MOSM – Design for Additive Manufacturing

Tutorial:

Topology Optimization via Rhino GH Applications

Version 1.0

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1. Introduction

Objective:

In this TP, we will learn how to do Topology Optimization via toPos plugin in GH. TOpos is a 3D Topology Optimization plugin which is using GPU for computation acceleration. It is based on SIMP methodology. With tOpos, you can optimize material distribution for a given design domain within Grasshopper's design environment.

Demonstration tool: tOpos, Pufferfish.

toPos: https://www.food4rhino.com/en/app/topos .

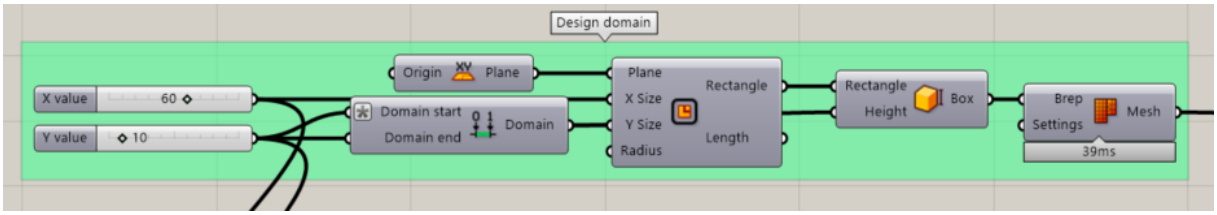
2. Tutoring example

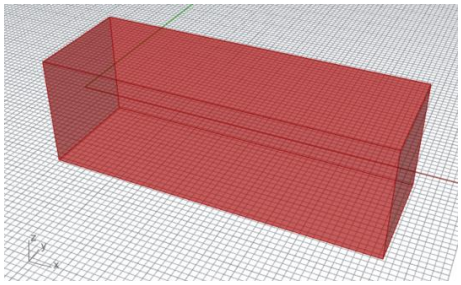
In this tutoring example, we will optimize material distribution for a 3D structural optimization problem.

2.1. Problem description

Step 1: Design domain construction

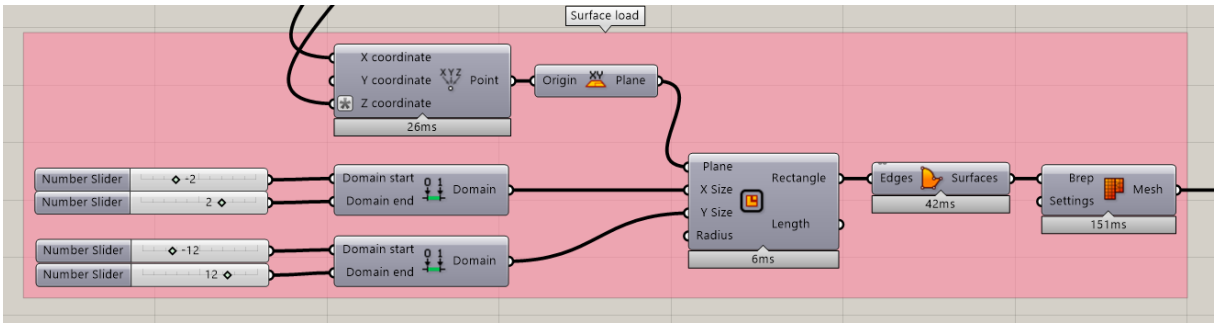
Use **Rectangle, Box Rectangle and Mesh Brep** components to generate a design domain (60*20*20).

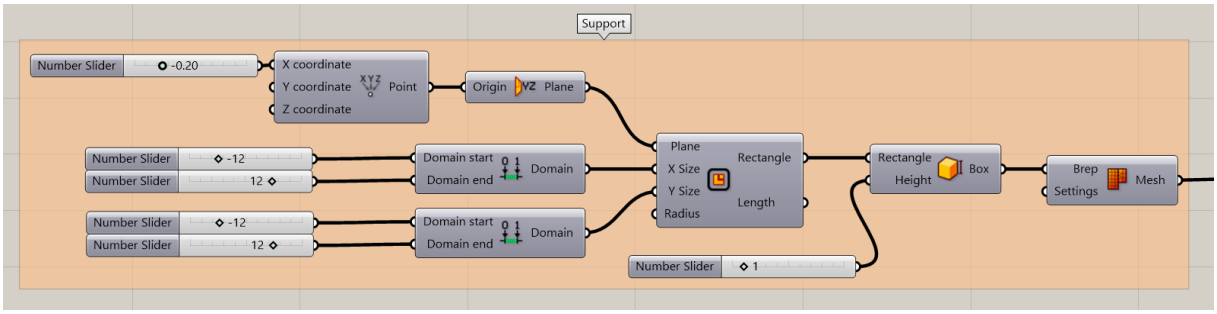


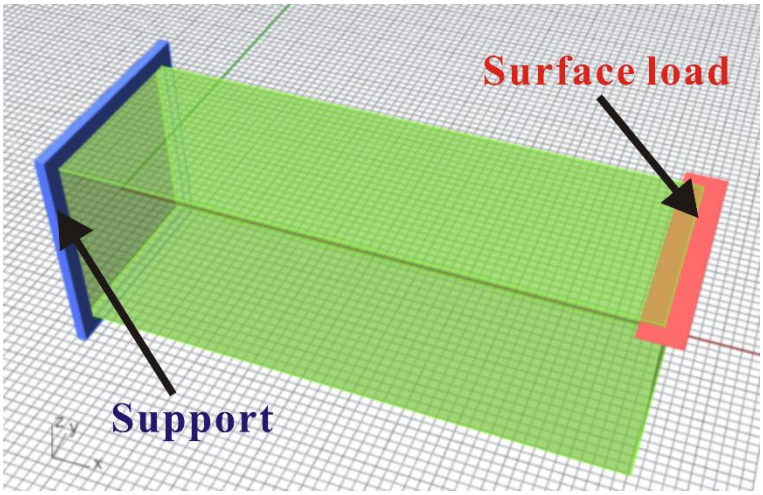


Step 2: Set boundary condition

We use **Rectangle and Boundary surfaces** components to generate load surface. Support is defined using **Rectangle and Box Rectangle** components.

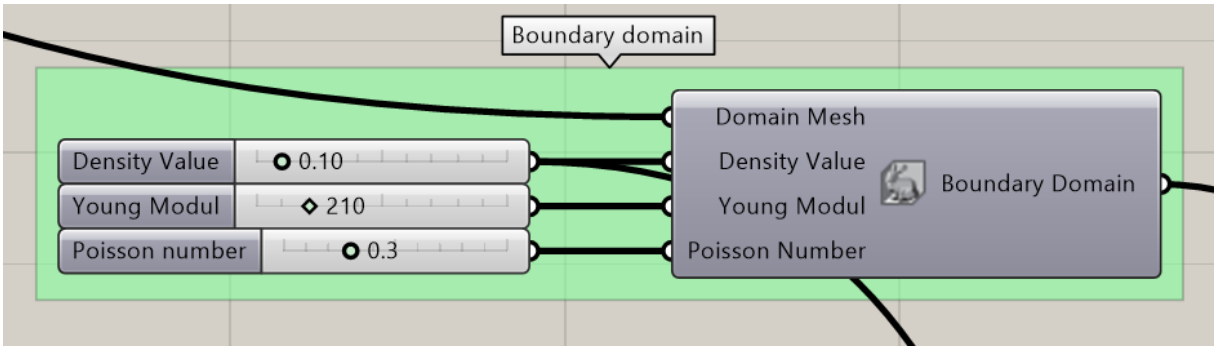






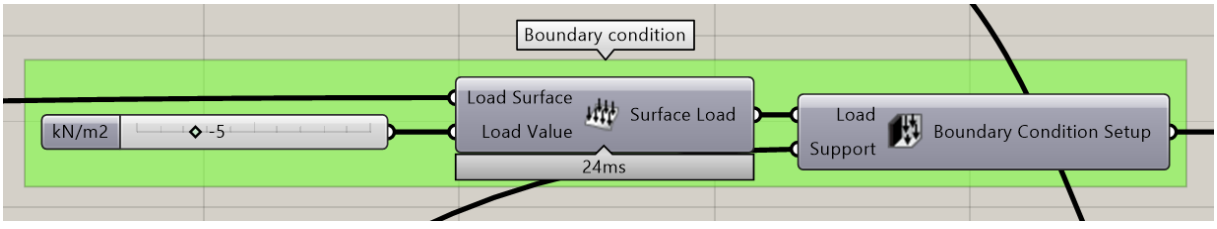
Step 3: Material properties

Connect design domain with **Boundary Domain** component, and set **Density Value, Young Module and Poisson Number** as 0.1, 210 and 0.3.



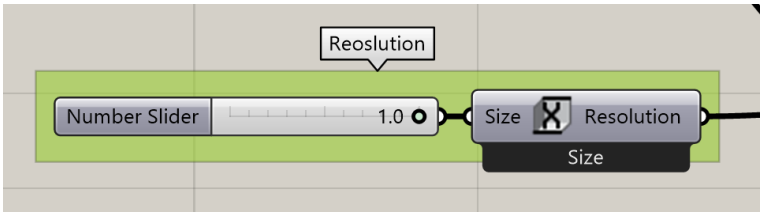
Step 4: Set Boundary Condition

Use **Surface load** component to connect ***Load surface input*** with the surface in Step 2. Set ***Load Value*** as -5. Link ***support input*** of **Boundary Conditions** to the support in Step 2.



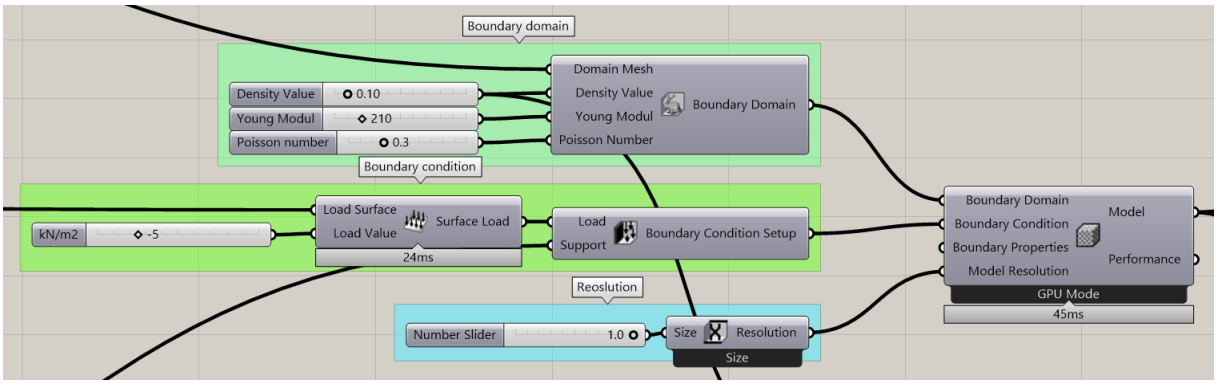
Step 5: Set resolution

Use **Resolution** component to define a resolution: resolution size = 1.



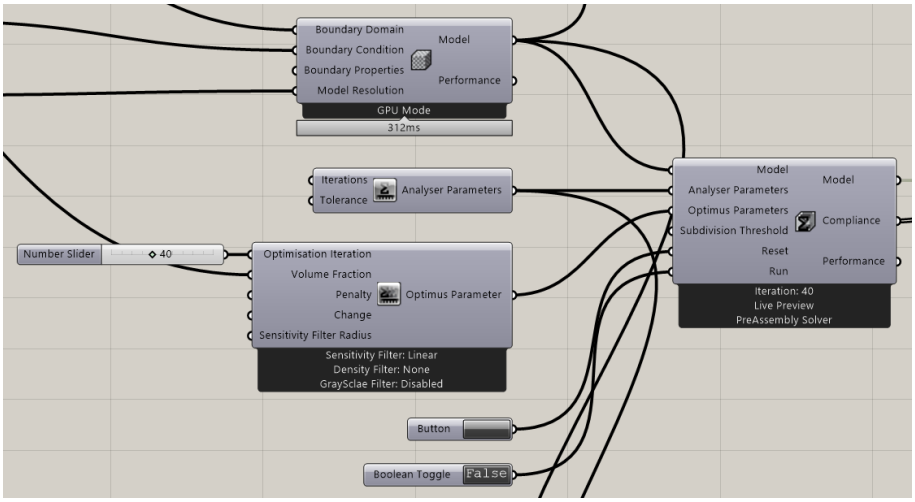
Step 6: Select GPU model

If you use NVIDIA graphic card with Cuda Computation Capability, you can select GPU **Model** to solve the TO problem. Connect **Boundary Domain, Boundary Condition Setup, and Resolution** with the inputs of GPU **Model** component.



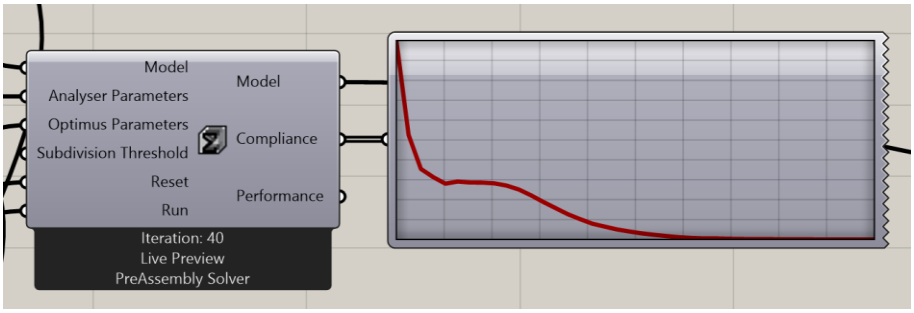
Step 7: Connect with TO **Optimus** component

Link GPU model to **Optimus** solver. Drag **Analyzer Parameters** and **Optimus Parameters** components to the interface and connect them with the **Optimus** component. Set the optimization iteration as 40.



Step 8: TO solver

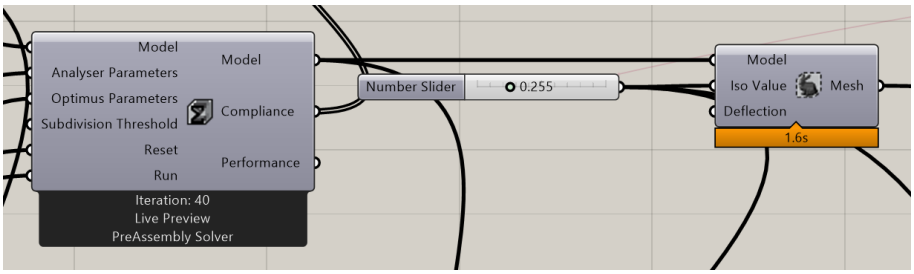
Click the **Boolean Toggle** component connected with ***Run*** input to solve the TO problem.

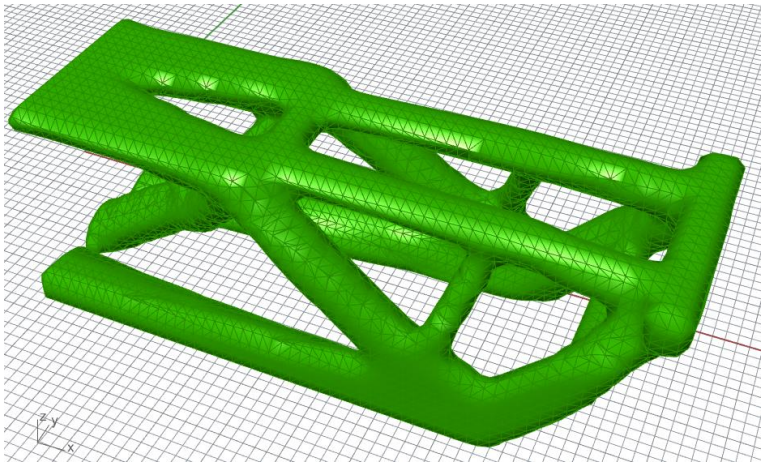


2.2. TO result output

Step 1: Iso mesh output

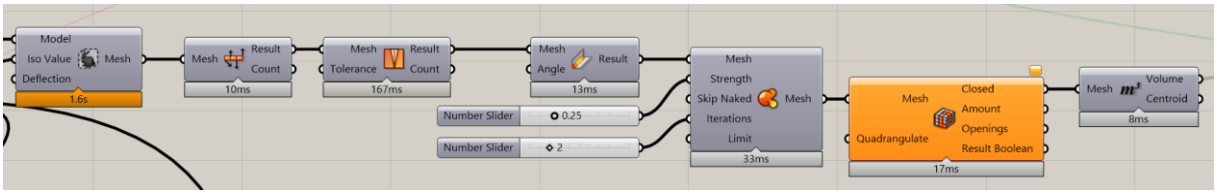
Change Iso value to find a valid Iso mesh.

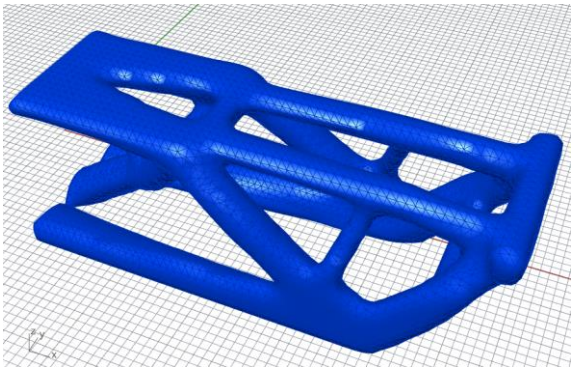


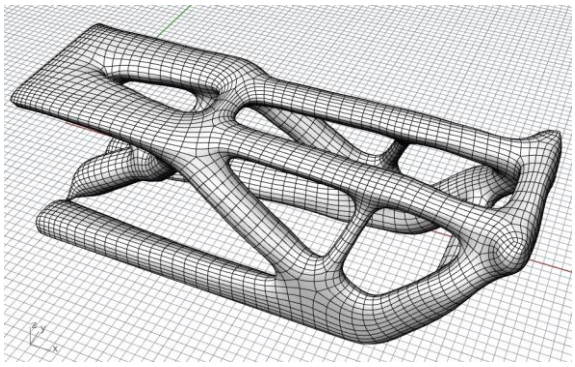


Step 2: Smooth the TO mesh result

Use **Unify Mesh, Align Vertices, Weld Mesh,** and **Smooth Mesh** components to obtain a valid mesh with smooth boundary. Or use **QuadRemesh** command in Rhino 7 to have a SubD TO result.







Step 3: Model preview

Use **Voxel Mesh and Element Data Preview** components to show more model results.