Topology Optimization with FEniCS

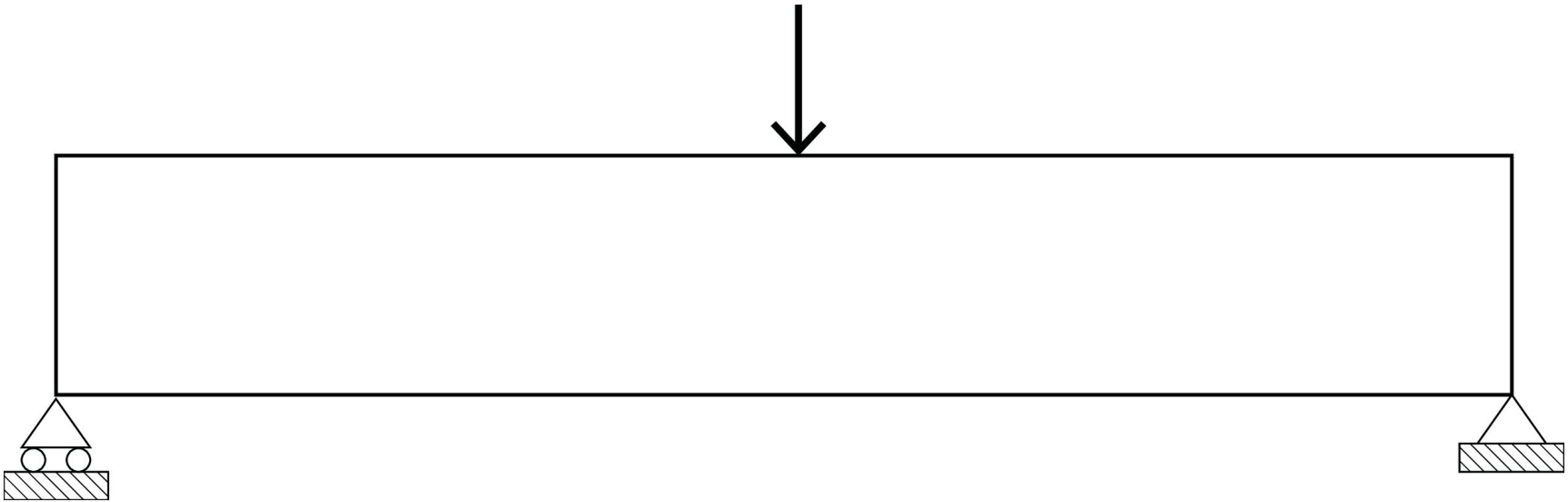
Zachary Ferguson & Francis Williams

Overview

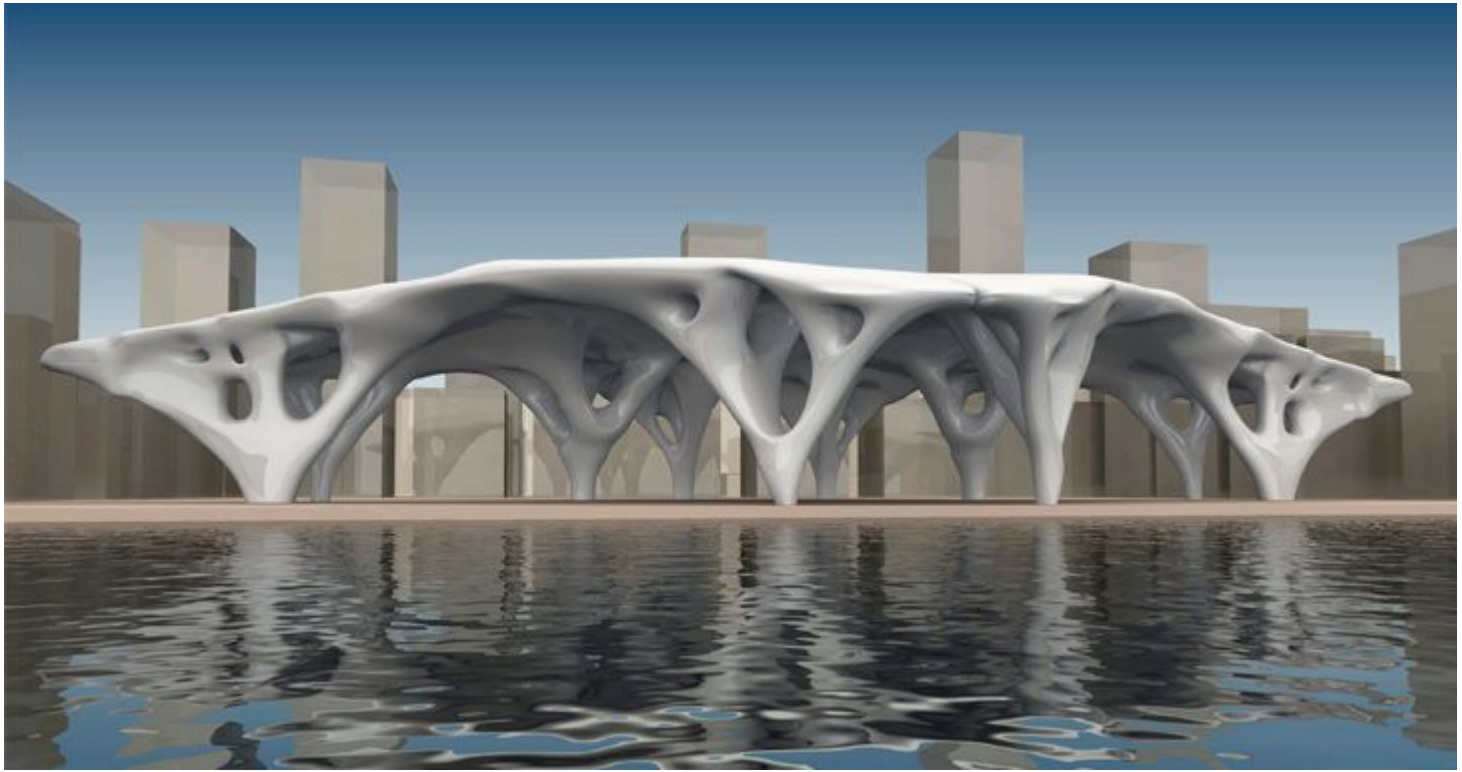
- Motivation
- What is topology optimization?
- Problem Statement
- Live Demo
- Results

Motivation

Optimal Design under constraints. E.g. Bridge:



Motivation



What is Topology Optimization?

Constrained optimization problem deciding where and how much material to place in a domain.

What is Topology Optimization?

Model material using linear elasticity and discretize the domain and function space using the Finite Element Method (FEM)

What is Topology Optimization?

Assign a density of material to each finite element which determines, the Young's modulus, a physical constant per element describing how the solid deforms under force

$$E_e(x_e) = E_{\min} + x_e^p(E_0 - E_{\min}), \qquad x_e \in [0, 1]$$

What is Topology Optimization?

Find density which minimizes *Compliance* subject to constraints on total material:

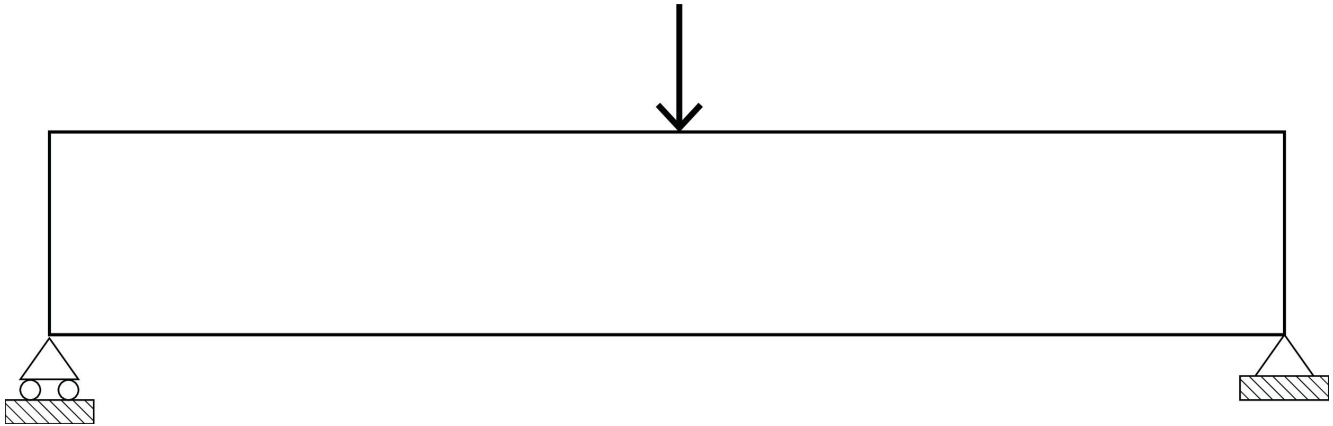
$$\min_x : c(x) = U^T K U = \sum_{e=1}^{N} E_e(x_e) \mathbf{u}_e^T \mathbf{k}_0 \mathbf{u}_e$$

$$\text{subject to} : \frac{V(x)}{V_0} = f$$

$$: KU = F$$

$$: 0 < x_{\min} \leq x \leq 1$$

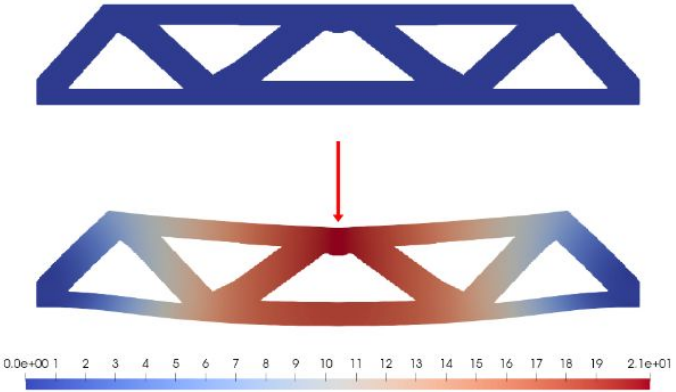
Results



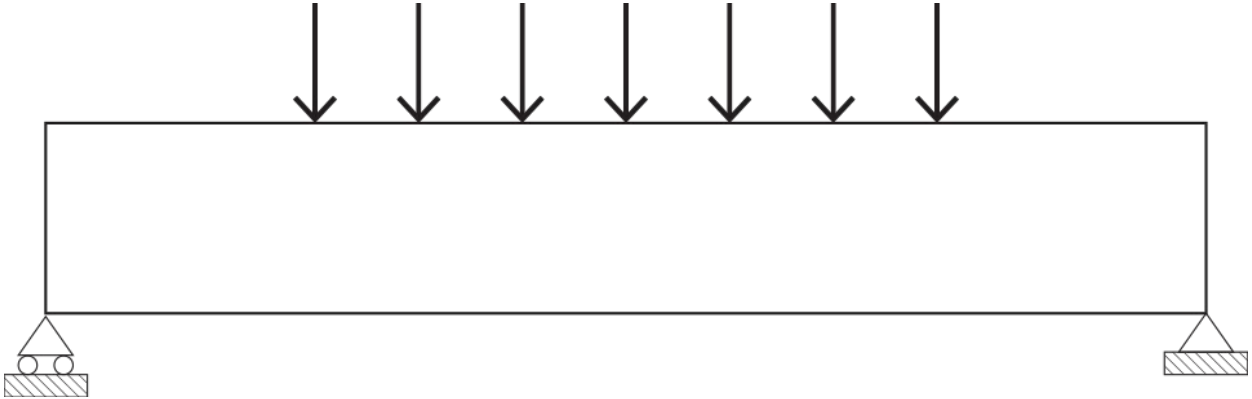
Results

Computed Output

FEniCS Simulation



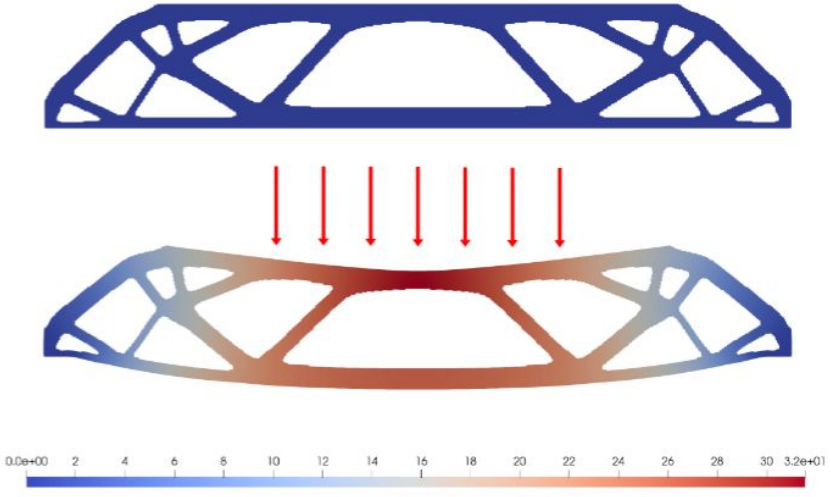
Results



Results

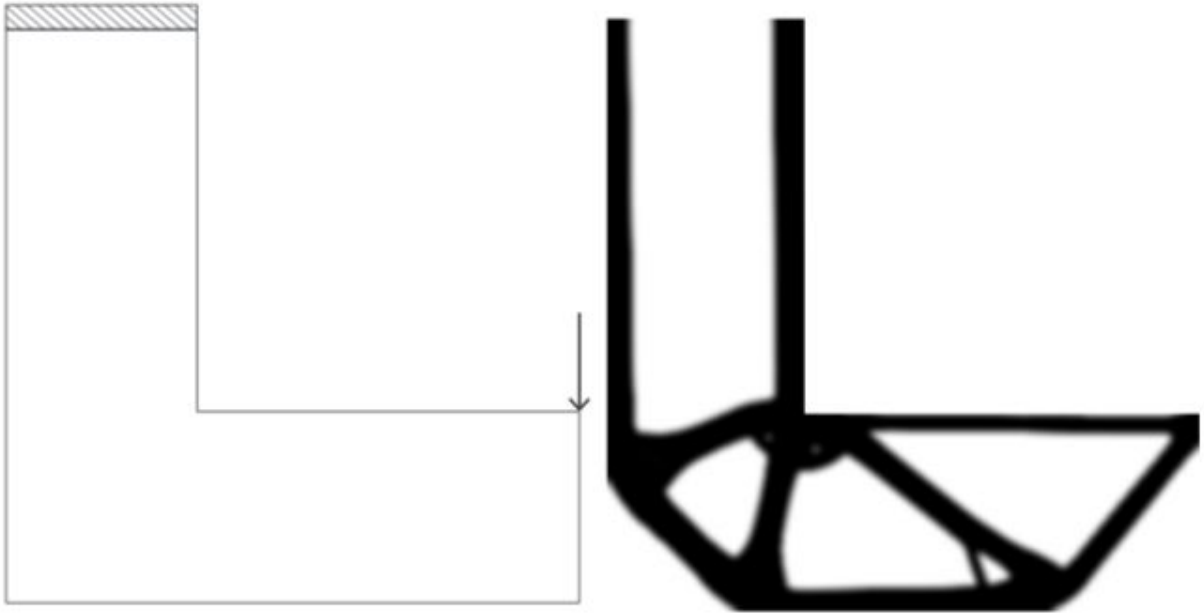
Computed Output

FEniCS Simulation



Results

Computed Output



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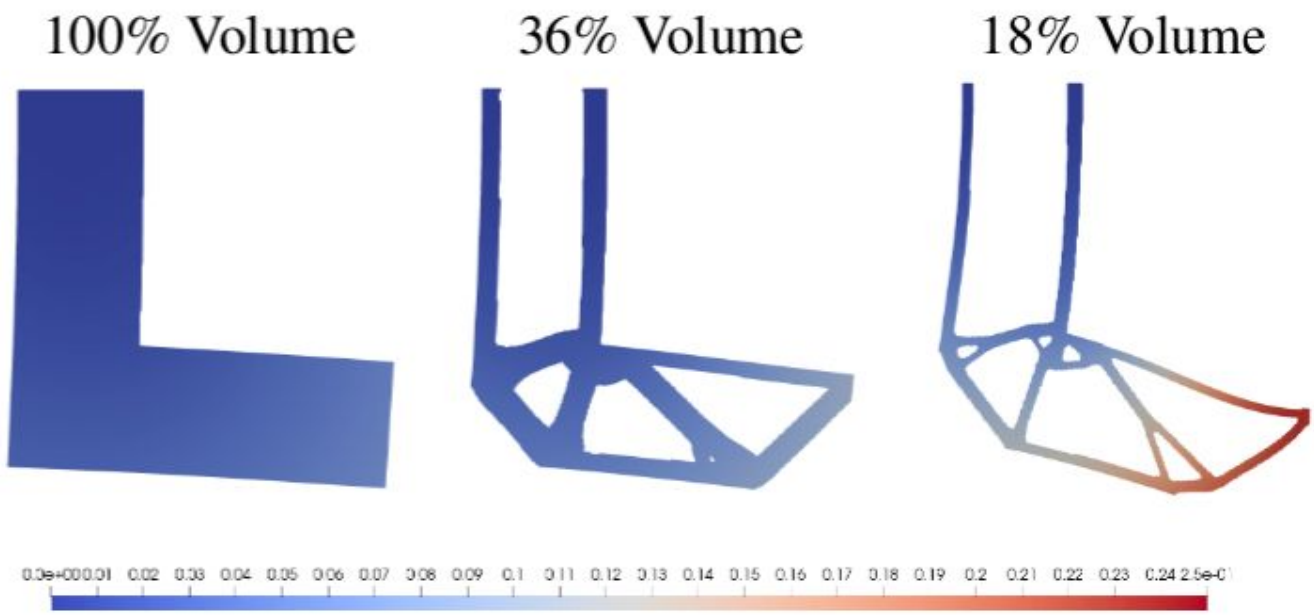
FEniCS Simulation



Fabricated Results

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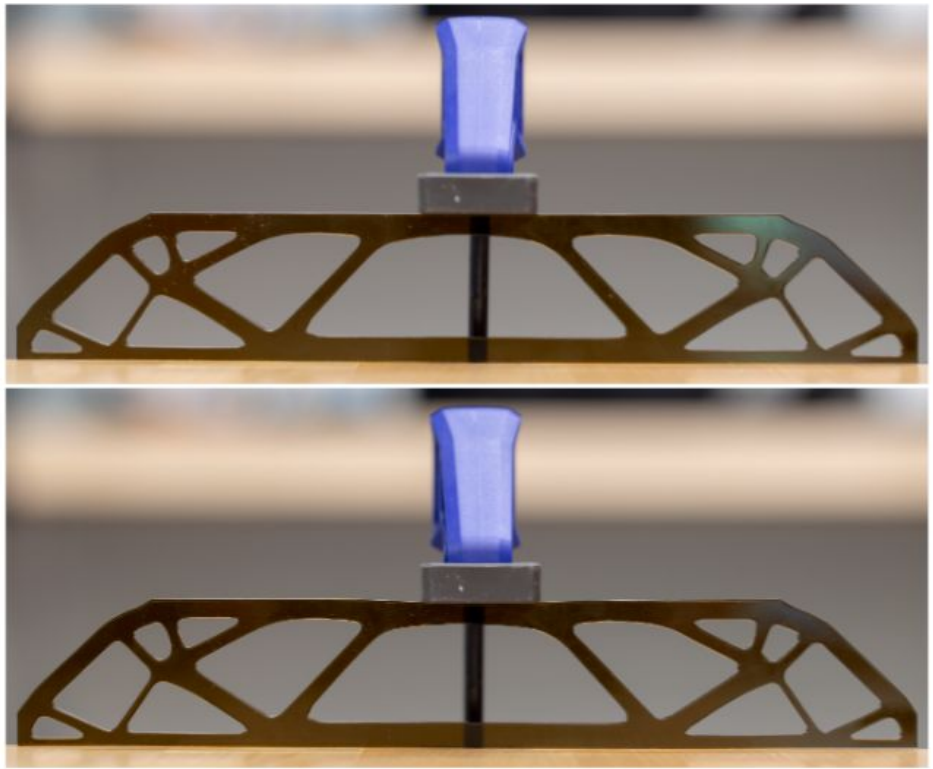

Live Demo

Thank You