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Deep Learning Enabled Nanophotonic Design via Finite Element Simulation

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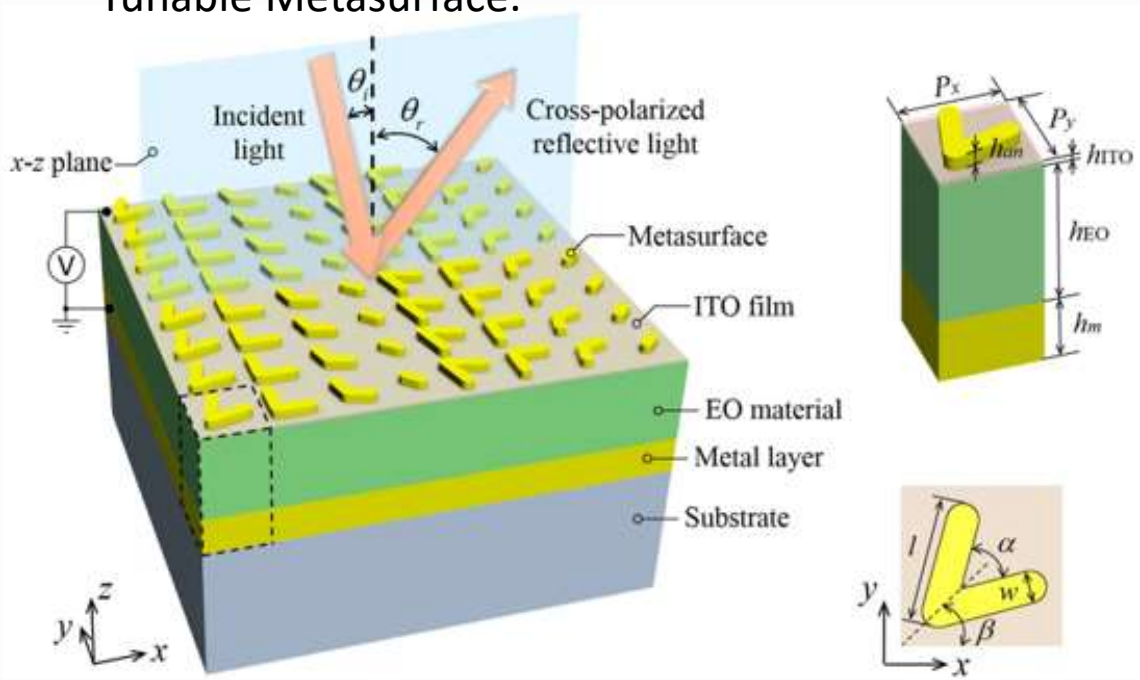
Outline

- Motivation.
  - -Metamaterials and Metasurfaces.
  - -Finite Element Approach, Data-Driven Approach .
- Machine Learning Models.
  - -Deep Neural Networks(DNNs) .
  - -Generative Adversarial Networks(GANs).
- Simulation and Results.
- Conclusions.

Metamaterials and Metasurfaces

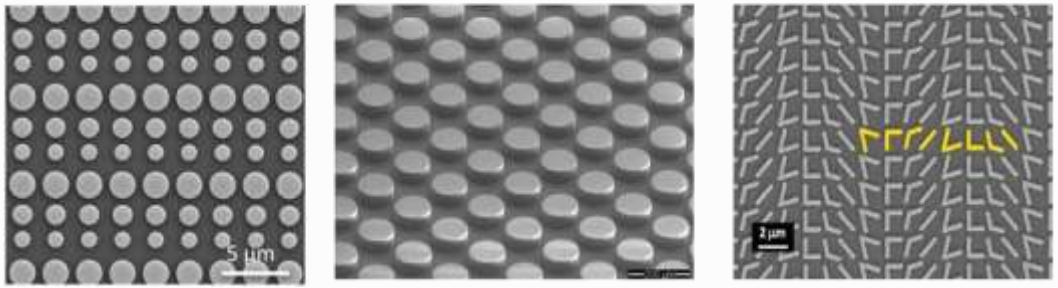
- Tunable Metasurface.



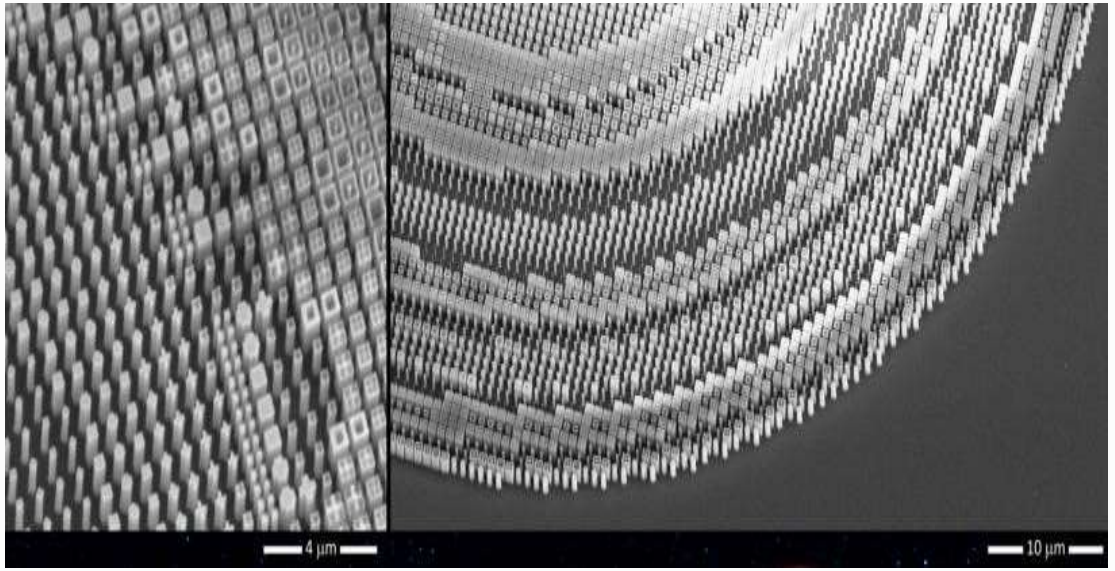
Jingjing Guo, Scientific **REPORTS** | 7: *14078*

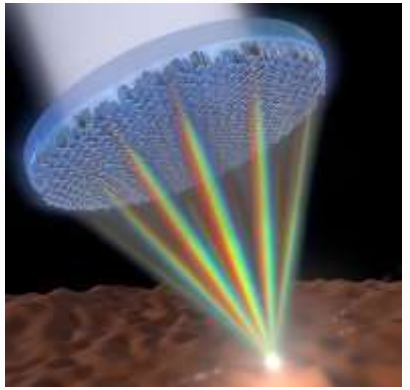
Tapashree Roy et al.2017 ,Acsnano

N. Yu et al. (2011)



- Meta-Lens.

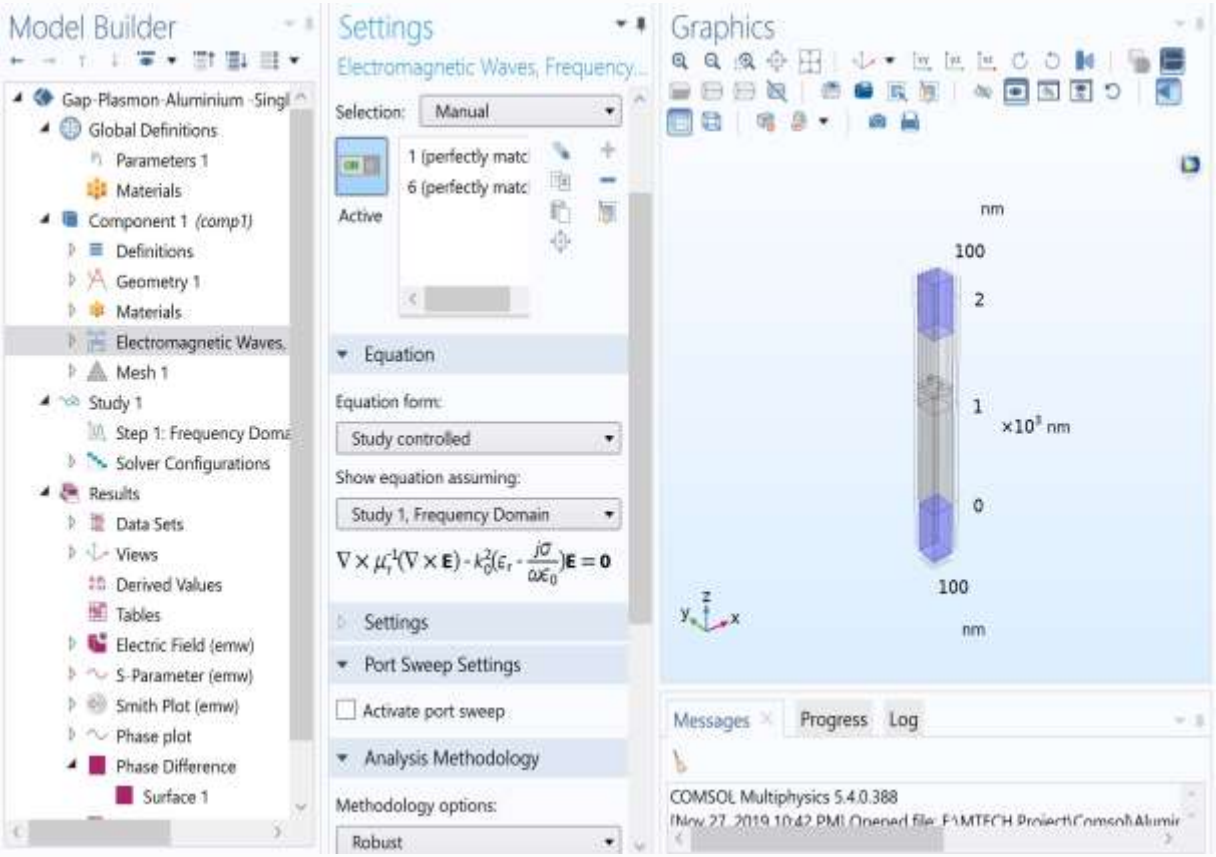




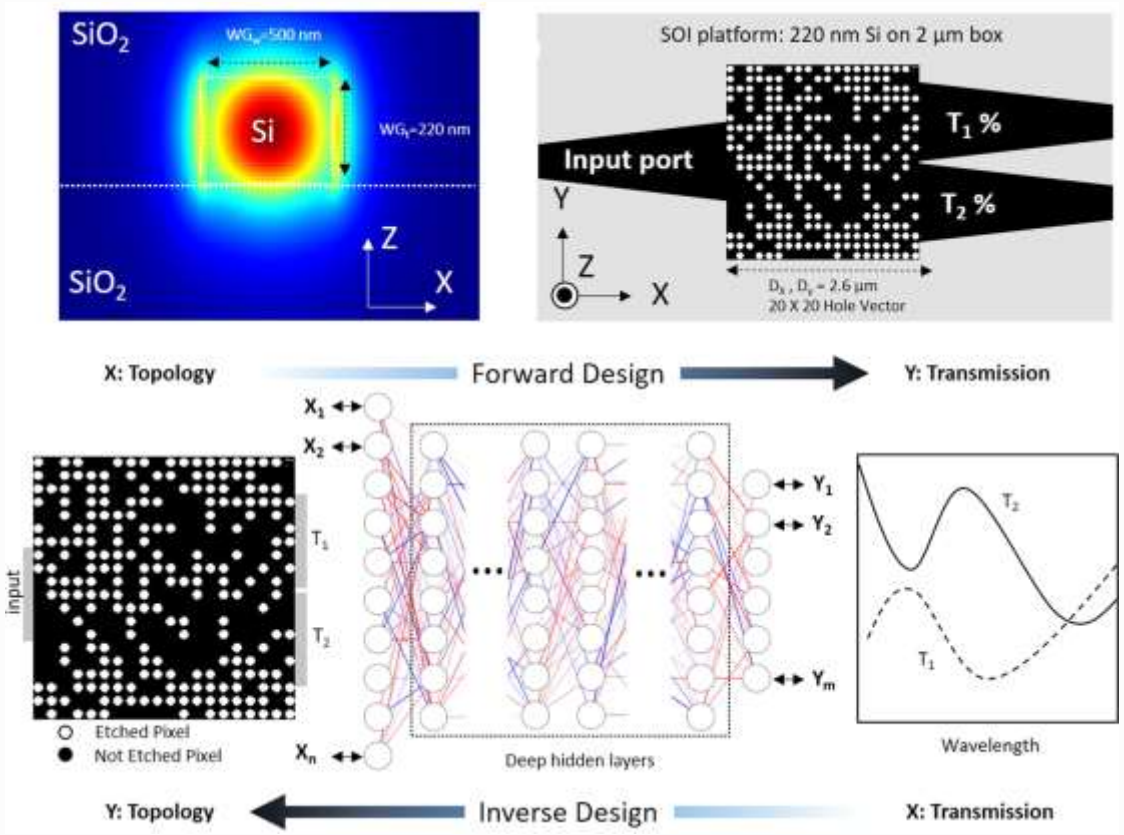
Sajan Shrestha,
Light: Science & Applications, **volume 7**, Article number: 85 (2018)

Why Machine Learning?

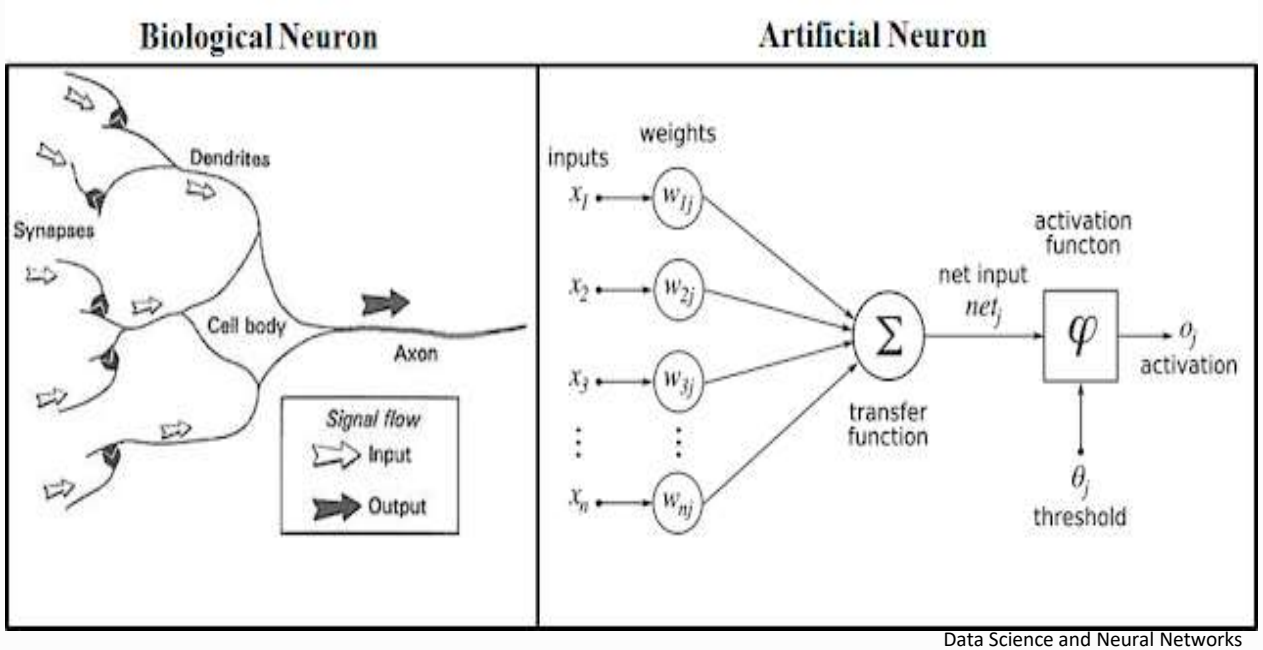
- Conventional Approach.



- Data-driven Approach.

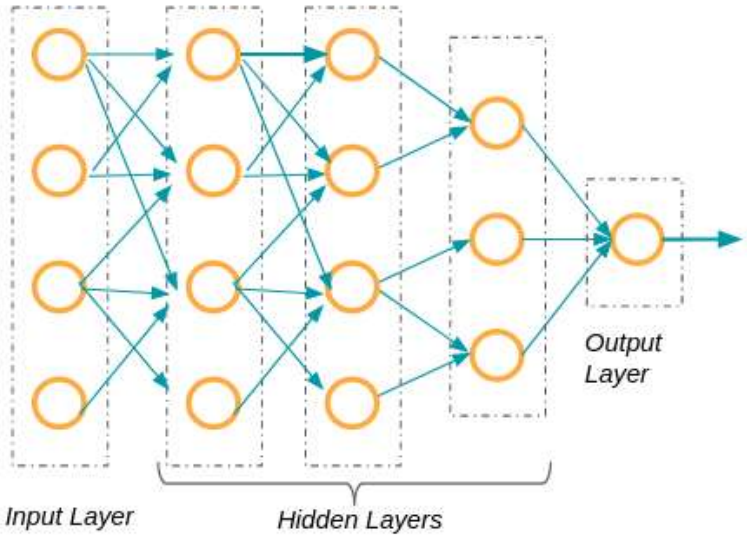


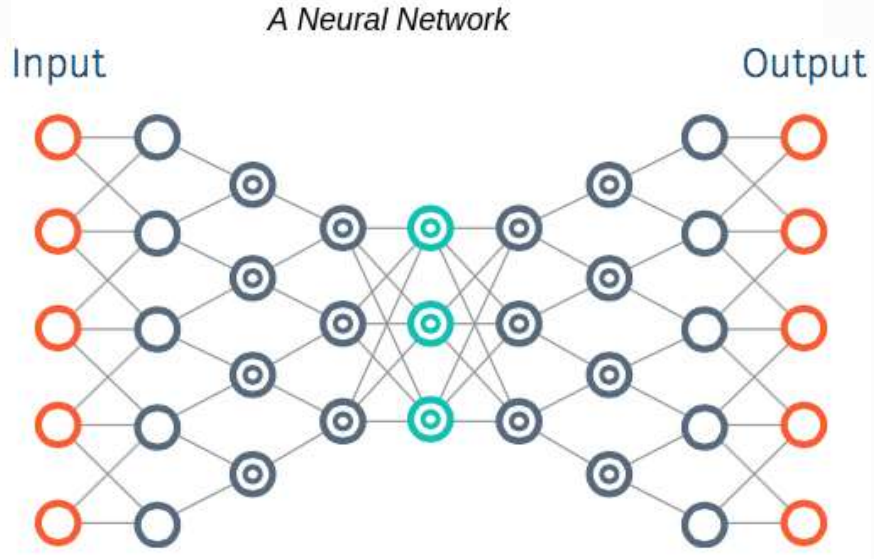
Machine learning Models



Data Science and Neural Networks

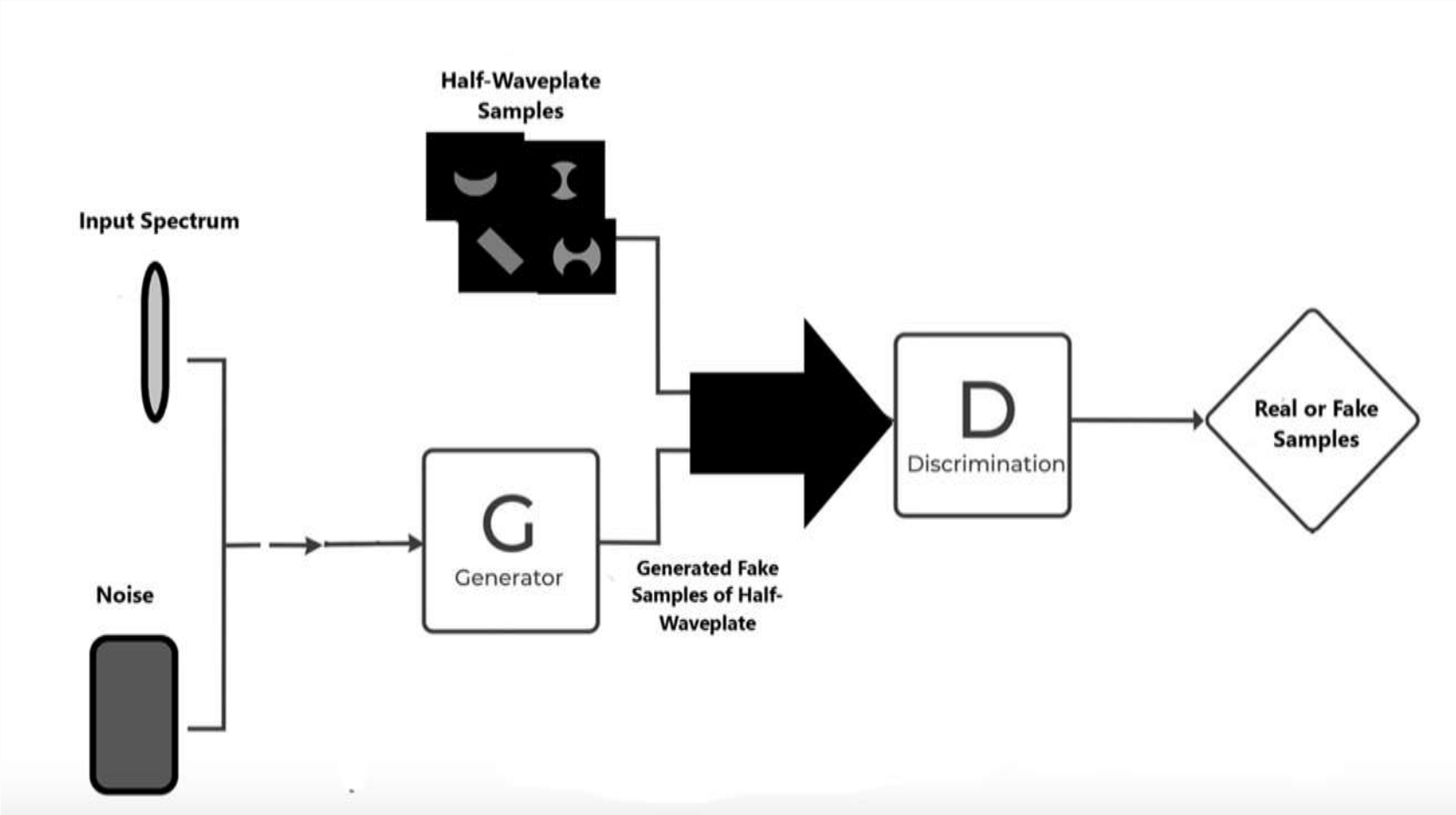
Deep Neural Networks



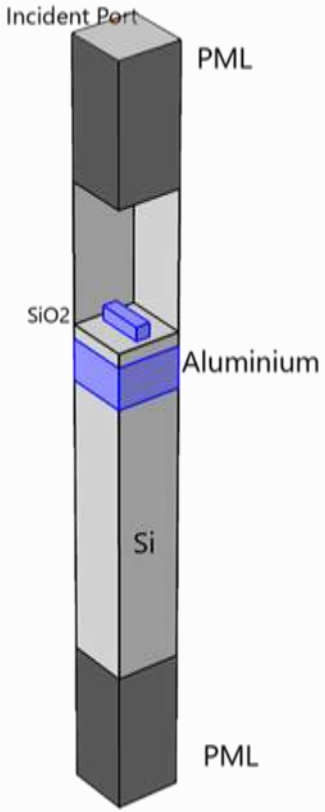


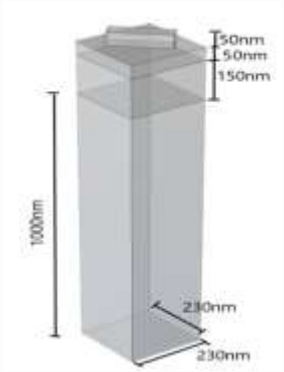
Community home, AI

- Conditional- Generative Adversarial Network

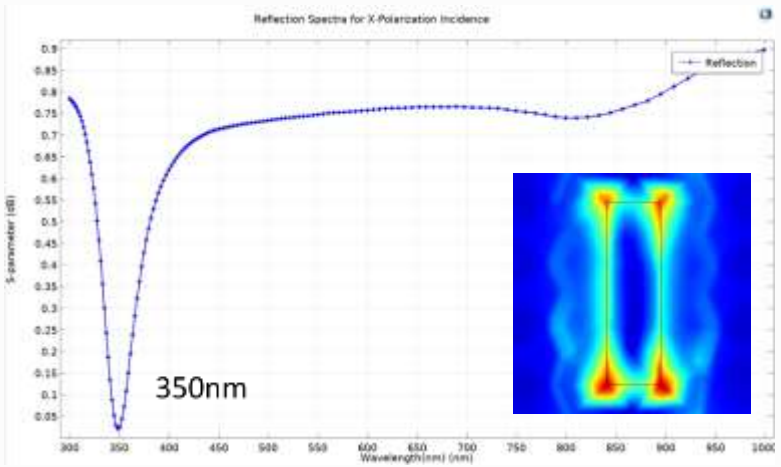


Modelling State of Polarization

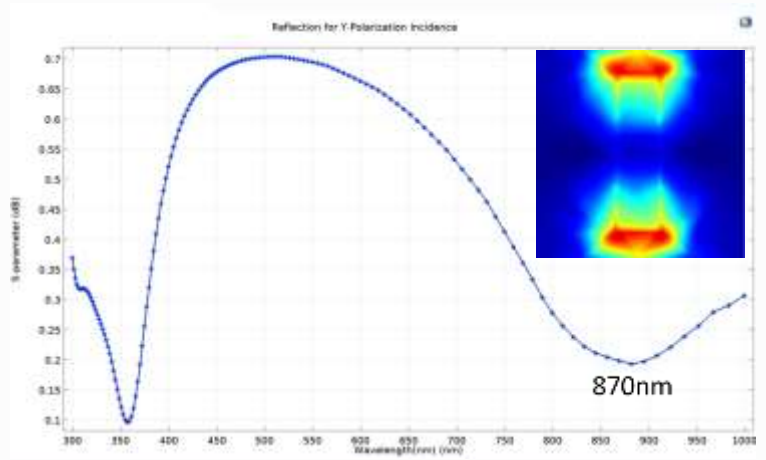




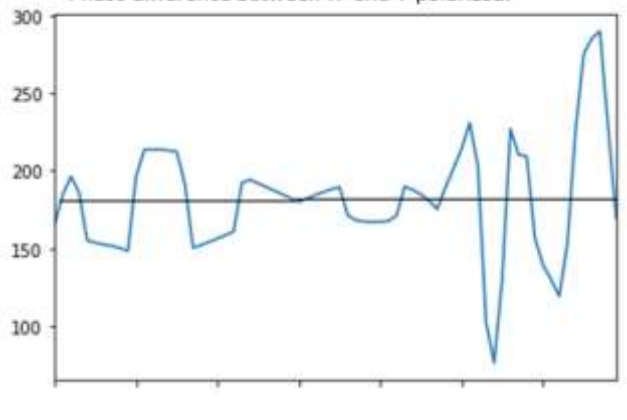
X-Polarization Incidence.

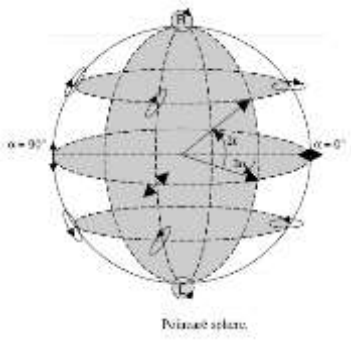


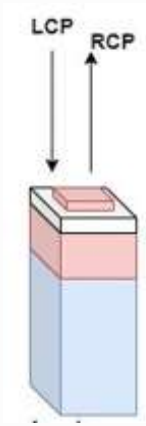
Y-Polarization Incidence.



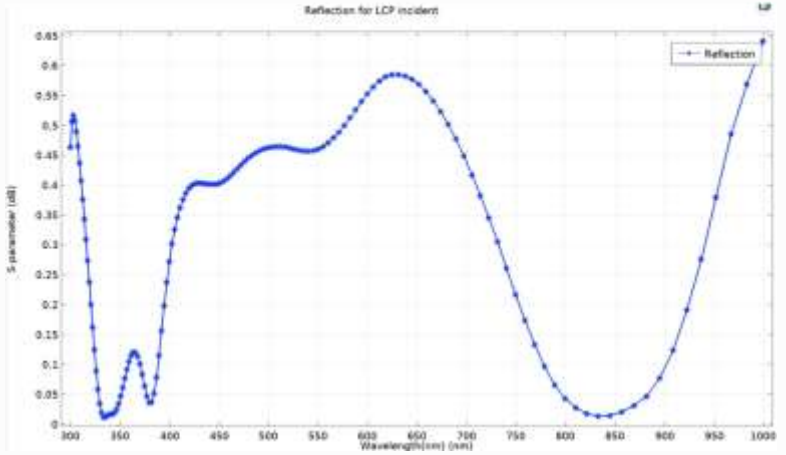
Phase difference between X- and Y-polarized.





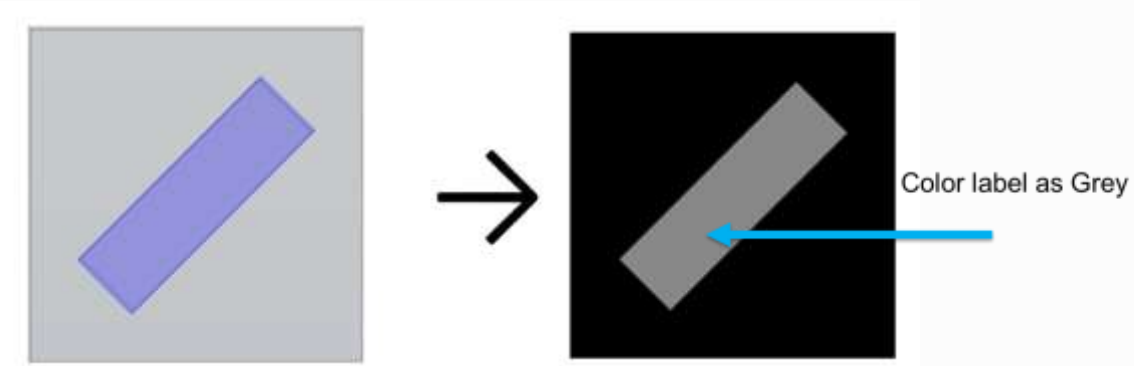


LCP to RCP conversion.



Can we achieve more efficiency?

Dataset Preparation.



Image

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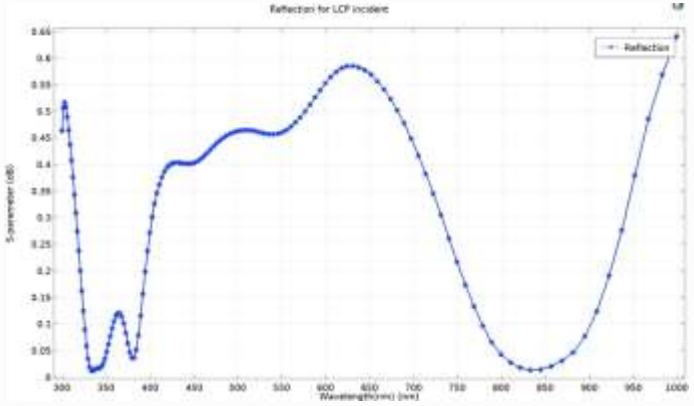
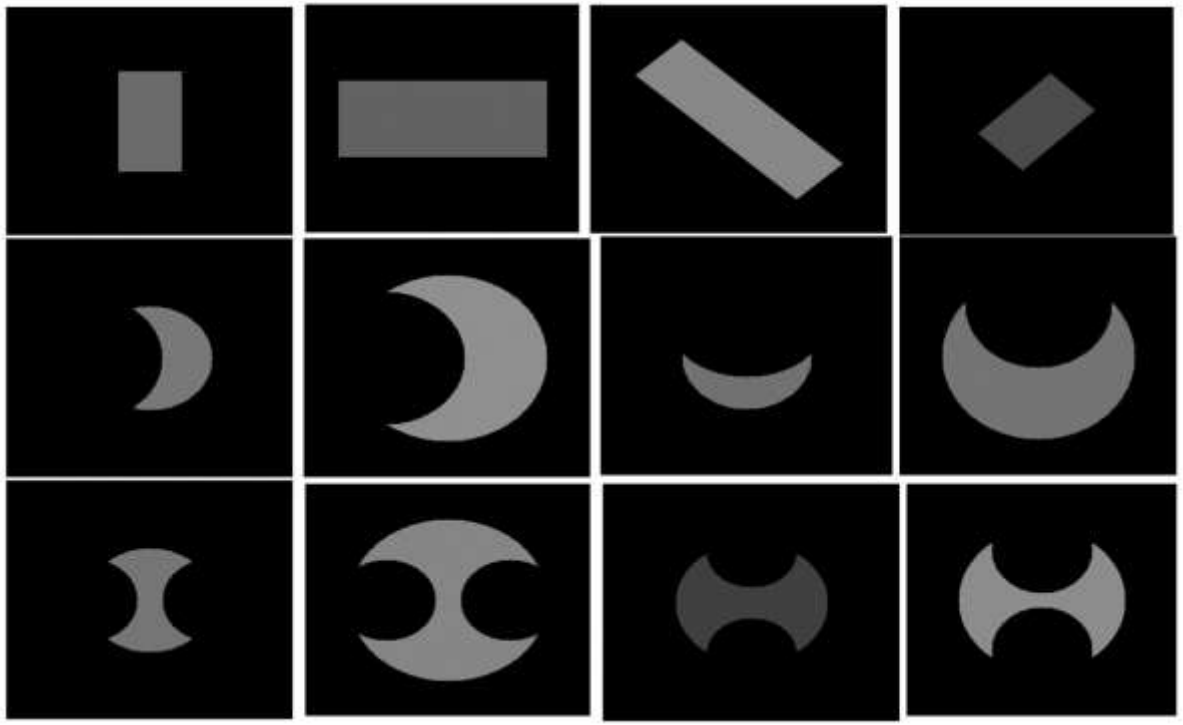


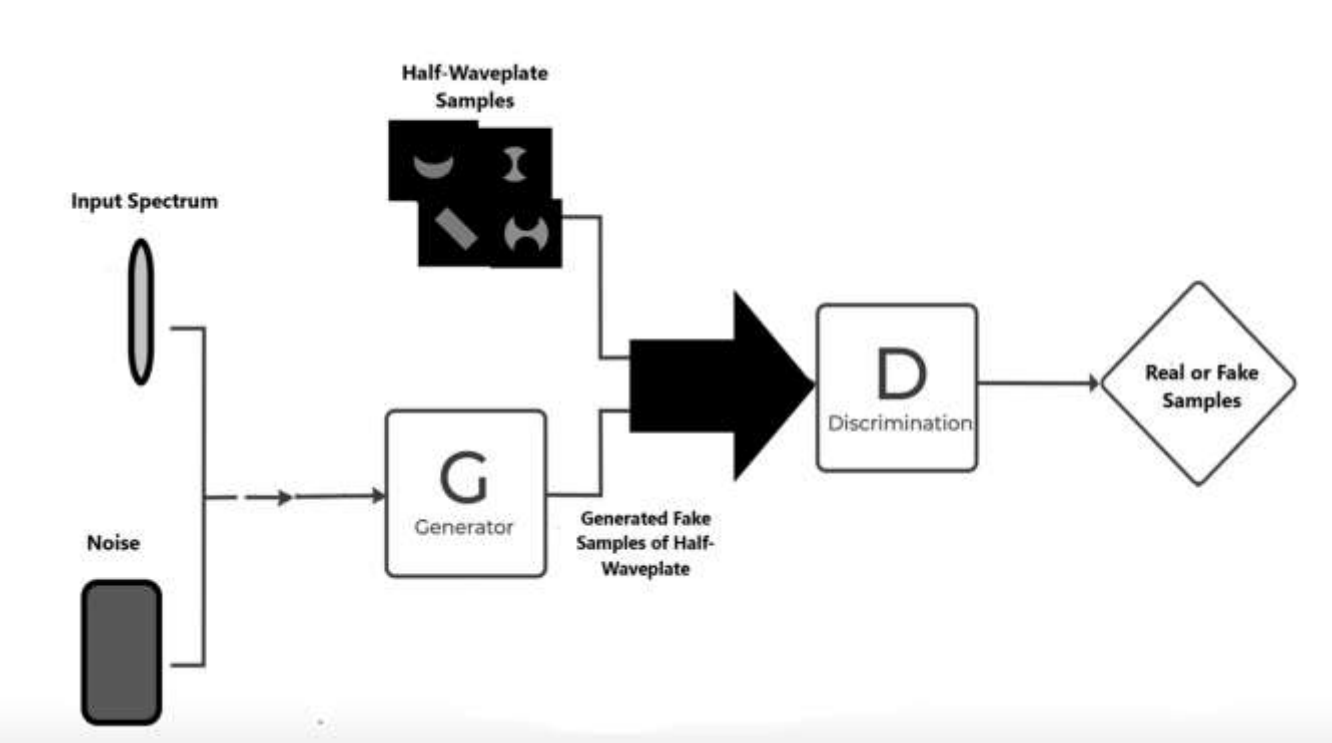
100-points vector spectrum

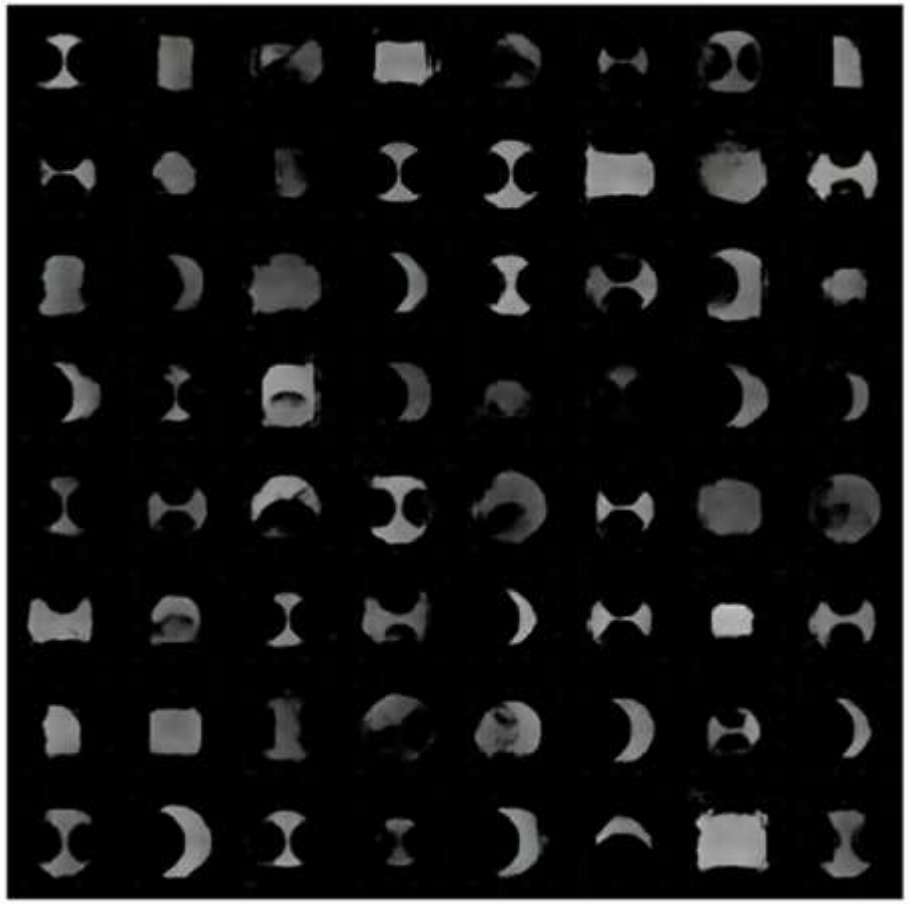
Half-waveplate Design Samples



- 1000 Half-waveplate simulations using Livelink for MATLAB with random generation algorithm.

Training of Deep Learning Model





Conclusion:

- High-quality training device data using the combination of iterative optimizers and accurate electromagnetic solvers i.e. Finite Element Simulations using Comsol.
- Machine Learning models can learn correlations between device topology and it’s electromagnetic response.
- A data-driven design and characterization process for nanophotonic devices.
- Complex designs with multiple structural parameters could be learned using machine learning models.

thank you