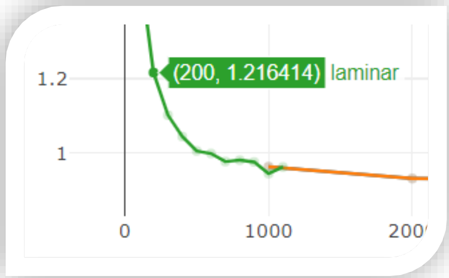
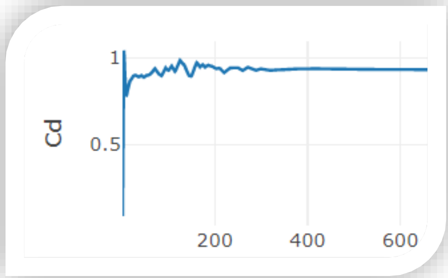
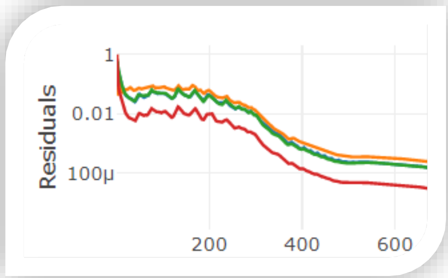
iPOST

USING PLOTLY DASH FOR INTERACTIVE OPENFOAM POST-PROCESSING







CURRENT SITUATION

- Solution data is stored in multiple text files
- The calculated flow fields can be visualized using Paraview.
- Python (+pyFoam), Matlab etc. commonly used for further post-processing e.g. in regard of measured forces
- Large number of operating points + mesh study + different cases lead to overwhelming amount of diagrams

THE GOAL

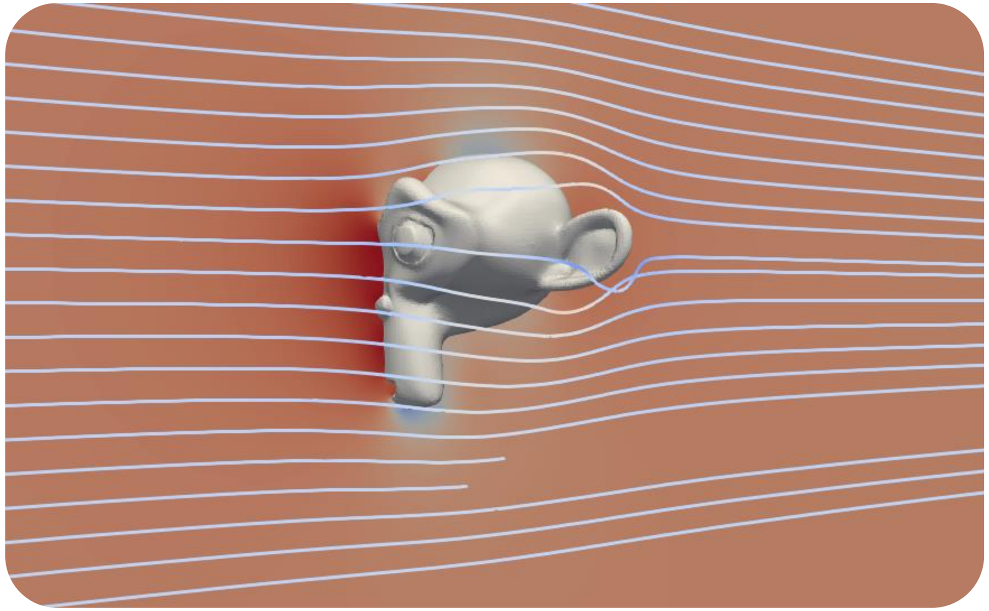
- Reduce number of result figures without losing relevant information
- Provide fast & easy setup
- Enable versatile application to large set of problems

SOLUTION

- Use interactive instead of static diagrams for better solution exploration
- This allows a much better overview of the whole result space
- If necessary, save relevant parts of interactive diagrams in static form

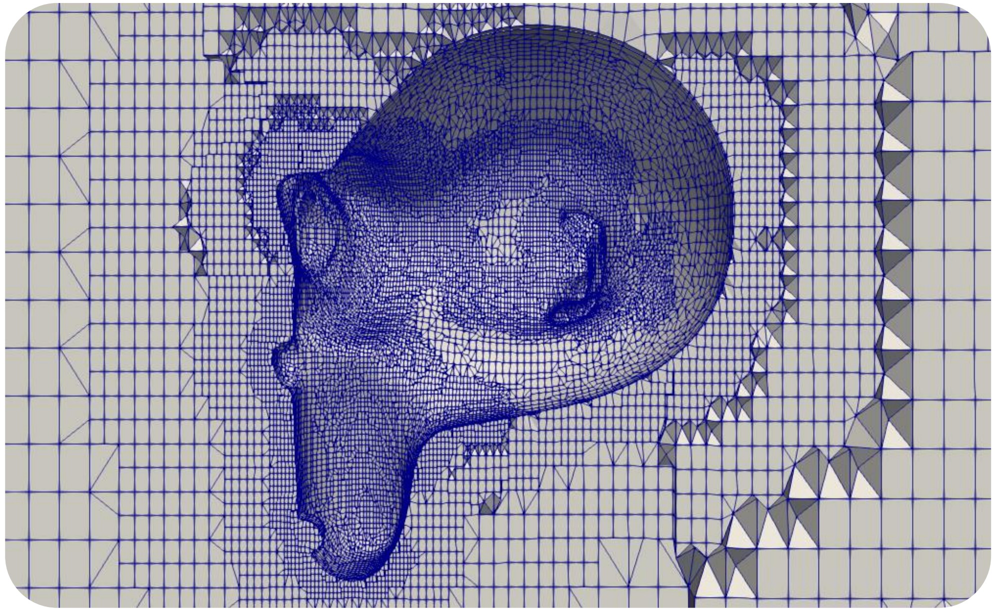
EXAMPLE

- Jozsef Nagy’s Christmas challenge 2017
- Reynolds number study of flow around monkey head
- Including mesh variation and comparison of turbulence models
- “Multidimensional” solution space is generated



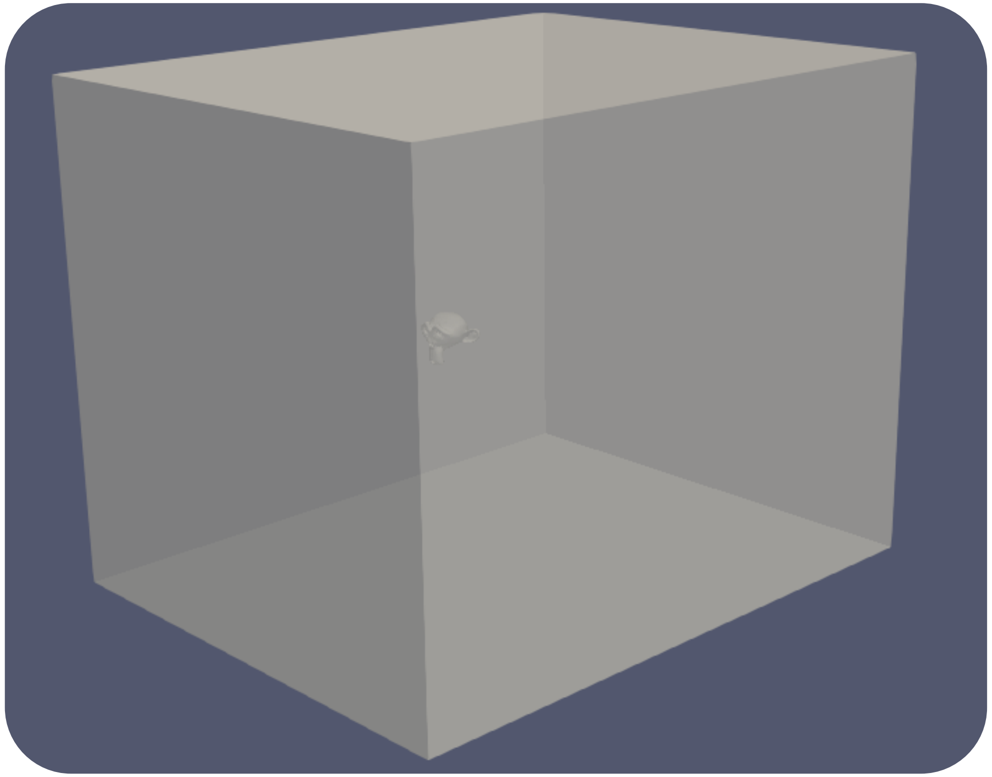
MESH PREPARATION

- Flow domain of size 2mx2mx2.5m (HxWxL) width monkey head placed at origin
- Two different block mesh setups:
  - 20x20x30 elements
  - 30x30x45 elements
- snappyHexMesh applies refinement around monkey head to better follow geometry, resulting in mesh counts:
  - 2,134,269 faces
  - 4,011,438 faces



BOUNDARY CONDITIONS

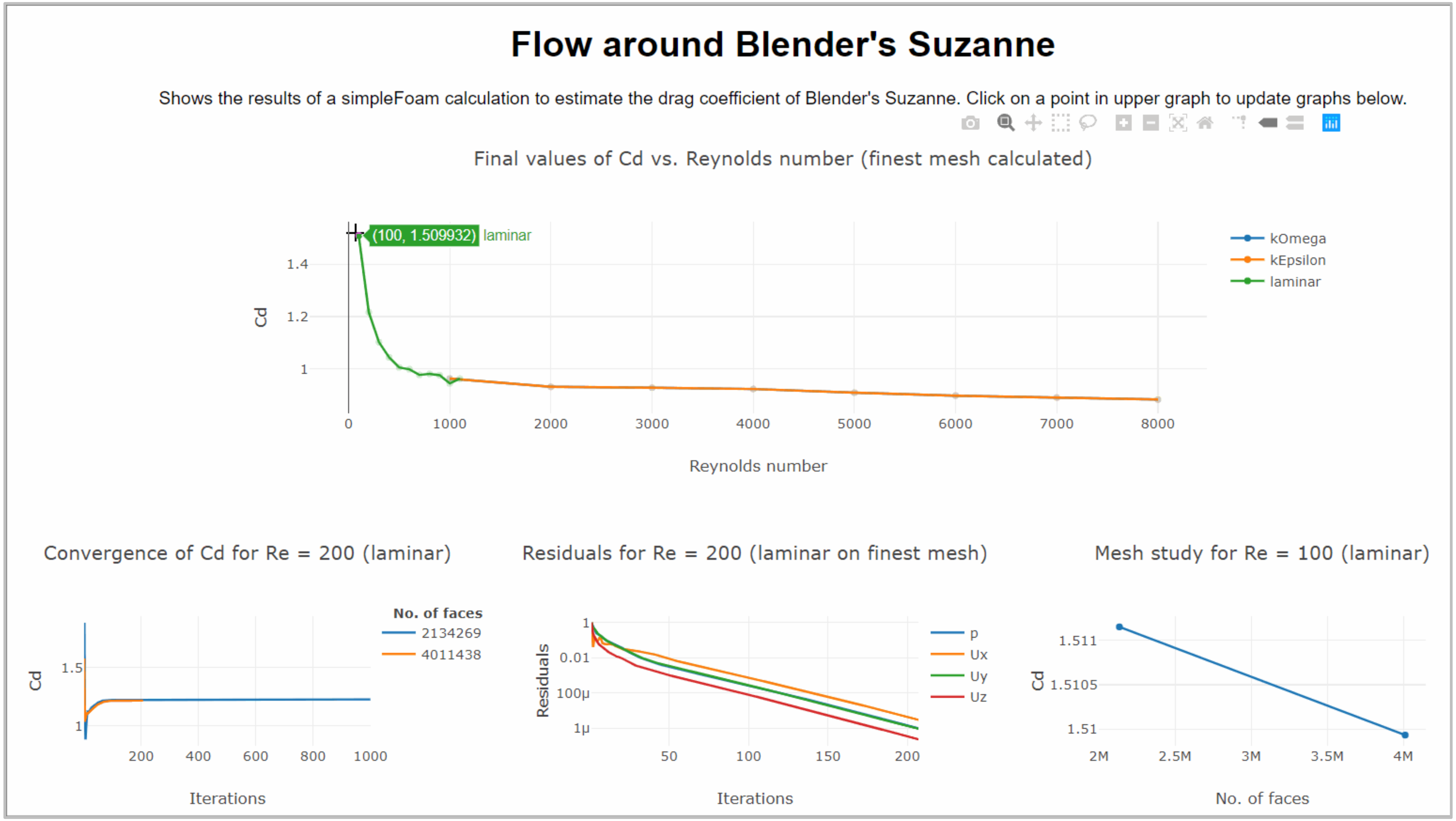
- Reynolds numbers between 100 and 8,000 will be considered
- Inlet velocity is automatically calculated for each Reynolds number as $u_{\mathrm{in}} = \frac{Re \cdot \nu}{D_{\mathrm{hyd}}}$
- For Reynolds numbers larger than 1,000 turbulent properties at the inlet are calculated as
  - Turbulence intensity $I = 0.05$
  - Turbulent kinetic energy $k = 1.5(u_{\mathrm{in}} I)^2$
  - Turbulent dissipation $\varepsilon = \frac{0.09^{\frac{3}{4}} \cdot k^{\frac{3}{2}}}{0.07 \cdot D_{\mathrm{hyd}}}$
  - Specific turbulent dissipation $\omega = \frac{\varepsilon}{k}$
- Slip boundary conditions are applied to side planes and noSlip to monkey head



OUTPUT DEFINITION

- Drag coefficient is of interest
- For calculation frontal area and circumference of the monkey head need to be known
- With these values given OpenFOAM can calculate the drag coefficient as $C_\mathrm{d} = \frac{2F_\mathrm{D}}{\rho u^2 A}$

USAGE



Flow around Blender's Suzanne
Shows the results of a simpleFoam calculation to estimate the drag coefficient of Blender's Suzanne. Click on a point in upper graph to update graphs below.
Final values of Cd vs. Reynolds number (finest mesh calculated)
(100, 1.509932) laminar
kOmega
kEpsilon
laminar
Cd
1.4
1.2
1
0
1000
2000
3000
4000
5000
6000
7000
8000
Reynolds number
Convergence of Cd for Re = 200 (laminar)
No. of faces
2134269
4011438
Cd
1.5
1
200
400
600
800
1000
Iterations
Residuals for Re = 200 (laminar on finest mesh)
Residuals
1
0.01
100μ
1μ
50
100
150
200
p
Ux
Uy
Uz
Iterations
Mesh study for Re = 100 (laminar)
Cd
1.511
1.5105
1.51
2M
2.5M
3M
3.5M
4M
No. of faces

INSTALLATION

- Prerequisites: Current versions of Python including pandas and numpy should be installed
- Follow instructions at https://dash.plotly.com/installation to install Dash
- Use `git clone https://github.com/axelfiedler/ipost.git` or download zip from Github

SETUP

- Setup is done in Bash and Python scripts
- Change relevant inlet information so that boundary conditions are set correctly
- Choose a range of velocity (or Reynolds numbers) that should be calculated
- Select the relevant calculated force that should be displayed in the main graph

```
DHYD=$(python -c "print 4*0.02562 / 0.804201")
```

```
for Re in {500..1100..100}
do
```

```
# Choose which force coefficient should be displayed
selected_force = 'Cd'
```

DEPLOYMENT

- To run your app on localhost just use `python [file_name].py`
- If you own a web server, you can publish your app using Flask
- For larger projects Plotly offers enterprise solutions

ADVANTAGES

Web-based

Results generated with ipost are web-based and can be shared by providing a link

Easy to use

For many cases only a few changes need to be done to the setup files

Versatile

More flow situations can be added without major code changes

NEXT STEPS

- Current number of users: 1
- Include more examples
- Broader generalization of setup
- Feedback needed

THANK YOU FOR YOUR ATTENTION!