

MTF_Interp_Polar_Data

September 23, 2015

1 !!WILL NOT WORK WITHOUT VOXEL DATA!!

If you have the voxel data then all code will work if the “files” variable contains string representations of the paths to each voxel file.

```
In [1]: from IPython import parallel
        clients = parallel.Client()
        clients.block = True # use synchronous computations
        print(clients.ids)
```

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lvview = clients.load_balanced_view()
```

```
[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, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99]
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In [2]: import pandas as pd
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In [11]: %%px --local
         from scipy import io
         import h5py
         import numpy as np
         import itertools
         from scipy.interpolate import interp1d
         from scipy import ndimage
         from scipy.optimize import fsolve, brentq, fmin_cg, brute, bisect, newton
```

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In [5]: %%px --local
        m = interp1d([-35,35],[0,300])
        conv_vec = lambda vec: np.array([m(vec[0]),m(vec[1]),m(vec[2])])

        vals = [-35,35]
        x = 10

        corners = [np.array(x) for x in itertools.product(vals,vals,vals)]
        edge_t_corners = 30/np.linalg.norm(corners[0])
        a = np.sqrt((x**2)/(4*np.dot(corners[0],corners[0])))
        corner_samples_actual = [[vec*t for t in np.linspace(edge_t_corners-a,edge_t_corners+a,100)] \
                                for vec in corners]
        corner_samples = [np.array([conv_vec(vec) for vec in sample]).T \
                           for sample in corner_samples_actual]

        #poles
        poles = [np.array([0,0,35]),np.array([0,0,-35])]
        edge_t_poles = 30/np.linalg.norm(poles[0])
        a = np.sqrt((x**2)/(4*np.dot(poles[0],poles[0])))
```

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pole_samples_actual = [[vec*t for t in np.linspace(edge_t_poles-a,edge_t_poles+a,100)] \
                        for vec in poles]
pole_samples = [np.array([conv_vec(vec) for vec in sample]).T \
                for sample in pole_samples_actual]

# x,y and z planes 45deg
zplane = [np.array([35,35,0]),np.array([-35,35,0]),np.array([35,-35,0]),np.array([-35,-35,0])]
xplane = [np.array([0,35,35]),np.array([0,35,-35]),np.array([0,-35,35]),np.array([0,-35,-35])]
yplane = [np.array([35,0,35]),np.array([-35,0,35]),np.array([35,0,-35]),np.array([-35,0,-35])]
edge_t_plane = 30/np.linalg.norm(zplane[0])
a = np.sqrt((x**2)/(4*np.dot(zplane[0],zplane[0])))
zplane_samples_actual = [[vec*t for t in np.linspace(edge_t_plane-a,edge_t_plane+a,100)] \
                        for vec in zplane]
xplane_samples_actual = [[vec*t for t in np.linspace(edge_t_plane-a,edge_t_plane+a,100)] \
                        for vec in xplane]
yplane_samples_actual = [[vec*t for t in np.linspace(edge_t_plane-a,edge_t_plane+a,100)] \
                        for vec in yplane]

zplane_samples = [np.array([conv_vec(vec) for vec in sample]).T \
                  for sample in zplane_samples_actual]
xplane_samples = [np.array([conv_vec(vec) for vec in sample]).T \
                  for sample in xplane_samples_actual]
yplane_samples = [np.array([conv_vec(vec) for vec in sample]).T \
                  for sample in yplane_samples_actual]

allsamples = zplane_samples + xplane_samples + yplane_samples

In [6]: %%px --local
def MTF(samples,sphere):
    Y = ndimage.map_coordinates(sphere, samples, order=5)
    dY = np.diff(Y)
    fftdY = np.fft.fft(dY)
    X =np.abs(fftdY)
    return X

In [18]: %%px --local
def half_width_calc(sphere):

    hlf_widths = []
    for sample in allsamples:

        MTF_out = MTF(sample,sphere)
        f = interp1d(np.linspace(-10,10,99),np.fft.fftshift(MTF_out))

        try:
            hlf_width = brentq(lambda x: f(x) - 0.5,0,5)
        except:
            hlf_width = 'error'

        hlf_widths.append(hlf_width)

    return hlf_widths

def MTF_calcs(fname,ind):
    sphere = h5py.File(fname)['img']['vox'].value

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        vals = [fname.split('/')[ -1]]
        vals += half_width_calc(sphere)

        return vals

In [ ]: %%px --local
a = !ls /scratch/jdg1g14/all_resultspc1/vox*
b = !ls /scratch/jdg1g14/all_resultspc2/vox*
files = a+b
files

In [22]: out = lview.map(MTF_calcs,files,range(len(files)))

In [56]: MTF_res = pd.DataFrame(columns=['fname','X1','X2','X3','X4','Y1','Y2','Y3','Y4' \
                                         , 'Z1','Z2','Z3','Z4'],index=range(len(files)))

        for ind,item in enumerate(out):
            MTF_res.iloc[ind] = item

MTF_res["mag"] = MTF_res["fname"].apply(lambda x: float(x.split('_')[1]))
MTF_res["D"] = MTF_res["fname"].apply(lambda x: int(x.split('_')[3][1]))
MTF_res["S"] = MTF_res["fname"].apply(lambda x: int(x.split('_')[4][1]))
MTF_res["exp"] = MTF_res["fname"].apply(lambda x: int(x.split('_')[2]))

MTF_res[['X1','X2','X3','X4','Y1','Y2','Y3','Y4','Z1','Z2','Z3','Z4']] = \
MTF_res[['X1','X2','X3','X4','Y1','Y2','Y3','Y4','Z1','Z2','Z3','Z4']].astype(np.float64)

MTF_res.head()

Out[56]:
```

	fname	X1	X2	X3	X4	Y1	Y2	Y3	Y4	Z1	Z2	Z3	Z4	mag
0	vox_1.5_1_D0_S0.mat	0.930477	0.930497	0.930508	0.930518	1.125532	1.125566	1.125579	1.125552	0.930488	0.930508	0.930488	0.930517	1.5
1	vox_1.5_1_D0_S1.mat	0.678586	0.683349	0.683018	0.688339	0.746435	0.739818	0.737046	0.740083	0.682981	0.683390	0.685119	0.681977	1.5
2	vox_1.5_1_D1_S0.mat	0.485466	0.473722	0.479446	0.481469	0.480553	0.480820	0.471945	0.487475	0.474332	0.474592	0.480154	0.466854	1.5
3	vox_1.5_1_D1_S1.mat	0.437433	0.430403	0.426044	0.442343	0.437075	0.437571	0.436529	0.456245	0.437329	0.437040	0.431327	0.438650	1.5
4	vox_1.5_2_D0_S0.mat	0.930531	0.930478	0.930503	0.930489	1.125583	1.125570	1.125572	1.125580	0.930520	0.930522	0.930465	0.930500	1.5

```

        D  S  exp
0  0  0   1
1  0  1   1
2  1  0   1
3  1  1   1
4  0  0   2

In [57]: MTF_res.to_pickle('MTFHalfInterp.p')

In [86]: from sortedcontainers import SortedSet
        from scipy.optimize import curve_fit, fsolve
        from scipy import interpolate

```

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In [74]: %%px --local
x = np.linspace(-35,35,301)
y = np.linspace(-35,35,301)

X,Y = np.meshgrid(x,y)

r = np.zeros_like(X)
theta = np.zeros_like(X)
for i in range(301):
    for j in range(301):
        r[i,j] = np.sqrt(X[i,j]**2+Y[i,j]**2)

In [77]: %%px --local
def oversampled_edge(slice_,rs):

    rs = rs.flatten()
    sorted_set_rs = SortedSet(list(rs))
    index = np.argsort(rs)
    sortedr = rs[index]
    slice_ = slice_.flatten()
    slice_ordered = slice_[index]

    out = []
    for r in sorted_set_rs:
        out.append(slice_ordered[sortedr == r].mean())

    return np.array(sorted_set_rs),np.array(out)

def profiles(fname,r):

    sphere = h5py.File(fname)['img']['vox'].value
    slice_x = sphere[150,:,:]
    slice_y = sphere[:,150,:]
    slice_z = sphere[:, :,150]

    _,bx = oversampled_edge(slice_x,r)
    _,by = oversampled_edge(slice_y,r)
    _,bz = oversampled_edge(slice_z,r)

    return bx,by,bz

def dummy_foo(file):
    x,y,z = profiles(file,r)
    return (x,y,z)

In [76]: %%px --local
rs = r.flatten()
sorted_set_rs = SortedSet(list(rs))
index = np.argsort(rs)
sortedr = rs[index]

In [79]: out = lview.map(dummy_foo,files)

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In [81]: def sigmoid(x, a,x0, k,d):
          y = a / (1 + np.exp(-k*(x-x0))) + d
          return y

sorted_rs = np.array(sorted_set_rs)

def fit_sigmoid(profile):
    popt, pcov = curve_fit(sigmoid, sorted_rs, profile)
    return popt

In [82]: sig_coeffs = []
          for file in out:
              file_coeffs = []
              for slice_ in file:
                  file_coeffs.append(fit_sigmoid(slice_))
              sig_coeffs.append(file_coeffs)

In [87]: def MTF(coeffs):

          rss = np.linspace(25,35,100)

          Y = sigmoid(rss,*coeffs)
          dY = np.diff(Y)
          MTF = np.abs(np.fft.fftshift(np.fft.fft(dY)))

          f = interpolate.interp1d(np.linspace(-10,10,99),MTF)

          def opti_f(x):
              return f(x) - 0.5

          half_width = brentq(opti_f,0,5)

          return half_width,MTF

In [88]: fout = open('halfwidths.dat','w')
          MTFS = []
          for ind,file in enumerate(files):
              fout.write(file)
              MTF_file = []
              for i in range(3):
                  width,modtransfunc = MTF(sig_coeffs[ind][i])
                  fout.write(','+str(width))
                  fout.write(','+str(sig_coeffs[ind][i][1]))
                  fout.write(','+str(sig_coeffs[ind][i][2]))
                  MTF_file.append(modtransfunc)
              fout.write('\n')
              MTFS.append(MTF_file)
          fout.close()

In [95]: df = pd.read_csv('halfwidths.dat',header=None,names=['name','xslice','xslice_radius' \
          , 'xslice_slope','yslice','yslice_radius','yslice_slope','zslice' \
          , 'zslice_radius','zslice_slope','Index'])

df.Index = df.index

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df['mag'] = df.name.apply(lambda x : float(x.split('/')[1].split('_')[1]))
df['exp'] = df.name.apply(lambda x : float(x.split('/')[1].split('_')[2]))
df['Soffset'] = df.name.apply(lambda x : 1.0 if x.split('/')[1].split('_')[4][1] == '1' \
                                else 0.0)
df['Doffset'] = df.name.apply(lambda x : 1.0 if x.split('/')[1].split('_')[3][1] == '1' \
                                else 0.0)
df.head()

```

```

Out[95]:

```

		name	xslice	xslice_radius	\
0	/scratch/jdg1g14/all_resultspc1/vox_1.5_1_D0.S...	1.117422	29.980251		
1	/scratch/jdg1g14/all_resultspc1/vox_1.5_1_D0.S...	0.752174	29.990553		
2	/scratch/jdg1g14/all_resultspc1/vox_1.5_1_D1.S...	0.481796	29.980785		
3	/scratch/jdg1g14/all_resultspc1/vox_1.5_1_D1.S...	0.443328	29.979673		
4	/scratch/jdg1g14/all_resultspc1/vox_1.5_2_D0.S...	1.117418	29.980252		

	xslice_slope	yslice	yslice_radius	yslice_slope	zslice	\
0	4.962754	0.852496	29.993956	3.784164	0.852498	
1	3.332433	0.690748	29.990173	3.050705	0.690348	
2	2.108766	0.480884	29.979794	2.105463	0.479564	
3	1.946244	0.441921	29.978216	1.941053	0.441271	
4	4.962735	0.852496	29.993954	3.784162	0.852496	

	zslice_radius	zslice_slope	Index	mag	exp	Soffset	Doffset
0	29.993955	3.784173	0	1.5	1	0	0
1	29.990156	3.048941	1	1.5	1	1	0
2	29.981178	2.099464	2	1.5	1	0	1
3	29.976192	1.938591	3	1.5	1	1	1
4	29.993956	3.784162	4	1.5	2	0	0

```

In [96]: df.to_pickle('MTFHalfPolar.p')

```