An Arbitrary-Lagrangian-Eulerian code for polygonal mesh: ALE INC(ubator).

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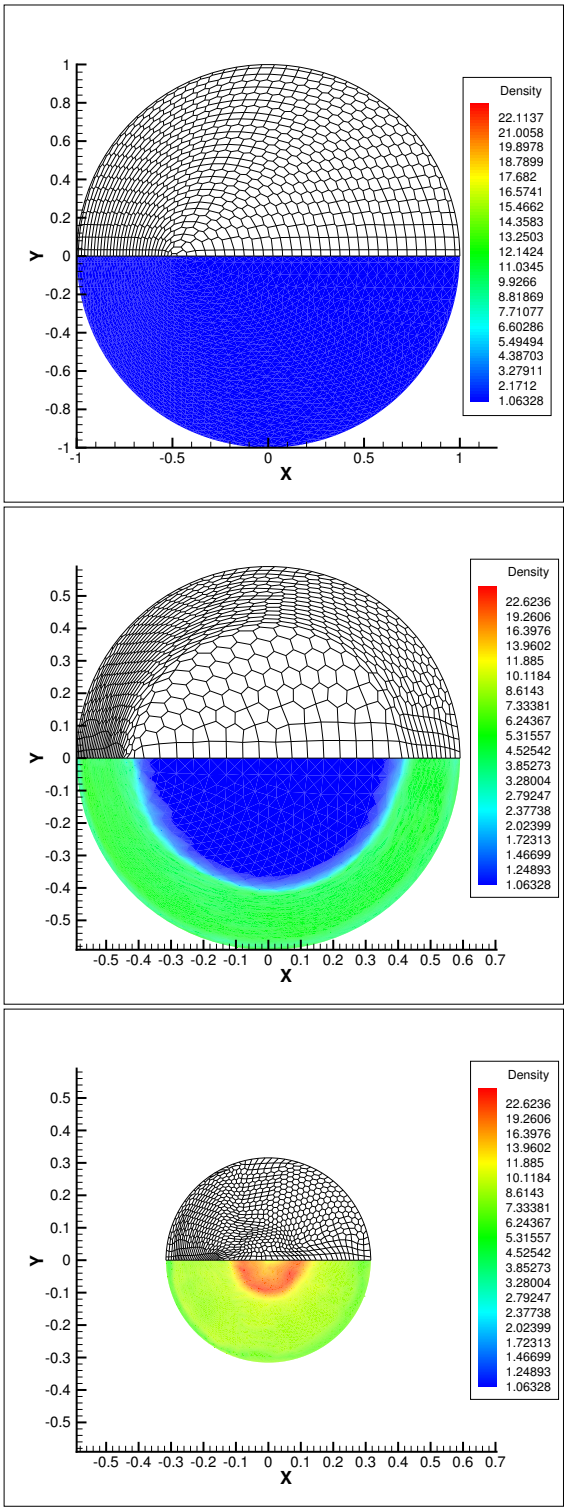
In this work we have developed a 2D unstructured Arbitrary-Lagrangian-Eulerian code. This code is devoted to solve CFD problems for general polygonal meshes with fixed connectivity. Main components of the method are: I- a *Lagrangian scheme*. Each polygon is split into subcells. The compatible Lagrangian hydrodynamics equations are solved during one time step and the mesh is moved according to the fluid velocity - see [6], [7], [5].
II- a *Reference Rezone Jacobian Strategy* which improves the quality of the untangled mesh and, at the same time, requires the new mesh to be close to the original untangled grid (from step II) and preserves interfaces between materials - see [2]. (An *Untangling process* ensures the validity of the mesh, if the mesh was tangled as a result of the Lagrangian step. The method finds an untangled mesh which is as close as possible to the previous Lagrangian grid - see [4], [3]).
III- a *Remapping method* which gives the linear and bound preserving remapped hydrodynamics variables on the new mesh - see [1], [8].
These three steps have been adapted to the subcell description of the scheme and the polygonal meshes. The untangling and the reference rezone Jacobian processes deal now with general polygonal meshes and preserve the interfaces between materials. The remapping step is performed from a subcell point of view and the accuracy of the remapping stage has been improved with new techniques from [9].
ALE INC. can be used as a purely Lagrangian code (only step I is used), an ALE one (x Lagrangian steps are performed then steps II,III are activated) or as an Eulerian one (steps I and III are used and the remapping is done on the same initial grid). Moreover the code can be used in



Guderley problem non symmetric polygonal mesh — ***Top:*** $t = 0.0$ — ***Middle:*** $t = 0.6$ — ***Bottom:*** $t = 1.0$.

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Cartesian or cylindrical coordinates.
The figures are the simulation of the Guderley problem: a unit disk ($\rho = 1, p = 0$) at rest is compressed by a cylindrical shock wave. The intial mesh is polygonal (either symmetric or with a false center of convergence, located at $(-0.5, 0)$ as in [6]). Time $t = 0$, $t = 0.6$, $t = 1.0$ are printed showing the cylindrical symmetry preservation with or without an initial symmetric polygonal mesh.

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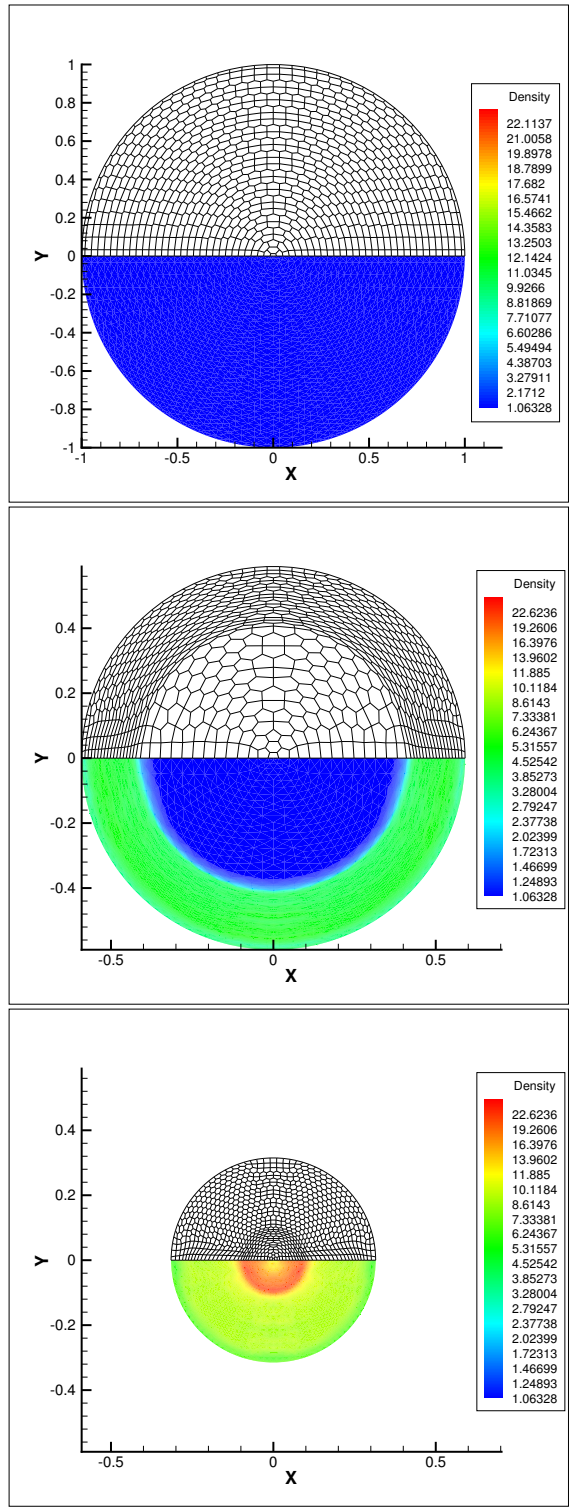

Guderley problem symmetric polygonal mesh — ***Top:*** $t = 0.0$ — ***Middle:*** $t = 0.6$ — ***Bottom:*** $t = 1.0$.