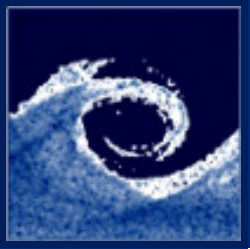


Laboratory tasks I.

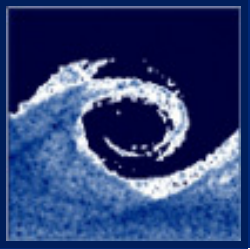
1. Modify icoFoam with additional temperature field (Reference)
   - Create the application directory in your OF home dir
   - Copy icoFoam solver to your application directory
   - Modify the file names and Make properties
   - Add the required modifications to the files

Listing 1: make a copy from original solver

```
1 cd $FOAM_SOLVERS/incompressible
2 mkdir -p $WM_PROJECT_USER_DIR/applications/solvers
3 cp -r icoFoam $WM_PROJECT_USER_DIR/applications/solvers/icoFoamT
4 cd $WM_PROJECT_USER_DIR/applications/solvers/icoFoamT
5 mv icoFoam.C icoFoamT.C
6 rm icoFoam.dep
```

Listing 2: modify Make/files

```
1 icoFoamT.C
2
3 EXE = $(FOAM_USER_APPBIN)/icoFoamT
```



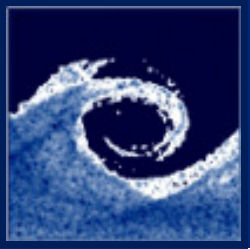
Laboratory tasks II.

Listing 3: test compilation

```
1 wclean
2 wmake
3 ls $FOAM_USER_APPBIN
```

Listing 4: add thermal diffusion coeff. to createFields.H

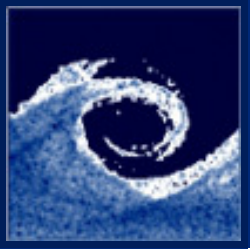
```
1     ...
2     dimensionedScalar nu
3     (
4         transportProperties.lookup("nu")
5     );
6     // Add DT thermal diffusion
7     dimensionedScalar DT
8     (
9         transportProperties.lookup("DT")
10    );
11    // end modifications
12 ...
```



Laboratory tasks III.

Listing 5: add temperature field to createFields.H

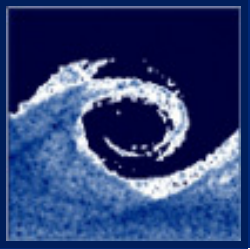
```
    ...

    // Add this temperature declaration
    Info<< "Reading field T\n" <<endl;
    volScalarField T
    (
        IOobject
        (
            "T",
            runTime.timeName(),
            mesh,
            IOobject::MUST_READ,
            IOobject::AUTO_WRITE
        ),
        mesh
    );
    // end modifications
#   include "createPhi.H"
...
```



Laboratory tasks III.

Listing 6: add temperature eq. to icoFoamT.C

```
1         ...
2             U = HbyA - rAU*fvc::grad(p);
3             U.correctBoundaryConditions();
4         }
5
6         // Add temperature eqs.
7         fvScalarMatrix TEqn
8         (
9             fvm::ddt(T)
10            + fvm::div(phi, T)
11            - fvm::laplacian(DT, T)
12        );
13
14        TEqn.solve();
15        // end of modifications
16
17        runTime.write();
18        ...
```



Laboratory tasks IV.

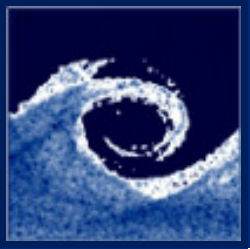
2. Perform a simulation with the new solver
   - Create a copy from the original cavity case (new name: cavityT)
   - Add thermal diffusion coeff. to transportProperties
   - Copy 0p field as 0T, and modify the required parts

Listing 7: make a copy from original solver

```
1 cd $FOAM_RUN/tutorials/incompressible/icoFoam
2 cp -r cavity cavityT
3 cd cavityT
4 cp 0/p 0/T
```

Listing 8: add thermal diffusion coeff. transportProperties

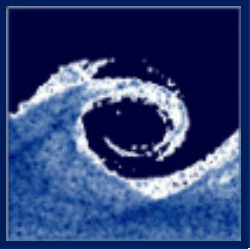
```
1 ...
2 // Thermal diffusion coeff.
3 DT              DT [ 0 2 -1 0 0 0 0 ] 0.002;
4 ...
```



Laboratory tasks V.

Listing 9: modification of 0/T

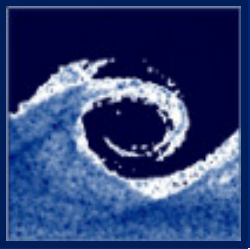
```
1  ...
2      object      T;
3  }
4  ...
5  dimensions      [0 0 0 1 0 0 0];
6  internalField   uniform 300;
7  boundaryField
8  {
9      movingWall
10     {
11         type            fixedValue;
12         value           uniform 350;
13     }
14     fixedWalls
15     {
16         type            fixedValue;
17         value           uniform 300;
18     }
19     frontAndBack
20     {
21         type            empty;
22     }
23 }
24 ...
```



Laboratory tasks VI.

Listing 10: modification of system/fvSchemes

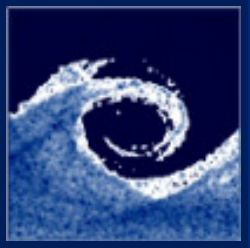
```
1  ...
2  divSchemes
3  {
4      default           none;
5      div(phi,U)        Gauss linear;
6      div(phi,T)        Gauss upwind limited; // This line added
7  }
8
9  laplacianSchemes
10 {
11     default           none;
12     laplacian(nu,U)   Gauss linear orthogonal;
13     laplacian((1|A(U)),p) Gauss linear orthogonal;
14     laplacian(DT,T)   Gauss linear orthogonal; // This line added
15 }
16 ...
```



Laboratory tasks VII.

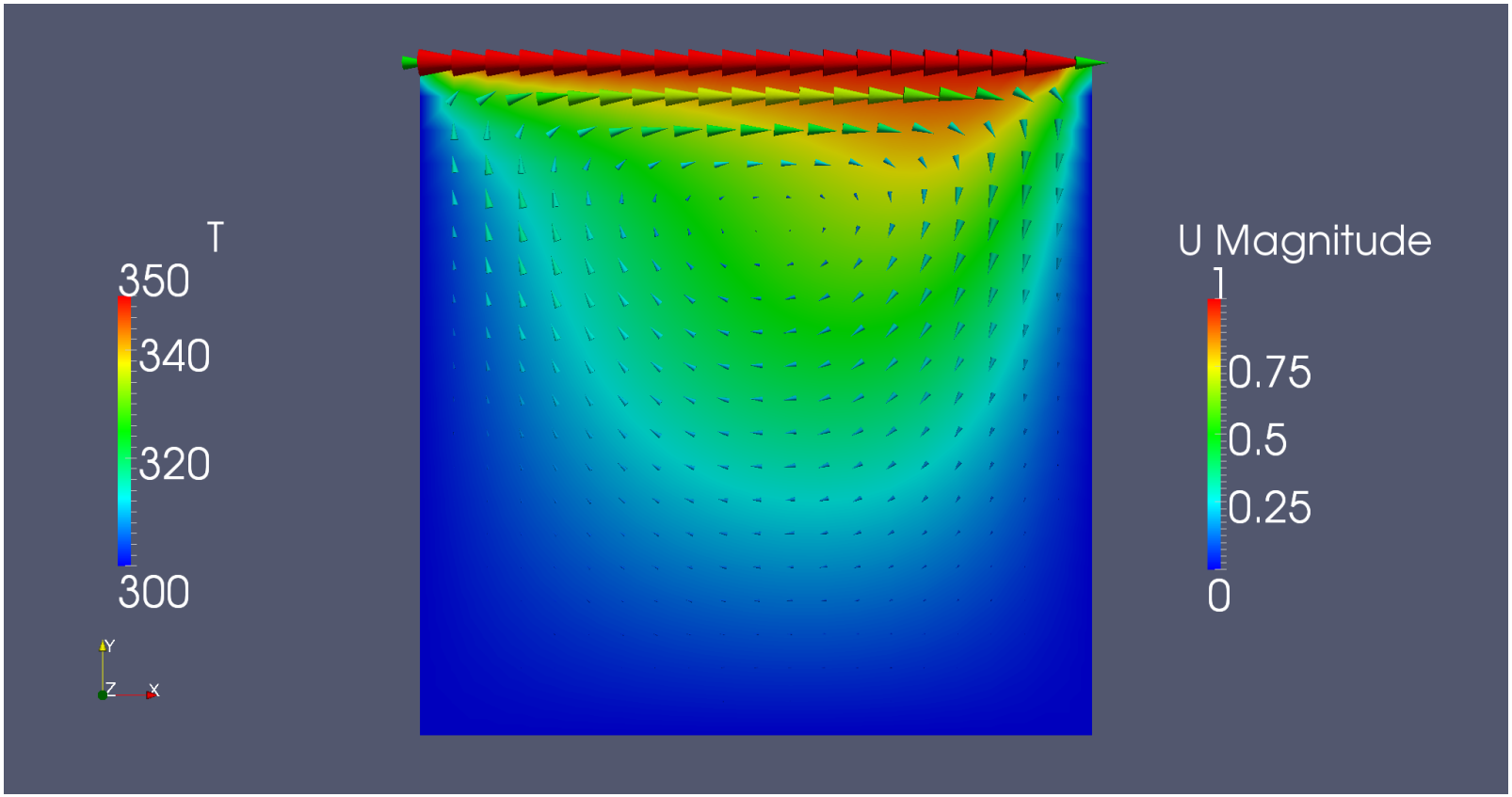
Listing 11: modification of system/fvSolution

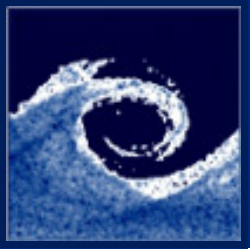
```
    p
    {
        solver          PCG;
        preconditioner  DIC;
        tolerance       1e-06;
        relTol          0;
    }

    T
    {
       solver            BICCG;
        preconditioner   DILU;
        tolerance        1e-7;
        relTol           0;
    };

    U
    {
        solver          PBiCG;
        preconditioner  DILU;
        tolerance       1e-05;
        relTol          0;
    }
```



Laboratory tasks VIII.

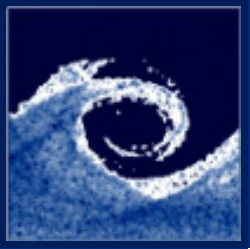
3. Perform the simulations and visualize the results





Assignments

1. What is the symbolic form of the temperature equation?
2. Which solver should be modified in order to take into account turbulence?
3. How can you add technically non-uniform thermal diffusion to the simulation?
4. How can you add heat flux on the walls? Which BC should be used?



Homework

1. Read Chapter 3 in the User Guide