

16th OpenFOAM Workshop - June 11, 2021 - Training session

Flexible & efficient multiphysics simulations with the coupling library preCICE

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Some statistics

1. How familiar are you with preCICE? (poll)
2. What would you like to couple OpenFOAM with/for? Which version/solver? (chat)

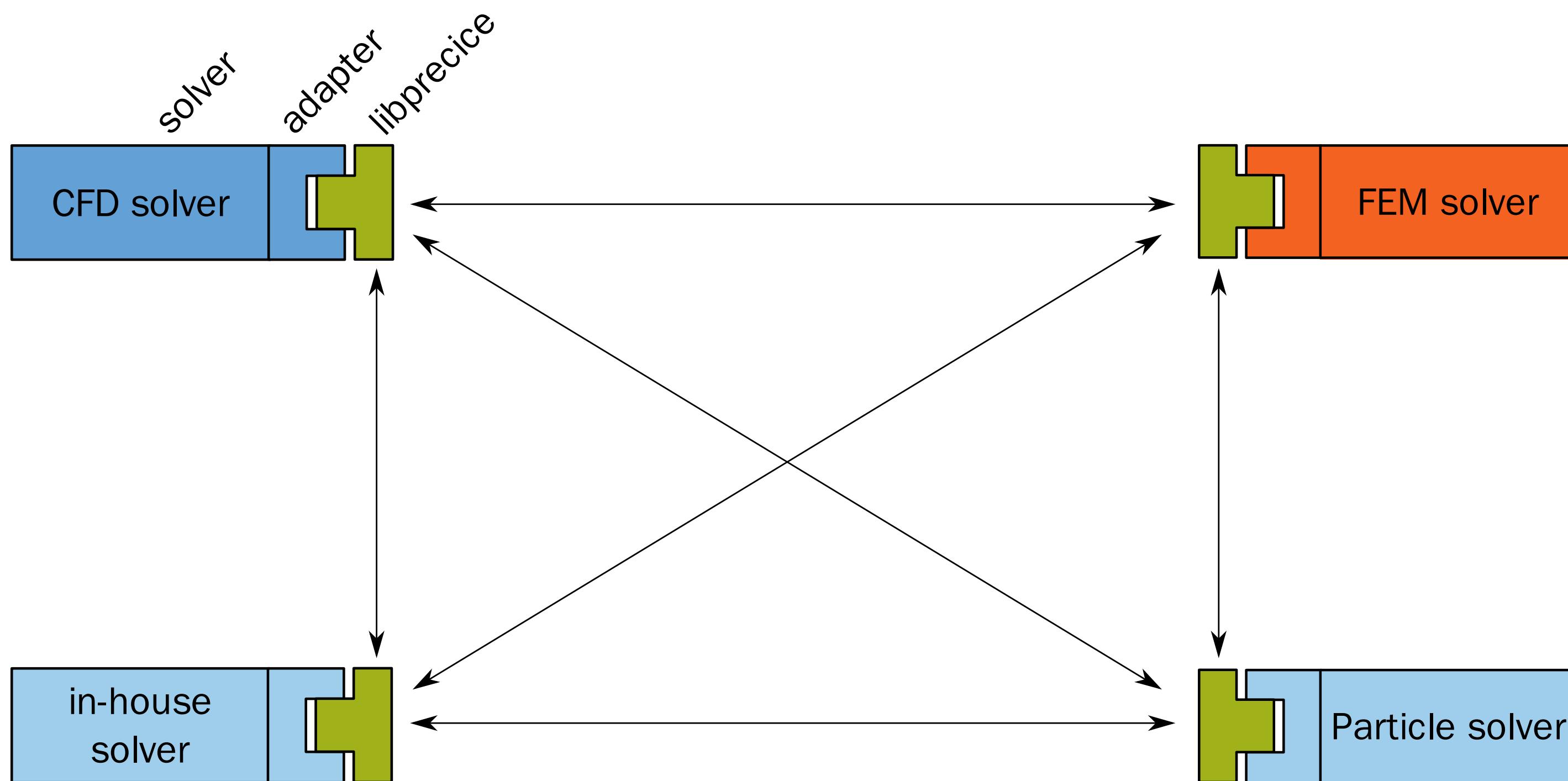
The people behind preCICE



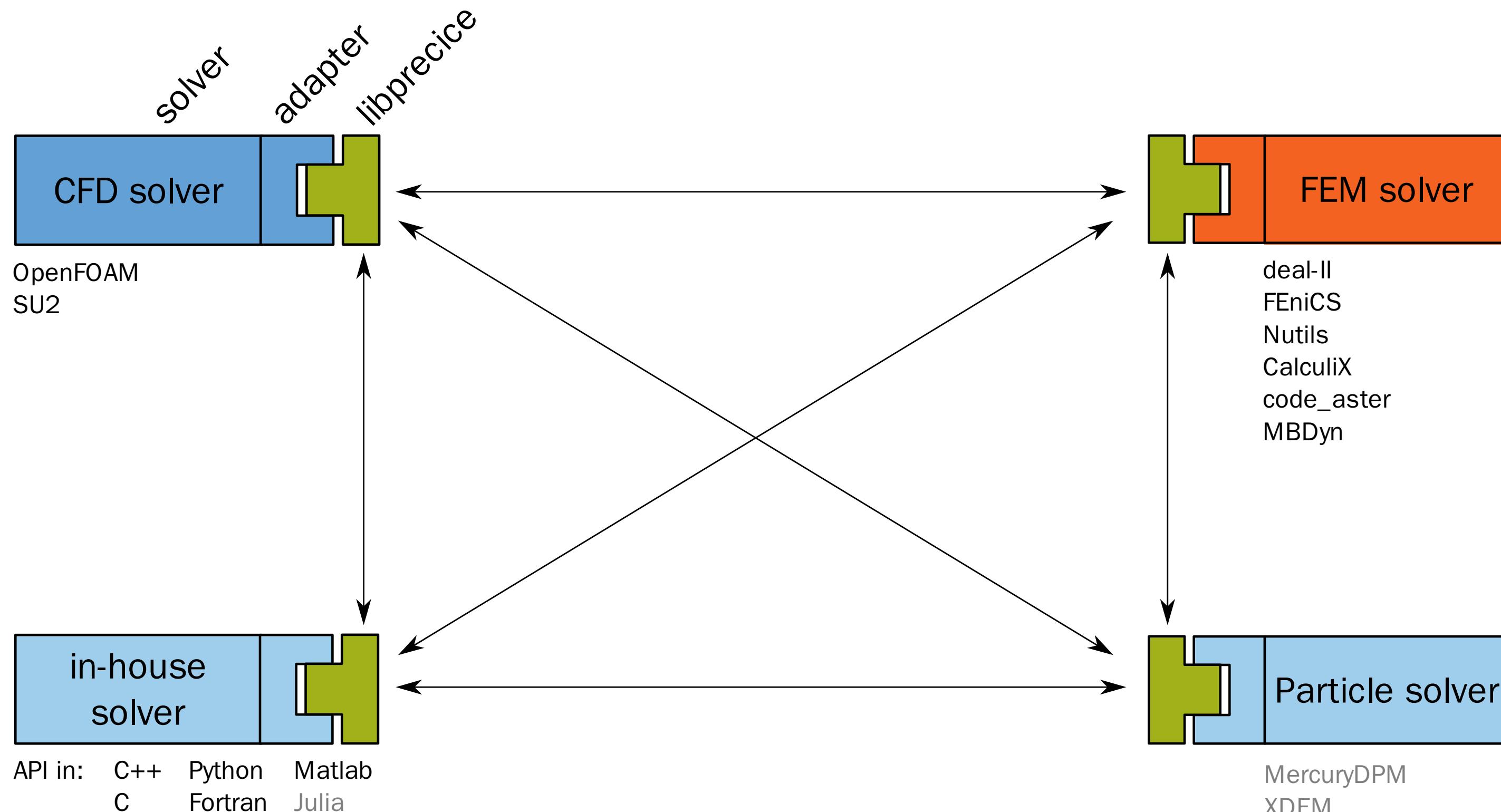
The big picture



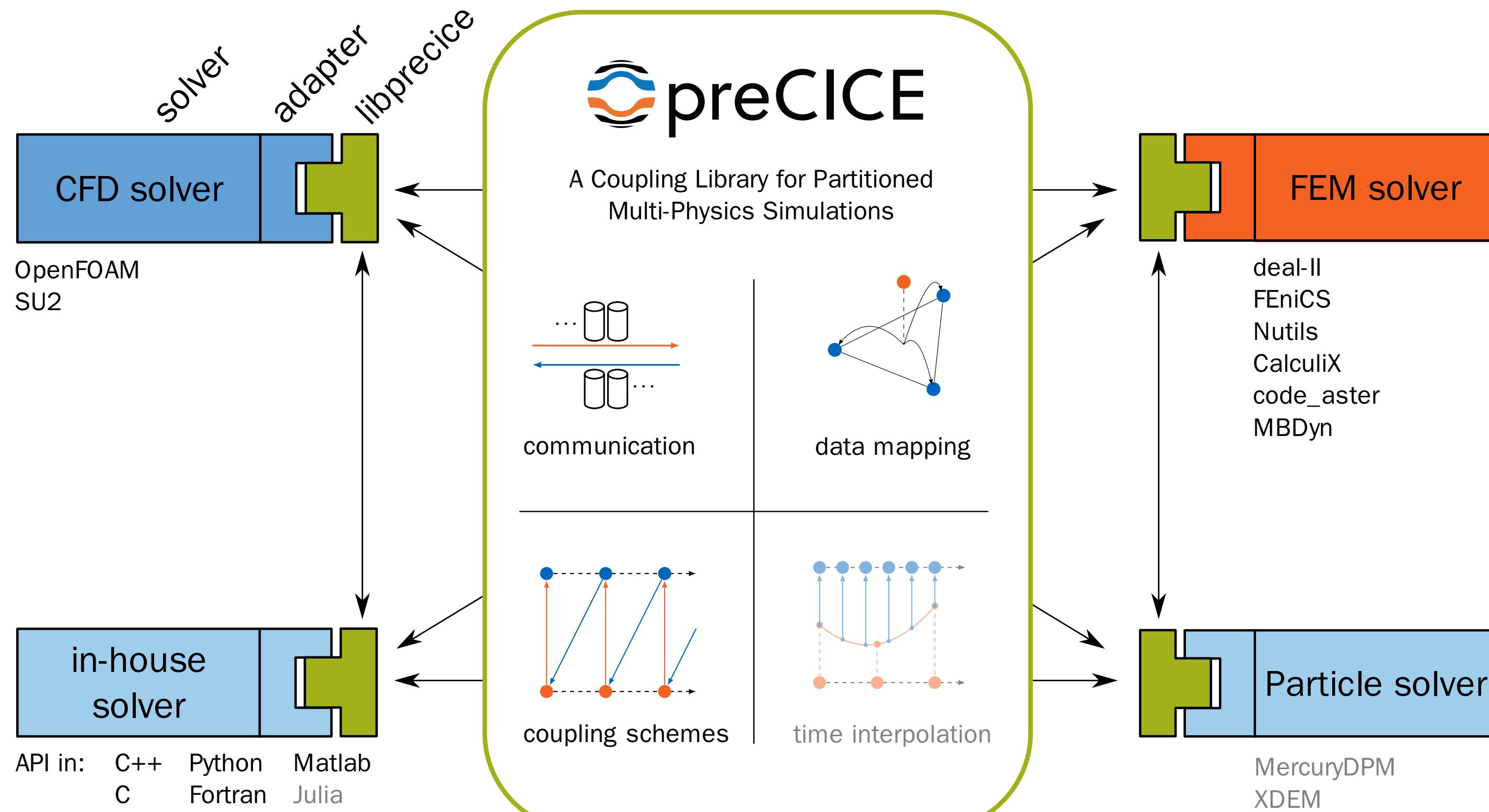
The big picture



The big picture



The big picture



This tutorial

- Level 1: Couple two simple Python solvers
- Level 2: Couple OpenFOAM with OpenFOAM
- Level 3: Couple OpenFOAM with an external solver

Level 1: Call the preCICE API in the code

Levels 2 & 3: Directly use off-the-shelf adapters

Organizational notes

1. You are not expected to try things live.
2. Ask questions in the chat, feel free to interrupt me.
3. Find these slides on GitHub:
github.com/MakisH/ofw16-training
4. Everything presented here is free software. preCICE and all the adapters are developed publicly on
<https://github.com/precice/>
5. Find all software installed in a demo virtual machine:
precice.org/installation-vm.html

Level 1: Coupling two simple solvers

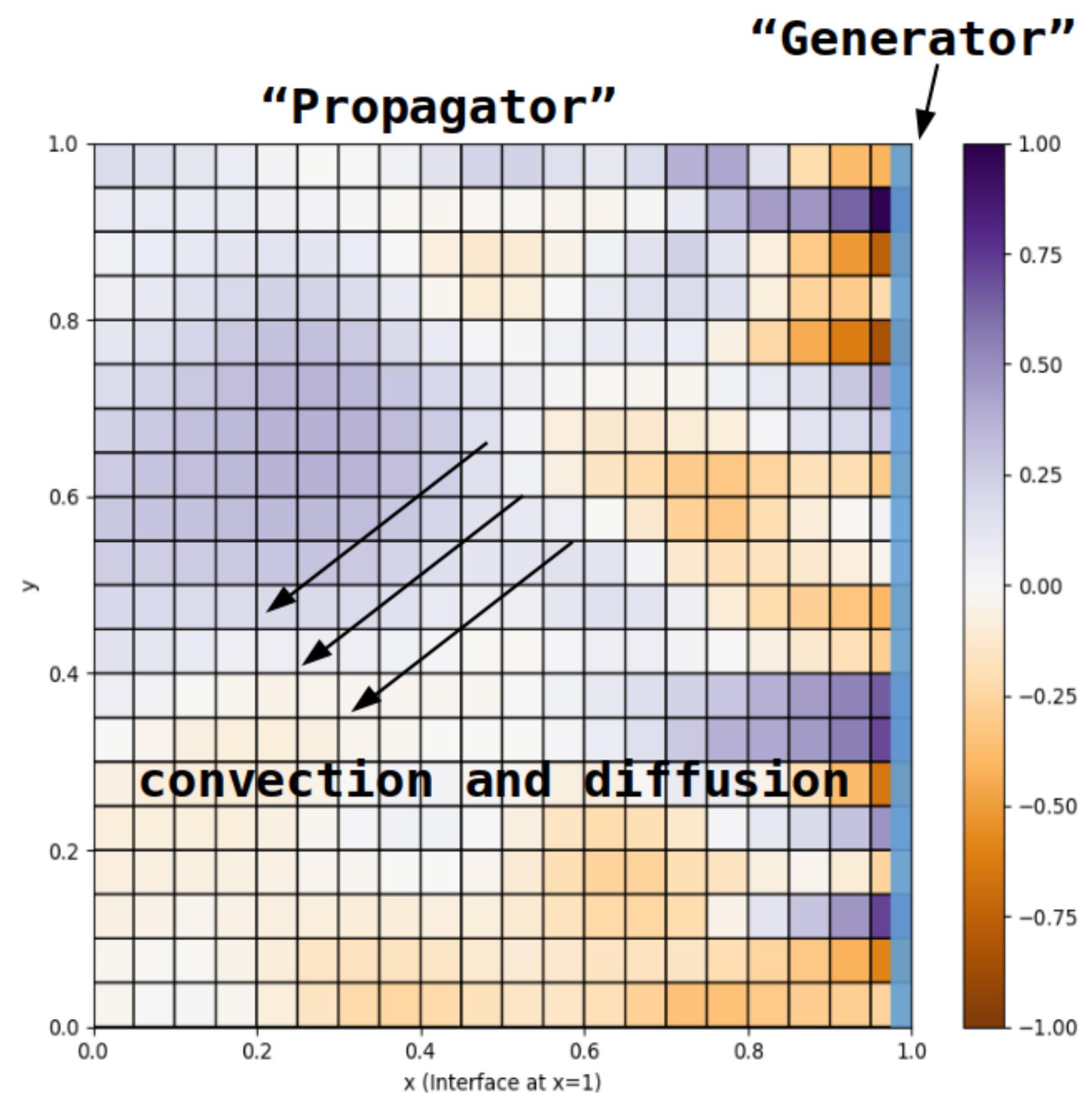
Dependencies

- preCICE v2 (e.g. packages for Ubuntu)
- Python 3
- Python packages numpy, matplotlib
- preCICE Python bindings:

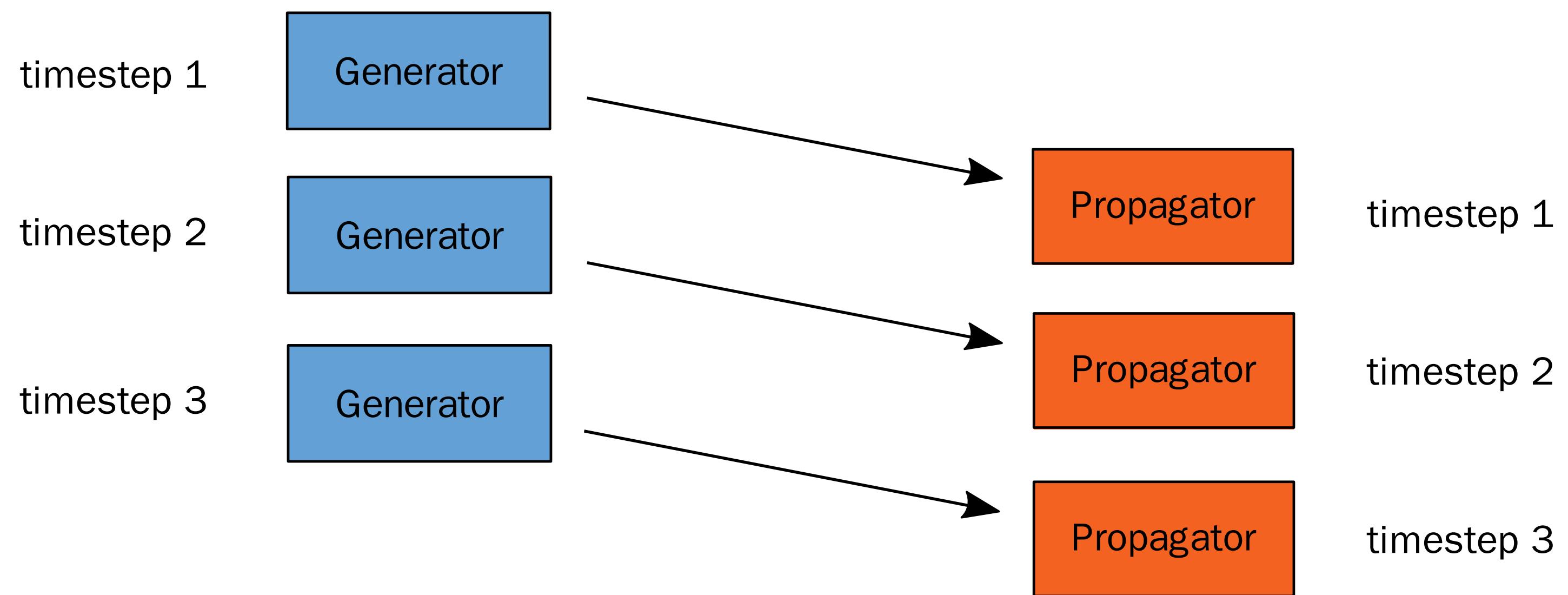
```
pip3 install --upgrade pip  
pip3 install --user pyprecice
```

"Generator" and "Propagator"

- `generator.py`: generates random data in a 1D domain
- `propagator.py`: propagates boundary data over a 2D domain



Unidirectional coupling



generator.py

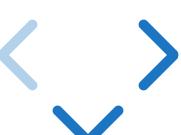
```
import numpy

# generate mesh
n = 20
y = numpy.linspace(0, 1, n + 1)

dt = 0.01
t = 0

while True:
    print("Generating data")
    u = 1 - 2 * numpy.random.rand(n)

    t = t + dt
    if(t > 0.1):
        break
```



propagator.py

```
# generate mesh
n = 20
x = numpy.linspace(0, 1, n+1)
y = numpy.linspace(0, 1, n+1)

# initial data, associated to cell centers
u = numpy.zeros([n, n])

dt = 0.01
t = 0

# boundary condition for u (arbitrary)
u[:, -1] = y[:-1]

while True:

    print("Propagating data")
```



vagrant@precicevm:~/Desktop/skeleton\$ tree
vagrant@precicevm:~/Desktop/skeleton/generator 187x52

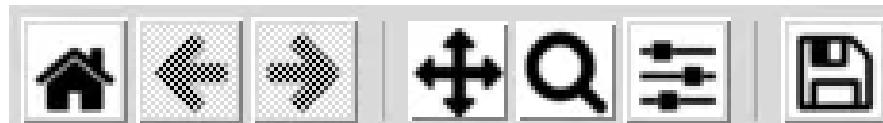
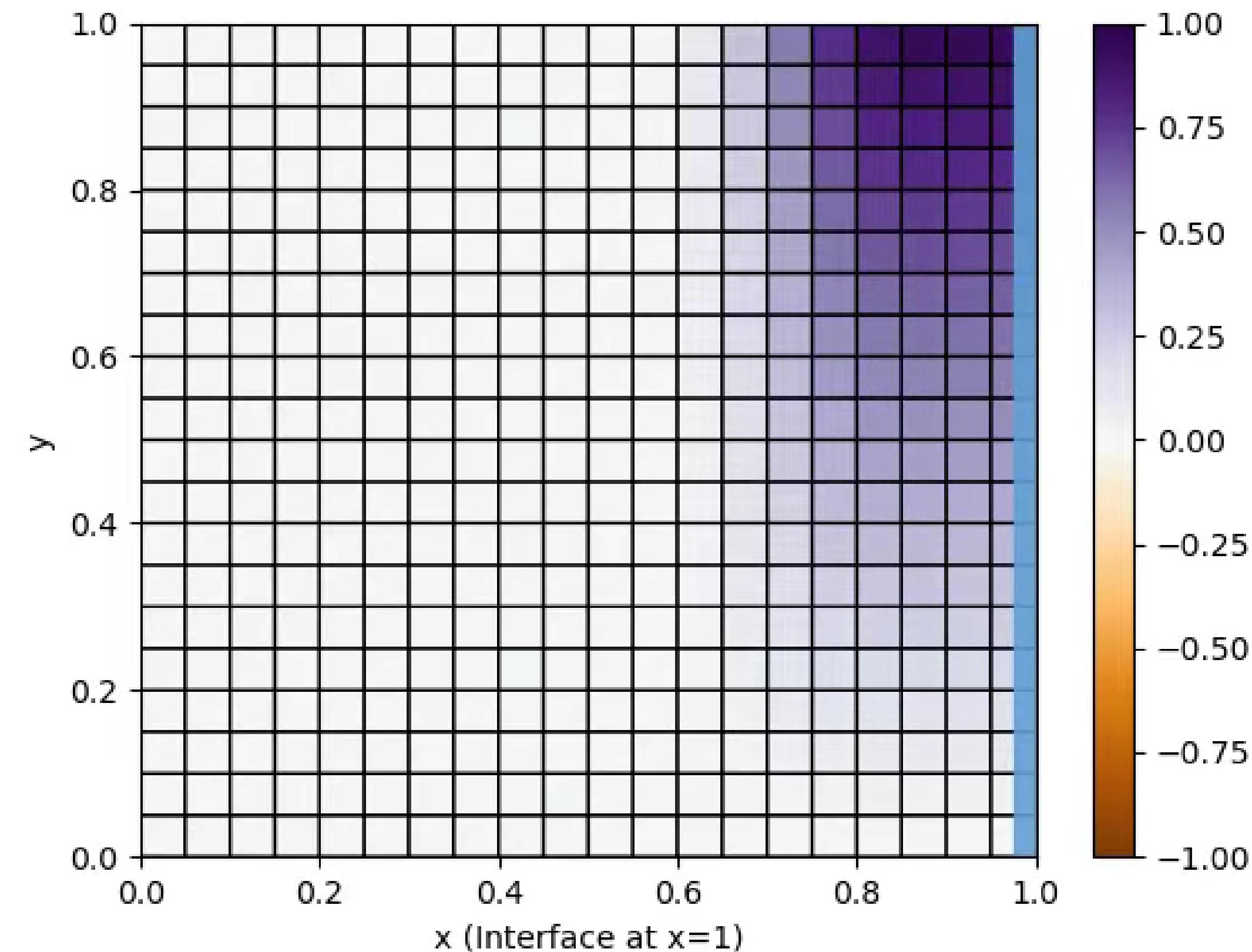
```
vagrant@precicevm:~/Desktop/skeleton$ tree
.
├── Allclean
├── generator
│   └── generator.py
├── precice-config.xml
└── propagator
    └── propagator.py
 README.txt

2 directories, 5 files
```

vagrant@precicevm:~/Desktop/skeleton\$ cd generator/
vagrant@precicevm:~/Desktop/skeleton/generator\$ python3 generator.py
Generating data
Generating data
Generating data
Generating data

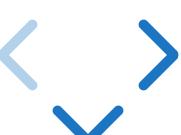


Uncoupled simulation



Import preCICE

```
1 import numpy
2
3
4 # generate mesh
5 n = 20
6 y = numpy.linspace(0, 1, n + 1)
7
8 dt = 0.01
9 t = 0
10
11 while True:
12     print("Generating data")
13     u = 1 - 2 * numpy.random.rand(n)
14
15     t = t + dt
16     if(t > 0.1):
17         break
```



Import preCICE

```
1 import numpy
2 import precice
3
4 # generate mesh
5 n = 20
6 y = numpy.linspace(0, 1, n + 1)
7
8 dt = 0.01
9 t = 0
10
11 while True:
12     print("Generating data")
13     u = 1 - 2 * numpy.random.rand(n)
14
15     t = t + dt
16     if(t > 0.1):
17         break
```



Configure preCICE

```
1 import numpy
2 import precice
3
4 # generate mesh
5 n = 20
6 y = numpy.linspace(0, 1, n + 1)
7
8 # preCICE setup
9 participant_name      = "Generator"
10 config_file_name     = "../precice-config.xml"
11 solver_process_index = 0
12 solver_process_size  = 1
13 interface =
14     precice.Interface(
15         participant_name,
16         config_file_name,
17         solver_process_index,
18         -1)
```



Configure preCICE

```
5 n = 20
6 y = numpy.linspace(0, 1, n + 1)
7
8 # preCICE setup
9 participant_name      = "Generator"
10 config_file_name     = "../precice-config.xml"
11 solver_process_index = 0
12 solver_process_size  = 1
13 interface =
14     precice.Interface(
15         participant_name,
16         config_file_name,
17         solver_process_index,
18         solver_process_size
19     )
20
21 dt = 0.01
22 t = 0
```



Define the coupling mesh

```
5 n = 20
6 y = numpy.linspace(0, 1, n + 1)
7
8 # preCICE setup
9 participant_name      = "Generator"
10 config_file_name     = "../precice-config.xml"
11 solver_process_index = 0
12 solver_process_size  = 1
13 interface =
14     precice.Interface(
15         participant_name,
16         config_file_name,
17         solver_process_index,
18         solver_process_size
19     )
20
21 # Get the preCICE mesh id
22 mesh_name = "Generator-Mesh"
```



Define the coupling mesh

```
16             config_file_name,
17             solver_process_index,
18             solver_process_size
19         )
20
21 # Get the preCICE mesh id
22 mesh_name = "Generator-Mesh"
23 mesh_id = interface.get_mesh_id(mesh_name)
24
25 # Define the coupling mesh
26 vertices = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 dt = 0.01
30 t = 0
31
32 while True:
```



Initialize and finalize preCICE

```
16         config_file_name,
17         solver_process_index,
18         solver_process_size
19     )
20
21 # Get the preCICE mesh id
22 mesh_name = "Generator-Mesh"
23 mesh_id = interface.get_mesh_id(mesh_name)
24
25 # Define the coupling mesh
26 vertices = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
```



Initialize and finalize preCICE

```
25 # Define the coupling mesh
26 vertices = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35     print("Generating data")
36     u = 1 - 2 * numpy.random.rand(n)
37
38     t = t + dt
39     if(t > 0.1):
40         break
41
42 interface.finalize()
```



Advance the coupling

```
27 vertex_ias = interface.set_mesn_vertices(mesn_ia, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35     print("Generating data")
36     u = 1 - 2 * numpy.random.rand(n)
37
38
39
40     t = t + dt
41     if(t > 0.1):
42         break
43
44 interface.finalize()
```



Advance the coupling

```
27 vertex_ias = interface.set_mesn_vertices(mesn_ia, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35     print("Generating data")
36     u = 1 - 2 * numpy.random.rand(n)
37
38
39
40     t = t + dt
41     if(t > 0.1):
42         break
43
44 interface.finalize()
```



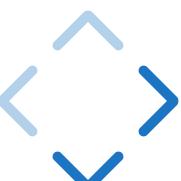
Advance the coupling

```
27     vertex_1as = interface.set_meson_vertices(meson_1a, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while True:
35     print("Generating data")
36     u = 1 - 2 * numpy.random.rand(n)
37
38     interface.advance(dt)
39
40     t = t + dt
41     if(t > 0.1):
42         break
43
44 interface.finalize()
```



Advance the coupling

```
27 vertex_ias = interface.set_mesn_vertices(mesn_ia, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35     print("Generating data")
36     u = 1 - 2 * numpy.random.rand(n)
37
38     interface.advance(dt)
39
40     t = t + dt
41
42
43
44 interface.finalize()
```



Advance the coupling

```
27 vertex_ias = interface.set_mesn_vertices(mesn_ia, vertices)
28
29 interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35     print("Generating data")
36     u = 1 - 2 * numpy.random.rand(n)
37
38     precice_dt = interface.advance(dt)
39
40     t = t + dt
41
42
43
44 interface.finalize()
```



Advance the coupling

```
27 vertex_ias = interface.set_mesn_vertices(mesn_ia, vertices)
28
29 precice_dt = interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35     dt = np.minimum(dt, precice_dt)
36
37     print("Generating data")
38     u = 1 - 2 * numpy.random.rand(n)
39
40     precice_dt = interface.advance(dt)
41
42     t = t + dt
43
44 interface.finalize()
```

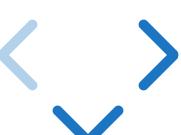


Advance the coupling

```
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 precice_dt = interface.initialize()
30
31 dt = 0.01
32 t = 0
33
34 while interface.is_coupling_ongoing():
35     dt = np.minimum(dt, precice_dt)
36
37     print("Generating data")
38     u = 1 - 2 * numpy.random.rand(n)
39
40     precice_dt = interface.advance(dt)
41
42     t = t + dt
43
44     if t > final_time:
```



Not there yet, but let's run it
(similar changes in propagator.py - try it at home)

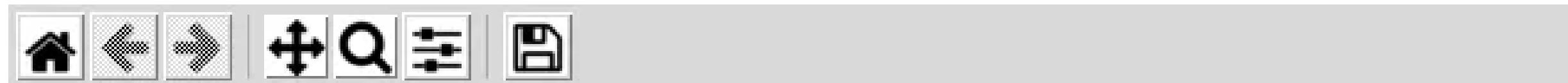
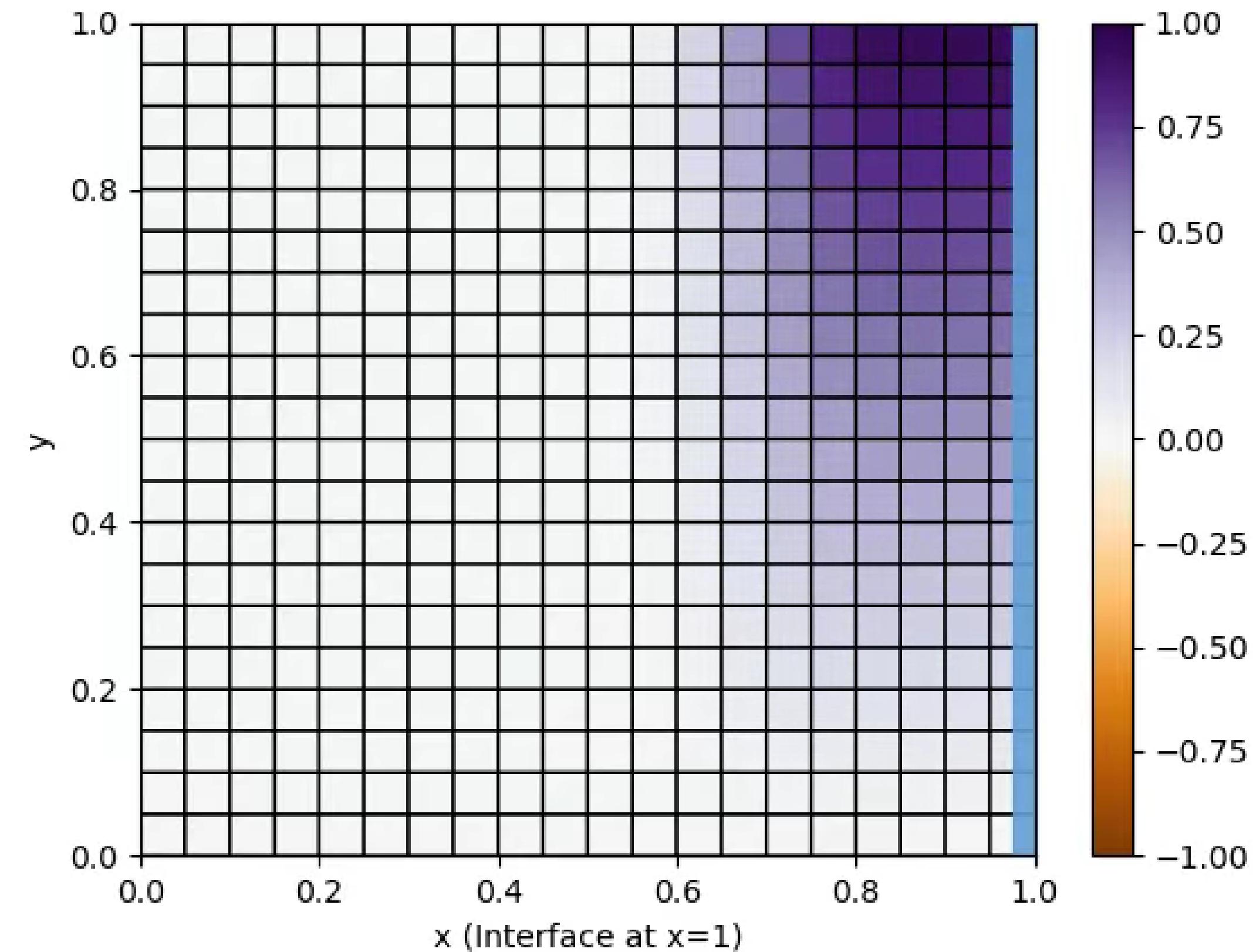


The screenshot shows a dual-terminal window with two panes. Both panes are titled `/bin/bash` and have a red header bar with the text `/bin/bash 92x52`. The left pane displays a command-line session for a user named `vagrant` on a host named `precicevm`. The session starts with `vagrant@precicevm:~/Desktop/solution/T4$ cd generator/`, followed by `generator/ propagator/`. Then, `vagrant@precicevm:~/Desktop/solution/T4$ cd generator/` and `vagrant@precicevm:~/Desktop/solution/T4/generator$ ls` are run, showing the file `generator.py`. Finally, `vagrant@precicevm:~/Desktop/solution/T4/generator$ python3 generator.py` is executed, outputting configuration information for preCICE version 2.2.0, revision v2.2.0, and configuration Debug. The right pane is mostly blank, with only a single character 'I' visible at the top center.

```
vagrant@precicevm:~/Desktop/solution/T4$ cd generator/
generator/ propagator/
vagrant@precicevm:~/Desktop/solution/T4$ cd generator/
vagrant@precicevm:~/Desktop/solution/T4/generator$ ls
generator.py
vagrant@precicevm:~/Desktop/solution/T4/generator$ python3 generator.py
---[precice] This is preCICE version 2.2.0
---[precice] Revision info: v2.2.0
---[precice] Configuration: Debug
---[precice] Configuring preCICE with configuration "../precice-config.xml"
---[precice] I am participant "Generator"
---[precice] Setting up master communication to coupling partner/s
I
```



Nothing happening?

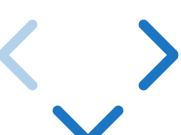


Did we forget something?



Write & read data

```
20
21 # Get the preCICE mesh id
22 mesh_name = "Generator-Mesh"
23 mesh_id = interface.get_mesh_id(mesh_name)
24
25 # Define the coupling mesh
26 vertices = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29
30
31
32
33 precice_dt = interface.initialize()
34
35 dt = 0.01
36 t = 0
```



Write & read data

```
20
21 # Get the preCICE mesh id
22 mesh_name = "Generator-Mesh"
23 mesh_id = interface.get_mesh_id(mesh_name)
24
25 # Define the coupling mesh
26 vertices = [[1, y0] for y0 in y[:-1]]
27 vertex_ids = interface.set_mesh_vertices(mesh_id, vertices)
28
29 # Get the exchanged data id
30 data_name = "Data"
31 data_id = interface.get_data_id(data_name, mesh_id)
32
33 precice_dt = interface.initialize()
34
35 dt = 0.01
36 t = 0
```



Write & read data

```
55 precice_dt = interface.initialize()
34
35 dt = 0.01
36 t = 0
37
38 while interface.is_coupling_ongoing():
39     dt = np.minimum(dt, precice_dt)
40
41     print("Generating data")
42     u = 1 - 2 * numpy.random.rand(n)
43
44     interface.write_block_scalar_data(data_id, vertex_ids, u)
45     precice_dt = interface.advance(dt)
46     # interface.read_block_scalar_data(data_id, vertex_ids, u)
47
48     t = t + dt
49
50 interface.finalize()
```



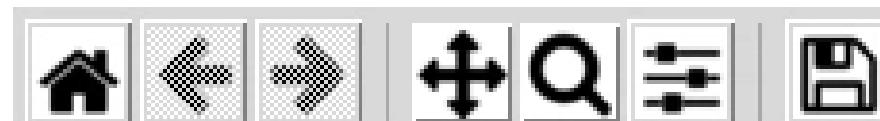
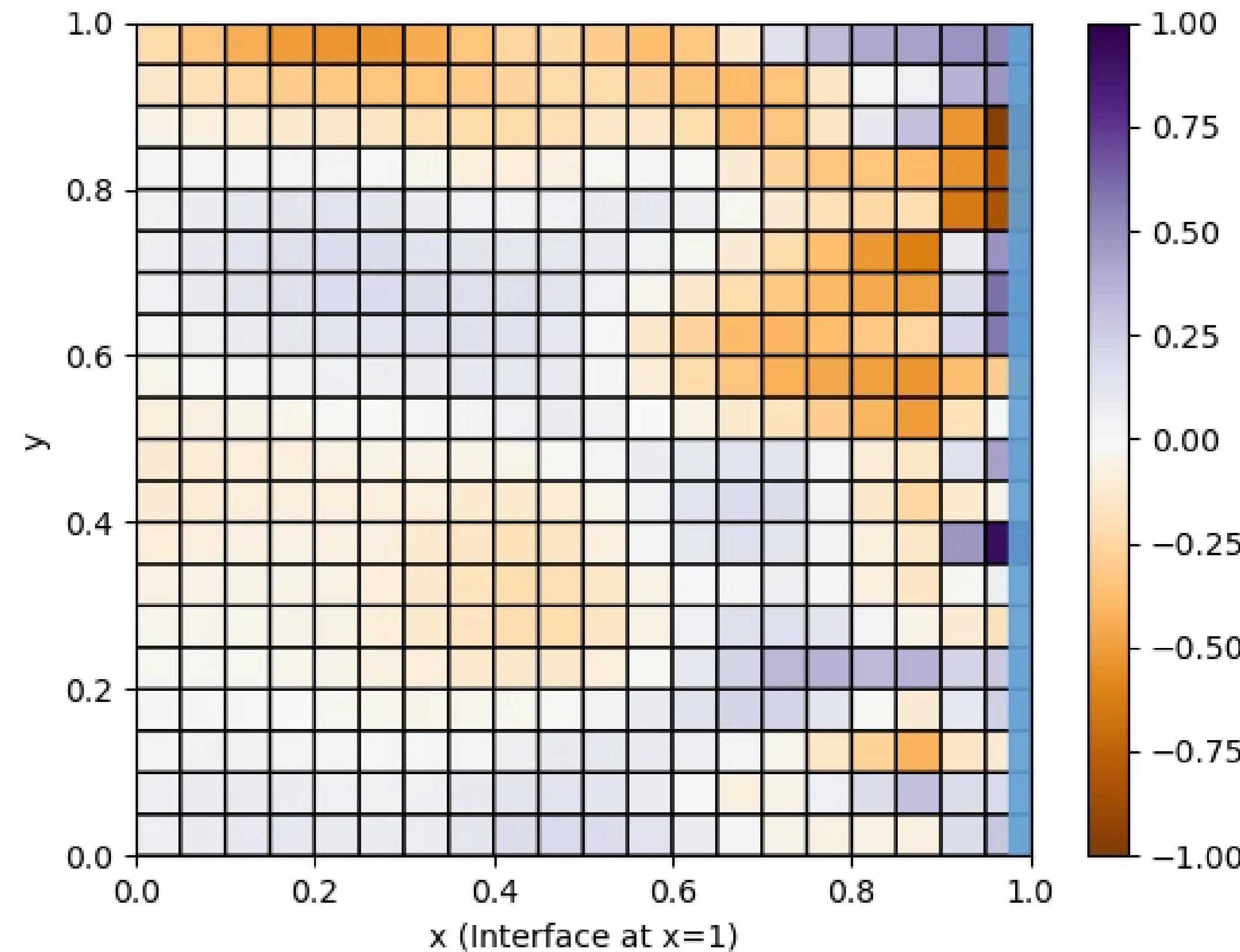
It should work now!

[Gnuplot window 0] vagrant@precicevm: ~/Des... vagrant@precicevm: ~/Desktop/solution/T5/generator vagrant@precicevm: ~/Desktop/solution/T5 187x52

```
vagrant@precicevm:~/Desktop/solution/T5$ ls
Allclean generator precice-config.xml propagator
vagrant@precicevm:~/Desktop/solution/T5$ cd generator/
```



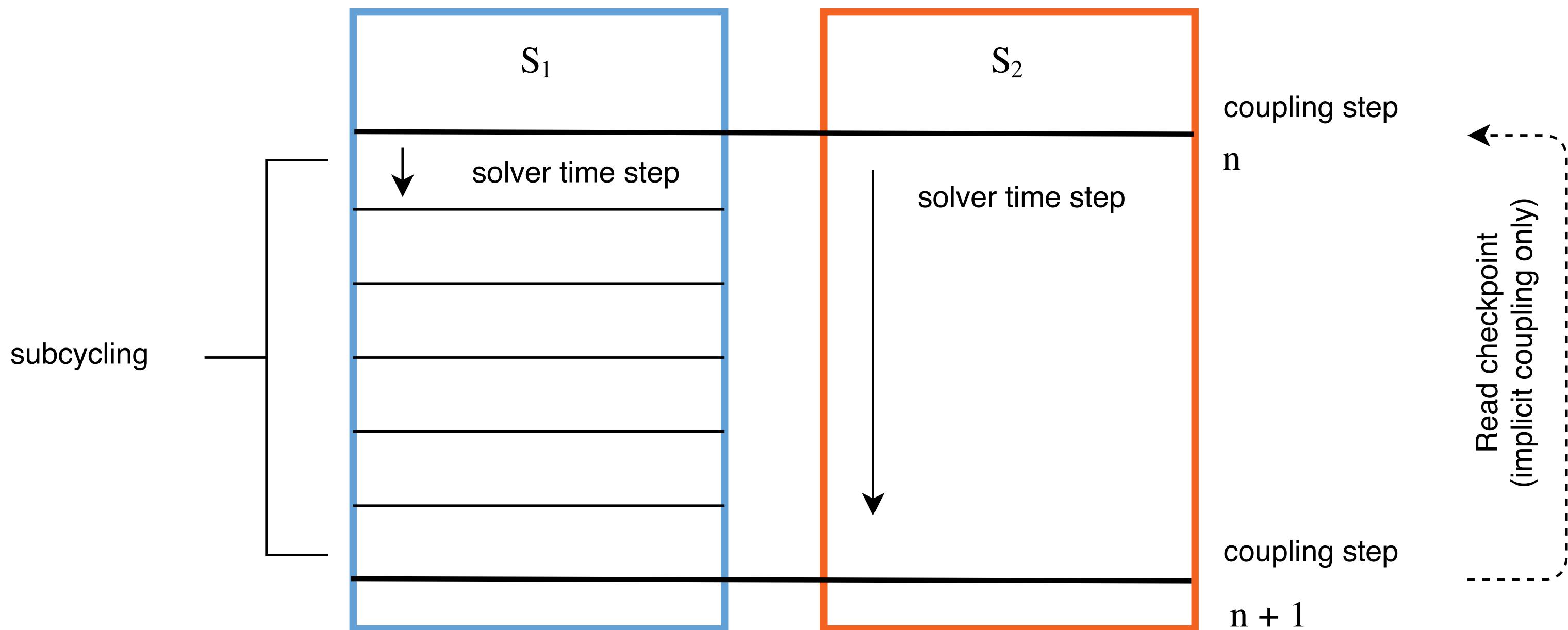
Data is being transferred!



Most basic case: uni-directional, serial-explicit, nearest-neighbor mapping, ...

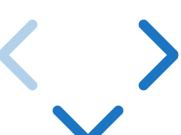
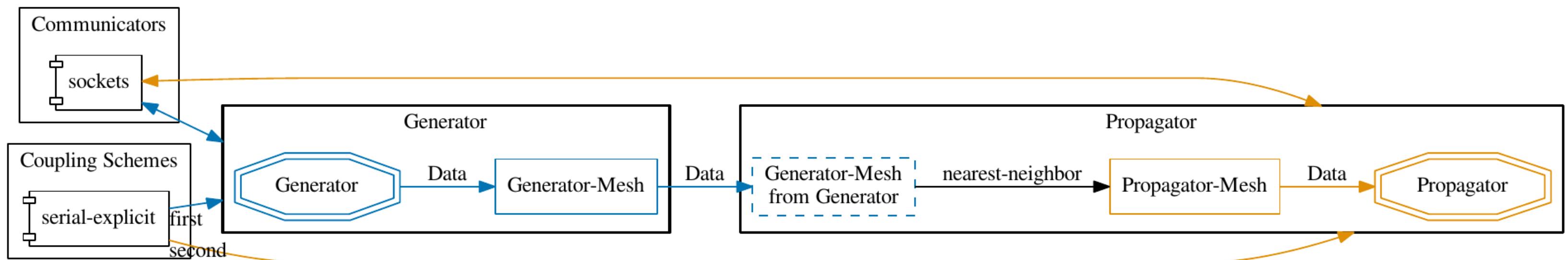


Side note: Subcycling



preCICE configuration file

Visual representation of `precice-config.xml` using the [config visualizer](#):



preCICE configuration file

precice-config.xml:

```
1 <precice-configuration>
2   <solver-interface dimensions="2">
3
4     <data:scalar name="Data"/>
5
6     <mesh name="Generator-Mesh">
7       <use-data name="Data"/>
8     </mesh>
9
10    <mesh name="Propagator-Mesh">
11      <use-data name="Data" />
12    </mesh>
13
14    <participant name="Generator">
15      <use-mesh name="Generator-Mesh" provide="yes"/>
16      <write-data name="Data" mesh="Generator-Mesh"/>
17    </participant>
18
```



preCICE configuration file

precice-config.xml:

```
1 <precice-configuration>
2   <solver-interface dimensions="2">
3
4     <data:scalar name="Data"/>
5
6     <mesh name="Generator-Mesh">
7       <use-data name="Data"/>
8     </mesh>
9
10    <mesh name="Propagator-Mesh">
11      <use-data name="Data" />
12    </mesh>
13
14    <participant name="Generator">
15      <use-mesh name="Generator-Mesh" provide="yes"/>
16      <write-data name="Data" mesh="Generator-Mesh"/>
17    </participant>
18
```



preCICE configuration file

precice-config.xml:

```
1 <precice-configuration>
2   <solver-interface dimensions="2">
3
4     <data:scalar name="Data"/>
5
6     <mesh name="Generator-Mesh">
7       <use-data name="Data"/>
8     </mesh>
9
10    <mesh name="Propagator-Mesh">
11      <use-data name="Data" />
12    </mesh>
13
14    <participant name="Generator">
15      <use-mesh name="Generator-Mesh" provide="yes"/>
16      <write-data name="Data" mesh="Generator-Mesh"/>
17    </participant>
18
```



preCICE configuration file

precice-config.xml:

```
7      <use-data name="Data"/>
8  </mesh>
9
10 <mesh name="Propagator-Mesh">
11   <use-data name="Data" />
12 </mesh>
13
14 <participant name="Generator">
15   <use-mesh name="Generator-Mesh" provide="yes"/>
16   <write-data name="Data" mesh="Generator-Mesh"/>
17 </participant>
18
19 <participant name="Propagator">
20   <use-mesh name="Generator-Mesh" from="Generator"/>
21   <use-mesh name="Propagator-Mesh" provide="yes"/>
22   <mapping:nearest-neighbor direction="read"
23     from="Generator-Mesh" to="Propagator-Mesh"
```



preCICE configuration file

precice-config.xml:

```
14 <participant name="Generator">
15   <use-mesh name="Generator-Mesh" provide="yes"/>
16   <write-data name="Data" mesh="Generator-Mesh"/>
17 </participant>
18
19 <participant name="Propagator">
20   <use-mesh name="Generator-Mesh" from="Generator"/>
21   <use-mesh name="Propagator-Mesh" provide="yes"/>
22   <mapping:nearest-neighbor direction="read"
23     from="Generator-Mesh" to="Propagator-Mesh"
24       constraint="consistent"/>
25   <read-data name="Data" mesh="Propagator-Mesh" />
26 </participant>
27
28 <m2n:sockets from="Generator" to="Propagator" exchange-directory=".
29
30 <coupling-scheme:serial-explicit>
```



preCICE configuration file

precice-config.xml:

```
14 <participant name="Generator">
15   <use-mesh name="Generator-Mesh" provide="yes"/>
16   <write-data name="Data" mesh="Generator-Mesh"/>
17 </participant>
18
19 <participant name="Propagator">
20   <use-mesh name="Generator-Mesh" from="Generator"/>
21   <use-mesh name="Propagator-Mesh" provide="yes"/>
22   <mapping:nearest-neighbor direction="read"
23     from="Generator-Mesh" to="Propagator-Mesh"
24       constraint="consistent"/>
25   <read-data name="Data" mesh="Propagator-Mesh" />
26 </participant>
27
28 <m2n:sockets from="Generator" to="Propagator" exchange-directory=".">
29
30   <coupling-scheme:serial-explicit>
```



preCICE configuration file

precice-config.xml:

```
 20   <use-mesh name="Generator-Mesh" from="Generator"/>
 21   <use-mesh name="Propagator-Mesh" provide="yes"/>
 22   <mapping:nearest-neighbor direction="read"
 23     from="Generator-Mesh" to="Propagator-Mesh"
 24       constraint="consistent"/>
 25   <read-data name="Data" mesh="Propagator-Mesh" />
 26 </participant>
 27
 28 <m2n:sockets from="Generator" to="Propagator" exchange-directory=".">
 29
 30   <coupling-scheme:serial-explicit>
 31     <participants first="Generator" second="Propagator"/>
 32     <time-window-size value="0.01"/>
 33     <max-time value="0.1"/>
 34     <exchange data="Data" mesh="Generator-Mesh"
 35       from="Generator" to="Propagator"/>
 36   </coupling-scheme:serial-explicit>
```



preCICE configuration file

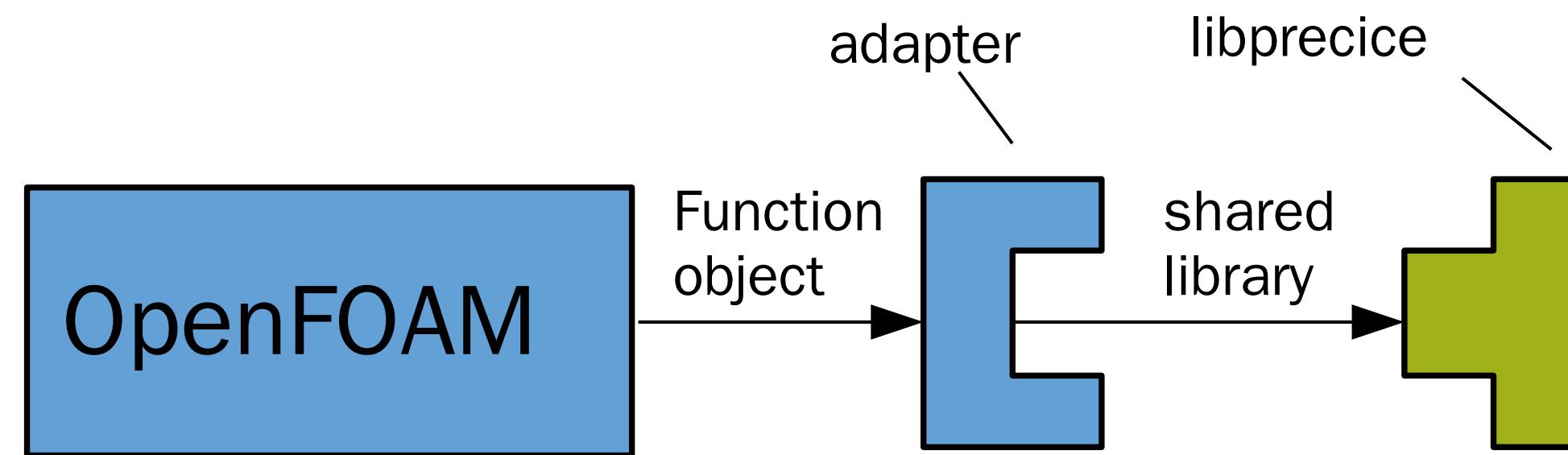
precice-config.xml:

```
--> <!--> <!--> <!--> <!--> <!--> <!--> <!--> <!-->
23   from="Generator-Mesh" to="Propagator-Mesh"
24     constraint="consistent"/>
25   <read-data name="Data" mesh="Propagator-Mesh" />
26 </participant>
27
28 <m2n:sockets from="Generator" to="Propagator" exchange-directory=".">
29
30   <coupling-scheme:serial-explicit>
31     <participants first="Generator" second="Propagator"/>
32     <time-window-size value="0.01"/>
33     <max-time value="0.1"/>
34     <exchange data="Data" mesh="Generator-Mesh"
35       from="Generator" to="Propagator"/>
36   </coupling-scheme:serial-explicit>
37
38   </solver-interface>
39 </precice-configuration>
```

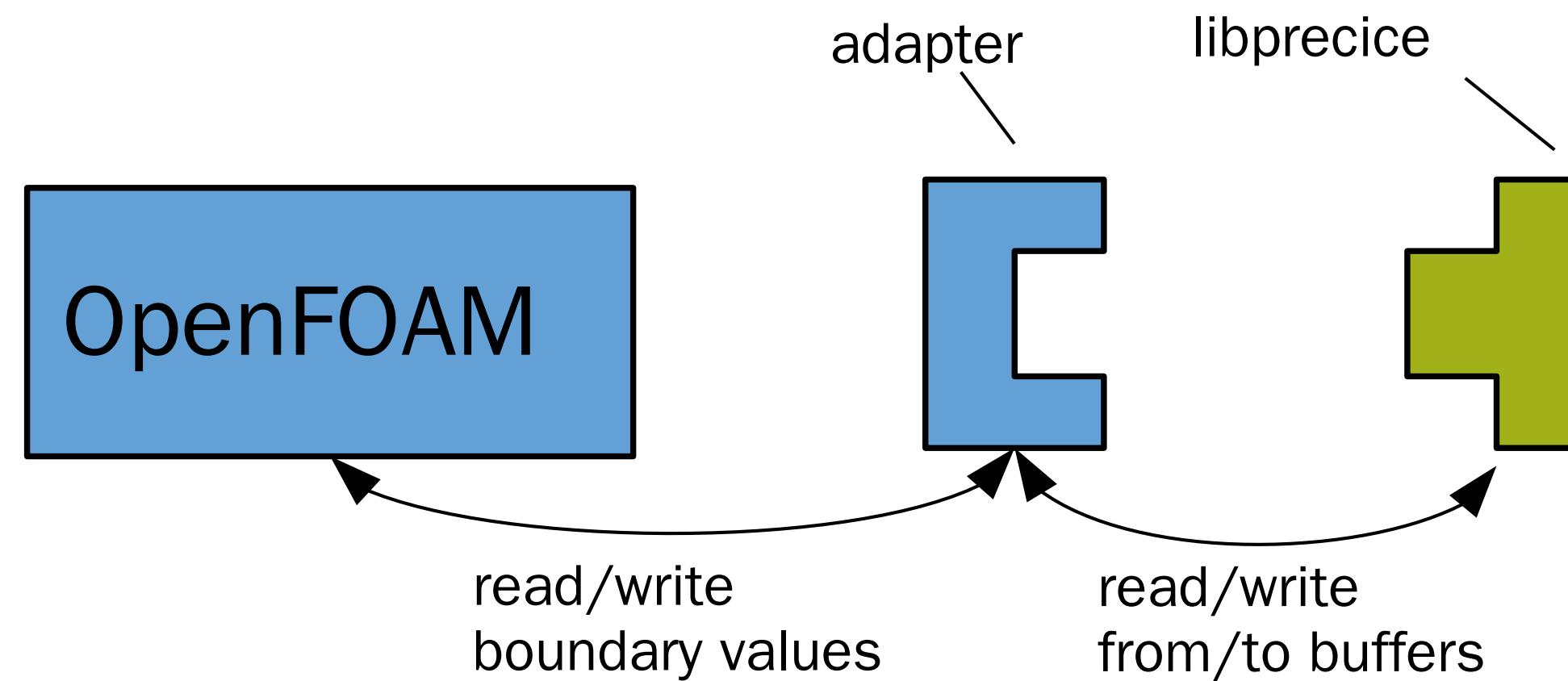


Level 2: Using the OpenFOAM adapter

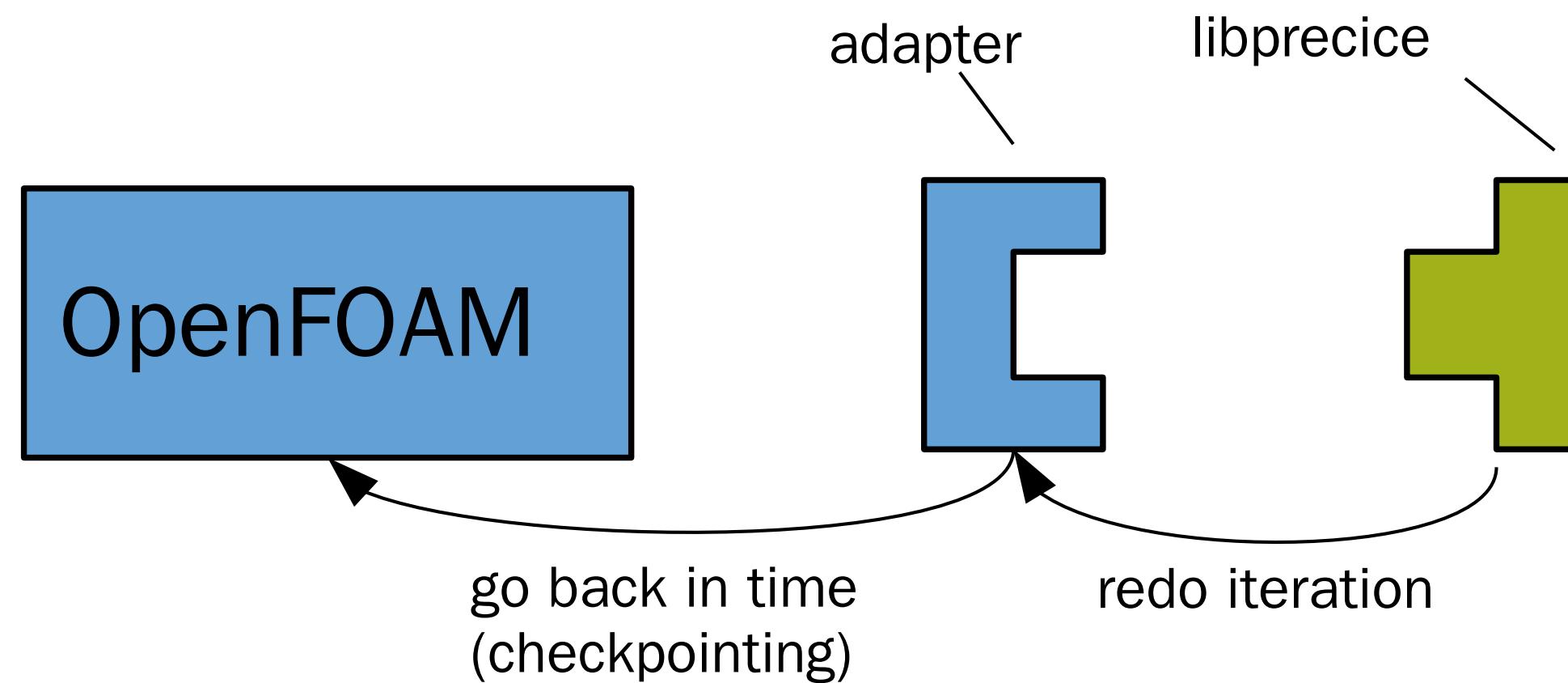
What does the adapter do?



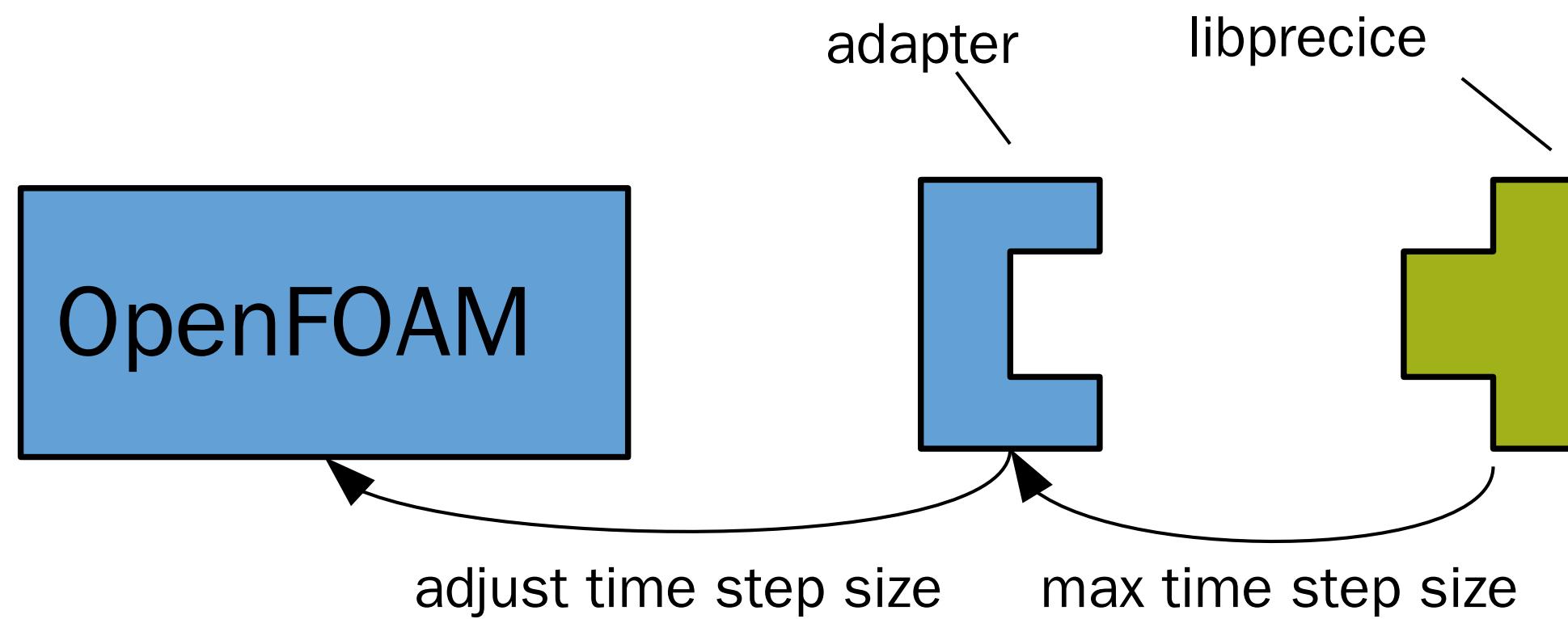
What does the adapter do?



What does the adapter do?



What does the adapter do?



Dependencies

- preCICE v2 (e.g. packages for Ubuntu)
- Recent OpenFOAM (e.g. v1706-v2012 or 4-8)
- OpenFOAM-preCICE adapter v1.0 (for your OpenFOAM)

Building

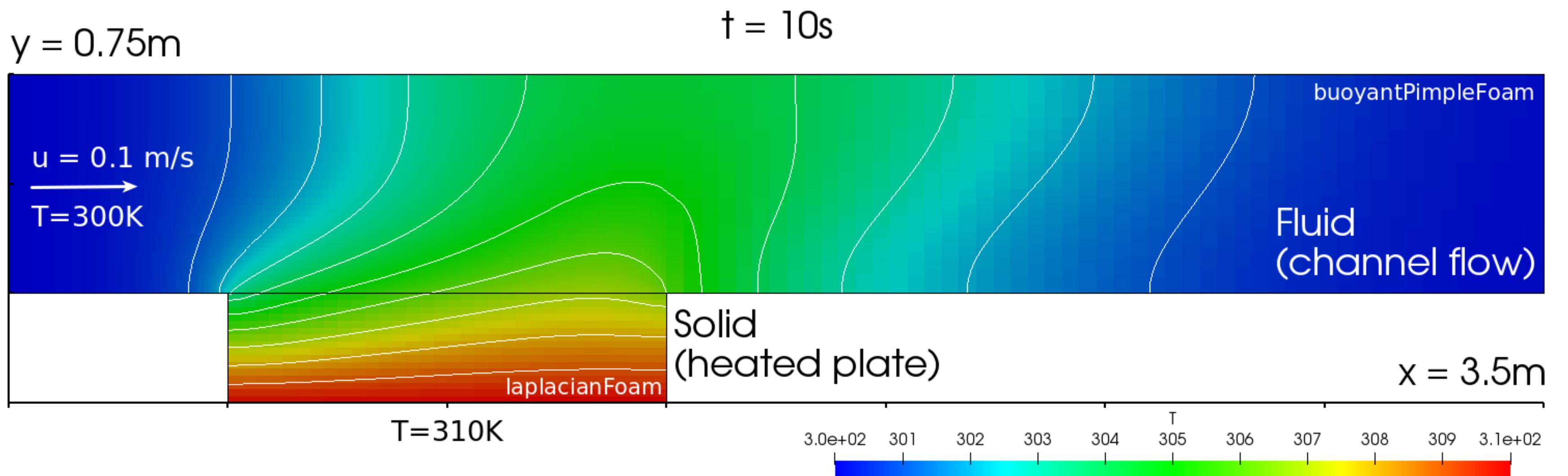
```
openfoam-adapter/ $ ./Allwmake
```



```
vagrant@precicevm:~/open... vagrant@precicevm:~/openfoam-adapter vagrant@precicevm:~/openfoam-adapter 187x52  
  
vagrant@precicevm:~/openfoam-adapter$ ls  
Adapter.C Allmake CODE_OF_CONDUCT.md CouplingDataUser.H FSI LICENSE preciceAdapterFunctionObject.H Utilities.C  
Adapter.H CHANGELOG.md CONTRIBUTING.md docs Interface.C Make README.md Utilities.H  
Allclean CHT CouplingDataUser.C FF Interface.H preciceAdapterFunctionObject.C tools  
vagrant@precicevm:~/openfoam-adapter$ ./Allmake  
Building the OpenFOAM-preCICE adapter...  
  
Current OpenFOAM environment:  
WM_PROJECT = OpenFOAM  
WM_PROJECT_VERSION = v2012  
  
The adapter will be built into /home/vagrant/OpenFOAM/vagrant-v2012/platforms/linux64GccDPInt320pt/lib  
Additional preprocessor/compiler options:  
  
If not already known by the system, preCICE may be located using:  
pkg-config --cflags libprecice =  
pkg-config --libs libprecice = -lprecice  
  
Building with WMake (see the wmake.log log file)...  
  
Compiling enabled on 4 cores  
wmake libso (openfoam-adapter)  
ln: ./lnInclude  
Making dependency list for source file preciceAdapterFunctionObject.C  
Making dependency list for source file Adapter.C  
Making dependency list for source file PressureGradient.C  
Making dependency list for source file Pressure.C  
wmkdepend: could not open 'wmkdepend: could not open 'precice/SolverInterface.hpp' for source file 'preciceAdapterFunctionObject.C': No such file or directory  
precice/SolverInterface.hpp' for source file 'Adapter.C': No such file or directory  
Making dependency list for source file VelocityGradient.C  
Making dependency list for source file Velocity.C  
Making dependency list for source file FF.C  
Making dependency list for source file DisplacementDelta.C  
Making dependency list for source file Displacement.C  
Making dependency list for source file Stress.C  
wmkdepend: could not open 'precice/SolverInterface.hpp' for source file 'FF/FF.C': No such file or directory  
Making dependency list for source file Force.C  
Making dependency list for source file ForceBase.C  
Making dependency list for source file FSI.C  
Making dependency list for source file CHT.C  
Making dependency list for source file SinkTemperature.C  
Making dependency list for source file HeatTransferCoefficient.C  
wmkdepend: could not open 'precice/SolverInterface.hpp' for source file 'FSI/FSI.C': No such file or directory  
Making dependency list for source file HeatFlux.C  
wmkdepend: could not open 'precice/SolverInterface.hpp' for source file 'CHT/CHT.C': No such file or directory  
Making dependency list for source file KappaEffective.C  
Making dependency list for source file Temperature.C  
Making dependency list for source file CouplingDataUser.C  
Making dependency list for source file Interface.C  
Making dependency list for source file Utilities.C  
wmkdepend: could not open 'precice/SolverInterface.hpp' for source file 'Interface.C': No such file or directory
```

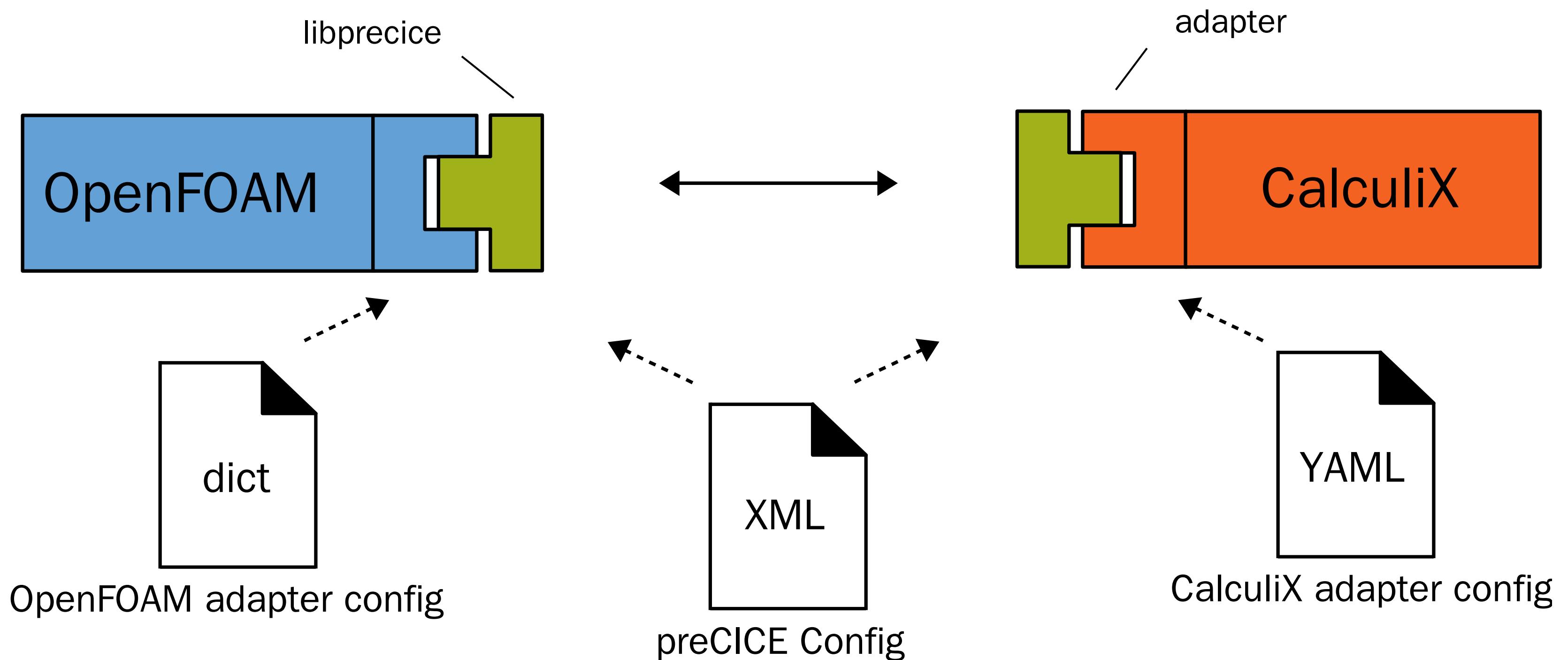


Tutorial: Flow over a heated plate



Find the tutorial on precice.org/tutorials-flow-over-heated-plate.html.

Configuration: overview



Configuration: files

```
1 .
2 └── clean-tutorial.sh
3 └── fluid-openfoam
4     ├── 0/
5     ├── clean.sh
6     ├── constant/
7     ├── run.sh
8     └── system
9         ├── blockMeshDict
10        ├── controlDict
11        ├── decomposeParDict
12        ├── fvSchemes
13        ├── fvSolution
14        └── preciceDict
15 └── precice-config.xml
16 └── README.md
17 └── solid-fenics/
```



Configuration: files

```
3 └── fluid-openfoam
4     ├── 0/
5     ├── clean.sh
6     ├── constant/
7     ├── run.sh
8     └── system
9         ├── blockMeshDict
10        ├── controlDict
11        ├── decomposeParDict
12        ├── fvSchemes
13        ├── fvSolution
14        └── preciceDict
15 └── precice-config.xml
16 └── README.md
17 └── solid-fenics/
18 └── solid-nutils/
19 └── solid-openfoam
20     └── .
```



Enabling the adapter

```
1 // fluid-openfoam/system/controlDict
2
3 functions
4 {
5 preCICE_Adapter
6 {
7
8 type preciceAdapterFunctionObject;
9 libs ("libpreciceAdapterFunctionObject.s
10
11 }
12 }
```

```
1 // solid-openfoam/system/con
2
3 functions
4 {
5 preCICE_Adapter
6 {
7
8 type preciceAdapterFunctionO
9 libs ("libpreciceAdapterFunc
10
11 }
12 }
```

OpenFOAM adapter config

```
1 // fluid-openfoam/system/preciceDictionary
2
3 preciceConfig "../precice-config.xml"
4
5 participant Fluid;
6
7 modules (CHT);
8
9 interfaces
10 {
11     Interface1
12     {
13         mesh      Fluid-Mesh;
14         patches   (interface);
15
16         readData
17         (
18             --
```

```
1 // solid-openfoam/system/preciceDictionary
2
3 preciceConfig "../precice-config.xml"
4
5 participant Solid;
6
7 modules (CHT);
8
9 interfaces
10 {
11     Interface1
12     {
13         mesh      Solid-Mesh;
14         patches   (interface);
15
16         readData
17         (
18             --
```

OpenFOAM boundary conditions

```
1 // fluid-openfoam/0/T
2
3 internalField uniform 300;
4
5 boundaryField
6 {
7     interface
8     {
9         type      fixedGradient;
10        gradient uniform 0;
11    }
12    inlet
13    {
14        type      fixedValue;
15        value    $internalField;
16    }
17    outlet
18 }
```

```
1 // solid-openfoam/0/T
2
3 internalField uniform 310;
4
5 boundaryField
6 {
7     interface
8     {
9         type      fixedValue;
10        value    $internalField;
11    }
12    left
13    {
14        type      zeroGradient;
15    }
16    // ...
17 }
```

precice-config.xml

```
1 <precice-configuration>
2
3     <solver-interface dimensions="2">
4
5         <data:scalar name="Temperature"/>
6         <data:scalar name="Heat-Flux"/>
7
8         <mesh name="Fluid-Mesh">
9             <use-data name="Temperature"/>
10            <use-data name="Heat-Flux"/>
11        </mesh>
12
13        <mesh name="Solid-Mesh">
14            <use-data name="Temperature"/>
15            <use-data name="Heat-Flux"/>
16        </mesh>
17
18    </solver-interface>
```



precice-config.xml

```
1 <precice-configuration>
2
3     <solver-interface dimensions="2">
4
5         <data:scalar name="Temperature"/>
6         <data:scalar name="Heat-Flux"/>
7
8         <mesh name="Fluid-Mesh">
9             <use-data name="Temperature"/>
10            <use-data name="Heat-Flux"/>
11        </mesh>
12
13        <mesh name="Solid-Mesh">
14            <use-data name="Temperature"/>
15            <use-data name="Heat-Flux"/>
16        </mesh>
17
18    </solver-interface>
```



precice-config.xml

```
4      <data:scalar name="Temperature"/>
5      <data:scalar name="Heat-Flux"/>
6
7      <mesh name="Fluid-Mesh">
8          <use-data name="Temperature"/>
9          <use-data name="Heat-Flux"/>
10     </mesh>
11
12     <mesh name="Solid-Mesh">
13         <use-data name="Temperature"/>
14         <use-data name="Heat-Flux"/>
15     </mesh>
16
17     <participant name="Fluid">
18         <use-mesh name="Fluid-Mesh" provide="yes"/>
19         <use-mesh name="Solid-Mesh" from="Solid"/>
20     </participant>
```



precice-config.xml

```
14      <use-data name="Temperature"/>
15      <use-data name="Heat-Flux"/>
16  </mesh>
17
18 <participant name="Fluid">
19     <use-mesh name="Fluid-Mesh" provide="yes"/>
20     <use-mesh name="Solid-Mesh" from="Solid"/>
21     <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22     <write-data name="Temperature" mesh="Fluid-Mesh"/>
23     <mapping:nearest-neighbor direction="read"
24         from="Solid-Mesh" to="Fluid-Mesh"
25         constraint="consistent"/>
26 </participant>
27
28 <participant name="Solid">
29     <use-mesh name="Fluid-Mesh" from="Fluid"/>
30     <use-mesh name="Solid-Mesh" provide="yes"/>
```



precice-config.xml

```
14      <use-data name="Temperature"/>
15      <use-data name="Heat-Flux"/>
16  </mesh>
17
18 <participant name="Fluid">
19     <use-mesh name="Fluid-Mesh" provide="yes"/>
20     <use-mesh name="Solid-Mesh" from="Solid"/>
21     <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22     <write-data name="Temperature" mesh="Fluid-Mesh"/>
23     <mapping:nearest-neighbor direction="read"
24         from="Solid-Mesh" to="Fluid-Mesh"
25         constraint="consistent"/>
26 </participant>
27
28 <participant name="Solid">
29     <use-mesh name="Fluid-Mesh" from="Fluid"/>
30     <use-mesh name="Solid-Mesh" provide="yes"/>
```



precice-config.xml

```
14      <use-data name="Temperature"/>
15      <use-data name="Heat-Flux"/>
16  </mesh>
17
18 <participant name="Fluid">
19     <use-mesh name="Fluid-Mesh" provide="yes"/>
20     <use-mesh name="Solid-Mesh" from="Solid"/>
21     <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22     <write-data name="Temperature" mesh="Fluid-Mesh"/>
23     <mapping:nearest-neighbor direction="read"
24         from="Solid-Mesh" to="Fluid-Mesh"
25         constraint="consistent"/>
26 </participant>
27
28 <participant name="Solid">
29     <use-mesh name="Fluid-Mesh" from="Fluid"/>
30     <use-mesh name="Solid-Mesh" provide="yes"/>
```



precice-config.xml

```
14      <use-data name="Temperature"/>
15      <use-data name="Heat-Flux"/>
16  </mesh>
17
18 <participant name="Fluid">
19     <use-mesh name="Fluid-Mesh" provide="yes"/>
20     <use-mesh name="Solid-Mesh" from="Solid"/>
21     <read-data name="Heat-Flux" mesh="Fluid-Mesh"/>
22     <write-data name="Temperature" mesh="Fluid-Mesh"/>
23     <mapping:nearest-neighbor direction="read"
24         from="Solid-Mesh" to="Fluid-Mesh"
25         constraint="consistent"/>
26 </participant>
27
28 <participant name="Solid">
29     <use-mesh name="Fluid-Mesh" from="Fluid"/>
30     <use-mesh name="Solid-Mesh" provide="yes"/>
```



precice-config.xml

```
24      from="Solid-Mesh" to="Fluid-Mesh"
25      constraint="consistent"/>
26  </participant>
27
28  <participant name="Solid">
29    <use-mesh name="Fluid-Mesh" from="Fluid"/>
30    <use-mesh name="Solid-Mesh" provide="yes"/>
31    <read-data name="Temperature" mesh="Solid-Mesh"/>
32    <write-data name="Heat-Flux" mesh="Solid-Mesh"/>
33    <mapping:nearest-neighbor direction="read"
34      from="Fluid-Mesh" to="Solid-Mesh"
35      constraint="consistent"/>
36  </participant>
37
38  <m2n:sockets from="Fluid" to="Solid" exchange-directory=".." />
39
40  <coupling-scheme:serial-implicit>
```



precice-config.xml

```
29      <use-mesh name="Fluid-Mesh" from="Fluid" />
30      <use-mesh name="Solid-Mesh" provide="yes"/>
31      <read-data name="Temperature" mesh="Solid-Mesh"/>
32      <write-data name="Heat-Flux" mesh="Solid-Mesh"/>
33      <mapping:nearest-neighbor direction="read"
34          from="Fluid-Mesh" to="Solid-Mesh"
35          constraint="consistent"/>
36  </participant>
37
38  <m2n:sockets from="Fluid" to="Solid" exchange-directory=".." />
39
40  <coupling-scheme:serial-implicit>
41      <time-window-size value="0.01" />
42      <max-time value="1" />
43      <max-iterations value="30" />
44      <participants first="Fluid" second="Solid" />
45      <exchange data="Temperature" mesh="Fluid-Mesh" from="Fluid" to="Solid" />
46      <exchange data="Heat-Flux" mesh="Solid-Mesh" from="Solid" to="Fluid" />
```



precice-config.xml

```
38 <m2n:sockets from="Fluid" to="Solid" exchange-directory=".." />
39
40 <coupling-scheme:serial-implicit>
41   <time-window-size value="0.01" />
42   <max-time value="1" />
43   <max-iterations value="30" />
44   <participants first="Fluid" second="Solid" />
45   <exchange data="Temperature" mesh="Fluid-Mesh" from="Fluid" to=
46   <exchange data="Heat-Flux" mesh="Solid-Mesh" from="Solid" to="F
47   <relative-convergence-measure limit="1.0e-5"
48     data="Temperature" mesh="Fluid-Mesh" />
49   <acceleration:aitken>
50     <data mesh="Solid-Mesh" name="Heat-Flux" />
51     <initial-relaxation value="0.5" />
52   </acceleration:aitken>
53 </coupling-scheme:serial-implicit>
54
```



precice-config.xml

```
38 <m2n:sockets from="Fluid" to="Solid" exchange-directory=".." />
39
40 <coupling-scheme:serial-implicit>
41   <time-window-size value="0.01" />
42   <max-time value="1" />
43   <max-iterations value="30" />
44   <participants first="Fluid" second="Solid" />
45   <exchange data="Temperature" mesh="Fluid-Mesh" from="Fluid" to=
46   <exchange data="Heat-Flux" mesh="Solid-Mesh" from="Solid" to="F
47   <relative-convergence-measure limit="1.0e-5"
48     data="Temperature" mesh="Fluid-Mesh" />
49   <acceleration:aitken>
50     <data mesh="Solid-Mesh" name="Heat-Flux" />
51     <initial-relaxation value="0.5" />
52   </acceleration:aitken>
53 </coupling-scheme:serial-implicit>
54
```



precice-config.xml

```
38 <m2n:sockets from="Fluid" to="Solid" exchange-directory=".." />
39
40 <coupling-scheme:serial-implicit>
41   <time-window-size value="0.01" />
42   <max-time value="1" />
43   <max-iterations value="30" />
44   <participants first="Fluid" second="Solid" />
45   <exchange data="Temperature" mesh="Fluid-Mesh" from="Fluid" to=
46   <exchange data="Heat-Flux" mesh="Solid-Mesh" from="Solid" to="F
47   <relative-convergence-measure limit="1.0e-5"
48     data="Temperature" mesh="Fluid-Mesh" />
49   <acceleration:aitken>
50     <data mesh="Solid-Mesh" name="Heat-Flux" />
51     <initial-relaxation value="0.5" />
52   </acceleration:aitken>
53 </coupling-scheme:serial-implicit>
54
```

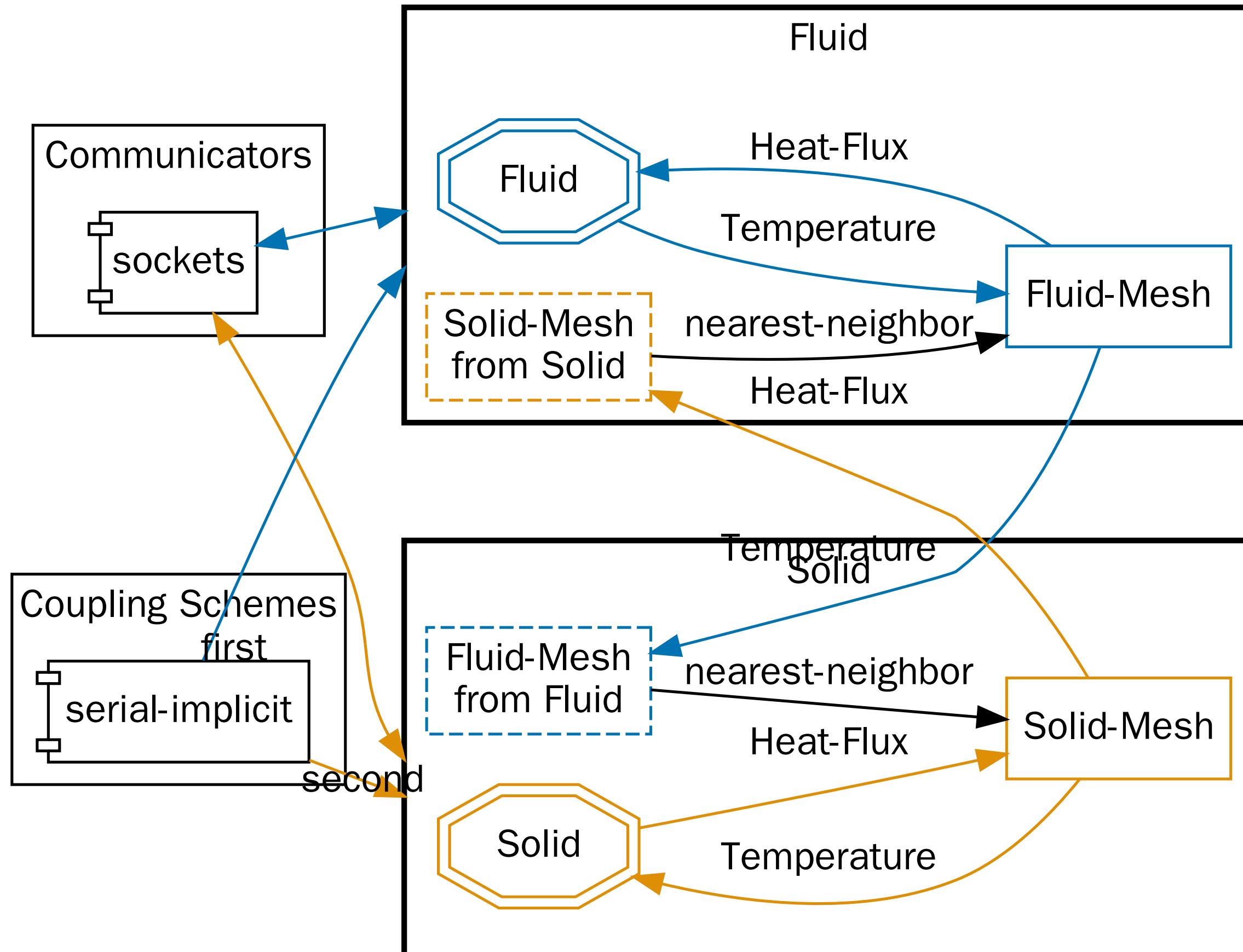


precice-config.xml

```
38 <m2n:sockets from="Fluid" to="Solid" exchange-directory=".." />
39
40 <coupling-scheme:serial-implicit>
41   <time-window-size value="0.01" />
42   <max-time value="1" />
43   <max-iterations value="30" />
44   <participants first="Fluid" second="Solid" />
45   <exchange data="Temperature" mesh="Fluid-Mesh" from="Fluid" to=
46   <exchange data="Heat-Flux" mesh="Solid-Mesh" from="Solid" to="F
47   <relative-convergence-measure limit="1.0e-5"
48     data="Temperature" mesh="Fluid-Mesh" />
49   <acceleration:aitken>
50     <data mesh="Solid-Mesh" name="Heat-Flux" />
51     <initial-relaxation value="0.5" />
52   </acceleration:aitken>
53 </coupling-scheme:serial-implicit>
54
```

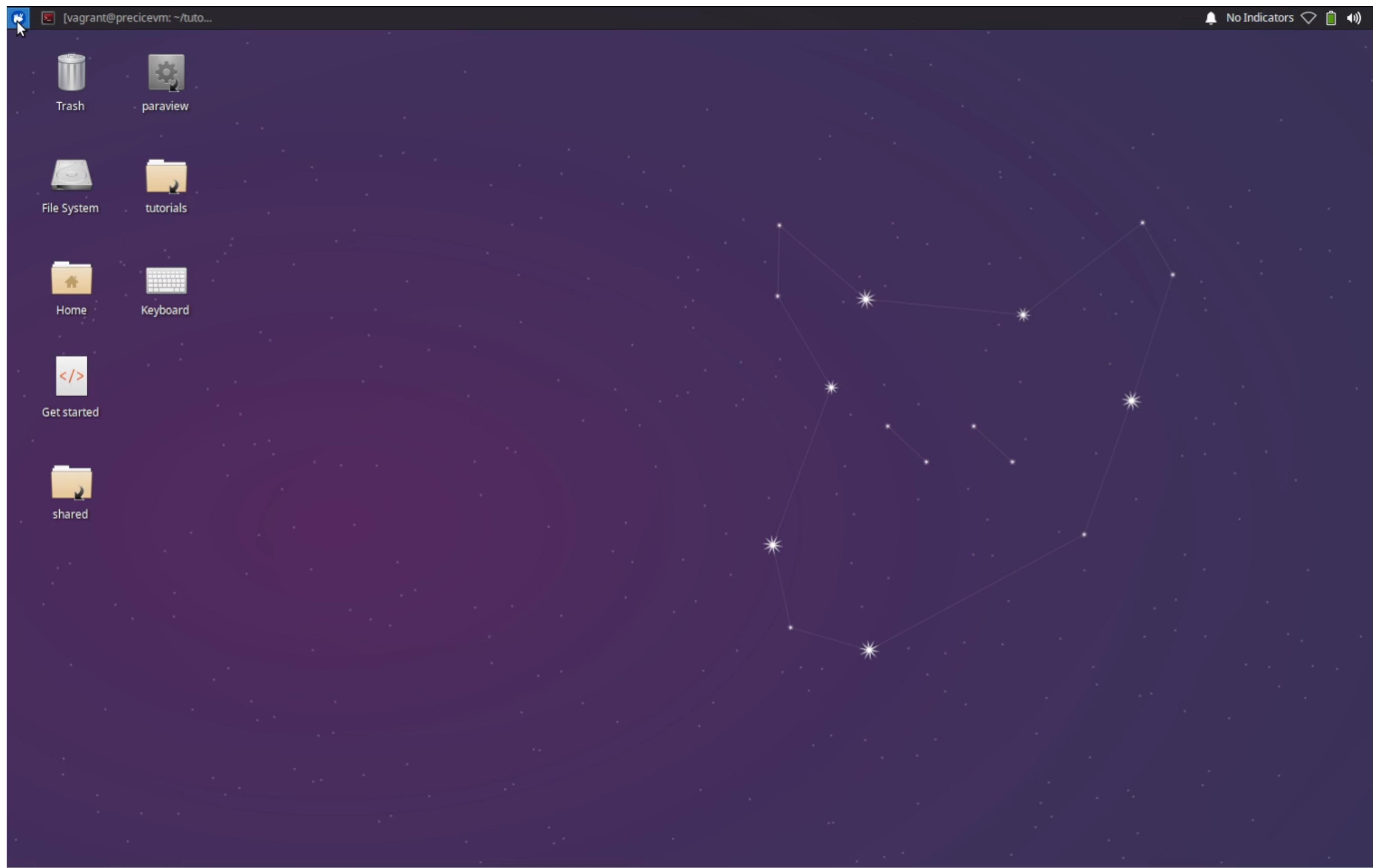


precice-config.xml



Visual representation of precice-config.xml using the [config visualizer](#)





```
vagrant@precicevm: ~/tutor... vagrant@precicevm: ~/tutorials/flow-over-heated-plate/fluid-openfoam vagrant@precicevm: ~/tutorials/flow-over-heated-plate/fluid-openfoam 187x52  
vagrant@precicevm:~/tutorials/flow-over-heated-plate/fluid-openfoam$ ls 0 0.2 0.4 0.6 0.8 1 clean.sh constant fluid-openfoam.foam precice-Fluid-events.json precice-Fluid-events-summary.log precice-Fluid-iterations.log run.sh system vagrant@precicevm:~/tutorials/flow-over-heated-plate/fluid-openfoam$ paraFoam
```

Level 3: Coupling OpenFOAM with other solvers

Other tutorials

```
1 tutorials
2   ├── elastic-tube-1d
3   │   ├── fluid-cpp
4   │   ├── fluid-python
5   │   ├── solid-cpp
6   │   └── solid-python
7   ├── elastic-tube-3d
8   │   ├── fluid-openfoam
9   │   └── solid-calculix
10  ├── flow-over-heated-plate
11  │   ├── fluid-openfoam
12  │   ├── solid-fenics
13  │   ├── solid-nutils
14  │   └── solid-openfoam
15  ├── flow-over-heated-plate-nearest-projection
16  │   ├── fluid-openfoam
17  │   └── solid-openfoam
18  └──
```

See precice.org/tutorials.html.

Other tutorials

```
4      ├── fluid-python
5      ├── solid-cpp
6      └── solid-python
7  ├── elastic-tube-3d
8      ├── fluid-openfoam
9      └── solid-calculix
10     ├── flow-over-heated-plate
11     |   ├── fluid-openfoam
12     |   ├── solid-fenics
13     |   └── solid-nutils
14     └── solid-openfoam
15     ├── flow-over-heated-plate-nearest-projection
16     |   ├── fluid-openfoam
17     |   └── solid-openfoam
18     ├── flow-over-heated-plate-steady-state
19     |   ├── fluid-openfoam
20     └── solid-codeaster
```

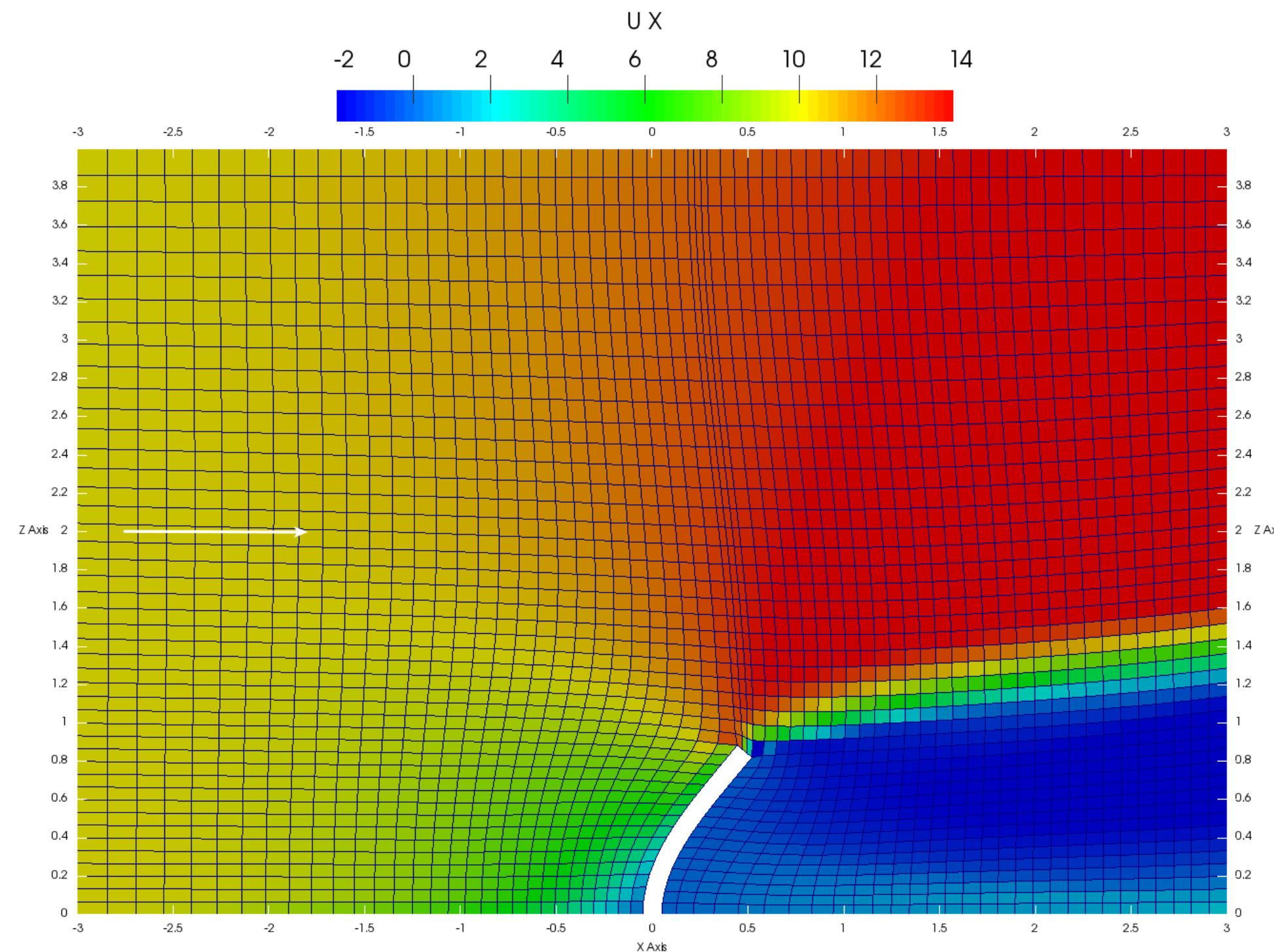
See precice.org/tutorials.html.

Other tutorials

```
36 ┌── fenics
37 ├── partitioned-pipe
38 │   ├── fluid1-openfoam-pimplefoam
39 │   ├── fluid1-openfoam-sonicliquidfoam
40 │   ├── fluid2-openfoam-pimplefoam
41 └── fluid2-openfoam-sonicliquidfoam
42 ├── perpendicular-flap
43 │   ├── fluid-nutils
44 │   ├── fluid-openfoam
45 │   ├── fluid-su2
46 │   ├── solid-calculix
47 │   ├── solid-dealii
48 └── solid-fenics
49 ├── quickstart
50 │   ├── fluid-openfoam
51 └── solid-cpp
52 ┌── turek-hron-fsi3
53 │   └── fluid-openfoam
```

See precice.org/tutorials.html.

Tutorial: Channel with a perpendicular flap



Find this tutorial on precice.org/tutorials-perpendicular-flap.html.

Dependencies

- preCICE v2 (e.g. packages for Ubuntu)
- Recent OpenFOAM (e.g. v1706-v2012 or 4-8)
- OpenFOAM-preCICE adapter v1.0
- deal.II v9.2
- deal.II-preCICE adapter/example

Configure OpenFOAM

```
1 // fluid-openfoam/0/U
2
3 flap
4 {
5     type          movingWallVelocity;
6     value         uniform (0 0 0);
7 }
```

```
1 // fluid-openfoam/0/pointDisplacement
2
3 flap
4 {
5     type          fixedValue;
6     value         $internalField;
7 }
```

```
1 // fluid-openfoam/constant/dynamicMeshDict
2
3 solver      displacementLaplacian;
```

Configure the OpenFOAM adapter

```
1 // fluid-openfoam/system/preciceDict
2 preciceConfig "../../precice-config.xml";
3 participant Fluid;
4
5 modules (FSI);
6
7 interfaces {
8     Interface1 {
9         mesh Fluid-Mesh;
10        patches (flap);
11        locations faceCenters;
12
13        readData (Displacement);
14
15        writeData (Force);
16    };
17}
```

Configure the deal.II adapter

```
1 // solid-dealii/parameters.prm
2
3 subsection precice configuration
4   # Cases: FSI3 or PF for perpendicular flap
5   set Scenario = PF
6
7   # Name of the precice configuration file
8   set precice config-file = ../precice-config.xml
9
10  # Name of the participant in the precice-config.xml file
11  set Participant name = Solid
12
13  # Name of the coupling mesh in the precice-config.xml file
14  set Mesh name = Solid-Mesh
15
16  # Name of the read data in the precice-config.xml file
17  set Read data name = Force
18
```

Configure preCICE

```
1 <solver-interface dimensions="2">
2   <data:vector name="Force" />
3   <data:vector name="Displacement" />
4
5   <mesh name="Fluid-Mesh">
6     <use-data name="Force" />
7     <use-data name="Displacement" />
8   </mesh>
9
10  <mesh name="Solid-Mesh">
11    <use-data name="Displacement" />
12    <use-data name="Force" />
13  </mesh>
14
15  <participant name="Fluid">
16    <use-mesh name="Fluid-Mesh" provide="yes" />
17    <use-mesh name="Solid-Mesh" from="Solid" />
18
```

Configure preCICE

```
11   <use-data name="Displacement" />
12   <use-data name="Force" />
13 </mesh>
14
15 <participant name="Fluid">
16   <use-mesh name="Fluid-Mesh" provide="yes" />
17   <use-mesh name="Solid-Mesh" from="Solid" />
18   <write-data name="Force" mesh="Fluid-Mesh" />
19   <read-data name="Displacement" mesh="Fluid-Mesh" />
20   <mapping:rbf-thin-plate-splines direction="write"
21     from="Fluid-Mesh" to="Solid-Mesh" constraint="conservative" />
22   <mapping:rbf-thin-plate-splines direction="read"
23     from="Solid-Mesh" to="Fluid-Mesh" constraint="consistent" />
24 </participant>
25
26 <participant name="Solid">
27   <use-mesh name="Solid-Mesh" provide="yes" />
28   <commit-data name="Displacement" mesh="Solid-Mesh" />
```

Configure preCICE

```
20   <mapping:rbf-thin-plate-splines direction="write"  
21     from="Fluid-Mesh" to="Solid-Mesh" constraint="conservative" />  
22   <mapping:rbf-thin-plate-splines direction="read"  
23     from="Solid-Mesh" to="Fluid-Mesh" constraint="consistent" />  
24 </participant>  
25  
26 <participant name="Solid">  
27   <use-mesh name="Solid-Mesh" provide="yes" />  
28   <write-data name="Displacement" mesh="Solid-Mesh" />  
29   <read-data name="Force" mesh="Solid-Mesh" />  
30   <watch-point mesh="Solid-Mesh" name="Flap-Tip" coordinate="0.0;1"  
31 </participant>  
32  
33 <m2n:sockets from="Fluid" to="Solid" exchange-directory=".." />  
34  
35 <coupling-scheme:parallel-implicit>  
36   <time-window-size value="0.01" />  
37   <max-time-steps "5" />
```

Configure preCICE

```
13   </mesh>
14
15  <participant name="Fluid">
16    <use-mesh name="Fluid-Mesh" provide="yes" />
17    <use-mesh name="Solid-Mesh" from="Solid" />
18    <write-data name="Force" mesh="Fluid-Mesh" />
19    <read-data name="Displacement" mesh="Fluid-Mesh" />
20    <mapping:rbf-thin-plate-splines direction="write"
21      from="Fluid-Mesh" to="Solid-Mesh" constraint="conservative" />
22    <mapping:rbf-thin-plate-splines direction="read"
23      from="Solid-Mesh" to="Fluid-Mesh" constraint="consistent" />
24  </participant>
25
26  <participant name="Solid">
27    <use-mesh name="Solid-Mesh" provide="yes" />
28    <write-data name="Displacement" mesh="Solid-Mesh" />
29    <read-data name="Force" mesh="Solid-Mesh" />
30    <mapping:rbf-thin-plate-splines direction="read"
31      from="Solid-Mesh" to="Fluid-Mesh" constraint="consistent" />
```

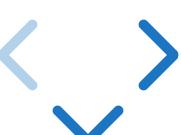
Configure preCICE

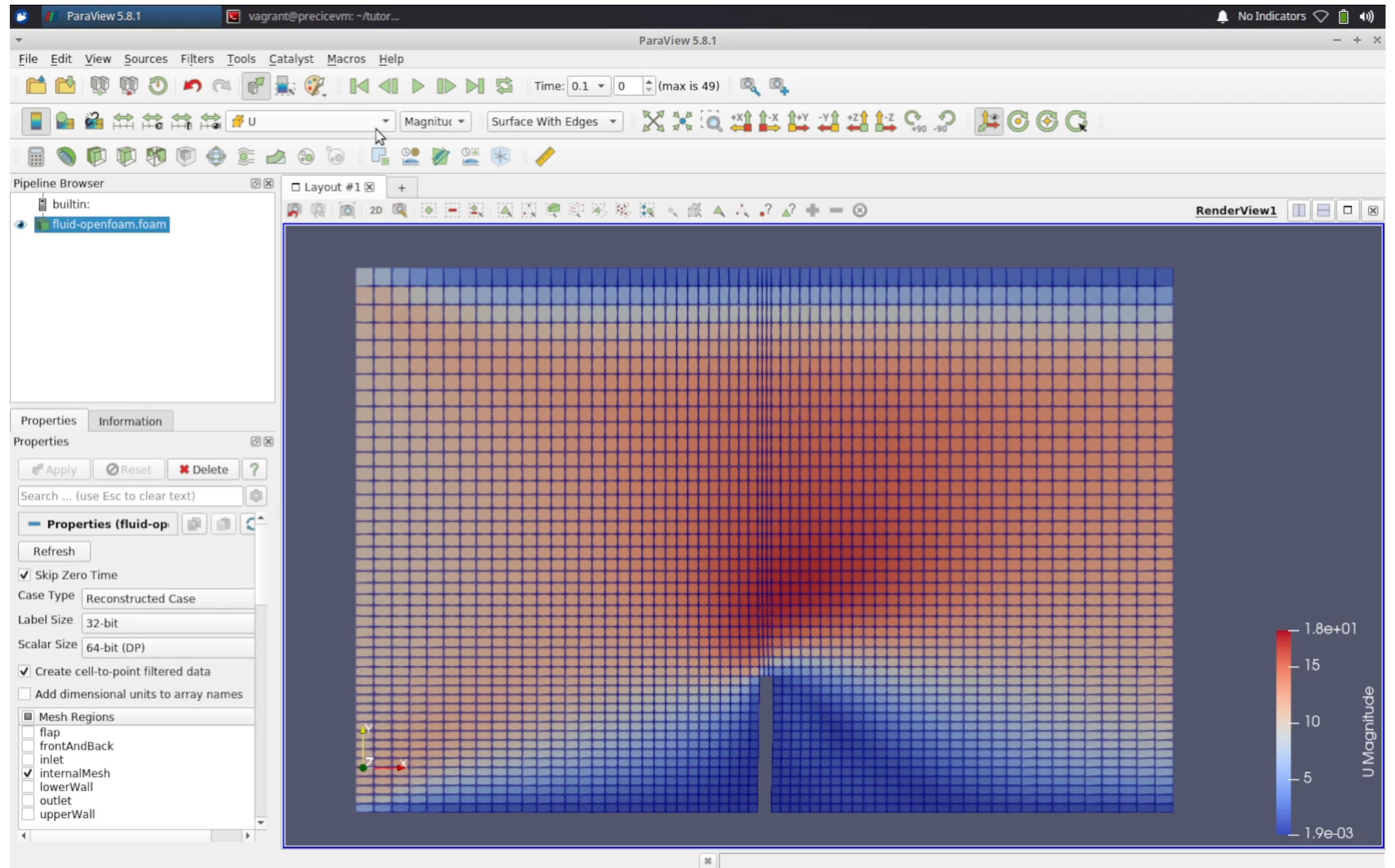
```
34
35 <coupling-scheme:parallel-implicit>
36   <time-window-size value="0.01" />
37   <max-time value="5" />
38   <participants first="Fluid" second="Solid" />
39   <exchange data="Force" mesh="Solid-Mesh" from="Fluid" to="Solid" />
40   <exchange data="Displacement" mesh="Solid-Mesh" from="Solid" to="Fluid" />
41   <max-iterations value="50" />
42   <relative-convergence-measure limit="5e-3" data="Displacement" mesh="Solid-Mesh" />
43   <relative-convergence-measure limit="5e-3" data="Force" mesh="Solid-Mesh" />
44 <acceleration:IQN-ILS>
45   <data name="Displacement" mesh="Solid-Mesh" />
46   <data name="Force" mesh="Solid-Mesh" />
47   <preconditioner type="residual-sum" />
48   <filter type="QR2" limit="1e-2" />
49   <initial-relaxation value="0.5" />
50
51
```

Configure preCICE

```
40    <exchange data="displacement" mesh="Solid-Mesh" from="Solid" to="Solid">
41        <max-iterations value="50" />
42        <relative-convergence-measure limit="5e-3"
43            data="Displacement" mesh="Solid-Mesh" />
44        <relative-convergence-measure limit="5e-3"
45            data="Force" mesh="Solid-Mesh" />
46    <acceleration:IQN-ILS>
47        <data name="Displacement" mesh="Solid-Mesh" />
48        <data name="Force" mesh="Solid-Mesh" />
49        <preconditioner type="residual-sum" />
50        <filter type="QR2" limit="1e-2" />
51        <initial-relaxation value="0.5" />
52        <max-used-iterations value="100" />
53        <time-windows-reused value="15" />
54    </acceleration:IQN-ILS>
55 </coupling-scheme:parallel-implicit>
56 </solver-interface>
```

```
vagrant@precicevm: ~/tutor...          vagrant@precicevm: ~/tutorials/perpendicular-flap          vagrant@precicevm: ~/tutorials/perpendicular-flap 187x52
vagrant@precicevm:~/tutorials/perpendicular-flap$ ls
clean-tutorial.sh  fluid-openfoam  images          plot-displacement.sh  README.md      solid-dealii
fluid-nutils       fluid-su2       plot-all-displacements.sh  precice-config.xml  solid-calculix  solid-fenics
vagrant@precicevm:~/tutorials/perpendicular-flap$ nano precice-config.xml
vagrant@precicevm:~/tutorials/perpendicular-flap$ # decreased the end time to 0.1s
```

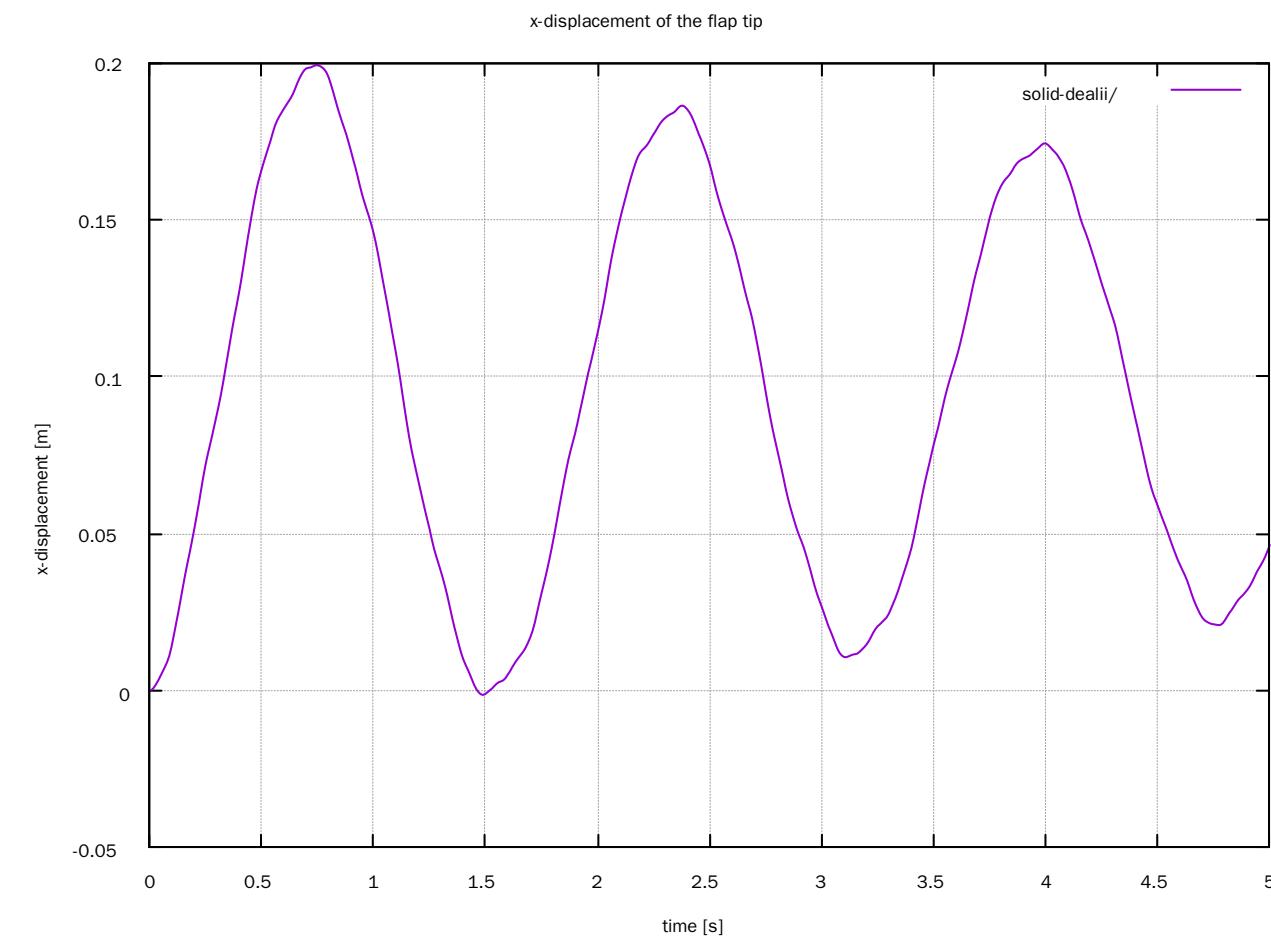




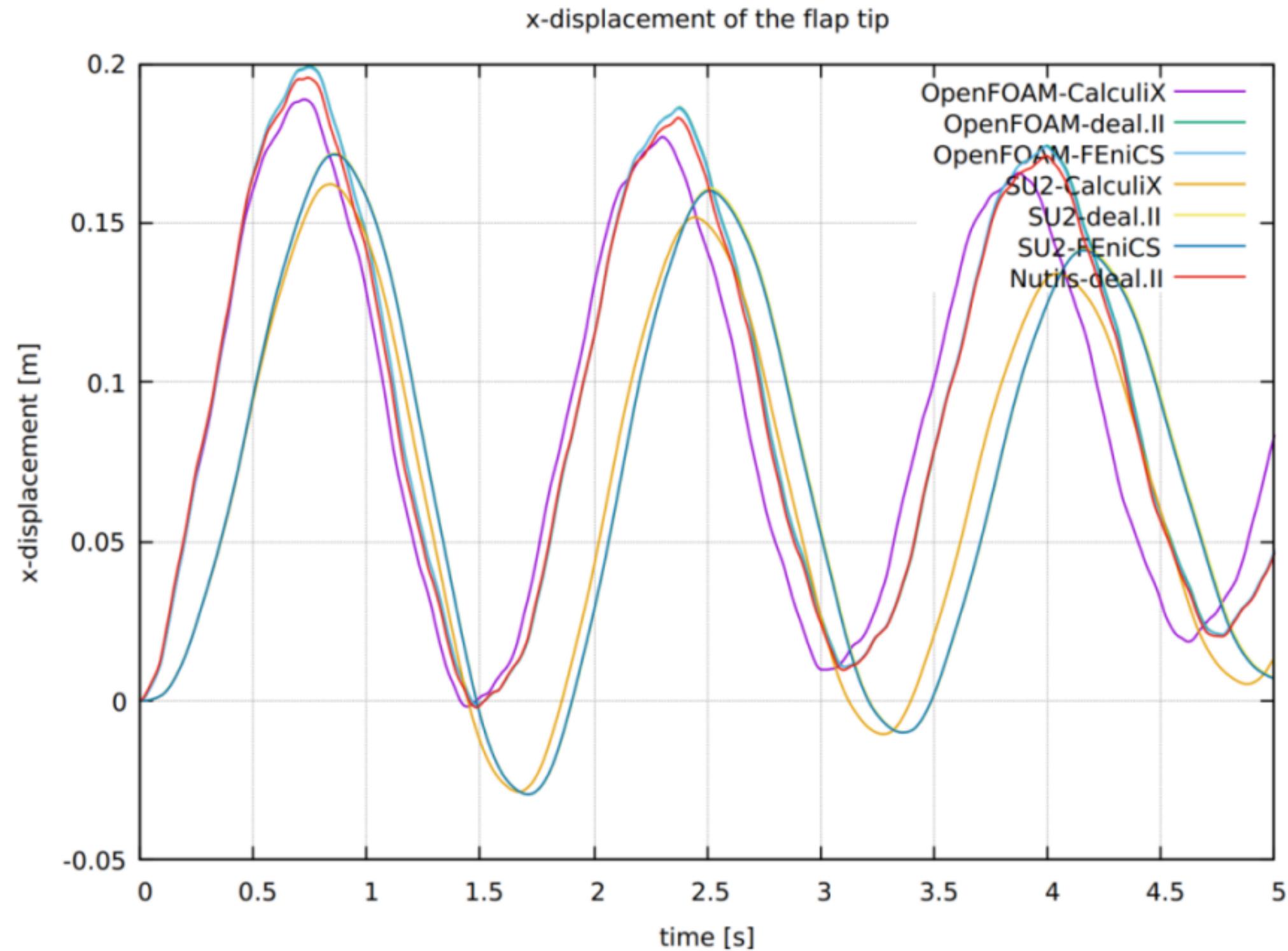
Linear solid model

How is the tip moving?

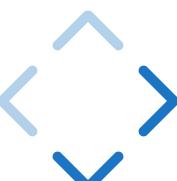
```
1 <participant name="Solid">  
2 ...  
3 <watch-point mesh="Solid-Mesh"  
4 name="Flap-Tip"  
5 coordinate="0.0;1" />  
6 </participant>  
  
1 ./plot-displacement.sh
```



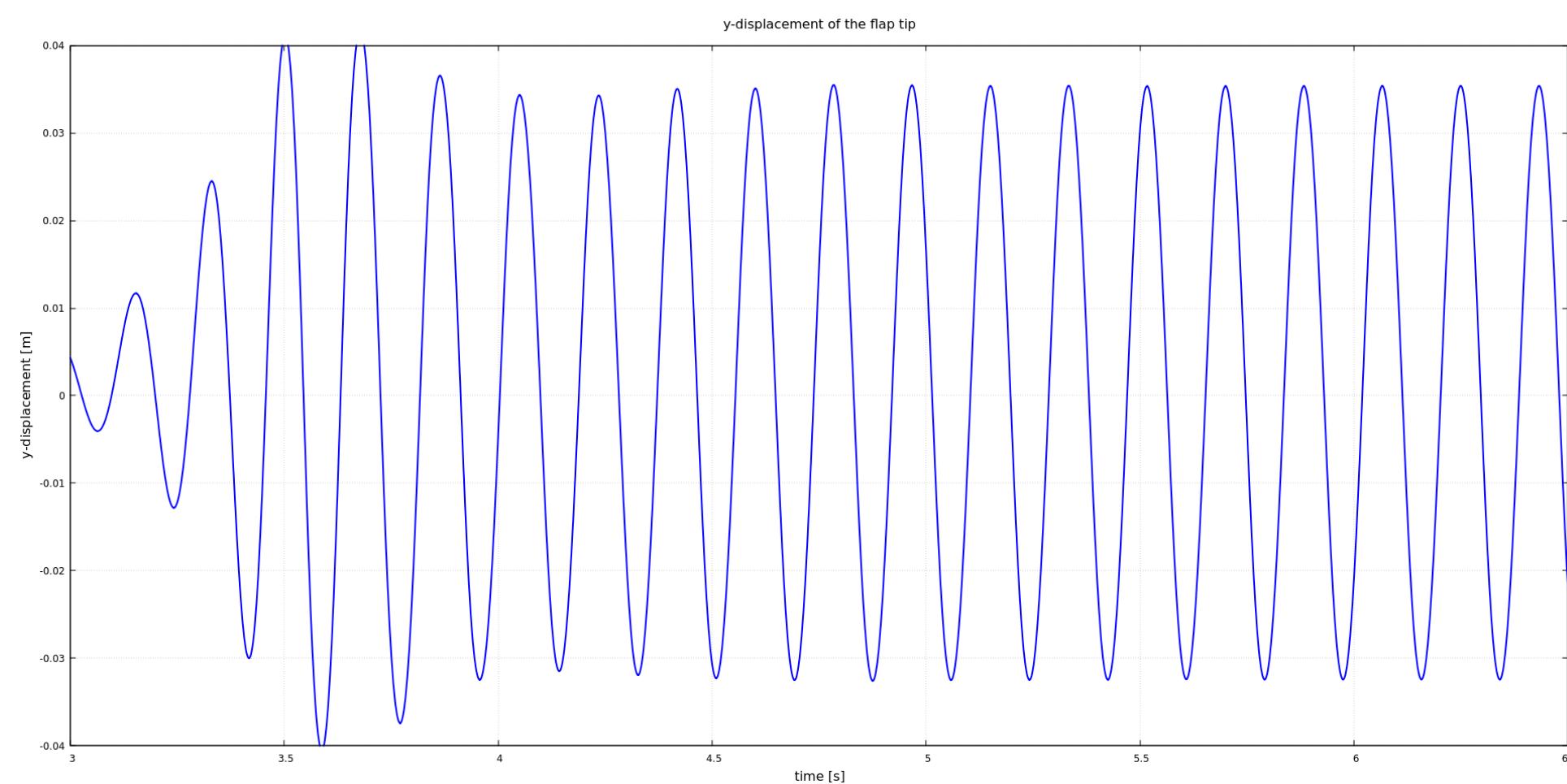
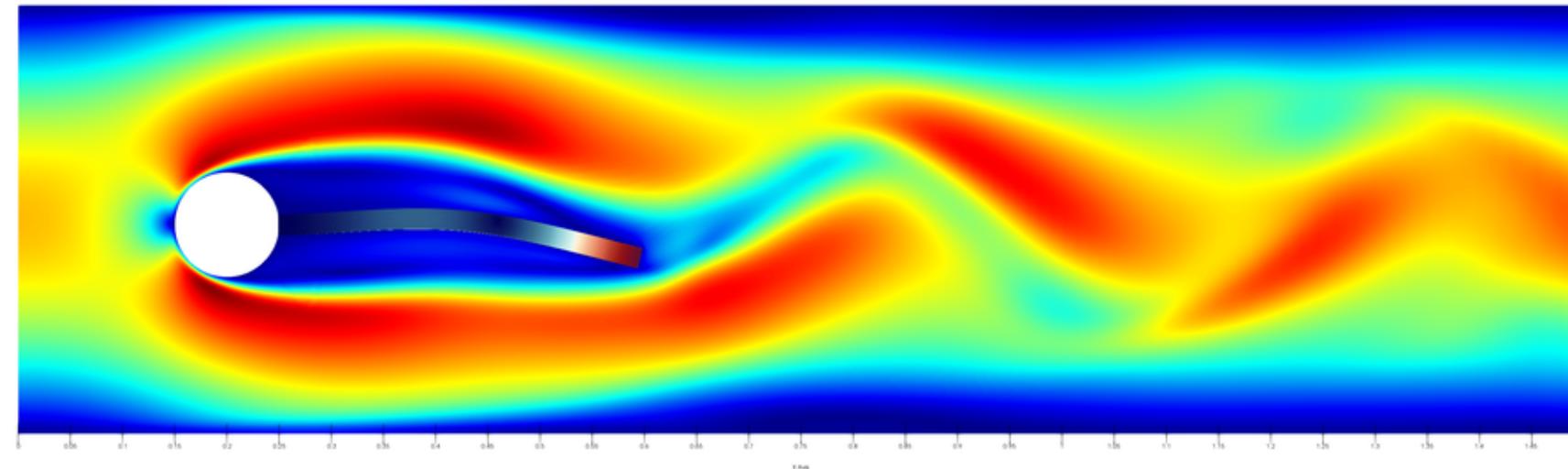
What if we use other solver combinations?



Notes for differences: The CalculiX adapter only supports linear finite elements (deal.II uses 4th order, FEniCS 2nd order). SU2 models a compressible fluid, OpenFOAM and Nutils an incompressible one.



See also: Turek-Hron FSI3 benchmark

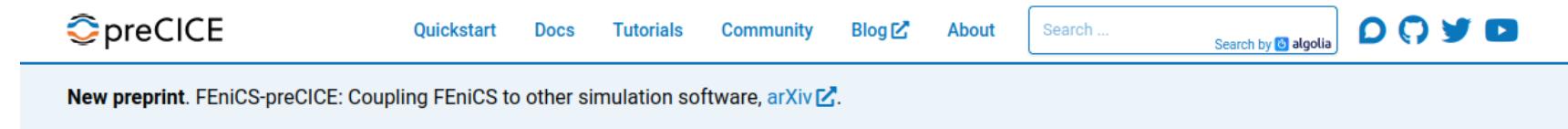


See tutorial on precice.org/tutorials-turek-hron-fsi3.html



Resources

Start here: precice.org



The screenshot shows the top navigation bar of the preCICE website. It includes links for Quickstart, Docs, Tutorials, Community, Blog, About, and a search bar. Below the navigation bar is a banner announcing a new preprint: "New preprint. FEniCS-preCICE: Coupling FEniCS to other simulation software, [arXiv](#)".

Welcome to preCICE

The coupling library for partitioned multi-physics simulations.

[Star on Github](#) ★ 309

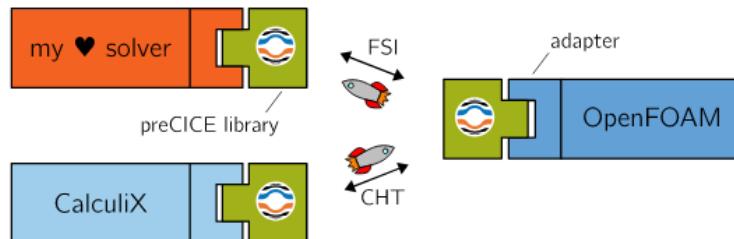
Latest v2.2.1 (May 18, 2021) 

[Get started >](#)

preCICE is an **open-source coupling library** for partitioned multi-physics simulations, including, but not restricted to fluid-structure interaction and conjugate heat transfer simulations.

Partitioned means that **preCICE couples existing programs/solvers** capable of simulating a subpart of the complete physics involved in a simulation. This allows for the high flexibility that is needed to keep a decent time-to-solution for complex multi-physics scenarios.

The software offers convenient methods for transient equation coupling, communication, and data mapping.



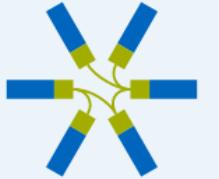
Prepared for the next generation of multi-physics simulations



Minimally invasive integration

- Elegant library approach
- High-level API in C++, C, Fortran, Python, Matlab

[Learn more >](#)



Coupling of arbitrary many programs

- Arbitrary combinations of strong and weak interactions
- Arbitrary many solvers

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State-of-the-art numerical methods

- Robust quasi-Newton acceleration
- Radial-basis function data mapping

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Scalability up to complete supercomputers

- Pure peer-to-peer approach
- Efficient also on a laptop

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Built & hosted on GitHub Pages.
This week (fresh data): 500+ visitors, 3k pageviews



Documentation



Docs v2.2.1

Fundamentals	▲
Overview	
Terminology	
Literature guide	
Roadmap	
Output files	
Installation	▼
Configuration	▼
Tooling	▼
Provided adapters	▼
Couple your code	▼
Dev docs	▼
Documentation meta	▼

The preCICE documentation

Summary: This page gives an overview of the complete preCICE documentation, including building, configuration, literature, the API, and many more.

Table of Contents

- [The big picture](#)
- [Where to find what](#)

[Edit me](#)

The big picture

preCICE stands for Precise Code Interaction Coupling Environment. Its main component is a library that can be used for partitioned multi-physics simulations, including, but not restricted to fluid-structure interaction and conjugate heat transfer simulations. Partitioned (as opposite to monolithic) means that preCICE couples existing programs (solvers) which simulate a subpart of the complete physics involved in a simulation. This allows for the high flexibility that is needed to keep a decent time-to-solution for complex multi-physics scenarios, reusing existing components. preCICE runs efficiently on a wide spectrum of systems, from low-end laptops up to complete compute clusters and has [proven scalability](#) on 10000s of MPI Ranks.

The preCICE library offers parallel communication means, data mapping schemes, and methods for transient equation coupling. Additionally, we are actively developing methods for time interpolation and more features (see our [roadmap](#)). preCICE is written in C++ and offers additional bindings for C, Fortran, Python, and Matlab. Coupling your own solver is very easy, due to the minimally-invasive approach of preCICE. Once you add the (very few) calls to the preCICE library in your code, you can couple it with any other code at runtime. For well-known solvers such as OpenFOAM, deal.II, FEniCS, Nutils, CalculiX, or SU2, you can simply use one of our official adapters.

preCICE is free/open-source software, using the [GNU LGPL3 license](#). This license ensures the open future of the project, while allowing you to use the library also in closed-source solvers. The code is publicly available and actively developed on [GitHub](#).



Everything in one place, user-editable on GitHub, 100+ pages



Discuss & get help (threaded)

preCICE

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all categories ► all tags ► Categories Latest Top

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Installing preCICE Any issues with getting the preCICE library installed	40
Using preCICE Using the preCICE API, configuring a new simulation	95
Official adapters and tutorials Installing, configuring, extending adapters, running or modifying the tutorials	79
Community projects Share your simulation cases for everybody to admire and try.	2
Non-preCICE Topics that are not specific to preCICE. For example, short solver configuration questions, post-processing tools, and more.	7
Site Feedback Discussion about this site, its organization, how it works, and how we can improve it.	2
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Latest

 <input checked="" type="checkbox"/> Welcome to the preCICE Forum on Discourse <input type="checkbox"/> Site Feedback	2	Nov '19
 <input type="checkbox"/> Rotational movements with preCICE and OpenFOAM using solidBody solver instead of displacementLaplacian solver <input checked="" type="checkbox"/> Is preCICE for me? <input type="checkbox"/> adapters <input type="checkbox"/> fsi <input type="checkbox"/> openfoam	7	4h
 <input checked="" type="checkbox"/> Perpendicular Flap (OpenFOAM + Calculix) Floating Point Exception <input type="checkbox"/> Official adapters and tutorials <input type="checkbox"/> calculix <input type="checkbox"/> fsi <input type="checkbox"/> openfoam	2	1d
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 <input checked="" type="checkbox"/> Fluid solver mesh - How to link a solid mesh with a fluid mesh <input checked="" type="checkbox"/> Is preCICE for me? <input type="checkbox"/> adapters <input type="checkbox"/> openfoam <input type="checkbox"/> python	2	3d
 <input checked="" type="checkbox"/> OpenFoam adapter with volumetric coupling <input type="checkbox"/> Official adapters and tutorials <input type="checkbox"/> openfoam	3	8d
 Redesigned preCICE tutorials and documentation, preCICE distribution, and more news <input checked="" type="checkbox"/> News <input type="checkbox"/> inactive	0	8d

Active since October 2019, 150+ users, 1.6k posts in 280+ topics



Discuss & get help (quick)

The screenshot shows a Gitter chat interface for the 'preCICE/Lobby' channel. The left sidebar features a purple background with the Gitter logo and the text 'Where communities thrive'. It includes sections for joining over 1.5M+ people, 100K+ communities, and creating your own community, along with a 'EXPLORE MORE COMMUNITIES' button.

The main chat area has a pink header with the channel name 'preCICE/Lobby' and a URL 'CONTRIBS-FINDING.md'. On the right, there's a sidebar with user icons and a matrix integration button '[m] CHAT VIA MATRIX'.

The conversation starts with a message from 'preCICE/Lobby' pointing to a GitHub script for code formatting. Participants 'Prasad ADHAV @Alphaoo1' and 'Gerasimos Chourdakis @MakisH' discuss the script, with 'Gerasimos' sharing its output. They also mention GitHub Actions for code format checks.

```
find . \(-iname "*.H" -o -iname "*.C"\) -exec clang-format -i {} \;
```

Prasad and Gerasimos continue their exchange, with Prasad explaining the inline format option and Gerasimos responding positively.

At the bottom of the screenshot, there are two buttons: 'SIGN IN TO START TALKING' and '[m] CHAT VIA MATRIX'.

Active since 2018, 150+ users



Learn: YouTube

preCICE Coupling
201 subscribers

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56 views • 2 months ago)

Transfer of FSI coupling with preCICE, OpenFOAM...
148 views • 2 months ago

Application of code coupling in magnetic fusion (Andrea...
37 views • 2 months ago)

Data Mapping in preCICE (Kyle Davis, preCICE,...
42 views • 2 months ago)

Using preCICE for GeoKW on SuperMUC-NG (Viktoria...
35 views • 2 months ago)

Talks about preCICE ► PLAY ALL
Conference talks about the preCICE coupling library

Couple scientific simulation codes with preCICE A...
FOSDEM
784 views • 2 years ago

Fundamentals of preCICE (Benjamin Uekermann,...
preCICE Coupling
277 views • 2 months ago)

What is new in preCICE? (Frédéric Simonis, preCICE,...
preCICE Coupling
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SimTech and the Simulation of Large Systems
Exzellenzcluster SimTech
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High-order and multi-rate time stepping with preCICE...
preCICE Coupling
183 views • 1 year ago

The OpenFOAM-preCICE adapter (Gerasimos...
preCICE Coupling
48 views • 2 months ago)

Simulations using preCICE ► PLAY ALL
A list of (mostly third-party) simulations using preCICE. These simulations may be under development and the results may not be up-to-date.

Cylinder with a flap in OpenFOAM and CalculiX
Derek Risseeuw
1.8K views • 2 years ago

Mesh deformation on a flexible flapping wing
Derek Risseeuw
301 views • 2 years ago

6-way coupling CFD+DEM+FEM
LuXDEM web
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CPU Heatsink | CFD & FEM Simulation | preCICE,...
proximas
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OpenFOAM/CalculiX FSI coupling with preCICE in...
DHCAE Tools GmbH
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Multicoupling with preCICE: two flaps in a channel...
preCICE Coupling
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preCICE (the coupling library)

@preCICE_org

A free/open-source coupling library for partitioned multi-physics simulations, including fluid-structure interaction, conjugate heat transfer, and more.

Germany  precice.org  Joined April 2018

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Active since 2018, 250+ followers



Get news: Mailing list

preCICE -- preCICE Parallel Coupling Environment

About preCICE

English (USA)

To see the collection of prior postings to the list, visit the [preCICE Archives](#).

Using preCICE

To post a message to all the list members, send email to precice@mailman.informatik.uni-stuttgart.de.

You can subscribe to the list, or change your existing subscription, in the sections below.

Subscribing to preCICE

Subscribe to preCICE by filling out the following form. You will be sent email requesting confirmation, to prevent others from gratuitously subscribing you. This is a private list, which means that the list of members is not available to non-members.

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Your name (optional):

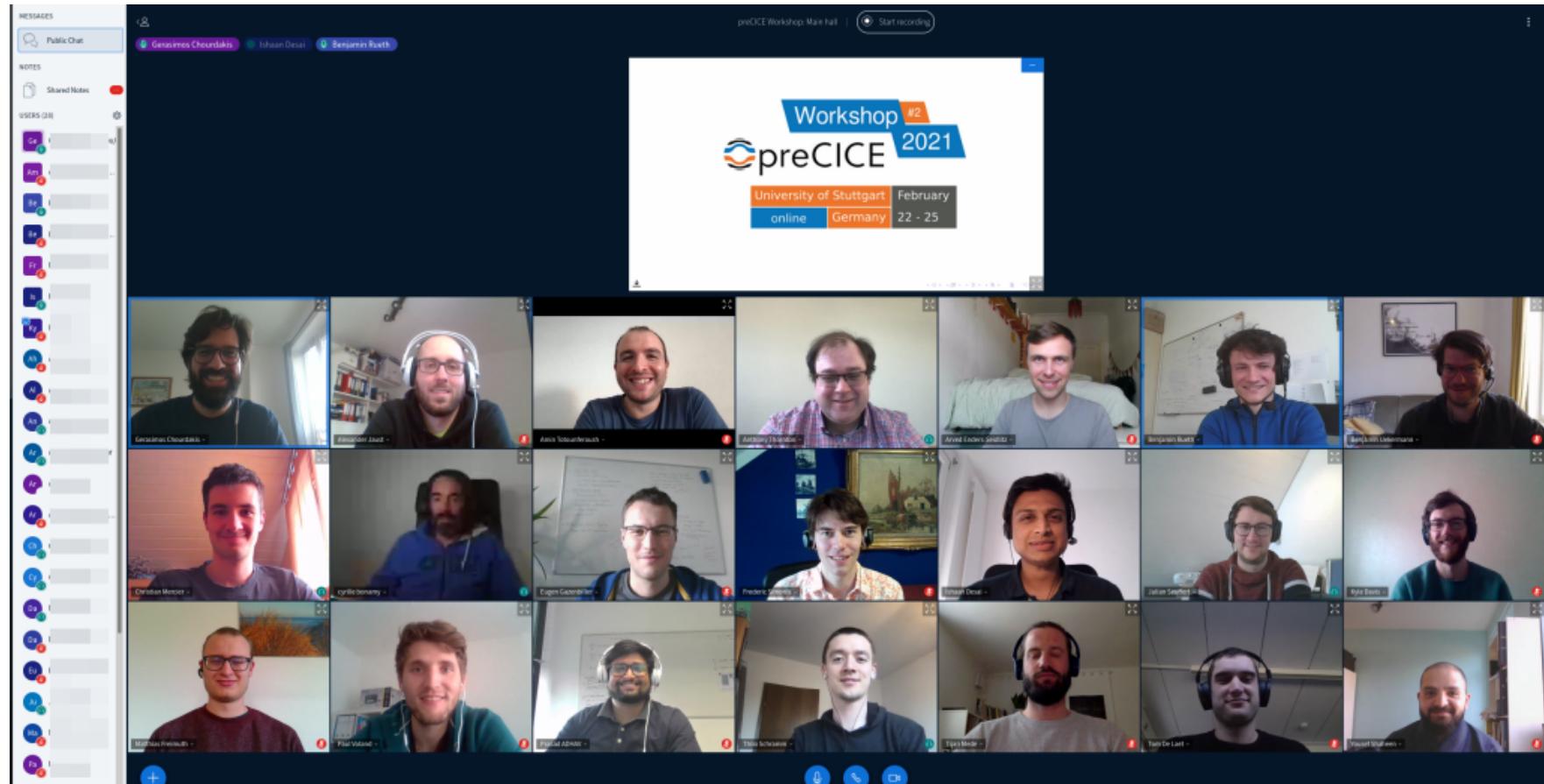
You may enter a privacy password below. This provides only mild security, but should prevent others from messing with your subscription. **Do not use a valuable password** as it will occasionally be emailed back to you in cleartext.

Still a few announcements per year



preCICE Workshops

February 2021 in Stuttgart / online



February 2020 in Munich



Next week: preCICE Minisymposium @ ECCOMAS Coupled Problems

preCICE is free because of



Research Software
Sustainability



Bundesministerium
für Wirtschaft
und Energie



EXC 2075
SimTech



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 754462

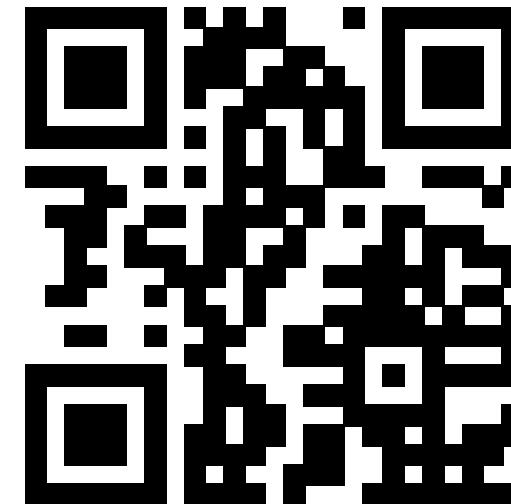
and the code/issues/testing/documentation contributions of people like you (thank you!).

Summary

Easily exchange your coupled solvers and explore advanced
& performant numerical algorithms

Gerasimos Chourdakis (TUM) + many more (see precice.org/about)

Please give me feedback on this talk: go.tum.de/820189



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