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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(1:N, 1:N), v(1:N, 1:N) ! velocity and pressure fields
6   integer :: step ! time 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, :) = 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) + v(i, j+1)) - (u(i, j-1) * v(i+1, j-1))) / (2*dx) + (v(i, j) * (u(i+1, j) + v(i, j+1)) - (u(i, j-1) * v(i+1, 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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