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1 program lid_driven_cavity
2 implicit none
3 integer, parameter :: N = 50 ! grid size (N x N grid)
4 real :: dx, dy, dt, Re ! grid spacing, time step, Reynolds number
5 real :: u(:, :, N), v(:, :, N), p(:, N) ! velocity and pressure fields
6 integer :: 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(:, :) = 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 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)) + (v(i, j) * (u(i, j+1) - u(i, j-1)) / (2*dy)))
54     end do
55   end do
56
57   ! Simple velocity update for v (similar)
58   do i = 2, N-1
59     do j = 2, N-1
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1    $v(i, j) = v(i, j) - dt * ((u(i, j) * (v(i+1, j) - v(i-1, j)) / (2 * dx) - (v(i, j+1) - v(i, j-1)) / (2 * dy))$ 
2   end do
3 end do
4 end subroutine compute_velocity
5
6 ! Function to solve for pressure (simplified Poisson equation solver)
7 subroutine update_pressure(p, dx, dy)
8   real, dimension(:, :) intent(inout) :: p
9   real, intent(in), :: dx, dy
10  integer :: i, j
11
12 ! Simple pressure Poisson equation (Jacobi iteration)
13 do i = 2, N-1
14   do j = 2, N-1
15     p(i, j) = 0.25 * (p(i+1, j) + p(i-1, j) + p(i, j+1) + p(i, j-1))
16   end do
17 end do
18 end do
19 end subroutine update_pressure
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21 end program lid_driven_cavity
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