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Joint master program
Artificial Intelligence and Data Science
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Master thesis evaluation

Dear exam committee,

I am pleased to provide an evaluation of the master's thesis titled "Predicting spectral channels related to mineralogy from CRISM spectral bands using deep learning".

The present work focuses on training a model to predict a spectral channel based on an RGB+NIR channel image. The specific application is in the field of planetology, particularly the prediction of satellite-based observation data of the Martian surface. Here, hyperspectral data is important to identify minerals in the geological composition. However most satelite data is missing important channels, hence there is a desire to supplement or deduce these missing features. There is already existing research on this approach, particularly Stepcenkov (2022), where an image from the black-and-white CTX camera was colorized by a neural network that predicted the three color channels. However, Stepcenkov's model was unable to satisfactorily predict the NIR channel. In this study, the prediction of the NIR channels was addressed by employing a new generation of generative models, known as diffusion models.

It is noteworthy that the highly scientific nature of the subject, particularly in spectroscopy and planetology, required the student to acquire expertise in these areas to comprehend the physical relationships involved. The introduction shows that the student grasped the motivation behind the work and clearly formulated the objectives. The structure of the work is logically organized, some parts are shorter than expected.

In the "Literature Review"chapter, the data sources are adequately explained, and the basics of Stable Diffusion are sufficiently covered, supported by various graphics, most of which are from external sources. Despite this, relevant sources were chosen and cited, particularly the prior works and reference publications upon which this work is based.

The methodological section includes various units, particularly the explanation of the classic prediction model from the reference publication. Data preprocessing is also described clearly and understandably. The inclusion of intermediate results is beneficial. Although an alternative data reduction method (PCA) is mentioned, it lacks a more explicit justification, which could be inferred from the

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context. Along with the Ëxperimental Setup"chapter, the technical implementation and modeling are sufficiently clear and traceable.

The results of the individual procedures are presented and explained. From a Data Science and machine learning perspective, relevant metrics were used, typical evaluations were conducted, and the results were assessed accordingly. The agreed-upon goals were achieved and satisfactorily presented. Alternative methods in data preprocessing to improve the models are discussed, and corresponding progress is highlighted, which particularly rounds out the work.

The discussion of the results are plausible from a Data Science perspective, interpreting the results in the context of the goals appropriately. Some further engagement with the subject might have provied ways to improve the models performance. The summary of the work clearly describes the main outcomes. New research approaches and suggestions for improvement are also mentioned, although the work could benefit from better contextualization within the broader research landscape.

In conclusion, the work is well-organized and well written. Images, tables, and graphics were effectively used to enhance understanding. The topic is original, and the work was demanding, presenting the student with various challenges that were well addressed with some support. This led to good results and insights that suggest new research aspects. The strengths of the work lie in the successful implementation and adaptation of the Stable Diffusion platform for the specific application. Weaknesses are found in some presentations and somewhat brief explanations. The developed approaches and methods provide a good insight into the topic of generative AI and serve as a strong introduction to this trending area. Overall, the work is positively evaluated with 2.7 as suggestion for the final grade.

Best regards

Prof. Dr. Elser