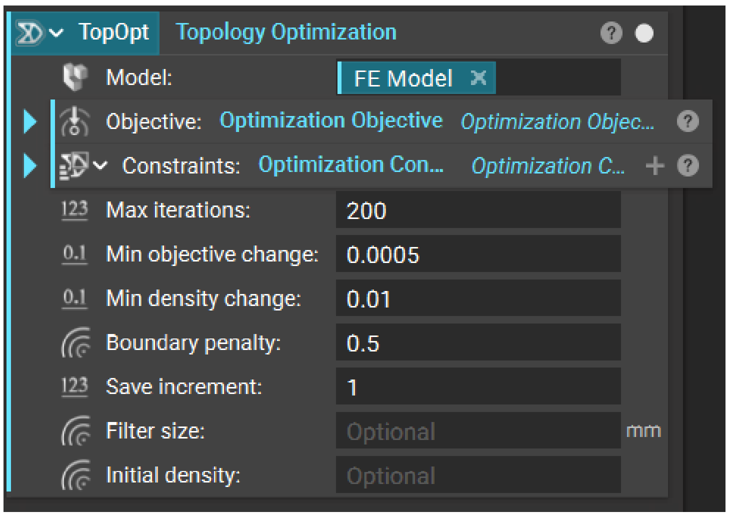
Follow Along: Topology Optimization

After establishing the optimization Objectives and Constraints in our last lesson, the Topology Optimization has already run. Let's take a closer look at this block, its inputs, and the information we see in the results. For now, we'll collapse our optimization objective and our constraints and focus only on the **Topology Optimization** block.

Step 1: The Topology Optimization Block



The input for Max iterations is pre-populated with a value of 200. Because Topology Optimization is iterative, we can set a limit for the number of iterations attempted. For more complex optimizations that may take longer to run, this should help users to reduce computation time with the slight tradeoff of accuracy.

Another way to reduce computation time, assuming the same tradeoff, is by modifying this Minimum objective change. Once the Top-Opt iterations converge within this number, the process is considered complete. Therefore, the higher the Minimum objective change, the faster the optimization will converge, and the lower this input, the longer it'll take to run.

Minimum density change is another convergence threshold–one that compares the optimized density between iterations. Again, we'll see a slight tradeoff between accuracy and computation time.

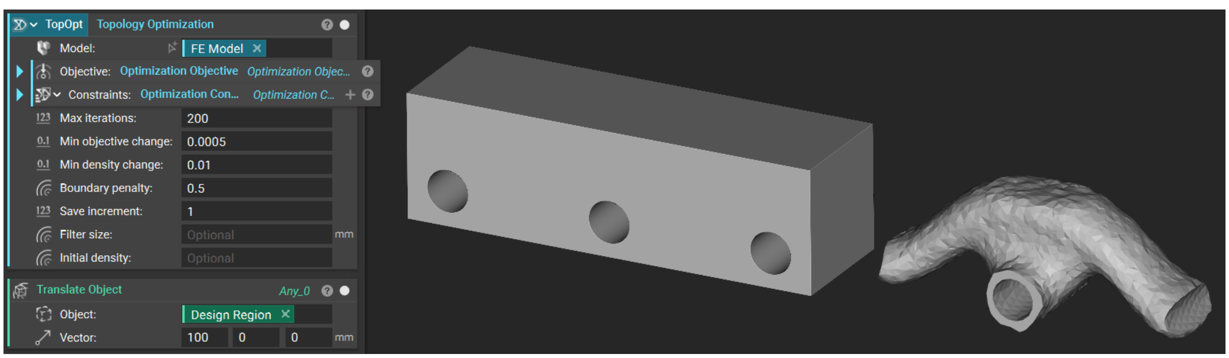
The Boundary penalty affects density values at the edges of the design space. An input of 1 will lower the density at the edges, while an input of 0 increases the density. Therefore, lesser inputs will remove more inner material from the part, and greater inputs will remove more material at the edges.

Save increment controls data storage and therefore affects file size. An input of 0 will save only the first and last iterations, an input of 1 will produce the largest file size and save every iteration, and any input larger than 1 will be the increment by which iterations are saved. For example, an input of 2 would save every other iteration of the topology optimization.

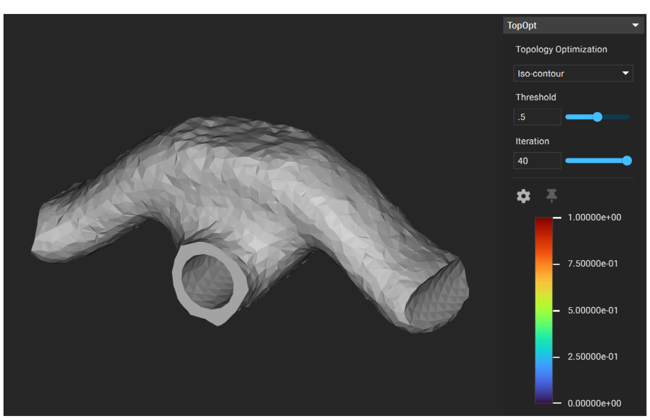
Filter size and be used to indirectly control the minimum feature size and remove the jagged checkerboard artifacts we see in Top-Opt. If left blank, this will auto-generate based on the model size.

Initial density can be any value between 0 and 1 to give an initial guess at how the result will look before the process begins. If left blank, this will be set to 0.5.

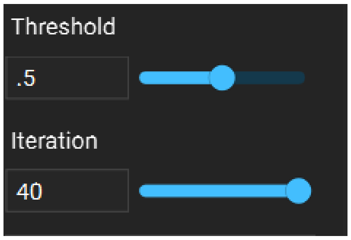
Step 2: Create a variable out of our Topology Optimization, and pull in a **Translate** block to view our result side by side with our original part. Use the *Design Region* variable from the Geometry section for the Object input. Input a vector of [100, 0, 0]mm. Viewing these two parts beside one another, we see that a lot of this material from our original part has been removed during the Top-Opt process.



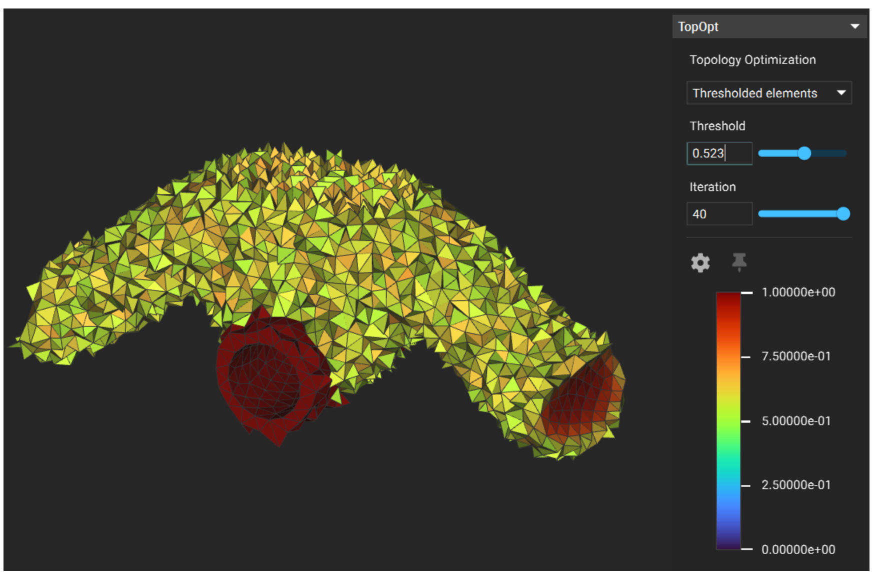
Step 3: Since Topology Optimization works by assigning a density value between 0 and 1 to each mesh element, we can use the Topology Optimization window to better understand how the calculated densities have affected our part and how the output meets our objective.



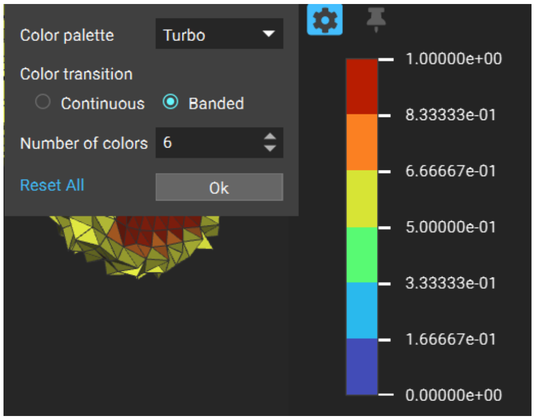
The Iso-contour option shows this single surface with elements meeting the nominal Threshold, which can be modified using this slider. When the Threshold equals 0, our initial part can be seen, and as it moves toward 1, we see the gradual removal of elements with lower top-opt densities. The iterations slider shows the evolution of the top-opt through each iteration.



Step 4: The Thresholded elements option offers a similar visual representation but gives a more granular view of individual mesh elements and their Top-Opt densities. This can help to visualize how and where elements with different Top-Opt densities are removed throughout the optimization.



Step 5: Opening up the settings in our results window, we can control the color palette of our elements, whether the gradient is continuous or banded, and the preferred number of color bands.



We've now completed our Topology Optimization. Next, we'll need to perform some post-processing of our results to generate useful geometric information in nTopology.