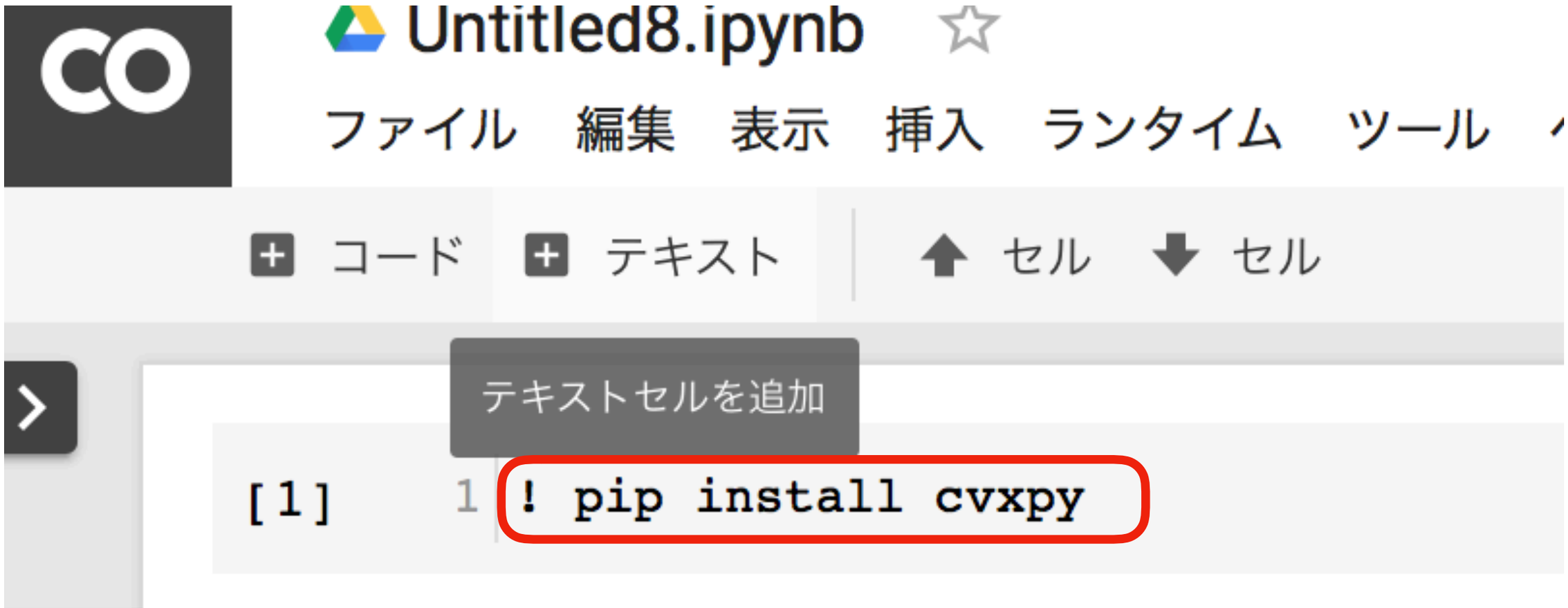
# 演習課題

# CVXPYを使う

**演習ホームページのcvxpy.ipnbをクリック**

# CVXPYのインストール




**ちょっと時間がかかるが、落ち着いて待つ**

```
Collecting cvxpy
  Downloading https://files.pythonhosted.org/packages/c2/d4/123077905277c2222b104be90012b533911cce7b7b9f38976763c3998c9f/cvx
    100% |████████████████████████████████| 901kB 5.9MB/s
Collecting osqp (from cvxpy)
  Downloading https://files.pythonhosted.org/packages/60/c3/929cf43fbfec0d68742760e8357f9f5f68fb129961d8278f29f2a7c19088/osq
    100% |████████████████████████████████| 143kB 6.5MB/s
Collecting ecos>=2 (from cvxpy)
  Downloading https://files.pythonhosted.org/packages/b6/b4/988b15513b13e8ea2eac65e97d84221ac515a735a93f046e2a2a3d7863fc/eco
    100% |████████████████████████████████| 122kB 7.5MB/s
Collecting scs>=1.1.3 (from cvxpy)
  Downloading https://files.pythonhosted.org/packages/b3/fd/6e01c4f4a69fcc6c3db130ba55572089e78e77ea8c0921a679f9da1ec04c/scs
    100% |████████████████████████████████| 143kB 7.6MB/s
Collecting multiprocess (from cvxpy)
  Downloading https://files.pythonhosted.org/packages/7a/ee/b9bf3e171f936743758ef924622d8dd00516c5532b00a1210a09bce68325/mul
    100% |████████████████████████████████| 1.4MB 9.3MB/s
Collecting fastcache (from cvxpy)
  Downloading https://files.pythonhosted.org/packages/fb/98/93f2d36730860e0dd5a0dbfc918169b24650f63e5fa041fe000c22ae4f8b/fas
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from cvxpy) (1.11.0)
Requirement already satisfied: toolz in /usr/local/lib/python3.6/dist-packages (from cvxpy) (0.9.0)
Requirement already satisfied: numpy>=1.14 in /usr/local/lib/python3.6/dist-packages (from cvxpy) (1.14.5)
Requirement already satisfied: scipy>=0.19 in /usr/local/lib/python3.6/dist-packages (from cvxpy) (0.19.1)
Requirement already satisfied: future in /usr/local/lib/python3.6/dist-packages (from osqp->cvxpy) (0.16.0)
Collecting dill>=0.2.8.1 (from multiprocess->cvxpy)
  Downloading https://files.pythonhosted.org/packages/6f/78/8b96476f4ae426db71c6e86a8e6a81407f015b34547e44229lcd397b18f3/dil
    100% |████████████████████████████████| 153kB 14.5MB/s
Building wheels for collected packages: cvxpy, ecos, scs, multiprocess, fastcache, dill
  Running setup.py bdist_wheel for cvxpy ... done
  Stored in directory: /content/.cache/pip/wheels/6d/78/df/bd8d02476516cf184699705248d001a806c220add5e3994caa
  Running setup.py bdist_wheel for ecos ... done
  Stored in directory: /content/.cache/pip/wheels/50/91/1b/568de3c087b3399b03d130e71b1fd048ec072c45f72b6b6e9a
  Running setup.py bdist_wheel for scs ... done
  Stored in directory: /content/.cache/pip/wheels/ff/f0/aa/530ccd478d7d9900b4e9ef5bc5a39e895ce110bed3d3ac653e
  Running setup.py bdist_wheel for multiprocess ... done
  Stored in directory: /content/.cache/pip/wheels/8b/36/e5/96614ab62baf927e9bc06889ea794a8e87552b84bb6bf65e3e
  Running setup.py bdist_wheel for fastcache ... done
  Stored in directory: /content/.cache/pip/wheels/b7/90/c0/da92ac52d188d9ebca577044e89a14d0e6ff333c1bcd1ebc14
  Running setup.py bdist_wheel for dill ... done
  Stored in directory: /content/.cache/pip/wheels/e2/5d/17/f87cb7751896ac629b435a8695f83ee75b11029f5d6f6bda72
Successfully built cvxpy ecos scs multiprocess fastcache dill
Installing collected packages: osqp, ecos, scs, dill, multiprocess, fastcache, cvxpy
Successfully installed cvxpy-1.0.6 dill-0.2.8.2 ecos-2.0.5 fastcache-1.0.2 multiprocess-0.70.6.1 osqp-0.3.1 scs-2.0.2
```

# cvxpyの基本的な使い方

```
import cvxpy as cvx

# Create two scalar optimization variables.
x = cvx.Variable()
y = cvx.Variable()

# Create two constraints
constraints = [x + y == 1,
               x - y >= 1]

# Form objective.
obj = cvx.Minimize((x - y)**2)

# Form and solve problem.
prob = cvx.Problem(obj, constraints)
prob.solve()  # Returns the optimal value.
print("status:", prob.status)
print("optimal value", prob.value)
print("optimal var", x.value, y.value)
```

制約条件

目的関数

問題インスタンス生成

問題を解く

# 演習問題

前のページのコードを実行してみよ。

```
status: optimal
optimal value 1.0
optimal var 1.0 1.5700862132409 83e-22
```

# 演習問題

- 講義のクイズにあらわれる線形計画問題(目的関数が-x_1+x_2のもの)をcvxpyを利用して解け。

- 次の凸最適化問題をcvxpyを利用して解け。

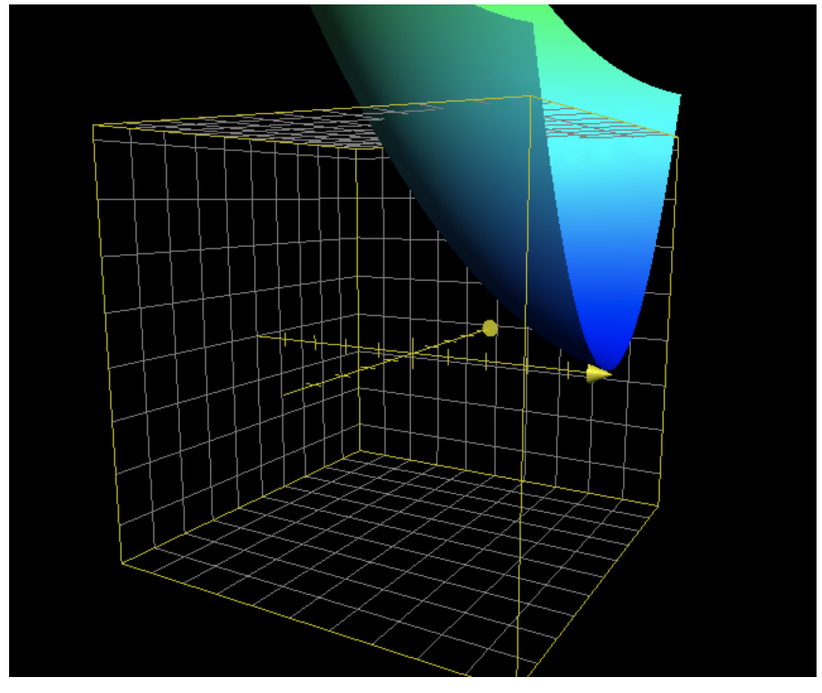
$$\text{minimize } x^2 + y^2 \text{ s.t. } x + y \geq 1$$

## 次の問題をcvxpyを利用して解け。

$$\text{minimize } (x_1 - 6)^2 + 2x_2^2$$

subject to

$$\begin{aligned} x_1 &\leq 5 \\ -x_1 &\leq 5 \\ x_2 &\leq 5 \\ -x_2 &\leq 5 \end{aligned}$$



# チャレンジ課題

あるレストランで，　手持ちの材料からハンバーグとオムレツを作って利益を最大にしたいと考えている.手持ちの材料は,
・ひき肉 3800 [g]
・タマネギ 2100 [g]・ケチャップ 1200 [g]
であり，それぞれの品を作るのに必要な材料の量は,
・ハンバーグ 1 個あたり，ひき肉 60 [g]，タマネギ 20 [g]，ケチャップ 20 [g]
・オムレツ 1 個あたり，　ひき肉 40 [g]，タマネギ 30 [g]，ケチャップ 10 [g] であるとする.(他に必要な材料は十分な量があるものとする)
販売価格は,
・ハンバーグ 400 [円/個]
・オムレツ 300 [円/個]
とする.総売上を最大にするには，　それぞれハンバーグとオムレツを幾つずつ作れば良いか?

出典:http://www.fujilab.dnj.ynu.ac.jp/lecture/system2.pdf の問題