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1 program lid_driven_cavity
2 implicit none
3 integer, parameter :: N = 50      ! grid size (NxN grid)
4 real :: dx, dy, dt, Re          ! grid spacing, time step, Reynolds number
5 real :: u(N, N), v(N, N), p(N, N) ! velocity and pressure fields
6 integer :: i, j, step
7 real :: start_time, end_time, elapsed_time
8
9 ! Parameters
10 dx = 1.0 / (N-1)    ! Grid spacing in x direction
11 dy = 1.0 / (N-1)    ! Grid spacing in y direction
12 dt = 0.001           ! Time step size
13 Re = 100             ! Reynolds number
14
15 ! Initialize arrays
16 u = 0.0
17 v = 0.0
18 p = 0.0
19
20 ! Initialize the top boundary (lid) velocity
21 u(N, :) = 1.0
22
23 ! Start timing
24 call cpu_time(start_time)
25
26 ! Main loop for time stepping
27 do step = 1, 1000
28     call compute_velocity(u, v, p, dx, dy, dt, Re)
29     call update_pressure(p, dx, dy)
30
31 ! Output or check convergence
32 if (mod(step, 100) == 0) then
33     print *, 'Step: ', step
34 end if
35 end do
36
37 ! Stop timing
38 call cpu_time(end_time)
39 elapsed_time = end_time - start_time
40 print *, 'Elapsed time for CFD simulation: ', elapsed_time, ' seconds'
41
42 contains
43
44 ! Function to update the velocity and pressure fields (simplified)
45 subroutine compute_velocity(u, v, p, dx, dy, dt, Re)
46     real, dimension(:, :, intent(inout)) :: u, v, p
47     real, intent(in) :: dx, dy, dt, Re
48     integer :: i, j
49
50 ! Simple explicit method for velocity (simplified)
51 do i = 2, N-1
52     do j = 2, N-1
53         u(i, j) = u(i, j) - dt * ( (u(i, j) * (u(i+1, j) - u(i-1, j))) / (2*dx)
54                               + (v(i, j) * (u(i, j+1) - u(i, j-1))) / (2*dy) )
55     end do
56 end do
57
58 ! Simple velocity update for v (similar)
59 do i = 2, N-1
60     do j = 2, N-1
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1      v(i, j) = v(i, j) - dt * ( (u(i, j) * (v(i+1, j) - v(i-1, j))) / (2*dx)
2      end do
3  end do
4 end subroutine compute_velocity
5
6
7 ! Function to solve for pressure (simplified Poisson equation solver)
8 subroutine update_pressure(p, dx, dy)
9   real, dimension(:,:), intent(inout) :: p
10  real, intent(in) :: dx, dy
11  integer :: i, j
12
13 ! Simple pressure Poisson equation (Jacobi iteration)
14  do i = 2, N-1
15    do j = 2, N-1
16      p(i, j) = 0.25 * ( p(i+1, j) + p(i-1, j) + p(i, j+1) + p(i, j-1) )
17    end do
18  end do
19 end subroutine update_pressure
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21 end program lidDrivenCavity
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