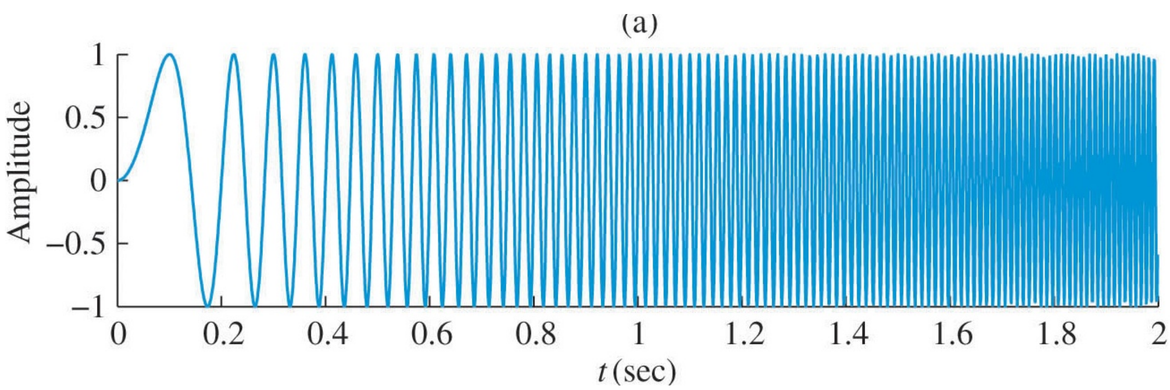
Chap 7.6

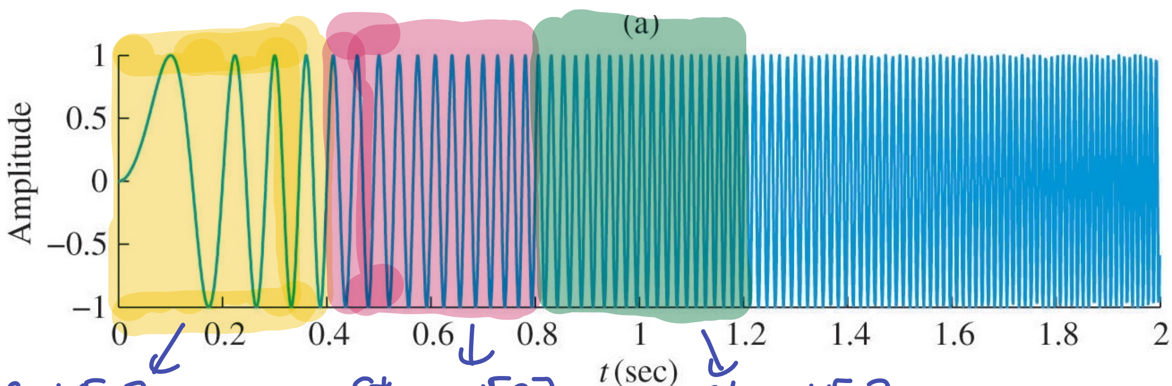
As we noted before, it is often not practical to collect all N-values of some signal x[n] before we do an N-point DFT

Another issue is that the frequency component may be changing over time

For example, the chirp signal, where the frequency is increasing over time



Since we don't know if a signal frequency changes or not, its best to keep the sampling frequency the same but compute the DFT in chunks (i.e. window) (window may overlap)



Store x[n], compute DFT

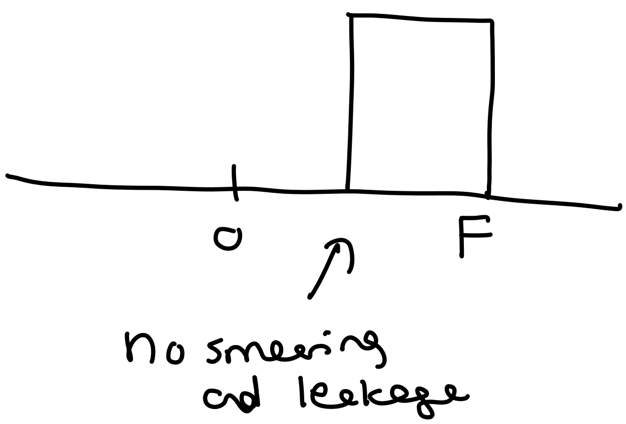
Store x[n] compute DFT

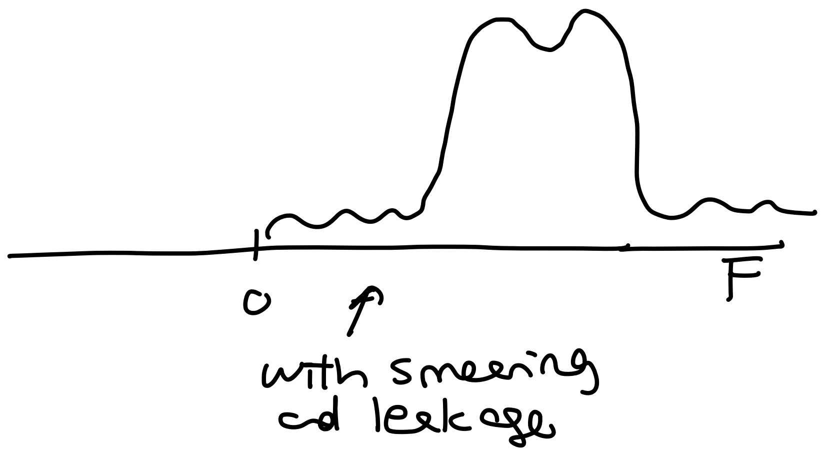
store x[n], compute DFT

We pay a price for this windowing method

1) more computation

2) we have to choose a windowing function (rectangular, hamming, hann, etc.)
All windowing function will cause smearing and leakage in the frequency domain





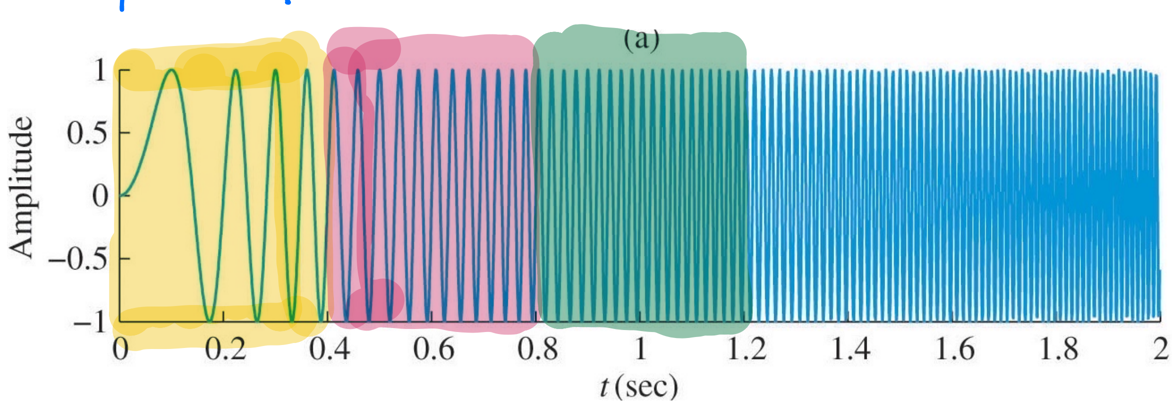
The idea of breaking a long signal into small segments and analyze each one with the DFT is called time-dependent or short-time DFT

$$X[k,n] = \sum_{m=0}^{L-1} w[m]\, x[n+m]\, e^{-j\left(\frac{2\pi k}{N}\right)m}$$

time

window function

L = length of each window, we compute an N-point DFT, so $N \geq L$



The windows may over lap by m, so $m \leq L$

Unlike classic DFT, the short-time DFT, $X[k,n]$ is 2-dimension

$$X[k, n]$$

frequency component $\omega_k = \frac{2\pi k}{N}$ at time index n

time

The 2-D picture is called a spectrogram. Usually $|X[k,n]|$ or $\log|X[k,n]|$ is visualized by color