Example 8-12: Noise filtering by Thresholding.

Purpose:

A signal given by
$x(t) = 1 + 4\sin(10\pi t) + 10\cos(20\pi t + 0.6435)$
has broad-spectrum noise added to it. The goal is to retrieve the original signal $x(t)$ from the noisy signal $x_{ns}(t)$, *without* knowledge of the original signal. The signal-to-noise ratio is -2.56 dB. Develop a simple technique to retrieve $x(t)$ from the noisy signal.

Inputs:

NS=noise strength (multiplies `randn`).
T=threshold for noisy spectrum.

Outputs:

Plots of noisy (top) and filtered (bottom) signals for $0 < t < 1$ s.
Spectrum of noisy signal (top) and thresholded spectrum (bottom).
Signal-to-noise ratio (SNR) in dB.

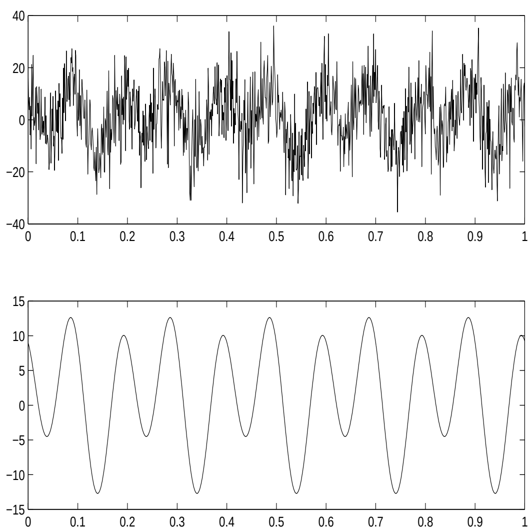

Figure 1: Plots of noisy (top) and filtered (bottom) signals for $0 < t < 1$ s.

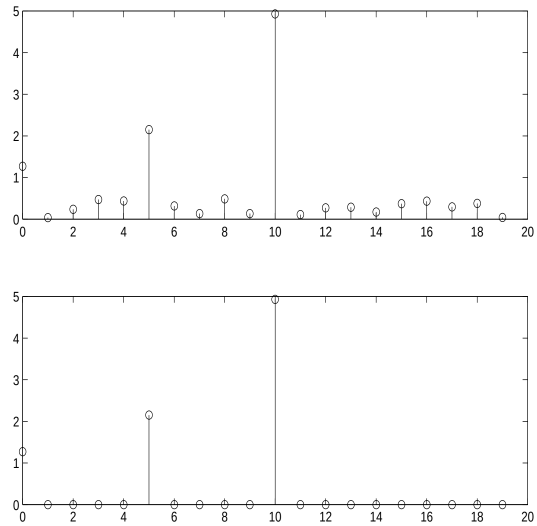

Figure 2: Spectrum of noisy signal (top) and thresholded spectrum (bottom).

Comments:

- Two-sided spectra are plotted for $f \geq 0$.
- Stem plots are used for spectra, since DFT computes them at discrete frequencies.
- We did not use knowledge of the signal.

Program:

```
clear;NS=10;T=0.9;
N=NS*randn(1,1000);
t=linspace(0,1,1000);
X=1+4*sin(2*pi*5*t);
X=X+10*cos(2*pi*10*t+0.6435);
Y=X+N;%Noisy periodic signal.
FY=fft(Y)/1000;FZ=FY;
FZ(find(abs(FY)<T))=0;%threshold.
Z=1000*real(ifft(FZ));
SNR=10*log10(sum(X.*X)/sum(N.*N))
subplot(211),plot(t,Y)
subplot(212),plot(t,Z),figure,
subplot(211),stem(0:19,abs(FY(1:20)))
subplot(212),stem(0:19,abs(FZ(1:20)))
```