```
# @title
!pip install torch --index-url https://download.pytorch.org/whl/cpu
!pip install scikit-build cmake ninja
!pip install git+https://github.com/Tim-Salzmann/l4casadi --no-build-isolation
```

```
Looking in indexes: https://download.pytorch.org/whl/cpu
Requirement already satisfied: torch in /usr/local/lib/python3.10/dist-packages (2.3.0+cu121)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from torch) (3.14.0)
Requirement already satisfied: typing-extensions>=4.8.0 in /usr/local/lib/python3.10/dist-packages (from torch) (4.11.0)
Requirement already satisfied: sympy in /usr/local/lib/python3.10/dist-packages (from torch) (1.12)
Requirement already satisfied: networkx in /usr/local/lib/python3.10/dist-packages (from torch) (3.3)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.10/dist-packages (from torch) (3.1.4)
Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages (from torch) (2023.6.0)
INFO: pip is looking at multiple versions of torch to determine which version is compatible with other requirements. This could take
Collecting torch
  Downloading https://download.pytorch.org/whl/cpu/torch-2.3.0%2Bcpu-cp310-cp310-linux_x86_64.whl (190.4 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 190.4/190.4 MB 6.5 MB/s eta 0:00:00
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packages (from jinja2->torch) (2.1.5)
Requirement already satisfied: mpmath>=0.19 in /usr/local/lib/python3.10/dist-packages (from sympy->torch) (1.3.0)
Installing collected packages: torch
  Attempting uninstall: torch
    Found existing installation: torch 2.3.0+cu121
    Uninstalling torch-2.3.0+cu121:
      Successfully uninstalled torch-2.3.0+cu121
Successfully installed torch-2.3.0+cpu
Collecting scikit-build
  Downloading scikit_build-0.17.6-py3-none-any.whl (84 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 84.3/84.3 kB 2.5 MB/s eta 0:00:00
Requirement already satisfied: cmake in /usr/local/lib/python3.10/dist-packages (3.27.9)
Collecting ninja
  Downloading ninja-1.11.1.1-py2.py3-none-manylinux1_x86_64.manylinux_2_5_x86_64.whl (307 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 307.2/307.2 kB 12.0 MB/s eta 0:00:00
Requirement already satisfied: distro in /usr/lib/python3/dist-packages (from scikit-build) (1.7.0)
Requirement already satisfied: packaging in /usr/local/lib/python3.10/dist-packages (from scikit-build) (24.0)
Requirement already satisfied: setuptools>=42.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-build) (67.7.2)
Requirement already satisfied: tomli in /usr/local/lib/python3.10/dist-packages (from scikit-build) (2.0.1)
Requirement already satisfied: wheel>=0.32.0 in /usr/local/lib/python3.10/dist-packages (from scikit-build) (0.43.0)
Installing collected packages: ninja, scikit-build
Successfully installed ninja-1.11.1.1 scikit-build-0.17.6
Collecting git+https://github.com/Tim-Salzmann/l4casadi
  Cloning https://github.com/Tim-Salzmann/l4casadi to /tmp/pip-req-build-df5lf008
  Running command git clone --filter=blob:none --quiet https://github.com/Tim-Salzmann/l4casadi /tmp/pip-req-build-df5lf008
  Resolved https://github.com/Tim-Salzmann/l4casadi to commit 4394d56991c712d3e1cc9bd84dde779b28ec3aed
  Preparing metadata (pyproject.toml) ... done
Requirement already satisfied: torch in /usr/local/lib/python3.10/dist-packages (from l4casadi==1.4.0) (2.3.0+cpu)
Collecting casadi>=3.6 (from l4casadi==1.4.0)
  Downloading casadi-3.6.5-cp310-none-manylinux2014_x86_64.whl (72.3 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 72.3/72.3 MB 8.6 MB/s eta 0:00:00
Requirement already satisfied: jinja2>=3.1 in /usr/local/lib/python3.10/dist-packages (from l4casadi==1.4.0) (3.1.4)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from casadi>=3.6->l4casadi==1.4.0) (1.25.2)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packages (from jinja2>=3.1->l4casadi==1.4.0) (2.1.5)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from torch->l4casadi==1.4.0) (3.14.0)
Requirement already satisfied: typing-extensions>=4.8.0 in /usr/local/lib/python3.10/dist-packages (from torch->l4casadi==1.4.0) (4.1
Requirement already satisfied: sympy in /usr/local/lib/python3.10/dist-packages (from torch->l4casadi==1.4.0) (1.12)
Requirement already satisfied: networkx in /usr/local/lib/python3.10/dist-packages (from torch->l4casadi==1.4.0) (3.3)
Requirement already satisfied: fsspec in /usr/local/lib/python3.10/dist-packages (from torch->l4casadi==1.4.0) (2023.6.0)
Requirement already satisfied: mpmath>=0.19 in /usr/local/lib/python3.10/dist-packages (from sympy->torch->l4casadi==1.4.0) (1.3.0)
Building wheels for collected packages: l4casadi
  Building wheel for l4casadi (pyproject.toml) ... done
  Created wheel for l4casadi: filename=l4casadi-1.4.0-cp310-cp310-linux_x86_64.whl size=51779 sha256=648349ada5eff1c91eeee8979173b1fe
  Stored in directory: /tmp/pip-ephem-wheel-cache-5yypi7nh/wheels/cd/54/8a/b8796f827085bb3682fe49796c0f4fe19ddeec1a76ab4187d1
Successfully built l4casadi
```

```
import casadi as ca

# Define the variables
x = ca.SX.sym('x')
y = ca.SX.sym('y')

# Parameters for the Rosenbrock function
a = 1
b = 100

# Define the Rosenbrock function
f = (a - x)**2 + b*(y - x**2)**2

# Create an NLP solver
nlp = {'x': ca.vertcat(x, y), 'f': f}
solver = ca.nlpsol('solver', 'ipopt', nlp)
```

```
# Initial guess
x0 = [2, 2]  # Starting point at (2, 2)

# Solve the problem
sol = solver(x0=x0)

# Extract the solution
x_opt = float(sol['x'][0])
y_opt = float(sol['x'][1])
f_opt = float(sol['f'])

print(f"Optimal x: {x_opt}, Optimal y: {y_opt}")
print(f"Minimum value of the function: {f_opt}")
```

```
Total number of variables............................:        2
                     variables with only lower bounds:        0
                variables with lower and upper bounds:        0
                     variables with only upper bounds:        0
Total number of equality constraints.................:        0
Total number of inequality constraints...............:        0
        inequality constraints with only lower bounds:        0
   inequality constraints with lower and upper bounds:        0
        inequality constraints with only upper bounds:        0

iter    objective    inf_pr   inf_du lg(mu)  ||d||  lg(rg) alpha_du alpha_pr  ls
   0  4.0100000e+02 0.00e+00 1.00e+02  -1.0 0.00e+00    -  0.00e+00 0.00e+00   0
   1  9.9501869e-01 0.00e+00 1.25e-01  -1.0 1.99e+00    -  1.00e+00 1.00e+00f  1
   2  9.4504442e-01 0.00e+00 2.80e+00  -2.5 3.98e+00    -  1.00e+00 2.50e-01f  3
   3  4.8069092e-01 0.00e+00 2.18e-01  -2.5 1.33e-01    -  1.00e+00 1.00e+00f  1
   4  4.5131290e-01 0.00e+00 1.80e+00  -2.5 1.44e+00    -  1.00e+00 5.00e-01f  2
   5  1.8815616e-01 0.00e+00 1.30e-01  -2.5 8.91e-02    -  1.00e+00 1.00e+00f  1
   6  1.3764917e-01 0.00e+00 8.10e-01  -2.5 8.70e-01    -  1.00e+00 5.00e-01f  2
   7  5.4811756e-02 0.00e+00 1.00e-01  -2.5 9.90e-02    -  1.00e+00 1.00e+00f  1
   8  2.9135384e-02 0.00e+00 2.35e-01  -2.5 3.90e-01    -  1.00e+00 5.00e-01f  2
   9  9.8790987e-03 0.00e+00 1.14e-01  -2.5 1.34e-01    -  1.00e+00 1.00e+00f  1
iter    objective    inf_pr   inf_du lg(mu)  ||d||  lg(rg) alpha_du alpha_pr  ls
  10  2.3197823e-03 0.00e+00 7.65e-02  -2.5 1.11e-01    -  1.00e+00 1.00e+00f  1
  11  2.3906138e-04 0.00e+00 1.82e-02  -2.5 5.02e-02    -  1.00e+00 1.00e+00f  1
  12  4.9797444e-06 0.00e+00 4.06e-03  -3.8 2.45e-02    -  1.00e+00 1.00e+00f  1
  13  2.9265475e-09 0.00e+00 6.71e-05  -3.8 2.98e-03    -  1.00e+00 1.00e+00f  1
  14  1.0974644e-15 0.00e+00 6.10e-08  -5.7 9.40e-05    -  1.00e+00 1.00e+00f  1
  15  1.2330882e-28 0.00e+00 6.90e-15  -8.6 4.48e-08    -  1.00e+00 1.00e+00f  1

Number of Iterations....: 15

                                   (scaled)                 (unscaled)
Objective...............:   7.6971797907215616e-30    1.2330882024735941e-28
Dual infeasibility......:   6.9025101905534681e-15    1.1057821325266655e-13
Constraint violation....:   0.0000000000000000e+00    0.0000000000000000e+00
Variable bound violation:   0.0000000000000000e+00    0.0000000000000000e+00
Complementarity.........:   0.0000000000000000e+00    0.0000000000000000e+00
Overall NLP error.......:   6.9025101905534681e-15    1.1057821325266655e-13


Number of objective function evaluations             = 37
Number of objective gradient evaluations             = 16
Number of equality constraint evaluations            = 0
Number of inequality constraint evaluations          = 0
Number of equality constraint Jacobian evaluations   = 0
Number of inequality constraint Jacobian evaluations = 0
Number of Lagrangian Hessian evaluations             = 15
Total seconds in IPOPT                               = 0.028

EXIT: Optimal Solution Found.
      solver  :   t_proc      (avg)   t_wall      (avg)    n_eval
       nlp_f  | 131.00us (  3.54us)  99.79us (  2.70us)        37
  nlp_grad_f  |  43.00us (  2.53us)  39.48us (  2.32us)        17
  nlp_hess_l  |  34.00us (  2.27us)  31.62us (  2.11us)        15
       total  |  28.73ms ( 28.73ms)  28.63ms ( 28.63ms)         1
Optimal x: 1.0000000000000109, Optimal y: 1.0000000000000215
Minimum value of the function: 1.233088202473594e-28
```