11-22_MF_problem_opt.chortle

November 22, 2021

```python
[42]: import sympy as sp
      import numpy as np
      import matplotlib.pyplot as plt
```

```python
[3]: sp.var('x1 x2')
```

```python
[3]: (x1, x2)
```

```python
[4]: f = sp.cos(x1 - sp.exp(x2) + 2) * sp.sin(x1**2 / 4 - x2**2 / 3 + 4)
```

```python
[16]: dx1 = sp.utilities.lambdify((x1, x2), f.diff(x1))
```

```python
[17]: dx2 = sp.utilities.lambdify((x1, x2), f.diff(x2))
```

```python
[18]: def gradient(x):
        return np.array([
          dx1(*x),
          dx2(*x),
        ])
```

```python
[19]: gradient([1, 1])
```

```python
[19]: array([-0.1485638 , -0.07134325])
```

```python
[20]: def test(a, b):
        print(a, b)
```

```python
[21]: test(1, 2)
```

```
1 2
```

```python
[24]: t = [3, 4]
      test(*t)
      test(t[0], t[1])
```

```
3 4
3 4
```

```
[35]: x0 = np.array([1, 1])
      T = 1e-8
      dx = 2 * T
      x_k = x0
      x_km1 = 0.9 * x0 - 0.1
      g_km1 = gradient(x_km1)
      x = [x0]
```

```
[36]: while dx > T:
          g_k = gradient(x_k)
          dg_k = g_k - g_km1
          dx_k = x_k - x_km1
          alpha_k = np.abs(np.dot(dx_k, dg_k) / np.dot(dg_k, dg_k))
          x_km1 = x_k
          x_k = x_k - alpha_k * g_k
          x.append(x_k)
          g_km1 = g_k
          dx = np.linalg.norm(x_k - x_km1)
```

```
[37]: x_k
```

```
[37]: array([4.7337411 , 2.29004011])
```

```
[40]: x = np.array(x)
      x
```

```
[40]: array([[1.        , 1.        ],
             [1.01620266, 1.00778083],
             [1.13309525, 1.05628044],
             [1.66757404, 1.21607054],
             [1.69527017, 1.31170653],
             [1.73190476, 1.2708757 ],
             [1.75136351, 1.2798441 ],
             [1.77867129, 1.28912344],
             [4.169466  , 2.08701498],
             [4.16843492, 2.72808886],
             [4.32563936, 2.45474413],
             [4.26307545, 2.24825794],
             [4.35087596, 2.17121628],
             [4.36006422, 2.23639291],
             [4.38189705, 2.23525752],
             [4.41140131, 2.2410884 ],
             [4.76103414, 2.29645838],
             [4.73756702, 2.22789855],
             [4.72876033, 2.28955607],
             [4.7290635 , 2.2893389 ],
             [4.72928404, 2.28940999],
```

```
            [4.72977237, 2.28947494],
            [4.73361113, 2.29007171],
            [4.73386494, 2.28910163],
            [4.73373231, 2.29003937],
            [4.73373279, 2.29003893],
            [4.73373318, 2.29003899],
            [4.73374109, 2.29004011],
            [4.7337411 , 2.29004012],
            [4.7337411 , 2.29004011]])
```
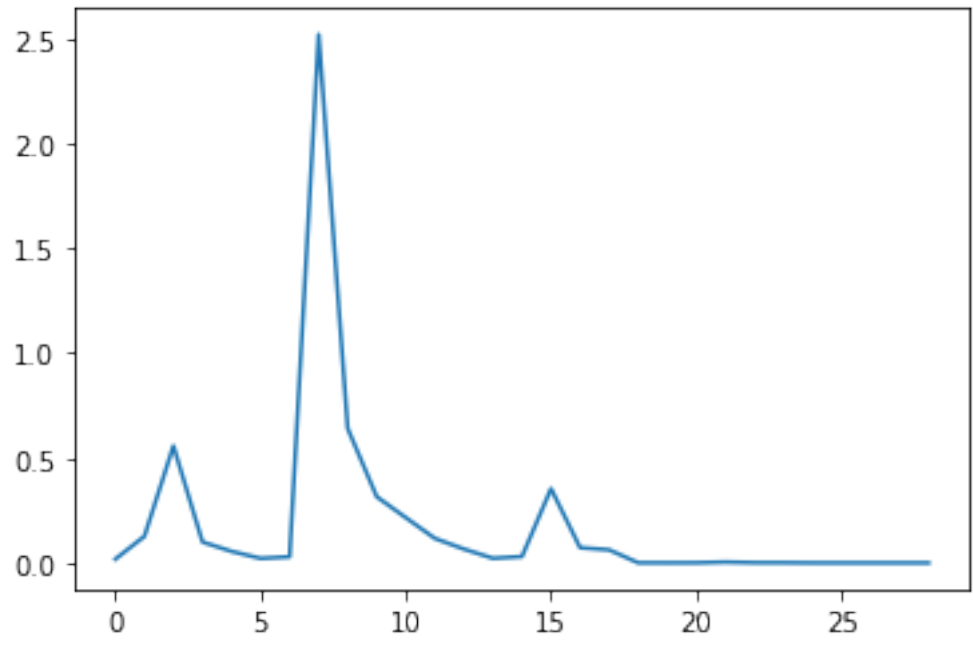
[50]: `plt.plot(x[:,0], x[:,1], '-o')`

[50]: [<matplotlib.lines.Line2D at 0x7fe96236e7c0>]
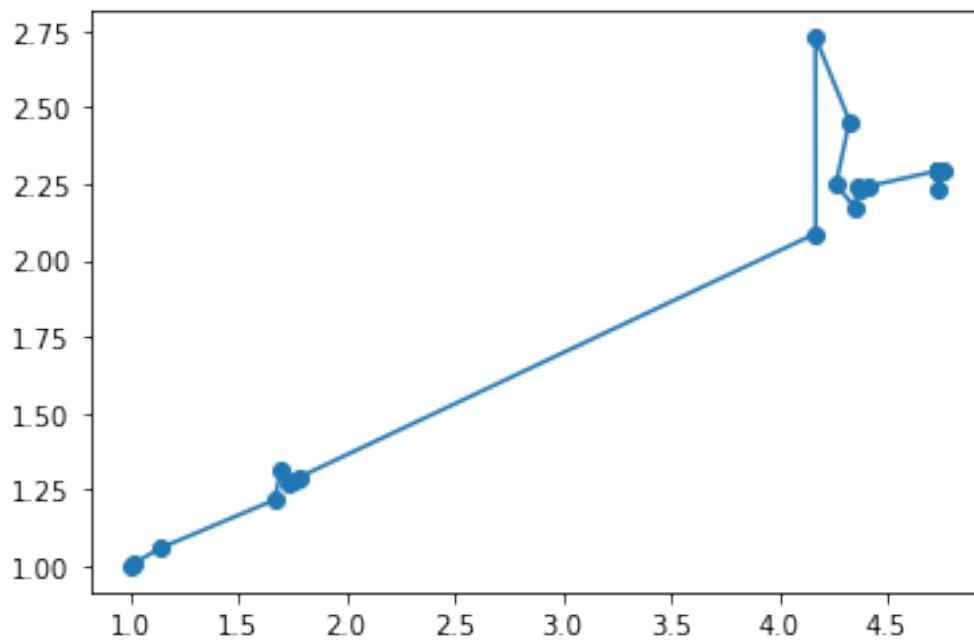
[48]: `plt.plot(np.linalg.norm(np.diff(x, axis=0), axis=1))`

[48]: [<matplotlib.lines.Line2D at 0x7fe9623b5ca0>]

[ ]: