OpenFoam Assignment | The Lid-Driven Cavity

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Abstract. –SAMPLE ABSTRACT–

Keywords: computational fluid dynamics, CFD, incompressible, Paraview, R, Python, coe347, spring 2022

1. Some Text

2. Motivation

why cavity is important

3. Implementation

We implement all simulation with OpenFoam, analysis with Paraview and Python3 , and documentation code in R (Xie; 2021a; Urbanek; 2021; Xie; 2021b; Bengtsson; 2021; Allaire et al.; 2021; Xie; 2013, 2015, Xie (2014),Xie et al. (2018),Xie et al. (2020)).

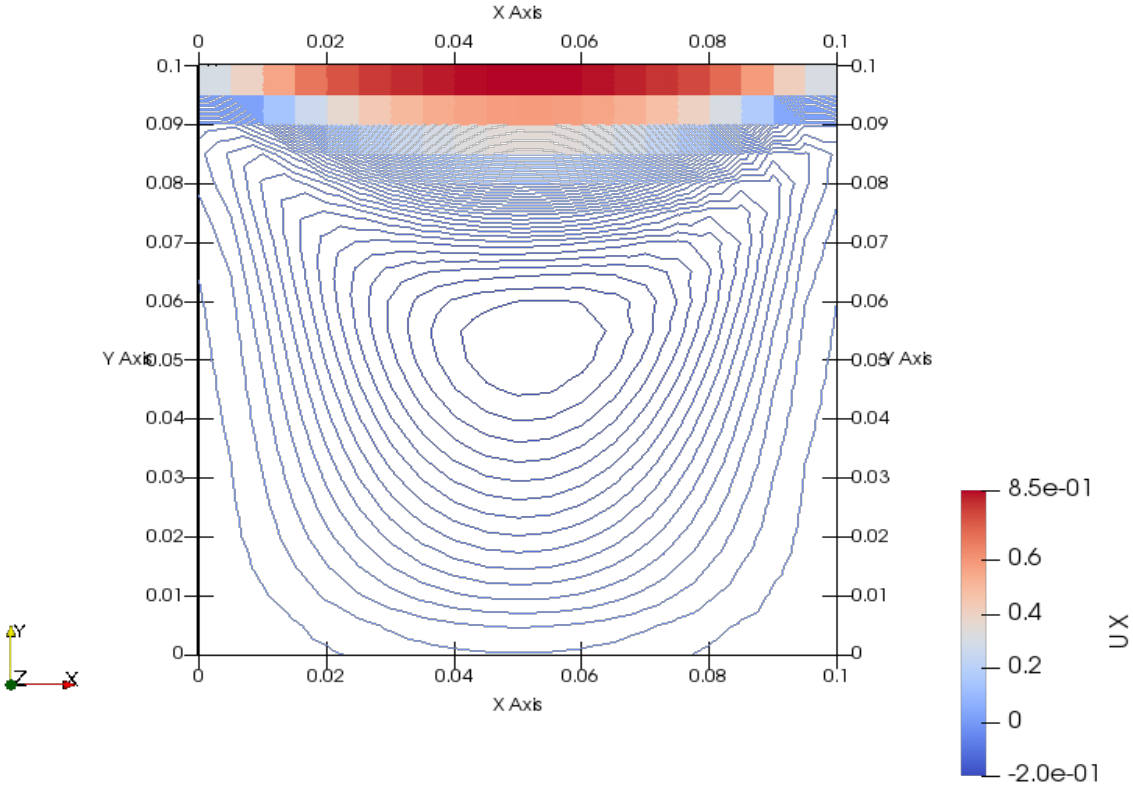
– some text —

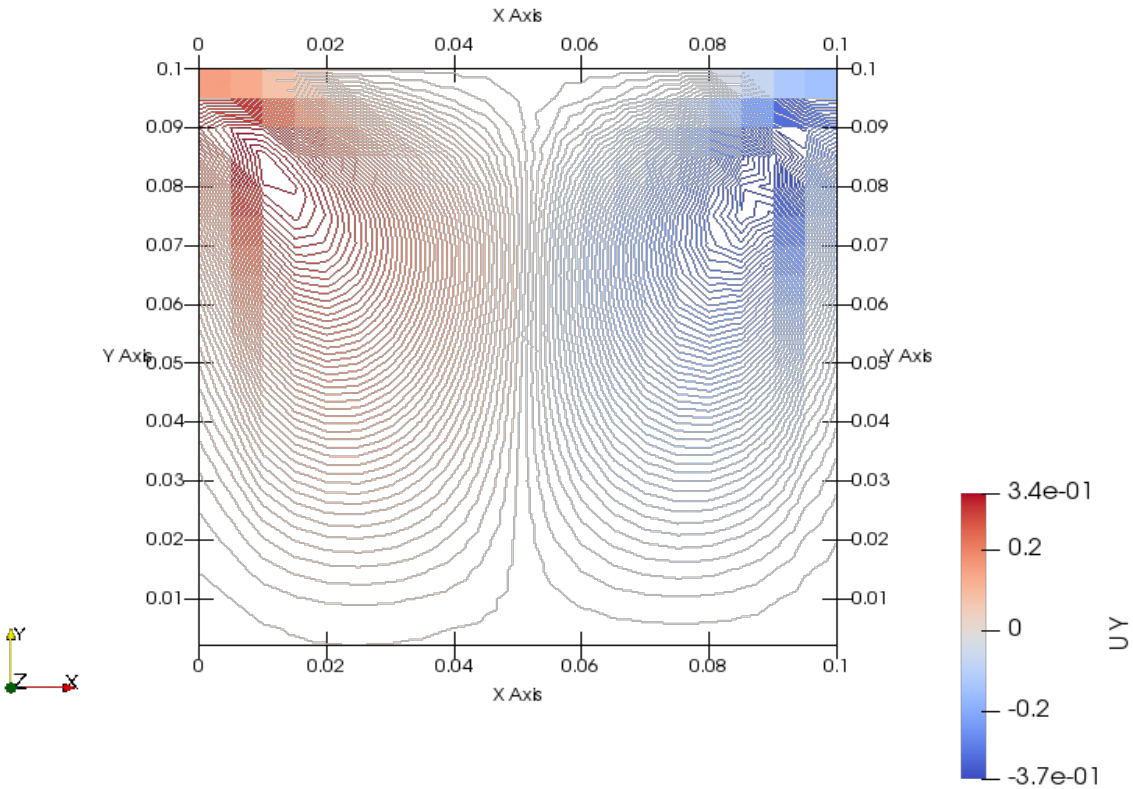
4. Description of the flow for Re = 10

Following is the solution to the lid-driven cavity with lid velocity $U_0 = 1\frac{m}{s}$ to the right, a characteristic length $L = 0.1m$, and kinematic viscosity $\nu = \frac{\mu}{\rho} = 0.01\frac{m^2}{s}$, yielding a Reynolds number of $Re = \frac{UL}{\nu} = 10$. Note the upper plane ($y = 0.1m$) represents the moving lid.

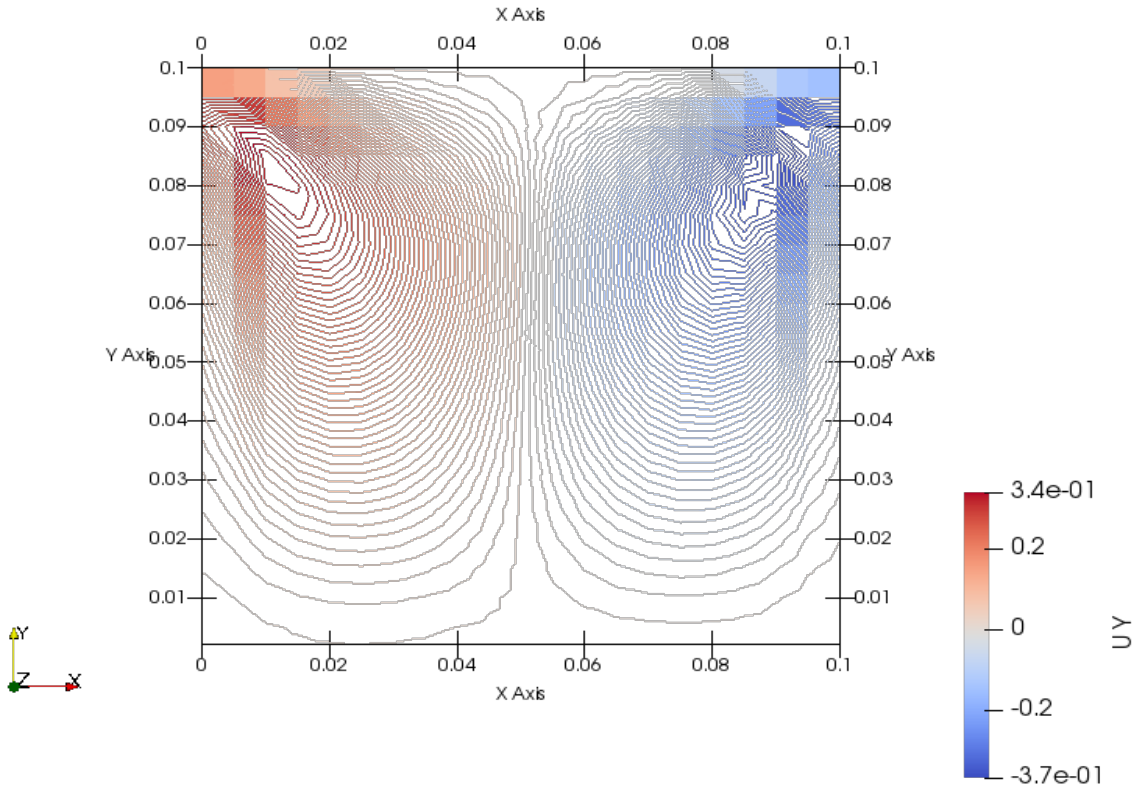
Please note that all output variables have been nondimensionalized to allow for easier comparision. So we report $\pi = \frac{P}{\rho}$ pressure, and $\tilde{u} = \frac{U}{U_0}$, $\tilde{v} = \frac{V}{U_0}$.

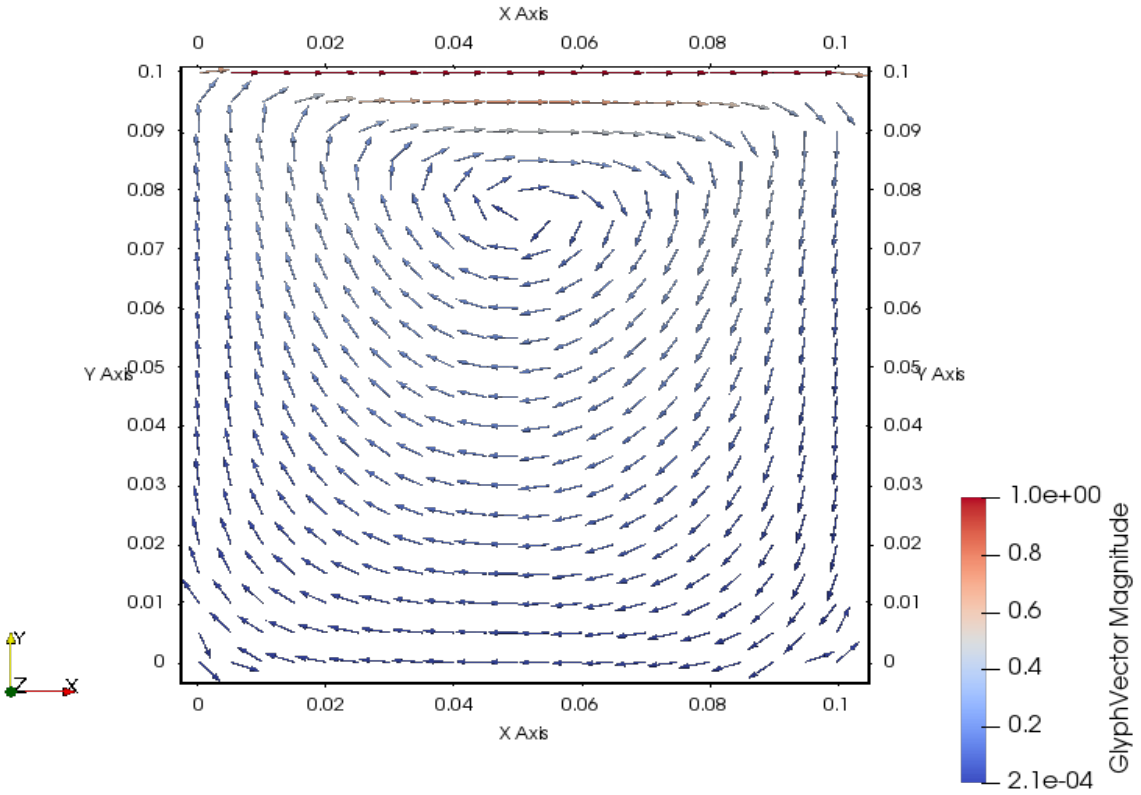
Contour plots for the X and Y components of fluid velocity:


X Axis
0
0.02
0.04
0.06
0.08
0.1
Y Axis
0.09
0.07
0.05
0.03
0.01
8.5e-01
0.6
0.4
0.2
0
-2.0e-01
UX
Y
Z
X

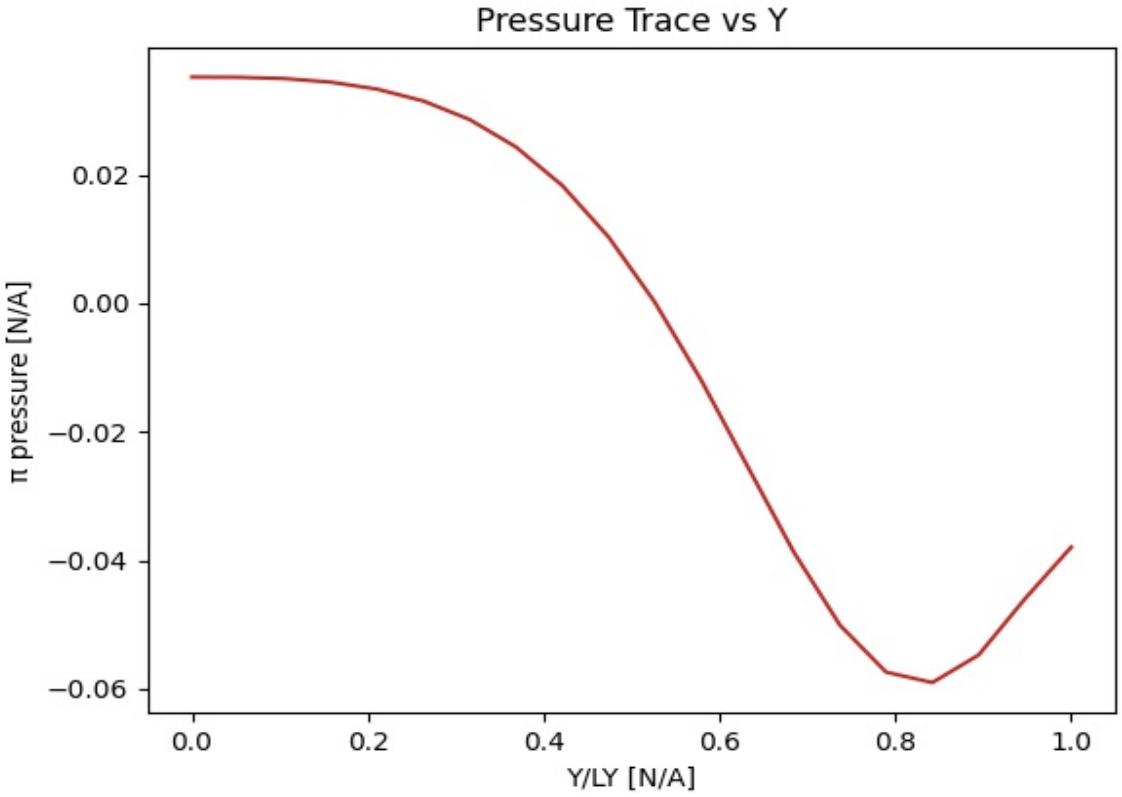

X Axis
0
0.02
0.04
0.06
0.08
0.1
Y Axis
0.09
0.07
0.05
0.03
0.01
3.4e-01
0.2
0
-0.2
-3.7e-01
UY
Y
Z
X

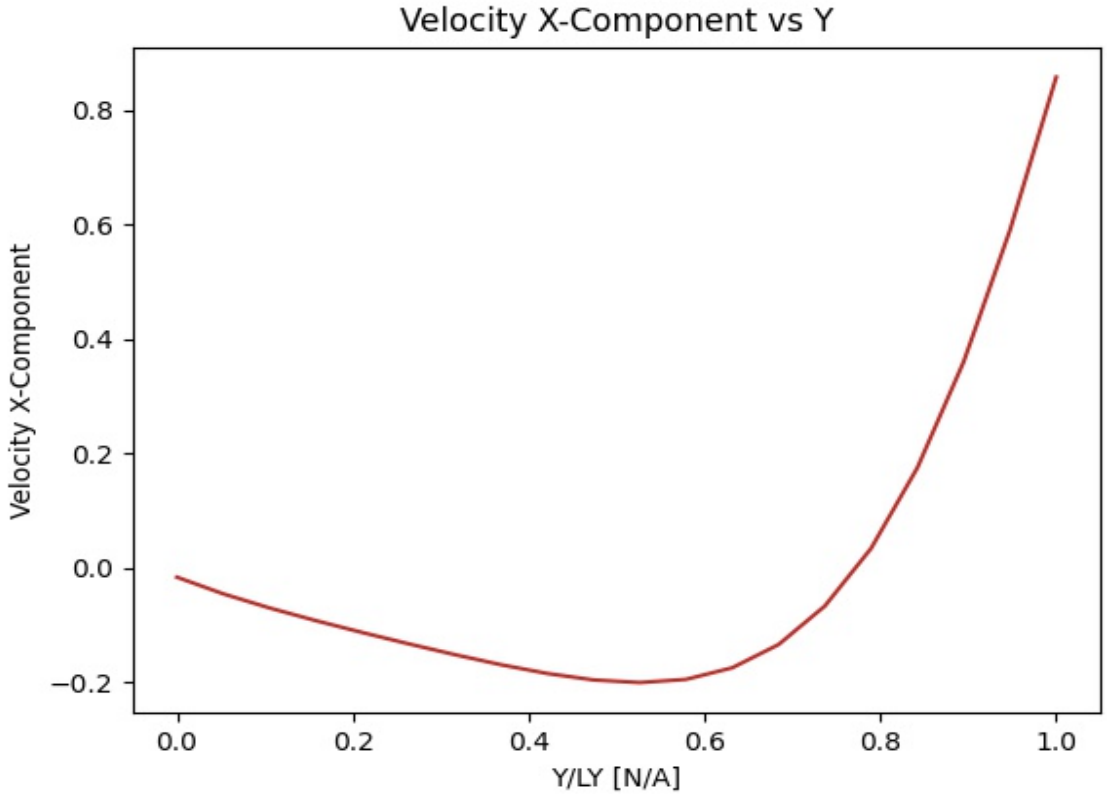
A streamline plot, and a glyph-based plot to show velocity direction:

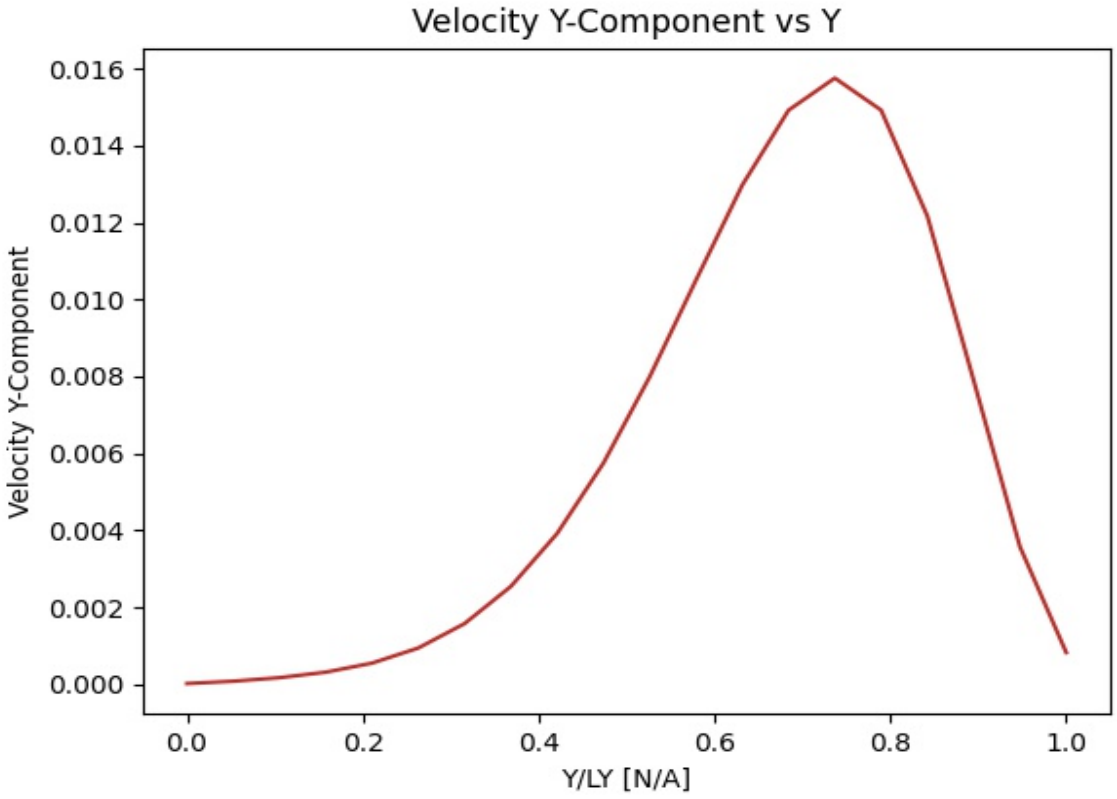




A pressure and velocity profile sampled along the midline: $\tilde{x} = 0.5$, in component form. Respectively, $\pi(\tilde{x} = 0.5, \tilde{y})$, $\tilde{u}(\tilde{x} = 0.5, \tilde{y})$, $\tilde{v}(\tilde{x} = 0.5, \tilde{y})$.

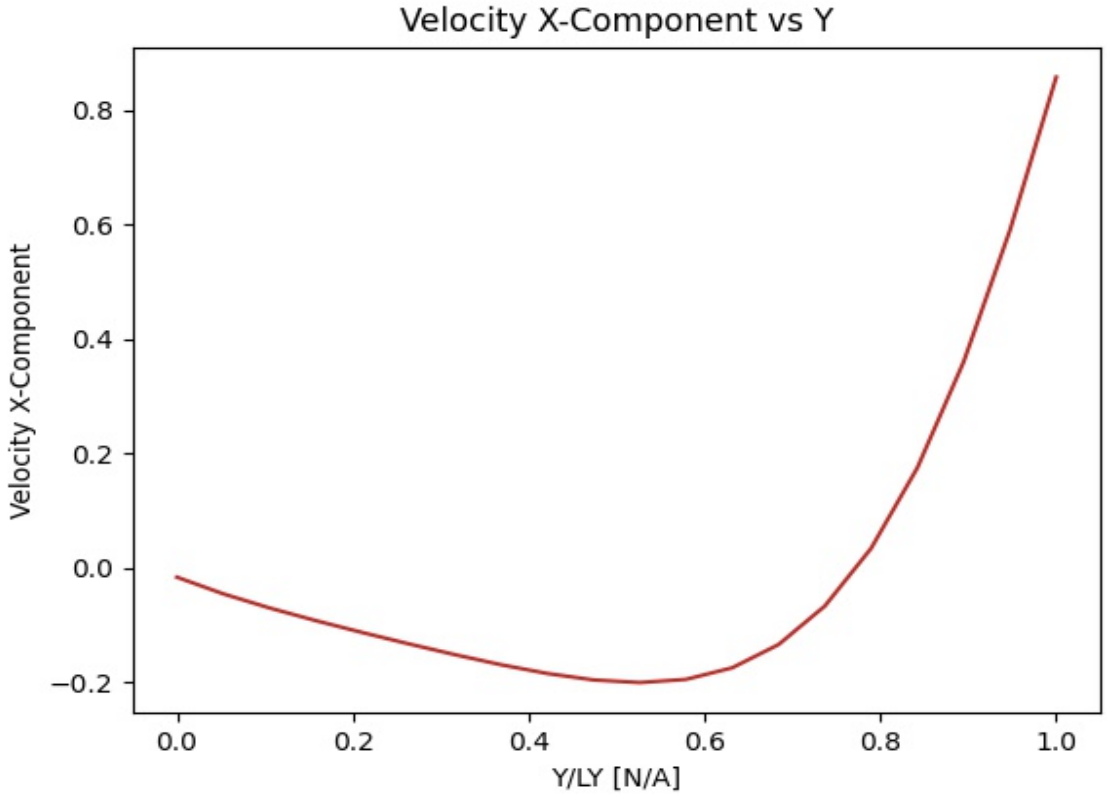

Pressure Trace vs Y
π pressure [N/A]
0.02
0.00
−0.02
−0.04
−0.06
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]

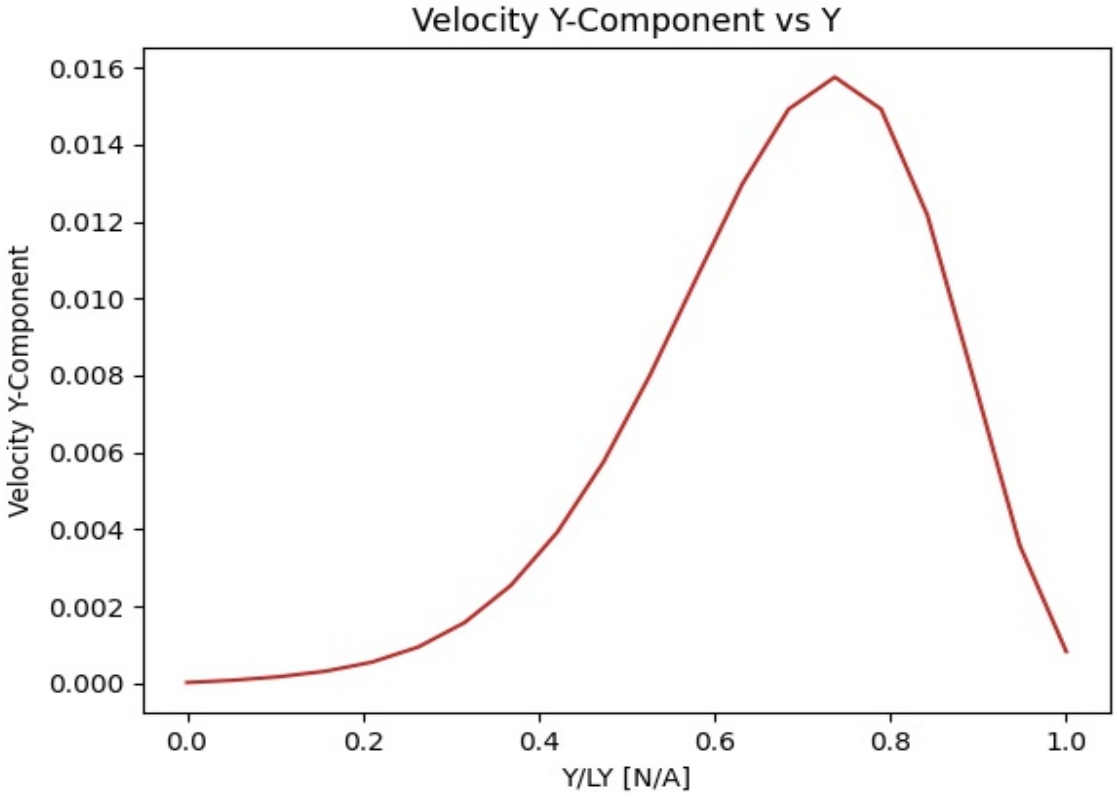

Velocity X-Component vs Y
Velocity X-Component
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]

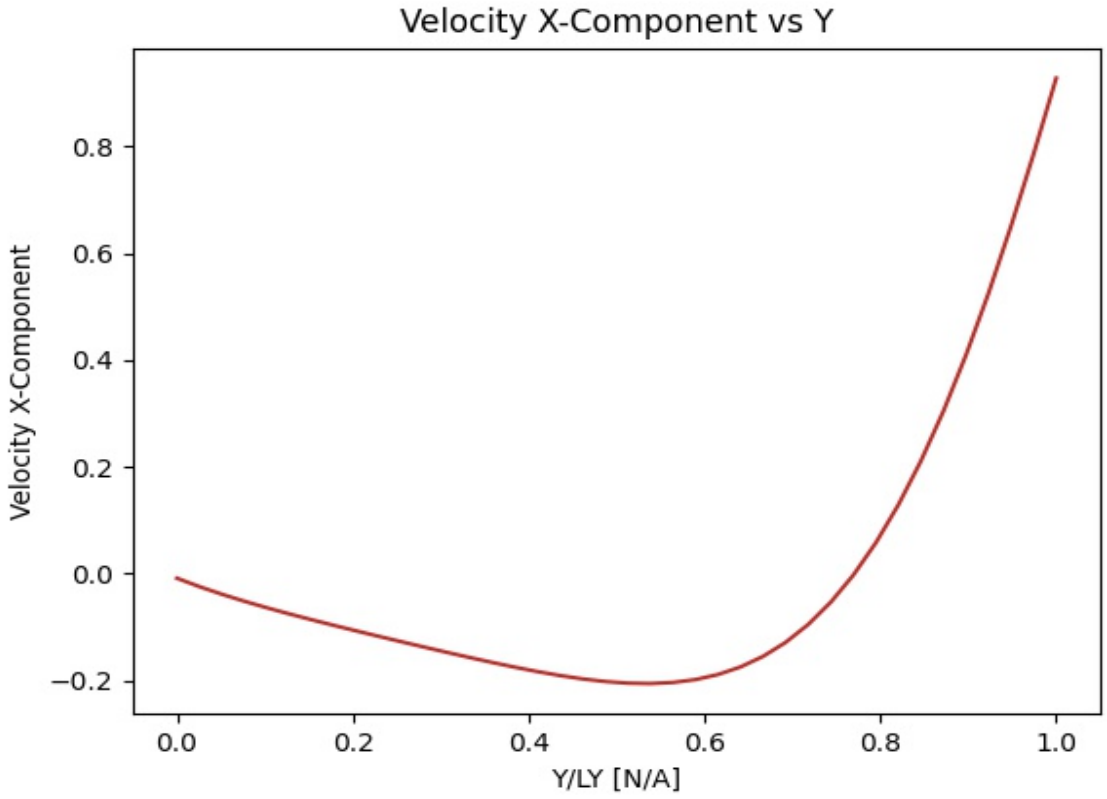


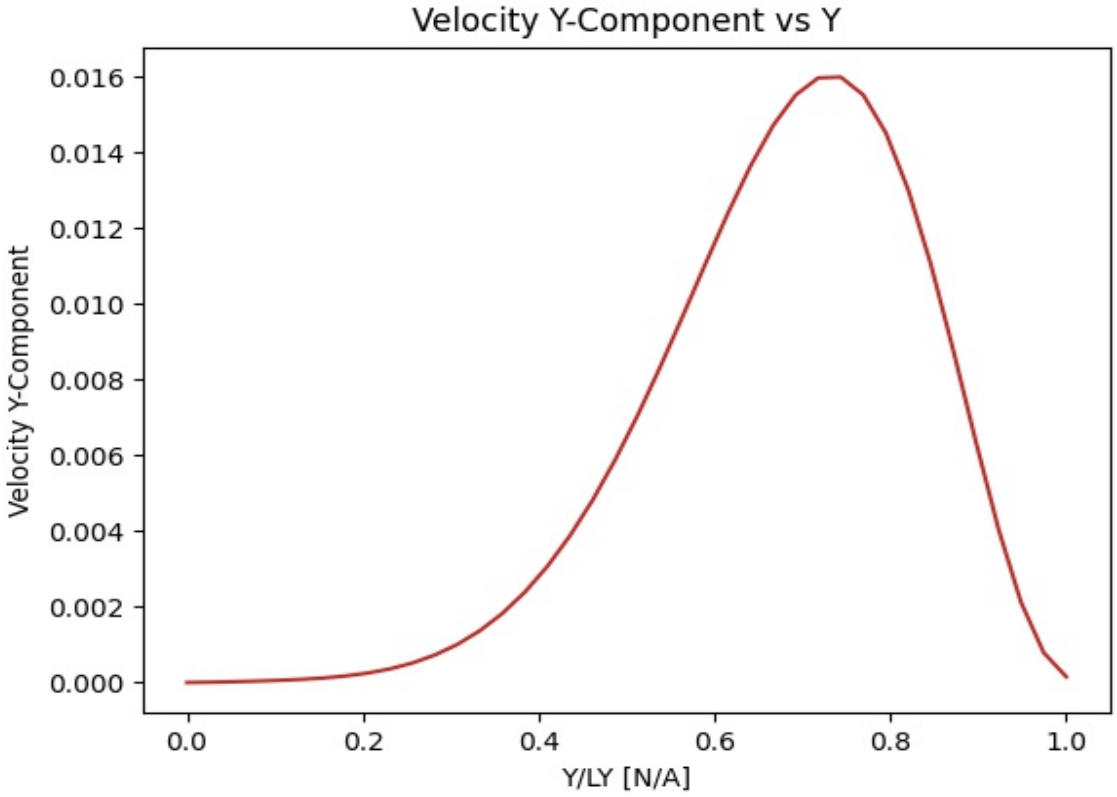
5. Refining the solution

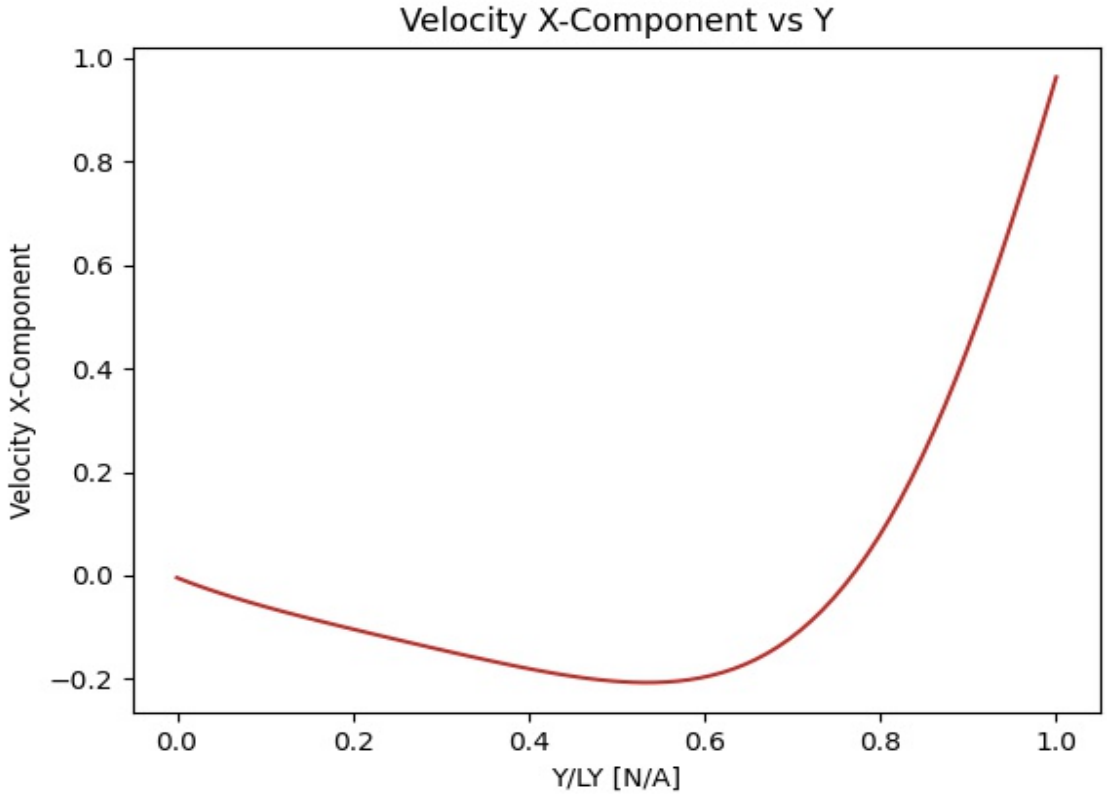
We will demonstrate the increase in image fidelity due to finer discretization. The earlier midline velocity profiles: $\tilde{u}(\tilde{x} = 0.5, \tilde{y})$, $\tilde{v}(\tilde{x} = 0.5, \tilde{y})$ are successively halved in binwidth (grid size) in all directions: x, y, and t, for comparision.

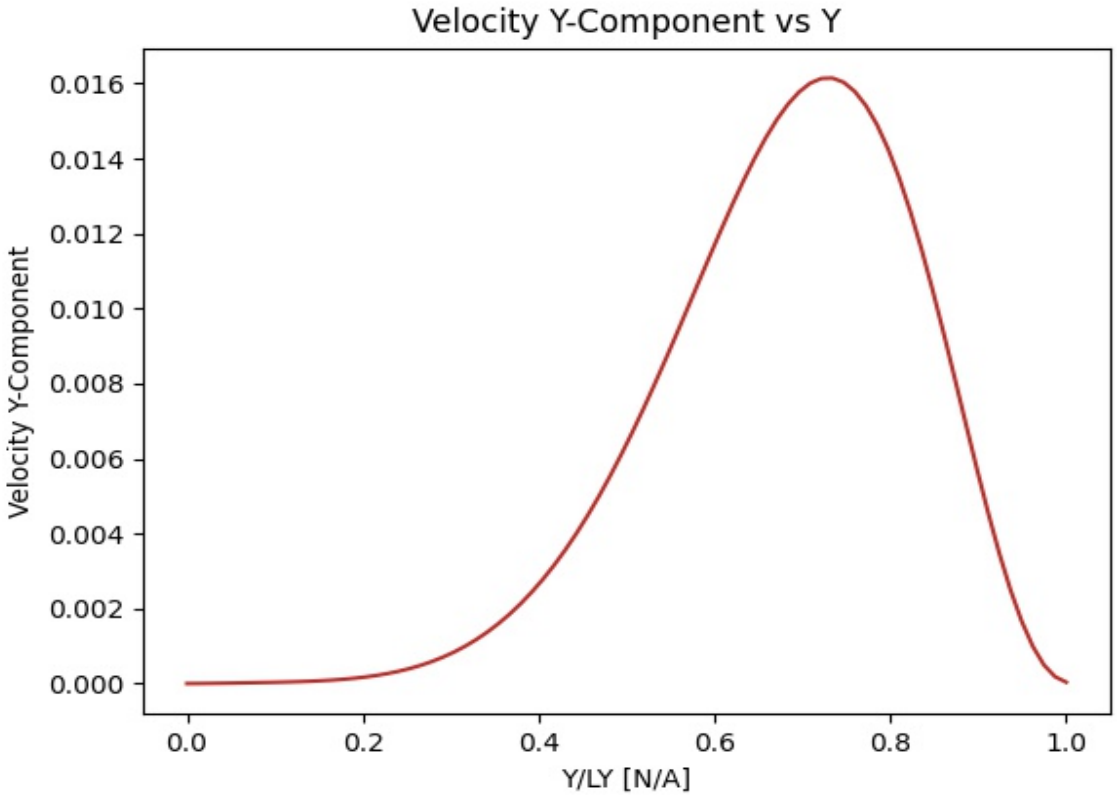

Velocity X-Component vs Y
Velocity X-Component
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]

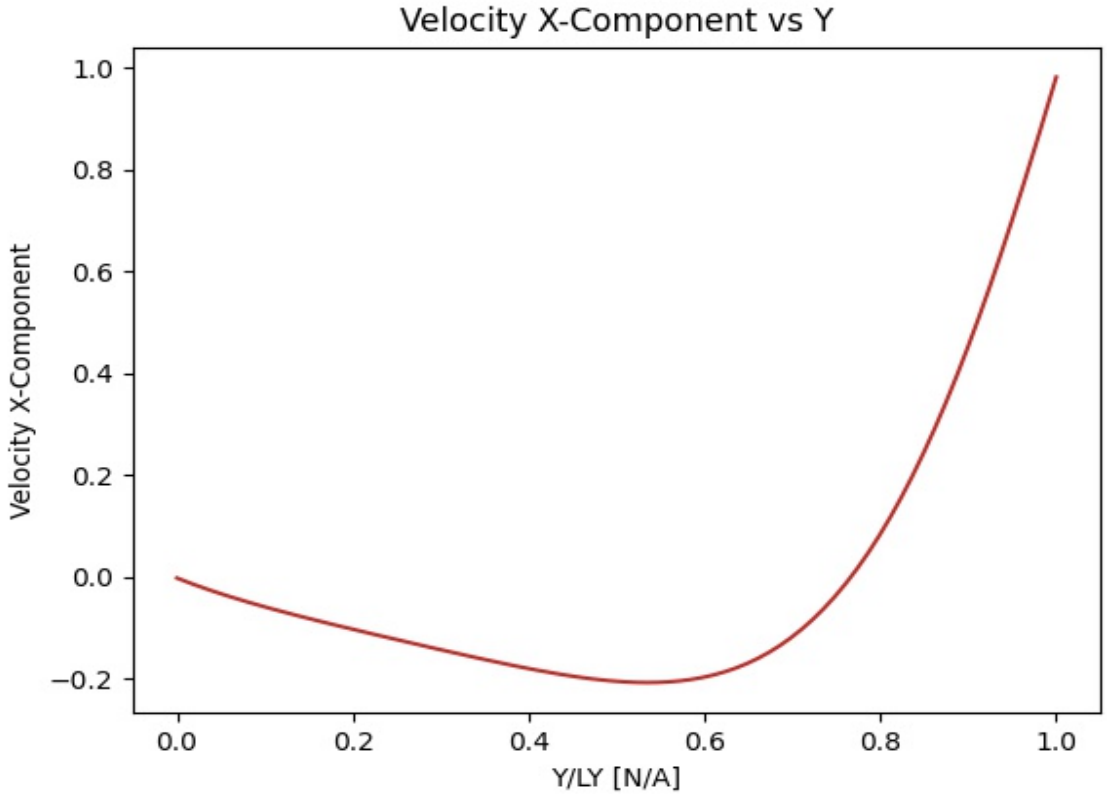

Velocity Y-Component vs Y
Velocity Y-Component
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]

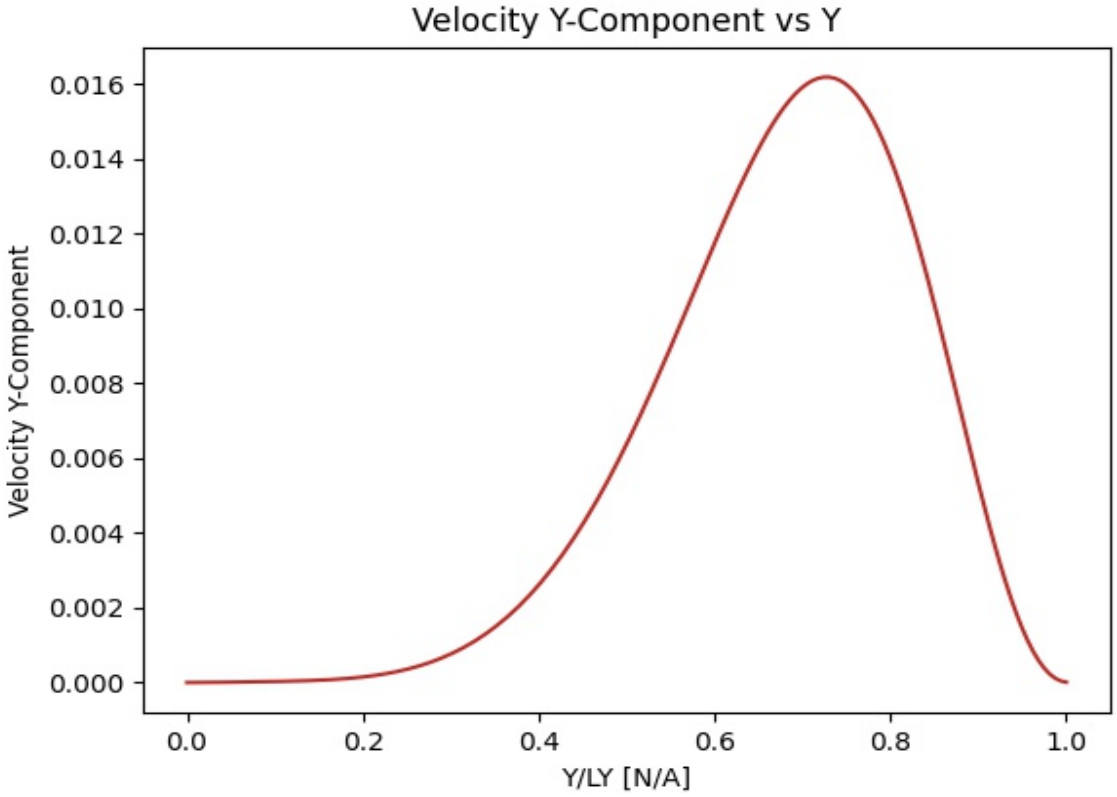

Velocity X-Component vs Y
Velocity X-Component
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]

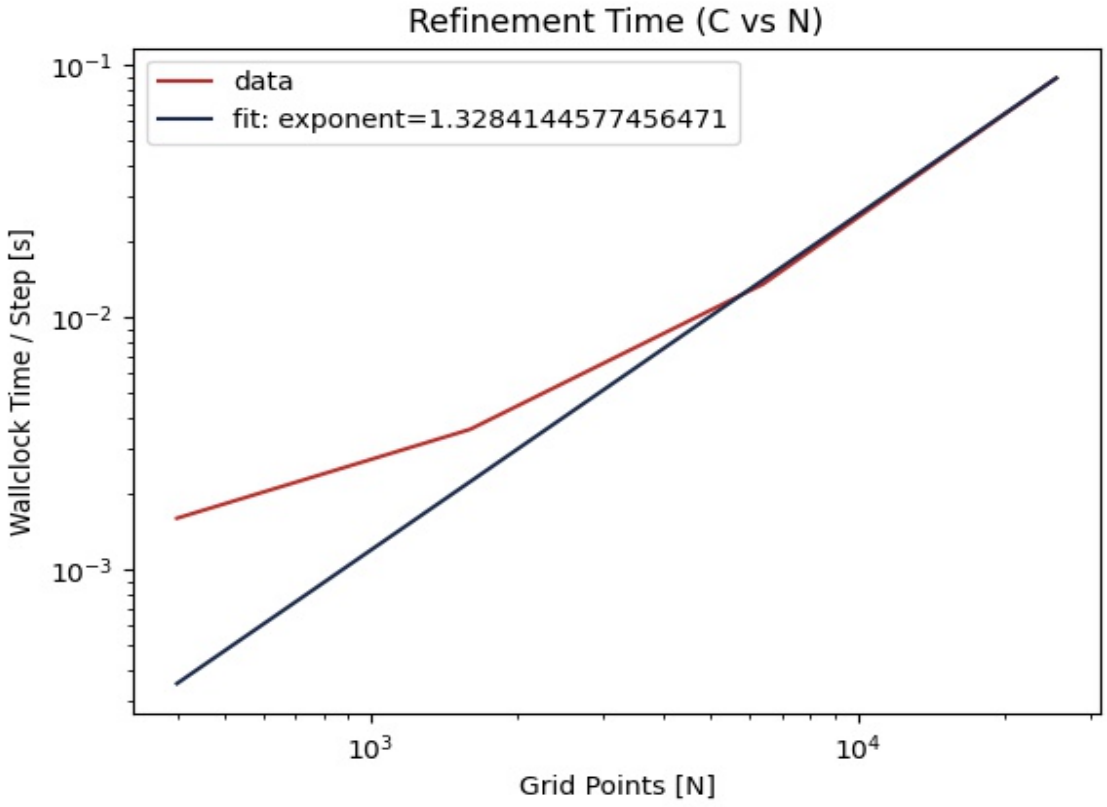

Velocity Y-Component vs Y
Velocity Y-Component
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]


Velocity X-Component vs Y
Velocity X-Component
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]


Velocity Y-Component vs Y
Velocity Y-Component
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]


Velocity X-Component vs Y
Velocity X-Component
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]


Velocity Y-Component vs Y
Velocity Y-Component
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0.0
0.2
0.4
0.6
0.8
1.0
Y/LY [N/A]



6. Conclusion

–conclusion here–

References

Appendix

Thank you so much for reading this work!

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URL: *https://bookdown.org/yihui/rmarkdown-cookbook*