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Apunts

Introduction to the Numerical Solution of the Navier-Stokes equations.

Module 5: Hands on session 2

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Introduction to the Numerical Solution of the Navier-Stokes equations

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Make sure you understand module 4 before you begin.

In particular, check the following items:

- Disposition of the fields and notation.
- Periodic domains.
- Halos and halo update.
- Staggered mesh.

Class questions:

1. Write the *print_field* function (you can use the code provided in the slides).
   Don't forget the documentation of the function (this also holds for the rest of the assignments from now on).
   Generate different fields and test the function with them.
   Make sure you understand the *fprintf* function and the format string.

2. Write the *halo_update* function. It should have one argument (the field not updated) and return one result (the field updated). Test it with some examples, using *print_field*.

3. Write a function that generates the u and v scalar fields with the analytic function $u = x, v = x$ in a square domain from 0 to 1 in x and y directions. Call it *analytic1x*. Check that the velocity values are correct with *print_field*. Recall that the mesh we are using is staggered. Repeat the assignment with $u = y, v = y$ and call it *analytic1y*.

4.Write a function that implements the analytic solution of the Navier-Stokes (Eq. 2.2). Call it *analyticTaylor* :

```
function  [u,v]  =  analyticTaylor(u,v,L,t)
% [u, v] = analyticTaylor(u, v, L, t)
% given two fields u and v, of dimensions u(N+2,N+2)
% v(N+2,N+2), the function fills then with the Taylor solution
% of the Navier-Stokes equations at time t, for a domain size L.
% A staggered mesh with halos is used, as described in module 4.
% IMPORTANT: The fields returned are NOT halo updated !
% Written by: Manel Soria 2021
% Example of use:
%    N = 8; % 8x8 mesh
%    u = zeros(N+2,N+2);
%    v = zeros(N+2,N+2);
%    [u,v] = analyticTaylor(u,v,1,0)
%    u = halo_update(u);
%    v = halo_update(v);
...
```

Notes:

Inside the function code we will obtain the number of nodes per dimension (N) as follows:

```
N=size(u,1)-2; % mesh size
```

Once programmed, check that the example code works as expected.

halo_update could have been called inside the function but in general we will prefer to do so at a higher level of the code, to be able to check that no *halo_update*'s are missing. If some are inside the functions, it is easy to forget about the others.