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import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import axes3d
from mpl_toolkits.mplot3d.art3d import Poly3DCollection
import matplotlib.cm as cm
from atest import*
from scipy.sparse.linalg import cg
from scipy.sparse import csc_matrix
print("Data reading completed")
be, te, se = nelem()
print("Elements generated")
lst()
lsf()
print("Surface points list completed")
lag()
print("Lagrange terms coefficients computed")
xs, ys, zs, br = col()
print("Dependent variables column computed")
ka = kat()
print("System matrix computed")
print("ka", ka[30,30])
print("shape", ka.shape)
kl,km = ka.shape
ka = csc_matrix(ka)
br = br @ ka
print("max", np.max(br))
ka = ka @ ka
a, exitCode = cg(ka, br, tol = 0.01)
print("cg", exitCode)
print("Variational param. computed")
fig1 = plt.figure()
ax = fig1.add_subplot(111, projection = "3d")
ax.set_xlim(-1, 2*me +1)
ax.set_ylim(-1, 2*me +1)
ax.set_zlim(-1, 2*me +1)
pol = Poly3DCollection(se, edgecolor = "k", linewidth = 0.2, zorder = 1)
pol.set_facecolor("tomato")
ax.add_collection3d(pol)
ax.plot_trisurf(xs,ys,zs, cmap = cm.cool, linewidth = 0.2, edgecolor = "k",
zorder = 2)
ax.set_title("Finite elements", fontdict = {"fontname": "DejaVu Sans",
"fontsize": 10})
ax.set_xlabel("x axis")
ax.set_ylabel("y axis")
ax.set_zlabel("z axis")
#fig1.show()
r = np.linspace(0,me-0.5,20)
t = np.linspace(0,2*np.pi,20)
r,t = np.meshgrid(r,t, indexing = "ij")
xa = r*np.sin(t)
ya = r*np.cos(t)
xi = me + 0.35*xa + 0.7*ya
yi = me - 0.35*xa + 0.7*ya
zi = me - 0.87*xa
u = np.zeros((20,20,3))
for i in range(20) :
    for j in range(20) :
        x = xi[i,j]
        y = yi[i,j]
        z = zi[i,j]
        s = np.array([x,y,z])
        m = che(s)
        if m < be :
            f = np.array([elem(te[m]).fc(k,s) for k in range(10)])
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            for l in range(3) :
                af = np.array([a[3*(10*m + k)+l] for k in range(10)])
                u[i,j,l] = np.sum(af*f)
x = xi + u[:,:,0]
y = yi + u[:,:,1]
z = zi + u[:,:,2]
print("Displacements computed")
fig2 = plt.figure()
ax1 = fig2.add_subplot(111, projection = "3d")
ax1.set_xlim(-1, 2*me +1)
ax1.set_ylim(-1, 2*me +1)
ax1.set_zlim(-1, 2*me +1)
ax1.plot(xi[19,:],yi[19,:],zi[19,:],linewidth = 1, color = "k", zorder = 1)
ax1.plot(x[19,:],y[19,:],z[19,:], linewidth = 1, color = "red", zorder = 2)
ax1.plot_surface(x,y,z, rstride = 1, cstride = 1, cmap = cm.cool, linewidth =
0.2)
ax1.set_title("Displacement in oblique plane", fontdict = {"fontname": "DejaVu
Sans", "fontsize": 10})
ax1.set_xlabel("x axis")
ax1.set_ylabel("y axis")
ax1.set_zlabel("z axis")
#fig2.show()
plt.show()
```