プログラム

実行環境と用いた言語・ライブラリを以下の表 1 に示す。

表 1: プログラムの実行環境

OS	:	Microsoft Windows 10 Pro (64bit)
CPU	:	Intel(R) Core(TM) i5-4300U
RAM	:	4.00 GB
使用言語	:	Python3.6
可視化	:	matplotlib ライブラリ

Listings 1: assignment3.py

```
# -*- coding: utf-8 -*-


import numpy as np
import matplotlib.pyplot as plt
import scipy.stats as stats


def generate_sample(n, theta):
    sample = (np.random.rand(n) < theta)
    return sample


def main():
    # settings
    theta = 0.3
    n_sample = 100000
    n_mle = 1000
    np.random.seed(0)


    theta_mle_list = []
    fisher_matrices = []
    for _ in range(n_mle):
        sample = generate_sample(n_sample, theta)
        n_o = sample.sum()
        theta_mle = n_o / n_sample
        fisher_matrix = (1/n_sample) * ((n_sample/(theta*(1-theta))) *
    (theta_mle - theta))**2
        theta_mle_list.append(theta_mle)
        fisher_matrices.append(fisher_matrix)

    mean = np.mean(theta_mle_list)
```

```
33      cov = np.cov(theta_mle_list)
34      F = np.mean(fisher_matrices)
35
36      W, p = stats.shapiro(theta_mle_list)
37      is_normal_dist = (p > 0.05)
38
39      print('n: {} \t n_MLE: {}'.format(n_sample, n_mle))
40      print('True: theta*: {} \t 1/nF: {} \t F: {}'.format(theta,
        1/(n_sample*F), F))
41      print('MLE: mean: {:.4f} \t cov: {}'.format(mean, cov))
42      print('is normal: {} \t W: {} \t p: {}'.format(is_normal_dist, W, p))
43
44
45      # histgram
46      plt.hist(theta_mle_list, bins=50)
47      plt.xlabel(r'$\theta_\mathrm{MLE}$')
48      plt.ylabel('freq')
49      plt.savefig('../figures/hist_n{}.png'.format(n_sample))
50      plt.show()
51
52      # QQ plot
53      stats.probplot(theta_mle_list, dist='norm', plot=plt)
54      plt.xlabel('Quantailes')
55      plt.ylabel('')
56      plt.savefig('../figures/qqplot_n{}.png'.format(n_sample))
57      plt.show()
58
59
60  if __name__ == '__main__':
61      main()
```