The Search for Harmonic Drums

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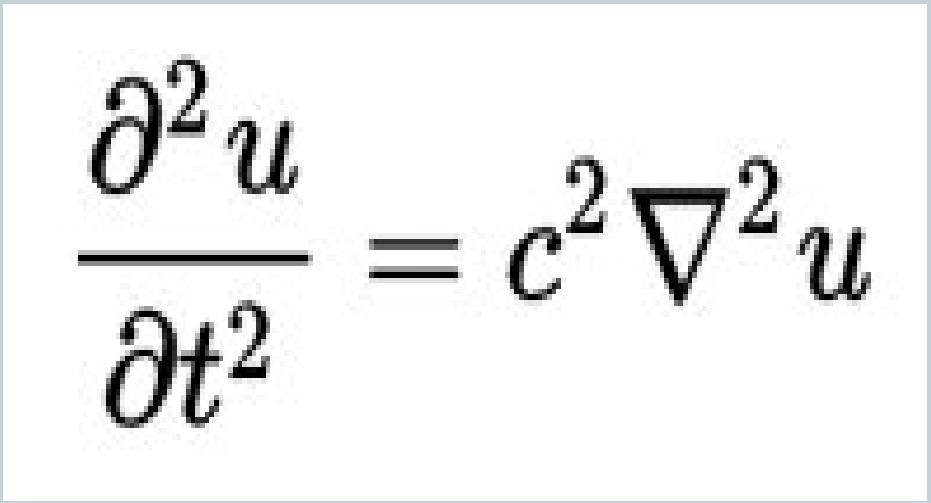
Vocabulary

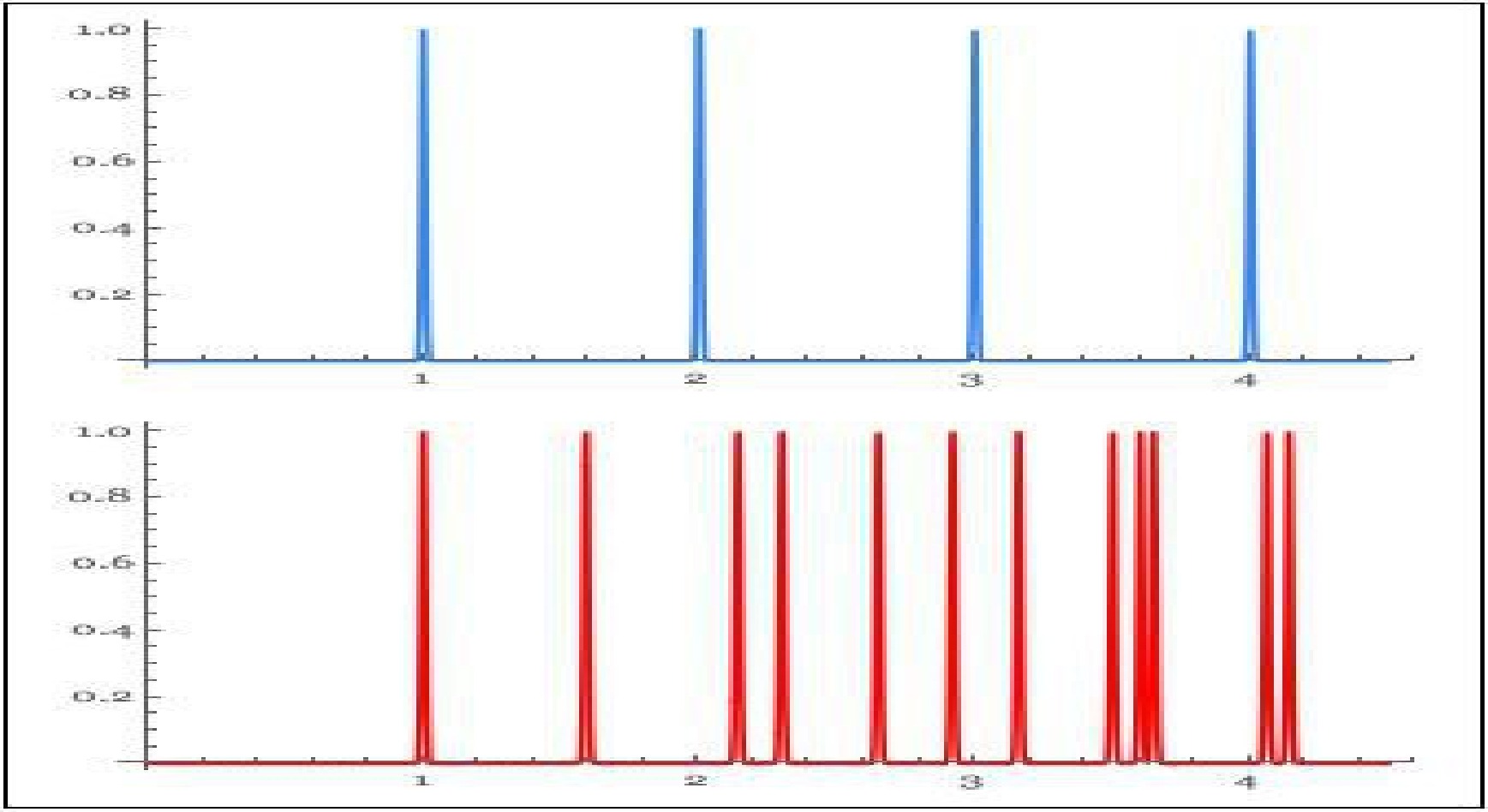
- Frequency Spectra
- Harmonics
- Fundamental Frequency
- Frequency Number
- Eigenmodes, eigenfrequencies
- Intensity

Mathematics

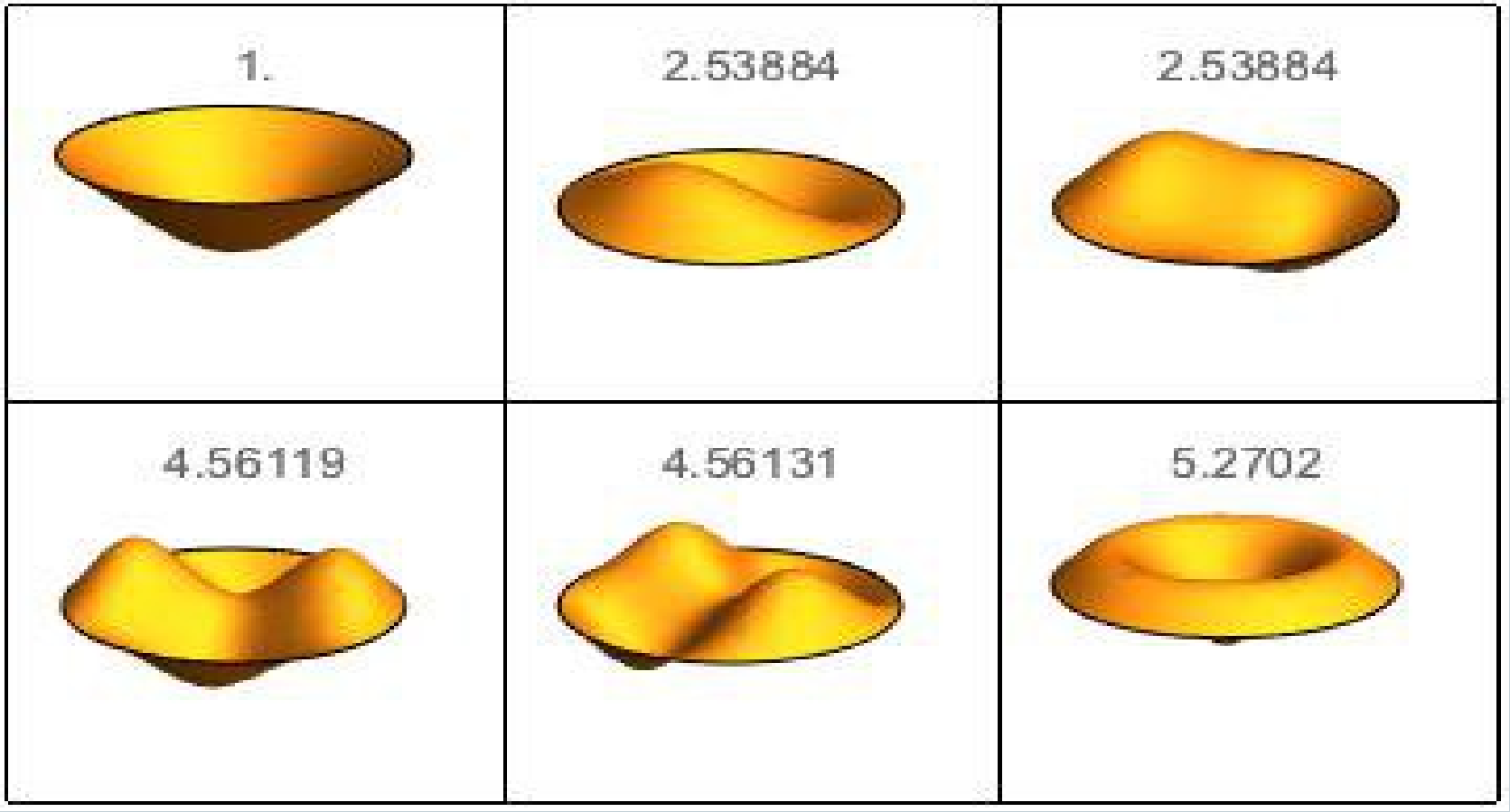


$$\frac{\partial^2 u}{\partial t^2} = c^2 \nabla^2 u$$

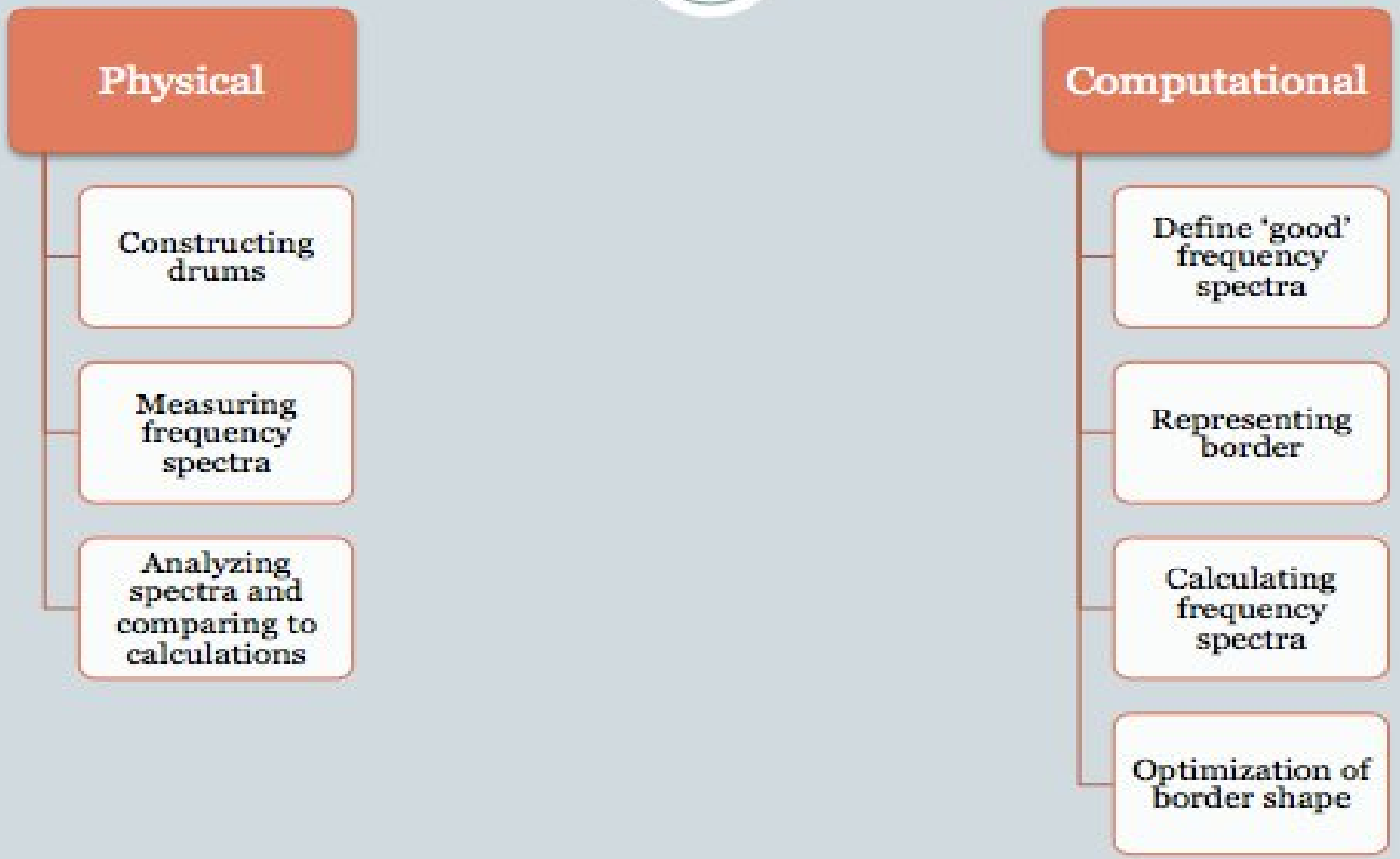
Circular Drums



Circular Drums

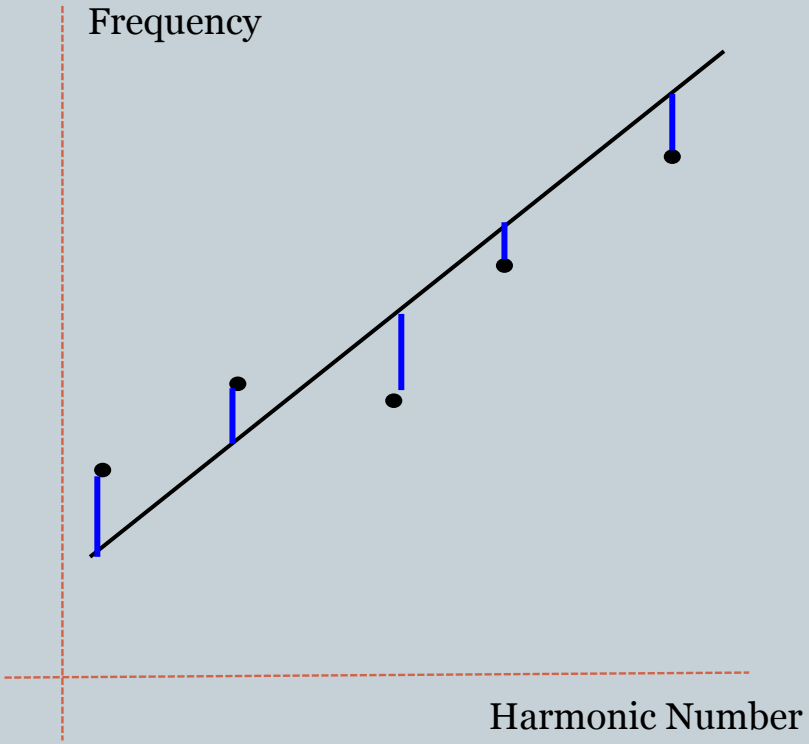


Methods


Physical
Constructing drums
Measuring frequency spectra
Analyzing spectra and comparing to calculations
Computational
Define 'good' frequency spectra
Representing border
Calculating frequency spectra
Optimization of border shape

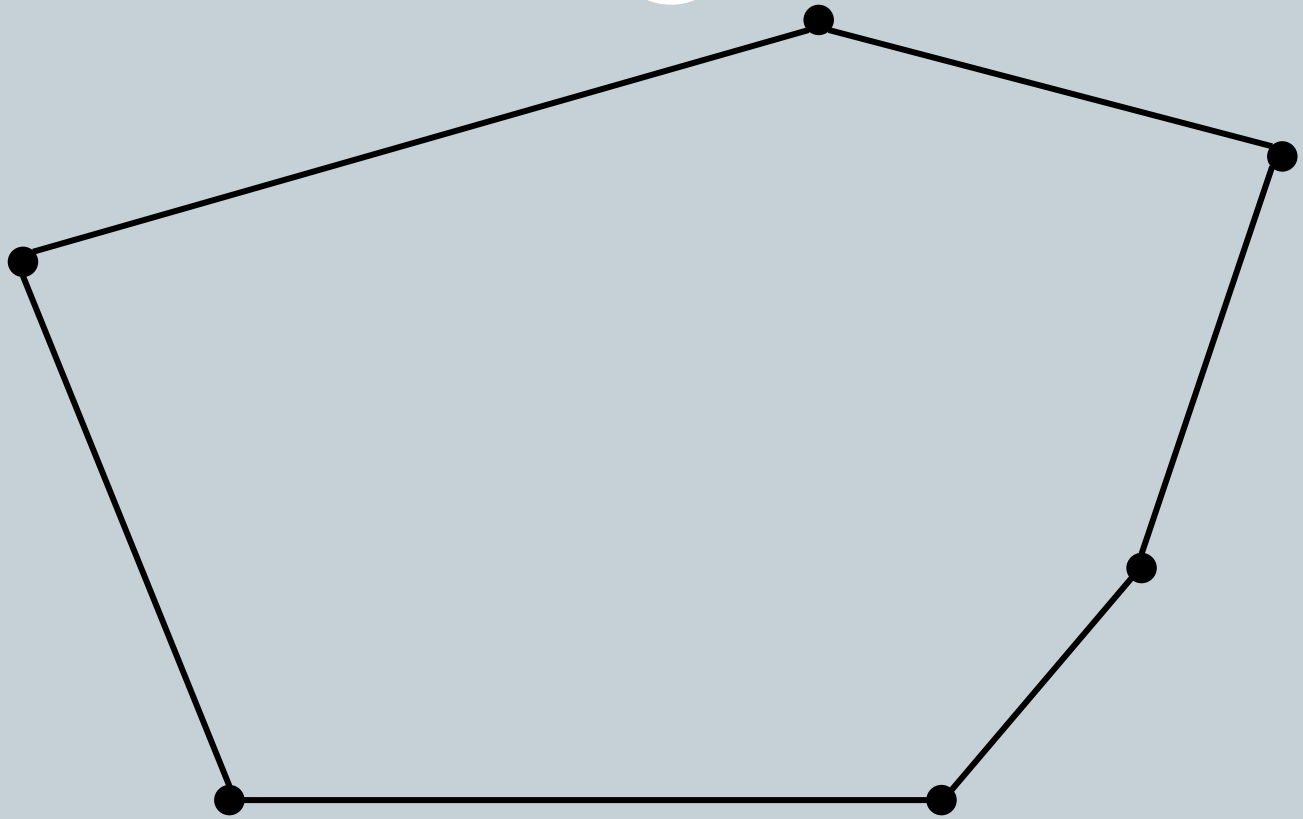
Definition of ‘Good’

Linear Fit



Neural Network

Border Representation



Frequency Calculation

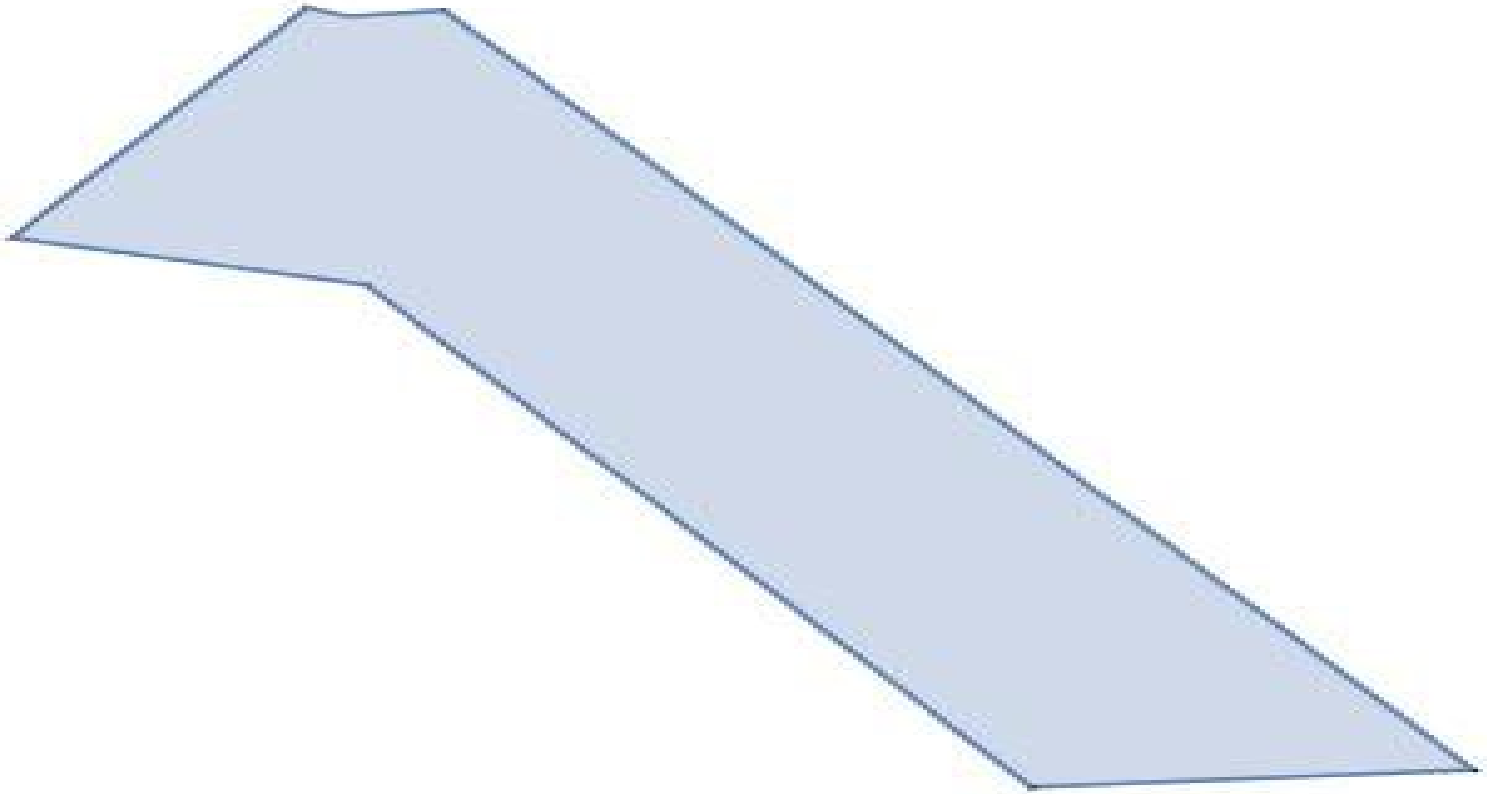
```
NDEigensystem[
 {-Laplacian[f[x, y], {x, y}],
  DirichletCondition[f[x, y] == 0, True]},
 {f}, {x, y} ∈ region, Num]
```

Optimization

- Random Search
- Differential Evolution

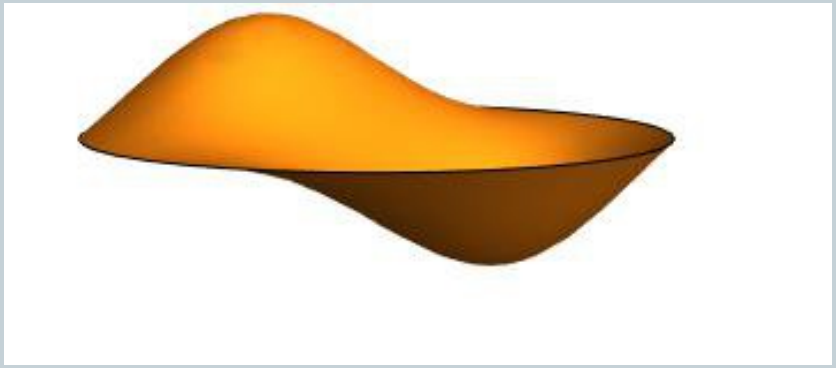
- Nelder Mead
- Simulated Annealing

Results

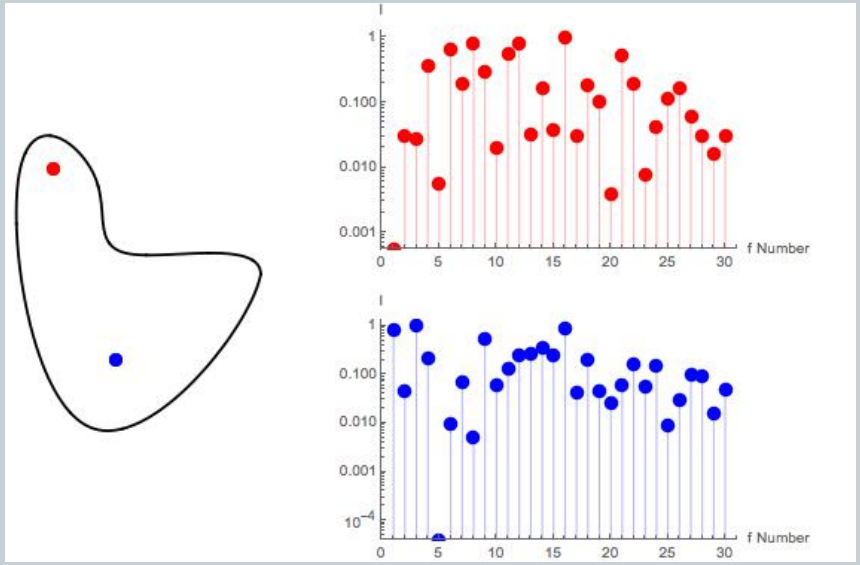


Unforeseen Complications

- Self-Cancellation



- Varying Intensities



Future Directions

- Run better and longer optimization routines
- Better physical testing procedures
- Define lowest audible intensity
- Include self-cancellation and varying intensities in analysis

Thank you