A Zoo of Computational Models

Prof. Americo Cunha Jr

americocunha.org

[in] @AmericoCunhaJr
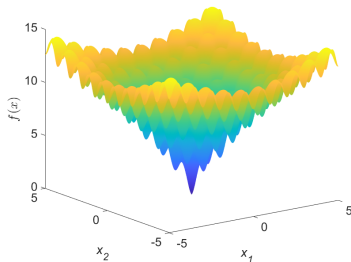
[YouTube] @AmericoCunhaJr   [GitHub] @AmericoCunhaJr

The codes for the tutorials are available on GitHub
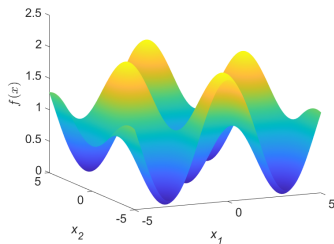
https://github.com/americocunhajr/UQ-CSE

Ackley function

$$f(x) = -a\exp\left(-b\sqrt{\frac{1}{2}\sum_{i=1}^{2}x_i^2}\right) - \exp\left(\frac{1}{2}\sum_{i=1}^{2}cos(2\pi x_i)\right) + a + \exp(1)$$

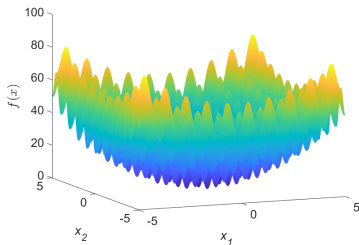* Tutorial elaborated by Marcos Vinícius Issa.

Griewank function

$$f(x) = \sum_{i=1}^{2} \frac{x_i^2}{4000} - \prod_{i=1}^{2} cos\left(\frac{x_i}{\sqrt{i}}\right) + 1$$

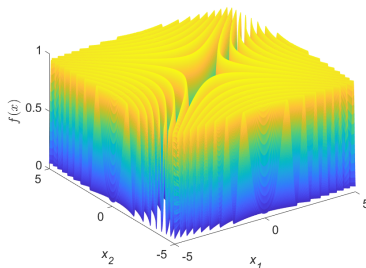* Tutorial elaborated by Marcos Vinícius Issa.

Rastrigin function

$$f(x) = 20 + \sum_{i=1}^{2} \left(x_i^2 - 10cos(2\pi x_i) \right)$$

* Tutorial elaborated by Marcos Vinícius Issa.
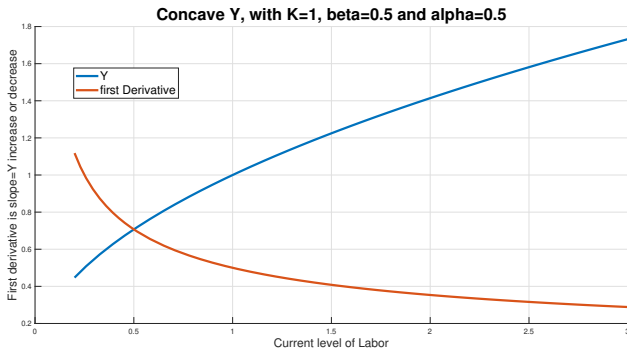
Schaffer function

$$f(x) = 0.5 + \frac{sin^2(x_1^2 - x_2^2) - 0.5}{(1 + 0.001(x_1^2 - x_2^2))^2}$$

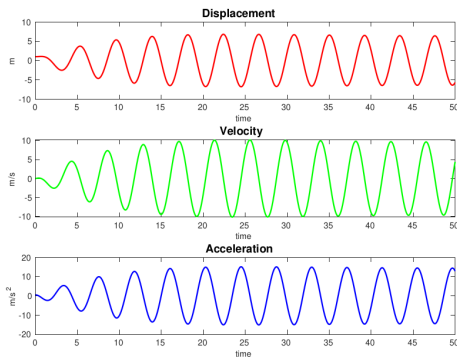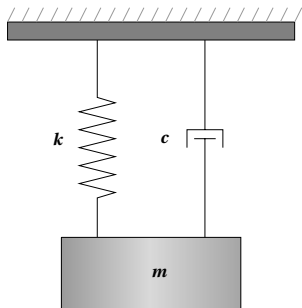* Tutorial elaborated by Marcos Vinícius Issa.

Cobb–Douglas production function

$$Y = L^{\beta} K^{\alpha}$$

Concave Y, with K=1, beta=0.5 and alpha=0.5

* Tutorial elaborated by Bruna Pavlack.
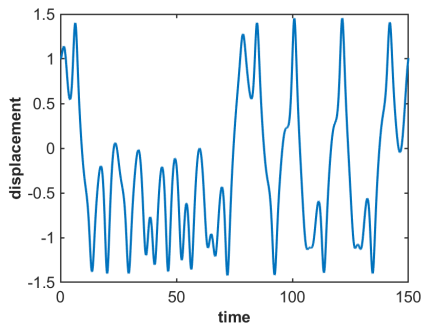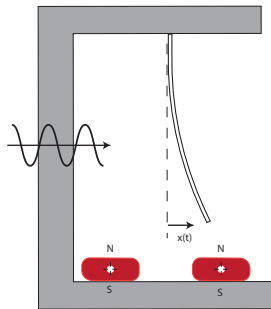
Harmonic oscillator

$$m\ddot{x} + c\dot{x} + kx = f\cos(\omega t)$$

+ initial conditions

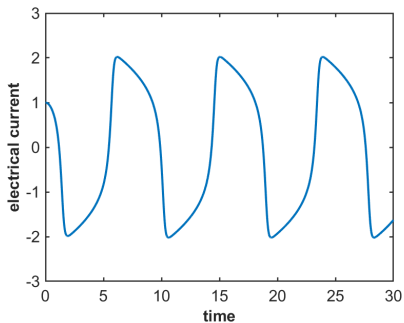* Tutorial elaborated by Diego Matos.
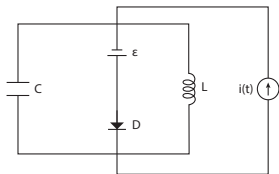
Duffing Oscillator

$$\ddot{x} + \delta\,\dot{x} + \alpha\,x + \beta\,x^3 = \gamma\,\cos(\Omega t)$$

+ initial conditions

* Tutorial elaborated by Joao Pedro Norenberg.

Van der Pol Oscillator

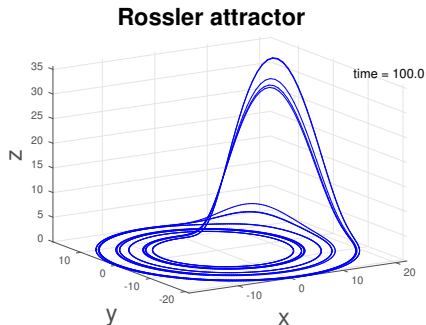$$\ddot{x} - \mu(1 - x^2)\,\dot{x} + x = 0$$

+ initial conditions

* Tutorial elaborated by Joao Pedro Norenberg.

Rössler system

$$
\begin{aligned}
\dot{x} &= -y - z \\
\dot{y} &= x + \alpha y \\
\dot{z} &= \beta + z(x - \gamma)
\end{aligned}
$$

+ initial conditions

Rossler attractor

time = 100.0

* Tutorial elaborated by Diego Matos.
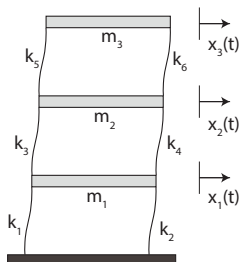
Shear Building

Generalized eigenvalue problem:

$$[K]\, \mathbf{u}_n = \omega_n^2\, [M]\, \mathbf{u}_n$$
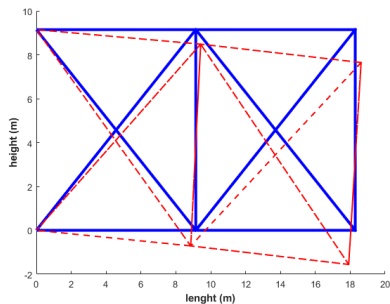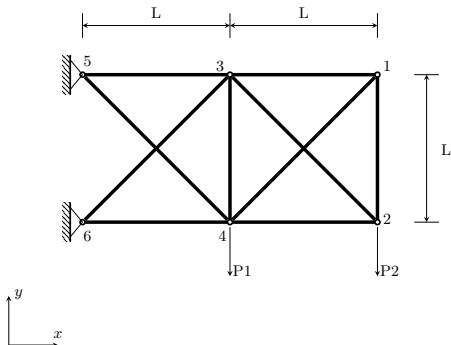
$$\omega_n = 2\,\pi\, f_n \quad n \in \{1, 2, 3\}$$

Natural frequencies:

- $f_1 = 7.01$ Hz
- $f_2 = 55.00$ Hz
- $f_3 = 114.84$ Hz

2D Truss

$$[K]\,\mathbf{u} = \mathbf{f}$$

* Tutorial elaborated by Marcos Vinícius Issa.

SIR-type temporal model

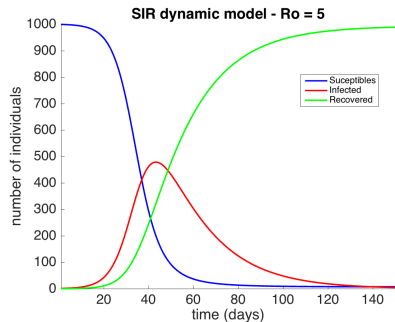$$\frac{\mathrm{d}S}{\mathrm{d}t} = -\beta\,\frac{I}{N}\,S$$

$$\frac{\mathrm{d}I}{\mathrm{d}t} = \beta\,\frac{I}{N}\,S - \gamma\,I$$

$$\frac{\mathrm{d}R}{\mathrm{d}t} = \gamma\,I$$

+ initial conditions

* Tutorial elaborated by Rachel Lucena.

SEIAHRD-type temporal model
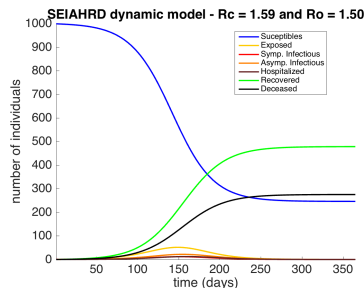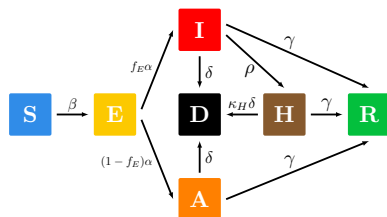
$$\frac{dS}{dt} = -\beta\, S\, \frac{(I + A + H)}{N}$$

$$\frac{dE}{dt} = \beta\, S\, \frac{(I + A + H)}{N} - \alpha\, E$$

$$\frac{dI}{dt} = f_E\, \alpha\, E - (\gamma + \rho + \delta)\, I$$

$$\frac{dA}{dt} = (1 - f_E)\, \alpha\, E - (\gamma + \delta)\, A$$
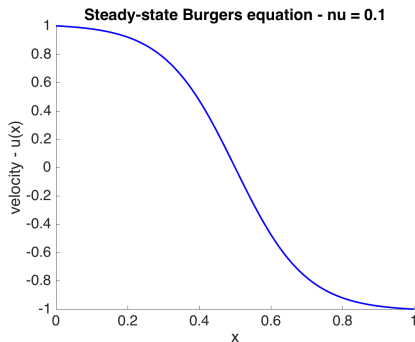
$$\frac{dH}{dt} = \rho\, I - (\gamma + \kappa_H\, \delta)\, H$$

$$\frac{dR}{dt} = \gamma\, (I + A + H)$$

$$\frac{dD}{dt} = \delta\, (I + A + \kappa_H\, H)$$

+ initial conditions

* Tutorial elaborated by Rachel Lucena.

Steady-state Burgers equation

$$\nu \frac{\mathrm{d}^2 u}{\mathrm{d}x^2} - u \frac{\mathrm{d}u}{\mathrm{d}x} = 0 \,, \qquad 0 < x < 1$$

$$u = 1 \,, \qquad x = 0$$

$$u = -1 \,, \qquad x = 1$$

Steady-state Burgers equation - nu = 0.1

* Tutorial elaborated by Rachel Lucena.

Data-driven damage detection

$$\mathcal{D} = \sqrt{(\mathbf{T}^i - \boldsymbol{\mu}_B)^t \boldsymbol{\Sigma}^{-1}(\mathbf{T}^i - \boldsymbol{\mu}_B)}$$
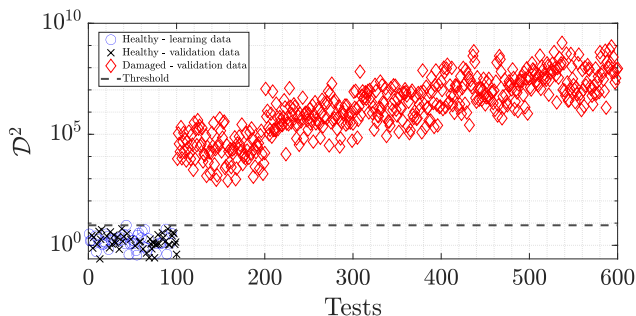
* Tutorial elaborated by Bruna Pavlack.

How to cite this material?

A. Cunha Jr, *A Zoo of Computational Models*, 2021.

in @AmericoCunhaJr

▶ @AmericoCunhaJr   ⬤ @AmericoCunhaJr

These class notes may be shared under the terms of
Creative Commons BY-NC-ND 4.0 license,
for educational purposes only.