Third Assignment

Salar Rezayani

Upwind method in convection term

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In this program upwind method has been used for finding proper coefficients of phi in convection term.

In last assignment the problem was at bilinear interpolation of phi.

The way we find the upwind is with making a line from each integration points with the level of the velocity vector at the starting at integration point and to the opposite of its direction. So there will be only one intersection with 4 line of that element.

Then calculating the distance of the intersection point from the points which it is in middle of them and then calculating the coefficient of them and applying it to a matrix 4x4 to be coefficients of convection term in calculating C matrix of our first and second assignment.

The order of error is lower than last assignment.

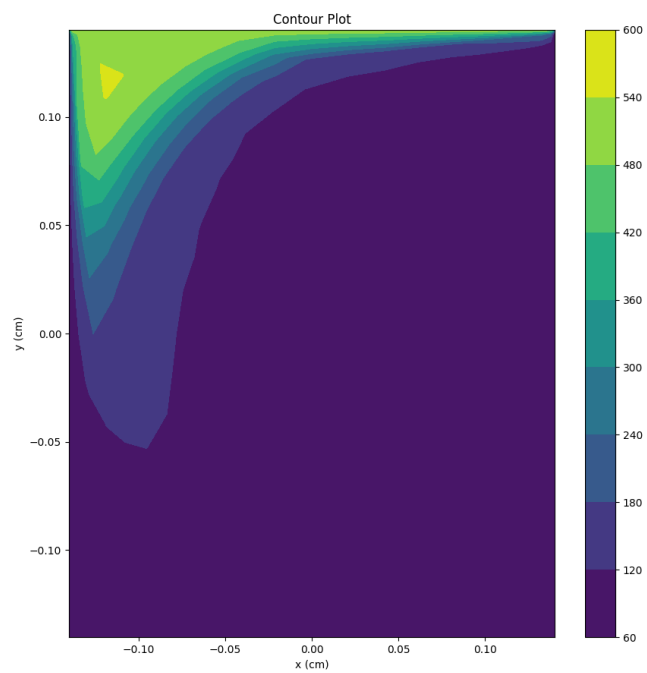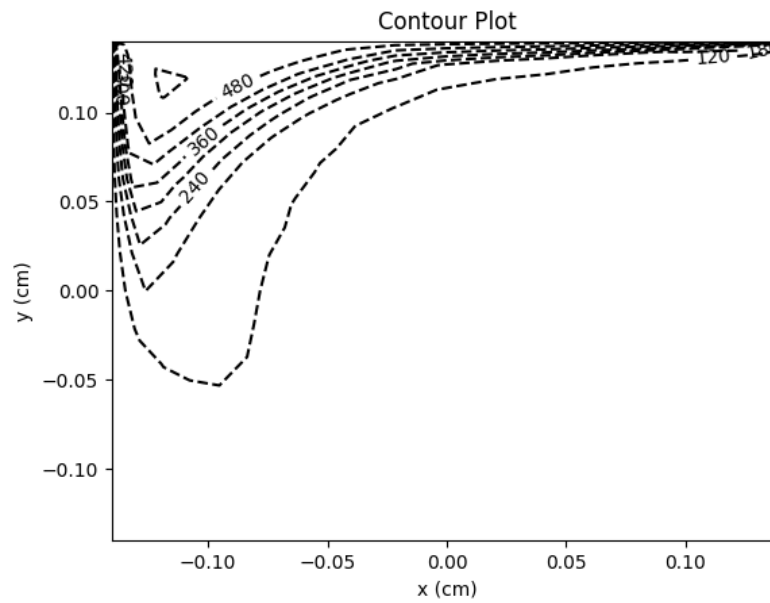Here we are presenting the best answers of calculation

Best answer for peclet 480
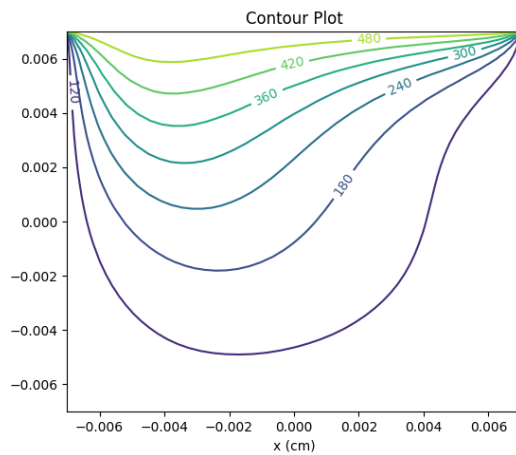
Best answer: grid 31x31 iteration 40000 dt 0.01 a 0.02

Contour Plot

Contour Plot
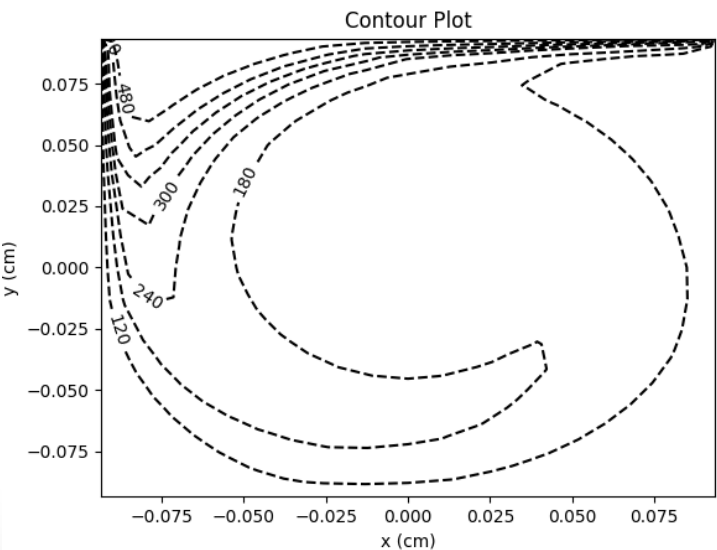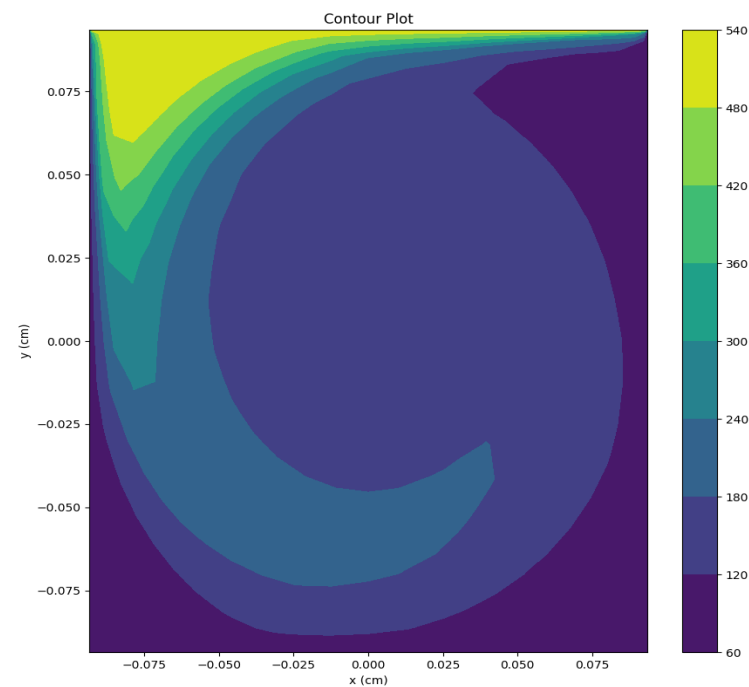
Transient answer

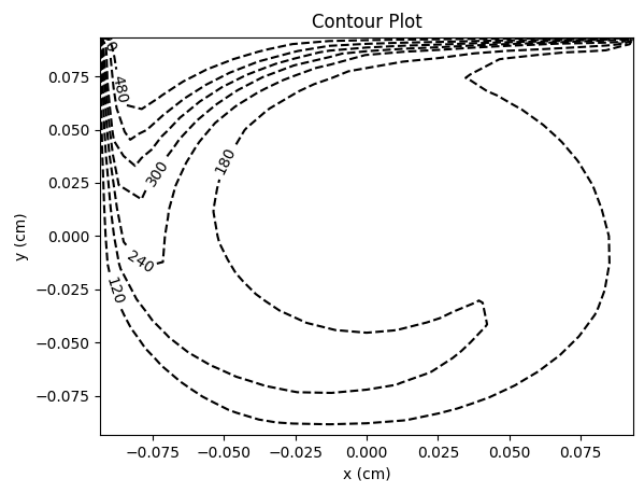Grid 31x31, dt=0.02 a=-0.02 iteration 1000

Comparing bilinear interpolation and upwind method

Bilinear interpolation: grid 47x47

Upwind method: grid 31x31

As it can be seen in up wind method we have achieved better result.

The cavity has been captured better in this method, even the number of grid in BL is grater than number of grid in cavity

The order of upwind method is 1 but for Bilinear interpolation it is 2 and by make the grid bigger the error makes bigger in bilinear interpolation.

Also in upwind method there is more likely to find a good answer because of more accuracy and being near to the physical modeling of the system. In bilinear there is no attention to the physic and movement of the flow but in this model we have applied th physics to. But it is not well enough because we are neglecting the govering equation.
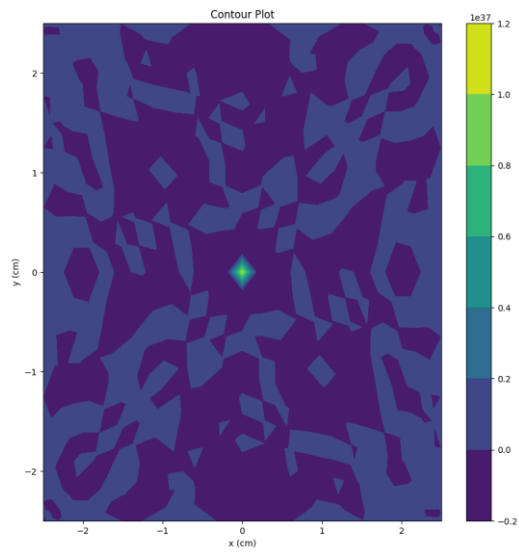
For example for

Peclet 110: dt : 0.01 grid 23x23

Also the upwind method needs more calculations at the grid generation which is not a high amount.
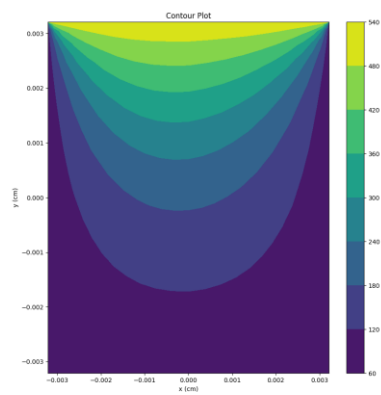
Some ill answers:
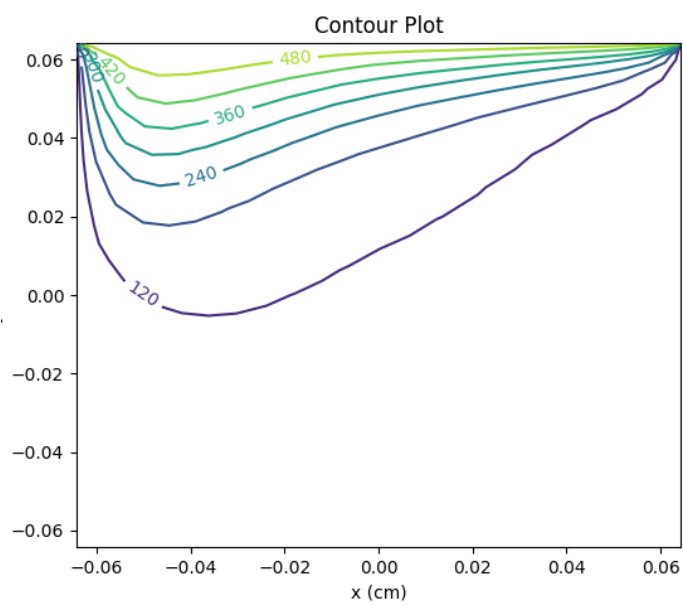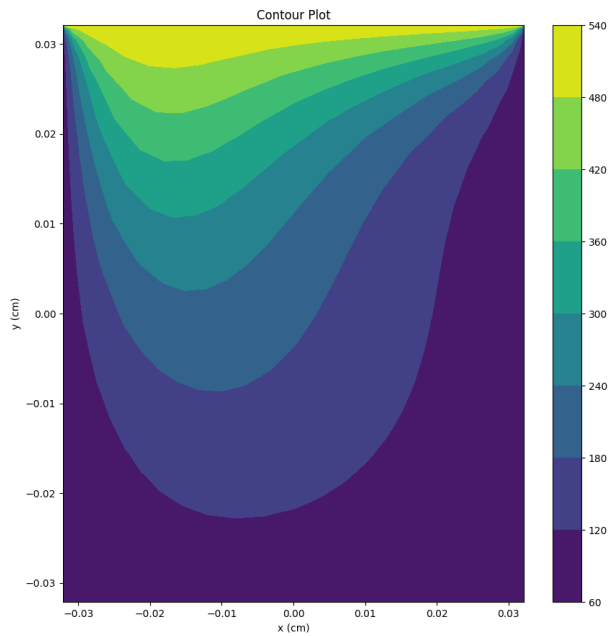
Peclet 11000

grid=15x15 t=0.1 a=0.1

An answer for peclet 110 grid 23x23 dt0.1
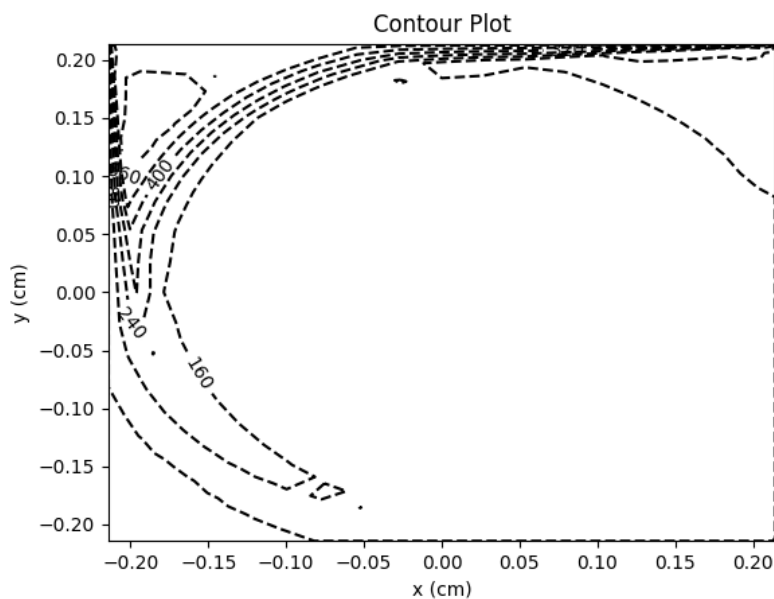
Big dt make huge error
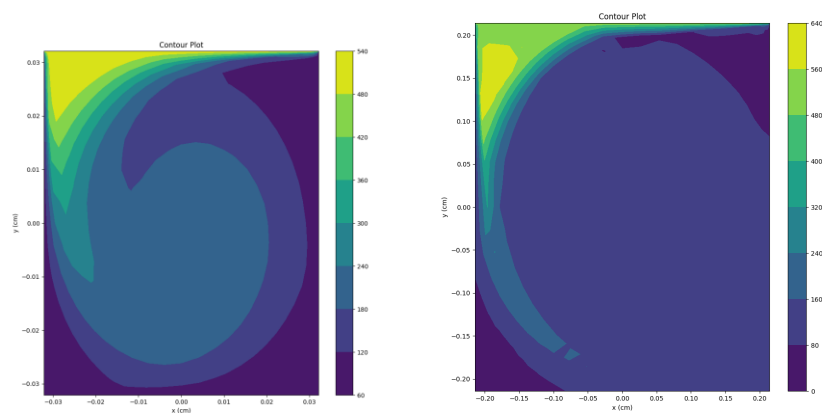
Peclet 110 best result:

Gerid: 31x31 dt:0.02 a:0.03

Contour Plot

y (cm)

x (cm)

Contour Plot

480

420
360

360

240

240

120

120

x (cm)

Peclet 1100 Best result:

Grid: 25x25 itteration 8720 dt 0.01 a 0.03

Contour Plot
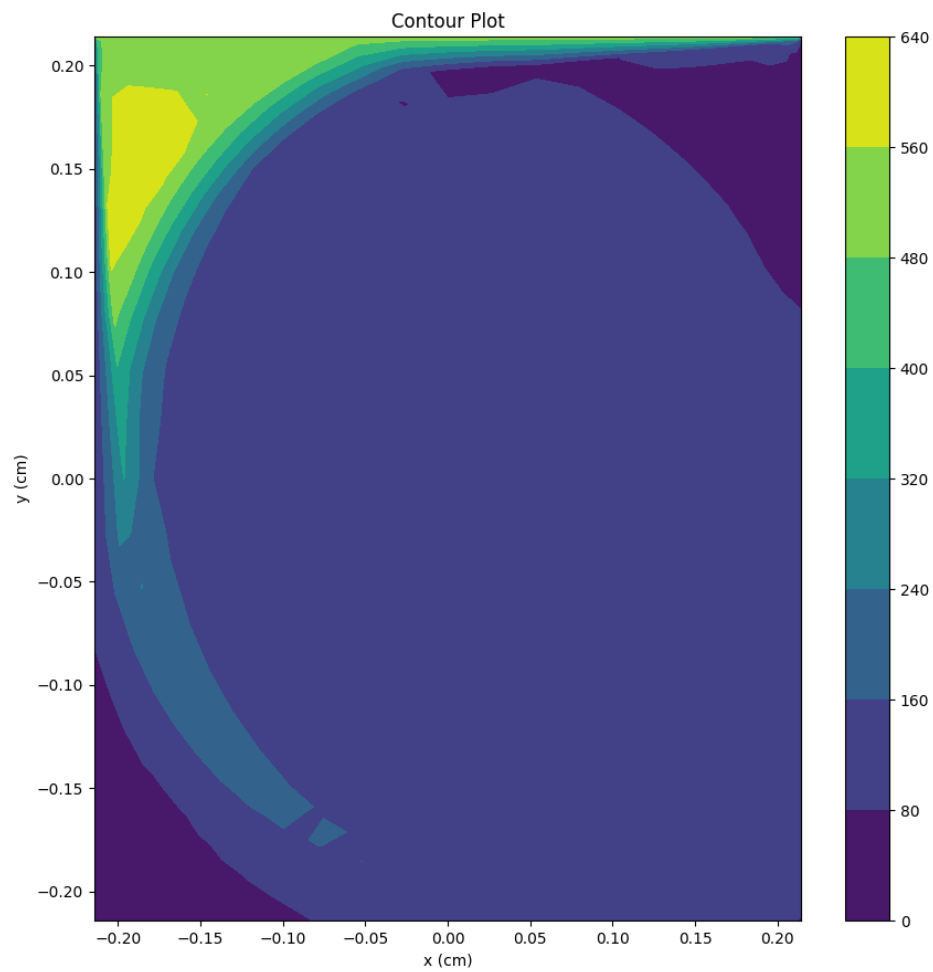
Comparing peclet number 1100 B-L and upwind method

The type of cavity formed in up wind method is more near than actual real problem since ther is a circulation at the middle of the page. The circular velocity field makes it.

Conclusion:

By comparing the style of cavity made in our box the accuracy of b-l method is under consideration. Because by B-L method there is no attention to the upwind direction, the properties are just calculated by some constant coefficients, with no respect to the physic and value or direction of speed, and being on a just mathematical perspective, there is a randomness in achieving good answers.

The error order of upwind method is first order but we have second order of error in Bilinear interpolation. This make grate error when making our grid smaller in bilinear interpolation which make harder to explore for better answers.

Both of this modeling are not well enough because we are neglecting governing equations.

Thank you for your kind attention!