Minimization of power-loss in conductive medium

The objective is here to distribute a fixed amount of conductive medium, with given currents on boundary, such that the total power-loss is minimized.

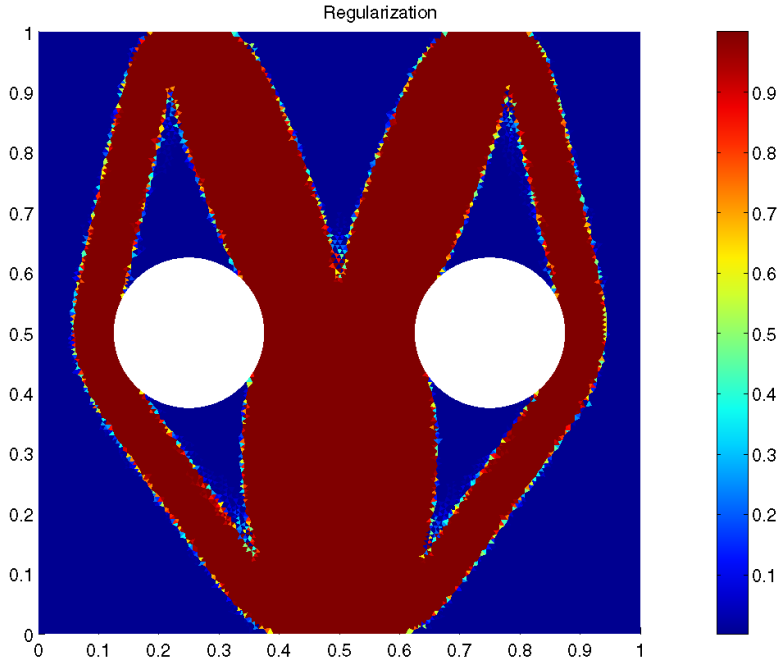

Figure 1: Plot of the conductivity σ. As seen, Ω is in this example a square with two circles cut out. Electrical current enters Ω at two positions on the top of the square and leaves at one position on the bottom. A piecewise linear FEM was used with 31440 elements, $\sigma_- = 0.001$, $\sigma_+ = 1$.

Maximizing torsional rigidity of an elastic bar

Solutions to the non-convex problem of maximizing the torsional rigidity of an elastic bar, using a fixed proportion of two different materials.

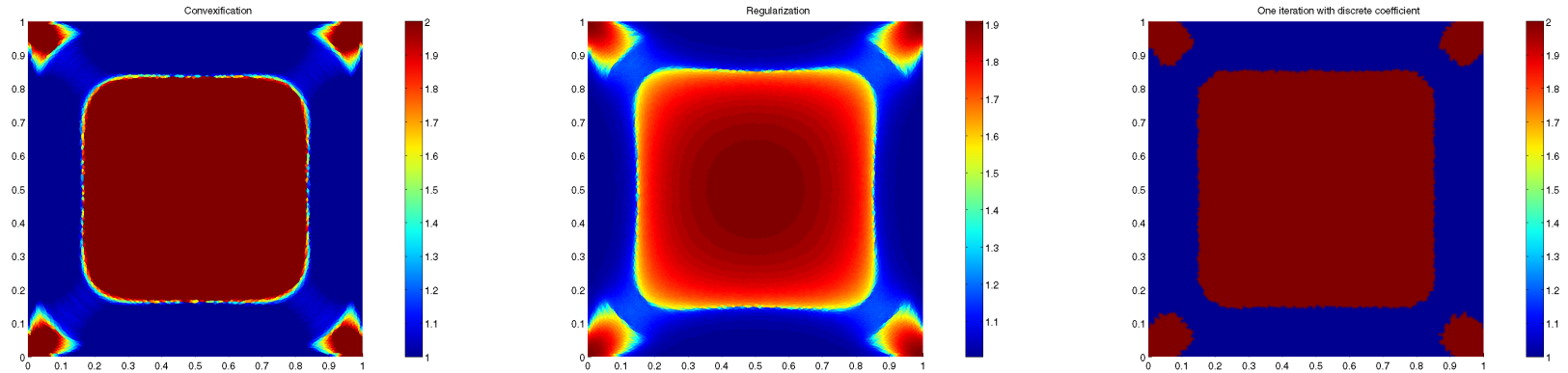

Figure 2: Plots of the inverse of the shear moduli on the cross section of a infinitely long bar. A piecewise linear FEM was used with maximum element diameter 0.01, $\sigma_- = 1$, $\sigma_+ = 2$. Left: Convexified reference solution. Middle: Solution from solving the regularized Hamiltonian system. The relative L2 error in the Hamiltonian is here less than 4%. Right: One additional iteration with σ restricted to $\{\sigma_-, \sigma_+\}$. The relative error is now less than 1%.

Elecrical impedance tomography

Objective: To reconstruct conductivity inside a body from applying currents and measuring the induced surface potentials.

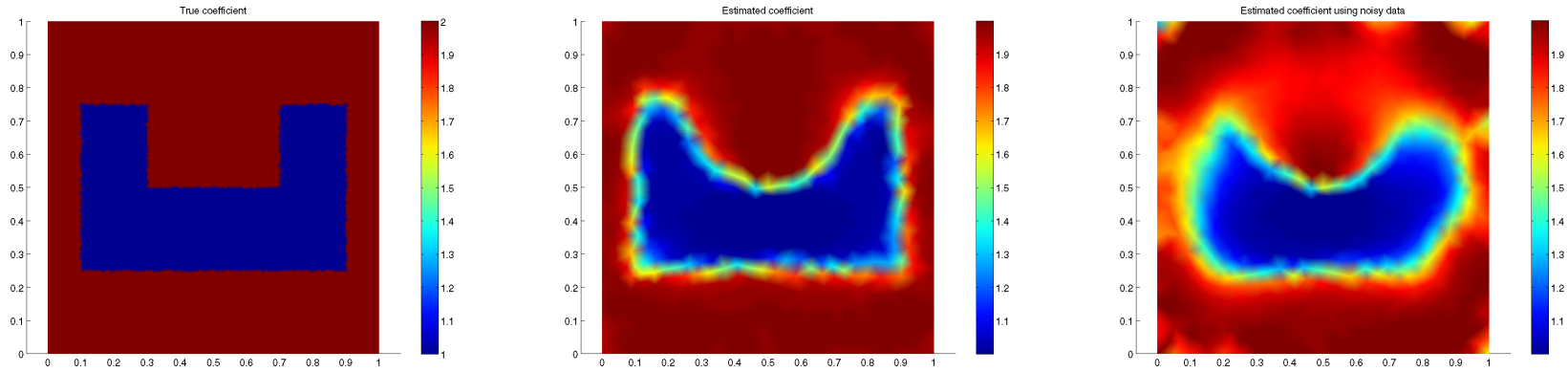

Figure 3: Approximations of the true conductivity σ from minimizing the L^2 error between calculated and measured potentials on the boundary. Left: True conductivity. Middle: Estimated conductivity from solving the regularized Hamiltonian system. Right: Estimated conductivity when 5% white noise is added to measurements. Data from four different experiments were used.

Compliance minimization

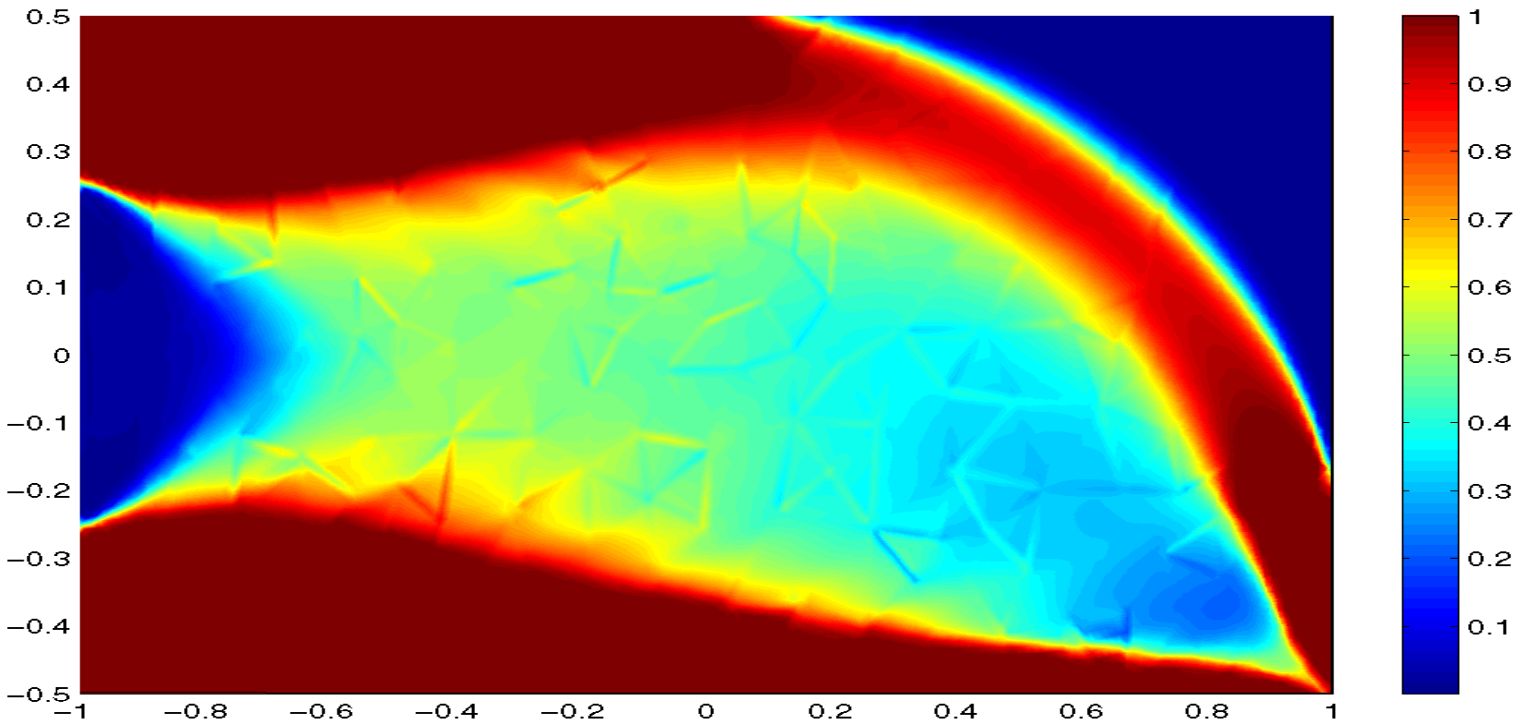

Figure 4: Plot of the relative material density σ of an isotropic elastic material when minimizing compliance of a plate subjected to external load. The left side is fixed and a downward force is applied to the lower right side. The solution can be used as initial data for a few iterations with $\sigma \in \{\sigma_-, \sigma_+\}$