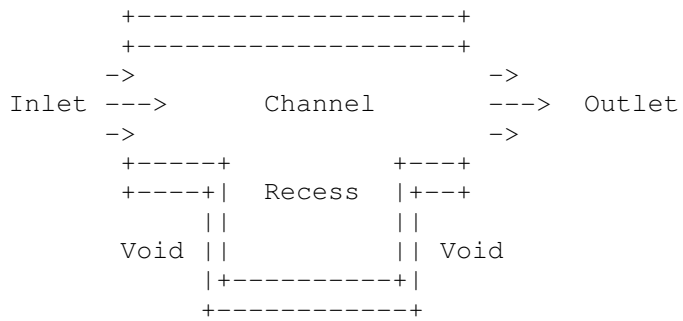
TCELL_FLOW
Flow Solutions in a T-Cell

TCELL_FLOW is a dataset directory which contains velocity solutions to a time-dependent incompressible parameterized flow problem in a 2D T-cell.

The "T-Cell" region is a T-shaped region contained in a subset of the unit square [01]x[01]. The top half of the region is a channel open to the left and right, with a rectangular recess in the bottom. The left channel opening extends from [0.0,0.5] to [0.0,1.0], and the right channel from [1.0,0.5] to [1.0,1.0]. The recess is a square, whose bottom extends from [0.25,0.0] to [0.75,0.0], and which extends upward to meet the channel.



The grid can be thought of as being generated by a uniform 81 by 81 uniformly spaced grid of nodes, from which the nodes corresponding to the two voids have been deleted. This leaves 4,961 nodes. These nodes are organized into 2400 6-node triangular elements which are quadratic in velocity and linear in pressure.

(Some runs of this problem were made earlier, with a cruder 41 by 41 uniformly spaced grid of nodes, which were arranged into 600 6-node elements).

The time-dependent incompressible 2D Navier-Stokes equations are to be applied in the region. No-slip and no-penetration conditions are applied along the walls. The inlet on the left of the region is open, and here a parabolic inflow is specified, whose strength is controlled by a parameter **alpha**. The outlet on the right is open, where the velocity is required to have zero vertical component, and zero horizontal derivative. The dynamic viscosity is taken to be **nu**=1/300.

The steady state solution is computed for the particular value **alpha**=1/3. Using the steady state solution as initial condition, the time-dependent problem is solved over the interval **0<=t<=0.1**, with **alpha** = 5/3 for timesteps 1 through 250, and then **alpha** = 1/3 for timesteps 251 through 500. The two instantaneous changes to **alpha** induce violent transient behaviors.

The goal is to extract typical modes of behavior of the solution. Such a set of modes may then be used as a finite element basis that is highly tuned to the physics of the problem, so that a very small set of basis functions can be used to closely approximate the behavior of the solution over a range of values of **alpha**.

Licensing:

Related Data and Programs:

CASE1_FLOW, a dataset directory which 401 solutions of a flow problem in a channel;

CAVITY_FLOW, a dataset directory which contains 500 time steps of Navier-Stokes flow in a driven cavity;

CVT_BASIS_FLOW, a FORTRAN90 program which can be used to analyze this data, and compute a small set of "basis vectors" using CVT techniques.

INOUT_FLOW, a dataset directory which contains 500 time steps of Navier-Stokes flow in a region with specified inflow and outflow;

INOUT_FLOW2, a dataset directory which contains 800 time steps of Navier-Stokes flow in a region with specified inflow and outflow;

POD_BASIS_FLOW, a FORTRAN90 program which can be used to analyze this data, and compute a small set of "basis vectors" using POD techniques.

TCELL, a FORTRAN77 program which solves a time dependent Navier Stokes problem in a T-cell region.

TCELL_FLOW_DISPLAY, a MATLAB library which displays a single velocity field solution for the T cell;

TCELL_FLOW_MOVIE, a MATLAB library which creates an animation of the velocity solutions for the T cell;

TRIANGULATION_PLOT, a FORTRAN90 program which can be used to draw an image of the nodes and elements used in the triangulation of the region.

VECTOR_PLOT, a FORTRAN90 program which can be used to draw an image of the velocity vector field over the region.

Reference:

- John Burkardt, Max Gunzburger, Hyung-Chun Lee,
  Centroidal Voronoi Tessellation-Based Reduced-Order Modelling of Complex Systems,
  SIAM Journal on Scientific Computing,
  Volume 28, Number 2, 2006, pages 459-484.

Datasets:

- xy.txt, the XY coordinates associated with the nodes.
- elements.txt, a grouping of the nodes into 6 node quadratic finite elements.
- steady.txt, the steady state velocity field.
- tcell_grid.png, a PNG image of the grid.
- tcell_flow.png, a PNG image of the steady state velocity field, created by VECTOR_PLOT.
- tcell_flow_direction.png, a PNG image of the steady state vector direction field, created by VECTOR_PLOT.

TCELL_FLOW_DISPLAY can display the flow data from a single timestep.

TCELL_FLOW_MOVIE can animate the flow data from a sequence of timesteps.