

# Homework Assignment #7 - Python Solution

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In [19]: #Homework #7 May 1, 2019
import math as math

#Import output locations for T(x,z) and C(x,z), head, mouth
#Running for 201 x2 nodes
Lp75=180 #exported to Rhode Island Sound
Lp25=20 #Imported to fishing grounds

#Define the N-S location of the pollutant pipe.
icx=130 #Casey Point location - 7km N from west passage mouth
idy=50 #grid spacing in x2 (50 centimeters)
Cmax=5.0 #Pollutant concentration leaving the pipe
icx=10 #depth level of pipe (valid values are integers from 0 to 31)

#Factors controlling flow
B=4e-5 #Applied pressure gradient (cm^2/s)
U0=2.0 #Applied surface velocity (cm/s)
Wu=1.0 #Dynamic viscosity (g/(cm*s))

#Define the Parameters (lengths all in cm)
L=200000 #length of estuary in cm (20 kilometers) North-South Distance
h=1500 #depth of estuary in cm (15 meters)
dy=10000 #grid spacing in x2 (100 meters) North-South Spacing
dx=50 #grid spacing in x1 (50 centimeters)
ny=math.floor(L/dy)+1 #Number of nodes in x2
nx=math.floor(h/dx)+1 #Number of nodes in x3

#Factors controlling eddy diffusion of T, C. Data team find values
#vary with distance from the mouth.
Kv3=0.2 #Vertical diffusivity near the estuary mouth
Kv2=0 #Vertical diffusivity in mid-estuary
Kv1=2.0 #Vertical diffusivity near the estuary head
Kh3=5e5 #Horizontal diffusivity near the estuary mouth
Kh2=10e5 #Horizontal diffusivity in mid-estuary
Kh1=10e5 #Horizontal diffusivity near the estuary head

#Factors controlling eddy diffusion of T
Kh=5e5 #Horizontal diffusivity (10^5 cm^2/s)
Kv=1.0 #Vertical diffusivity (1 cm^2/s)

Kv=np.zeros(nx)
#we found three different vertical mixing regimes nearer the head of estuary, higher mixing.
Kv[1:nx]=Kv3 #Kv function of x - mouth mixing.
Kv[math.floor(ny/3):ny]=Kv2 #Kv2 =set middle mixing
Kv[math.floor(ny/3)+1:math.floor(2*ny/3)]=Kv1 #Kv1 =set middle mixing

Khy=np.zeros(nx)
#we found three different vertical mixing regimes nearer the head of estuary, higher mixing.
Khy[1:nx]=Kh3 #Kh function of x - mouth mixing.
Khy[math.floor(ny/3):ny]=Kh2 #set middle mixing
Khy[math.floor(ny/3)+1:math.floor(2*ny/3)]=Kh1 #set middle mixing

#total run time (days)
ntimes=365 #days
#time per time step (in seconds)
dt=50 #seconds

#current max dt (kh, kv), var. selected dt, dt
ntimeok=math.floor(ntimes/dt) #number of time steps
timercor=0.5*dt*(max(Kv))

ntimes=5000 #number of time steps
dt=50 #time per time step (in seconds)

Tinit = #initial temperature for 31 (depth) x 201 (length) 2-D array
[28.129,28.0304,27.9286,27.8248,27.7196,27.6136,27.5073,27.4008,27.2945,27.1884,27.0827,26.9775,26.8727,26.7681,
28.129,28.08,27.9676,27.8567,27.7453,27.6337,27.5221,27.4105,27.2989,27.1873,27.0757,26.9641,26.8525,26.7409,26.6293,26.5177,26.4061,26.2945,26.1829,26.0713,25.9597,25.8481,25.7365,25.6249,25.5133,25.4017,25.2901,25.1785,25.0669,24.9553,24.8437,24.7321,24.6205,24.5089,24.3973,24.2857,24.1741,24.0625,23.9509,23.8393,23.7277,23.6161,23.5045,23.3929,23.2813,23.1697,23.0581,22.9465,22.8349,22.7233,22.6117,22.5001,22.3885,22.2769,22.1653,22.0537,21.9421,21.8305,21.7189,21.6073,21.4957,21.3841,21.2725,21.1609,21.0493,20.9377,20.8261,20.7145,20.6029,20.4913,20.3797,20.2681,20.1565,20.0449,19.9333,19.8217,19.7101,19.5985,19.4869,19.3753,19.2637,19.1521,19.0405,18.9289,18.8173,18.7057,18.5941,18.4825,18.3709,18.2593,18.1477,18.0361,17.9245,17.8129,17.7013,17.5897,17.4781,17.3665,17.2549,17.1433,17.0317,16.9201,16.8085,16.6969,16.5853,16.4737,16.3621,16.2505,16.1389,16.0273,15.9157,15.8041,15.6925,15.5809,15.4693,15.3577,15.2461,15.1345,15.0229,14.9113,14.7997,14.6881,14.5765,14.4649,14.3533,14.2417,14.1301,14.0185,13.9069,13.7953,13.6837,13.5721,13.4605,13.3489,13.2373,13.1257,13.0141,12.9025,12.7909,12.6793,12.5677,12.4561,12.3445,12.2329,12.1213,12.0097,11.8981,11.7865,11.6749,11.5633,11.4517,11.3401,11.2285,11.1169,11.0053,10.8937,10.7821,10.6705,10.5589,10.4473,10.3357,10.2241,10.1125,10.0009,9.8893,9.7777,9.6661,9.5545,9.4429,9.3313,9.2197,9.1081,8.9965,8.8849,8.7733,8.6617,8.5501,8.4385,8.3269,8.2153,8.1037,7.9921,7.8805,7.7689,7.6573,7.5457,7.4341,7.3225,7.2109,7.0993,6.9877,6.8761,6.7645,6.6529,6.5413,6.4297,6.3181,6.2065,6.0949,5.9833,5.8717,5.7601,5.6485,5.5369,5.4253,5.3137,5.2021,5.0905,4.9789,4.8673,4.7557,4.6441,4.5325,4.4209,4.3093,4.1977,4.0861,3.9745,3.8629,3.7513,3.6397,3.5281,3.4165,3.3049,3.1933,3.0817,2.9701,2.8585,2.7469,2.6353,2.5237,2.4121,2.3005,2.1889,2.0773,1.9657,1.8541,1.7425,1.6309,1.5193,1.4077,1.2961,1.1845,1.0729,1.0000,0.9500,0.9000,0.8500,0.8000,0.7500,0.7000,0.6500,0.6000,0.5500,0.5000,0.4500,0.4000,0.3500,0.3000,0.2500,0.2000,0.1500,0.1000,0.0500,0.0000]

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28.129,28.08,27.9676,27.8567,27.7453,27.6337,27.5221,27.4105,27.2989,27.1873,27.0757,26.9641,26.8525,26.7409,26.6293,26.5177,26.4061,26.2945,26.1829,26.0713,25.9597,25.8481,25.7365,25.6249,25.5133,25.4017,25.2901,25.1785,25.0669,24.9553,24.8437,24.7321,24.6205,24.5089,24.3973,24.2857,24.1741,24.0625,23.9509,23.8393,23.7277,23.6161,23.5045,23.3929,23.2813,23.1697,23.0581,22.9465,22.8349,22.7233,22.6117,22.5001,22.3885,22.2769,22.1653,22.0537,21.9421,21.8305,21.7189,21.6073,21.4957,21.3841,21.2725,21.1609,21.0493,20.9377,20.8261,20.7145,20.6029,20.4913,20.3797,20.2681,20.1565,20.0449,19.9333,19.8217,19.7101,19.5985,19.4869,19.3753,19.2637,19.1521,19.0405,18.9289,18.8173,18.7057,18.5941,18.4825,18.3709,18.2593,18.1477,18.0361,17.9245,17.8129,17.7013,17.5897,17.4781,17.3665,17.2549,17.1433,17.0317,16.9201,16.8085,16.6969,16.5853,16.4737,16.3621,16.2505,16.1389,16.0273,15.9157,15.8041,15.6925,15.5809,15.4693,15.3577,15.2461,15.1345,15.0229,14.9113,14.7997,14.6881,14.5765,14.4649,14.3533,14.2417,14.1301,14.0185,13.9069,13.7953,13.6837,13.5721,13.4605,13.3489,13.2373,13.1257,13.0141,12.9025,12.7909,12.6793,12.5677,12.4561,12.3445,12.2329,12.1213,12.0097,11.8981,11.7865,11.6749,11.5633,11.4517,11.3401,11.2285,11.1169,11.0053,10.8937,10.7821,10.6705,10.5589,10.4473,10.3357,10.2241,10.1125,10.0009,9.8893,9.7777,9.6661,9.5545,9.4429,9.3313,9.2197,9.1081,8.9965,8.8849,8.7733,8.6617,8.5501,8.4385,8.3269,8.2153,8.1037,7.9921,7.8805,7.7689,7.6573,7.5457,7.4341,7.3225,7.2109,7.0993,6.9877,6.8761,6.7645,6.6529,6.5413,6.4297,6.3181,6.2065,6.0949,5.9833,5.8717,5.7601,5.6485,5.5369,5.4253,5.3137,5.2021,5.0905,4.9789,4.8673,4.7557,4.6441,4.5325,4.4209,4.3093,4.1977,4.0861,3.9745,3.8629,3.7513,3.6397,3.5281,3.4165,3.3049,3.1933,3.0817,2.9701,2.8585,2.7469,2.6353,2.5237,2.4121,2.3005,2.1889,2.0773,1.9657,1.8541,1.7425,1.6309,1.5193,1.4077,1.2961,1.1845,1.0729,1.0000,0.9500,0.9000,0.8500,0.8000,0.7500,0.7000,0.6500,0.6000,0.5500,0.5000,0.4500,0.4000,0.3500,0.3000,0.2500,0.2000,0.1500,0.1000,0.0500,0.0000]

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28.129,28.08,27.9676,27.8567,27.7453,27.6337,27.5221,27.4105,27.2989,27.1873,27.0757,26.9641,26.8525,26.7409,26.6293,26.5177,26.4061,26.2945,26.1829,26.0713,25.9597,25.8481,25.7365,25.6249,25.5133,25.4017,25.2901,25.1785,25.0669,24.9553,24.8437,24.7321,24.6205,24.5089,24.3973,24.2857,24.1741,24.0625,23.9509,23.8393,23.7277,23.6161,23.5045,23.3929,23.2813,23.1697,23.0581,22.9465,22.8349,22.7233,22.6117,22.5001,22.3885,22.2769,22.1653,22.0537,21.9421,21.8305,21.7189,21.6073,21.4957,21.3841,21.2725,21.1609,21.0493,20.9377,20.8261,20.7145,20.6029,20.4913,20.3797,20.2681,20.1565,20.0449,19.9333,19.8217,19.7101,19.5985,19.4869,19.3753,19.2637,19.1521,19.0405,18.9289,18.8173,18.7057,18.5941,18.4825,18.3709,18.2593,18.1477,18.0361,17.9245,17.8129,17.7013,17.5897,17.4781,17.3665,17.2549,17.1433,17.0317,16.9201,16.8085,16.6969,16.5853,16.4737,16.3621,16.2505,16.1389,16.0273,15.9157,15.8041,15.6925,15.5809,15.4693,15.3577,15.2461,15.1345,15.0229,14.9113,14.7997,14.6881,14.5765,14.4649,14.3533,14.2417,14.1301,14.0185,13.9069,13.7953,13.6837,13.5721,13.4605,13.3489,13.2373,13.1257,13.0141,12.9025,12.7909,12.6793,12.5677,12.4561,12.3445,12.2329,12.1213,12.0097,11.8981,11.7865,11.6749,11.5633,11.4517,11.3401,11.2285,11.1169,11.0053,10.8937,10.7821,10.6705,10.5589,10.4473,10.3357,10.2241,10.1125,10.0009,9.8893,9.7777,9.6661,9.5545,9.4429,9.3313,9.2197,9.1081,8.9965,8.8849,8.7733,8.6617,8.5501,8.4385,8.3269,8.2153,8.1037,7.9921,7.8805,7.7689,7.6573,7.5457,7.4341,7.3225,7.2109,7.0993,6.9877,6.8761,6.7645,6.6529,6.5413,6.4297,6.3181,6.2065,6.0949,5.9833,5.8717,5.7601,5.6485,5.5369,5.4253,5.3137,5.2021,5.0905,4.9789,4.8673,4.7557,4.6441,4.5325,4.4209,4.3093,4.1977,4.0861,3.9745,3.8629,3.7513,3.6397,3.5281,3.4165,3.3049,3.1933,3.0817,2.9701,2.8585,2.7469,2.6353,2.5237,2.4121,2.3005,2.1889,2.0773,1.9657,1.8541,1.7425,1.6309,1.5193,1.4077,1.2961,1.1845,1.0729,1.0000,0.9500,0.9000,0.8500,0.8000,0.7500,0.7000,0.6500,0.6000,0.5500,0.5000,0.4500,0.4000,0.3500,0.3000,0.2500,0.2000,0.1500,0.1000,0.0500,0.0000]

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Tinit = #initial temperature for 31 (depth) x 201 (length) 2-D array
[28.129,28.0304,27.9286,27.8248,27.7196,27.6136,27.5073,27.4008,27.2945,27.1884,27.0827,26.9775,26.8727,26.7681,
28.129,28.08,27.9676,27.8567,27.7453,27.6337,27.5221,27.4105,27.2989,27.1873,27.0757,26.9641,26.8525,26.7409,26.6293,26.5177,26.4061,26.2945,26.1829,26.0713,25.9597,25.8481,25.7365,25.6249,25.5133,25.4017,25.2901,25.1785,25.0669,24.9553,24.8437,24.7321,24.6205,24.5089,24.3973,24.2857,24.1741,24.0625,23.9509,23.8393,23.7277,23.6161,23.5045,23.3929,23.2813,23.1697,23.0581,22.9465,22.8349,22.7233,22.6117,22.5001,22.3885,22.
```