

El Centro Earthquake Data Analysis

▼ Introduction

This application analyzes the response of a SDOF to the 1940 El Centro earthquake. It uses acceleration data recorded from a seismograph located near the fault line

▼ Import and Visualize Data from Seismograph

- > *restart* :
- with(SignalProcessing) : with(plots) :*
- > *NS := ImportMatrix("elcentro_NS.csv", source = csv[standard], datatype = float[8]);*

NS := $\left[\begin{array}{l} 2688 \times 2 \text{ Matrix} \\ \text{Data Type: float}_8 \\ \text{Storage: rectangular} \\ \text{Order: Fortran_order} \end{array} \right]$

Separate the data into time (in seconds) and acceleration (in g) components

- > *t_NS := NS[.., 1] :*
- acc_NS := NS[.., 2] :*

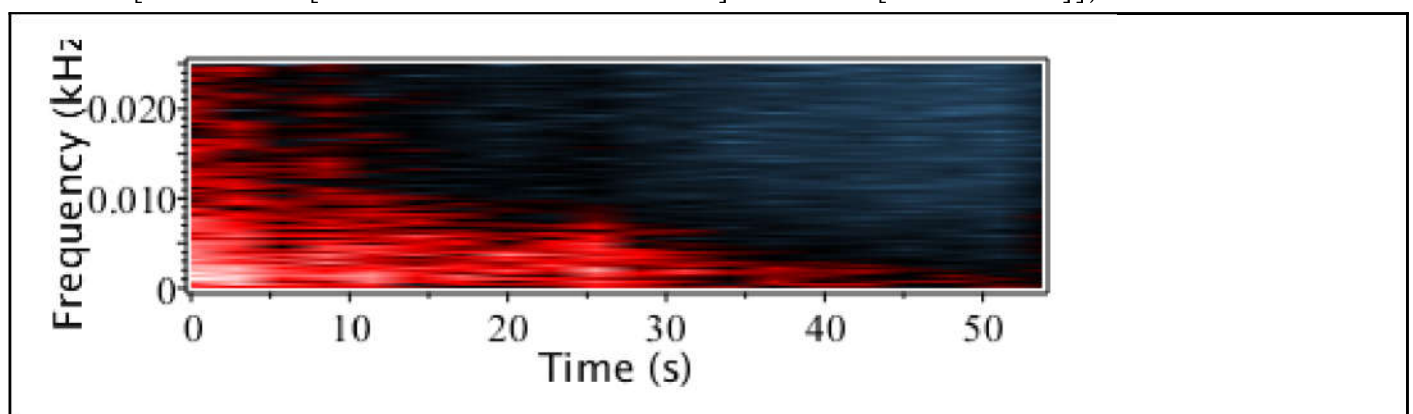
Sample rate of data

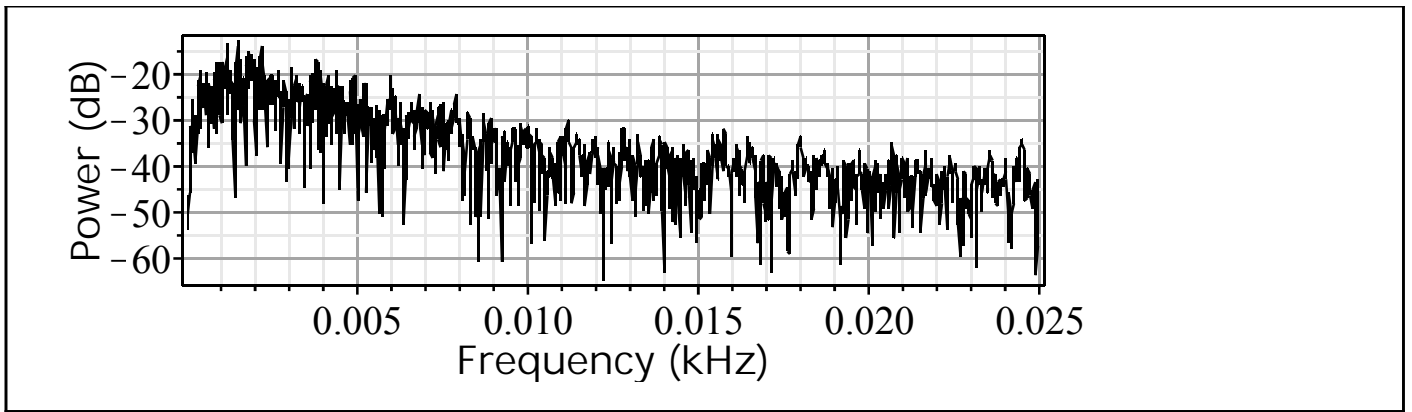
- > *sr :=* $\frac{1}{t_NS[2] - t_NS[1]}$

sr := 50.

Plot a spectrogram and power spectrum

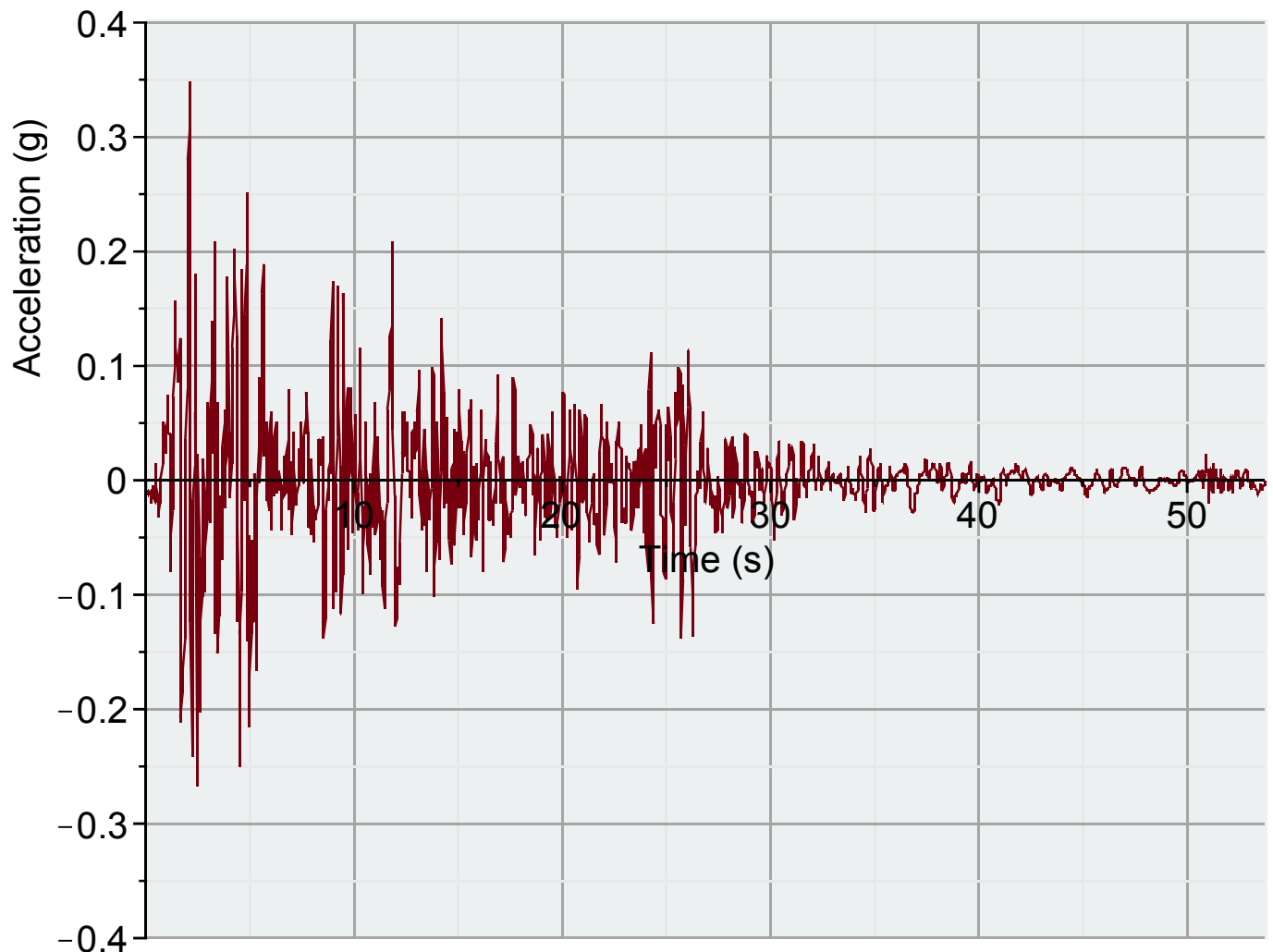
- > *Spectrogram(acc_NS, samplerate = 50, fftsize = 256, includepowerspectrum, colorscheme = ["zgradient", ["SteelBlue", "black", red, white]], markers = [0, 0.7, 0.85, 1])*





Plot the time history

```
> plot(t_NS, acc_NS, view = [default, -0.4 .. 0.4], labels = ["Time (s)", "Acceleration (g)"], labeldirections
      = [horizontal, vertical], labelfont = [Arial], axesfont = [Arial], gridlines, size = [1200, 400],
      background = ColorTools:-Color("RGB", [ 236 / 255, 240 / 255, 241 / 255 ]), style = patchnogrid, thickness = 0)
```



▼ Displacement Response of a SDOF

$$> eq := \ddot{u} + 2\xi\omega_n\dot{u} + \omega_n^2 u = -9.81 acc(t) :$$

$$> \omega_n := \frac{2 \cdot \text{Pi}}{T_n} :$$

where ω_n is the natural frequency, and T_n is the natural period of vibration.

$$> \xi := 0.02 : \\ T_n := 5 :$$

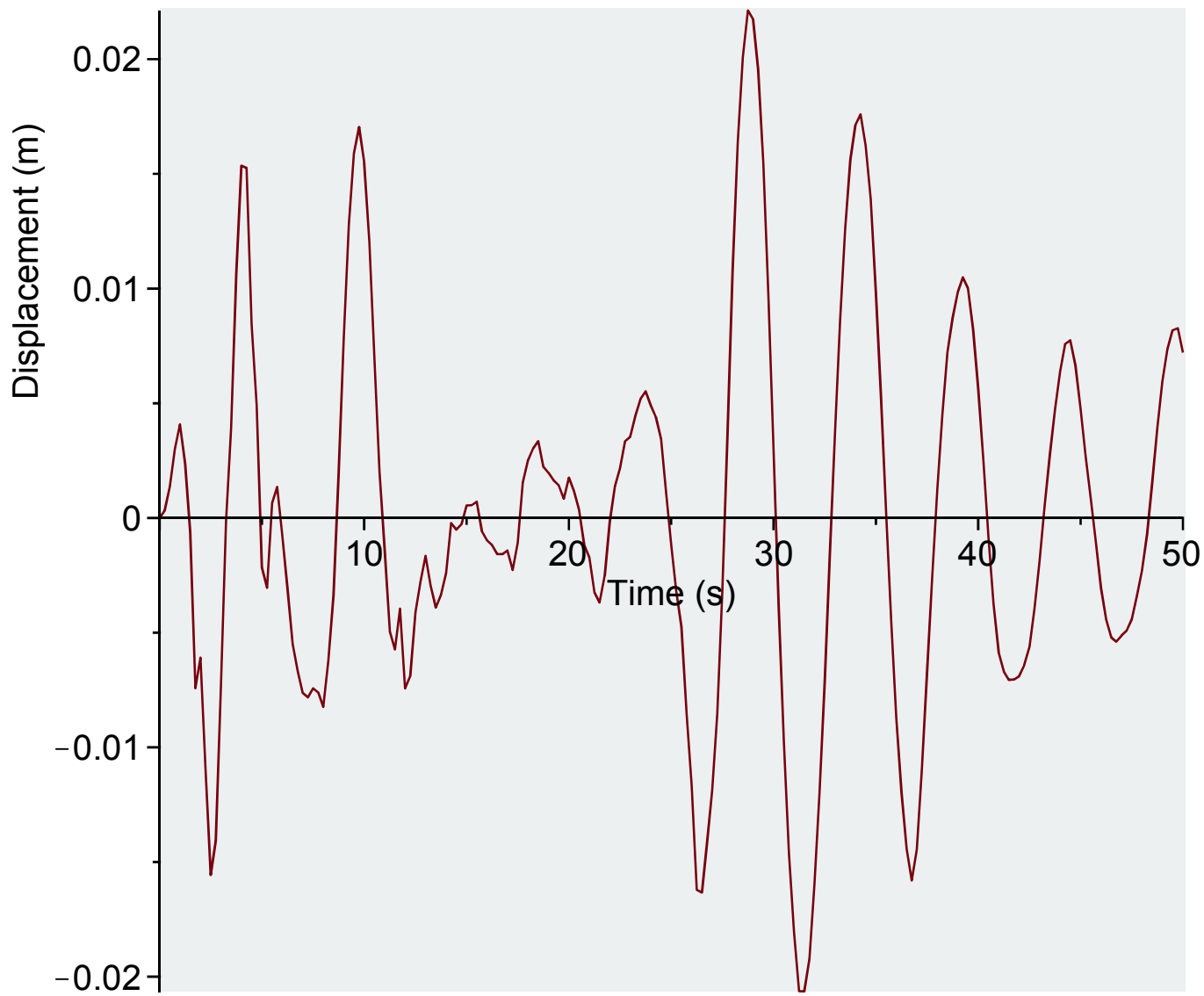
$$> acc := unapply\left(\text{CurveFitting:-Spline}\left(t_{NS}, \frac{acc_{NS}}{9.81}, t, \text{degree} = 1\right), t\right) :$$

$$> res := dsolve(\{eq, u(0) = 0, D(u)(0) = 0\}, \text{numeric}, \text{maxfun} = 0) :$$

$$> odeplot\left(res, [t, u(t)], t = 0 .. 50, \text{labels} = ["Time (s)", "Displacement (m)"], \text{labeldirections}$$

= [horizontal, vertical], \text{labelfont} = [Arial], \text{axesfont} = [Arial], \text{size} = [800, 500], \text{background}

= ColorTools:-Color\left("RGB", \left[\frac{236}{255}, \frac{240}{255}, \frac{241}{255}\right]\right), \text{style} = \text{patchngrid}, \text{thickness} = 0, \text{size} = [800, 400])



>