FluidMonster user’s guide

# Purpose of code

FluidMonster is able to provide **different numerical solvers** to solve 2-dimensional incompressible flow problems. The code is able to handle simple scenarios without obstacle in the domain and was tested on Lid-Driven Cavity flow. The variety of solvers enable the user to choose the most suitable solver to the problem.

# How to choose my solver?

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| --- | --- | --- | --- | --- |
| **Solver list** | **Suitable for** | **Disclaimer** | **(1) Number of iterations scaling** | **(2) Residual convergence** |
| Jacobi (JAC) | Suitable for simple problems with a small domain size and moderate refinement level. Not particularly sensitive for small or large timesteps. | Instabilities may occur for coarse mesh size h>0.02.  (1) In case of very small grid size the simulation time can increase significantly.  (2) In case of large domain, the convergence occurs later. |  | *\*DS indicates DomainSize in x and y* |
| Gauss-Seidel (GAS) | Suitable for simple problems with a moderate domain size. Not particularly sensitive for small or large timesteps. Good initial guess increases performance, therefore GAS is a good choice for error reduction near the convergence to gain high accuracy. | Instabilities may occur for coarse mesh size h>0.05.  (1) In case of very small grid size the simulation time can increase.  (2) In case of large domain, the convergence occurs later. |  |  |
| Successive Overrelaxation (SOR) | Suitable for problems with moderate velocity, swirling, or oscillations. Not particularly sensitive for timestep change, nor grid refinement (1). | Due to overrelaxation tolerance can be reached fast, but the minimum number of iterations is 2 (cannot reduce to 1).  Residual oscillates at each iteration loop due to relaxation (2). | *\*Scaling changed!* | *\*NOC indicates Number of Cells in the domain* |
| Multigrid V 5-cycle (MGV) | Suitable for problems with defined size of power 2 series, arbitrary complexity and refinement level. Working best for high hard problems (oscillation). | Fast convergence with low number of iterations. Less benefit near the convergence tolerance due to increased number of iterations within a cycle. | *\*PS indicates Problem Size (equivalent with NOC, but with h=0.02 at each case)* | *\*PS indicates Problem Size (equivalent with NOC, but with h=0.02 at each case)* |
| Multigrid W 5-cycle (MGW) | Suitable for problems with defined size of power 2 series, arbitrary complexity and refinement level. Working best for high hard problems. | Very fast convergence with low number of iterations. Less benefit near the convergence tolerance due to increased number of iterations within a cycle. |  |  |
| Conjugate Gradient (CG) | Suitable for simple problems with a moderate domain size. Good initial guess can increase performance; therefore, CG can be a good choice for error reduction near the convergence to gain high accuracy. | (1) In case of very small grid size the simulation time can increase (~linearly).  (2) In case of large domain size, the convergence occurs later. |  |  |
| Adaptive (ADAPTIVE) | Suitable for problems with arbitrary size, complexity and refinement level. | NONE | *\*Iterations taken for an oscillatory problem* | *\*Solving of the pressure Poisson equation* |

# How to run the code

1. First, use the following commands in your terminal
2. git clone https://gitlab.lrz.de/raghav\_tv/fluidchen-skeleton.git
3. mkdir build && cd build
4. cmake ..
5. make
6. make install
7. Secondly, adjust the user settings in the case.dat file, that can be found in the example\_cases corresponding folder

* size of domain, number of cells, time steps, nu (kinematic viscosity of fluid)
* output frequency (for visualization), itermax (max iteration taken in a pressure solver loop)
* pressure solver (JAC, GAS, SOR, MGV, MGW, CG, ADAPTIVE) Please note, that the default starting solver for ADAPTIVE is MGV. This can be changed, however not recommended.
* oscillation (0=off, 1=on, frequency)

1. Run with the command ./fluidchen “address\_to\_the\_folder”/fluidchen/example\_cases/LidDrivenCavity/LidDrivenCavity.dat and enjoy the amazing results.