Graduate Student Research Seminar

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Using Deep Reinforcement Learning for Engineering Design: Topology Optimization

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Improvements in computational capabilities and better availability of big data have allowed machine learning techniques to be more readily used in engineering design. Machine learning can extract patterns in design-relevant data to detect trends or make predictions that may not be inherently visible to a human designer. However, most machine learning-based engineering design tools rely on supervised learning, which requires the prefabrication of design domain data that may be challenging to derive or inherently biased by a human designer. This presentation investigates the implementation of reinforcement learning, a unique subset of machine learning that learns through accumulating past experiences in an interactive environment, into the engineering design problem of topology optimization. A reinforcement learning environment was formatted to allow a deep reinforcement learning agent to design 2D elementally discretized topologies based on a multi-objective reward function. After proper training, the agent was tested using progressive refinement on a variety of common load cases to validate the design capabilities and generalization of the agent. The agent's proposed designs were comparable to those of a traditional gradient-based topology optimization solver. For most load cases, including some the agent had not experienced during training, the objective performance of the reinforcement learning topologies was superior to the gradient-based solver. These results show that a deep reinforcement learning agent can learn generalized design strategies to satisfy multi-objective design tasks. The proposed strategy should be investigated in other engineering design domains to validate the capabilities of using a reinforcement learning agent as a high-level design tool to improve the capabilities of the engineering design process.

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