1. Problem statement
Given the transmission spectrum of an optical filter, specifically a fiber Bragg grating, can we use deep learning to predict its essential physical parameters: index modulation, fiber loss, and the DC-AC modulation ratio?

2. Motivation
Optical fibers are used for:
- Worldwide communication
- Internet connectivity
- Strain and pressure sensors
- High power fiber lasers

3. Dataset
- Since this is a fairly niche problem, no publicly available dataset exists
- Thus, the dataset was created in-house
- A well-known MATLAB code, developed on transmission theory, was used to create the transmission spectra
- The data was pre-processed to extract its features before using it as the input to the neural network

4. Examples of data
![Example of data](image)
Parameters:
\[\Delta n = 2.2 \times 10^{-3}\]
\[\text{Loss} = 5.3 \times 10^{-2}\]
\[\alpha = 0.7\]

5. Feature extraction from spectra
The image of the spectrum cannot be used as is due to the enormous resolution (~9 million points/image) it would take to encode the many different peaks in the spectrum.
The six most important features of the transmission spectra were extracted from the figures:
1. Presence of peak (0/1)
2. Peak height \( \propto R(0,1) \)
3. Distance from previous peak \( \propto R(0, \infty) \)
4. Peak width \( \propto R \)
5. Peak prominence \( \propto R(0,1) \)
6. Bandwidth

6. Neural network architecture
![Neural network architecture](image)
Input: \( n_x = 501\)
\( m = 6000\)
Output: \( n_y = 3\)
\( m = 6000\)

7. Results
The network trains weights while optimizing for the mean squared error.
MSE after training for 400 epochs is extremely low: 0.03

For one example in test set:

<table>
<thead>
<tr>
<th>Truth</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta n = 3.23 \times 10^{-3})</td>
<td>(\Delta n = 3.22 \times 10^{-3})</td>
</tr>
<tr>
<td>Loss = 0.21</td>
<td>Loss = 0.16</td>
</tr>
<tr>
<td>(\alpha = 0.57)</td>
<td>(\alpha = 0.57)</td>
</tr>
</tbody>
</table>

![Graph showing comparison between truth and predicted results](image)
The predicted spectra matches extremely well with the ground truth. Mission successful!