

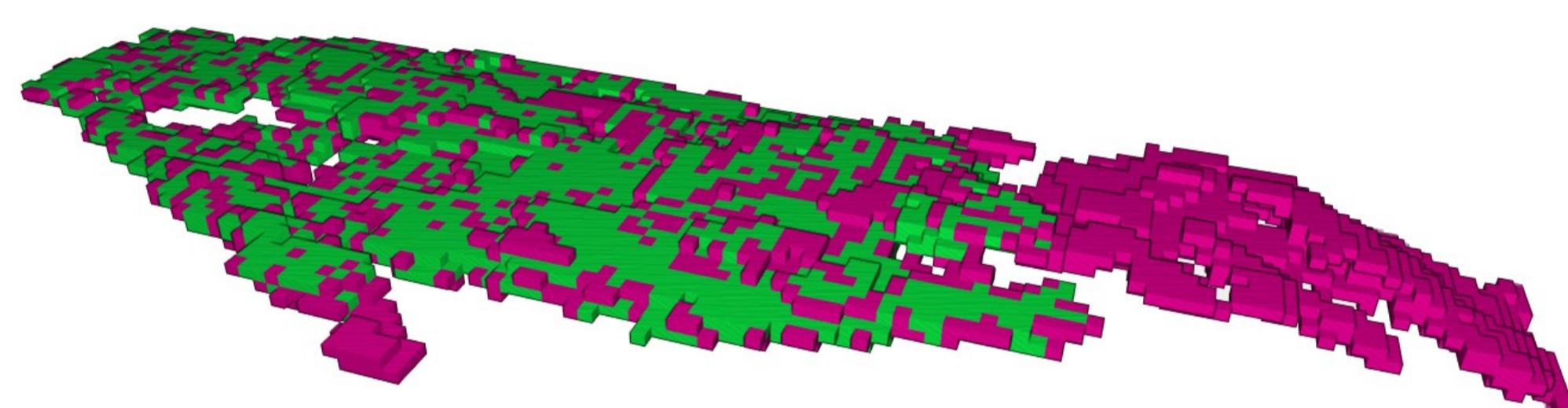


Geobody Upscaling Connects Model with Measurements

Finding new reservoirs with computer aid

To accurately pin point underground reservoirs such as oil fields, computer calculations are needed. One technique is upscaling and is a way of combining the material composition of the earth in the (geobody) with a geological model (grid) provided by a geoscientist. This is done by activating sub parts (cells) of the grid. The

upscale process needs to be fast and produce a result of activated cells which nicely cover the geobody. However, speed and accuracy does not come hand in hand. In order to increase accuracy without loosing speed the method selects which cells to spend time on as well as which cells should be neglected.



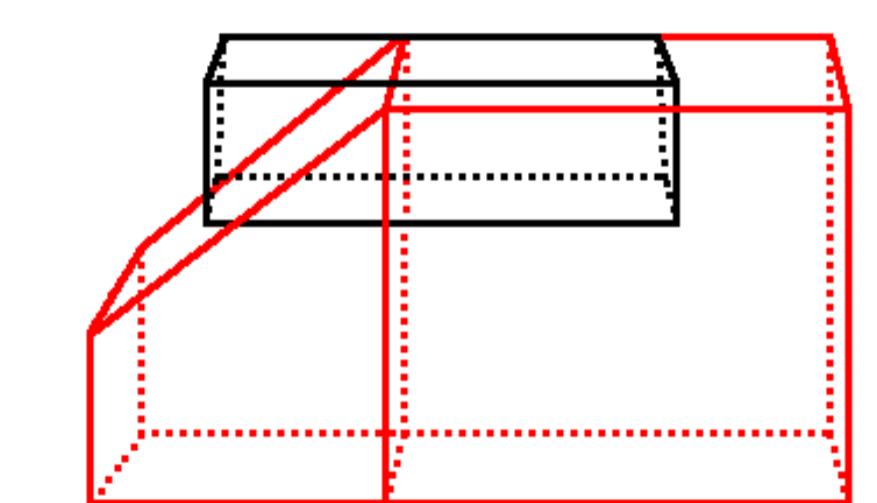
A geobody is structured and consists of voxels, and every voxel have the same dimensions. Furthermore, it is constructed from seismic data, each voxel represents a material property

Investigating intersections takes time

The upscaling is performed by checking if the voxels are inside the cells, and a cell is upscaled when any points on or inside the voxel are inside the cell. However, this means that many costly intersection tests has to be performed. To reduce the amount of tests they are only done when the voxel intersects the bounding box of a cell.

Since cells are defined by their eight corners, each time tests are requested the cell's planes must first be constructed. This costs huge amounts of time. By checking if a cell's planes already have been created the method keeps plane creation to a minimum and significantly decreases the run time.

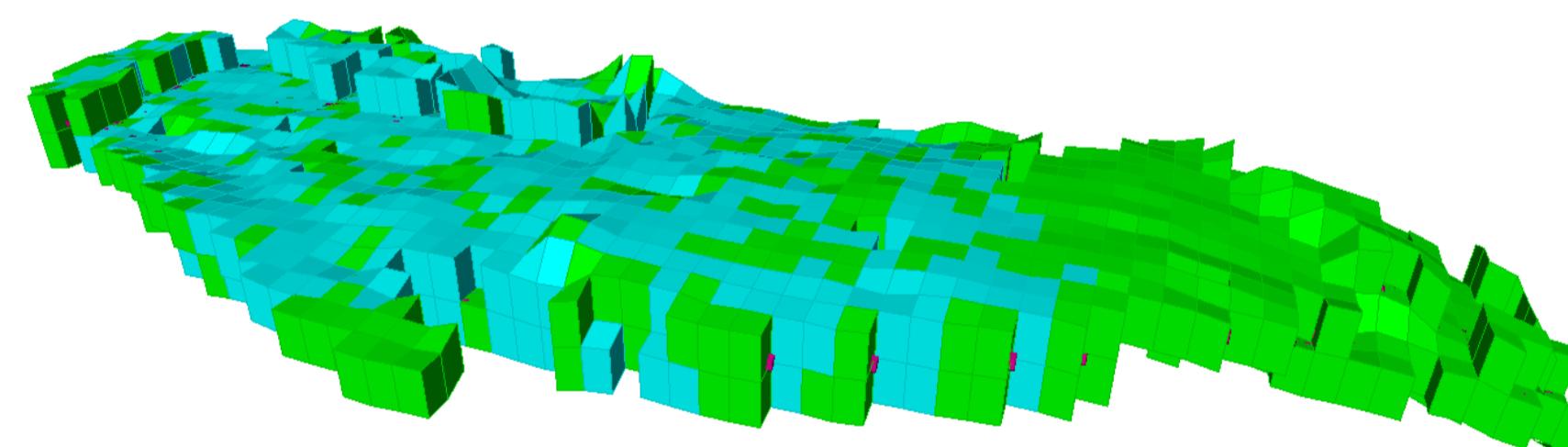
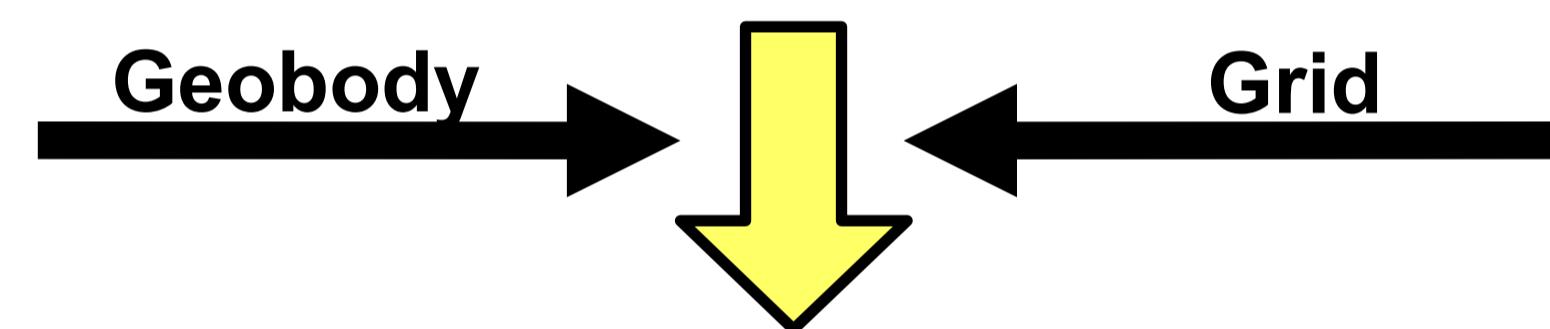
Intersection tests are preferably avoided. If a cell located on top of an already upscaled cell is not upscaled then it is reasonable to assume no more cells further up will be upscaled and the method can continue with another pillar.



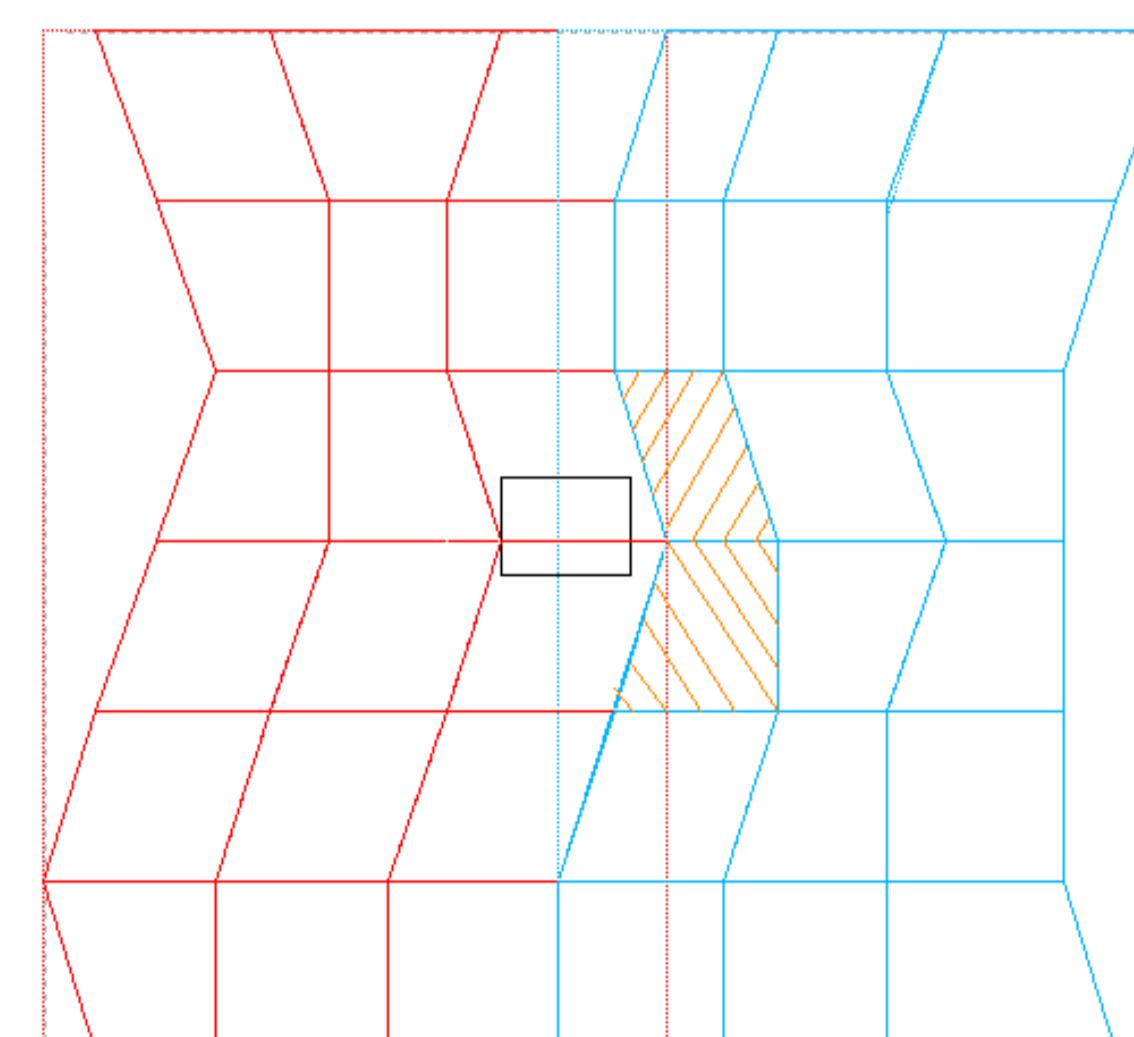
Unstructured cells make it hard to find all intersections. Here the red cell to the left will not be upscaled to unless more points apart from the corners and center of the black voxel are used.

Upscaling to unstructured grids is difficult because of the cells random size. Therefore, bounding boxes of a collection of cells (chunk) is used to find cells in the vicinity of a certain voxel more quickly than going through all cells for all voxels. When a voxel intersects the bounding box of a chunk of cells but not the faces of the cells, the method must make sure no cells are intersected.

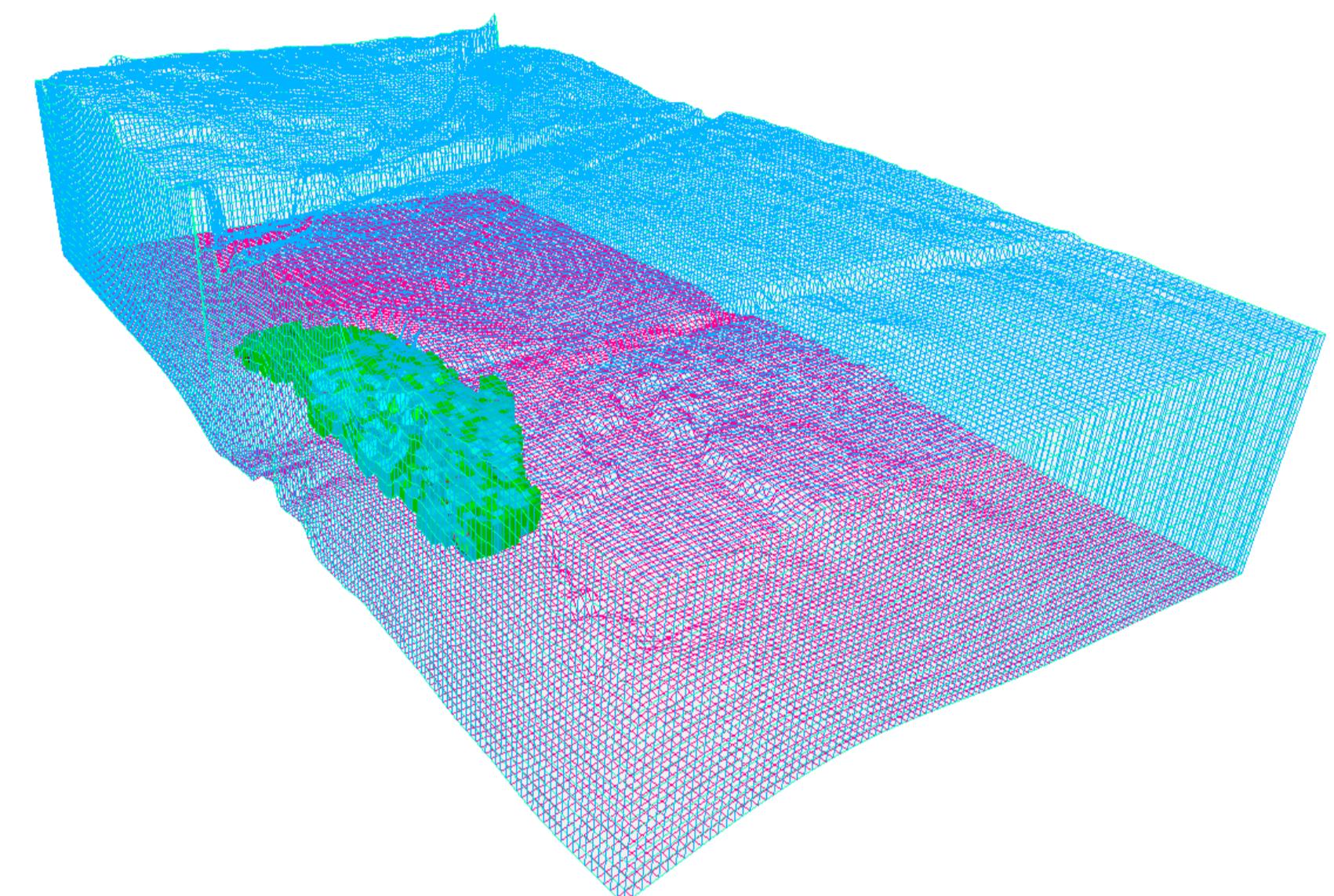
Connect the geological model with the seismic data by upscaling



Upscaled result, notice how well the activated cells reconstruct the form of the geobody. This is a good result



2D image of overlapping chunks of cells represented here by a collection of red and blue cells. The black voxel is in the overlapping region of both chunk boxes and cell boxes of the orange striped cells, to the right. This is a huge cost since all tests are performed in order to be sure that the voxel does not intersect any of the cells.



The grid represents a geoscientists model of the area where the geobody is located. It consists of unstructured cells, that is all cells can have different shape. Cells are defined by their eight corners.

Upscaling is now faster and more accurate

As a result of the project two new methods were produced, one method optimized for partly structured grids and one for unstructured grids. Both methods build on the same fundamentals, but the unstructured method also indexes the grid by creating bounding boxes of chunks of cells. The bounding boxes share index with the cell located in the minimum corner of the box. This simplifies the process of finding the cells in the vicinity of a certain voxel without having to search through the whole grid, thereby the execution time is reduced.

	Original method	Structured method	Unstructured method			
Models tested	Execution time (ms)	Upscaled cells	Execution time (ms)	Upscaled cells	Execution time (ms)	Upscaled cells
Model 1	23499	1359	5325	493	24614	6534
Model 2	976	1228	439	6119	6132	40689

Execution time and the number of upscaled cells produced by three different methods on two different geobody models. The relevant difference between the original and the structured method are programming and structural optimizations. Compare the original method with the unstructured one model 1, which is an unstructured model. Because the original method is unable to handle unstructured models it spends most time checking cells not even close to the respective voxel.