Technical University of Denmark

Course name	Introduction to programming and data processing Programming and data processing (second programming language)
Course number	02631, 02692
Aids allowed	All Aids
Exam duration	2 hours
Weighting	All exercises have equal weight

Contents

Submission details

You must hand in your solution electronically:

1. You can upload your solutions individually on CodeJudge (`dtu.codejudge.net/prog-e15/assignment`) under *Afleveringer/Exam*. When you hand in a solution on CodeJudge, the test example given in the assignment description will be run on your solution. If your solution passes this single test, it will appear as *Submitted*. This means that your solution passes on this single test example. You can upload to CodeJudge as many times as you like during the exam.

2. You must upload your solutions on CampusNet. Each assignment must be uploaded as one separate .py file, given the same name as the function in the assignment:

   (a) `convertGrade.py`
   (b) `hireApplicant.py`
   (c) `averagedB.py`
   (d) `buildLego.py`
   (e) `sudokuCheck.py`

   The files must be handed in separately (*not* as a zip-file) and *must have these exact filenames*.

After the exam, your solutions will be automatically evaluated on CodeJudge on a range of different tests, to check that they work correctly in general. The assessment of you solution is based only on how many of the automated tests it passes.

- Make sure that your code follows the specifications exactly.
- Each solution shall not contain any additional code beyond the specified function.
- Remember, you can check if your solutions follow the specifications by uploading them to CodeJudge
- Note that all vectors and matrices used as input or output must be numpy arrays.

Assignment A Conversion of grades

One advantage of the new Danish 7-point grading scale compared to the old 00-13 grading scale is that it is easily converted to the European Credit Transfer System (ECTS). The following table provides conversion between the three different scales.

13-scale	7-point	ECTS
13	12	A
11		
10	10	B
9	7	C
8		
7	4	D
6	02	E
5	00	Fx
03		
00	−3	F

Problem definition

Create a function named `convertGrade` that takes a grade given in the 7-point or 13-scale as numeric input (use the numbers in brackets) and the scale (7-point or 13-scale) as a string, and returns the grade converted to the ECTS scale as a string (written exactly as in the table above.)

Solution template

```
def convertGrade(grade, scale):
  #insert your code
  return ECTSGrade
```

Input	
grade	Grade given on the 7-point scale or 13-scale (whole number).
scale	Scale to convert from (string): either '13-scale' or '7-point'.

Output	
ECTSGrade	Grade on the ECTS scale (string).

Example

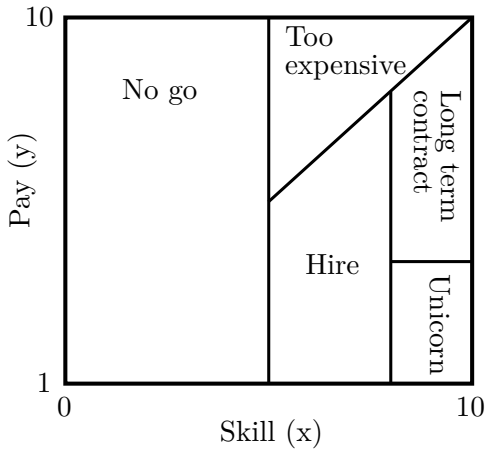
If the grade is 7 and the scale to convert from is `13-scale`, the string `D` must be returned.

A

Assignment B When to hire an employee

An employer has made a chart of when to hire applicants to his firm. He uses two parameters to decide how to handle the applicant; how skilled the applicant is (skill) and how high a salary the applicant wants (pay). Skill is raided on a scale from 0 to 10 and Pay is raided on a scale from 1 to 10, since no applicants want to work for free. The employer do not want to hire any applicants who are less than 5 skilled, so this is the "No go" zone. He makes a Skill-Pay line and applicants above this line is considered "Too expensive". Applicants below the Skill-Pay line and between 5 and 8 skilled ends up in the "Hire" zone. Applicants above 8 skilled, below the skill-pay line and above 4 pay should be considered for a "Long term contract". Applicants which are more than 8 skilled and who want less than 4 pay are considered "Unicorn", since such applicants simply do not exist. The following table lists the applicant zones:

Applicant zone	Skill (x)	Pay (y)
`No go`	$x < 5$	
`Too expensive`	$x \geq 5$	$y > 0.9x + 1$
`Hire`	$5 \leq x < 8$	$y \leq 0.9x + 1$
`Long term contract`	$x \geq 8$	$4 < y \leq 0.9x + 1$
`Unicorn`	$x \geq 8$	$y \leq 4$



Problem definition

Create a function named `hireApplicant` that takes the skill and pay as numeric input and returns the applicantZone as a string (written exactly as in the table above).

Solution template

```
def hireApplicant(skill, pay):
  #insert your code
  return applicantZone
```

Input	
skill	Skill given on a scale from 0 to 10 (decimal number).
pay	Pay given on a scale from 1 to 10 (decimal number).

Output	
applicantZone	Applicant zone (string).

Example

If the skill is 8 and the pay is 7, the string `Long term contract` must be returned.

B

Assignment C Average hearing loss

Hearing loss is usually evaluated using an audiogram where the hearing loss is measured for different pure tones as the deviation from 0 dB. You are working with a data set where hearing loss has been measured for 7 different frequencies and for a number of individuals. The data for each individual is saved as the rows in a matrix `M`. The matrix therefore contains 7 columns, one for each measured frequency. You want to calculate the average hearing loss across the individuals for each frequency, however without including individuals with a severe hearing loss. A hearing loss of more than 70 dB is considered severe.

Problem definition

Create a function named `averagedB` which takes a matrix as input, removes rows that contain values above 70 dB, and returns a vector containing the average of each column for the reduced matrix.

Solution template

```
def averagedB(M):
  #insert your code
  return averageM
```

Input	
M	Input matrix

Output	
averageM	Output vector

Example

Consider the following input matrix:

$$M = \begin{bmatrix} 25 & 25 & 30 & 40 & 40 & 40 & 45 \\ 50 & 55 & 55 & 65 & 65 & 70 & 75 \\ 75 & 70 & 70 & 70 & 50 & 50 & 55 \\ 25 & 30 & 35 & 40 & 50 & 55 & 60 \end{bmatrix}$$

Since row 2 and 3 contain a value above 70 dB the rows must be removed.

$$M = \begin{bmatrix} 25 & 25 & 30 & 40 & 40 & 40 & 45 \\ \cancel{50} & \cancel{55} & \cancel{55} & \cancel{65} & \cancel{65} & \cancel{70} & \cancel{75} \\ \cancel{75} & \cancel{70} & \cancel{70} & \cancel{70} & \cancel{50} & \cancel{50} & \cancel{55} \\ 25 & 30 & 35 & 40 & 50 & 55 & 60 \end{bmatrix}$$

The average of each column are calculated for the reduced matrix to produce the vector below, which should be the output of the function:

$$averageM = \begin{bmatrix} 25.0 & 27.5 & 32.5 & 40.0 & 45.0 & 47.5 & 52.5 \end{bmatrix}$$

C

Assignment D Building LEGO bricks

You want to build the tallest tower of lego bricks such that the volume of the tower does not exceed 1000cm^3. It is assumed that the volume of a lego brick can be calculated by:

$$V = h \cdot l \cdot w$$

where h, w and l are the height, width, and length of the lego brick, respectively.

Problem definition

Create a function named `buildLego` that takes as input the height h, width w, and length l of a lego brick and computes the maximum number of lego bricks that can be used for your tower if the volume can not exceed 1000cm^3.

Solution template

```
def buildLego(h, l, w):
  #insert your code
  return bricks
```

Input	
h	Height of the lego brick (positive decimal number)
l	Length of the lego brick (positive decimal number)
w	Width of the lego brick (positive decimal number)

Output	
bricks	Number of lego bricks (integer)

Example

Consider $h = 1$, $l = 8$, and $b = 1.6$. For different values of *bricks* the volume can be computed as shown below:

bricks	75	76	77	78	79	80
volume	960.00	972.80	985.60	998.40	1011.2	1024.0

The largest number of lego bricks for which the volumen does not exceed 1000cm^3 is *bricks* = 78. Thus, the function should return the value 78.

D

Assignment E Sudoku check

Sudoku is a number puzzle, where the objective is to fill a 9-by-9 grid with numbers between 1 and 9 so that each row, each column, and each 3-by-3 block contains all the numbers from 1 through 9. Each row, each column, and each 3-by-3 block must therefore sum to 45.

Problem definition

Create a function named `sudokuCheck` that takes as input a 9-by-9 matrix, sudokuBoard, and checks whether the sum of each row, each column, and each 3-by-3 block is 45. The function must output the variable check that contains the overall number of rows, columns, and blocks that do not sum to 45.

Solution template

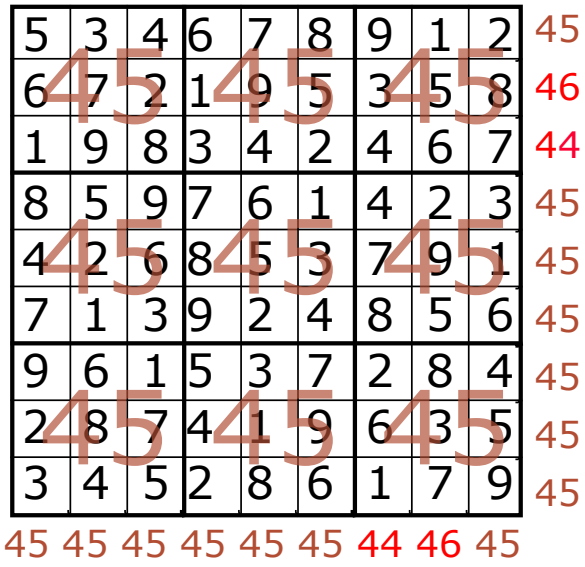
```
def sudokuCheck(sudokuBoard):
  #insert your code
  return check
```

Input	
sudokuBoard	9-by-9 matrix (numbers from 1 to 9)

Output	
check	Result from check (integer)

Example

Consider the sudoku board below. The sum is calculated for each row, column, and 3-by-3 block (brown and red numbers).



The sum of row 2 and 3 and column 7 and 8 is different from 45, and the program must therefore return the integer 4.

E