COSC 343: Test 1

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1 vector P-Norm

Listing 1: vector p-norm

```
import numpy as np
import matplotlib


def p_norm(vec, p):
    sum = 0
    for element in vec:
        sum += np.abs(element) ** p
    return sum ** (1/p)
```

$$\left\| \begin{pmatrix} -3 \\ 7 \\ -3 \\ -10 \end{pmatrix} \right\|_3 = 11.178893071112261$$

$$\left\| \begin{pmatrix} 4 \\ -5 \\ 9 \\ 4 \\ -9 \end{pmatrix} \right\|_1 = 31.0$$

$$\left\| \begin{pmatrix} 6 \\ -5 \\ -3 \\ 8 \\ 2 \\ -7 \end{pmatrix} \right\|_3 = 10.717315545247244$$

2 Matrix 1 norm

Listing 2: matrix 1-norm

```
import numpy as np
import matplotlib


def one_norm(matrix):
    max = 0
    for j in range(len(matrix[0])):
        sum = 0
        for i in range(len(matrix)):
            sum += np.abs(matrix[i][j])
        if sum > max:
```

```
            max = sum
    return max
```

$$\left\| \begin{pmatrix} -4 & 6 & 4 & -7 & -4 \\ 8 & -3 & -3 & -9 & -4 \\ -2 & -5 & -7 & 0 & -4 \\ -8 & 1 & -7 & -7 & -5 \end{pmatrix} \right\|_1 = 23$$

$$\left\| \begin{pmatrix} 3 & -10 & 6 & 4 \\ 6 & -3 & 8 & 6 \\ -9 & -4 & 10 & 6 \\ 5 & -7 & -1 & -3 \end{pmatrix} \right\|_1 = 25$$

$$\left\| \begin{pmatrix} 1 & -4 & -9 & -6 & -1 \\ -4 & 6 & -3 & 6 & 3 \\ -5 & -10 & -9 & 8 & 1 \\ 0 & -10 & 0 & -7 & 5 \end{pmatrix} \right\|_1 = 30$$

3 Matrix ∞ norm

Listing 3: matrix ∞ norm

```
import numpy as np
import matplotlib

def inf_norm(matrix):
    max = 0
    for i in range(len(matrix)):
        sum = 0
        for j in range(len(matrix[0])):
            sum += np.abs(matrix[i][j])
        if sum > max:
            max = sum
    return max
```

$$\left\| \begin{pmatrix} -4 & -5 & -6 & -2 & -9 \\ -2 & 3 & -6 & -4 & 3 \\ -2 & 10 & 8 & 7 & -8 \\ -4 & -6 & -5 & -5 & -1 \\ -7 & 5 & -4 & -4 & -3 \end{pmatrix} \right\|_\infty = 35$$

$$\left\| \begin{pmatrix} 7 & 6 & 0 & -1 & 3 \\ 0 & -7 & -3 & -9 & -3 \\ -3 & -8 & 7 & 8 & 10 \\ -2 & 0 & 9 & -10 & 6 \\ -10 & 3 & 7 & -7 & -5 \end{pmatrix} \right\|_\infty = 36$$

$$\left\| \begin{pmatrix} -9 & -9 & -2 & -4 & -7 \\ -10 & 2 & 5 & 10 & 2 \\ -3 & -2 & 2 & -2 & -7 \\ -4 & 8 & -4 & 3 & -2 \\ 9 & -8 & -4 & -3 & 0 \end{pmatrix} \right\|_\infty = 31$$

4 testing and formatting code

Listing 4: testing code

```
from vector_norm import *
from matrix_inf_norm import *
from matrix_one_norm import *
```

```
from random import randint


def vector_to_latex(vec):
    """formatts vectors to be added to a latex document"""
    latex_code = "\\begin{pmatrix}"
    for element in vec:
        latex_code += str(element) + "\\\\"
    latex_code += "\\end{pmatrix}"

    return latex_code

def matrix_to_latex(matrix):
    """formats matrices to be added to a latex document"""
    latex_code = "\\begin{pmatrix}"
    for row in matrix:
        latex_code += "&".join(map(str, row)) + "\\\\"
    latex_code += "\\end{pmatrix}"
    return latex_code

def pnorm_to_latex(matrix_latex ,p, ans):
    """ formats the norm to be added to the latex document """
    return "$$\\left\\|"+matrix_latex+"\\right\\|_{"+str(p)+"}="+str(ans)+"$$"

""" test vector Norm """
for i in range(4,7):
    vec = []
    for j in range(i):
        vec.append(randint(-10, 10))
    p = randint(1,3)
    ans = p_norm(vec, p)
    latex = vector_to_latex(vec)
    print(pnorm_to_latex(latex ,p, ans))

print()
"""test one_norm """
for i in range(3):
    m = randint(3,5)
    n = randint(3,5)
    matrix = []
    for i in range(m):
        row = []
        for j in range(n):
            row.append(randint(-10,10))
        matrix.append(row)
    p = 1
    ans = one_norm(matrix)
    matrix_latex = matrix_to_latex(matrix)
    print(pnorm_to_latex(matrix_latex, p, ans))

print()
"""test inf_norm """
for i in range(3):
    m = randint(3,5)
    n = randint(3,5)
    matrix = []
```

```
for i in range(m):
    row = []
    for j in range(n):
        row.append(randint(-10,10))
    matrix.append(row)
p = "\\infty"
ans = inf_norm(matrix)
matrix_latex = matrix_to_latex(matrix)
print(pnorm_to_latex(matrix_latex, p, ans))
```