Technische Universität Berlin

Inverse Multidimensional Scaling:
Assessing Dimensional benefits though an Interactive Interface for iMDS in three dimensions

Noah Kogge | Bachelor Thesis | 28.11.2025

1. Introduction

1.1 Background and Motivation

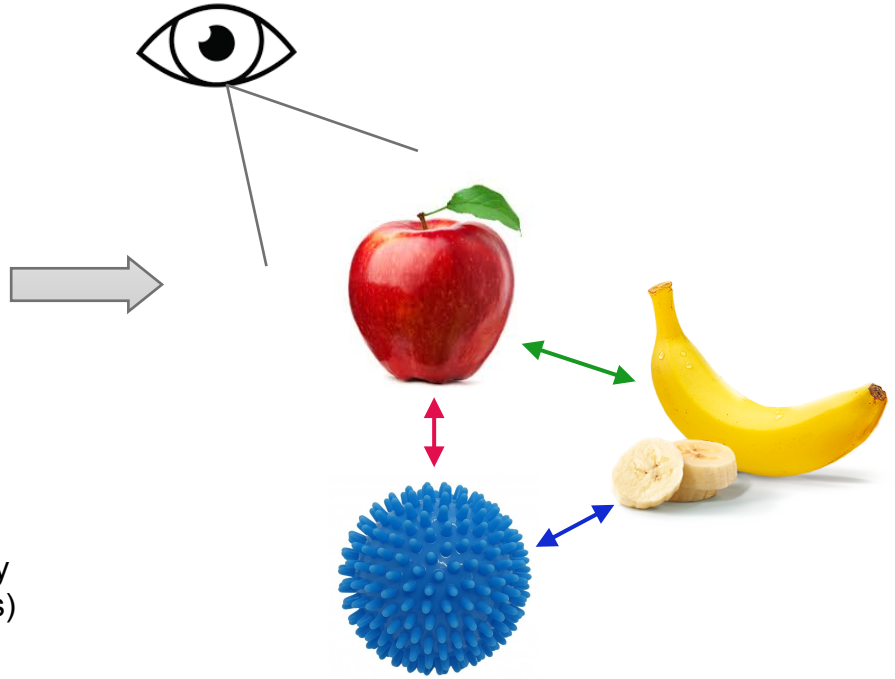
Background

Human Object Perception

Encodes in multiple **perceptual attributes**
(e.g. **Color**, **Size**, **Shape**)

How to study, how **humans encode**
and **represent** given **attributes ?**

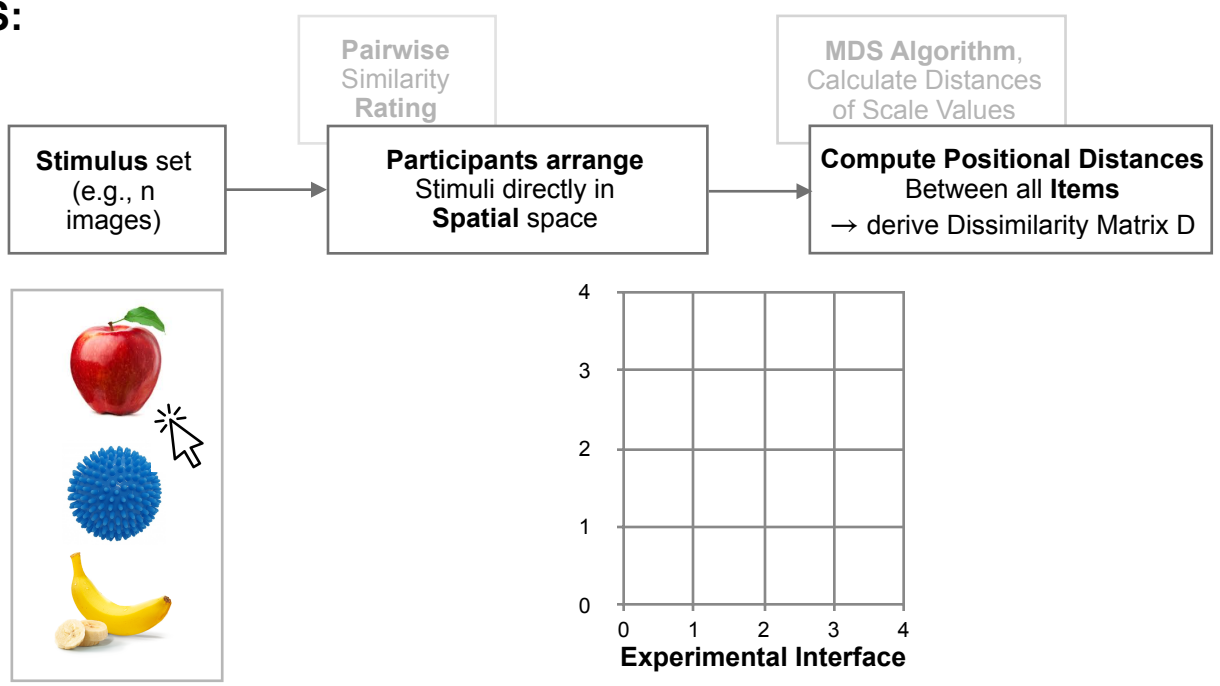
Investigate **multiple methods** that rely on similarity
Judgments (e.g. triplet-based, spatial arrangements)



1. Introduction

1.2 Spatial Arrangement Task

Inverse MDS:

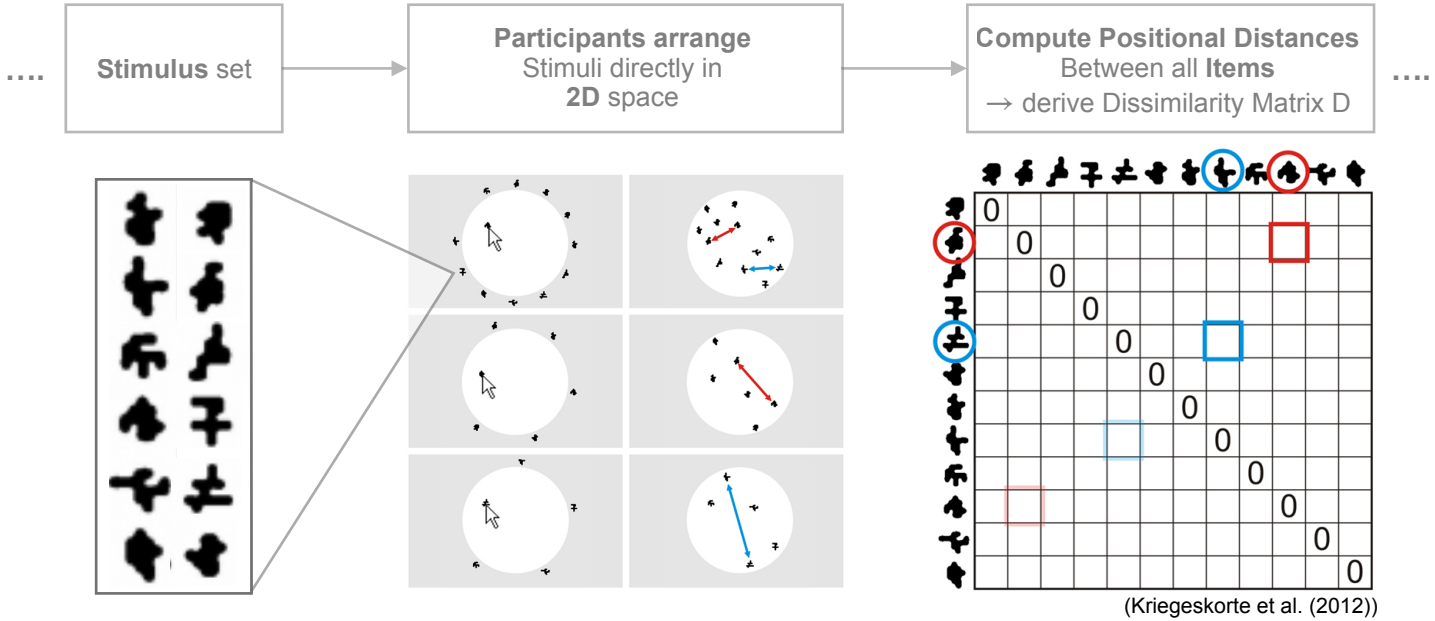


(SpAM; Hout, Goldinger & Ferguson, 2013)

Technische Universität Berlin

1. Introduction

1.2 Spatial Arrangement Task (Example)



(Kriegeskorte et al. (2012))

⇒ 2D Interface restrictions cause ambiguity in distance judgements

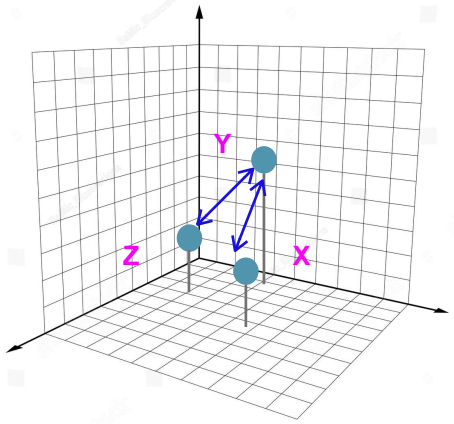
⇒ Projection in 2D spaces force Participants to make perceptual compromises

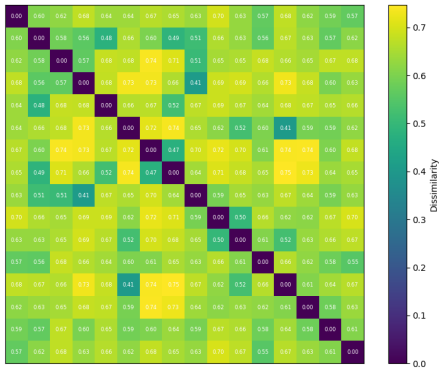
1. Introduction

1.3 Present Work (3D iMDS)

I Introduce 3D spatial arrangement task:

.... **Participants freely arrange** Stimuli in 3D space, utilizing **2D grids** → **Compute Positional Distances** Between all **Items** → derive Dissimilarity Matrix D ....





(Dissimilarity Heatmap)

Technische Universität Berlin

1. Introduction

1.3 Present Work (3D iMDS)

Research Question:

How do perceptual similarity structures vary across 2D and 3D spatial arrangement tasks ?

2. Hypotheses

Main Hypotheses:

H1:

⇒ Allowing **Participants** to **freely arrange** Stimuli in three dimensions, **(without** predefined **constraints)**

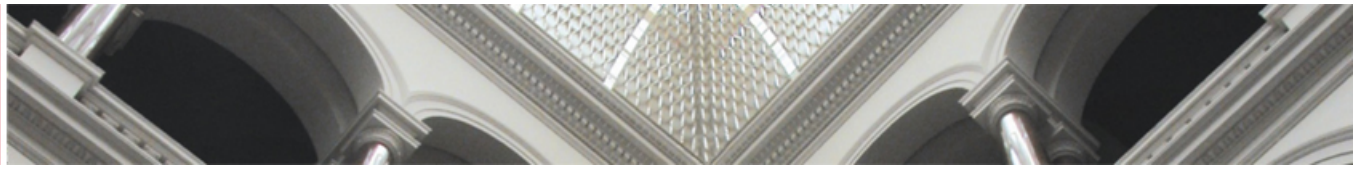
→ leading to more accurate and consistent representation of perceived dissimilarities in comparison to 2D iMDS

H2:

⇒ **Data** obtained form tasks with **richer dimensionality** possess **more** output **variability**

→ leading to more stable, convergent, and interpretable reconstructions across participants.

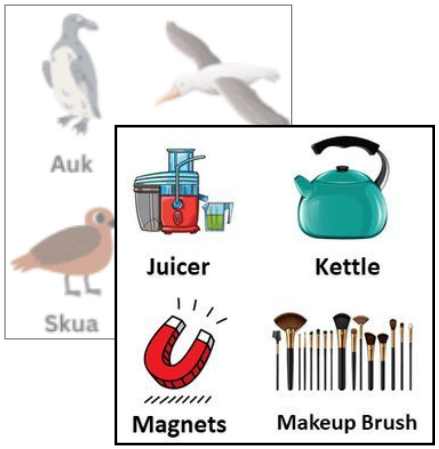
→ Pre-generated feature models serve as a baseline “ground truth” for cross-comparison against participant-generated dissimilarity data, supporting H2.



3. Methods

3.1 Experimental Setup

~ 3-6 Participants



~ 15-20 Stimuli

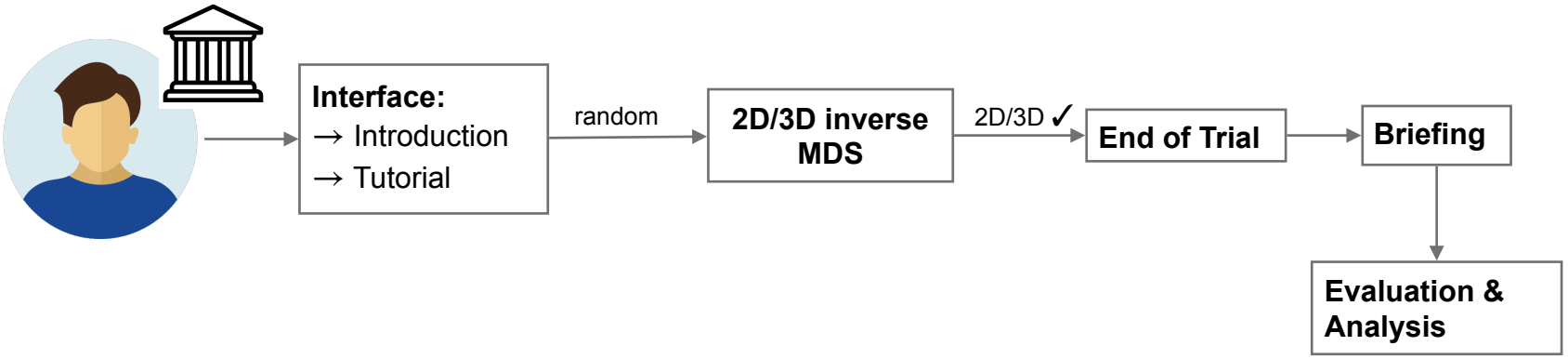
MacBook Pro M3

Stimuli must differ in perceptual dimensions to ensure unbiased similarity judgments

3. Methods

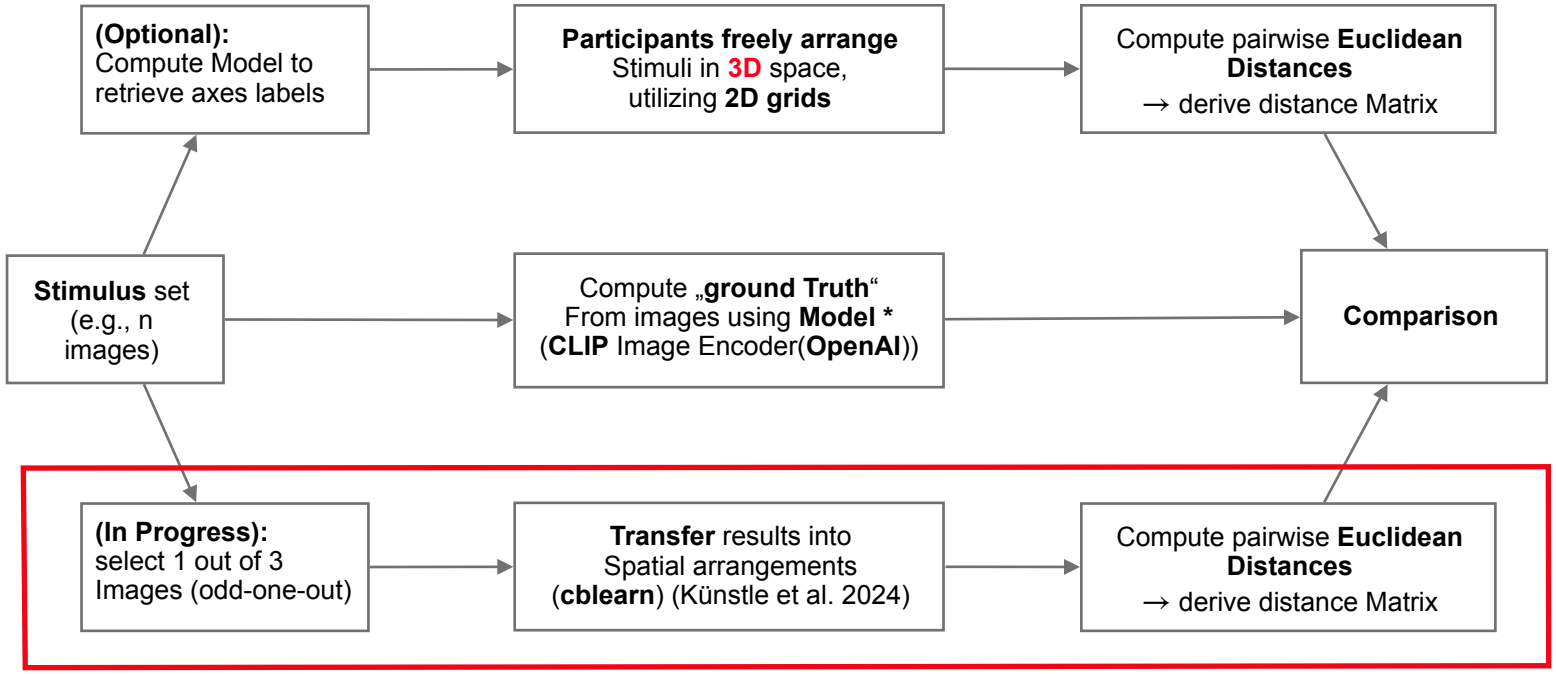
3.2 Experimental Design

Workflow:



3. Methods

3.3 Analysis



(Subject to change)

* Feature models enable **objective comparison**, because 2D/3D iMDS placements have **no true ground truth**—each participant interprets the stimuli differently.

4. Expected Results

H1:

⇒ Allowing **Participants** to **freely arrange** Stimuli in three dimensions, leading to more accurate and consistent representation of perceived dissimilarities

…

⇒ 3D iMDS yields **balanced variance** across axes, **clearer cluster separation, higher correlations**, **lower stress** values.

H2:

⇒ **Data** obtained form tasks with **richer dimensionality** possess **more** output **variability**

…

⇒ **3D** derived **datasets** yield **richer** / more **distinguishable** feature **variation.** More **stable** reconstructions across participants and **higher** more **Intersubject Consistency**