Python Workshop
How we use python

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How we use python

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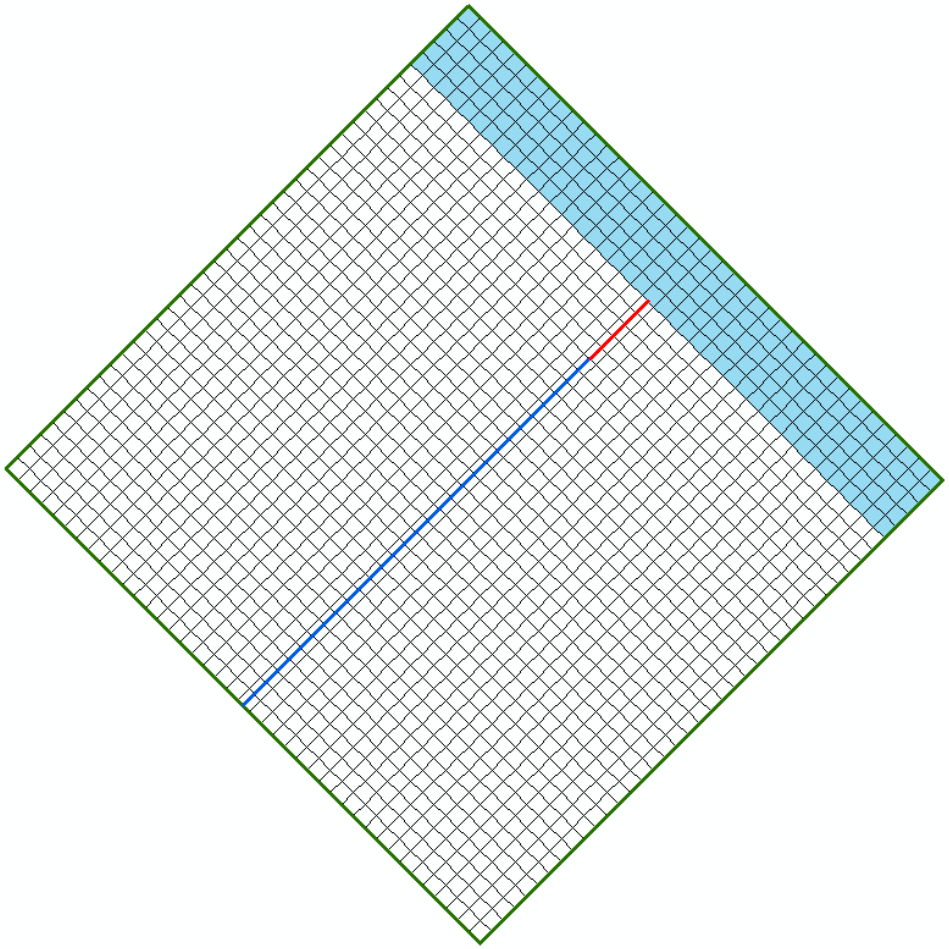
Create GHB file from raw data (1)

[xoff,yoff,rot]=[1000,1000,45]



Create GHB file from raw data (2)

CreateCoastalGHB.py

```
1  import numpy as np
2  import MFArrayUtil as au
3  #--function for calculating equivalent freshwater head
4  def eqfwh( rho, h, z ):
5      return ( rho / 1000. ) * h - ( ( rho - 1000. ) / 1000. ) * min( h, z )
6  #--main script
7  #--spatial dimensions
8  nlay, nrow, ncol  = 1, 41, 40
9  dx, dy = 500.0, 500.0 #m
10 #--temporal dimensions
11 nper = 3
12 #--boundary condition data
13 icbc, start_coast = 0, 36
14 kh     = 10.000 #m/d
15 cond   = kh * dx * dy
16 #--read MODFLOW data from external files
17 ibound  = au.loadArrayFromFile(nrow,ncol,'..\\ref\\ibound.ref')
18 top     = au.loadArrayFromFile(nrow,ncol,'..\\ref\\top.ref')
```

Create GHB file from raw data (3)

CreateCoastalGHB.py

```
19  #--ghb dataset
20  nghb = 0
21  for ir in range(0,nrow):
22      for ic in range(0,ncol):
23          if ibound[ir,ic] == 2:
24              nghb += 1
25  f = open('Model.ghb','w')
26  #--dataset 0
27  f.write( '#Coastal Aquifer GHB Package\n' )
28  #--dataset 1
29  f.write( '{0:10d}{1:10d}  NOPRINT\n'.format( nghb, icbc ) )
30  #--write header for ghb file -- stress period 1
31  f.write( '{0:10d}          0          #STRESS PERIOD {1:05d}\n'.format( nghb, 1 ) )
32  for ir in range(0,nrow):
33      for ic in range(0,ncol):
34          if ibound[ir,ic] == 2:
35              f.write( ' {0:9d} {1:9d} {2:9d} {3:9.5f} {4:9.3g}\n'.format(nlay,ir+1,ic+1, \
36                       eqfwh( 1025., 0.0, top[ir,ic]),cond ) )
37  #--reuse data for the remaining stress period(s)
38  for iper in range(1,nper):
39      f.write( '{0:10d}          0          #STRESS PERIOD {1:05d}\n'.format(-1,iper+1) )
40  f.close()
```

Output GHB file from raw data (4)

Model.ghb

```
1   #Coastal Aquifer GHB Package
2          205          0  NOPRINT
3          205          0            #STRESS PERIOD 00001
4            1          1         36   0.00000   2.5e+06
5            1          1         37   0.05000   2.5e+06
6            1          1         38   0.10000   2.5e+06
7            1          1         39   0.15000   2.5e+06
8            1          1         40   0.20000   2.5e+06
9            1          2         36   0.00000   2.5e+06
10           1          2         37   0.05000   2.5e+06
11           1          2         38   0.10000   2.5e+06
12           1          2         39   0.15000   2.5e+06
13           1          2         40   0.20000   2.5e+06

210          1         41         36   0.00000   2.5e+06
211          1         41         37   0.05000   2.5e+06
212          1         41         38   0.10000   2.5e+06
213          1         41         39   0.15000   2.5e+06
214          1         41         40   0.20000   2.5e+06
215         -1          0            #STRESS PERIOD 00002
216         -1          0            #STRESS PERIOD 00003
```

Extract heads to create a new initial head array

extractSteadyHead.py

```
1  import numpy as np
2  import MFBinaryClass as mfb
3  #--problem size
4  nlay, nrow, ncol = 1, 41, 40
5  nper, nstp = 1, 100
6  #--name of MODFLOW head file
7  head_file = '..\\Results.SWI\\CoastalAquifer.hds'
8  #--read head data
9  #--create instance of head object from MFBinaryClass
10 headObj = mfb.MODFLOW_Head(nlay,nrow,ncol,head_file)
11 #--read array
12 totim,kstp,kper,h,success = headObj.get_record(nstp,nper)
13 #--save array or print error message
14 if success:
15     np.savetxt('..\\ref\\steady_ihead.ref',h[0,:,:])
16 else:
17     print 'Could not read Stress Period {0} Time Step {1}\n  from {2}'.format(nper,nstp,\
18                                                                              head_file)
```

Binary head data

plotHeads.py

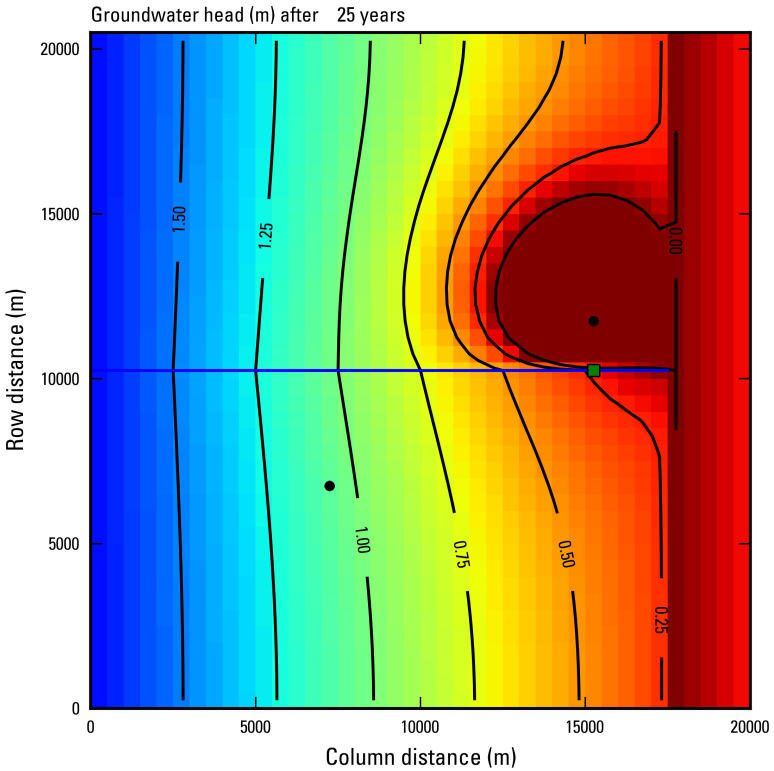
```
43  #--get available times
44  headObj = mfb.MODFLOW_Head(nlay,nrow,ncol,head_file)
45  t = headObj.get_gage(1)
46  ntimes = t.shape[0]
47  mf_times = np.zeros( (ntimes), np.float )
48  for i in range(0,ntimes):
49      mf_times[i] = t[i,0]


55  #--create figures for each output time
56  for ipos,on_time in enumerate( mf_times ):
57      #--build output file name
58      output_name = '{0}{1}_{2:05d}.{3}'.format(base_dir,base_name,int(ipos),extension)
59      fnames.append( output_name )
60      #--read head data
61      headObj = mfb.MODFLOW_Head(nlay,nrow,ncol,head_file)
62      totim,kstp,kper,h,success = headObj.get_record(on_time)
63      hd = np.copy( h[0,:,:] )
```

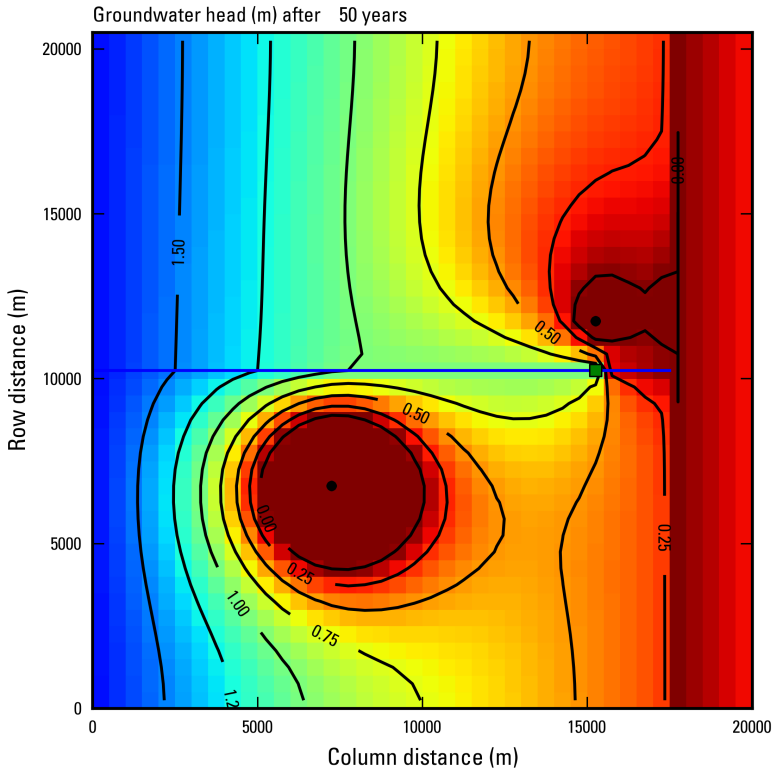
Figures (1)

plotHeads.py

```
84      hp = ax.pcolor(Xedge,Yedge,hd,\
85                     vmin=0,vmax=2,cmap='jet_r',alpha=1.0,edgecolors='None')
86      ch = ax.contour(xcell,ycell,hd,\
87                      levels=hdcontour,colors='k',linewidths=1)
88      ax.clabel(ch,inline=1,fmt='%5.2f',fontsize=6)
89      ax.plot([xedge[0],xedge[35]],[ycell[20],ycell[20]],linewidth=1,color='b',label='River')
90      ax.plot(xcell[struct_loc[1]],ycell[struct_loc[0]],'gs',markersize=4,label='Structure')
91      ax.plot(xcell[well_loc[0,1]],ycell[well_loc[0,0]],'ko',markersize=3,label='PW-1')
92      ax.plot(xcell[well_loc[1,1]],ycell[well_loc[1,0]],'ko',markersize=3,label='PW-2')
```

Figures (2)

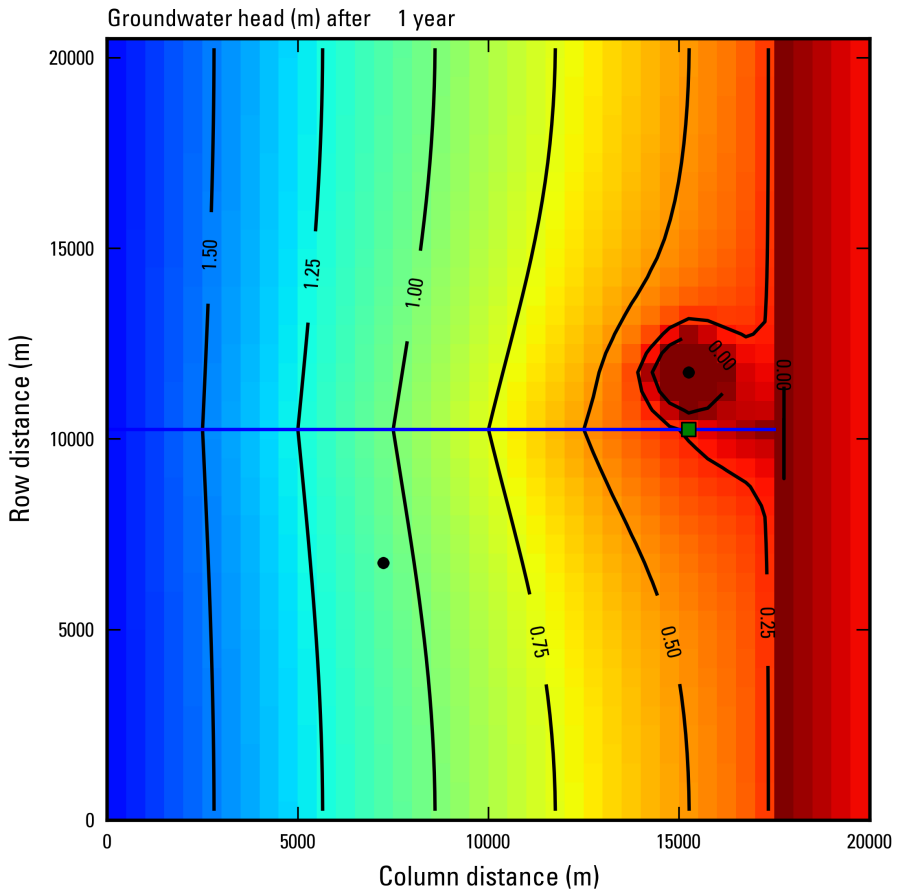

Groundwater head (m) after 25 years
Row distance (m)
Column distance (m)
0
5000
10000
15000
20000
1.50
1.25
1.00
0.75
0.50
0.25
0.00


Groundwater head (m) after 50 years
Row distance (m)
Column distance (m)
0
5000
10000
15000
20000
1.50
1.00
0.75
0.50
0.25
0.00

Using `ffmpeg.exe`

```
101  #--animate head data
102  coutf = '{0}{1}.swf'.format(base_dir,base_name)
103  cline = 'ffmpeg.exe -i {0}{1}_%05d.png {2} -y'.format( base_dir,base_name,coutf )
104  try:
105      os.remove(coutf)
106  except:
107      print 'could not remove...{0}'.format( coutf )
108  subprocess.call(cline, stdin=None, stdout=None, stderr=None, shell=False)
```

Using `ffmpeg.exe`



Making shapefiles (1)

makeShapefileFromDIS.py

```
4   import numpy as np
5   import shapefile
6   import MFArrayUtil as au


89  filename = '..\\data\\CoastalAquifer.dis'
90  offset,nlay,nrow,ncol,delr,delc = load_dis_file(filename)
91  #--flip the delc since we moved the orgin to lower left
92  delc = np.flipud( delc )
93  #--sum the lengths along the distance vectors
94  delr_cum = np.cumsum(delr)
95  delc_cum = np.cumsum(delc)
96  #--flip the delc since we moved the origin to lower left
97  delc_cum = np.flipud( delc_cum )
98  #--insert '0' in the first position
99  xedge = np.hstack((0,delr_cum))
100 yedge = np.hstack((delc_cum,0))
101 #--read MODFLOW data from external files
102 ibound  = au.loadArrayFromFile(nrow,ncol,'..\\ref\\ibound.ref')
103 top     = au.loadArrayFromFile(nrow,ncol,'..\\ref\\top.ref')
```

Making shapefiles (2)

makeShapefileFromDIS.py

```
104  #--create polygon shapefile of grid
105  wr = shapefile.Writer()
106  wr.field('row',fieldType='N',size=20)
107  wr.field('column',fieldType='N',size=20)
108  wr.field('delx',fieldType='N',size=20)
109  wr.field('dely',fieldType='N',size=20)
110  wr.field('cellnum',fieldType='N',size=20)
111  wr.field('ibound',fieldType='N',size=20)
112  wr.field('elev_m',fieldType='N',size=16,decimal=7)
113  #--create each polygon
114  cell_count = 0
115  for ir in range(0,nrow):
116      for ic in range(0,ncol):
117          #--calc the box points relative to the grid
118          lowleft = [xedge[ic],yedge[ir]]
119          lowright = [xedge[ic+1],yedge[ir]]
120          upright = [xedge[ic+1],yedge[ir+1]]
121          upleft = [xedge[ic],yedge[ir+1]]
122          closeit = [xedge[ic],yedge[ir+1]-0.0001]
123          this_box = [upleft,upright,lowright,lowleft,closeit]
```

Making shapefiles (3)

makeShapefileFromDIS.py

```
124             #--if rotation is non-zero
125             if offset[2] != 0.0:
126                 this_box = rotate(this_box,offset[2])
127             #--add the offset in after the rotation
128             this_box = add_offset(this_box,offset)
129             ibt    = ibound[ir,ic]
130             ttop   = top[ir,ic]
131             wr.poly(parts=[this_box], shapeType=5)
132             wr.record([ir+1,ic+1,delc[ir],delr[ic],cell_count+1,ibt,ttop])
133             cell_count += 1
134     #--save polygon shapefile
135     wr.save(target='..\\data\\CoastalAquifer_grid')
```