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"""
Registration: xxxx;
Description: Runge phenomena
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"""

import numpy as np
import matplotlib.pyplot as plt

def f(x,a): return 1/(x*x+a*a)       # Lorentzian

def interpol(x, a, G):
    A = np.ones(len(x))              # create vector of 1's
    A = A.reshape(-1, 1)             # convert row to column vector
    for k in range(1, len(x)):
        x1 = np.power(x, k)
        x1 = x1.reshape(-1, 1)       # convert into column vector
        A = np.hstack([A, x1])       # concatenate to form matrix
    cf = np.linalg.solve(A, f(x, a)) # solve
    cf = cf[::-1]                    # reverse
    return np.polyval(cf, G)

# main
a = 0.09                              # Width of Lorentzian
xg, gg = 14, 100                     # number of x-grid and g-grid points
x = np.linspace(-1, 1, xg)           # x-grid
g = np.linspace(-1, 1, gg)           # g-grid
y = interpol(x, a, g)

# Plot
plt.figure(1)
plt.plot(x, f(x, a), 'co', label=r'$f(x)=\frac{1}{x^2+'+str(a)+'^2}$', ms=8)
plt.plot(g, y, 'm.-', label=r'$P(x)$')
plt.xlabel(r'$x$', size=14); plt.xticks(size=12);
plt.ylabel(r'$f(x)$', size=14); plt.yticks(size=16)
plt.title('Runge phenomena with %s grid Points'%(gg), size=14);
plt.legend(loc='best', prop={'size':16})
plt.grid(); plt.tight_layout()
#plt.savefig('plot/06_runge.pdf')
plt.show()
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