# Hyperbolic Representations for Hierarchical Learning

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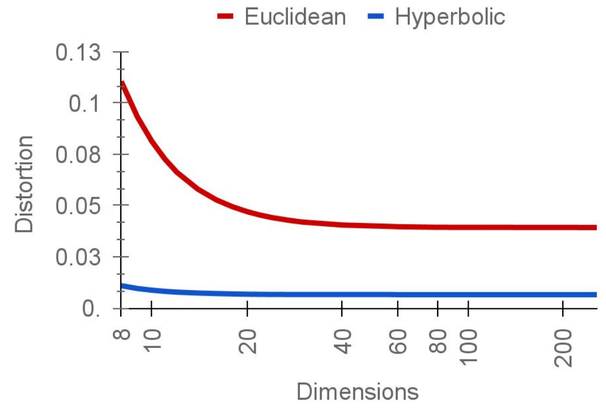
## Introduction

Most of the data we collect from the world around is implicitly structured via latent hierarchical relationships. Consider the example of a fashion catalog. A *cardigan* and a *jacket* are intuitively more closely related than a *cardigan* and a *skirt*. Implicitly, we assume the existence of a parent class, which we may call *upper body garments*, from which *skirt* does not inherit from. Due to their *tree-ness,* hierarchies and hierarchy-bound datasets are amenable to low-dimensional and highly informative representations in hyperbolic space, which may be thought of as a continuous version of a tree.

In this work, carried out within iFetch, we show that, leveraging the taxonomy of a fashion catalog to supervise an hyperbolic classifier improves the top-1 classification accuracy. As a byproduct, we create representations that are faithful to the underlying hierarchy and thus, more interpretable than Euclidean alternatives.

## Results

How much do different representation spaces distort the hierarchy tree? (smaller is better)

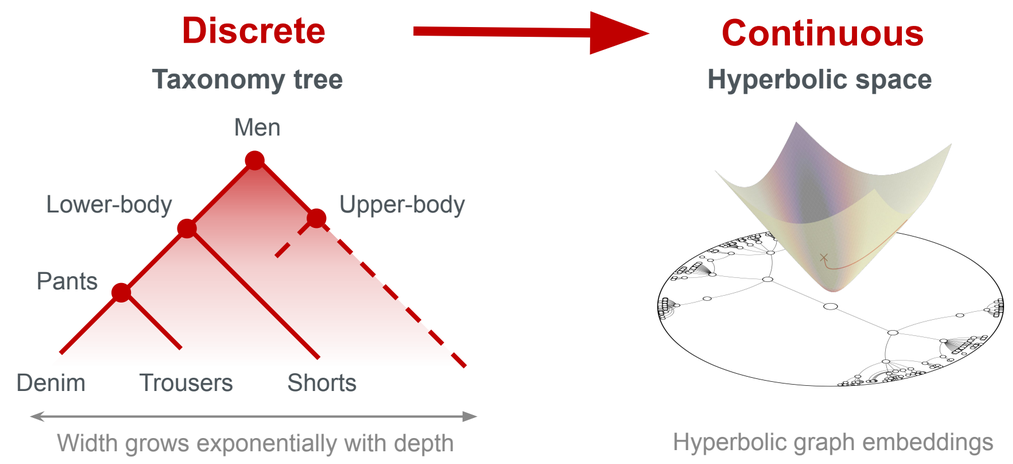



DeepFashion dataset (in shop item classification)

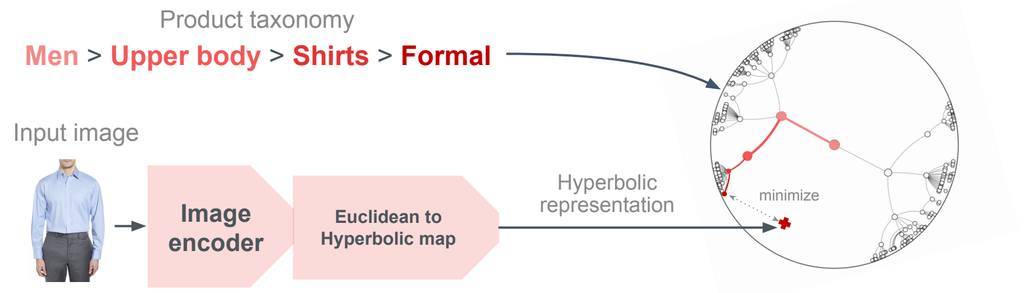
| | Test accuracy (%) |
|---|---|
| Pre-trained CLIP ViT-B/32 | 71.7 |
| Fine-tuned 128d Resnet-50 | 72.3 |
| **128d Hyperbolic classifier** | **79.3** |

## Model

**1)** The taxonomy is embedded in hyperbolic space




**2)** The taxonomy embeddings supervise the encoder




**Representation space - 2D UMAP projections**


## Conclusions

- Hyperbolic space - representation of datasets and thus, product catalogs, that is **faithful to the underlying data hierarchy.**
- Underlying data structure may be captured with **less dimensions**.
- On-going research on hyperbolic representations for fashion product **classification** and **retrieval**.

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