Optimization of Optical Structures Using Machine Learning Algorithms
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Introduction
• In optical engineering, it is important to be able to design devices with a desired reflection spectrum
• Such designs are nontrivial and often rely on complex optimization algorithms
• We explore the use of machine learning algorithms to control the reflection spectrum of a multi-layer structure
• We show that Markov Decision Process produces structures with desired spectra

Background
• Multi-layer structure
  • Refractive indices: \{n_1, ..., n_K\}
  • Layer lengths: \{d_1, ..., d_K\}

Markov Decision Process
• Objective:
  • Given: \(r_{\text{target}} (\lambda_i)\)
  • Find: \([n_i, d_i]\) to minimize
  \[ f([n_i, d_i]) \equiv \| r_{\text{target}} - r_{\text{struc}} ([n_i, d_i]) \|^2 \]
• Definitions and Procedure
  • \(K\) = number of layers
  • \(W\) = number of points sampled in wavelengths
  • \(Q\) = number of points sampled in reflection
  • State: discretized reflection spectrum

Objective function
\[ J_{n, d} = \| r_{\text{target}} - r_{\text{struc}} \|^2 \]

MDP Results

MDP: ~\(KQ^2W\)

Brute force: ~\((\text{Resolution})^{2K}\)

Advantages
• Computation complexity: # of spectra calculated
• Immune to local minima

Performance with increase in the number of layers

On average, 23.4% of points fall around the global minimum

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