# **3T2:** Fourier Transform properties (2 of 2)

### *Xavier Serra*
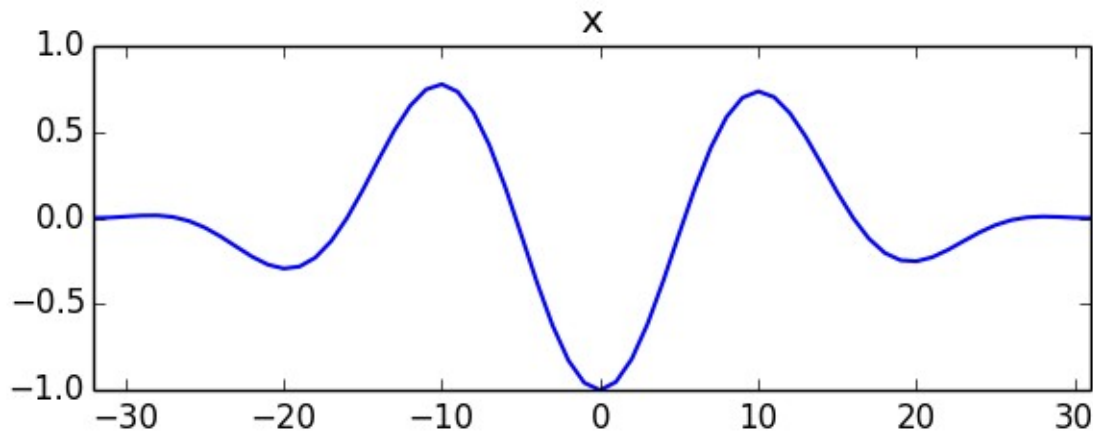
Universitat Pompeu Fabra, Barcelona
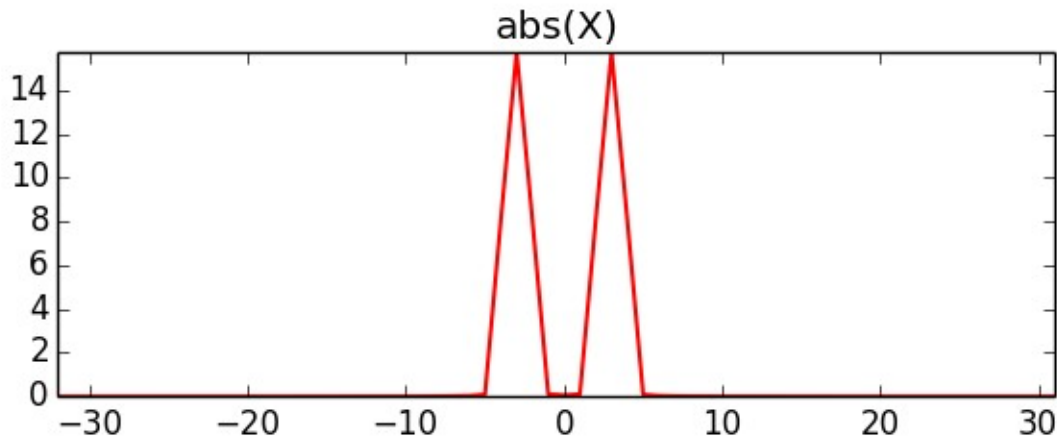
&

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# Energy conservation

$$\sum_{n=-N/2}^{N/2-1} |x[n]|^2 = \frac{1}{N} \sum_{k=-N/2}^{N/2-1} |X[k]|^2$$
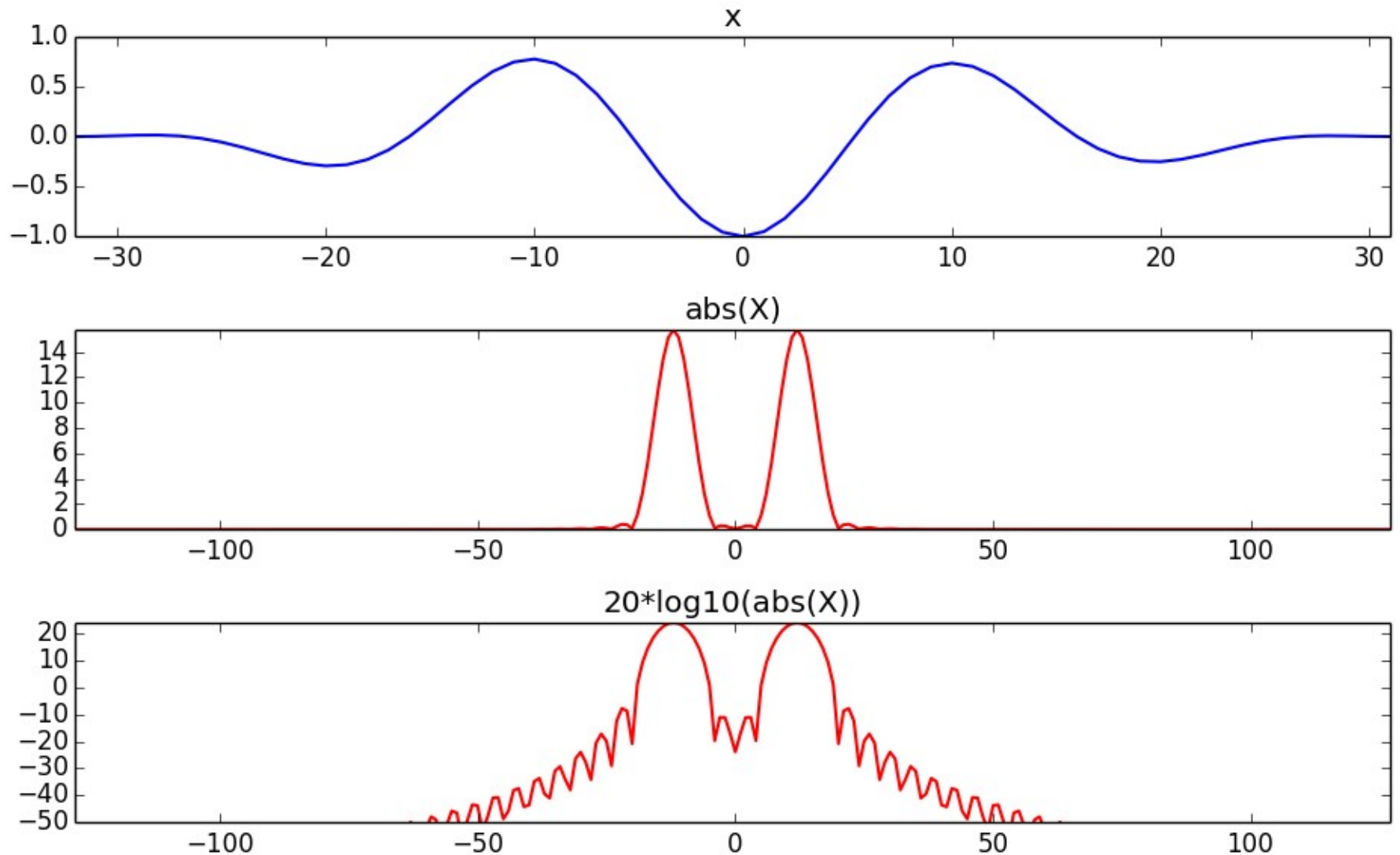


x
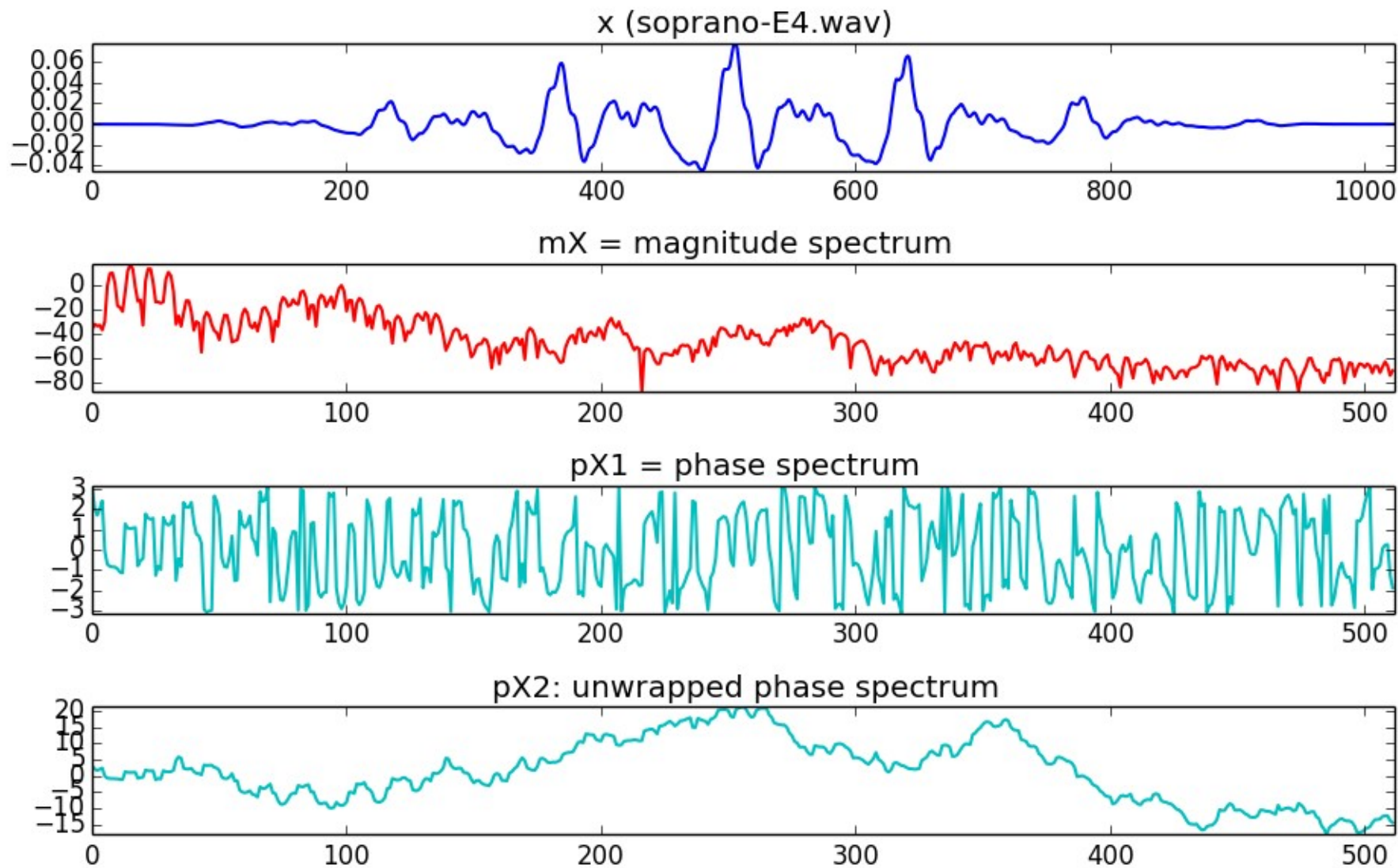


abs(X)

$$\sum_{n=N/2}^{N/2-1} |x[n]|^2 = 11.81182$$

$$\frac{1}{N} \sum_{k=N/2}^{N/2-1} |X[k]|^2 = 11.81182$$
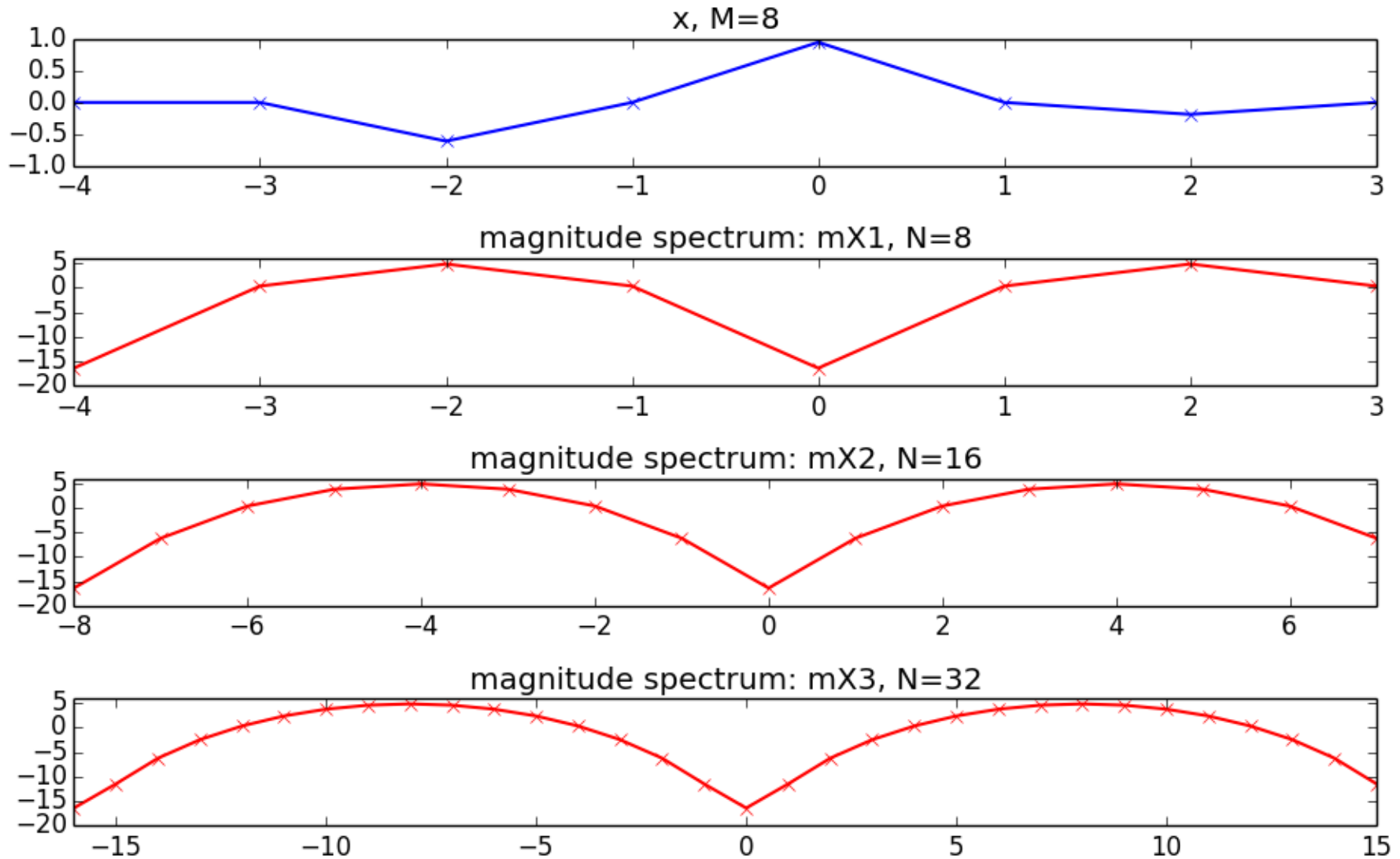
# Amplitude in decibels (dB)
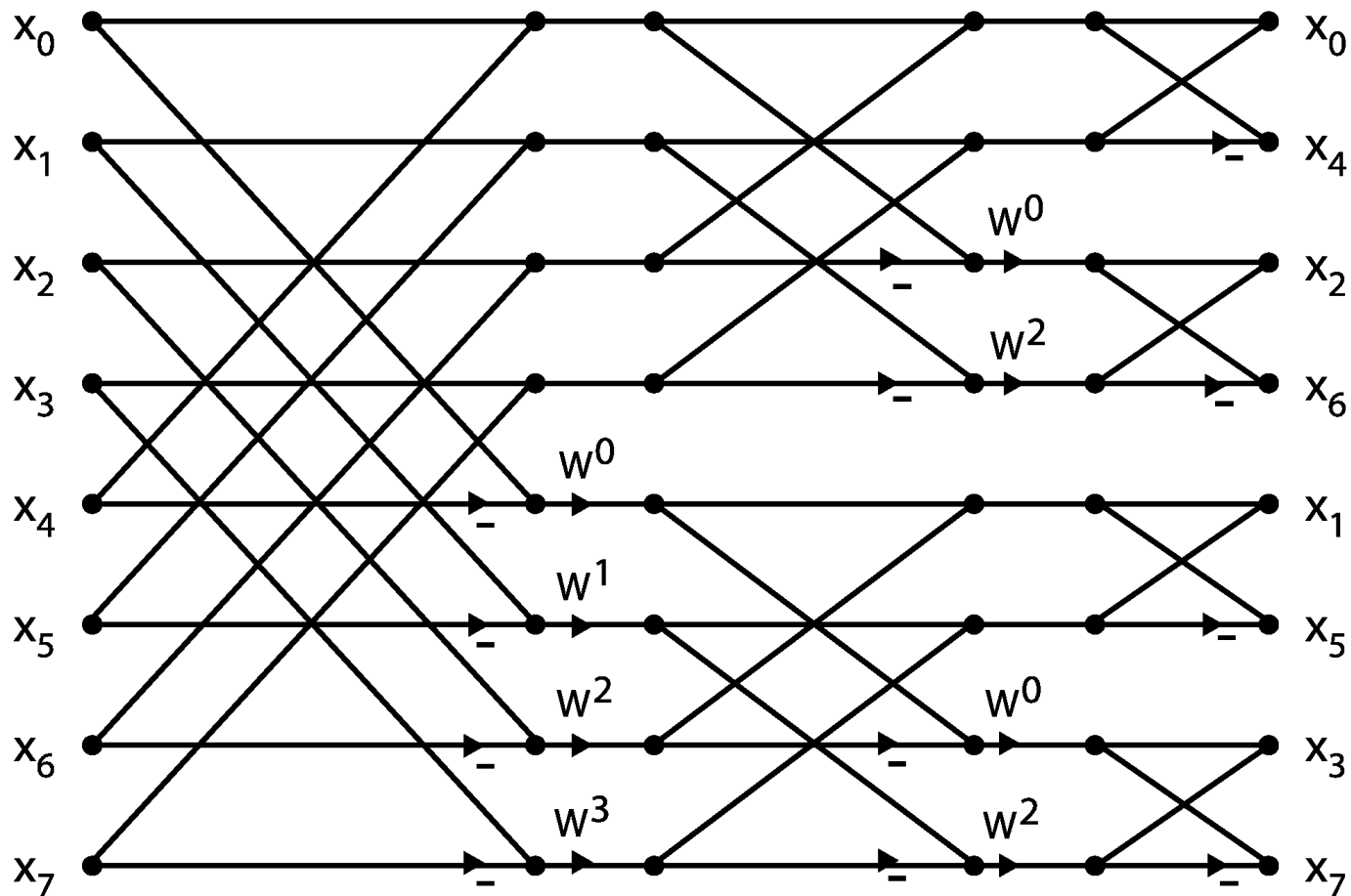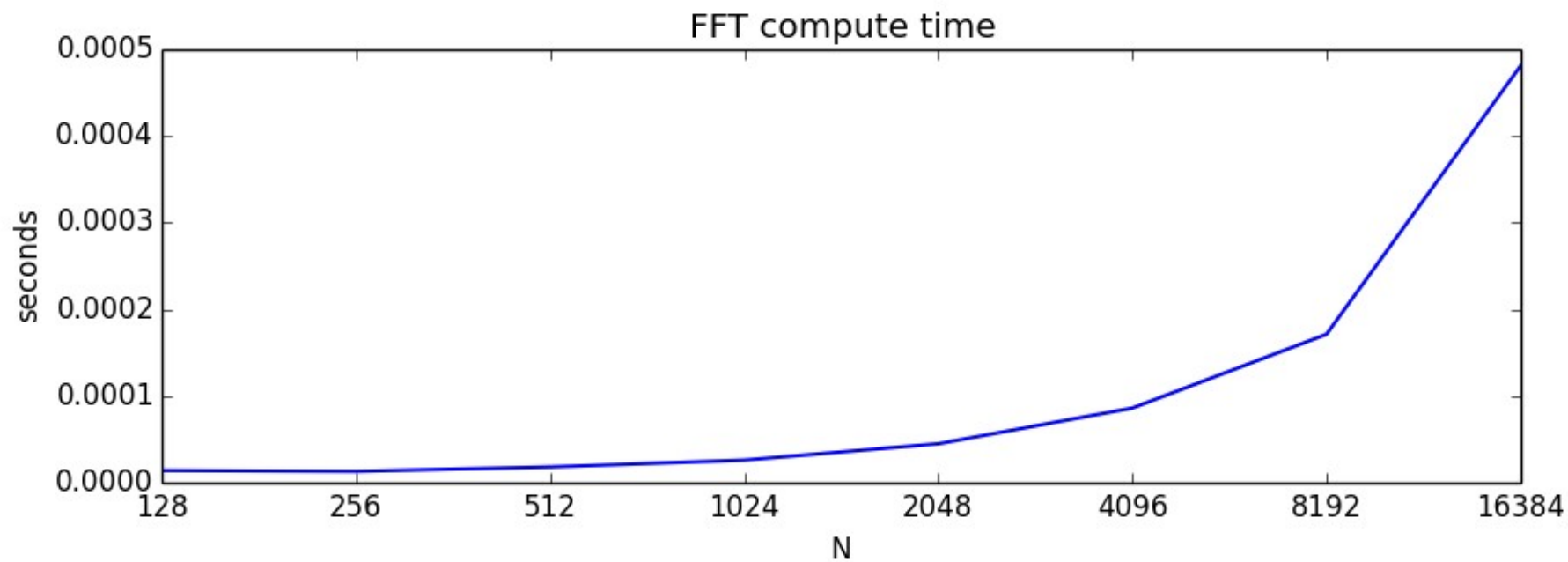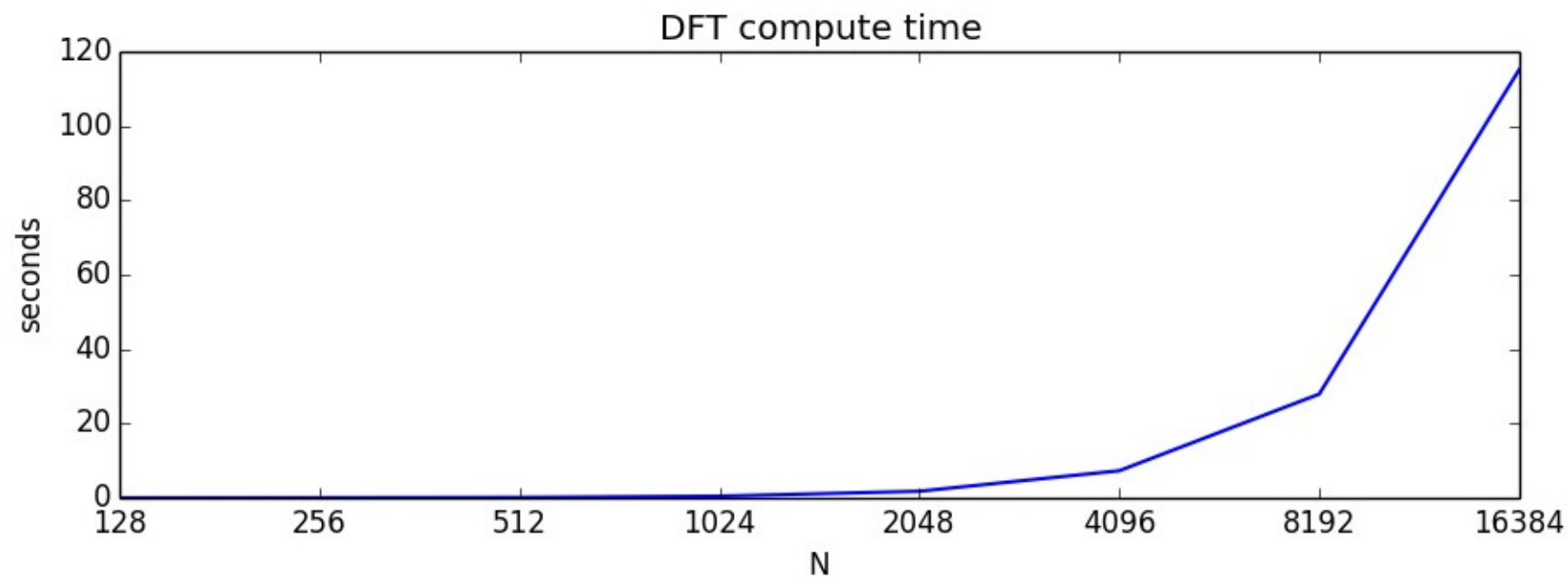
# Phase unwrapping

# Zero-padding

zero padding $\leftrightarrow$ interpolation

# Fast Fourier Transform

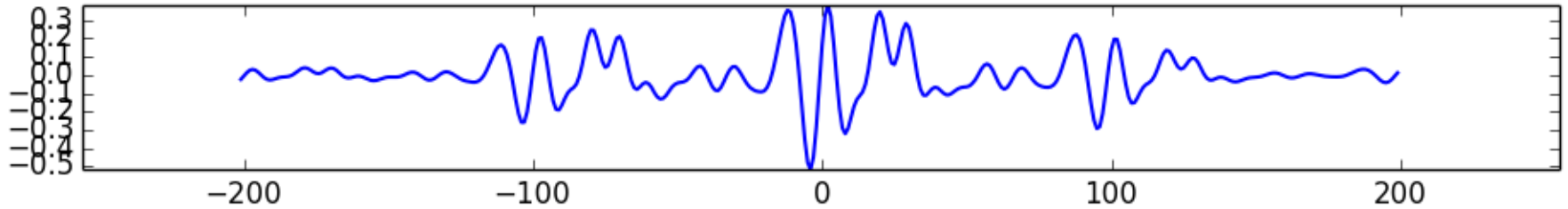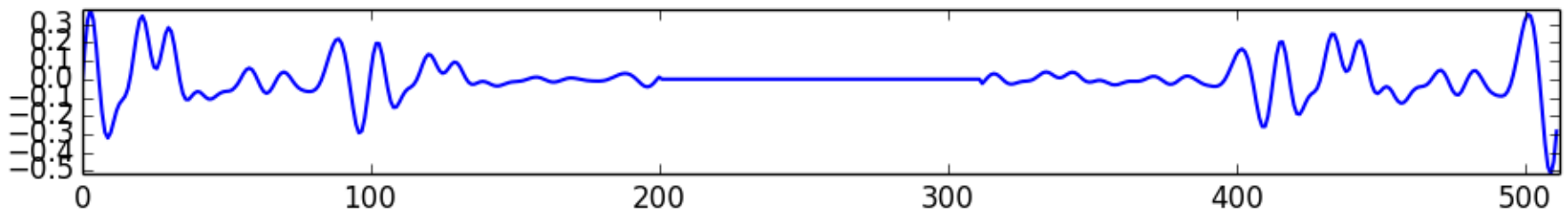*Cooley-Tukey algorithm:* breaks down recursively the DFT of a power of 2 size into two pieces of size N/2.

DFT compute time

FFT compute time
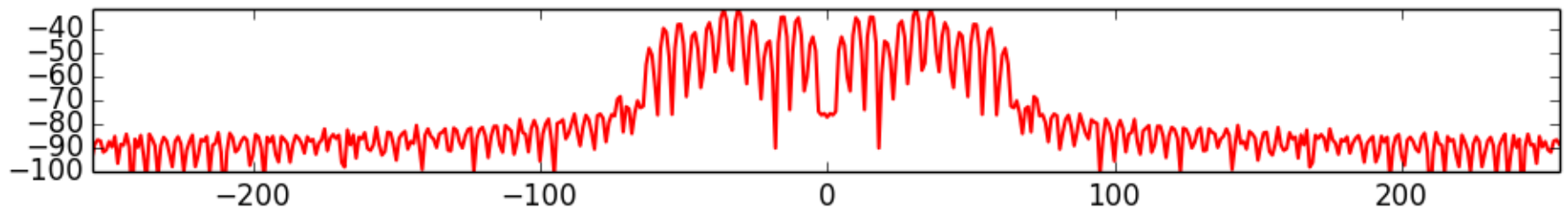
# FFT and zero-phase windowing
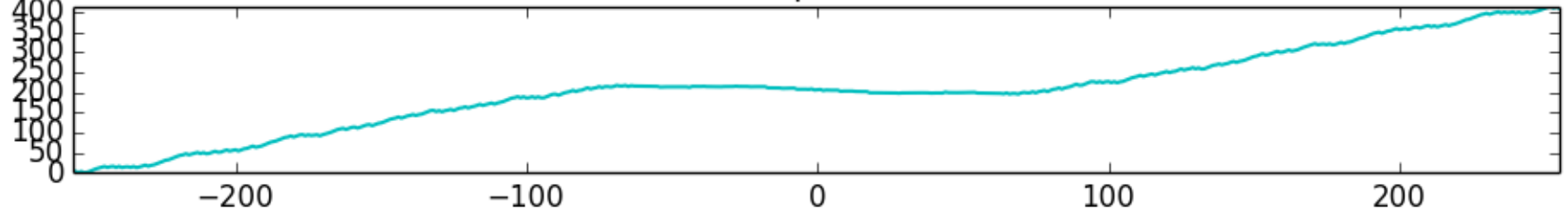
# Analysis/synthesis
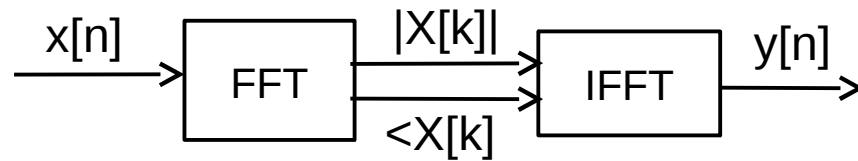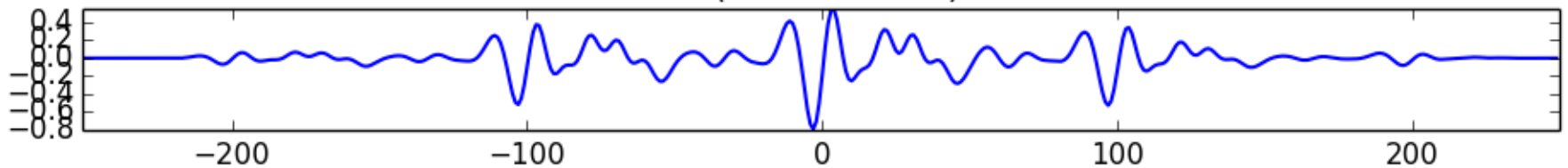
# References and credits
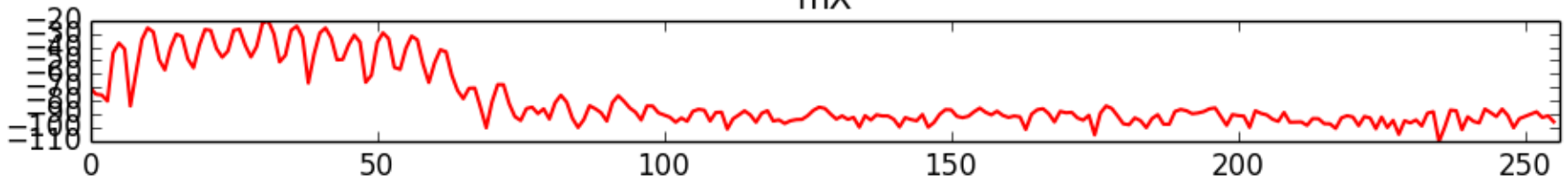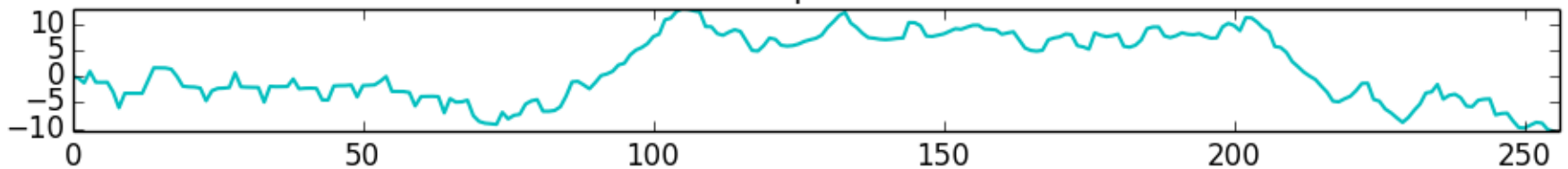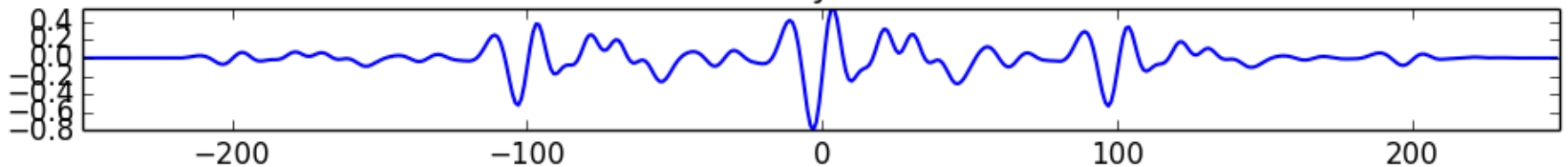
- More information on:

    – https://en.wikipedia.org/wiki/Discrete_Fourier_transform

    – https://en.wikipedia.org/wiki/Fast_Fourier_transform

- Sounds  from: http://www.freesound.org/people/xserra/packs/13038/

- Reference for the DFT by Julius O. Smith: https://ccrma.stanford.edu/~jos/mdft/

- Slides and code released using the CC Attribution-Non Commercial-Share Alike license or the Affero GPL license and available from https://github.com/MTG/sms-tools

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