Income Estimation: Applying a Transformer Architecture to Socio-Demographic Sequences

Degree programme: Master of Science in Engineering
Specialisation: Data Science
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Financial benefits for individuals with disabilities play a crucial role in any welfare state, ensuring a sustainable livelihood for those affected. This thesis explores the application of a transformer architecture to estimate the income of persons living in Switzerland. The presented work contributes to improving financial support for people in need.

Introduction

To provide adequate assistance in Switzerland, a legal framework has been established to define disability and derive personal pension entitlements. Traditionally, rule-based methods are used to estimate appropriate income compensation, aiming to mitigate major financial disadvantages following life-altering events. However, these approaches are often criticized for being overly simplistic, relying on generic assumptions that fail to capture individual complexity.

Methods

In an effort to improve on current practices, this work investigates a transformer-based approach to learn individual income patterns in Switzerland. Using administrative records from Disability Insurances and survey data from the Federal Statistical Office, machine interpretable socio-demographic sequences were constructed. These sequences aim to address the general assumptions made during evaluation of a person's pension entitlement. By further leveraging the temporally structured data, the model learned wage developments over different work sectors, professions and educational levels.

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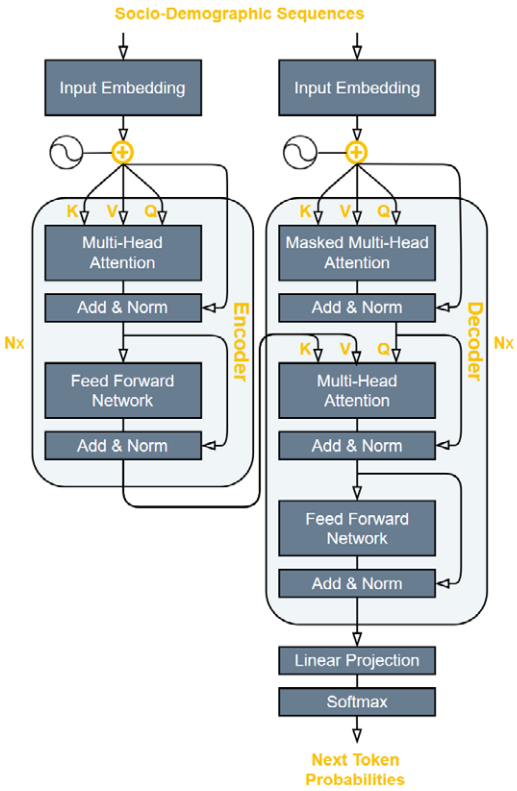
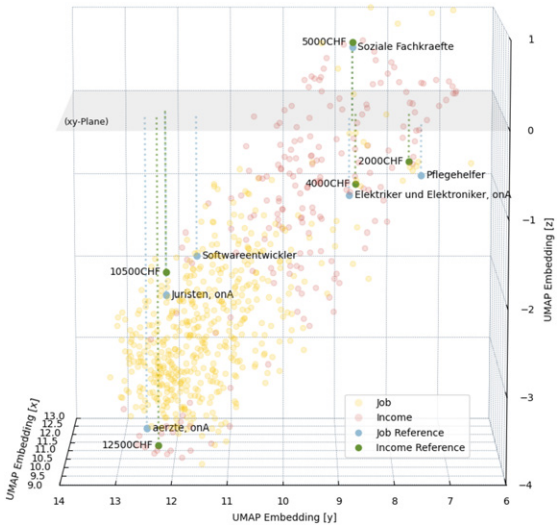
Results

Results have shown that non-linear progressions in the near future could be predicted successfully. By forming interdependent patterns between different variables in the embedding space, the model was able to contextualize changing incomes over time. With prevalence scores of 0.905 (token-level) and 1.0 (feature-level), the model achieved a word error rate (WER) of 0.131 on the test sequences. Comparison of validation (1.135) and test perplexity (1.135) further suggested very good generalization to unseen data. These findings indicate a promising potential for transformers in socio-economic applications.



Vanilla Transformer – Model Architecture



Embeddings Translated Into Three Dimensional Space with UMAP