INSTITUTIONEN FÖR DATAVETENSKAP | LUNDS TEKNISKA HÖGSKOLA | PRESENTERAD 2023-06-02

MASTER THESIS Exploration of Alternative Image Representation Using Signed Distance Functions
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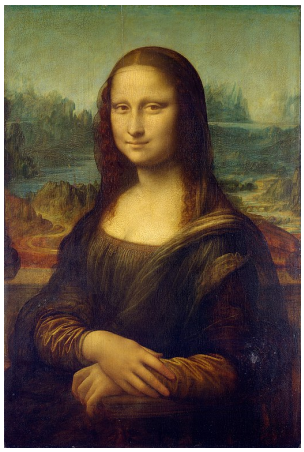
Reconstructing raster images with a set of geometric primitives

POPULAR SCIENCE SUMMARY **Jakub Olejnik**

This project leverages the core concepts of differentiable rendering to find alternative representation of images using geometric primitives rendered with Signed Distance Functions. By utilising machine learning it is possible to find optimal parameters of rendered primitives to create high-quality reconstructions.

Exploration of different representations of data structures allow programmers to find solutions that introduce a new level of abstraction, optimise time and space complexity, conserve required memory, or tailor structures to specific needs. This is especially vital in the field of computer graphics, where rendering performance needs to be high, while maintaining low memory consumption, and allow for efficient processing of complex graphical data. With this idea in mind, we undertake the challenge of finding an alternative representation of digital images, which play a central role in various applications such as video games, image processing, and computer-aided design.

In theory, images can be approximated with just a set of geometric primitives, like rectangles, circles or triangles. The hard part is finding the optimal values for their parameters and how they should be combined. For that reason this thesis explores various aspects, including error metrics for measuring image reconstruction accuracy, optimisation algorithms for finding optimal parameters, and the intricate characteristics of Signed Distance Functions. The approach to the reconstruction problem can be described by the following steps: 1. Draw a random primitive of a given shape; 2. Calculate the error compared to the reference image; 3. Minimise the error by altering the parameters of the primitive; 4. Repeat until the error is sufficiently small. By building a machine learning model and differentiable rendering pipeline we are able to create faithful reconstruction described with just a set of geometric primitives, instead of pixels.



Furthermore, one of the projects exciting possibility is the extensions of the approach beyond the reconstruction of 2D images. Given that Signed Distance Functions can be used for representation of 3D objects, the core concepts of this project can be applied to 3D model reconstruction.