Polytechnic University of Catalonia

Master in Numerical Methods

Computational Mechanics Tools

Assignment 1: "Transfinite Interpolation (TFI)"

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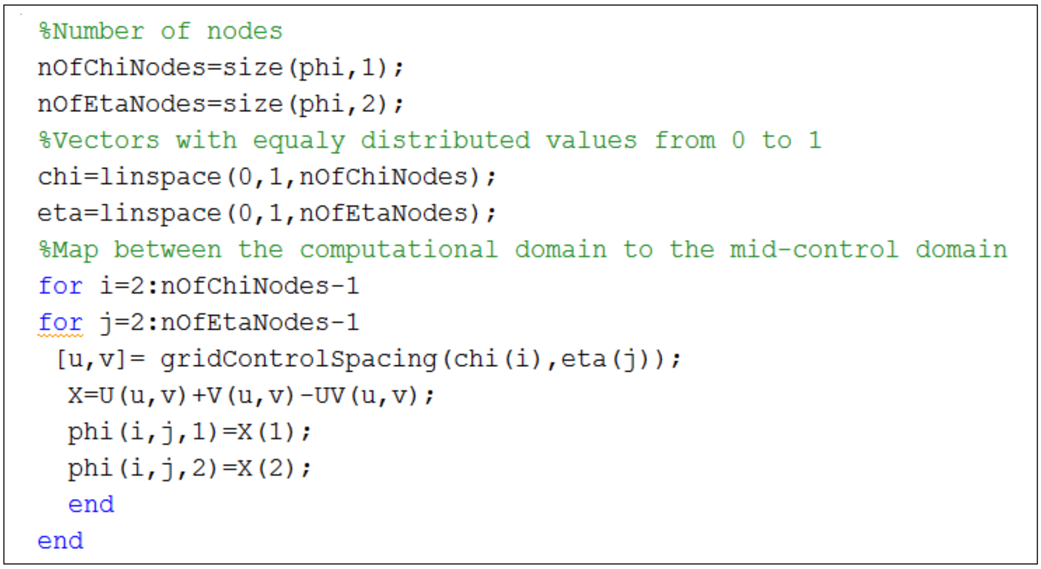
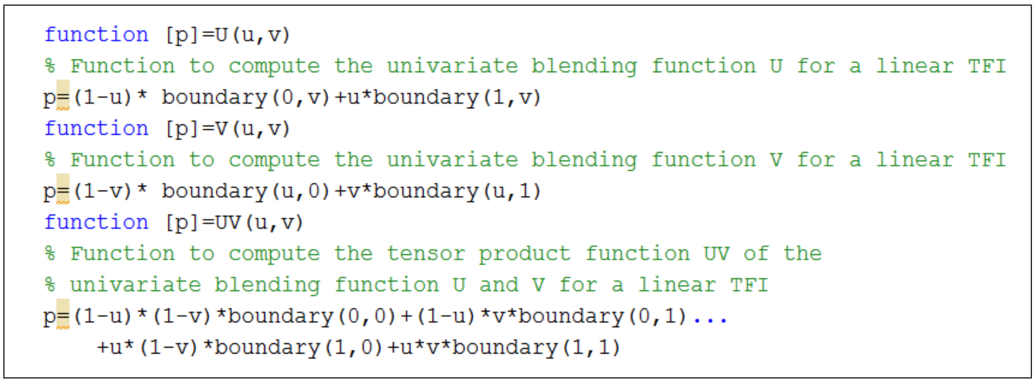
1. In file linearTFI.m write the code corresponding to functions:

- createInnerNodes



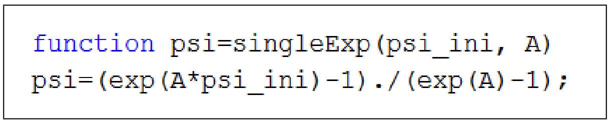
```
%Number of nodes
nOfChiNodes=size(phi,1);
nOfEtaNodes=size(phi,2);
%Vectors with equaly distributed values from 0 to 1
chi=linspace(0,1,nOfChiNodes);
eta=linspace(0,1,nOfEtaNodes);
%Map between the computational domain to the mid-control domain
for i=2:nOfChiNodes-1
for j=2:nOfEtaNodes-1
 [u,v]= gridControlSpacing(chi(i),eta(j));
  X=U(u,v)+V(u,v)-UV(u,v);
  phi(i,j,1)=X(1);
  phi(i,j,2)=X(2);
  end
end
```

- U, V, UV



```
function [p]=U(u,v)
% Function to compute the univariate blending function U for a linear TFI
p=(1-u)* boundary(0,v)+u*boundary(1,v)
function [p]=V(u,v)
% Function to compute the univariate blending function V for a linear TFI
p=(1-v)* boundary(u,0)+v*boundary(u,1)
function [p]=UV(u,v)
% Function to compute the tensor product function UV of the
% univariate blending function U and V for a linear TFI
p=(1-u)*(1-v)*boundary(0,0)+(1-u)*v*boundary(0,1)...
    +u*(1-v)*boundary(1,0)+u*v*boundary(1,1)
```

2. In file gridControlSpacing.m write the code corresponding to function singleExp.

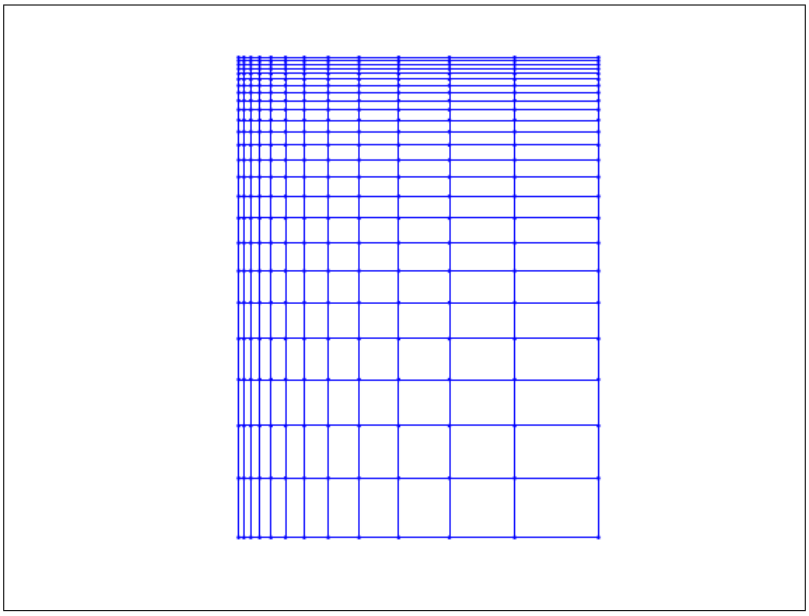


```
function psi=singleExp(psi_ini, A)
psi=(exp(A*psi_ini)-1)./(exp(A)-1);
```

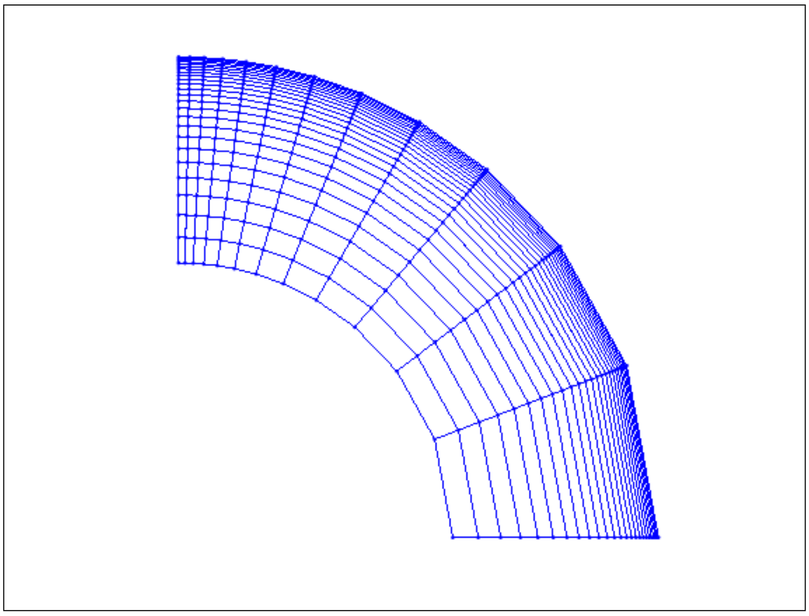
3. Generate a structured mesh using your application for:

   - a rectangular domain of height equals 4 and width equals 3 (example 1 in boundary.m file).

   - a quarter of circular ring of inner radii equals 4, outer radii equals 7 and angle equals $\pi/2$ (example 2 in boundary.m file). For both examples present the obtained mesh using A = 3 and A = -3 when function singleExp is used to concentrate nodes in the χ and η directions.



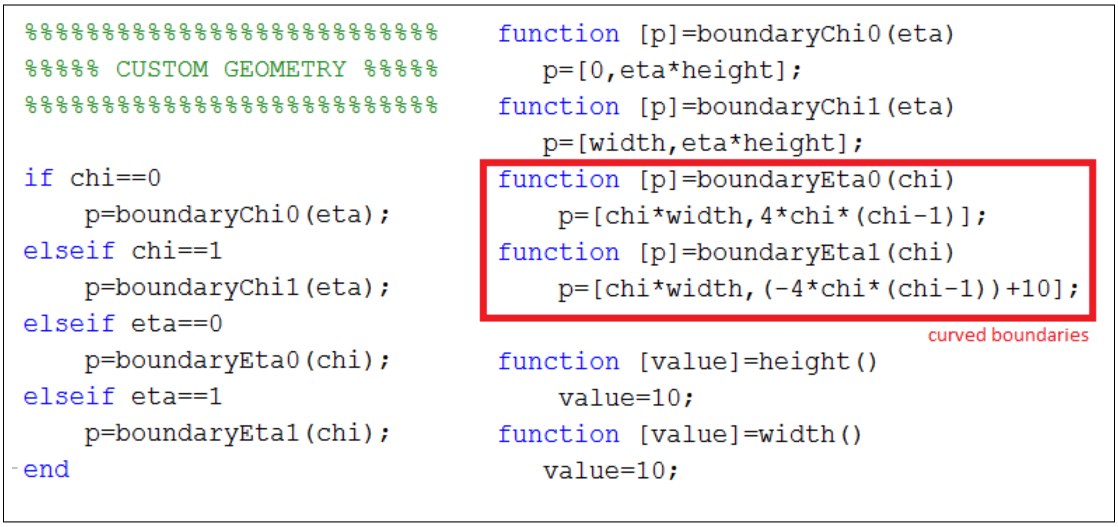
Example Mesh 1: Rectangular domain. "A" values = -3 and -3



Example Mesh 2: quarter of circular ring. "A" values = -3 and -3

4. Apply the developed application to a new geometry. To this end modify file boundary.m and create a new domain. Present three meshes concentrating nodes near different boundaries.

The custom geometry created has two straight sides and two curved ones (parabolas). The code written to follow the desire form was the following:



```
%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%% CUSTOM GEOMETRY %%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%

if chi==0
    p=boundaryChi0(eta);
elseif chi==1
    p=boundaryChi1(eta);
elseif eta==0
    p=boundaryEta0(chi);
elseif eta==1
    p=boundaryEta1(chi);
end
```

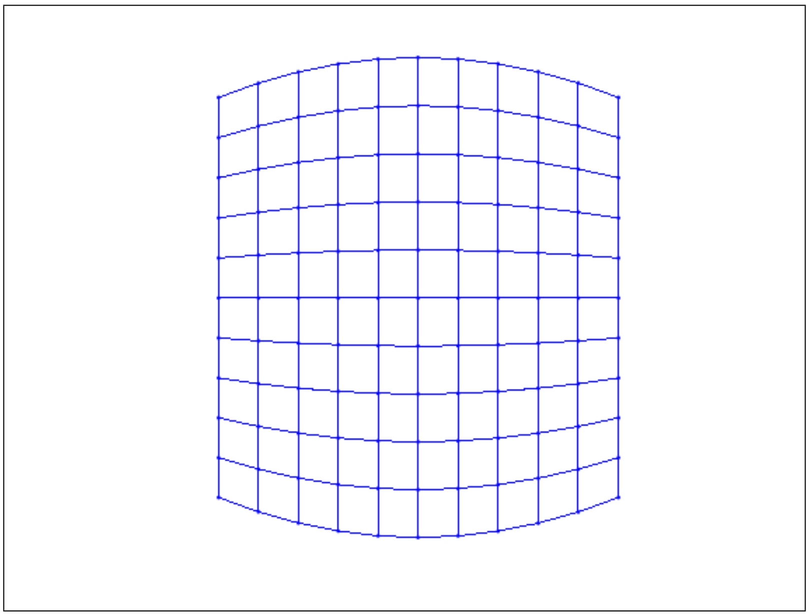
```
function [p]=boundaryChi0(eta)
   p=[0,eta*height];
function [p]=boundaryChi1(eta)
   p=[width,eta*height];
function [p]=boundaryEta0(chi)
    p=[chi*width,4*chi*(chi-1)];
function [p]=boundaryEta1(chi)
    p=[chi*width,(-4*chi*(chi-1))+10];
```

curved boundaries

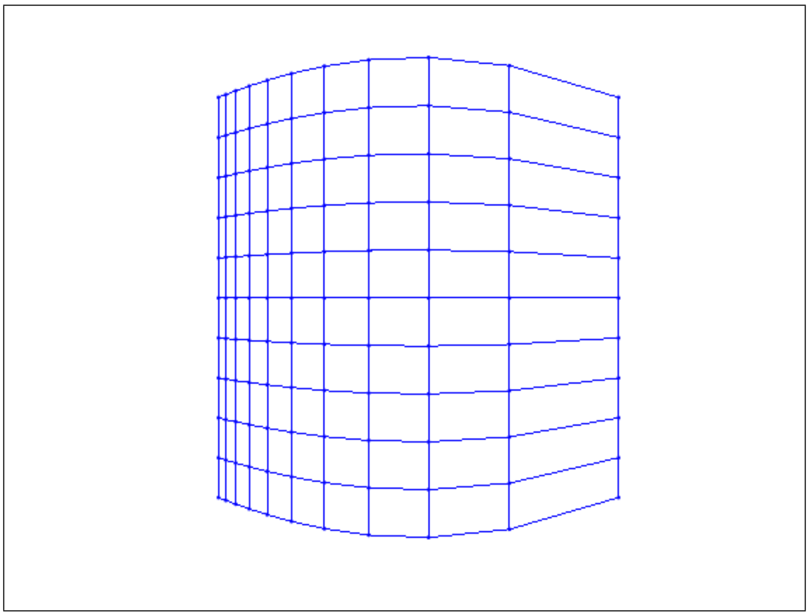
```
function [value]=height()
    value=10;
function [value]=width()
   value=10;
```

Custom geometry code

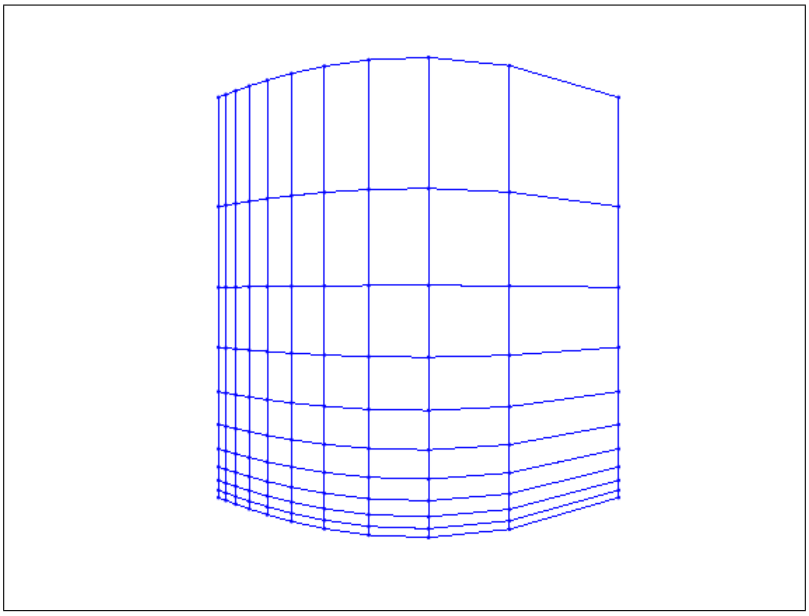
Three different mesh concentration where plotted:



Custom Mesh 1: "A" values = 0.01 and 0.01



Custom Mesh 2: "A" values = 3 and 0.01



Custom Mesh 3: "A" values = 3 and 3