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Mixed-initiative engineering design: How AI can support design decisions

Product innovation is a multi-step process: a creative phase where ideas are born, an evaluation phase where the ideas are evaluated, and an implementation phase where these ideas become tangible. While computer-based assistance systems are already available for the latter two phases, creativity is often still considered an exclusively human attribute. However, recent advances in artificial intelligence (AI) have challenged this notion, as creative AI agents are increasingly integrated into our daily lives and have demonstrated their potential to create original content (e.g., ChatGPT, DALL-E, MuseNet, DeepDream). In light of these advances, a new field of research has emerged in the area of AI-enabled design processes, leading to a more-than-human design process in which a computer agent collaborates with a design team to efficiently and creatively explore the entire design space in search of novel design solutions.

To this end, we will demonstrate new technologies, such as how Variational Autoencoders (VAE) can be used to learn low-dimensional, yet feature-rich shape representations. This approach promises significant improvements in both performance and variety of shapes that can be learned. The resulting geometric representation is then incorporated into a shape optimization framework. In addition, we explore the potential of reinforcement learning (RL) as an optimization strategy. RL is based on the trial-and-error interaction of an agent with its environment. As such, RL can be characterized as experience-driven, autonomous learning. While not necessarily superior to classical optimization algorithms (such as gradient-based approaches) for a single optimization problem, based on the existing literature, we expect RL techniques to thrive when recurrent optimization tasks arise.

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