Exam Bio-Image Analysis, Biostatistics,   
Programming and Machine Learning

Charles University Prague / TU Dresden

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Duration: 45 min

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**Part 1: Programming 8  *Points***

1. Assume you just started up your computer and you would like to continue the Python programming project you worked on yesterday. What is the command you need to enter first?

*1 Point*

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1. Write a python program that outputs all the numbers between 0 and 10 (including 0 and 10) that fulfill all of the following conditions:

* Divisible by 2
* Not divisible by 3

*2 Points*

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1. Complete the following python program so that it computes the mean of the list x.

x = [1, 3, 2, 6, 2, 1, 5, 6, 7]

*1 Point*

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1. What is the output of this python code?

print([1, 2] + [3, 4])

*1 Point*

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1. You find a program from a former colleague. When executing it, it draws the plot shown below. a) What does the function pnd do? b) What do the two parameters m and s stand for? c) What would be good axis descriptions in the plot?

*3 Points*

import math

import matplotlib.pyplot as plt

def pnd(m, s):

x\_values = []

y\_values = []

for x in range(m - 4 \* s, m + 4 \* s):

     p = 1 / (s \* math.sqrt(4 \* math.pi)) \*

         math.exp(-0.5 \* math.pow( (x - m) / s, 2))

     x\_values = x\_values + [x]

     y\_values = y\_values + [p]

plt.plot(x\_values, y\_values)

plt.show()

pnd(5, 3)

Chart, line chart

Description automatically generated

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**Part 2: Bio-image Analysis 13  *Points***

1. In science, the terms a) “Objective”, b) “Quantitative”, c) “Reliable”, d) “Reproducible” and e) “Repeatable” are important. Describe these terms with your own words.

*5 points*

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1. What do image analysts understand of a “filter”? b) How are linear filters related to the terms “kernel”, “filter matrix” and “convolution”? c) Why is there no filter matrix for non-linear filters?

*3 points*

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1. Describe how a 3x3 kernel of a maximum filter works.

*1 point*

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1. What is characteristic for a label image? What mathematical operation allows to determine the number of objects in a label image?

*2 points*

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1. Name four shape descriptors

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**Part 3: Bio-Statistics and Machine learning 9 *Points***

1. Name two potential sources of bias, when setting up an imaging experiment and how you can avoid them.

1 points

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1. What does the p-value in statistical analysis stand for?

1 point

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1. Which measures are necessary to describe the density of a normal distribution?

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1. Which measures are necessary to describe the density of a Poisson distribution?

1 point

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1. Name two assumptions which have to be considered for a t-test.

2 points

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1. What are the axis titles in a Bland-Altman plot?

2 points

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1. Describe what the 95% confidence interval stands for.

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