thws
Technische Hochschule
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Faculty of Computer Science and Business Information Systems
5172080: Fundamentals of Mobile Robotics

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Computer Practical / Laboratory 1

Topic: Programming Probabilities in Python

On Monday 12:10-13:10, Week 43 of the calendar year,
you will complete the following tasks:

T 1 – Define a Probability Density Function

In Python, functions are usually defined inside a file. Create a file called `lab_1_script.py` and implement the probability density function $p(x)$. Use the parameters $\sigma = 1.0$ and $\mu = 0.0$. Hint: The Python module `numpy` provides relevant functions and a variable for π: `numpy.pi`.

$$p(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

1.a

What are the values of the mean and standard deviation of the density function $p(x)$?

1.b

In general, what is the effect of the prefactor $^{1}/_{\sigma\sqrt{2\pi}}$ on the density function $p(x)$?

1.c

Next, launch your script as python `lab_1_script.py` in the command line. What common probability distribution does the implemented density function describe? In Python, several functions can be defined in one and the same file. The file name and the function names used do not depend on each other.

T 2 – Plot Data

Each Python file is a script that can be evaluated later. It can contain several functions and other numerical calculations in one file. The `matplotlib.pyplot` module can be used for plotting.

2.a

In lab_1_script.py, use the numpy.linspace command to draw 100 evenly spaced samples from the density function $p(x)$ in the interval $[-6, 6]$. Plot $p(x)$ vs x for the drawn samples.

2.b

Change the parameters to $\sigma = 2.0$ and $\mu = 0.0$. Plot the changed density function as above. Based on the difference that you observe in the original and changed density functions, what is the main effect of changing σ?

2.c

Comment on the effect of changing the parameters to $\sigma = 1.0$ and $\mu = 1.0$ on the density function.

T 3 – Generate Random Numbers

Random numbers are important in probabilistic modeling, so it is better to know what kind of random variables Python provides and how to use them. Tip: Use numpy.

3.a

In lab_1_script.py, use the numpy.random.normal function to draw 1,000,000 random samples from a normal distribution with a mean of 10.0 and a standard deviation of 4.0.

3.b

Use the numpy.random.uniform function to draw 1,000,000 random samples from a uniform distribution over the interval between 0 and 20.

3.c

Calculate and output the sample means and standard deviations of the two sets computed in a) and b) using numpy functions. Explain how the results compare to each other.

3.d

Use the hist function to plot separate histograms with 100 bins for each of the sample sets you have generated. Use the help(matplotlib.pyplot.hist) function to get more information on its use.

3.e

What is the effect of setting the seed to a fixed value with the function numpy.random.seed before sampling, i.e. when random numbers are generated?