IDEAL Integrated DEsign Automation Laboratory

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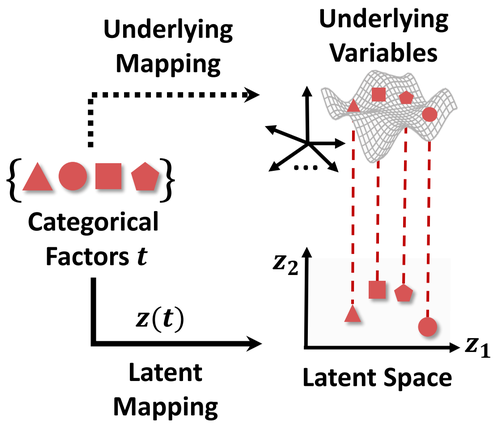
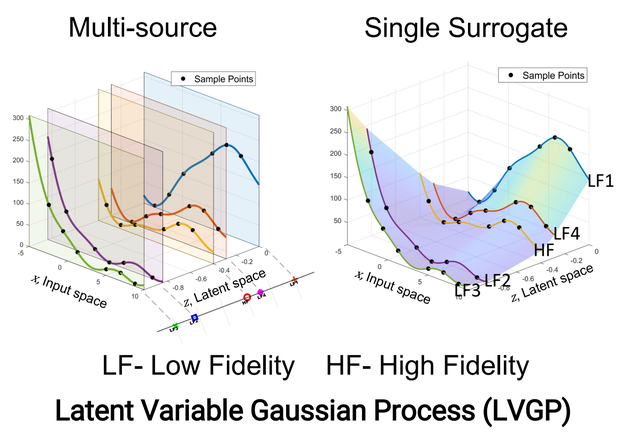
Research Mission

Develop computational and statistical techniques for engineering design, manufacturing and product realization

Mixed-Variable and Multi-Modal Data Fusion



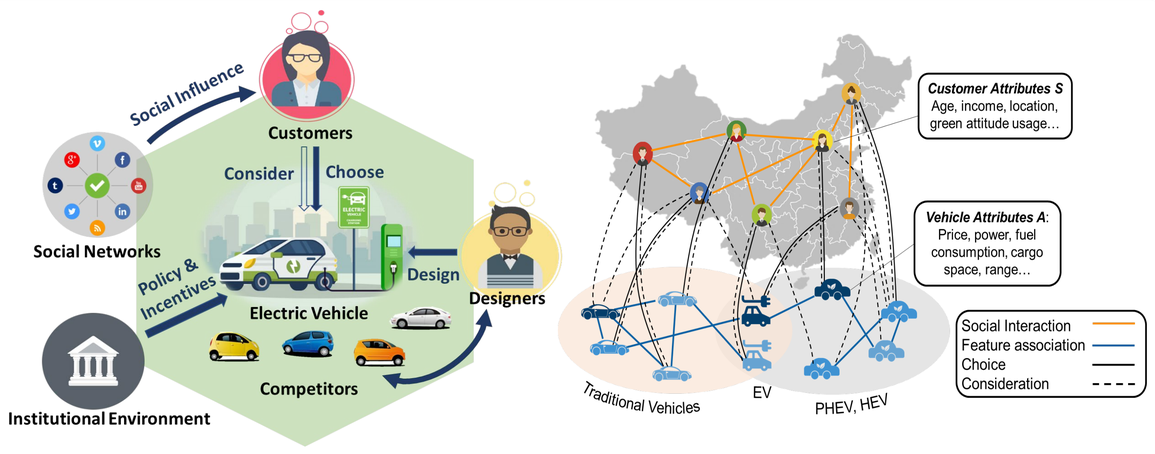


LF- Low Fidelity HF- High Fidelity

Latent Variable Gaussian Process (LVGP)

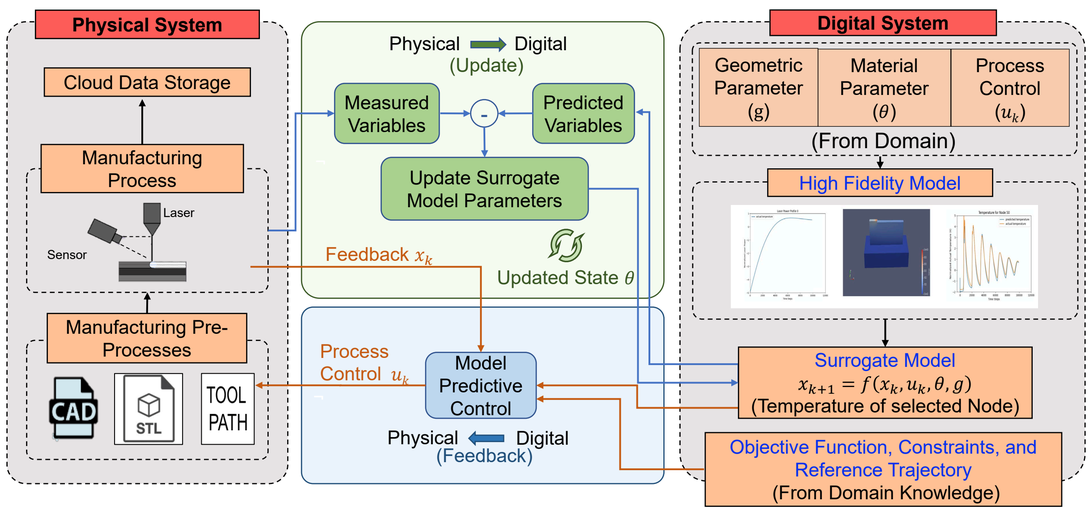
Learn correlations between various model fidelities or data modalities for uncertainty aware adaptive learning.

Modeling of Customer-Product Network



Understand the dynamics of product and customer interactions within a complex design ecosystem using network modeling.

Digital Twins with Uncertainty Quantification for Autonomous Manufacturing



Aleatoric Uncertainty	Epistemic Uncertainty	Unknown of the Unknowns
• Material, manufacturing, and environmental variability • Sensor noise • Mitigated by reducing data redundancy and robust design	• Numerical uncertainty • Model uncertainty • Machine learning uncertainty • Mitigated by adaptive sampling and continuous model refinement.	• Uncertainty sources that we are not even aware. • Mitigated by real time model predictive control (MPC)

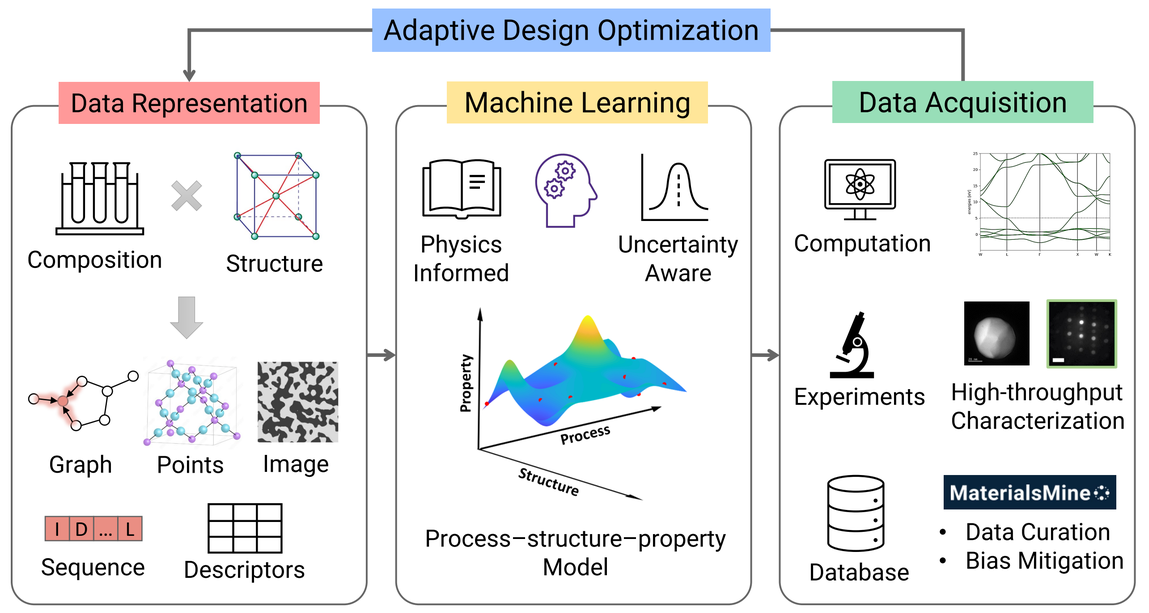
Achieve concurrent geometry, material, and process design using digital twins with “real time” uncertainty quantification and mitigation.

Representative Projects

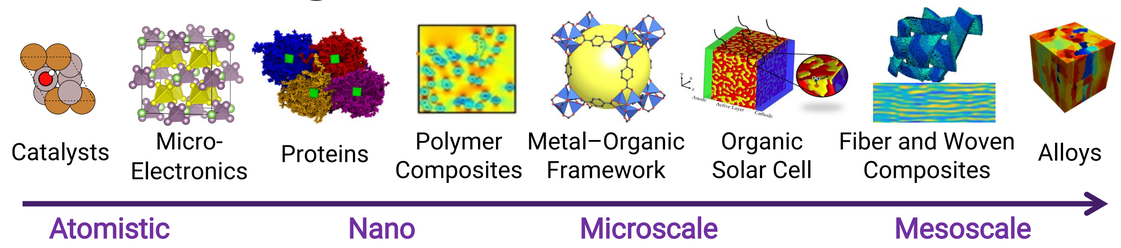
- NSF-BRITE : AI-Enabled Discovery and Design of Programmable Material Systems
- NSF-FMSG: Learning Foundation Models for Manufacturing Design Automation
- NSF ERC: Hybrid Autonomous Manufacturing, Moving Evolution to Revolution
- ARL: The Center on High-throughput Materials Discovery for Extremes (HT-MAX)
- DOE-ReMADE: Development of Instruments and Techniques that Can Assess Tire Life and Increase Remanufacturing of Commercial Vehicle Tires

AI for Materials Discovery and Design

Machine Learning Enhanced Design Framework



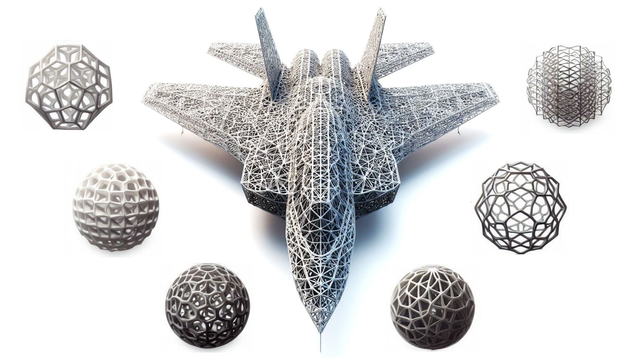
Design of Advanced Materials



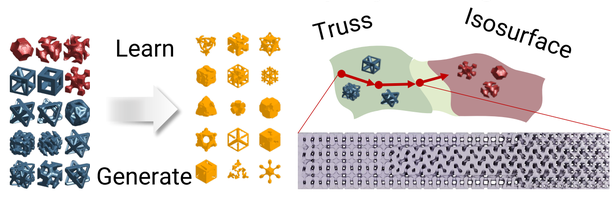
Integrate physics + data for AI-enabled discovery and design of advanced materials across multiple scales.

Design of Functional Materials and Structures

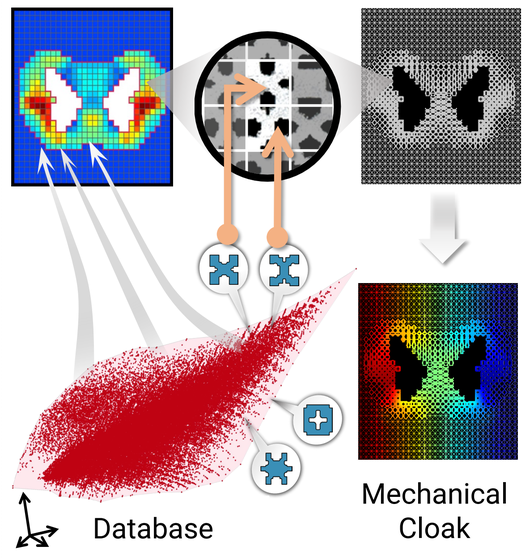
Data-Driven Heterogeneous Metamaterials Design



Metamaterials as Property Building Blocks

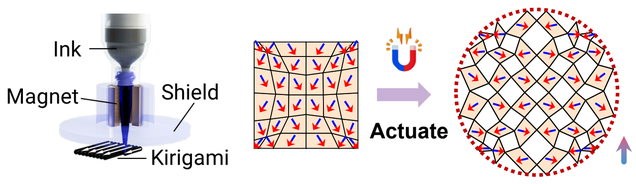


Generative Metamaterials Design

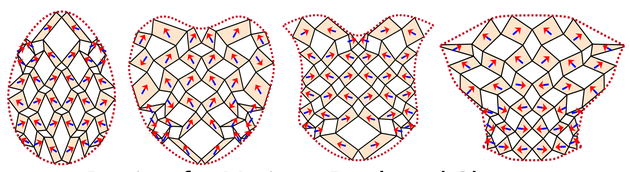


Multiscale Topology Optimization

Design of Programmable Materials Systems

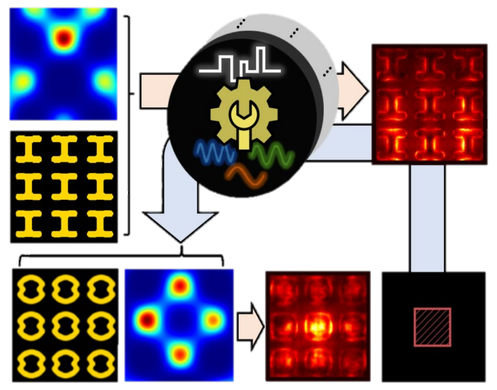


Kirigami with Magnetic-Responsive Deployment



Design for Various Deployed Shapes

Differentiable Design of Magnetic Kirigami



Neural Operator Enabled Concurrent Design of Optical Metamaterials

Establish a novel Acquire-Learn-Generate-Optimize (ALGO) framework for co-design of materials, architectures and stimuli.