CP1

January 25, 2024

PGE 382 - Numerical Methods in Petroleum and Geosystems Engineering

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a) Evaluate a sin with an infinite series

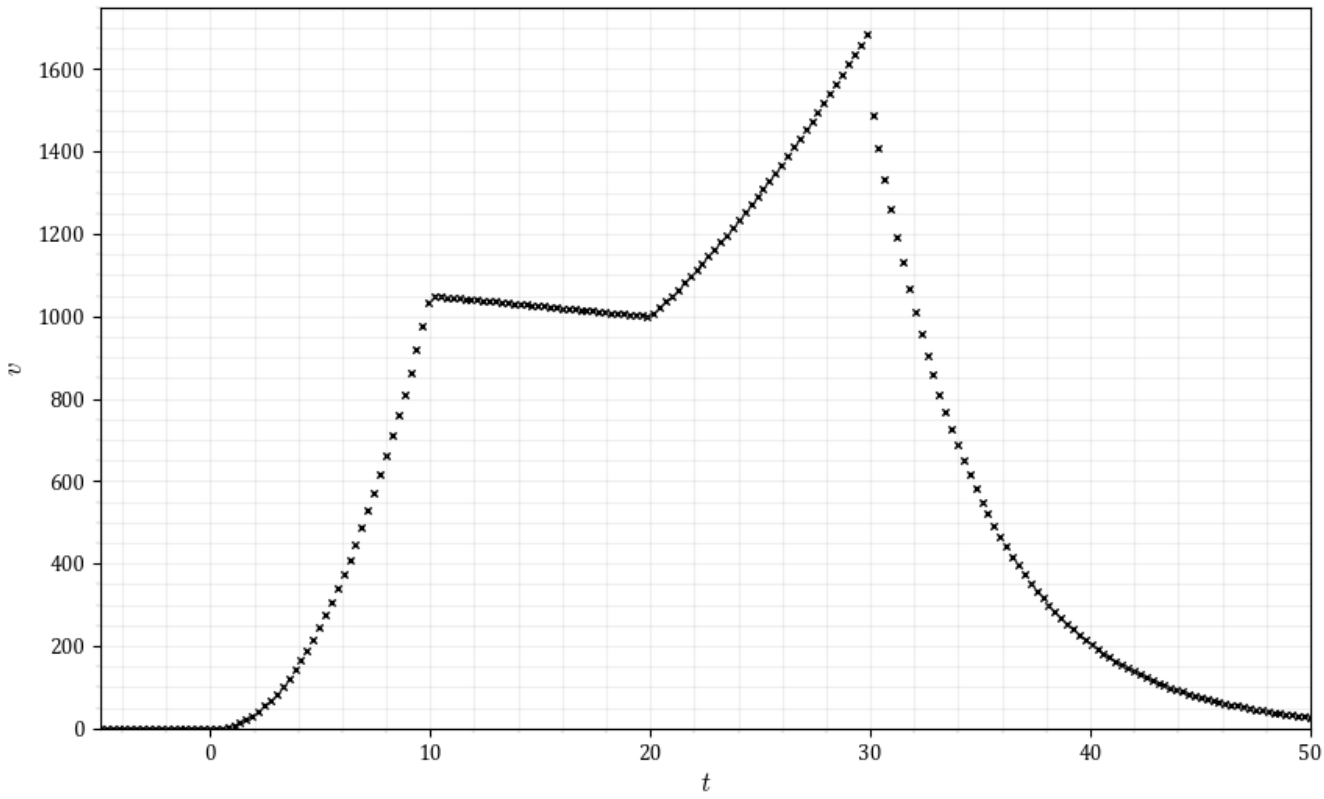
[1]:
```
from math import factorial, pi, sin
import numpy as np

x = 1.5
TRUESIN = sin(x)
SIN = 0
sign = 1

print (f"{'EXPONENT':10}{'SIN':<30}{'ERROR(%)'}")
print (50*'-')
for i in (2*np.arange( 8 )+1) :
    SIN = SIN + sign * x**i / factorial( i )
    ERR = ( TRUESIN - SIN ) / TRUESIN * 100
    sign = - sign
    print (f"{i:<10d}{SIN:<30.20f}{ERR:<20.5e}")
print (50*'-')
print(f"{'EXACT:':<10}{TRUESIN:<20.20F}")
```

```
EXPONENT  SIN                            ERROR(%)
--------------------------------------------------
1         1.50000000000000000000         -5.03767e+01
3         0.93750000000000000000         6.01457e+00
5         1.00078124999999995559         -3.29452e-01
7         0.99739118303571427937         1.04064e-02
9         0.99749712262834822063         -2.14139e-04
11        0.99749495568213530916         3.09996e-06
13        0.99749498693616722722         -3.32947e-08
15        0.99749498660130264671         2.75871e-10
--------------------------------------------------
EXACT:    0.99749498660405444550
```

b) Piecewise functions

[2]:
```
from numpy import exp, linspace, vectorize
import matplotlib.pyplot as plt

plt.style.use('paper.mplstyle')

def foo_v(t) :
    if t < 0   : return 0
    if t <= 10 : return 11*t**2-5*t
    if t <= 20 : return 1100 - 5*t
    if t <= 30 : return 50*t + 2*(t-20)**2
    return 1520 * exp(-0.2 * (t-30) )

X = linspace( -5, 50, 200 )
Y = vectorize(foo_v)(X)

plt.figure(figsize=(10,6))
plt.scatter( X, Y, marker='x', s=10, lw=1, c='k' )
plt.xlabel("$t$")
plt.ylabel("$v$")
plt.xlim( -5, 50)
plt.ylim( 0, 1750)
```

[2]: (0.0, 1750.0)



c) Distances and tan^{-1}

[3]:
```
from numpy import arctan, pi, arctan, sqrt

def ATAN(x,y) :
    if x<0 :
        if y > 0  : return arctan( y/x ) + pi
        if y < 0  : return arctan( y/x ) - pi
        if y == 0 : return pi
    if x==0 :
        if y > 0  : return pi/2
        if y < 0  : return -pi/2
        if y == 0 : return 0
    return arctan( y / x )

def RT(x,y) :
    r = sqrt( x**2 + y**2 )
    return r, ATAN(x,y)

XY = [[1,0],[1,1],[0,1],[-1,1],[-1,0],[-1,-1],[0,0],[0,-1],[1,-1]]

print(f" {'x':<20}{'y':<16}{'theta':<16}{'r':<20}")
print(80*'-')
for x,y in XY :
    R,T=RT(x,y)
    print(f"{x:>2}{y:>20}{T*180/pi:>20.1f}{R:>20.7f}")
print(80*'-')
```

```
 x                   y               theta           r
--------------------------------------------------------------------------------
 1                   0                 0.0           1.0000000
 1                   1                45.0           1.4142136
 0                   1                90.0           1.0000000
-1                   1               135.0           1.4142136
-1                   0               180.0           1.0000000
-1                  -1              -135.0           1.4142136
 0                   0                 0.0           0.0000000
 0                  -1               -90.0           1.0000000
 1                  -1               -45.0           1.4142136
--------------------------------------------------------------------------------
```