lerp Documentation

Release

ER

Oct 30, 2017

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`lerp` aims to supply lookup table facility in python on top of numpy.

This project is in early alpha phase.

Documentation (and example of use): http://lerp.readthedocs.io/

Source code repository (and issue tracker): https://github.com/gwin-zegal/lerp

CHAPTER 1

Installation

To install the development version:

```
pip install git+https://github.com/gwin-zegal/lerp
```

Update with:

```
pip install --upgrade --no-deps git+https://github.com/gwin-zegal/lerp
```

CHAPTER 2

License

MIT – see the file `LICENSE` for details.

CHAPTER 3

Content

In mathematics, linear interpolation is a method of curve fitting using linear polynomials to construct new data points within the range of a discrete set of known data points.[1]

```
In [1]: %matplotlib inline
        %watermark -dtvmp numpy,matplotlib,pandas,cython

        import matplotlib.pylab as plt
        import lerp
        from lerp import *
```

```
2017-10-12 22:57:48

CPython 3.6.2
IPython 6.1.0

numpy 1.13.1
matplotlib 2.0.2
pandas 0.20.3
cython 0.26.1

compiler   : GCC 4.2.1 Compatible Clang 4.0.1 (tags/RELEASE_401/final)
system     : Darwin
release    : 15.6.0
machine    : x86_64
processor  : i386
CPU cores  : 2
interpreter: 64bit
```

```
In [2]: lerp.options.display.max_rows = 15
```

3.1 Usage

3.1.1 BreakPoints

```
In [3]: A = BreakPoints(d=[1.040, 1.051, 1.057, 1.063, 1.064, 1.067, 1.068, 1.068, 1.068, 1.066, 1.06
                           1.060, 1.056, 1.050, 1.042, 1.032], label="Ballistic coefficient", unit="G1")
```

Display in the notebook, integer above the value are helps for indexing purpose

```
In [4]: A
```

```
Out[4]: BreakPoints(d=[ 1.04,  1.05,  1.06,  1.06,  1.06,  1.07,  1.07,  1.07,  1.07,
                        1.07,  1.06,  1.06,  1.06,  1.05,  1.04,  1.03], label="Ballistic coefficient",
```

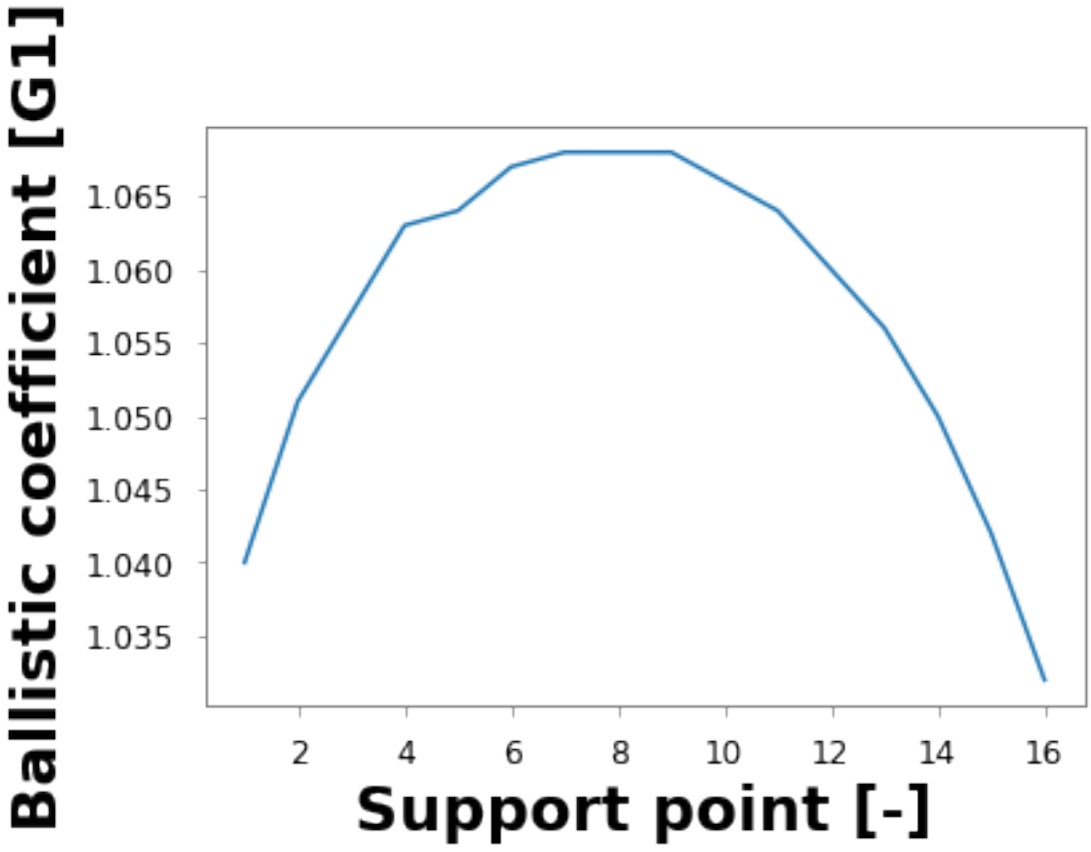
```
In [5]: A[6]
```

```
Out[5]: 1.0680000000000001
```

Get a plot with the `plot()` method

```
In [6]: A.plot()
```

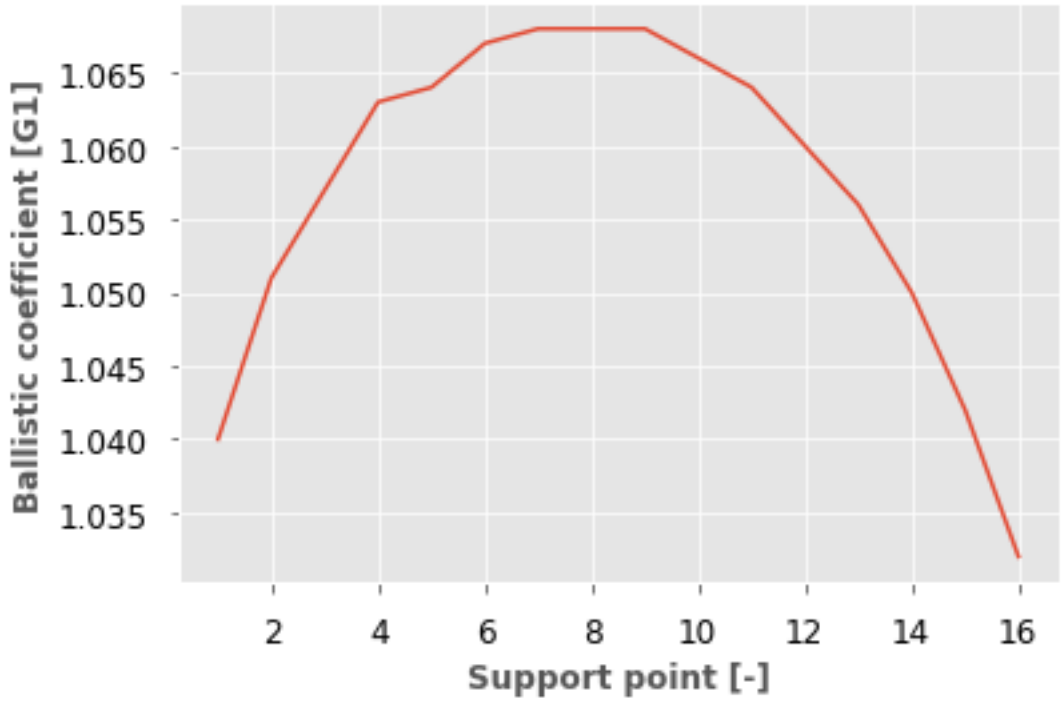
```
Out[6]: [<matplotlib.lines.Line2D at 0x181b8a0400>]
```



Not that fancy... you can set the `ggplot` style

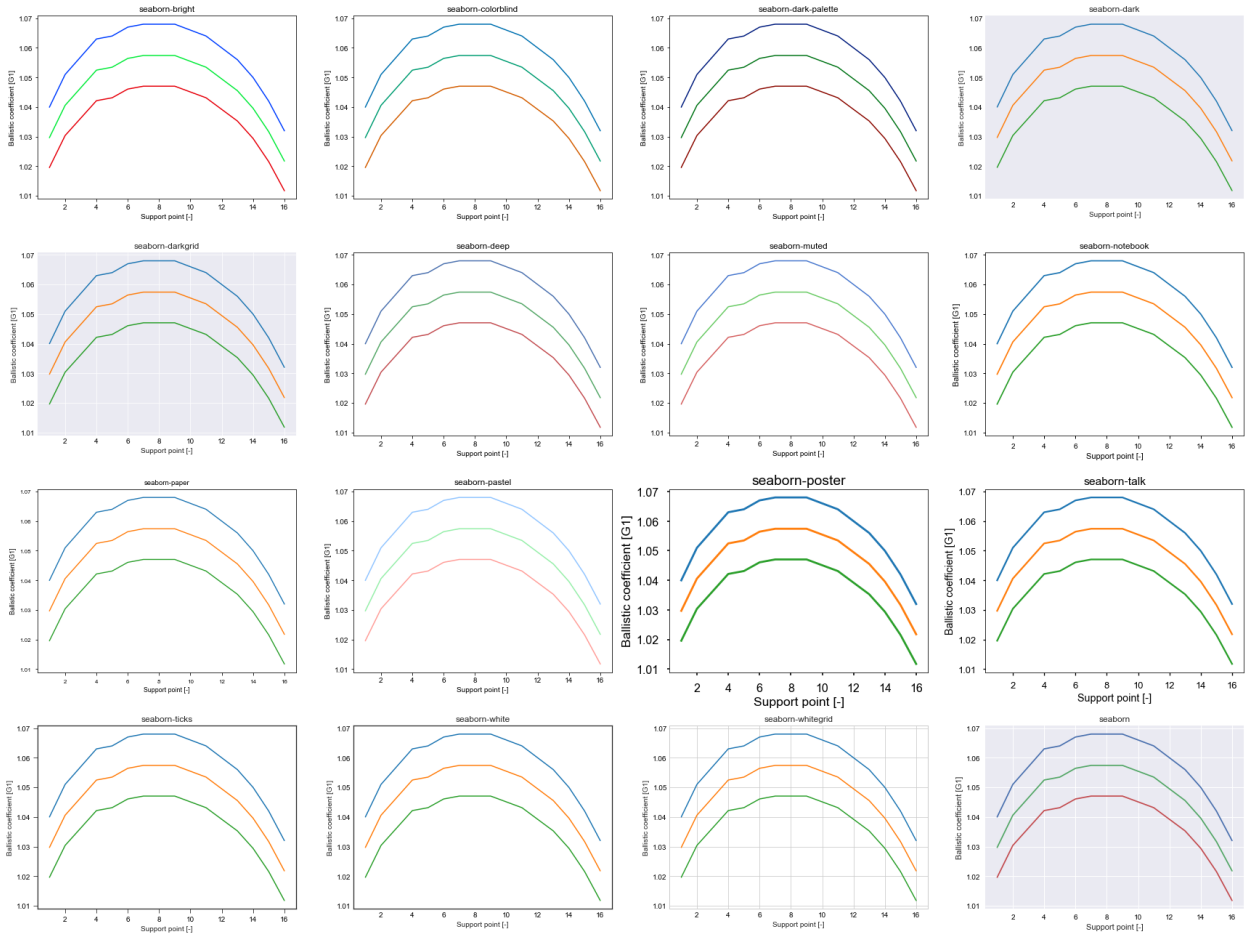
```
In [7]: plt.style.use('ggplot')
        A.plot()
```

```
Out[7]: [<matplotlib.lines.Line2D at 0x181ba223c8>]
```



If you don't like ggplot, choose one of the seaborn styles

```
In [8]: import matplotlib.gridspec as gridspec
        import matplotlib as mpl
        styles = [_s for _s in plt.style.available if 'seaborn' in _s]
        n = np.ceil(np.sqrt(len(styles))).astype(np.int)

        gs = gridspec.GridSpec(n, n)

        plt.figure(figsize=(24,18))

        for i, s in enumerate(styles):
            mpl.rcParams.update(mpl.rcParamsDefault)
            plt.style.use(s)
            plt.subplot(gs[i])
            A.plot()
            (A / 1.01).plot()
            (A / 1.02).plot()
            plt.title(s)

        plt.tight_layout()
```



3.1.2 mesh2d

From Ballistic coefficient article in Wikipedia.

Doppler radar measurement results for a lathe turned monolithic solid .50 BMG very-low-drag bullet (Lost River J40 13.0 millimetres (0.510 in), 50.1 grams (773 gr) monolithic solid bullet / twist rate 1:380 millimetres (15 in)) look like this:

```
In [9]: BC = mesh2d(x=np.arange(500,2100,100), x_label="Range", x_unit="m",
                    d=[1.040, 1.051, 1.057, 1.063, 1.064, 1.067, 1.068, 1.068, 1.068, 1.066, 1.064,
                       1.060, 1.056, 1.050, 1.042, 1.032], label="Ballistic coefficient", unit="G1")
```

Display in the jupyter notebooks / ipython

```
In [10]: BC
```

```
Out[10]: x = BreakPoints(d=[ 500,  600,  700,  800,  900, 1000, 1100, 1200, 1300, 1400,
                      1500, 1600, 1700, 1800, 1900, 2000], label="Range", unit="m")
         d = array([ 1.04 ,  1.051,  1.057,  1.063,  1.064,  1.067,  1.068,  1.068,
                1.068,  1.066,  1.064,  1.06 ,  1.056,  1.05 ,  1.042,  1.032])
```

Interpolation

```
In [11]: BC(501)
```

```
Out[11]: 1.04011
```

```
In [12]: BC([501, 609, 2500])
```

```
Out[12]: array([ 1.04011,  1.05154,  0.982  ])
```

Default : values are extrapolated

```
In [13]: BC.interpolate([501, 609, 2500])
```

```
Out[13]: array([ 1.04011,  1.05154,  1.032  ])
```

Interpolation is performed and boundaries values are kept

```
In [14]: BC.options
```

```
Out[14]: {'extrapolate': True, 'step': False}
```

```
In [15]: BC.options['extrapolate']= False
```

This can be controled though the dict key extrapolate in options or interpolate method.

```
In [16]: BC([501, 609, 2500])
```

```
Out[16]: array([ 1.04011,  1.05154,  1.032  ])
```

```
In [17]: BC.max()
```

```
Out[17]: 1.0680000000000001
```

```
In [18]: BC.max(argwhere=True)
```

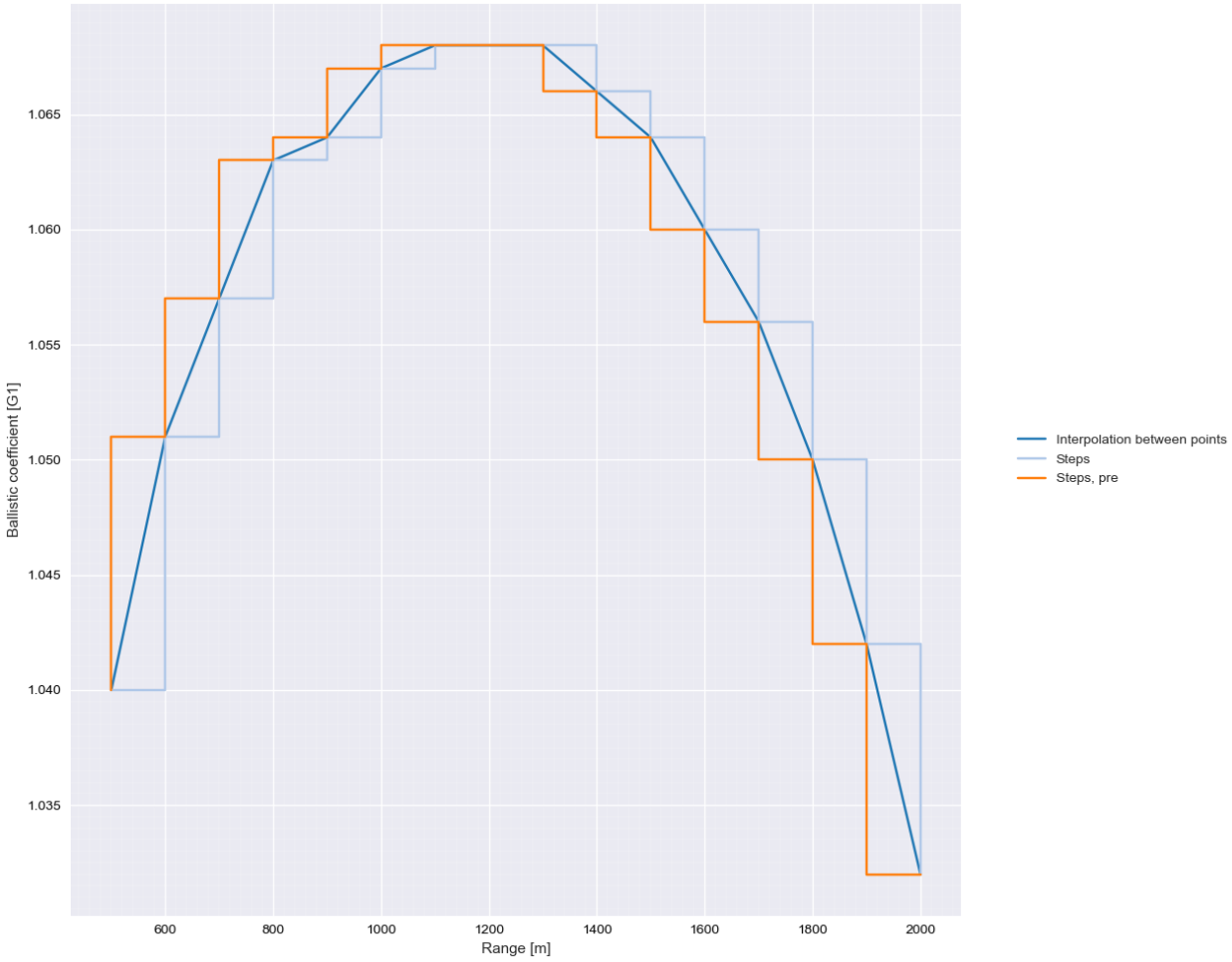
```
Out[18]: (1100, 1.0680000000000001)
```

Plot as steps

I like the color from vega

```
In [19]: from cycler import cycler
         category20 = cycler('color', ['#1f77b4', '#aec7e8', '#ff7f0e',
                                       '#ffbb78', '#2ca02c', '#98df8a',
                                       '#d62728', '#ff9896', '#9467bd',
                                       '#c5b0d5', '#8c564b', '#c49c94',
                                       '#e377c2', '#f7b6d2', '#7f7f7f',
                                       '#c7c7c7', '#bcbd22', '#dbdb8d',
                                       '#17becf', '#9edae5'])

         plt.style.use('seaborn-darkgrid')
         plt.rc('axes', prop_cycle=category20)
```

```
In [20]: plt.figure(figsize=(10,10))

         BC.plot(label="Interpolation between points")
         BC.steps.plot(label="Steps")
         BC.steps.plot(where="pre", label="Steps, pre")

         plt.graphpaper(dx=200, dy=0.005)
         plt.legend(bbox_to_anchor=(1.05, 0.5), loc='center left', facecolor="white", frameon=False)
         plt.tight_layout()
```



Slicing

```
In [21]: BC[2:4]

Out[21]: x = BreakPoints(d=[700, 800], label="Range", unit="m")
         d = array([ 1.057,  1.063])
```

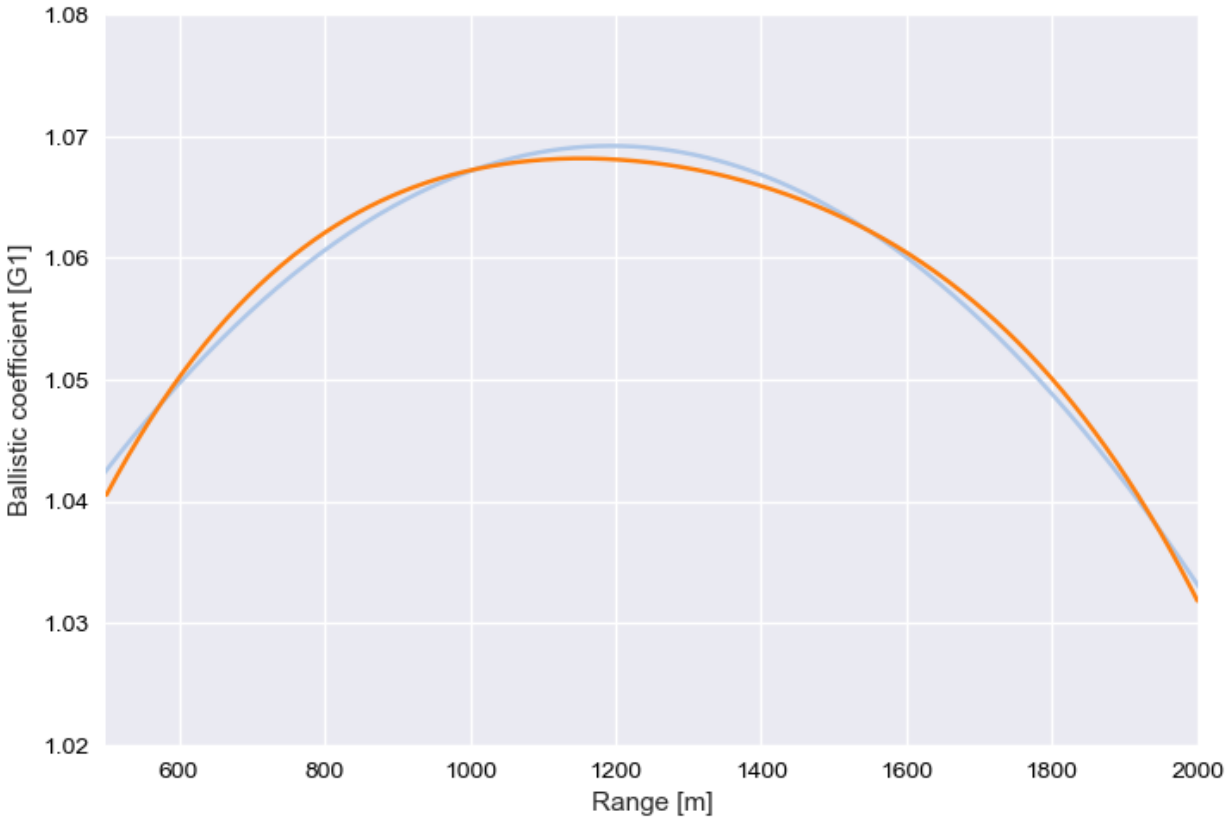
Breakpoints strictly monotone, reverse order has no effect

```
In [22]: BC[::-1]

Out[22]: x = BreakPoints(d=[ 500,  600,  700,  800,  900, 1000, 1100, 1200, 1300, 1400,
                     1500, 1600, 1700, 1800, 1900, 2000], label="Range", unit="m")
         d = array([ 1.04 ,  1.051,  1.057,  1.063,  1.064,  1.067,  1.068,  1.068,
                1.068,  1.066,  1.064,  1.06 ,  1.056,  1.05 ,  1.042,  1.032])

In [23]: BC[6]

Out[23]: (1100, 1.0680000000000001)

In [24]: BC.x

Out[24]: BreakPoints(d=[ 500,  600,  700,  800,  900, 1000, 1100, 1200, 1300, 1400,
                     1500, 1600, 1700, 1800, 1900, 2000], label="Range", unit="m")

In [25]: BC(np.arange(500, 550, 10))

Out[25]: array([ 1.04  ,  1.0411,  1.0422,  1.0433,  1.0444])

In [26]: BC.resample(np.arange(500, 2000, 200))
```

```
Out[26]: x = BreakPoints(d=[ 500,  700,  900, 1100, 1300, 1500, 1700, 1900], label="Range", unit="m")
         d = array([ 1.04 ,  1.057,  1.064,  1.068,  1.068,  1.064,  1.056,  1.042])

In [27]: BC.steps(BC.x)

Out[27]: array([ 1.04 ,  1.051,  1.057,  1.063,  1.064,  1.067,  1.068,  1.068,
                 1.068,  1.066,  1.064,  1.06 ,  1.056,  1.05 ,  1.042,  1.032])

In [28]: BC.__dict__

Out[28]: {'_d': array([ 1.04 ,  1.051,  1.057,  1.063,  1.064,  1.067,  1.068,  1.068,
                        1.068,  1.066,  1.064,  1.06 ,  1.056,  1.05 ,  1.042,  1.032]),
          '_options': {'extrapolate': False, 'step': False},
          '_steps': x = BreakPoints(d=[ 500,  600,  700,  800,  900, 1000, 1100, 1200, 1300, 1400,
                                        1500, 1600, 1700, 1800, 1900, 2000], label="Range", unit="m")
                    d = array([ 1.04 ,  1.051,  1.057,  1.063,  1.064,  1.067,  1.068,  1.068,
                                1.068,  1.066,  1.064,  1.06 ,  1.056,  1.05 ,  1.042,  1.032]),
          '_x': BreakPoints(d=[ 500,  600,  700,  800,  900, 1000, 1100, 1200, 1300, 1400,
                                1500, 1600, 1700, 1800, 1900, 2000], label="Range", unit="m"),
          'label': 'Ballistic coefficient',
          'unit': 'G1'}
```

.polyfit(): how to get a polymesh object from discrete values

```
In [29]: BC.plot("+")
         BC.polyfit(degree=2).plot(xlim=[500,2000])
         BC.polyfit(degree=4).plot(xlim=[500,2000], ylim=[1.02, 1.08])
```



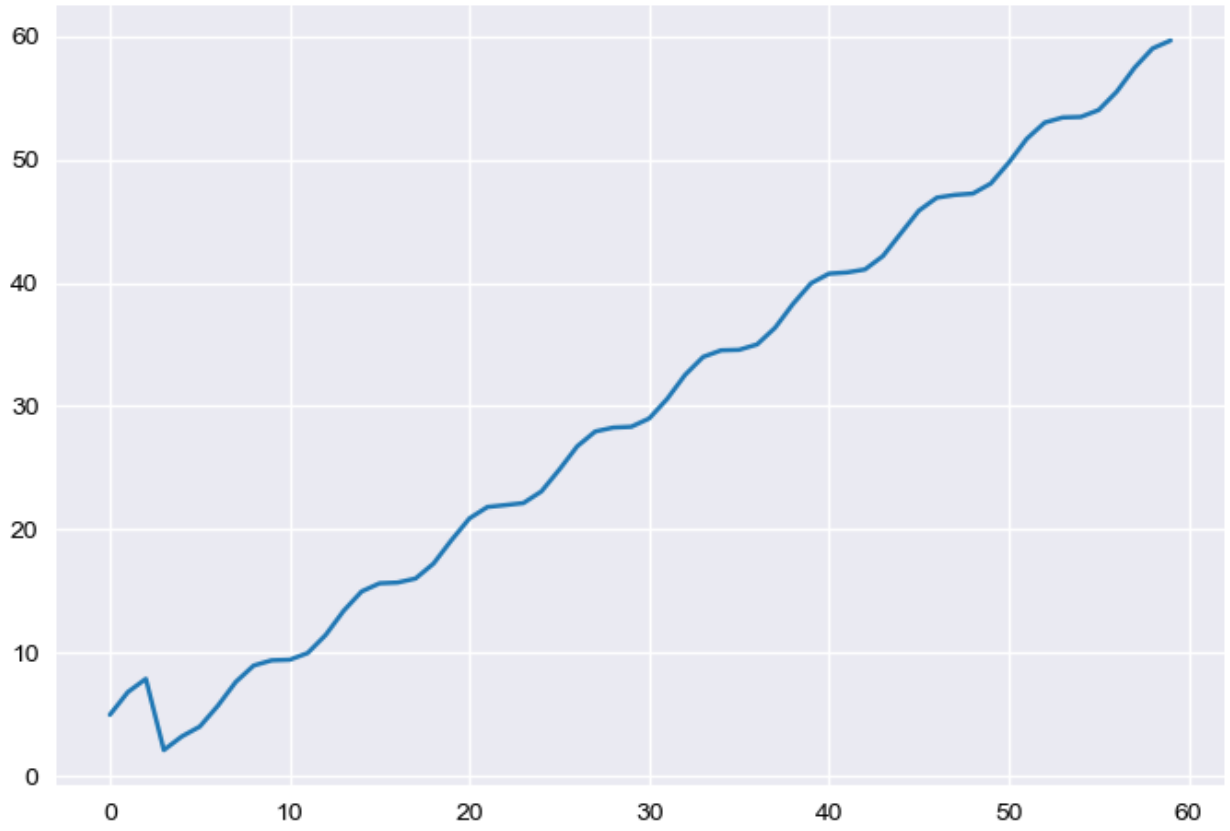

```
In [30]: BC.polyfit(degree=4)

Out[30]: -3.5896443597682554e-14·x^4 + 1.820225053584262e-10·x^3 - 3.821239680082758e-07·x^2 + 0.0003

In [31]: from sklearn.metrics import r2_score
```

```
        for i in range(10):
            print(i, r2_score(BC.d, BC.polyfit(degree=i)(BC.x).d))
```

```
0 0.0
1 0.0698263920953
2 0.988101760851
3 0.988408030976
4 0.997727098729
5 0.998238919776
6 0.998565636158
7 0.998569159428
8 0.998610724807
9 0.998652377691
```

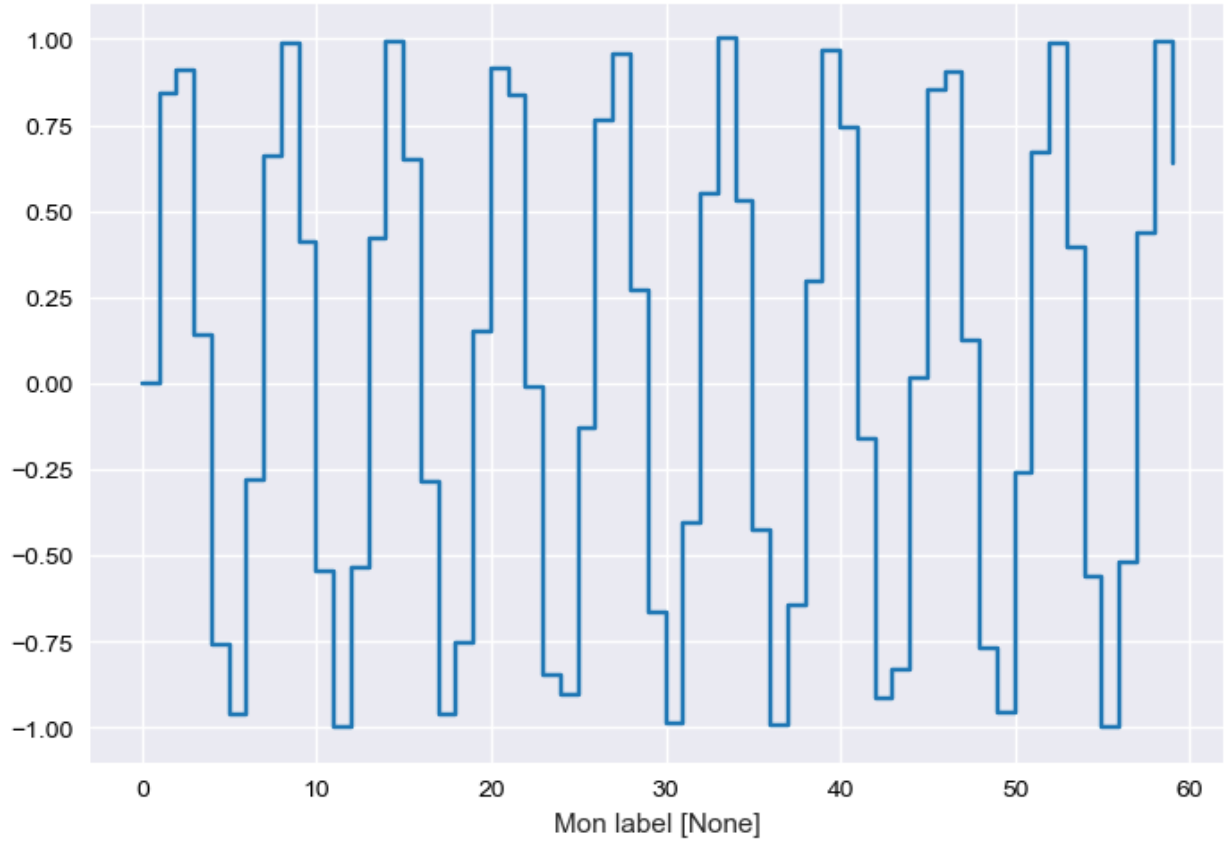
.add()

```
In [32]: # prepare some data
         x = [1, 2, 3, 4, 5]
         y = [6, 7, 2, 4, 5]
         test2 = mesh2d(x, y)
         x2 = np.arange(0,60)
         test = mesh2d(x2, np.sin(x2), x_label="Mon label", unit="%")

In [33]: (test + test2)

Out[33]: x = BreakPoints(d=[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14,
                     15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29,
                     30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44,
                     45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59], label="None", unit
         d = array([  5.        ,   6.84147098,   7.90929743,   2.14112001,
                  3.2431975 ,   4.04107573,   5.7205845 ,   7.6569866 ,
                  8.98935825,   9.41211849,   9.45597889,  10.00000979,
                 11.46342708,  13.42016704,  14.99060736,  15.65028784,
                 15.71209668,  16.03860251,  17.24901275,  19.14987721,
                 20.91294525,  21.83665564,  21.99114869,  22.1537796 ,
                 23.09442164,  24.86764825,  26.76255845,  27.95637593,
                 28.27090579,  28.33636612,  29.01196838,  30.59596235,
                 32.55142668,  33.99991186,  34.52908269,  34.57181733,
                 35.00822115,  36.35646187,  38.29636858,  39.96379539,
                 40.74511316,  40.84137733,  41.08347845,  42.16822526,
                 44.01770193,  45.85090352,  46.90178835,  47.12357312,
                 47.23174534,  48.04624735,  49.73762515,  51.67022918,
                 52.98662759,  53.39592515,  53.44121095,  54.00024483,
                 55.478449  ,  57.43616476,  58.99287265,  59.63673801])

In [34]: test[:4]

Out[34]: x = BreakPoints(d=[0, 1, 2, 3], label="Mon label", unit="None")
         d = array([ 0.        ,  0.84147098,  0.90929743,  0.14112001])

In [35]: test[-3:] + test[:4]

Out[35]: x = BreakPoints(d=[ 0,  1,  2,  3, 57, 58, 59], label="None", unit="None")
         d = array([-31.29618514, -29.89800626, -29.27347192, -29.48494145,
                -40.90429585, -41.11576538, -42.24007744])

In [36]: (test + test2).plot()

Out[36]: [<matplotlib.lines.Line2D at 0x181d938240>]
```




```
In [37]: test.steps.plot()
```

```
Out[37]: [<matplotlib.lines.Line2D at 0x181c046630>]
```




```
In [38]: test
```

```
Out[38]: x = BreakPoints(d=[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14,
                      15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29,
                      30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44,
                      45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59], label="Mon label",
         d = array([ 0.        ,  0.84147098,  0.90929743,  0.14112001, -0.7568025 ,
                -0.95892427, -0.2794155 ,  0.6569866 ,  0.98935825,  0.41211849,
                -0.54402111, -0.99999021, -0.53657292,  0.42016704,  0.99060736,
                 0.65028784, -0.28790332, -0.96139749, -0.75098725,  0.14987721,
                 0.91294525,  0.83665564, -0.00885131, -0.8462204 , -0.90557836,
                -0.13235175,  0.76255845,  0.95637593,  0.27090579, -0.66363388,
                -0.98803162, -0.40403765,  0.55142668,  0.99991186,  0.52908269,
                -0.42818267, -0.99177885, -0.64353813,  0.29636858,  0.96379539,
                 0.74511316, -0.15862267, -0.91652155, -0.83177474,  0.01770193,
                 0.85090352,  0.90178835,  0.12357312, -0.76825466, -0.95375265,
                -0.26237485,  0.67022918,  0.98662759,  0.39592515, -0.55878905,
                -0.99975517, -0.521551  ,  0.43616476,  0.99287265,  0.63673801])
```

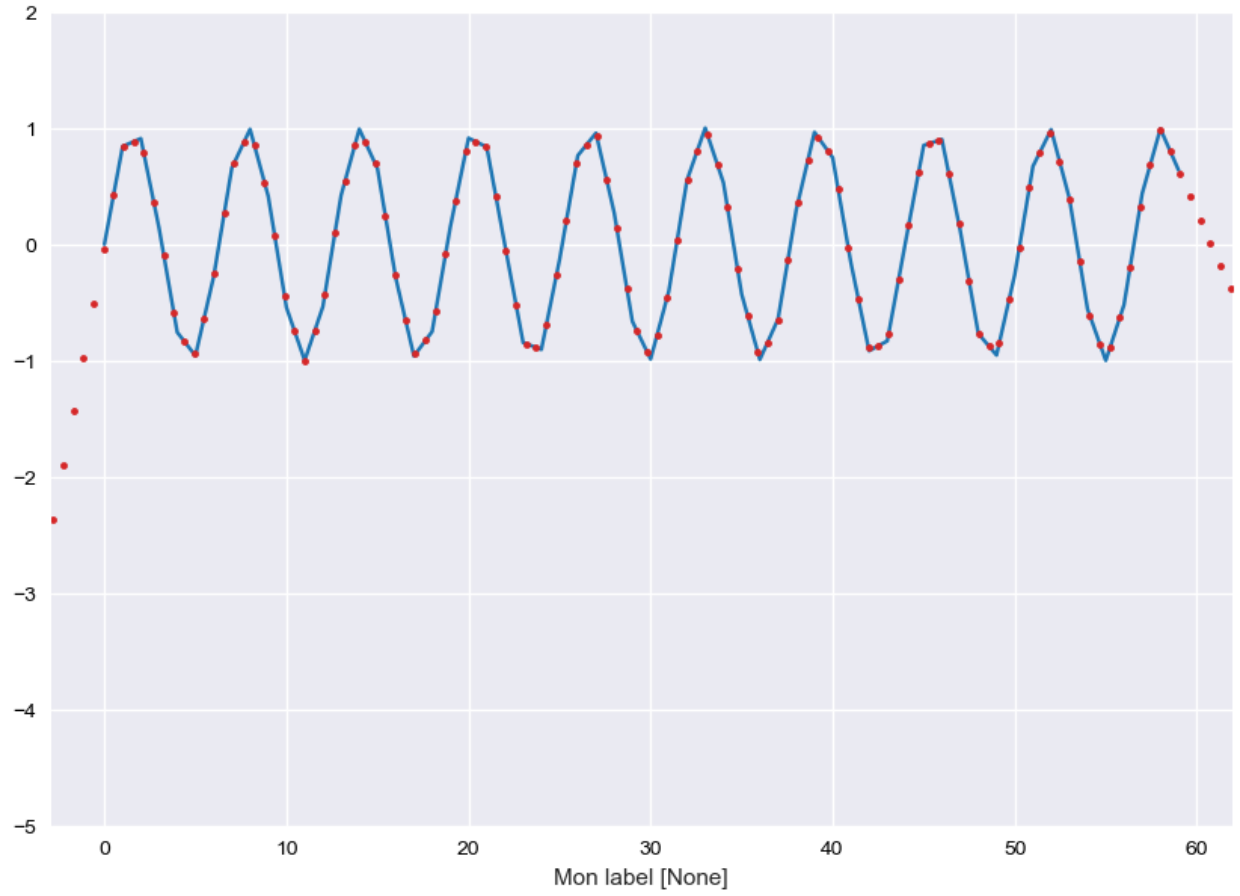
```
In [39]: test.resample(np.linspace(0,60,100))
```

```
Out[39]: x = BreakPoints(d=[  0.  ,   0.61,   1.21,   1.82,   2.42,   3.03,   3.64,
                       4.24,   4.85,   5.45,   6.06,   6.67,   7.27,   7.88,
                       8.48,   9.09,   9.7 ,  10.3 ,  10.91,  11.52,  12.12,
                      12.73,  13.33,  13.94,  14.55,  15.15,  15.76,  16.36,
                      16.97,  17.58,  18.18,  18.79,  19.39,  20.  ,  20.61,
                      21.21,  21.82,  22.42,  23.03,  23.64,  24.24,  24.85,
                      25.45,  26.06,  26.67,  27.27,  27.88,  28.48,  29.09,
                      29.7 ,  30.3 ,  30.91,  31.52,  32.12,  32.73,  33.33,
                      33.94,  34.55,  35.15,  35.76,  36.36,  36.97,  37.58,
```

```
                    38.18,  38.79,  39.39,  40.  ,  40.61,  41.21,  41.82,
                    42.42,  43.03,  43.64,  44.24,  44.85,  45.45,  46.06,
                    46.67,  47.27,  47.88,  48.48,  49.09,  49.7 ,  50.3 ,
                    50.91,  51.52,  52.12,  52.73,  53.33,  53.94,  54.55,
                    55.15,  55.76,  56.36,  56.97,  57.58,  58.18,  58.79,
                    59.39,  60.  ], label="Mon label", unit="None")
       d = array([ 0.        ,  0.50998242,  0.85585841,  0.89696535,  0.58340398,
               0.11391024, -0.43028522, -0.80580171, -0.92829976, -0.65005665,
              -0.22266386,  0.34485257,  0.74763341,  0.94907077,  0.70948442,
               0.3251967 , -0.25428184, -0.68219356, -0.95853847, -0.76126009,
              -0.42060444,  0.15923796,  0.61031381,  0.95603522,  0.80497853,
               0.50813766, -0.06046304, -0.53281029, -0.94098858, -0.8402522 ,
              -0.58719371, -0.04121525,  0.45047977,  0.91294525,  0.86670912,
               0.65730568,  0.14487723, -0.3640988 , -0.84801913, -0.88399365,
              -0.71812949, -0.2495073 ,  0.27442561,  0.77430496,  0.8917701 ,
               0.76942953,  0.35399308, -0.18220436, -0.69312459, -0.88972928,
              -0.81106375, -0.45712801,  0.08817125,  0.60578852,  0.87759772,
               0.8429688 ,  0.55761779,  0.00693795, -0.51357603, -0.85514948,
              -0.86514586, -0.65409088, -0.10237972,  0.41771891,  0.82222   ,
               0.87764784,  0.74511316,  0.19739448, -0.3193891 , -0.77872175,
              -0.88056836, -0.80603303, -0.29119868,  0.21969019,  0.72466086,
               0.87403299,  0.85462379,  0.3829782 , -0.11965264, -0.66015432,
              -0.85819308, -0.89090013, -0.47188328,  0.02023243,  0.58544699,
               0.8332223 ,  0.9150273 ,  0.55702582,  0.07768708, -0.50092758,
              -0.79931603, -0.9273    , -0.63747929, -0.17329073,  0.40714307,
               0.75669354,  0.9281209 ,  0.71228172,  0.49644254,  0.28060337])
```

```
In [40]: plt.figure(figsize=(12,7))
         test.plot()
         newX = np.linspace(-10,100,200)
         test.resample(newX).plot('.', c=category20.by_key()['color'][6], lw=0.1)
         plt.ylim(-5, 2)
```

```
Out[40]: (-5, 2)
```



Not implemented

```
In [41]: test + test2.steps
```

```
Out[41]: x = BreakPoints(d=[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14,
                      15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29,
                      30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44,
                      45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59], label="None", unit
         d = array([  5.        ,   6.84147098,   7.90929743,   2.14112001,
                  3.2431975 ,   4.04107573,   5.7205845 ,   7.6569866 ,
                  8.98935825,   9.41211849,   9.45597889,  10.00000979,
                 11.46342708,  13.42016704,  14.99060736,  15.65028784,
                 15.71209668,  16.03860251,  17.24901275,  19.14987721,
                 20.91294525,  21.83665564,  21.99114869,  22.1537796 ,
                 23.09442164,  24.86764825,  26.76255845,  27.95637593,
                 28.27090579,  28.33636612,  29.01196838,  30.59596235,
                 32.55142668,  33.99991186,  34.52908269,  34.57181733,
                 35.00822115,  36.35646187,  38.29636858,  39.96379539,
                 40.74511316,  40.84137733,  41.08347845,  42.16822526,
                 44.01770193,  45.85090352,  46.90178835,  47.12357312,
                 47.23174534,  48.04624735,  49.73762515,  51.67022918,
                 52.98662759,  53.39592515,  53.44121095,  54.00024483,
                 55.478449  ,  57.43616476,  58.99287265,  59.63673801])
```

```
In [42]: test.steps([-10, 2.3, 3, 3.1, 59, 58.9, 90])
```

```
Out[42]: array([ -8.41470985,   0.6788442 ,   0.14112001,   0.05132776,
                  0.63673801,   0.67235147, -10.40343586])
```

```
In [43]: test.steps
```

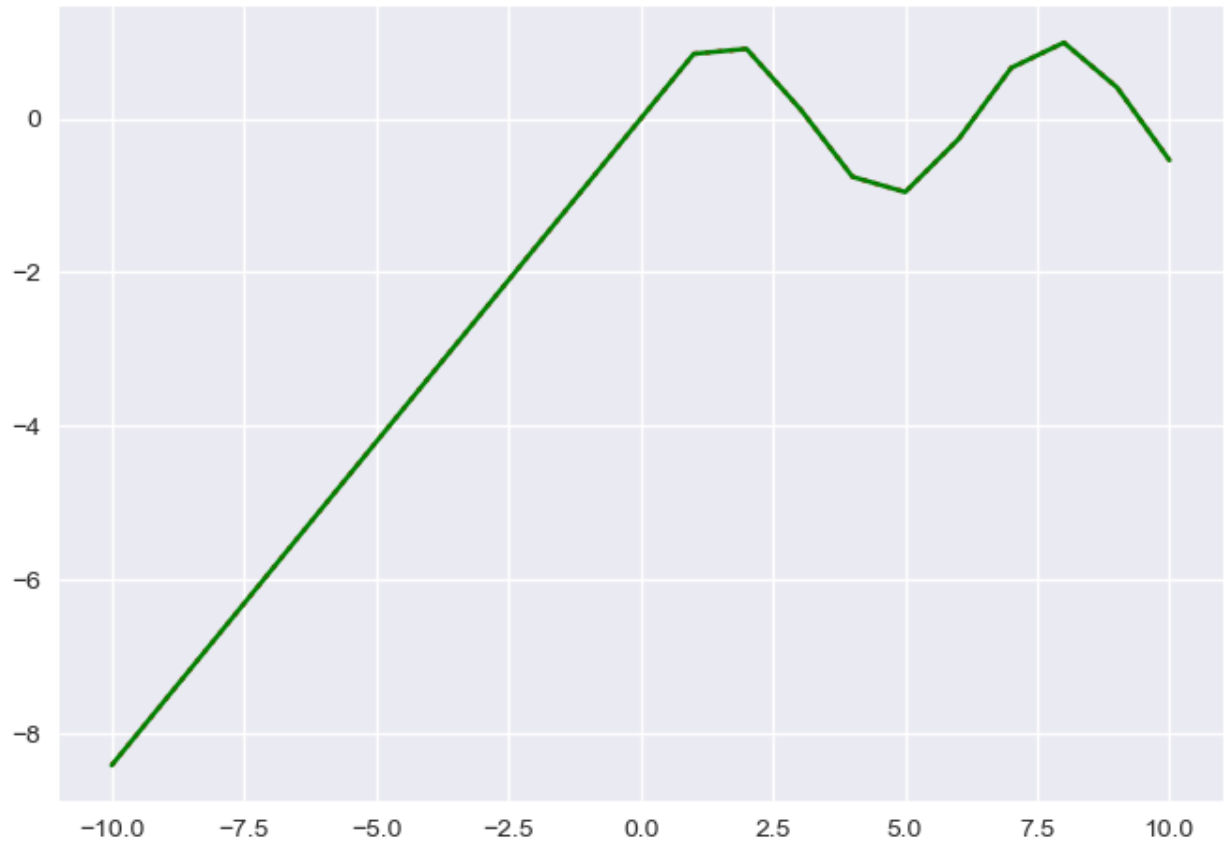
```
Out[43]: x = BreakPoints(d=[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14,
                      15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29,
                      30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44,
                      45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59], label="Mon label",
         d = array([ 0.        ,  0.84147098,  0.90929743,  0.14112001, -0.7568025 ,
                -0.95892427, -0.2794155 ,  0.6569866 ,  0.98935825,  0.41211849,
                -0.54402111, -0.99999021, -0.53657292,  0.42016704,  0.99060736,
                 0.65028784, -0.28790332, -0.96139749, -0.75098725,  0.14987721,
                 0.91294525,  0.83665564, -0.00885131, -0.8462204 , -0.90557836,
                -0.13235175,  0.76255845,  0.95637593,  0.27090579, -0.66363388,
                -0.98803162, -0.40403765,  0.55142668,  0.99991186,  0.52908269,
                -0.42818267, -0.99177885, -0.64353813,  0.29636858,  0.96379539,
                 0.74511316, -0.15862267, -0.91652155, -0.83177474,  0.01770193,
                 0.85090352,  0.90178835,  0.12357312, -0.76825466, -0.95375265,
                -0.26237485,  0.67022918,  0.98662759,  0.39592515, -0.55878905,
                -0.99975517, -0.521551  ,  0.43616476,  0.99287265,  0.63673801])
```

```
In [44]: test.diff(n=1)
```

```
Out[44]: x = BreakPoints(d=[ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14,
                      15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29,
                      30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44,
                      45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58], label="Mon label", uni
         d = array([ 0.84147098,  0.06782644, -0.76817742, -0.8979225 , -0.20212178,
                 0.67950878,  0.9364021 ,  0.33237165, -0.57723976, -0.9561396 ,
                -0.4559691 ,  0.46341729,  0.95673995,  0.57044032, -0.34031952,
                -0.93819116, -0.67349418,  0.21041025,  0.90086446,  0.76306804,
                -0.07628961, -0.84550695, -0.83736909, -0.05935796,  0.77322661,
                 0.8949102 ,  0.19381748, -0.68547014, -0.93453967, -0.32439774,
                 0.58399398,  0.95546433,  0.44848518, -0.47082917, -0.95726536,
                -0.56359618,  0.34824072,  0.93990671,  0.66742681, -0.21868223,
                -0.90373583, -0.75789888,  0.08474681,  0.84947667,  0.8332016 ,
                 0.05088482, -0.77821522, -0.89182778, -0.18549799,  0.6913778 ,
                 0.93260403,  0.31639842, -0.59070244, -0.9547142 , -0.44096612,
                 0.47820417,  0.95771576,  0.55670789, -0.35613464])
```

```
In [45]: #plt.plot(test.X, test.Y, c="b")
         newX = np.arange(-10, 10, 0.001)
         plt.plot(newX, test(newX), ":r")
         plt.plot(newX, test.steps(newX), "-g")
```

```
Out[45]: [<matplotlib.lines.Line2D at 0x181ba962e8>]
```



In [46]:
```
test.steps(newX)
```

Out[46]:
```
array([-8.41470985, -8.41386838, -8.41302691, ..., -0.54115269,
       -0.54210883, -0.54306497])
```

In [47]:
```
import random
from numba import jit

N = 200
myMesh = mesh2d(np.arange(N)*5, [random.uniform(2.5, 10.0) for i in range(N)], x_label="MON
```

In [48]:
```
@jit
def _extrapolate(self, X):
    """
    """
    if X <= self.x[0]:
        res = self.d[0] + (X - self.x[0]) *\
            (self.d[1] - self.d[0]) / (self.x[1] - self.x[0])
    elif X >= self.x[-1]:
        res = self.d[-1] + (x - self.x[-1]) *\
            (self.d[-1] - self.d[-2]) / (self.x[-1] - self.x[-2])
    else:
        res = np.interp(X, self.x, self.d)
    return res
```

In [49]:
```
%timeit myMesh.extrapolate(255)
```

```
21.7 µs ± 915 ns per loop (mean ± std. dev. of 7 runs, 10000 loops each)
```

In [50]:
```
%timeit _extrapolate(myMesh, 255)
```

```
The slowest run took 5.50 times longer than the fastest. This could mean that an intermediate result
94.3 µs ± 87.9 µs per loop (mean ± std. dev. of 7 runs, 1 loop each)
```

```
In [51]: np.diff(test2.d) / np.diff(test2.x)
```

```
Out[51]: BreakPoints(d=[ 1., -5.,  2.,  1.], label="None", unit="None")
```

3.1.3 mesh3d

```
In [52]: m3d = mesh3d(x=np.arange(10), x_label="X", x_unit="X unit",
                      y=np.arange(10), y_label="Y", y_unit="Y unit",
                      d=np.random.random((10,10)), label="data", unit="data unit")
```

```
In [53]: lerp.options.display.max_rows = 15
```

```
In [54]: m3d
```

```
Out[54]: <lerp.mesh.mesh3d at 0x1a20a6f198>
```

```
In [55]: m3d(4.5, 5.7)
```

```
Out[55]: 0.22891672933562421
```

Interpolation

```
In [56]: m3d(3.5, 5.6)
```

```
Out[56]: 0.24804759269057369
```

Call method default : extrapolation above boundaries

```
In [57]: m3d(9.1,9.4)
```

```
Out[57]: 1.2617807437078306
```

As far mesh2d, can be set with options attributes or method call .interpolate

```
In [58]: m3d.options
```

```
Out[58]: {'extrapolate': True}
```

```
In [59]: m3d.interpolate(9.1,9.4)
```

```
Out[59]: 0.9606969801252196
```

```
In [60]: m3d(x=3.5)
```

```
Out[60]: x = BreakPoints(d=[0, 1, 2, 3, 4, 5, 6, 7, 8, 9], label="Y", unit="Y unit")
         d = array([ 0.69944545,  0.45196195,  0.62338401,  0.22360536,  0.56315821,
                 0.30124409,  0.21258326,  0.25238123,  0.70839876,  0.35742004])
```

Slicing

```
In [61]: m3d[3:6]
```

```
Out[61]: <lerp.mesh.mesh3d at 0x1a20a6fba8>
```

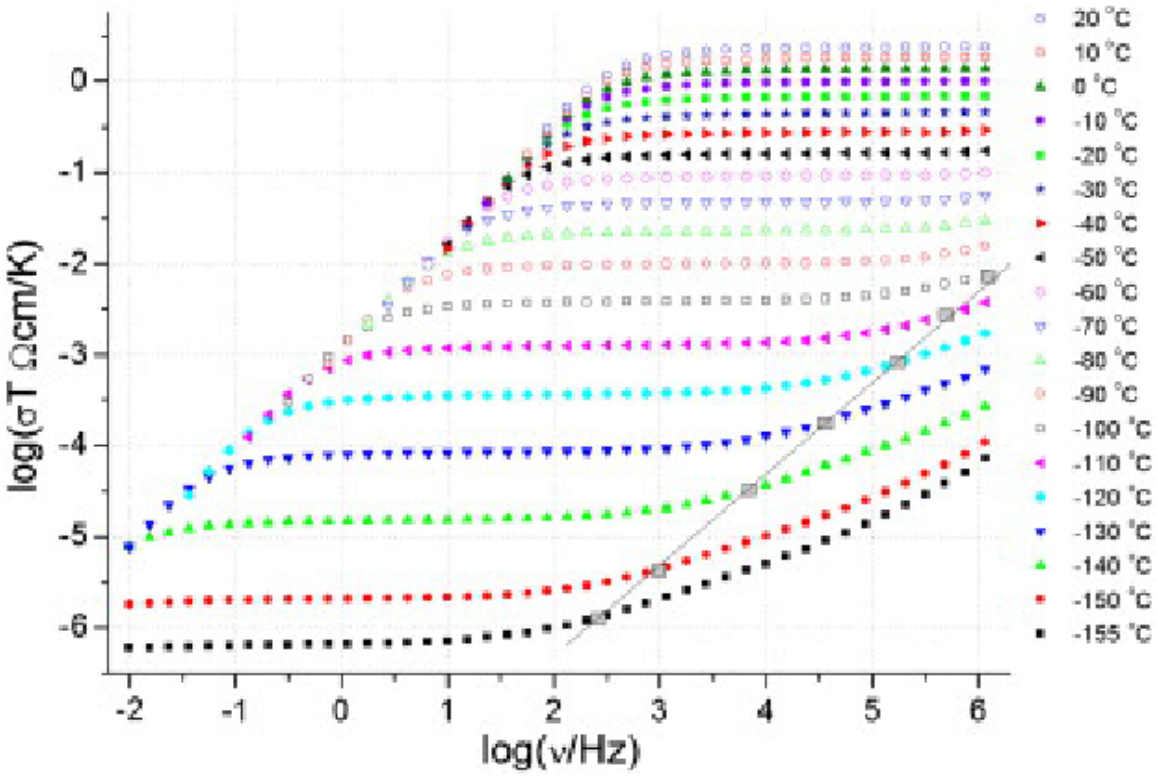
Garbage after that point

```
In [62]: from scipy import misc
         from scipy import ndimage
         # http://www.ndt.net/article/wcndt00/papers/idn360/idn360.htm

         from PIL import Image
         from urllib.request import urlopen
         import io

         URL = 'https://www.researchgate.net/profile/Robert_Dinnebier/publication/268693474/figure/f
```

```
        with urlopen(URL) as url:
            im = misc.imread(io.BytesIO(url.read()))

        # face = misc.imread(f)
```

In [63]:
```
plt.imshow(im, cmap=plt.cm.gray, vmin=30, vmax=200)
plt.axis('off')
# plt.contour(im, [50, 200])
```

Out[63]: (-0.5, 388.5, 259.5, -0.5)



In [64]:
```
sx = ndimage.sobel(im, axis=0, mode='constant')
sy = ndimage.sobel(im, axis=1, mode='constant')
sob = np.hypot(sx, sy)
```

In [65]:
```
sx = ndimage.sobel(im, axis=0, mode='constant')
```

import numpy as np import matplotlib.pyplot as plt from scipy import interpolate

x = np.array([[0.12, 0.11, 0.1, 0.09, 0.08], [0.13, 0.12, 0.11, 0.1, 0.09], [0.15, 0.14, 0.12, 0.11, 0.1], [0.17, 0.15, 0.14, 0.12, 0.11], [0.19, 0.17, 0.16, 0.14, 0.12], [0.22, 0.19, 0.17, 0.15, 0.13], [0.24, 0.22, 0.19, 0.16, 0.14], [0.27, 0.24, 0.21, 0.18, 0.15], [0.29, 0.26, 0.22, 0.19, 0.16]])

y = np.array([[71.64, 78.52, 84.91, 89.35, 97.58], [66.28, 73.67, 79.87, 85.36, 93.24], [61.48, 69.31, 75.36, 81.87, 89.35], [57.61, 65.75, 71.7, 79.1, 86.13], [55.12, 63.34, 69.32, 77.29, 83.88], [54.58, 62.54, 68.7, 76.72, 82.92], [56.58, 63.87, 70.3, 77.69, 83.53], [61.67, 67.79, 74.41, 80.43, 85.86], [70.08, 74.62, 80.93, 85.06, 89.84]])

plt.figure(figsize = (9, 9)) plt.subplot(111) for i in range(5): $x_val = np.linspace(x[0, i], x[-1, i], 100) x_int = np.interp(x_val, x[:, i], y[:, i]) tck = interpolate.splrep(x[:, i], y[:, i], k = 2, s = 4) y_int = interpolate.splev(x_val, tck, der = 0) plt.plot(x[:, i], y[:, i], linestyle = ''$

$, marker =' o')plt.plot(x_val, y_int, linestyle =':', linewidth = 0.25, color ='$
$black')plt.xlabel('X')plt.ylabel('Y')plt.show()$

from scipy.interpolate import dfitpack, fitpack

def extrapolate(self, X, Y): if X <= self.X[0]: iX = 0 elif X >= self.X[-1]: iX = -2 else: iX = np.searchsorted(self.X, X) - 1

if Y <= self.Y[0]: iY = 0 elif Y >= self.Y[-1]: iY = -2 else: iY = np.searchsorted(self.Y, Y) - 1

Z1 = self.W[iX, iY] + (self.W[iX, iY+1] - self.W[iX, iY]) * (Y - self.Y[iY]) / (self.Y[iY+1] - self.Y[iY]) Z2 = self.W[iX+1, iY] + (self.W[iX+1, iY+1] - self.W[iX+1, iY]) * (Y - self.Y[iY]) / (self.Y[iY+1] - self.Y[iY])

return Z1 + (Z2 - Z1) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX])

def interpolate(self, X, Y): if X <= self.X[0]: return np.interp(Y, self.Y, self.W[0]) elif X >= self.X[-1]: return np.interp(Y, self.Y, self.W[-1]) else: iX = np.searchsorted(self.X, X) - 1

if Y <= self.Y[0]: return np.interp(X, self.X, self.W[:,0]) elif Y >= self.Y[-1]: return np.interp(X, self.X, self.W[:,-1]) else: iY = np.searchsorted(self.Y, Y) - 1

Z1 = self.W[iX, iY] + (self.W[iX, iY+1] - self.W[iX, iY]) * (Y - self.Y[iY]) / (self.Y[iY+1] - self.Y[iY]) Z2 = self.W[iX+1, iY] + (self.W[iX+1, iY+1] - self.W[iX+1, iY]) * (Y - self.Y[iY]) / (self.Y[iY+1] - self.Y[iY])

return Z1 + (Z2 - Z1) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX])

np.diff(m3d.W[1:3,2:4], axis=1)

np.diff(m3d.W[1:3,2:4], axis=0)

m3d = mesh3d(np.arange(100),np.arange(50),np.random.random((50,100)))

def extrapolate(self, X, Y): iX = 0 iY = 0

if X <= self.X[0]: iX = 0 elif X >= self.X[-1]: iX = -2 else: iX = np.where(self.X < X)[0][-1]

if Y <= self.Y[0]: iY = 0 elif Y >= self.Y[-1]: iY = -2 else: iY = np.where(self.Y < Y)[0][-1]

Z1 = self.W[iY, iX] + (self.W[iY, iX+1] - self.W[iY, iX]) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX]) Z2 = self.W[iY+1, iX] + (self.W[iY+1, iX+1] - self.W[iY+1, iX]) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX])

return Z1 + (Z2 - Z1) * (Y - self.Y[iY]) / (self.Y[iY+1] - self.Y[iY])

def extrapolate1(self, $_{X,Y}$) : $xNew = np.searchsorted(self.X,_X).clip(1, len(self.X)-1).astype(int)yNew =$
$np.searchsorted(self.Y,_Y).clip(1, len(self.Y) - 1).astype(int)$

4. Calculate the slope of regions that each X value falls in. xLo, xHi = xNew - 1, xNew yLo, yHi = yNew - 1, yNew

x11 = self.X[xLo] x12 = self.X[xHi] y11 = self.Y[yLo] y21 = self.Y[yHi] w11 = self.W[:,xLo] w12 = self.W[:,xHi]

Note that the following two expressions rely on the specifics of the broadcasting semantics. xSlope = (w12 - w11) / (x12 - x11)

5. Calculate the actual value for each entry in X. yNew = xSlope * $(_X - x11) + w11$

w11 = yNew[yLo] w21 = yNew[yHi]

ySlope = (w21 - w11) / (y21 - y11)

yNew = ySlope * $(_Y - y11) + w11$

return np.array(yNew)

def extrapolate2(self, X, Y):

iX = -2 if X >= self.X[-1] else np.searchsorted(self.X, X).clip(1, len(self.X)-1).astype(int) - 1

iY = -2 if Y >= self.Y[-1] else np.searchsorted(self.Y, Y).clip(1, len(self.Y)-1).astype(int) - 1

Z1 = self.W[iY, iX] + (self.W[iY, iX+1] - self.W[iY, iX]) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX]) Z2 = self.W[iY+1, iX] + (self.W[iY+1, iX+1] - self.W[iY+1, iX]) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX])

return Z1 + (Z2 - Z1) * (Y - self.Y[iY]) / (self.Y[iY+1] - self.Y[iY])

def extrapolate3(self, X, Y): gc.disable() st = time.time()

if X <= self.X[0]: iX = 0 elif X >= self.X[-1]: iX = -2 else: iX = np.searchsorted(self.X, X) - 1

if Y <= self.Y[0]: iY = 0 elif Y >= self.Y[-1]: iY = -2 else: iY = np.searchsorted(self.Y, Y) - 1

Z1 = self.W[iY, iX] + (self.W[iY, iX+1] - self.W[iY, iX]) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX]) Z2 = self.W[iY+1, iX] + (self.W[iY+1, iX+1] - self.W[iY+1, iX]) * (X - self.X[iX]) / (self.X[iX+1] - self.X[iX])

return Z1 + (Z2 - Z1) * (Y - self.Y[iY]) / (self.Y[iY+1] - self.Y[iY])

New mesh

from functools import singledispatch

class newmesh(np.ndarray):

def $_{new}{}_{(cls,data=None,label=None,unit=None):Wefirstcasttobeourclasstypenp.asfarray([],dtype='float64')@singledispatchdefmyArray(o):ifoisNone:o=[]Willcall}$

@myArray.register(mesh1d) def $_{(o)}$: $iflabelisnotNone$: $o.label = labelifunitisnotNone$: $o.unit = unitreturno$

return myArray(data)

see InfoArray.$_{arrayfinalize}{}_{forcommentsdef}{}_{arrayfinalize}{}_{(self,obj):"""}$

:type obj: object """ self.unit = getattr(obj, 'unit', None) self.label = getattr(obj, 'label', None)

@property def d(self): return self[0]

@d.setter def d(self, obj): self[0] = obj

test = newmesh([1, 3, 4])

test.d = 5

test.flags

Source

[1] lerp article on Wikipedia

3.2 mesh

3.2.1 mesh1d

lerp.**mesh1d**
alias of BreakPoints

3.2.2 mesh2d

class lerp.**mesh2d**(*x=[]*, *d=None*, *x_label=None*, *x_unit=None*, *label=None*, *unit=None*, *clipboard=False*, *extrapolate=True*, *contiguous=False*, *step=False*, ***kwargs*)
Fundamental 2D object, strict monotonic

Instantiation by giving (x, d) parameters or by loading a csv-file.

Parameters

- **x** (*numpy.array or mesh1d*) – 1D array of x-coordinates of the mesh on which to interpolate
- **d** (*numpy.array*) – 1D array of d-coordinates of the mesh on result to be interpolated
- **options** (*dict [optiona]*) –
- **clipboard** (*boolean [optionall]*) – when set, override any instantiation with x and d
- **fileName** (*string*) – Complete address to csv-file, further

Notes

Currently supported features:

- calling the object *cur(x)* return the interpolated value at x.
- common operations: +, -, , /
- standard functions:func:*len()*, `print()`

T

apply(*f*, *axis='d'*, *inplace=False*)
Apply a function along axis

Parameters

- **f** (*function*) –
- **axis** (*string*) – "x" or "d"
- **inplace** (*boolean*) – True if you want the mesh1d to be modified inplace

Returns Depends if inplace is set to False or True

Return type Nothing or *mesh1d*

d
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

diff(*n=1*)
Checked

difff

dropnan()
Drop NaN values and return new mesh2d.

extrapolate(*x*, **args*, ***kwargs*)
np.interp function with linear extrapolation np.polyfit np.poly1d

gradient(*x=None*)

interpolate(*x*, *assume_sorted=False*, **args*, ***kwargs*)
Purpose of this method is to return a linear interpolation of a d vector for an unknown value x. If the targeted value is out of the x range, the returned d-value is the first, resp. the last d-value.

No interpolation is made out of the x definition range. For such a functionality, use:py:meth:*extrapolate* instead.

:param x:: iterable or single element,: :param kind: :type kind: str or int, optional :param Specifies the kind of interpolation as a string (‘linear’, ‘nearest’,: :param ‘zero’, ‘slinear’, ‘quadratic’, ‘cubic’ where ‘slinear’, ‘quadratic’: :param and ‘cubic’ refer to a spline interpolation of first, second or third: :param order) or as an integer specifying the order of the spline: :param interpolator to use. Default is ‘linear’.:

Returns

- A single element or a `numpy.array` if the x parameter was
- a `numpy.array` or a list

plot(*data*, **args*, ***kwargs*)

polyfit(*degree=2*)

push(*x=None*, *d=None*)
Pushes an element/array to the array

Notes

The element or the array is added and sorted inplace

Parameters

- **x** (*single numeric, array, numpy.array*) –
- **d** (*single numeric, array, numpy.array*) –

read_clipboard()

resample(*x*)

steps

to_clipboard(*transpose=False*, *decimal=’, ’*)

to_csv(*fileName=None*, *nbreDecimales=2*)
Export CUR data into csv

Parameters

- **fileName** (*String*) – Complete path + filename where csv data will be wrote. Default to ‘C:/temp/aze.csv’
- **nbreDecimales** (*integer*) –

x
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

3.2.3 mesh3d

class lerp.**mesh3d**(*x=[]*, *y=[]*, *d=None*, *x_label=None*, *x_unit=None*, *y_label=None*, *y_unit=None*, *label=None*, *unit=None*, *extrapolate=True*, *clipboard=False*, *sort=True*, **pargs*, ***kwargs*)
Interpolate over a 2-D grid.

x, *y* and *d* are arrays of values used to approximate some function f: `d = f(x, y)`. This class returns a function whose call method uses spline interpolation to find the value of new points.

Parameters

- **x** (*array_like*) –

- **Y** (*array_like*) – Arrays defining the data point coordinates.

  If the points lie on a regular grid, *x* can specify the column coordinates and *Y* the row coordinates

Examples

Construct a 2-D grid and interpolate on it:

```
from scipy import interpolate
x = np.arange(-5.01, 5.01, 0.25)
y = np.arange(-5.01, 5.01, 0.25)
xx, yy = np.meshgrid(x, y)
z = np.sin(xx**2+yy**2)
```

T

apply(*f*, *inplace=False*)

d

partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

diff(*axis=0*, *n=1*)

extrapolate(*x*, *y*)

from_pandas(*obj*)

interpolate(*x=None*, *y=None*)

plot(*xy=False*, *filename=None*, ***kwargs*)

pop(*axis=0*)

push(*s=None*, *d=None*, *axis=0*, *inplace=False*)

read_clipboard()

reshape(*sort=True*)

sort()

to_gpt(*fileName=None*)

x

partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

y

partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

3.2.4 mesh4d

class lerp.**mesh4d**(*x=[]*, *y=[]*, *z=[]*, *d=None*, *x_label=None*, *x_unit=None*, *y_label=None*, *y_unit=None*, *z_label=None*, *z_unit=None*, *label=None*, *unit=None*, *extrapolate=False*, *dtype='float64'*)

d
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

interpolate(*x=None*, *y=None*, *z=None*)
a

push(*s=None*, *d=None*, *axis=0*)

read_pickle(*fileName=None*)

reshape()

shape

sort()

to_pickle(*fileName=None*)

x
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

y
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

z
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

3.2.5 mesh5d

class lerp.**mesh5d**(*x=[]*, *y=[]*, *z=[]*, *v=[]*, *d=None*, *x_label=None*, *x_unit=None*, *y_label=None*, *y_unit=None*, *z_label=None*, *z_unit=None*, *v_label=None*, *v_unit=None*, *label=None*, *unit=None*, *extrapolate=True*, *dtype='float64'*)

d
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

read_pickle(*fileName=None*)

reshape()

shape

sort()

to_pickle(*fileName=None*)

v
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

x
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

y
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

z
partial(func, *args, **keywords) - new function with partial application of the given arguments and keywords.

3.3 polymesh

3.3.1 polymesh2d

class lerp.**polymesh2d**(*p=[]*, *x_label=None*, *x_unit=None*, *label=None*, *unit=None*)
Polynom based mash support.

plot(**pargs*, ***kwargs*)

resample(*x*)

3.3.2 polymesh3d

class lerp.**polymesh3d**(*x_label=None*, *x_unit=None*, *y_label=None*, *y_unit=None*, *label=None*, *unit=None*)

plot(**pargs*, ***kwargs*)

push(*y*, *p*)

resample(*y*)

x

y
Describe the highest coefficent

3.4 API

Apply to all mesh objects:

mesh.max
mesh.mean
mesh.median
mesh.min
mesh.shape
mesh.read_pickle
mesh.to_pickle

3.4.1 mesh2d

mesh2d.apply(f[, axis, inplace])	Apply a function along axis
mesh2d.diff([n])	Checked
mesh2d.dropnan()	Drop NaN values and return new mesh2d.
mesh2d.extrapolate(x, *args, **kwargs)	np.interp function with linear extrapolation

Continued on next page

Table 3.2 – continued from previous page

mesh2d.gradient([x])	
mesh2d.interpolate(x[, assume_sorted])	Purpose of this method is to return a linear interpolation of a d vector for an unknown value x.
mesh2d.plot(data, *args, **kwargs)	
mesh2d.polyfit([degree])	
mesh2d.push([x, d])	Pushes an element/array to the array
mesh2d.read_clipboard()	
mesh2d.resample(x)	
mesh2d.step	
mesh2d.steps	
mesh2d.to_clipboard([transpose, decimal])	
mesh2d.to_csv([fileName, nbreDecimales])	Export CUR data into csv

3.4.2 mesh3d

mesh3d.apply(f[, inplace])	
mesh3d.diff([axis, n])	
mesh3d.extrapolate(x, y)	
mesh3d.from_pandas(obj)	
mesh3d.interpolate([x, y])	
mesh3d.plot([xy, filename])	
mesh3d.pop([axis])	
mesh3d.push([s, d, axis, inplace])	
mesh3d.read_clipboard()	
mesh3d.reshape([sort])	
mesh3d.sort()	

3.4.3 mesh4d

mesh4d.interpolate([x, y, z])	a
mesh4d.push([s, d, axis])	
mesh4d.reshape()	
mesh4d.sort()	

3.4.4 polymesh2d

polymesh2d.resample(x)	

3.4.5 polymesh3d

polymesh3d.resample(y)	
polymesh3d.plot(*pargs, **kwargs)	
polymesh3d.push(y, p)	

CHAPTER 4

Indices and tables

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