静岡理工科大学　情報学部　幸谷担当講義

レポート用紙

講義名　：数値解析１	年月日：　2024 年　　5 月　　27 日(月)
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本日の課題 P.27 問題 4.1, P.28　問題 4.2

感想

2. 課題の難易度はどうでしたか？

詳細

難しかった	12
少し難しかった	3
ちょうど良かった	2
簡単だった	0
とても簡単だった	0

問題 4.1, 1

mytool.py に下記を追加：

```
import numpy as np

# 誤差の計算
def relerr(approx_list, true_list):
    err = approx_list - true_list
    #print('E(cos(acos(xlist))) = ', err)
    # 絶対誤差
    aErr = np.abs(err)
    # 相対誤差
    rErr = {}
    index = 0
    for abs_err in aErr:
        if abs_err != 0:
            rel_err = abs_err / np.abs(true_list[index])
            rErr[index] = rel_err

        index += 1
```

```
    return rErr

# 10進有効桁数
def num_sig10(rErr):
    num_sig = {}
    for key, value in rErr.items():
        num_sig[key] = np.floor(-np.log10(value))

    #print('num_sig = ', num_sig)
    max_num_sig, min_num_sig = 0, 20
    for key, value in num_sig.items():
    #    print('key, value = ', key, value)
        if max_num_sig < value: max_num_sig = value
        if min_num_sig > value: min_num_sig = value
    print('max, min_num_sig = ', max_num_sig, min_num_sig)

    return num_sig
```

スクリプト例：

```
import numpy as np # NumPy
from mytool import relerr, num_sig10

# [a, b]をn分割
n = 5 # 分割数
#a, b = -np.pi / 4.0, np.pi / 4.0 # 端点
a, b = 0.01, np.pi / 4.0 # 端点
h = (b - a) / n # 区間幅

# x = [a, a + h, ..., a * (n - 1)h = b - h, a * nh = b]
xlist = np.linspace(a, b, n) #  [a + h * i for i in range(n + 1)]
print('x = ', xlist)

# exp, log
print('log(exp(xlist))   = ', np.log(np.exp(xlist)))
print('exp(log(xlist))   = ', np.exp(np.log(xlist)))
print('log10(exp(xlist)) = ', np.log10(10**(xlist)))
print('10^(log10(xlist)) = ', 10**(np.log10(xlist)))
print('rErr(log(exp(xlist)))   = ', relerr(np.log(np.exp(xlist)), xlist))
print('rErr(exp(log(xlist)))   = ', relerr(np.exp(np.log(xlist)), xlist))
```

```
print('rErr(log10(exp(xlist))) = ', relerr(np.log10(10**(xlist)), xlist))
print('rErr(10^(log10(xlist))) = ', relerr(10**(np.log10(xlist)), xlist))
print('num_sig10((log(exp(xlist)))                    )          =          ',
num_sig10(relerr(np.log(np.exp(xlist)), xlist)))
print('num_sig10((exp(log(xlist)))                    )          =          ',
num_sig10(relerr(np.exp(np.log(xlist)), xlist)))
print('num_sig10((log10(exp(xlist))))                   =                  ',
num_sig10(relerr(np.log10(10**(xlist)), xlist)))
print('num_sig10((10^(log10(xlist))))                   =                  ',
num_sig10(relerr(10**(np.log10(xlist)), xlist)))
```

実行結果：

```
x =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
log(exp(xlist))   =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
exp(log(xlist))   =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
log10(exp(xlist)) =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
10^(log10(xlist)) =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
rErr(log(exp(xlist)))   =  {0: 1.0755285551056204e-14, 1: 2.723143304613999e-16, 2: 1.3958078805248573e-16, 4: 1.4135798
584282297e-16}
rErr(exp(log(xlist)))   =  {0: 3.469446951953614e-16, 1: 1.3615716523069995e-16}
rErr(log10(exp(xlist))) =  {0: 1.3877787807814457e-15, 1: 1.3615716523069995e-16}
rErr(10^(log10(xlist))) =  {1: 1.3615716523069995e-16}
max, min_num_sig =  15.0 13.0
num_sig10((log(exp(xlist)))  ) =  {0: 13.0, 1: 15.0, 2: 15.0, 4: 15.0}
max, min_num_sig =  15.0 15.0
num_sig10((exp(log(xlist)))  ) =  {0: 15.0, 1: 15.0}
max, min_num_sig =  15.0 14.0
num_sig10((log10(exp(xlist)))) =  {0: 14.0, 1: 15.0}
max, min_num_sig =  15.0 15.0
num_sig10((10^(log10(xlist)))) =  {1: 15.0}
```

問題 4.1, 2

スクリプト例：

```
# check_cos_acos.py: 問題 4.1, 2
import numpy as np # NumPy
from mytool import relerr, num_sig10

# [a, b]を n 分割
n = 5 # 分割数
#a, b = -np.pi / 4.0, np.pi / 4.0 # 端点
a, b = 0.01, np.pi / 4.0 # 端点
h = (b - a) / n # 区間幅

# x = [a, a + h, ..., a * (n - 1)h = b - h, a * nh = b]
xlist = np.linspace(a, b, n) #  [a + h * i for i in range(n + 1)]
print('x = ', xlist)

# cos, acos, tan, atan
print('acos(cos(xlist)) = ', np.arccos(np.cos(xlist)))
```

```
print('cos(acos(xlist)) = ', np.cos(np.arccos(xlist)))
print('atan(tan(xlist)) = ', np.arctan(np.tan(xlist)))
print('tan(atan(xlist)) = ', np.tan(np.arctan(xlist)))
print('rErr(acos(cos(xlist))) = ', relerr(np.arccos(np.cos(xlist)), xlist))
print('rErr(cos(acos(xlist))) = ', relerr(np.cos(np.arccos(xlist)), xlist))
print('rErr(atan(tan(xlist))) = ', relerr(np.arctan(np.tan(xlist)), xlist))
print('rErr(tan(atan(xlist))) = ', relerr(np.tan(np.arctan(xlist)), xlist))
print('num_sig10(acos(cos(xlist))))                    =                    ',
num_sig10(relerr(np.arccos(np.cos(xlist)), xlist)))
print('num_sig10(cos(acos(xlist))))                    =                    ',
num_sig10(relerr(np.cos(np.arccos(xlist)), xlist)))
print('num_sig10(atan(tan(xlist))))                    =                    ',
num_sig10(relerr(np.arctan(np.tan(xlist)), xlist)))
print('num_sig10(tan(atan(xlist))))                    =                    ',
num_sig10(relerr(np.tan(np.arctan(xlist)), xlist)))
```

実行例：

```
x =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
acos(cos(xlist)) =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
cos(acos(xlist)) =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
atan(tan(xlist)) =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
tan(atan(xlist)) =  [0.01       0.20384954 0.39769908 0.59154862 0.78539816]
rErr(acos(cos(xlist))) =  {0: 1.4415552085367267e-13, 1: 8.169429913841998e-16, 2: 1.3958078805248573e-16}
rErr(cos(acos(xlist))) =  {0: 9.194034422677078e-15, 1: 2.723143304613999e-16, 2: 2.7916157610497147e-16}
rErr(atan(tan(xlist))) =  {}
rErr(tan(atan(xlist))) =  {3: 1.8768077251923752e-16}
max, min_num_sig =  15.0 12.0
num_sig10(acos(cos(xlist))) =  {0: 12.0, 1: 15.0, 2: 15.0}
max, min_num_sig =  15.0 14.0
num_sig10(cos(acos(xlist))) =  {0: 14.0, 1: 15.0, 2: 15.0}
max, min_num_sig =  0 20
num_sig10(atan(tan(xlist))) =  {}
max, min_num_sig =  15.0 15.0
num_sig10(tan(atan(xlist))) =  {3: 15.0}
```

以上