


# MuJoCo: Nonlinear Optimization

Decision variables 

$$\min_x f(x) \quad \text{Cost}$$

subject to:

$$lb \leq x \leq ub \quad \text{Bounds on } x$$
$$c_{eq} = 0 \quad \text{Equality constraints}$$
$$c \leq 0 \quad \text{Inequality constraints}$$

# MuJoCo: Installing nlopt (I)\*

1. Download latest version of nlopt: <https://nlopt.readthedocs.io/en/latest/> or search nlopt + download.
2. Unzip in a suitable location. Say Documents.
3. In terminal navigate to nlopt folder and type
  - `mkdir build`
  - `cd build`
  - `cmake ..`
  - `make`
  - `sudo make install`

\* I don't have instructions for Windows. For Windows, use Ubuntu via Virtualbox.

# MuJoCo: Installing nlopt (2)\*

4. Download `template_nlopt` from [tiny.cc/mujoco](http://tiny.cc/mujoco).
5. Navigate to `template_nlopt` and type the following
  - `gcc tutorial.c -o tutorial -w -lnlopt -lm`
  - `./tutorial`
6. If everything worked fine you will see the following:  
found minimum at  $f(0.333333, 0.296296) = 0.5443310474$

\* I don't have instructions for Windows. For Windows, use Ubuntu via Virtualbox.

# MuJoCo: Example Nonlinear optimization(I)

Decision variables  $\rightarrow$   $\min_x f(x) = a_1 x_1^2 + a_2 x_2^2 + a_3 x_3^2 + a_4 x_4^2 + a_5 x_5^2$  Cost

subject to:

$$-\infty \leq x_2, x_4, x_5 \leq \infty$$

$$0.3 \leq x_1 \leq \infty$$

$$-\infty \leq x_3 \leq 5$$

} Bounds on  $x$

$$x_1 + x_2 + x_3 = c_{eq1}$$

$$x_3^2 + x_4 = c_{eq2}$$

} Equality constraints

$$x_4^2 + x_5^2 \leq c_{in}$$

Inequality constraints

$$a_i = 1, \text{ where } i = 1, 2, 3, 4, 5$$

$$c_{eq1} = 5, c_{eq2} = 2, c_{in} = 5$$

Parameters

# MuJoCo: Example Nonlinear optimization(2)

1. Navigate to `template_nlopt` and type the following

- `gcc constrained.c -o constrained -w -lnlopt -lm`
- `./constrained`

2. If everything worked fine you will see the following:

found minimum at

$f(1.77378, 1.77354, 1.45269, -0.110295, 4.95945e-05) =$   
`8.414180297`

Let us look at `constrained.c` closely

API: [https://nlopt.readthedocs.io/en/latest/NLopt\\_Reference/](https://nlopt.readthedocs.io/en/latest/NLopt_Reference/)