Time signals in Matlab

First, the time domain

Signal in time

$X =$ | x_1 | x_2 | ... | | | | | | ... | x_N |

Time signals in Matlab

First, the time domain

Signal in time

Time vector

Time signals in Matlab

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Time vector

$t =$ | t_1 | t_2 | ... | | | | | | ... | t_N |

Quick quiz: What is N if we have a signal of duration T, sampled with sampling frequency f_s?

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$$N = f_s \cdot T$$

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In practice, not so simple!

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0	Δt	$2\Delta t$	...					...	$(N-1)\Delta t$

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0	$1/f_s$	$2/f_s$	...					...	$T-1/f_s$

$$\Delta t = T/N = 1/ f_s$$

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Fourier transforms and spectra in Matlab

Now, the frequency domain

Signal's spectrum

$Y = \text{fft}(x) =$

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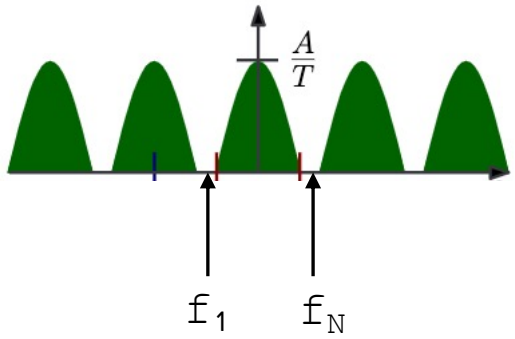
Quick quiz: Ideally, what should the values in f_1 and f_N be?



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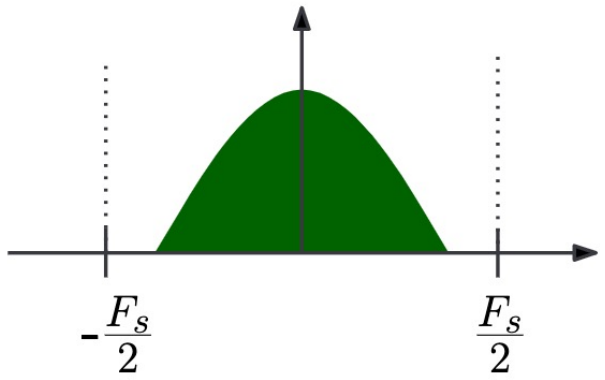
Quick quiz: Ideally, what should the values in f_1 and f_N be?

$f_1 = -f_s/2$ $\qquad$ $f_N = f_s/2$



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$$\Delta f = f_s/N = f_s/(f_s \cdot T) = 1/T$$

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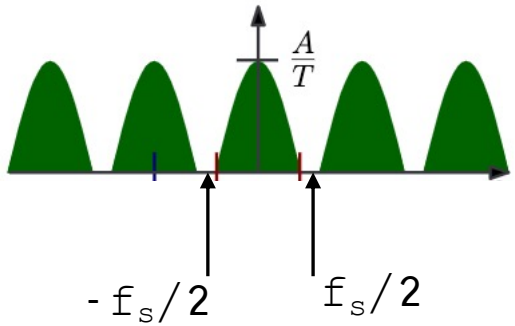

Fourier transforms and spectra in Matlab

Matlab is particuliar

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Negative frequencies

Positive frequencies

Fourier transforms and spectra in Matlab

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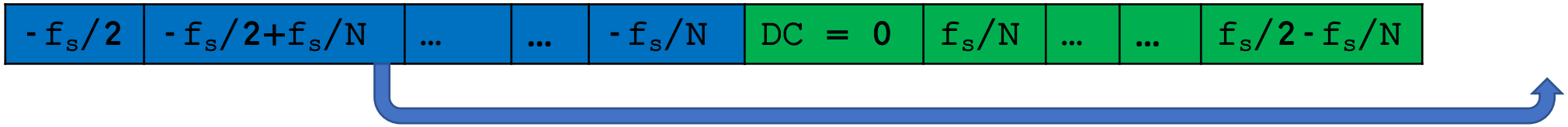
freq = 

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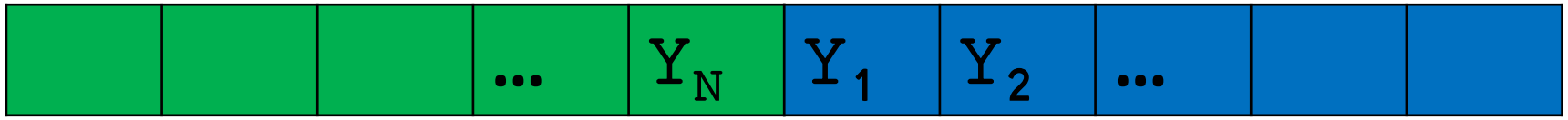
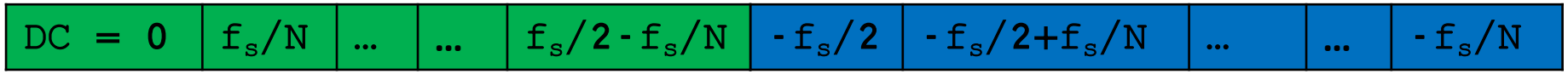


Frequency vector

$freq =$



Matlab returns the positive frequencies first!

Fourier transforms and spectra in Matlab

What to remember:

- The frequency vector is built very similarly to a time vector

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Fourier transforms and spectra in Matlab

What to remember:

- The frequency vector is built very similarly to a time vector
- The Nyquist ($f_s/2$) and DC (0 Hz) appear only once each in the spectrum
- ***Matlab returns the positive frequencies first when using*** *`fft`*

  This can be reversed using `fftshift` and `ifftshift` on the spectrum (type `help fftshift` to see what it does)