

preparing_plotting_paper

September 30, 2020

1 Preparing Probability Paper

This example highlight the concept for preparing a probability paper. For preparing a plotting paper of given data the function `probplot` from `scipy.stats` as done in `return_period_estimation` example code.

In this example we will see that how an axis is sclaed so that cumulative probability can be shown as a straight line on probability paper.

```
[1]: # Intialization: Import required libraries
import os

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

# Configuration for plotting
plt.style.use('ggplot')
plt.rcParams['text.usetex'] = True
FIGURE_FOLDER = os.path.join('output', 'figures')
os.makedirs(FIGURE_FOLDER, exist_ok=True)
```

Now, exponential distributed variable with different λ parameters are generated. These values will then be plotted in later section.

```
[2]: # Global variables
cdfs = np.array([i/10 for i in range(10)] + [0.95, 0.975, 0.99])

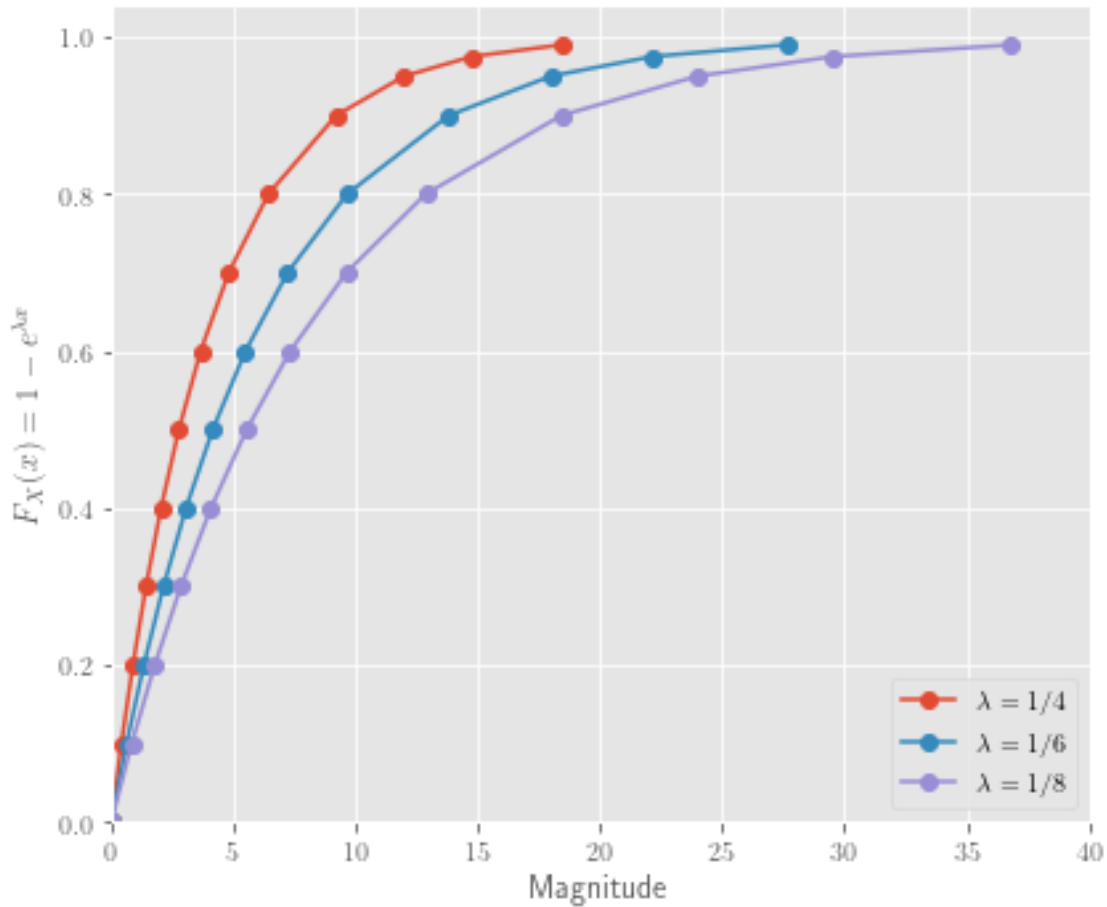
f_cdf = -np.log(1-cdfs)
lambdas = [1/4, 1/6, 1/8]
lambdas.sort(reverse=True)
values = [stats.expon.ppf(cdfs, loc=0, scale=1/la)
          for la in lambdas]
```

1.1 Cumulative Probability Distribution Plots

The cumulative probability for exponential distribution with mean $1/\lambda$ is given by:

$$F_X(x) = 1 - e^{(-\lambda x)} \quad \text{for } x > 0, \lambda > 0$$

```
[3]: fig = plt.figure(figsize=[6, 5])
for val, la in zip(values, lambdas):
    plt.plot(val, cdfs, marker='o', label=f'$\lambda=1/{int(1/la)}$')
plt.legend(loc='lower right')
plt.xlabel('Magnitude')
plt.ylabel('$F_X(x)=1-e^{-\lambda x}$')
plt.xlim([0, 40])
plt.ylim(0)
plt.grid(True)
plt.savefig(os.path.join(FIGURE_FOLDER, 'sample_exp_cdf_plot'), dpi=200)
```



1.2 Probability Paper for exponential distribution

For plotting probability paper, we need to find a linear relationship between the variable (x) and a function of cumulative probability ($F_X(x)$). As

$$F_X(x) = 1 - e^{(-\lambda x)} \quad \text{for } x > 0, \lambda > 0$$

Hence, $x = (1/\lambda)[- \log(1 - F_X(x))]$

In the following probability paper plot the function of cumulative probability (*i.e.* $- \log(1 - F_X(x))$) is plotted on X -axis and the variable is plotted on Y -axis.

You can observed that after the transformation of the X -axis the cumulative probability are straight line over the probability paper.

Further, I have also shown the values of cumulative probability on top axis for reference.

```
[4]: fig = plt.figure(figsize=[6, 5])
for val, la in zip(values, lambdas):
    plt.plot(f_cdf, val, marker='o', label=f'$\lambda=1/{int(1/la)}$')
plt.ylim([0, 40])
plt.ylabel('Magnitude')
plt.xlim([0, 5])
plt.xlabel('$-\log(1-F_X(x))$')
ax = plt.gca()
secax = ax.secondary_xaxis('top', functions=(lambda x: 1-np.exp(-x),
                                             lambda x: -np.log(1-x)))

secax.set_xlabel('$F_X(x)$')
secax.set_ticks(cdfs)
secax.tick_params(rotation=90)
plt.grid(True)
for fv, ym in zip(f_cdf, values[0]):
    ax.axvline(x=fv, ymin=ym/40, linewidth=0.5, color='k', linestyle='--')
plt.legend(loc='lower right')
plt.savefig(os.path.join(Figure_Folder, 'sample_exp_prob_paper'), dpi=200)
```

