BaNaNa talk

Gabriela Diaz *

*Email: g.b.diazcortes@tudelft.nl
†Delft Institute of Applied Mathematics
Delft University of Technology
Delft, The Netherlands

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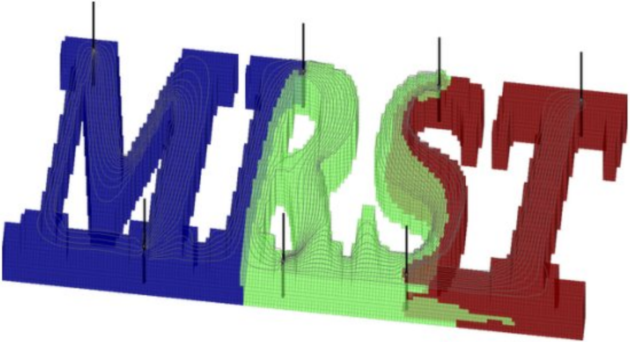


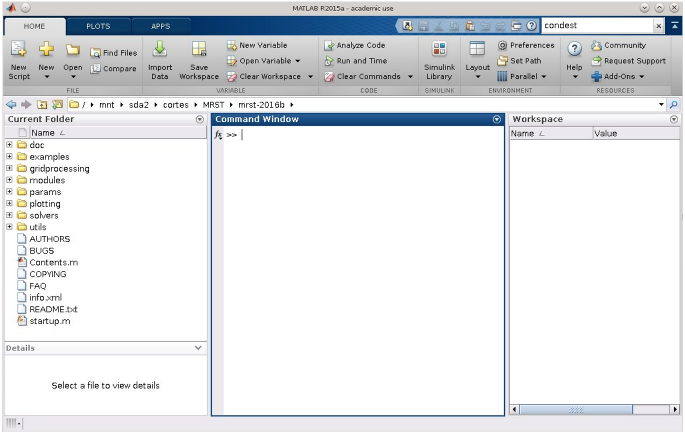
Developed by the Computational Geosciences group in the Department of Applied Mathematics at SINTEF ICT.

Website:

- http://www.sintef.no/projectweb/mrst/

How to start??

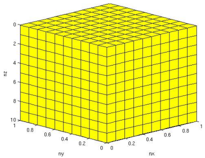
- Download from website
- Run the startup program



- Start

Grid construction.

- Cartesian grids.
  Length of the domain: Lx, Ly, Lz
  Number of cells: nx, ny, nz
  $G = cartGrid([nx\ ny\ nz], [Lx\ Ly\ Lz])$



- Rectangular grids.
- Other.

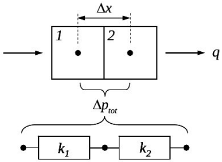
Flow through porous media

Darcy's law + Mass balance equation

$$-\nabla \cdot \left[\frac{\alpha\rho}{\mu} \mathbf{K}(\nabla p - \rho g \nabla d) \right] + \alpha \frac{\partial(\rho\phi)}{\partial t} - \alpha\rho q = 0.$$

$$\frac{\partial}{\partial x}\left(k \frac{\partial p}{\partial x} \right) = \frac{k_{i+\frac{1}{2},j}(p_{i+1,j,l} - p_{i,j,l}) - k_{i-\frac{1}{2},j,l}(p_{i,j,l} - p_{i-1,j,l})}{(\Delta x)^2} + \mathcal{O}(\Delta x^2),$$

$k_{i-\frac{1}{2},j,l}$: harmonic average of the permeability for the cells $(i-1,j,l)$ and (i,j,l) and $T_{i-\frac{1}{2},j,l}$ is the transmissibility between these cells

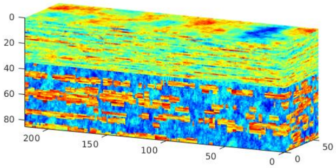


$$k_{i-\frac{1}{2},j,l} = \frac{1}{\frac{1}{k_{i-1,j,l}} + \frac{1}{k_{i,j,l}}}, \qquad T_{i-\frac{1}{2},j,l} = \frac{\Delta y}{\Delta x} \frac{h}{\mu} k_{i-\frac{1}{2},j,l}.$$

$$\mathbf{V}\dot{\mathbf{p}} + \mathbf{T}\mathbf{p} = \mathbf{q}.$$

Define the model.

- Compute Geometry: Define faces, nodes, neighbours of the grid
- Rock: Permeability and Porosity fields
- Fluid: μ, ρ
- Compute transmissibility
- Boundary Conditions: Boundaries, Wells, Sources



Flow through porous media (single phase, compressible)

$$\phi\frac{\rho(\mathbf{p}^{n+1})-\rho(\mathbf{p}^{n})}{\Delta t^n}-\frac{1}{\mu}\nabla\cdot(\rho(\mathbf{p}^{n+1})\mathbf{K}\nabla\mathbf{p}^{n+1})+\mathbf{q}^{n+1}=0.$$

System to solve

$$\mathbf{F}(\mathbf{p}^{n+1};\mathbf{p}^{n})=0.$$

Solution: Newton Raphson

$$\mathbf{J}(\mathbf{p}^{k})\delta\mathbf{p}^{k+1}=\mathbf{b}(\mathbf{p}^{k}).$$

Automatic Diferentiation ADI

$$z=3*exp^{(-x*y)}|_{x=2,y=1}=0.0406$$

$$\frac{\partial z}{\partial x}=-3*y*exp^{(-x*y)}|_{x=2,y=1}=-0.0406$$

$$\frac{\partial z}{\partial y}=-3*x*exp^{(-x*y)}|_{x=2,y=1}=-0.0812$$

Extras

Solvers
Multiphase flow
...

...That's it

Thanks