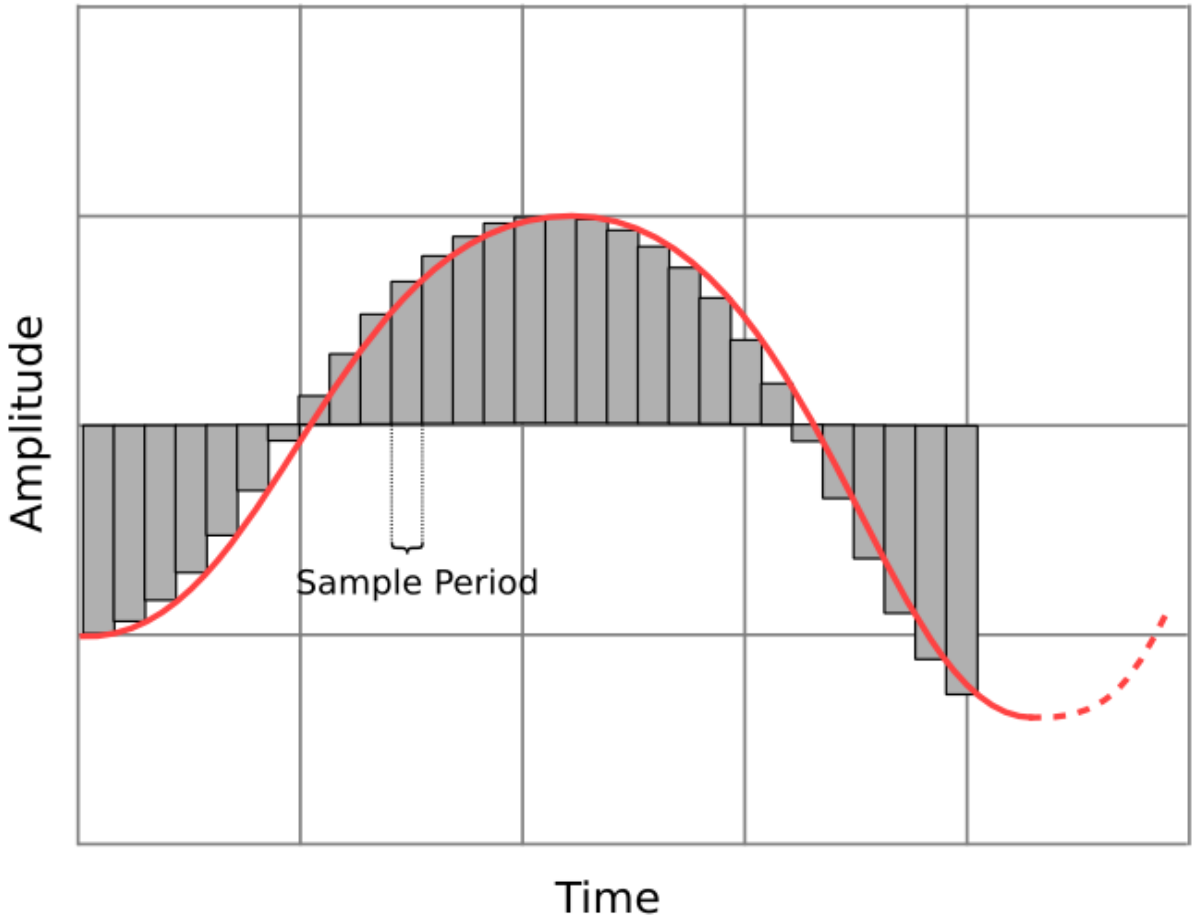
Green color is presense of luminance and absence of Blue and Red color

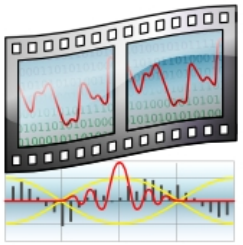


Digital signals / sampling



Digital signals / sampling

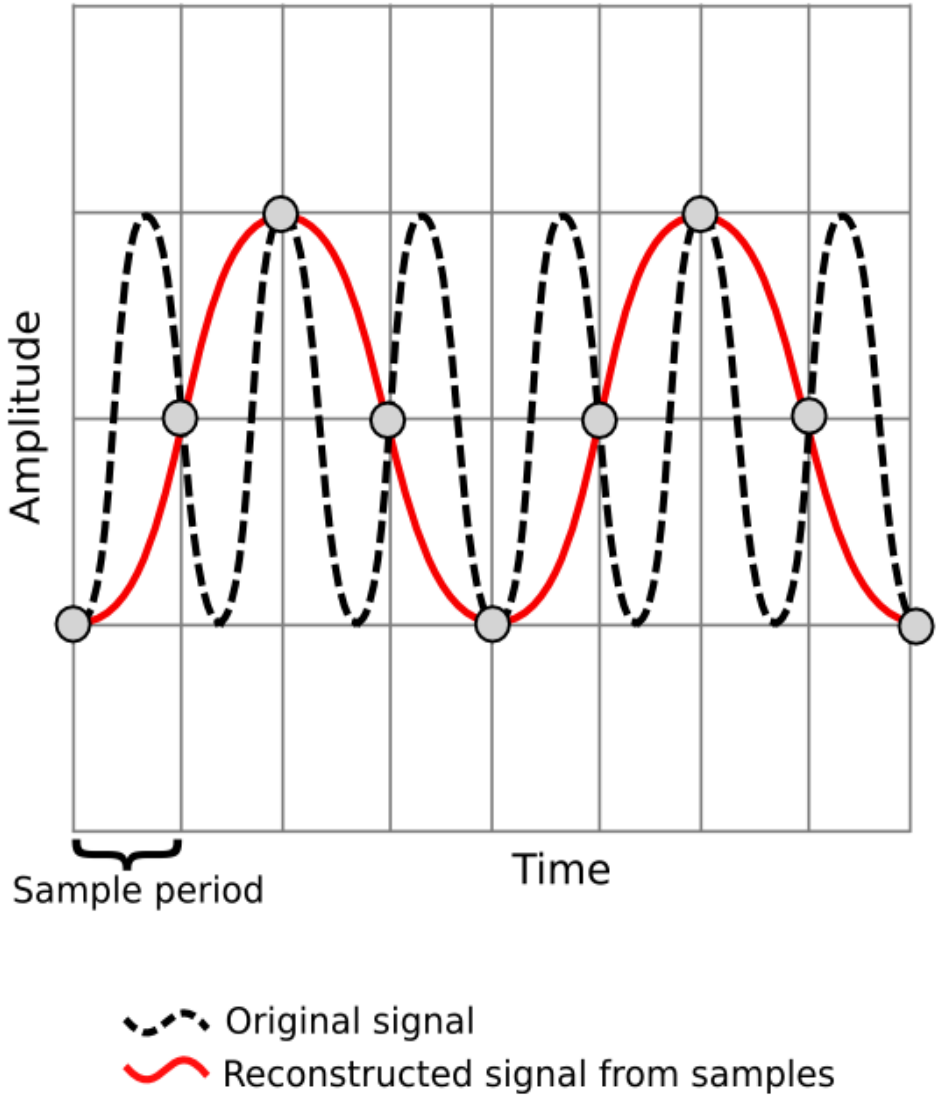




Digital signals / sampling

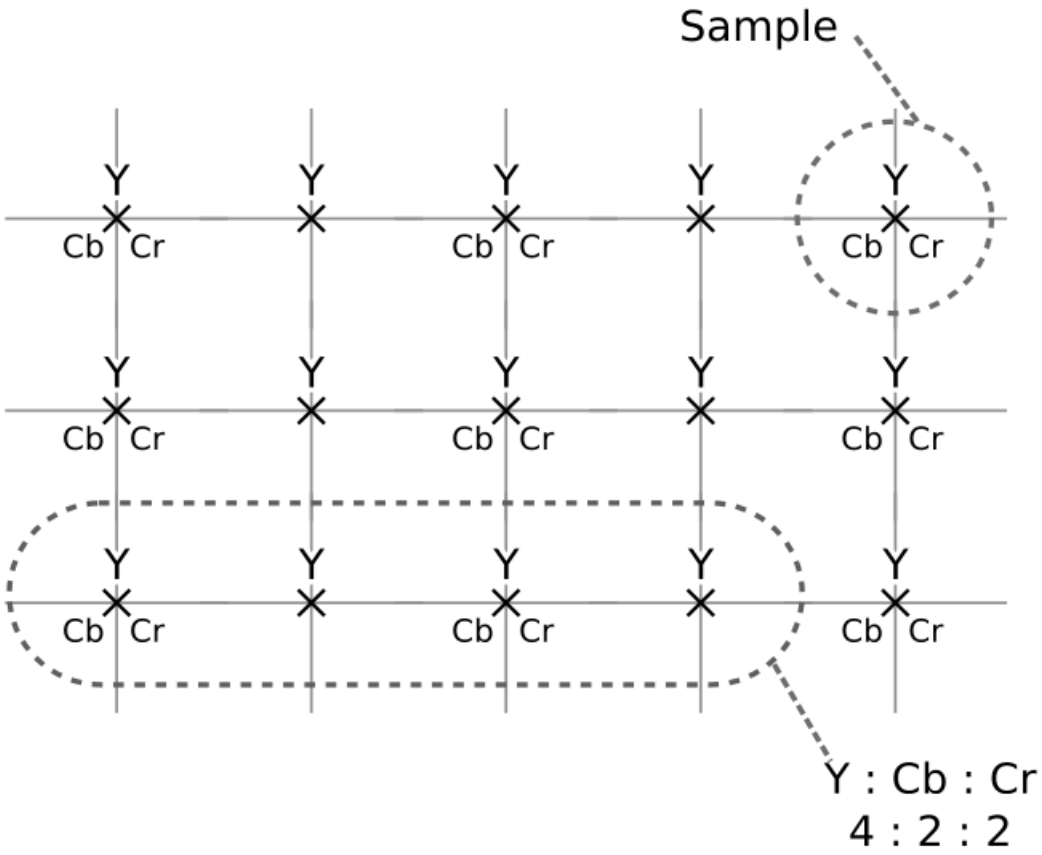
Sampling Aliasing:

Sample rate must be twice as input bandwidth

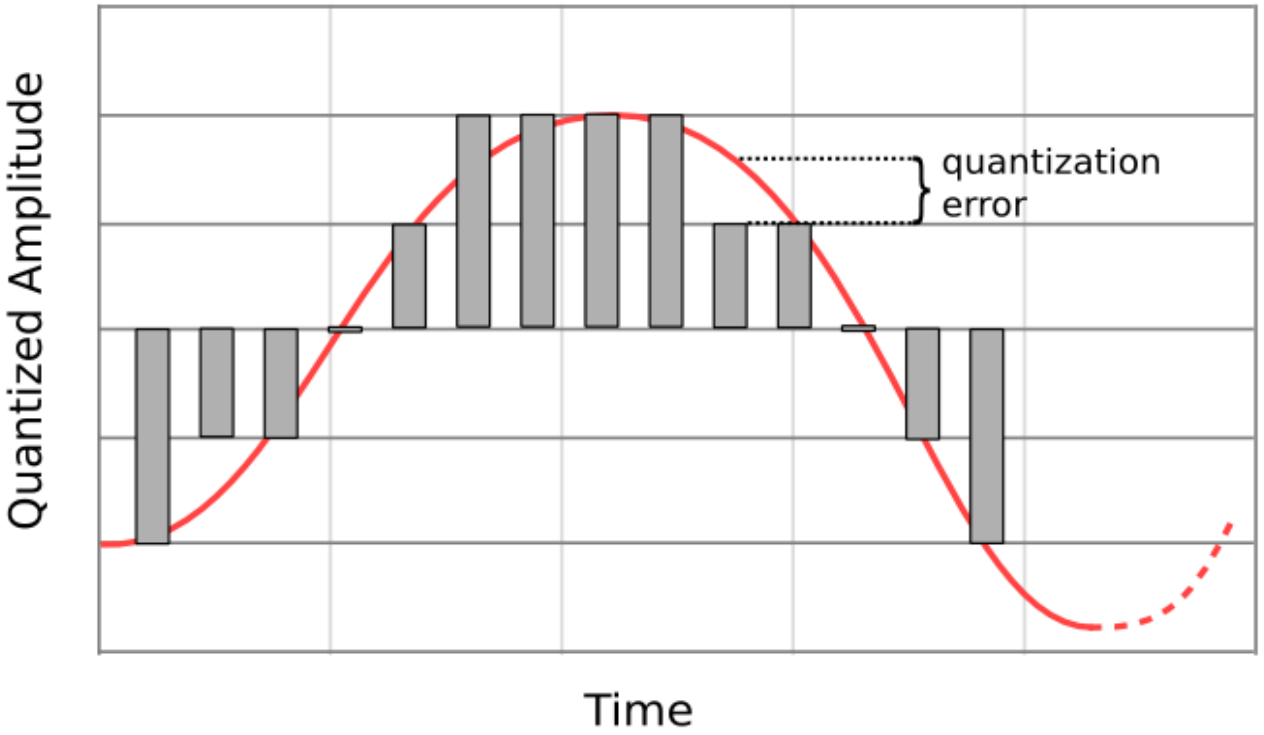


Digital signals / sampling

Sampling images

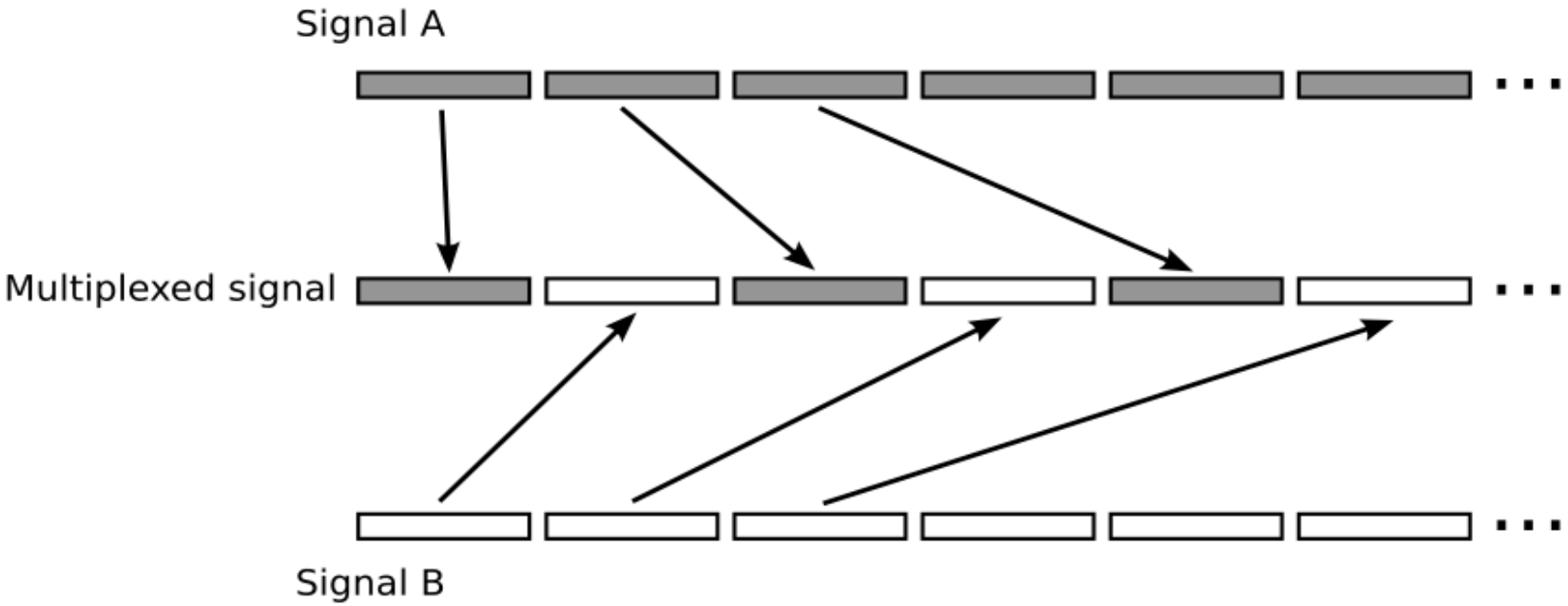


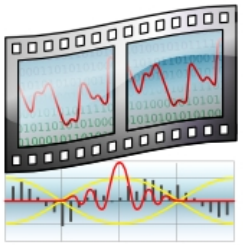
Quantizing



7 possible quantized amplitude values:
need 3 bits to represent

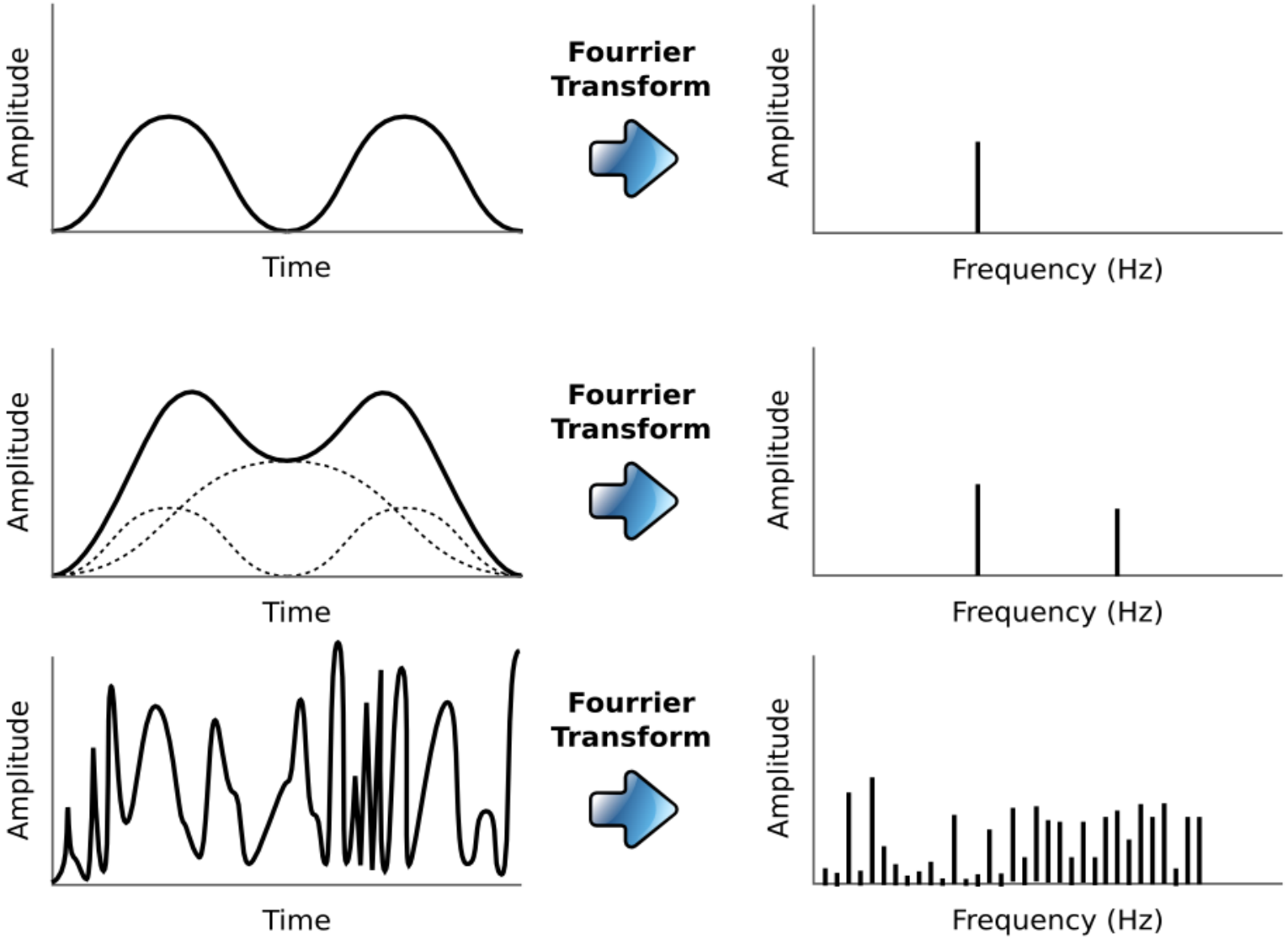
Multiplexing

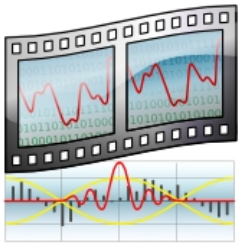




Fourrier Transform

Fourrier Transform





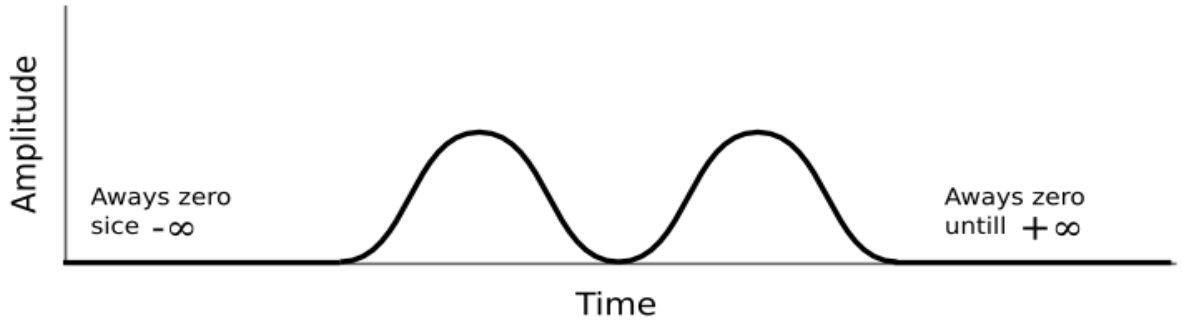
Fourrier Transform

The transform must consider the complete signal history to get the exact frequencies in the signal.

To apply the transform we must known the signal behavior since -∞ to +∞

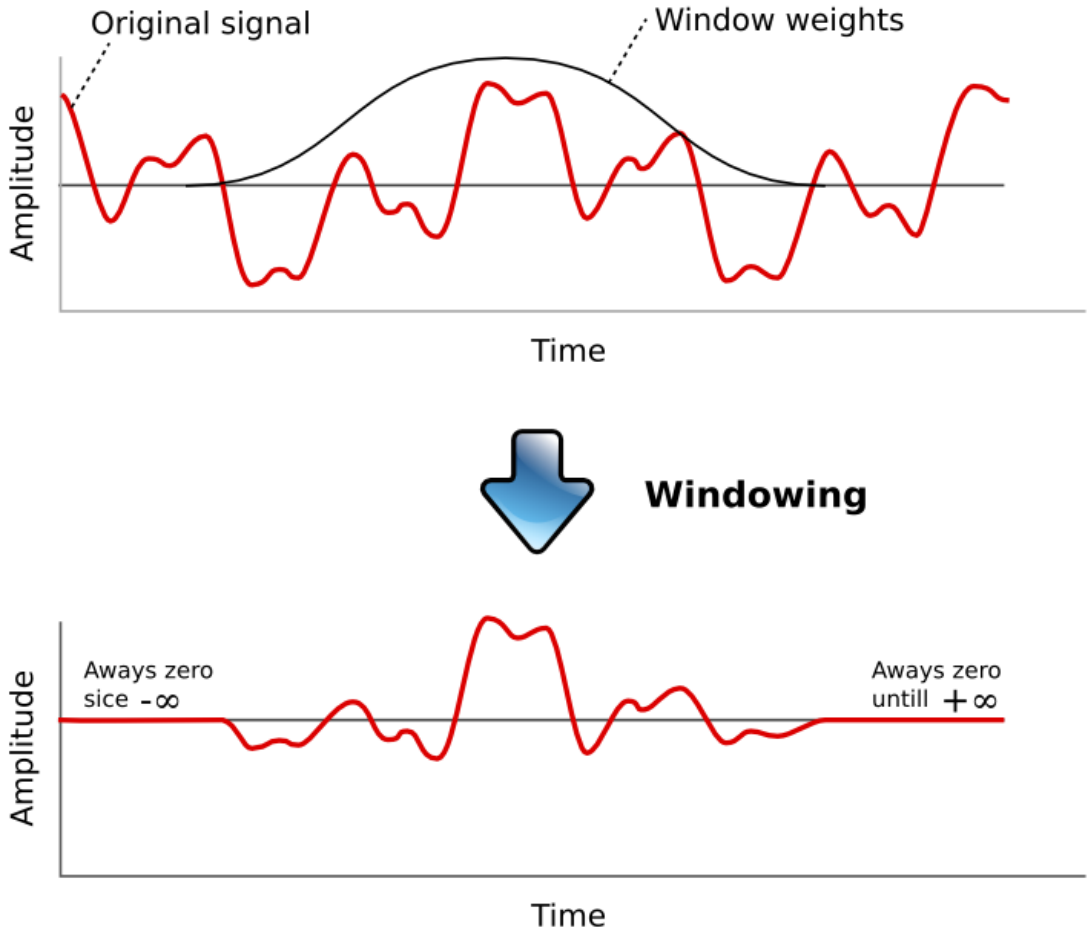
Is it possible ?

And, what if the signal behaves like this :



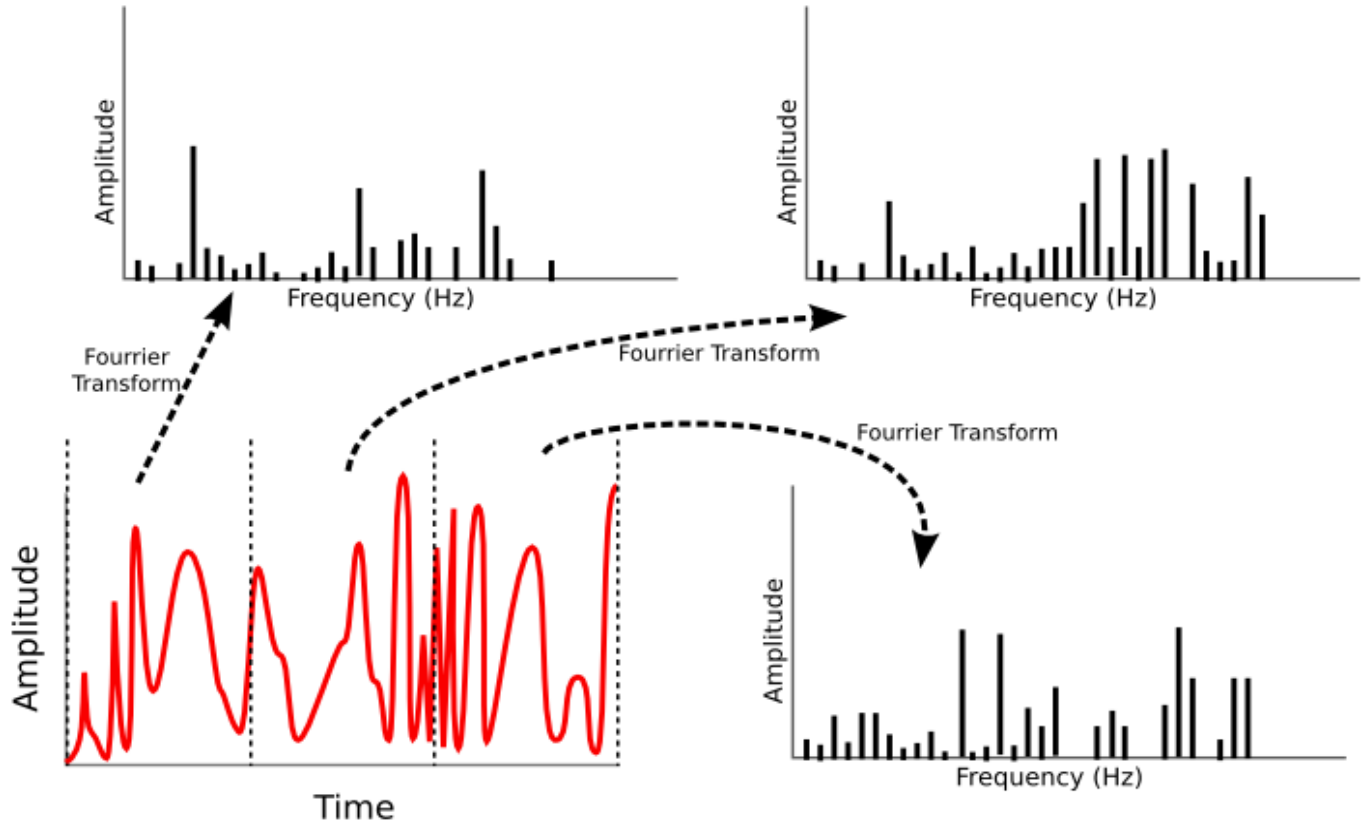
Windowing

The windowing must be applied in the signal before the Fourrier transform, to focalize the analysis



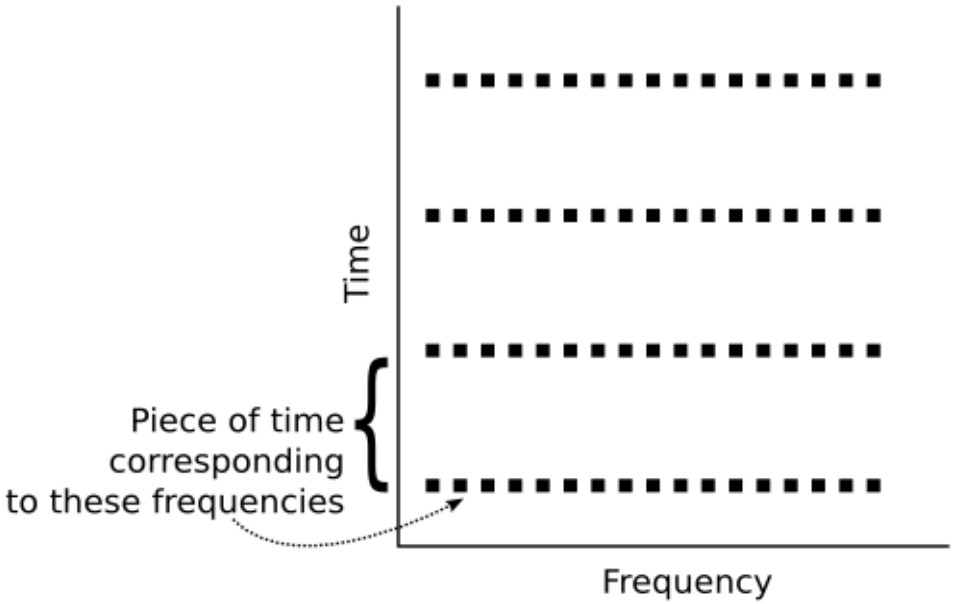
Windowing

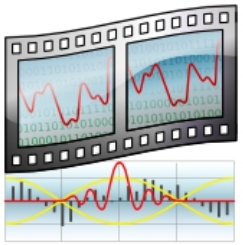
The windowing can be used to divide the signal in small pieces, and transform them separately



Windowing

Another way to view:





Windowing

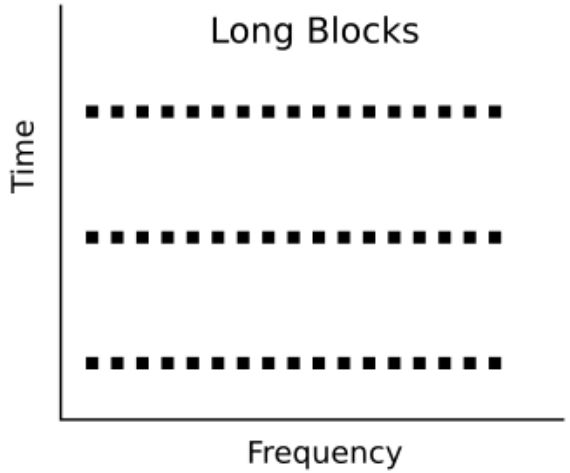
The Heisenberg uncertainty principle states that:
the knowledge of the position of a particle is inversely proportional to the knowledge of its energy

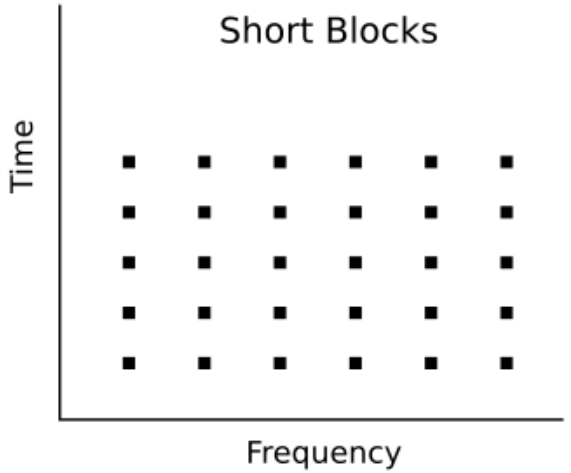
It is the same to say:
knowledge about time is inversely proportional to knowledge about frequency

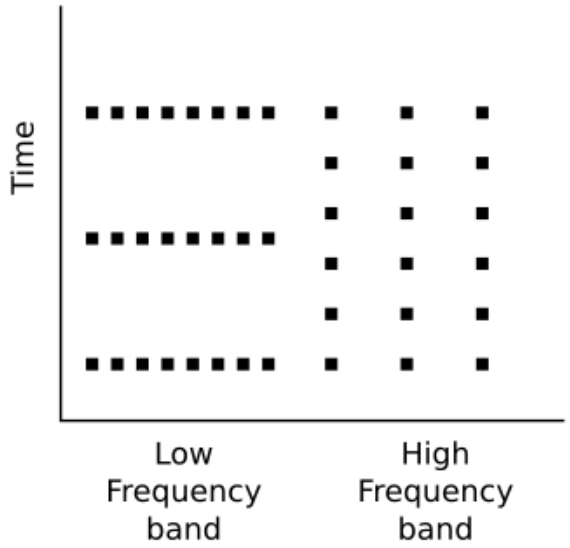
Position knowledge is relative to time

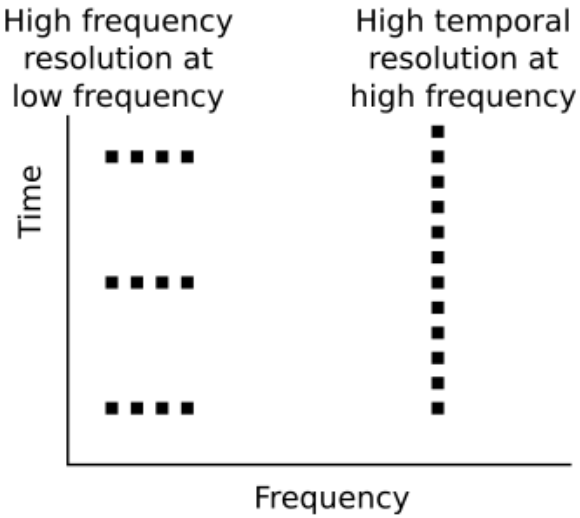
Energy knowledge is related to frequency

Windowing

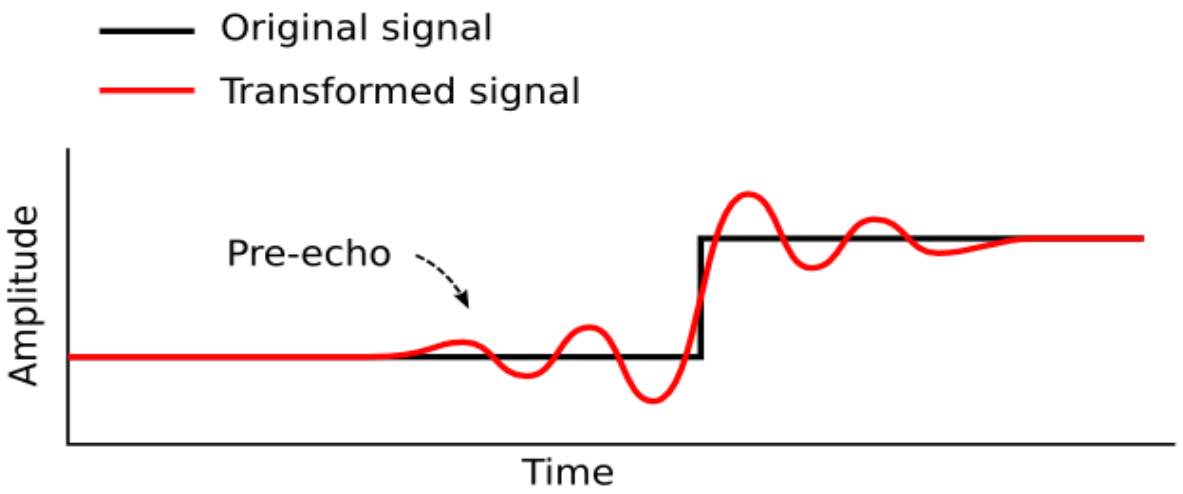

Long Blocks
Time
Frequency

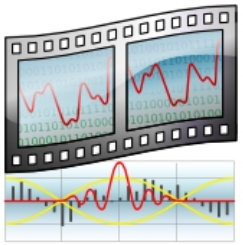

Short Blocks
Time
Frequency


Time
Low Frequency band
High Frequency band

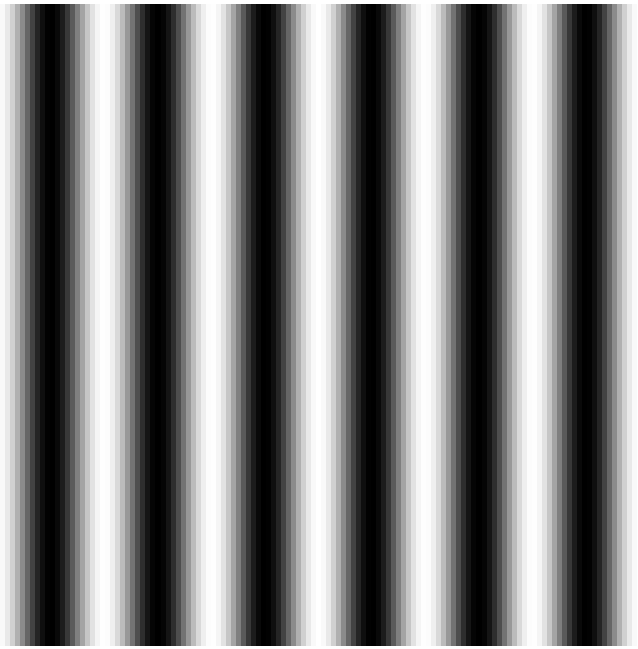

High frequency resolution at low frequency
High temporal resolution at high frequency
Time
Frequency

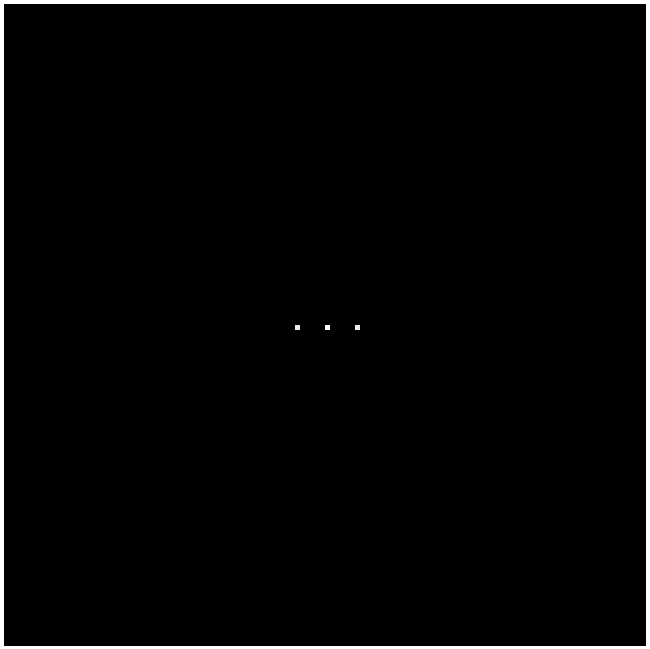
Pre-echo

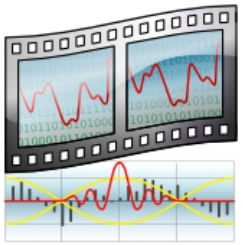

Original signal
Transformed signal
Pre-echo
Amplitude
Time



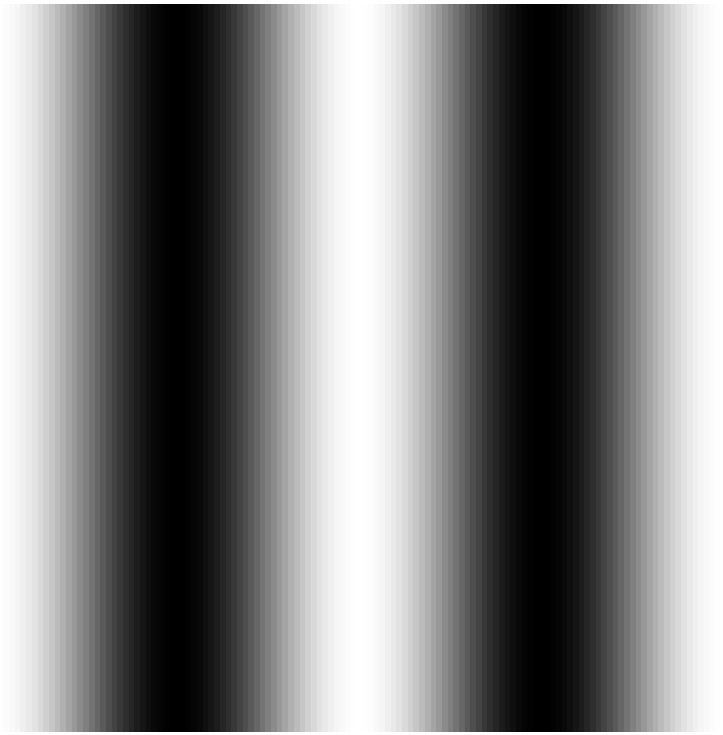
Fourrier Transform in a image

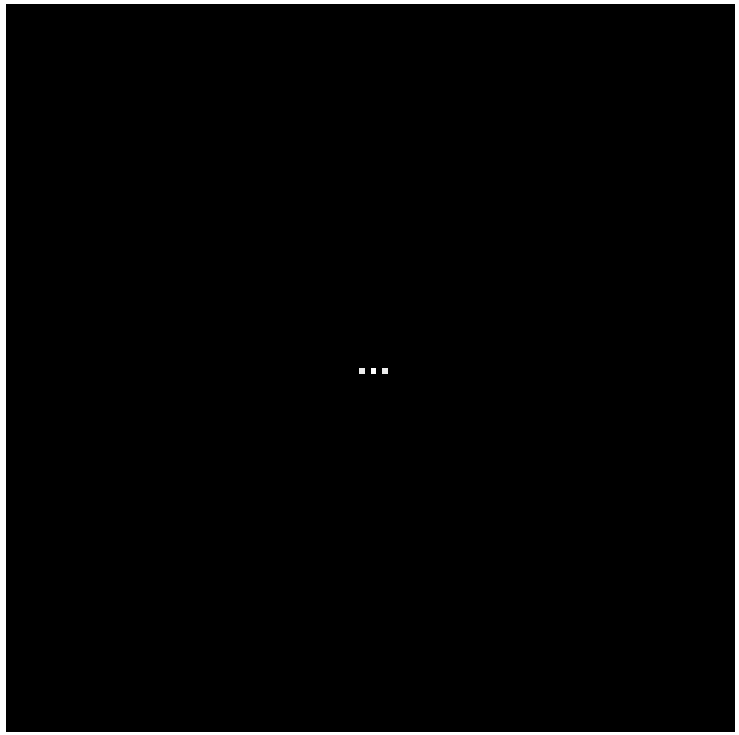


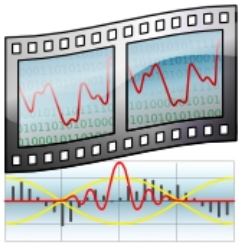




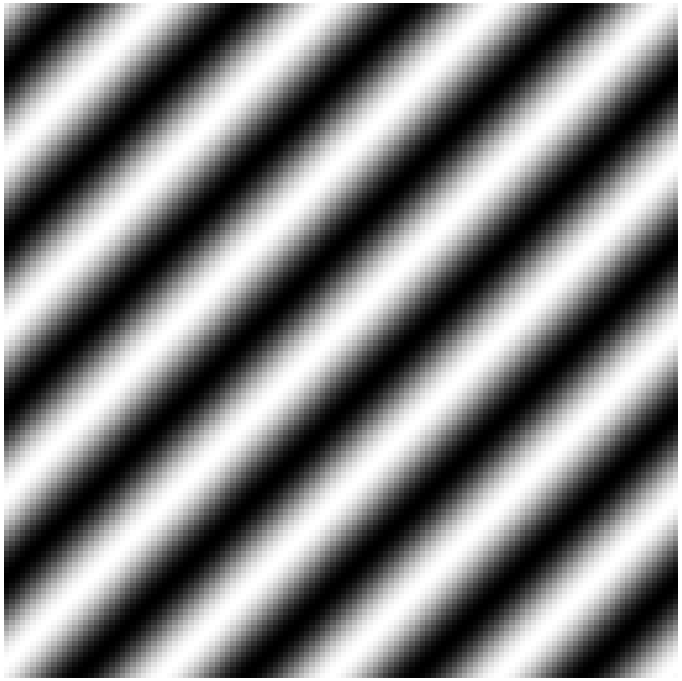
Fourrier Transform in a image

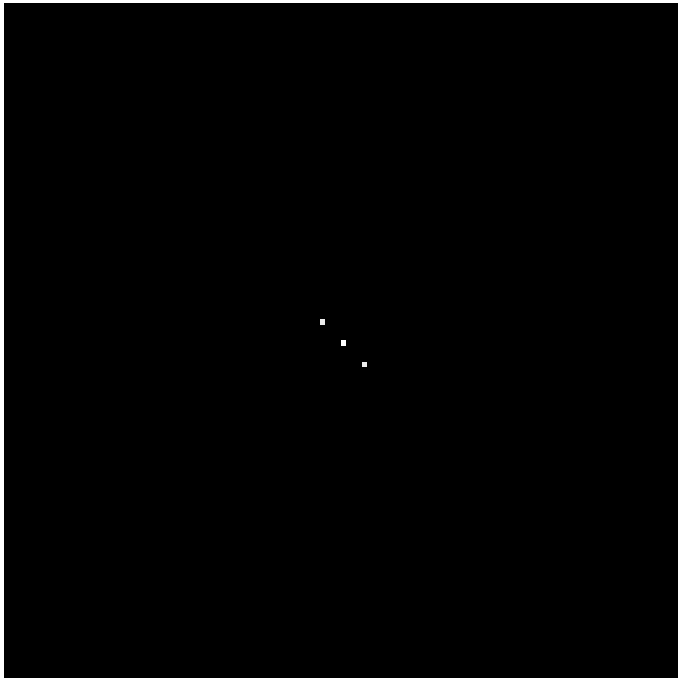


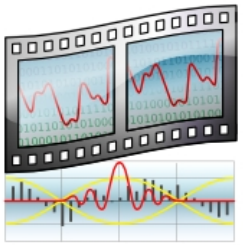




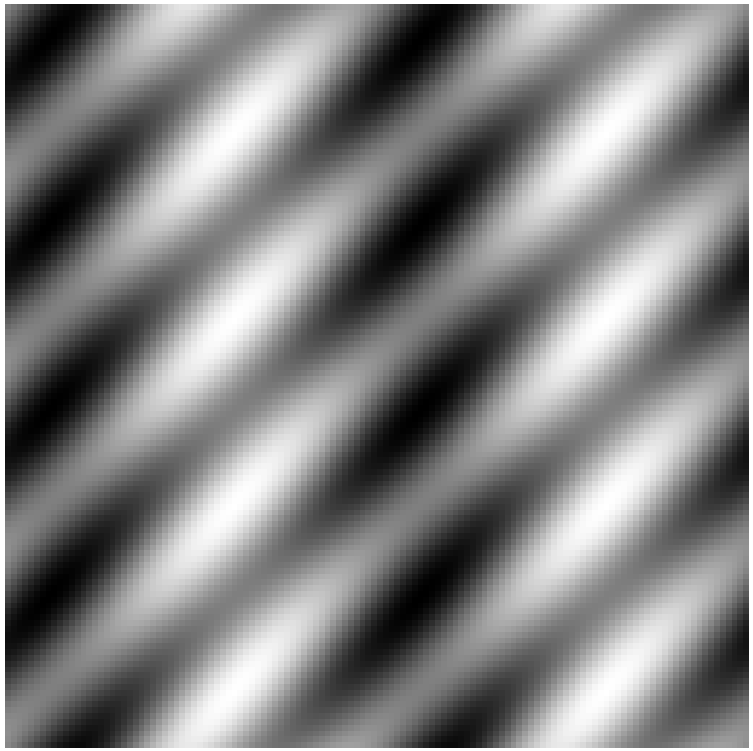
Fourrier Transform in a image

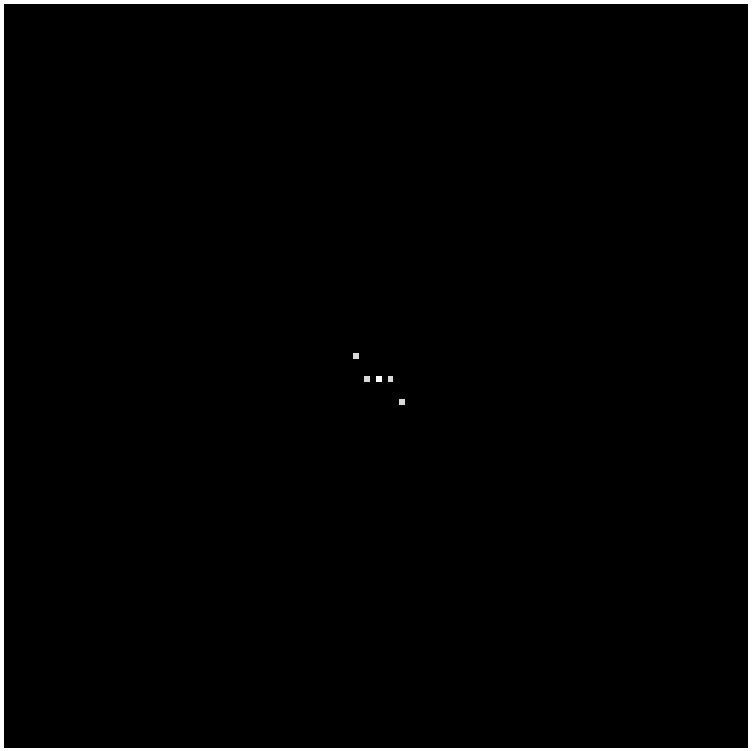




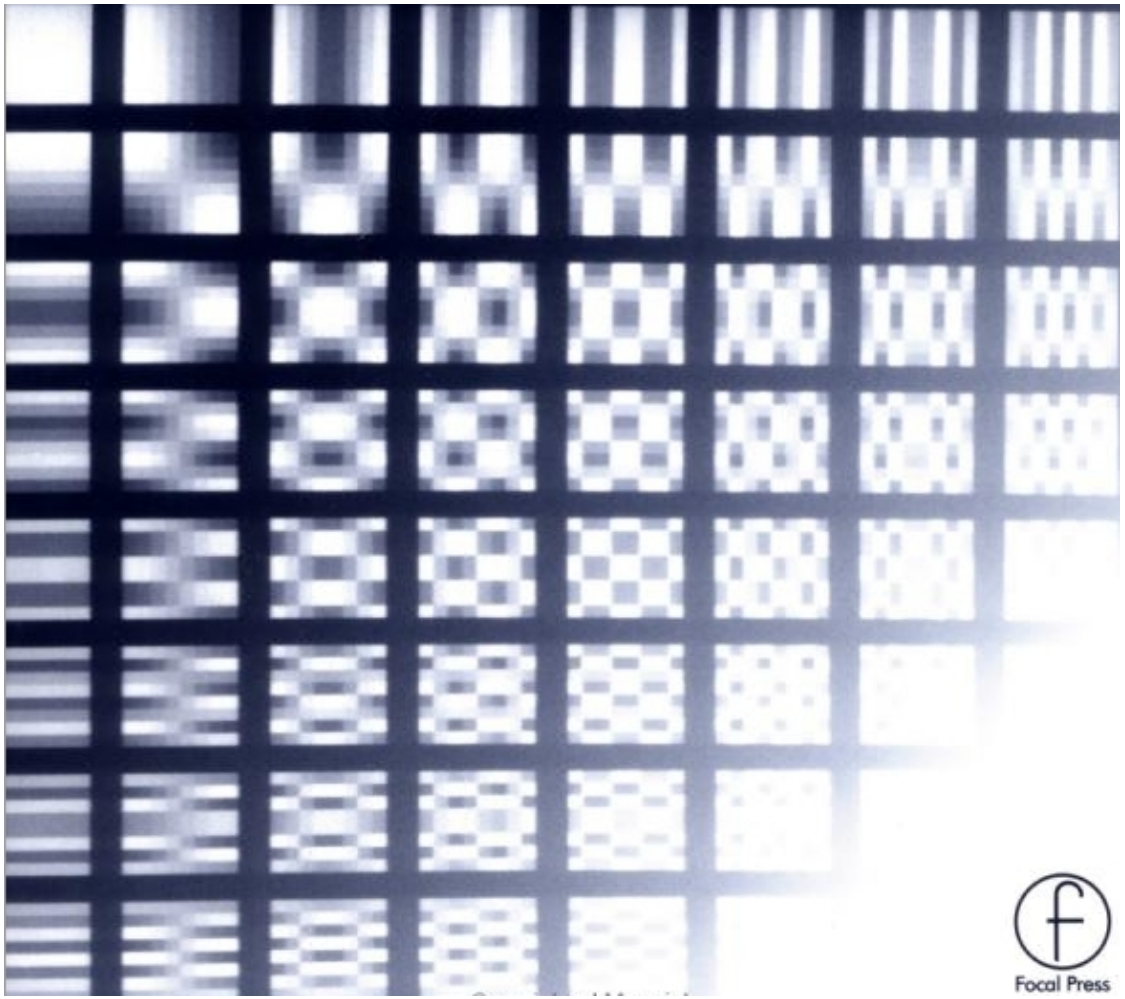


Fourrier Transform in a image

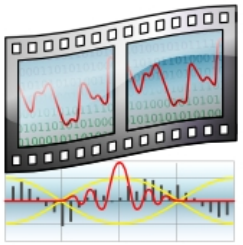




Fourrier Transform in a image



This picture is the cover of book: MPEG-2 , John Watkinson , Focal Press

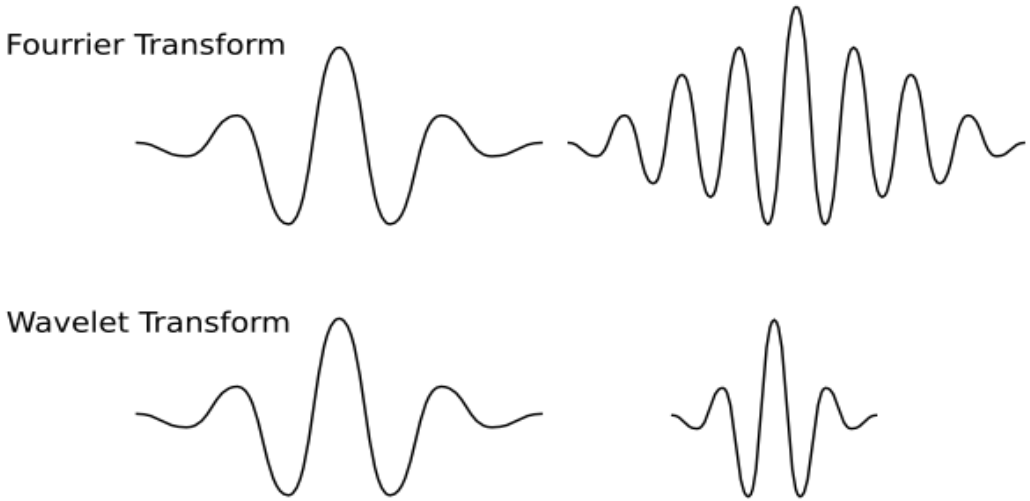


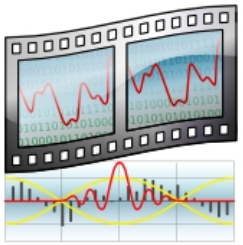
Wavelet transform

Wavlet dont use endless sine wave functions as its basis, but instead, use functions that are finite on time axis.

The window lenght is variable and is inversely proportional to the frequency.

High frequencies are transformed with short basis functions and therefore are accurately located. Low frequencies are transformed with long basis functions which have good frequency resolution.

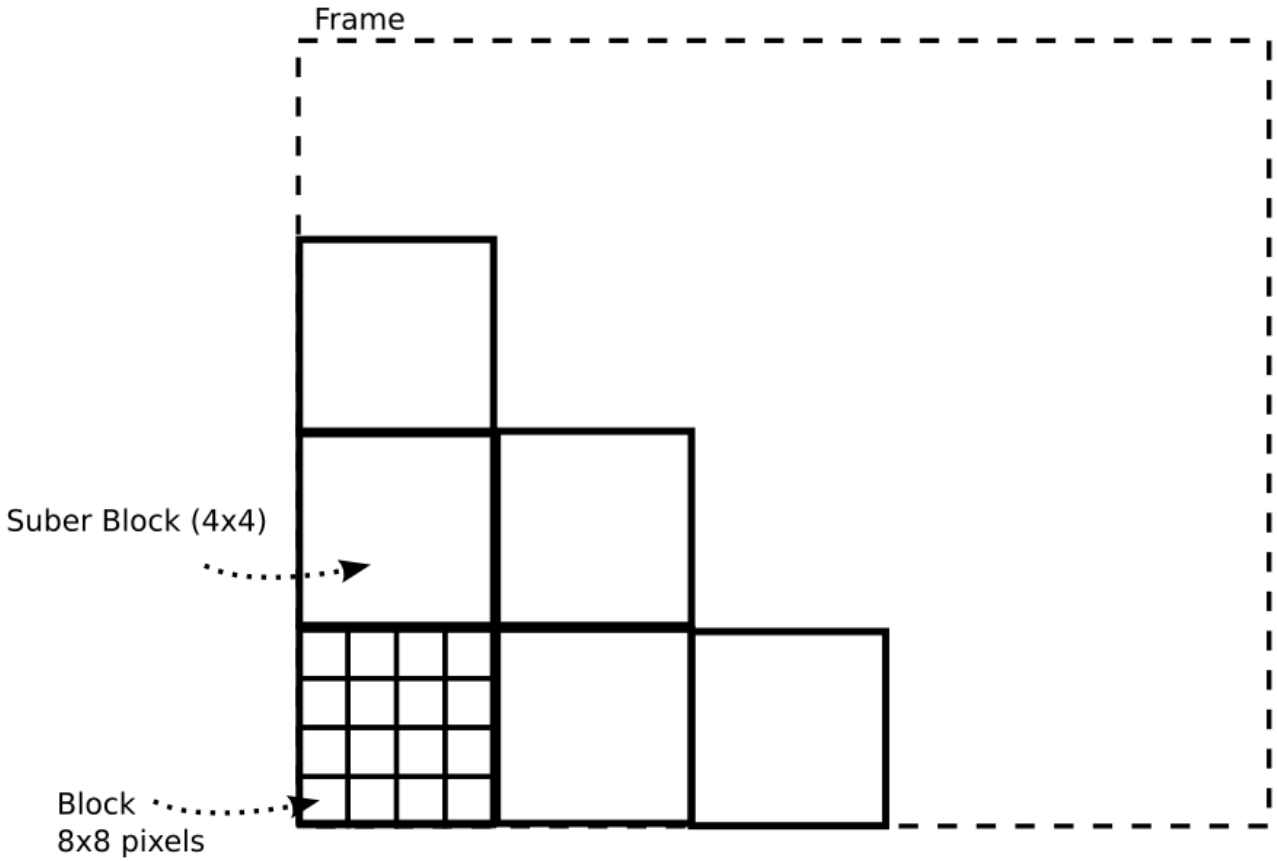




Frame subdivision

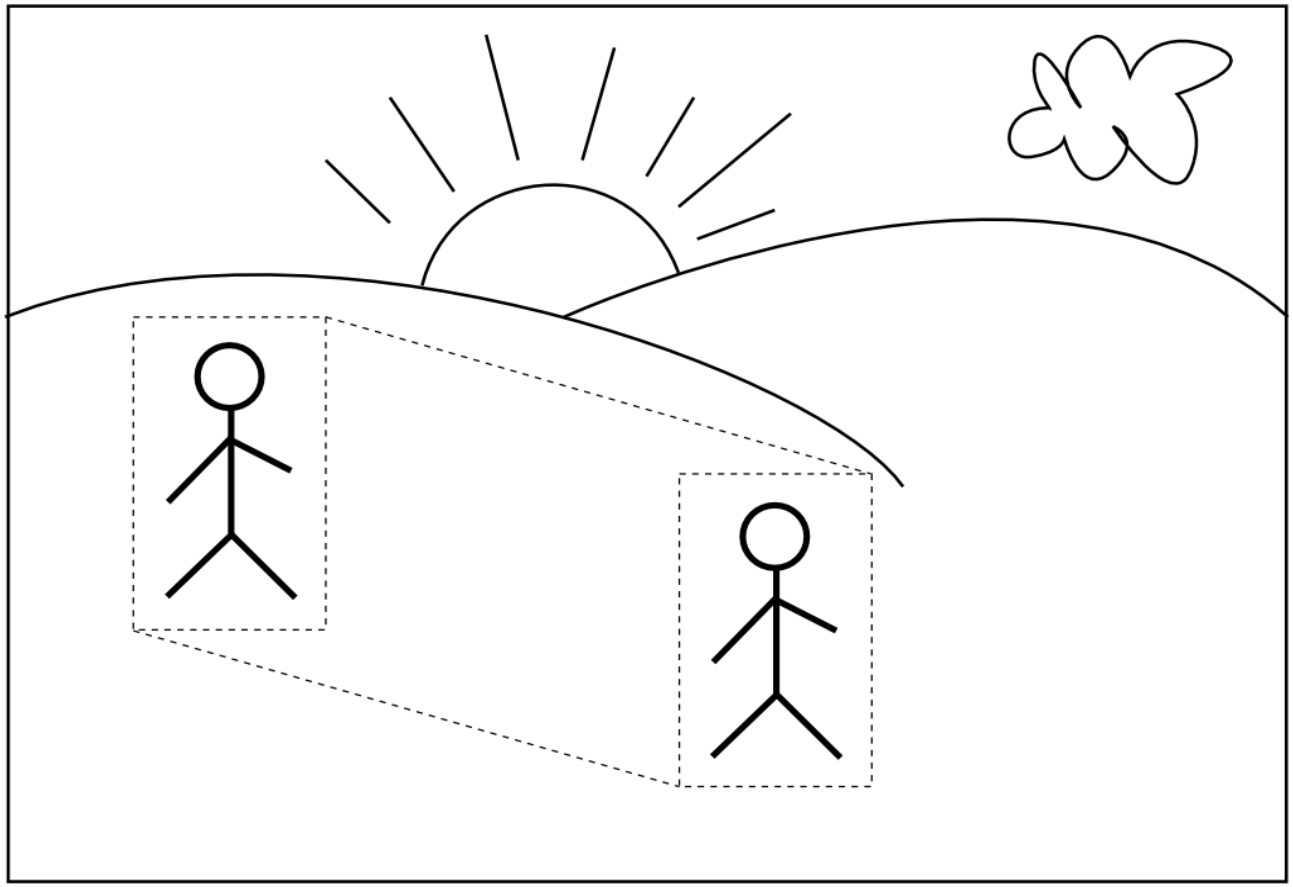
Frame subdivision

Subdivision of a Frame into blocks and super blocks
Each color plane has its own set of blocks and super blocks



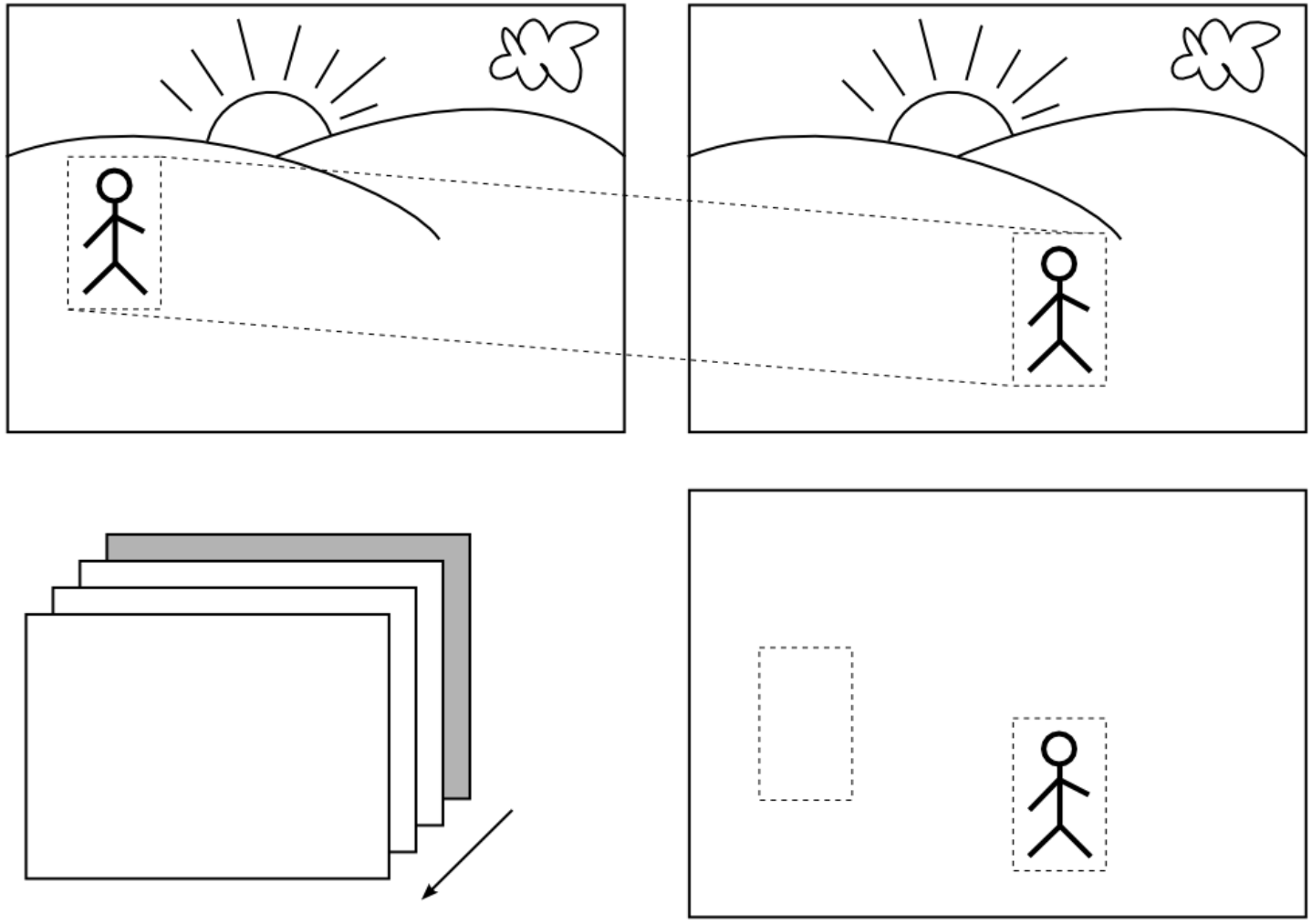
Intra Frame

Intra-coding explores redundancy within a picture



Inter Frame

Inter-coding explores redundancy between pictures



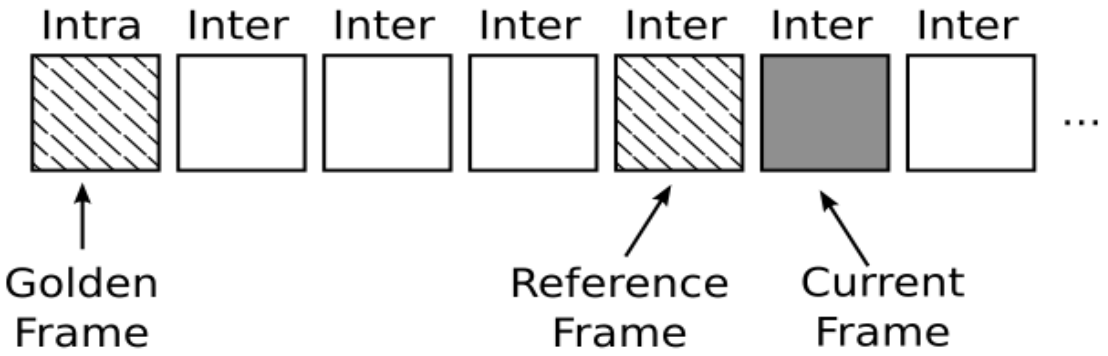
Inter Frame

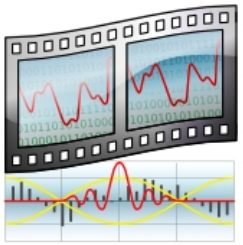
Golden Frame (intra)

Inter Frames

Coded frame

Inter Frame


Intra
Inter
Inter
Inter
Inter
Inter
Inter
...
Golden Frame
Reference Frame
Current Frame



References

- **Theora I Specification; Xiph.org Foundation**
- **John Watkinson; MPEG-2 ; Focal Press**
- **Martin Ruckert; Understanding MP3: Syntax, Semantics, Mathematics, and Algorithms ; Viewg**
- **http://www.animemusicvideos.org/guides/avtech/video3.htm**
- **http://www.complextoreal.com/tutorial.htm**
- **http://cns-alumni.bu.edu/~slehar/fourier/fourier.html**