

## Multigrid methods – two levels

- The web page, link Multigrid methods:  
link [http://msekcce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS\\_source/MG/index.html](http://msekcce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS_source/MG/index.html)  
files: [MG.f90](#), [Makefile](#), [mg.data](#)
- Go through the code `MG.f90` to see the algorithmization of two-grid method
- Using the code `MG.f90`, reproduce the smoothing property of Jacobi solver. What does happen if we put  $\mathbf{u}_h^0 = 0$  (initial approximation)?
- Using the code `MG.f90`, compare MG method with the direct solver and the iterative solver on the coarse grid level.
- Using the code `MG.f90`, try the restriction operator given by

$$d_{2h,i} := d_{h,2i}, \quad i = 1, 2, \dots, (N-1)/2.$$

- Modify the code and test it for the Jacobi method without the damping.
  - Modify the code and test it for the Gauss-Seidel method.
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### output files

- `fort.100`, `fort.101`, `fort.102`, ... – damped Jacobi only
- `fort.200`, `fort.201`, `fort.202`, ... – multigrid method

### visuzalization in gnuplot

- `p 'fort.101' u 1:2 w l` – solution
- `p 'fort.101' u 1:5 w l` – error  $u_h^k - u_h$
- `p 'fort.101' u 1:4 w l` – error  $u_h^k - u(x_k)$

## Multigrid methods – full levels

- The web page, link Multigrid methods:  
link [http://msekce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS\\_source/MG/index.html](http://msekce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS_source/MG/index.html)  
files: [MG\\_full.f90](#), [Makefile](#)
  - Go through the code `MG_full.f90` to see the algorithmization of multigrid method
  - Demonstrate the convergence of order  $O(N)$  by choosing different  $N = 2^m + 1$ , (e.g.,  $m = 6, 8, 10, 12$ )
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### output files

- `fort.500`, `fort.501`, `fort.502`, ... – multigrid method solution in loops  $i = 0, 1, 2, \dots$
- `fort.16`, `fort.18`, `fort.20`, ... – multigrid method convergence of residual (number of files corresponds  $10 + m$ ,  $m = \text{level}$ )

### visualization in gnuplot

- `p 'fort.501' w lp` – solution
- `p 'fort.16' w lp, 'fort.18' w lp, 'fort.20' w lp` – convergence of residual for  $m = 6, 8, 10$