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1: import numpy as np
2: import pylab
3: import math
4:
5: vp = 5
6: r1 = 1e3
7: r2 = 4e3
8: r3 = 3e3
9: r4 = 2e3
10: i0 = 3e-9
11: vt = 0.05
12:
13: def Newton2(f1, f2, x1_init, x2_init, delta=1e-4):
14:     h = 0.05
15:     df1x1 = lambda x: 1/r1+1/r2+(i0/vt)*np.exp((x[0]-x[1])/vt)
16:     df1x2 = lambda x: (-i0/vt)*np.exp((x[0]-x[1])/vt)
17:     df2x1 = lambda x: (-i0/vt)*np.exp((x[1]-x[0])/vt)
18:     df2x2 = lambda x: 1/r3+1/r4+(i0/vt)*np.exp((x[0]-x[1])/vt)
19:     # df1x1 = lambda x: (f1(x[0] + h, x[1]) - f1(x[0] - h, x[1])) / (2 * h)
20:     # df1x2 = lambda x: (f1(x[0], x[1] + h) - f1(x[0], x[1] - h)) / (2 * h)
21:     # df2x1 = lambda x: (f2(x[0] + h, x[1]) - f2(x[0] - h, x[1])) / (2 * h)
22:     # df2x2 = lambda x: (f2(x[0], x[1] + h) - f2(x[0], x[1] - h)) / (2 * h)
23:     X = [x1_init, x2_init]
24:     # while np.fabs(f1(X[0], X[1])) > delta or np.fabs(f2(X[0], X[1])) > delta:
25:     diff = [1,1]
26:     while np.fabs(diff[0]) > delta or np.fabs(diff[1]) > delta:
27:         J = np.array([[df1x1(X), df1x2(X)], [df2x1(X), df2x2(X)]])
28:         F = np.array([f1(X[0], X[1]), f2(X[0], X[1])])
29:         DX = np.linalg.solve(J,F)
30:         X[0] -= DX[0]
31:         X[1] -= DX[1]
32:         diff = DX
33:     return X[0], X[1]
34:
35:
36: def main():
37:     f1 = lambda v1, v2: (v1-vp)/r1+v1/r2+i0*(np.exp((v1-v2)/vt)-1)
38:     f2 = lambda v1, v2: (v2-vp)/r3+v2/r4+i0*(np.exp((v2-v1)/vt)-1)
39:     res = Newton2(f1, f2, 4.5, 4.5, 1e-12)
40:     print(res)
41:     print(np.fabs(res[0] - res[1]))
42:     print(f1(res[0], res[1]), f2(res[0], res[1]))
43:     print(f1(2.66, 2.00), f2(2.66, 2.00))
44:     # pylab.plot(np.linspace(0, 5,100), [])
45:
46: if __name__ == "__main__":
47:     main()
```