Application Demonstration

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El Centro Earthquake Data Analysis

Introduction

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

Import and Visualize Data from Seismograph

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

$$NS := \begin{bmatrix} 0. & -0.00142757990000000 \\ 0.0200000000000000 & -0.0110127600000000 \\ 0.0400000000000000 & -0.0102989700000000 \\ 0.0600000000000000 & -0.00897335990000000 \\ 0.0800000000000000 & -0.00968714970000000 \\ 0.100000000000000 & -0.0122364000000000 \\ 0.120000000000000 & -0.0144797390000000 \\ 0.140000000000000 & -0.0130521600000000 \\ 0.160000000000000 & -0.0112167000000000 \\ 0.180000000000000 & -0.00866744970000000 \\ \vdots & \vdots \end{bmatrix} \quad (2.1)$$

2688 × 2 Matrix

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

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

Sample rate of data

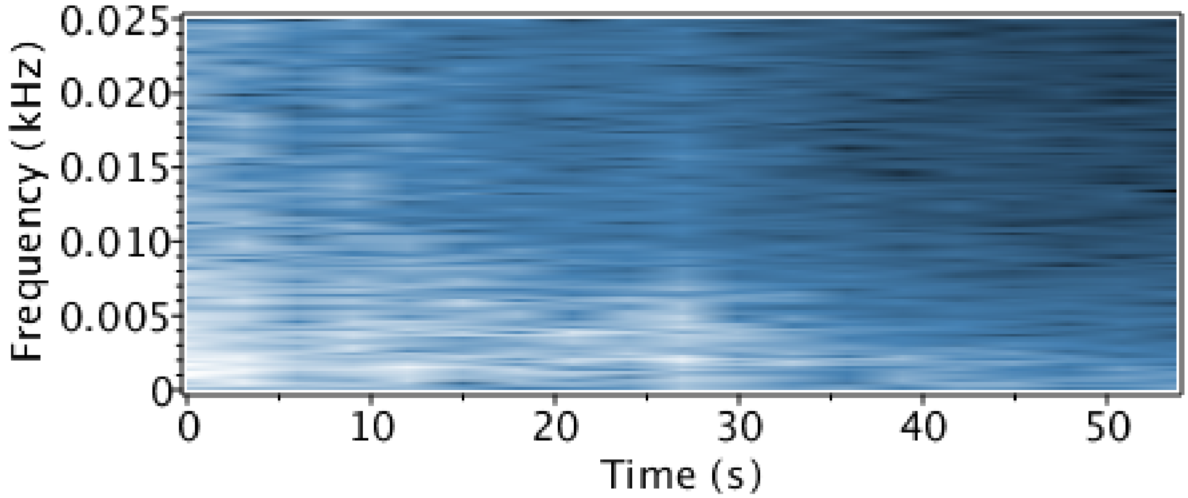
$$> sr := \frac{1}{t\_NS[2] - t\_NS[1]}$$

$$sr := 50. \quad (2.2)$$

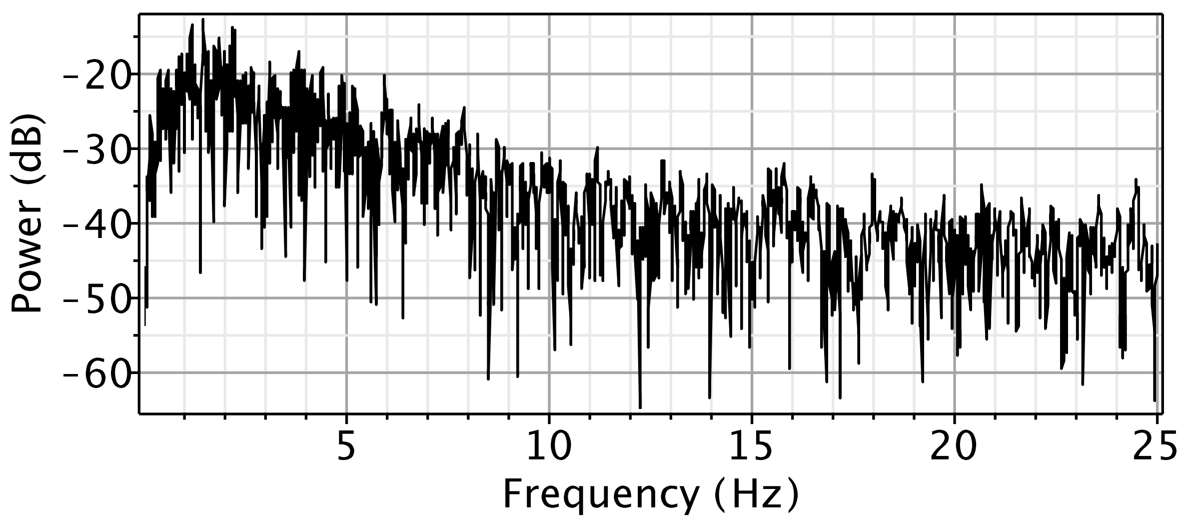
Plot a spectrogram, power spectrum and time history

```
> Spectrogram(acc_NS, samplerate = 50, fftsize = 256, colorscheme = ["zgradient", [black,
```

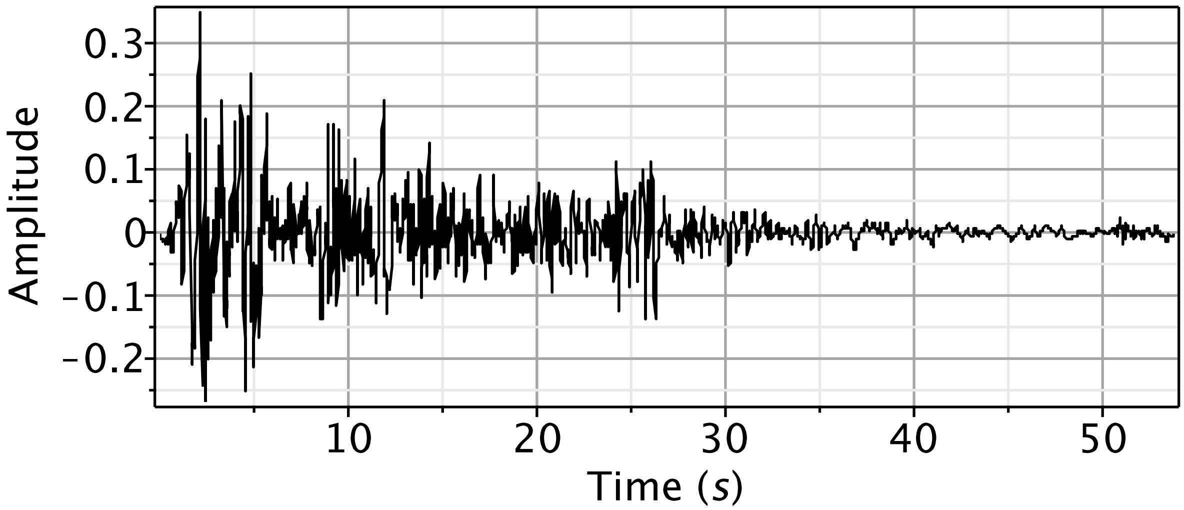
"SteelBlue", *white*], *markers* = [0, 0.7, 1]], *size* = [800, 200])



> *Periodogram*(*acc_NS*, *samplerate* = 50, *size* = [800, 200])



> *SignalPlot*(*acc_NS*, *samplerate* = 50, *size* = [800, 200])



Displacement Response of a SDOF

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

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

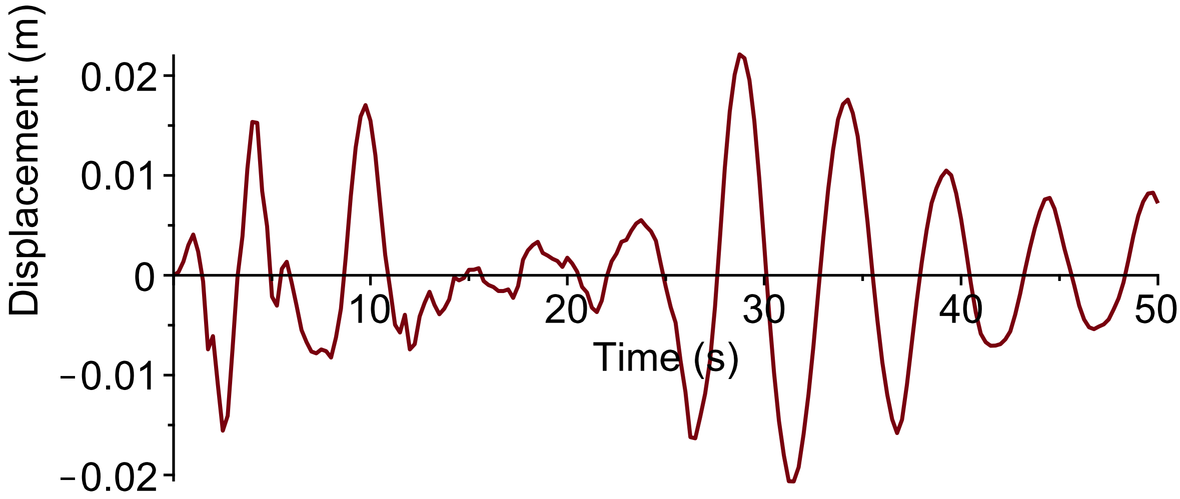
where ω_n is the natural frequency, and T_n is the natural period of vibration.

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

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

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

> *odeplot*(*res*, [*t*, *u*(*t*)], *t* = 0 ..50, *labels* = ["Time (s)", "Displacement (m)"], *labeldirections* = [*horizontal*, *vertical*], *labelfont* = [*Arial*], *axesfont* = [*Arial*], *size* = [800, 500], *size* = [800, 200])



Displacement (m)
0.02
0.01
0
−0.01
−0.02
10
20
30
40
50
Time (s)