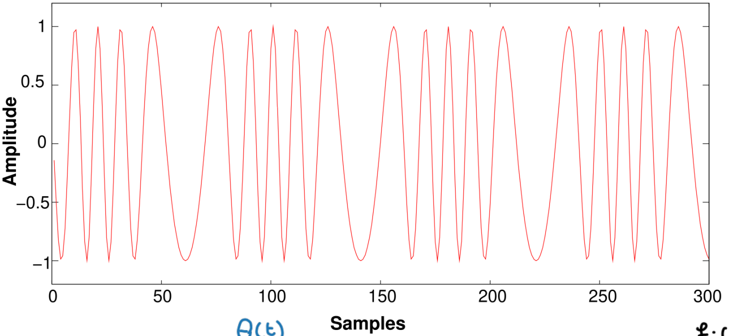
Short-time Fourier transform (STFT)

Nonstationary signal analysis

Herman Kamper

Nonstationary sinusoid



Instantaneous frequency:

$$\sin\left(\theta(t)\right)$$

$$f_i(t) = \frac{1}{2\pi}\frac{\mathrm{d}}{\mathrm{d}t}\theta(t)$$

E.g. $\sin(2\pi f_0 t)$

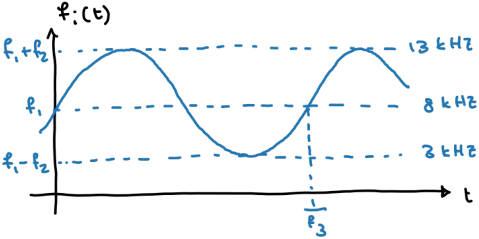
$$f_i(t) = \frac{1}{2\pi}\frac{d}{dt}(2\pi f_0 t)$$

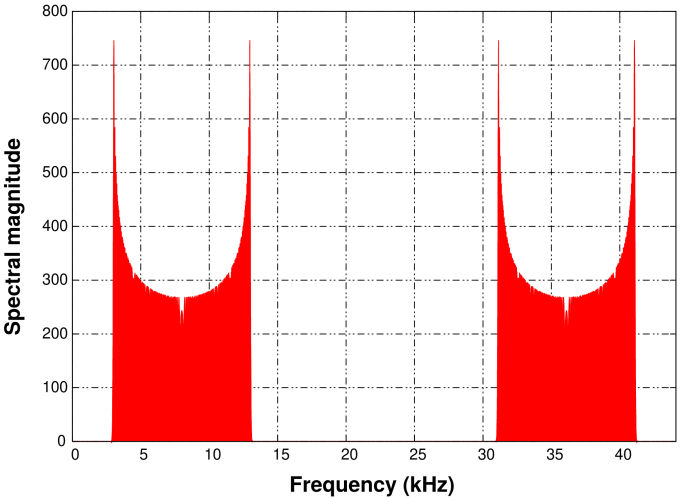
$$= \frac{1}{\cancel{2\pi}} \cdot \cancel{2\pi} f_0 = f_0$$

$$y(t) = \sin\left(\overbrace{2\pi f_1 t - \frac{f_2}{f_3}\cos(2\pi f_3 t)}^{\theta(t)}\right)$$

$$f_i(t) = \frac{1}{2\pi}\frac{\mathrm{d}}{\mathrm{d}t}\theta(t) = \frac{1}{2\pi}\left[2\pi f_1 + \frac{f_2}{f_3}(2\pi f_3)\sin(2\pi f_3 t)\right]$$

$$= f_1 + f_2 \sin(2\pi f_3 t)$$

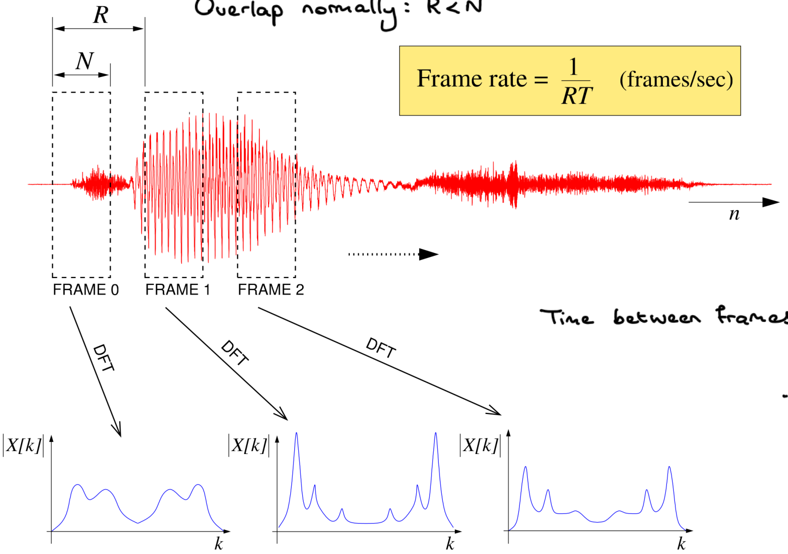




$$y[n] = \sin\left(2\pi f_{\omega_1} n - \frac{f_{\omega_2}}{f_{\omega_3}} \cos(2\pi f_{\omega_3} n)\right)$$

Short-time Fourier transform (STFT)

Overlap nomally: $R < N$



$$\text{Frame rate} = \frac{1}{RT} \quad \text{(frames/sec)}$$

Samples

Time between frames $= R \times T$ [sec/frame]

$\therefore \frac{1}{RT}$ [frames/sec]

Spectrogram