Deep Geometric Learning for Engineering Design

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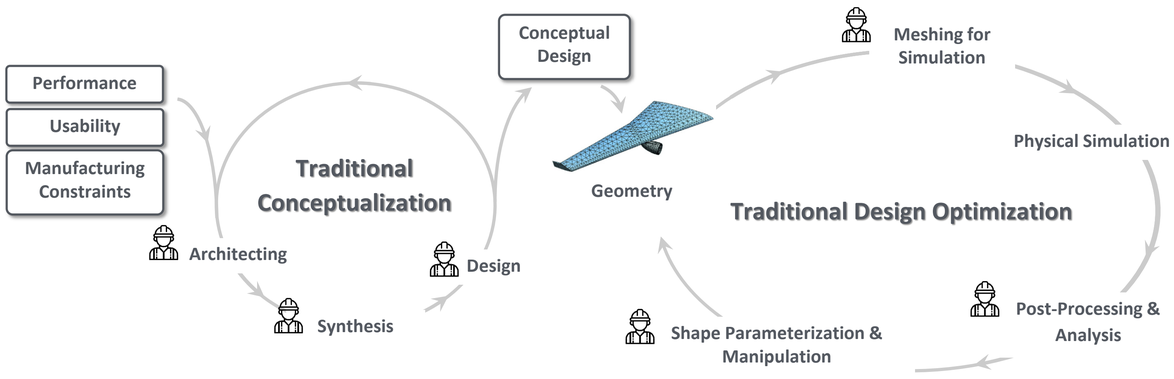
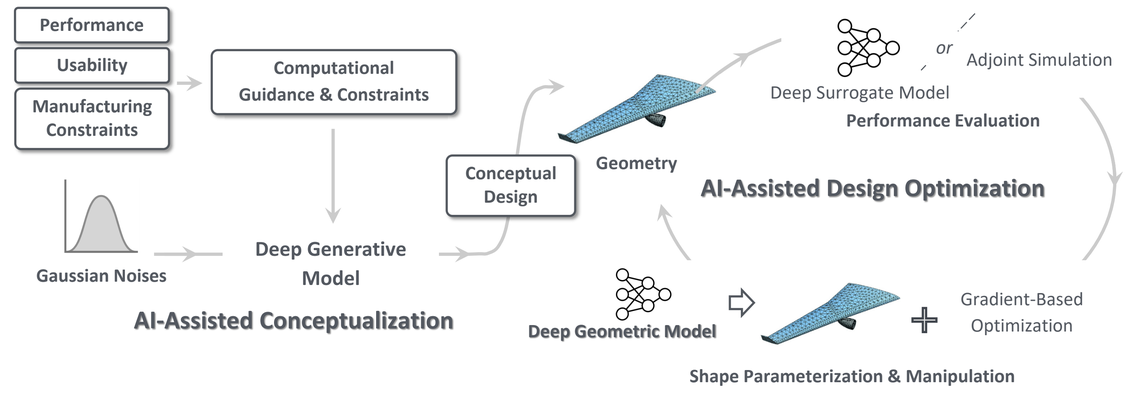
AI's Role in Engineering Design: Conceptualization and Design Optimization





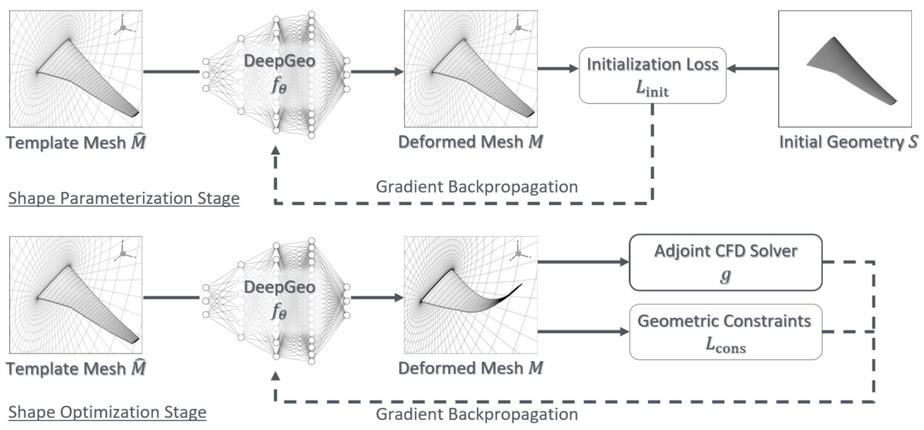
Traditional Engineering Design:

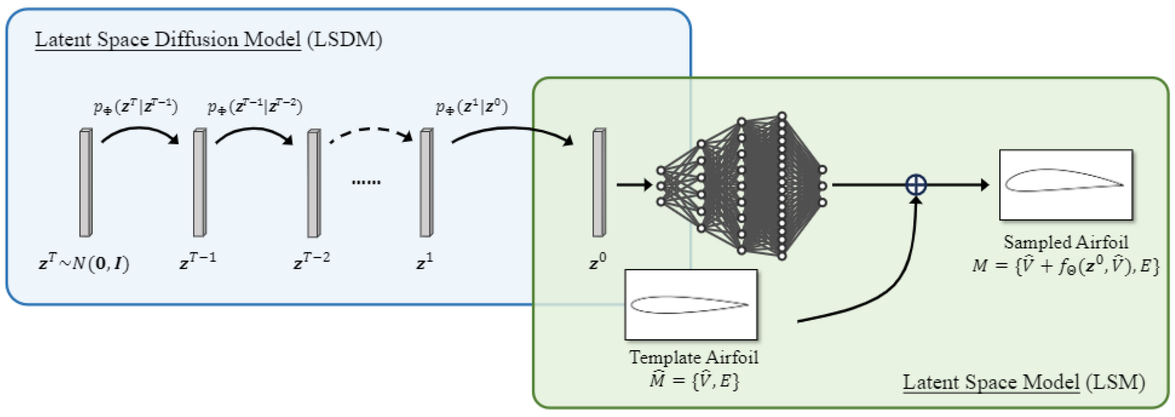
- Labor-intensive;
- Interdisciplinary expertise required;
- Unaffordable for resource-limited groups (e.g., startups).

AI-Assisted Engineering Design:

- High automation level;
- Accelerated design lifecycle;
- Lower R&D cost and broader technical accessibility.

Deep Geometric Models:





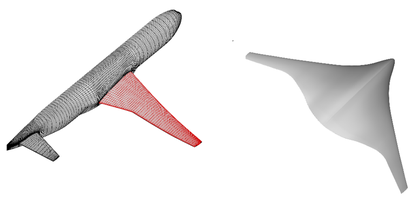
Automatic Shape Parameterization: DeepGeo

- AIAA Aviation Forum (2024);
- AIAA Aviation Forum Best Student Paper Award;
- AIAA 2024 Best Multidisciplinary Design Optimization Paper.

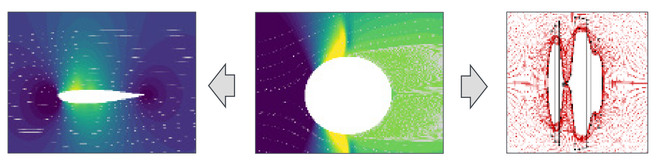
Latent-Space Diffusion Model: DiffAirfoil

- AIAA Journal (2023);
- AIAA Aviation Forum (2023 & 2024).

Highlights of Deep Geometric Models



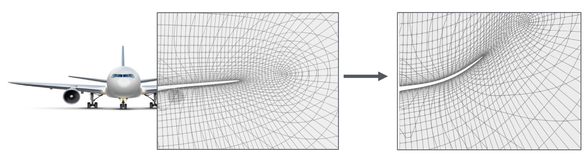
Automatically adaptive and tunning-free.



design optimization with DeepGeo

design optimization with FFD

Facilitate large deformation while ensuring surface smoothness.

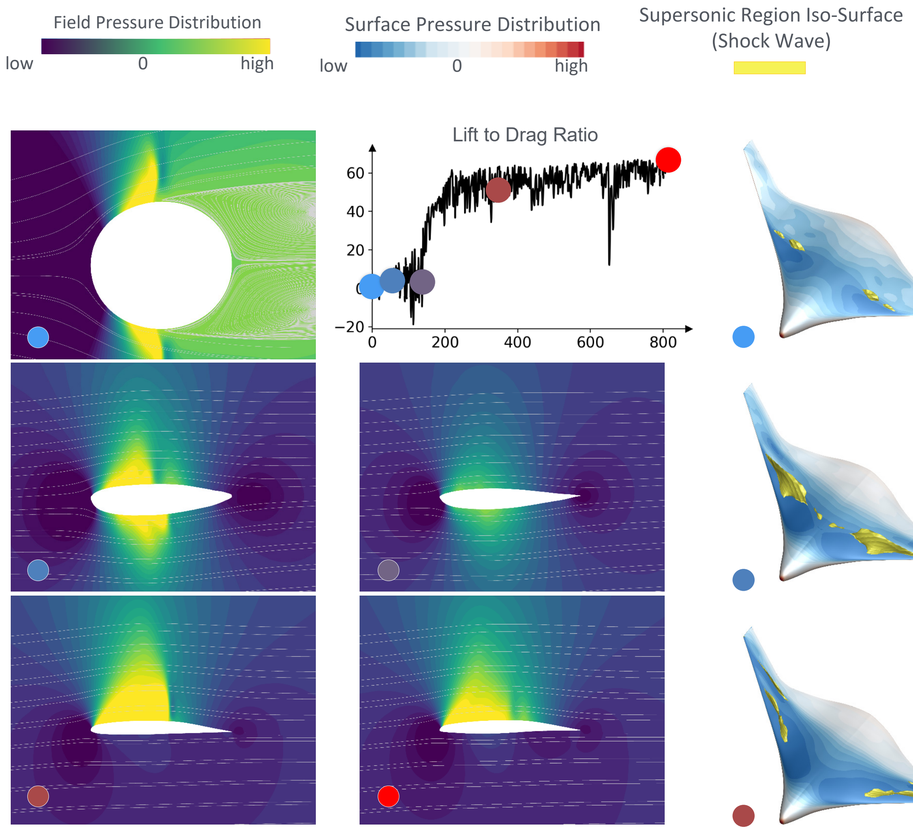


Parameterize and generate both surface and simulation mesh.

Use no/minimal training data.

Applications in Engineering Design:

Aerodynamic Shape Optimization with DeepGeo:

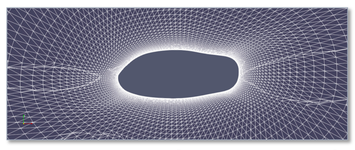


Optimization of a 2D circle.

Optimization of the Blended-Wing-Body Aircraft.

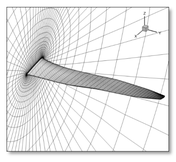
Simulation Meshing with DeepGeo:

Boxfish Model.
© Muséum de Toulouse



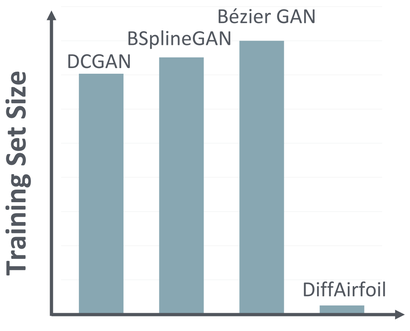
Structured CFD Mesh on Boxfish.

Albatross Photo.
© Wikipedia

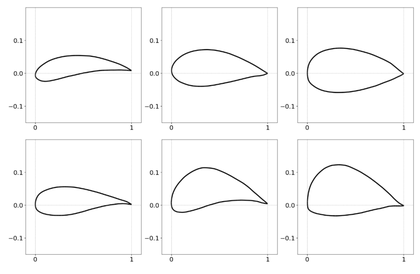


CFD Mesh on Albatross's Wing.

Design Space Exploration with DiffAirfoil:



Data Efficiency Comparison with SOTAs.



Generated Novel Airfoils.