– Seminar –
Cognitive Reasoning Seminar

Midterm Meeting

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November 19th, 2019

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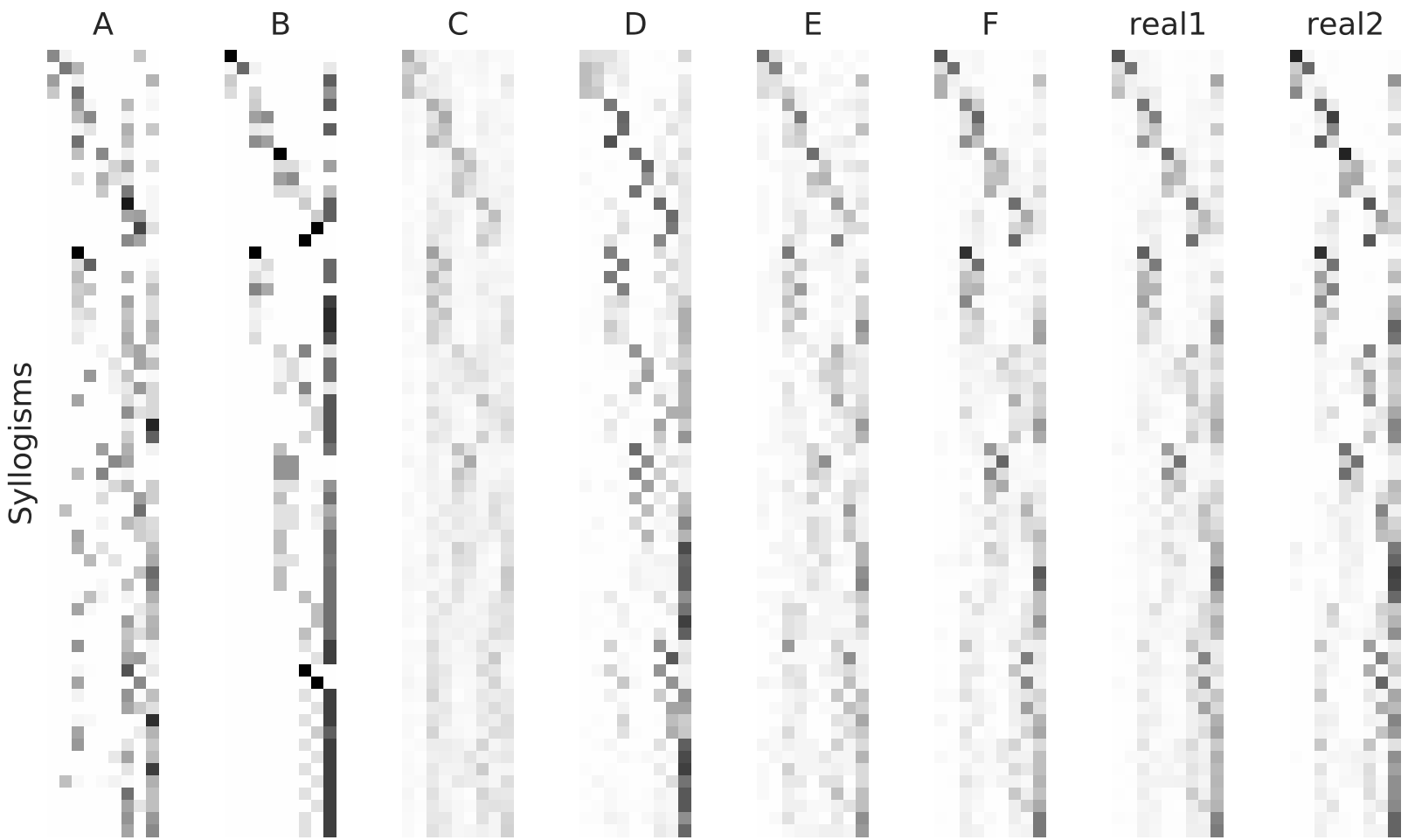
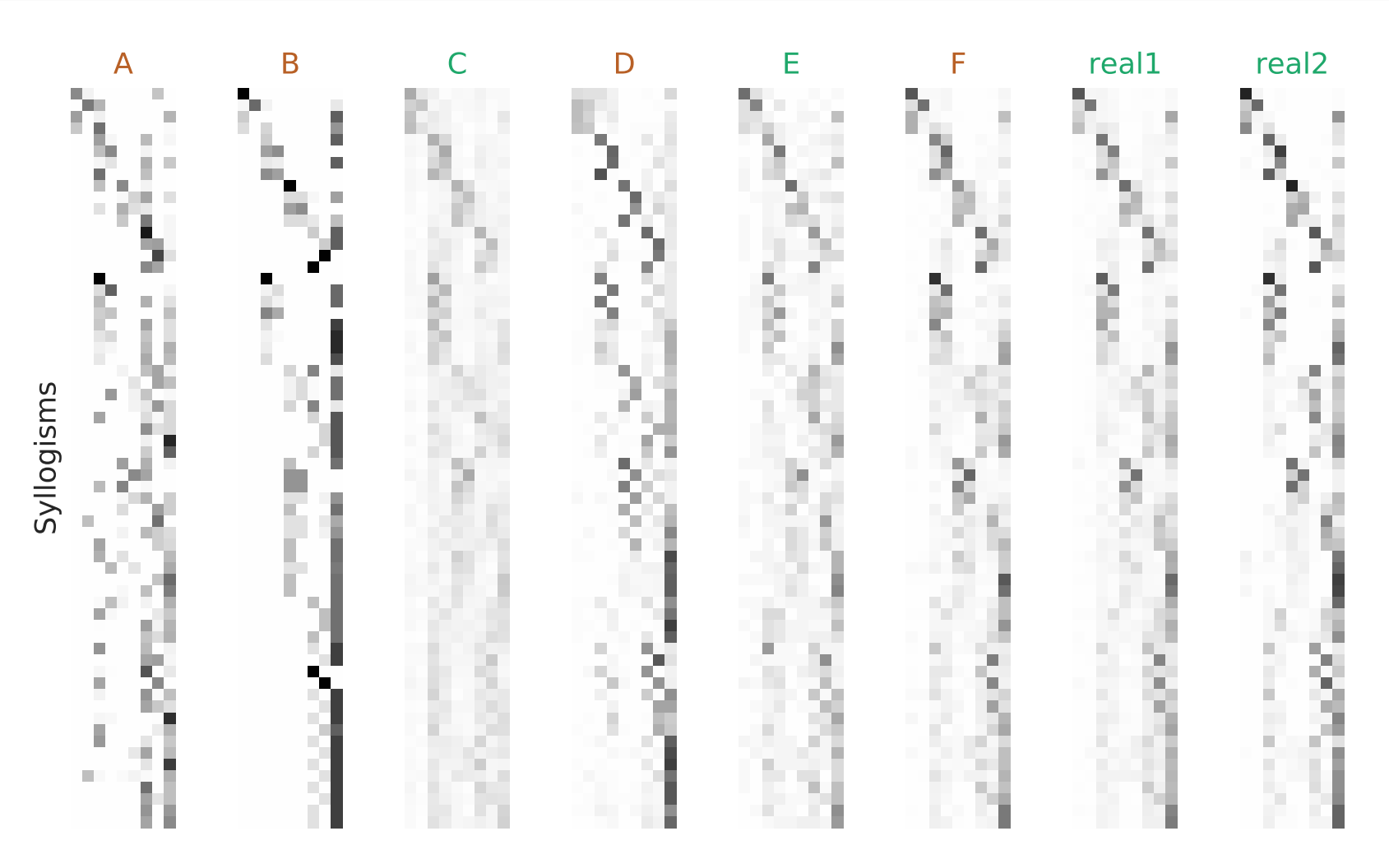
Task

Given known real data of human syllogistic reasoning, label other datasets as real or artificial.

Datasets



Datasets



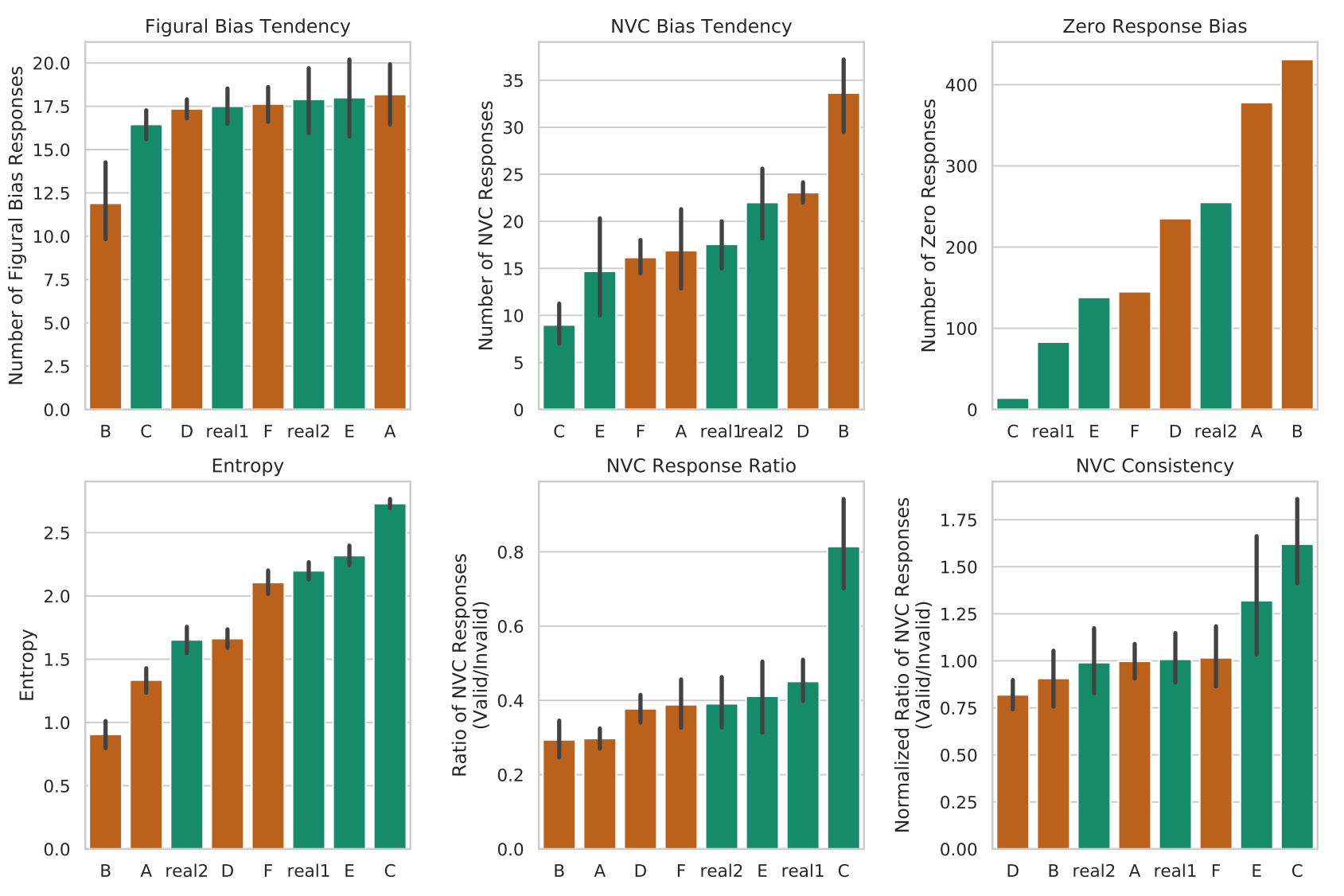
Data Generation Strategies

Dataset	Generation Strategy
A	Autoencoder supplied with random latent states
B	Cognitive model: *mReasoner*
D	Cognitive model: *Probability Heuristics Model*
F	Responses from votes by samples of individuals from real1

Differentiating Data

- Goal is to find discrepancies between the datasets
- Need to investigate different properties of the datasets
- Two directions to approach this task:
  1. Aggregate properties of the datasets
     - Distribution of responses
     - Variances of certain response biases
     - Comparison with theoretical insight into reasoning (figural bias, NVC responses, etc.)
  2. Individual response behavior
     - Individual response strategies in the datasets

Aggregate Data Analysis



Aggregate Data Analysis - Conclusions

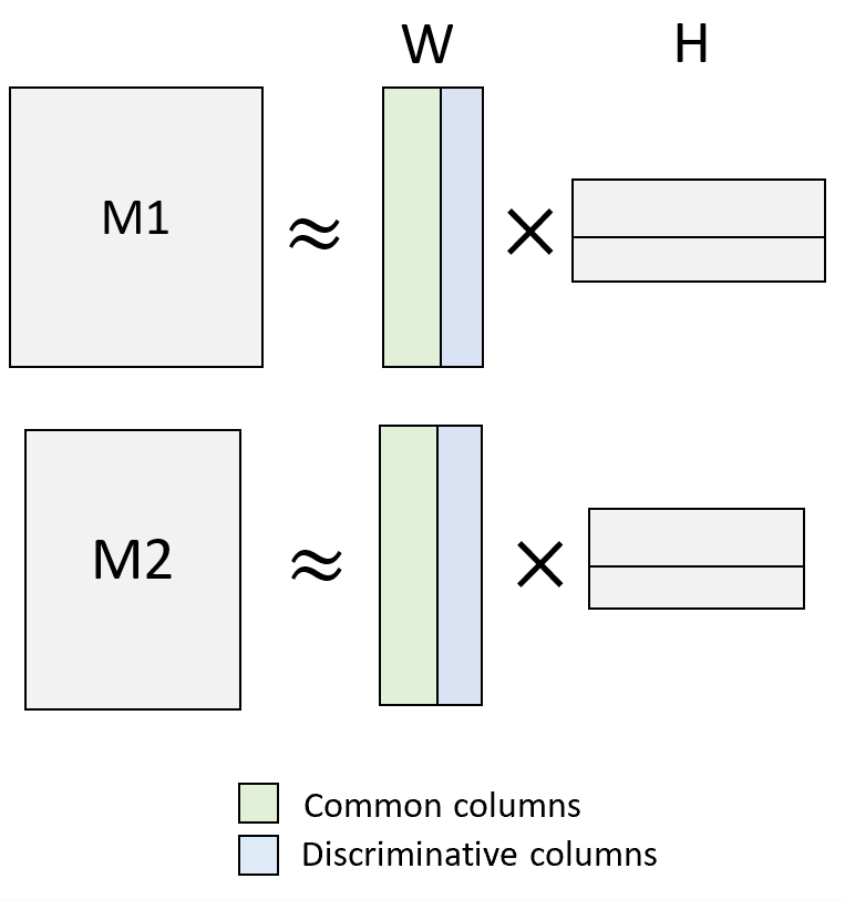
Dataset	Decision	Truth
A	Artificial	Artificial
B	Artificial	Artificial
C	Artificial	Real
D	–	Artificial
E	–	Real
F	–	Artificial

Data Analysis: Matrix Factorization

- Given a matrix $M = m \times n$, the goal is to find two matrices $W = m \times k$ and $H = k \times n$ (for $k << m, n$), so that $M \approx W \times H$
- Latent states have to be exploited to compress the data
- The principle is often used in topic extraction and recommender systems
- The approach can also be adapted to constrast data

Contrasting data using Matrix Factorization

- The main idea is to perform two matrix factorizations at the same time[1]
- Regularization forces k_c columns to be similar and k_d columns to be dissimilar

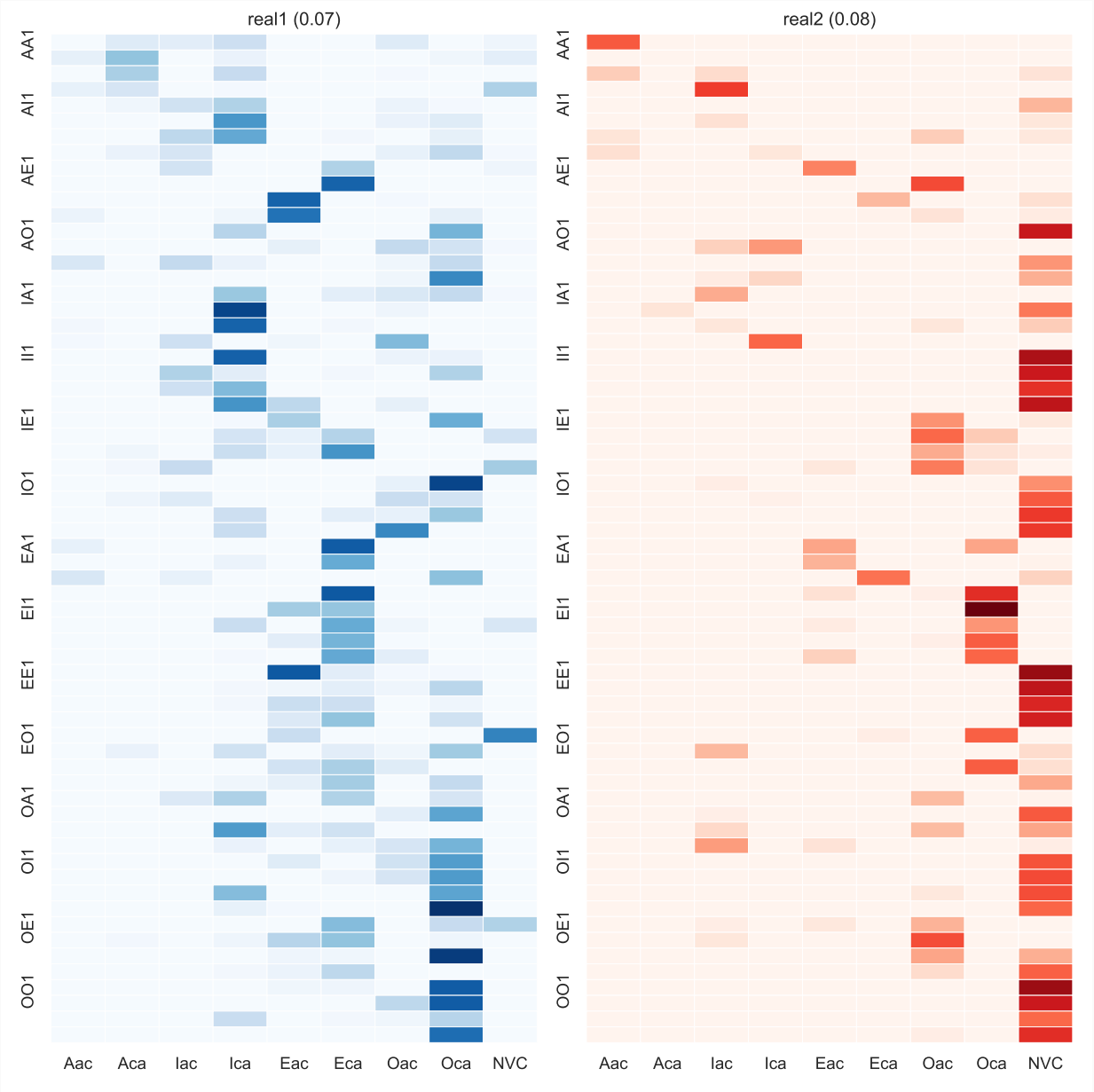


[1] Kim, H., Choo, J., Kim, J., Reddy, C. K., & Park, H. (2015). Simultaneous discovery of common and discriminative topics via joint nonnegative matrix factorization

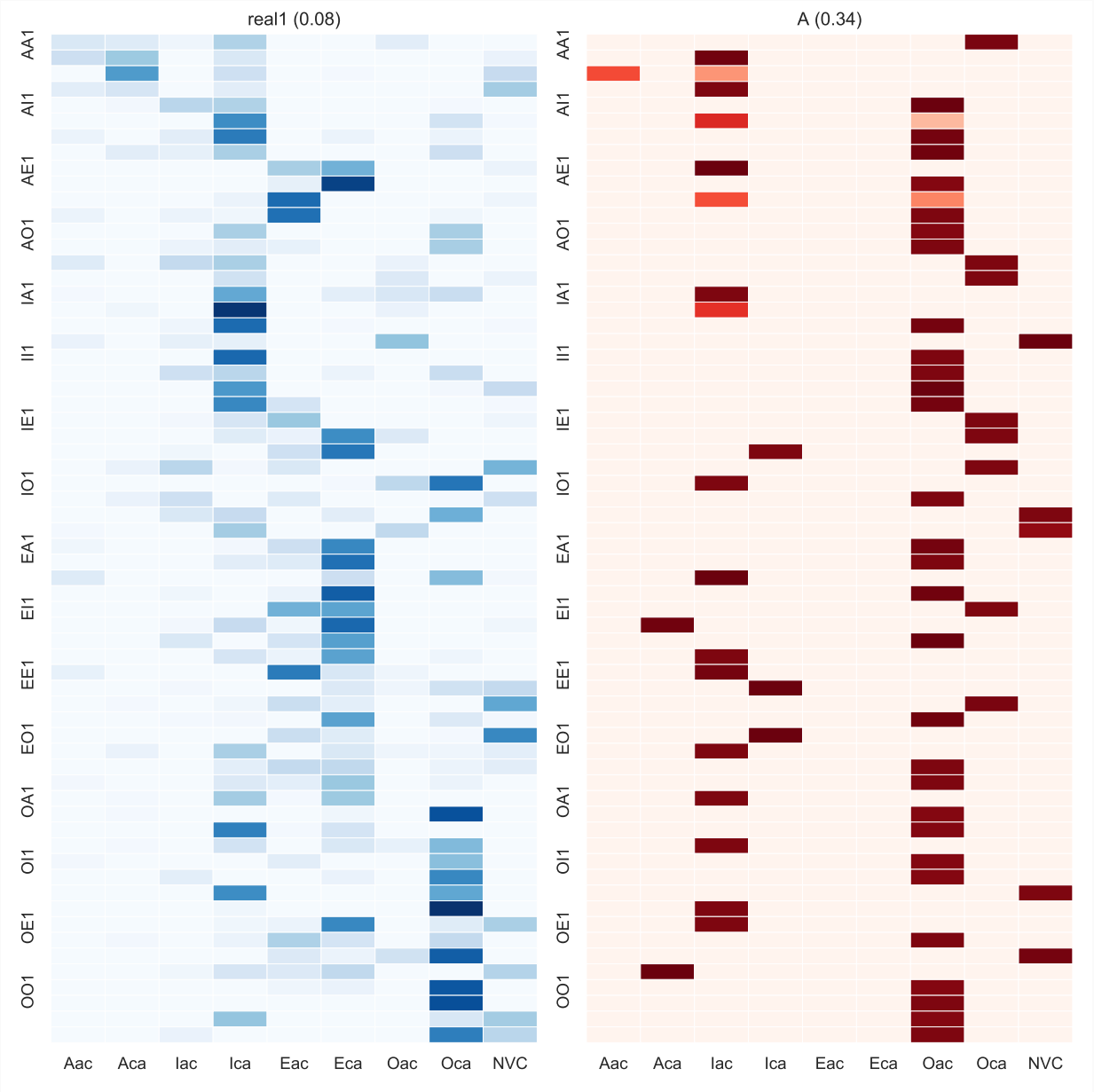
Contrasting data using Matrix Factorization

- We expect the datasets to contain mostly similar patterns, so we use $k_c = 9$ common and $k_d = 1$
- The different response patterns of the datasets can be obtained from the W-matrices
- The importance of the differences can be estimated from the H-matrices
- For this task, we used mainly the importance (is there a pattern that substantially discriminates between both datasets)

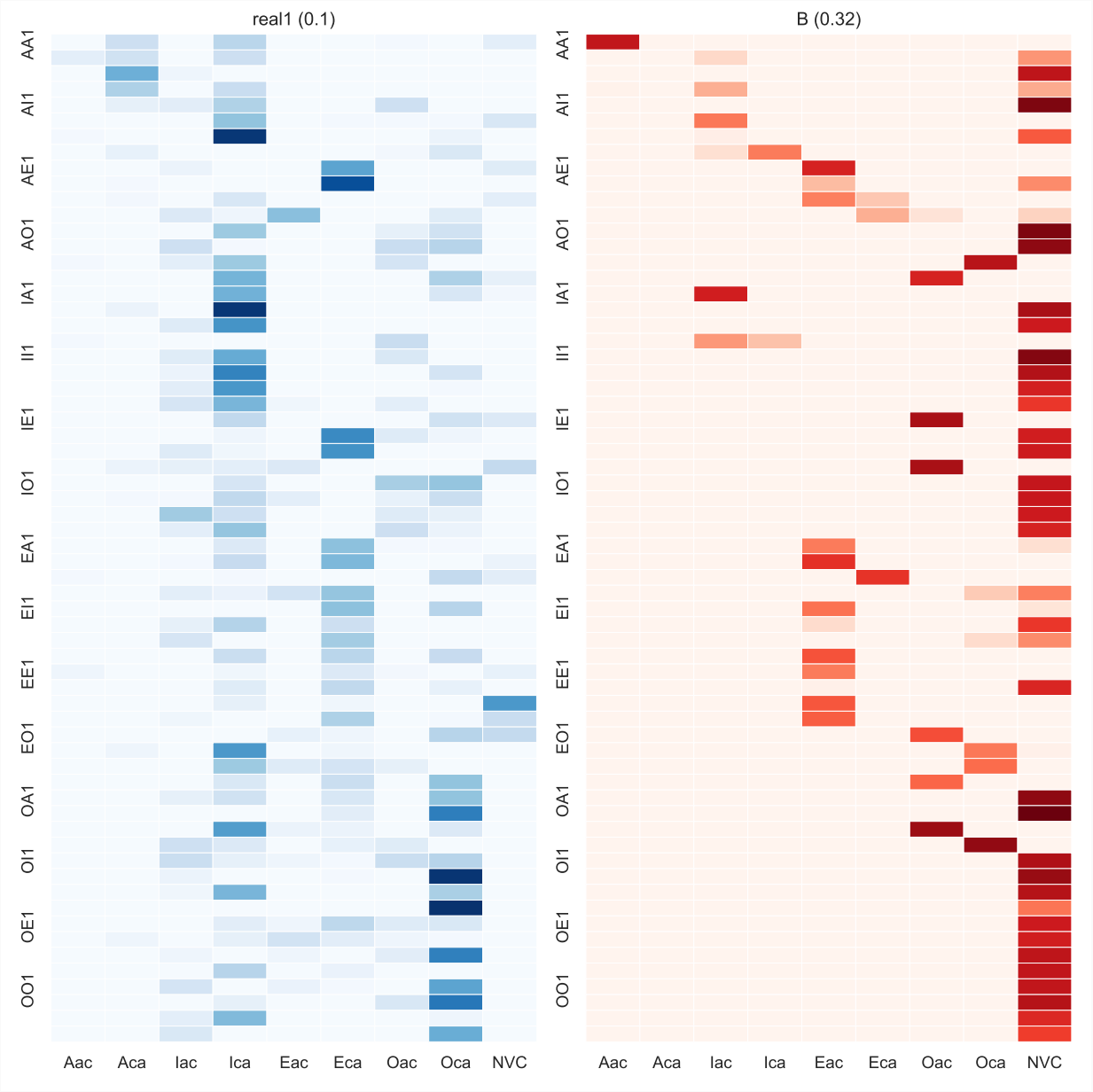
Contrasting data: Reference



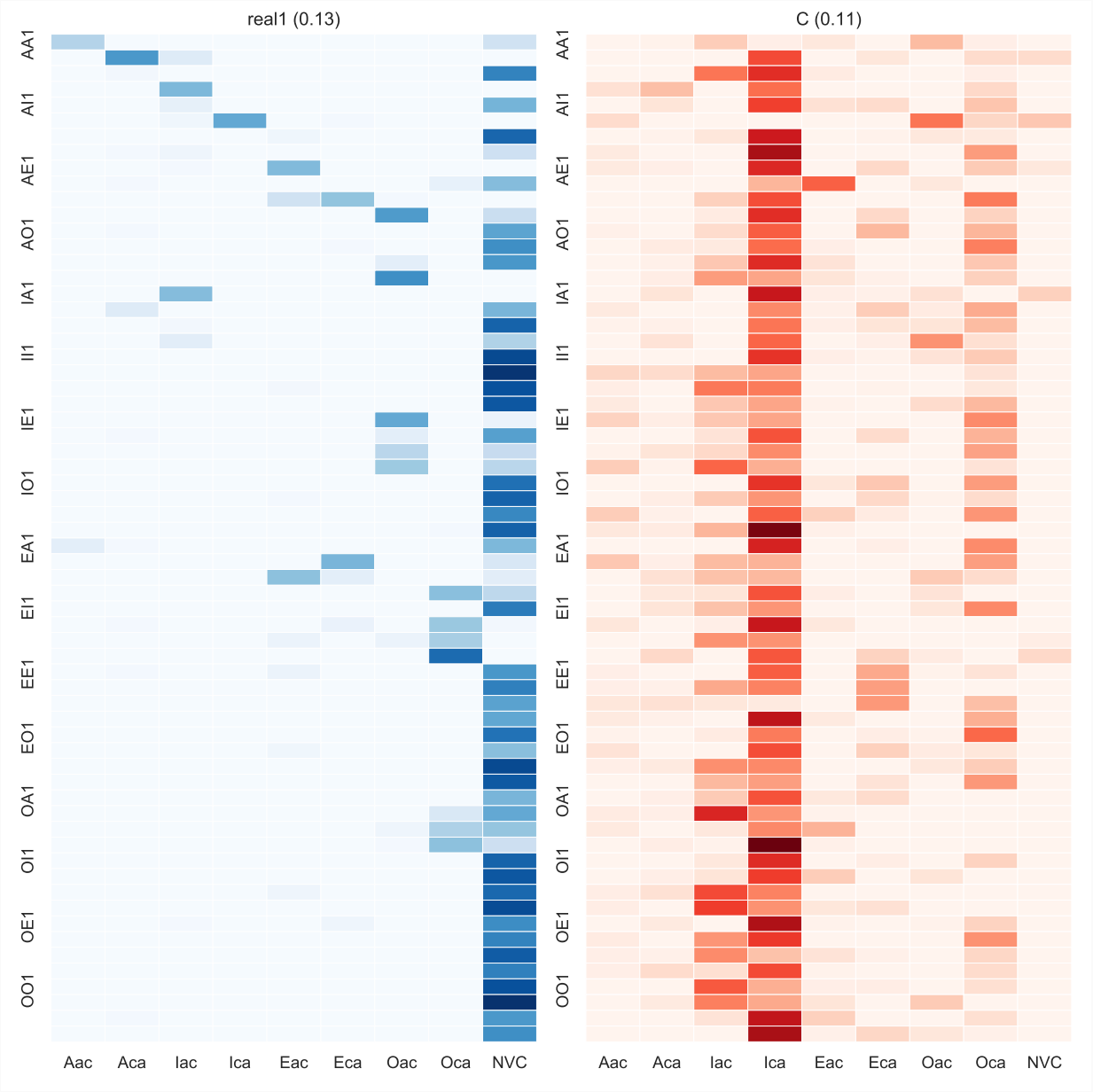
Contrasting data: Dataset A



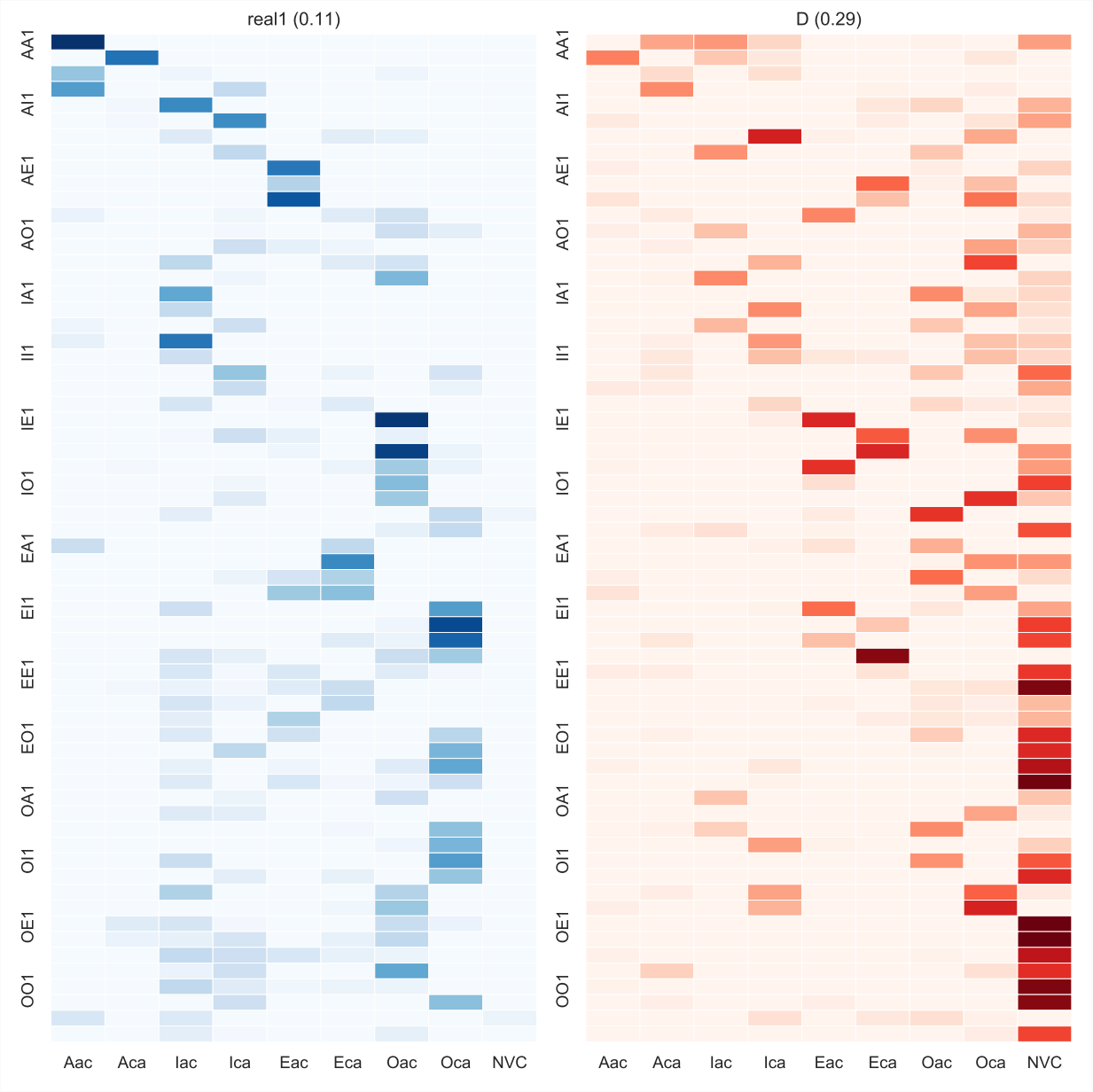
Contrasting data: Dataset B



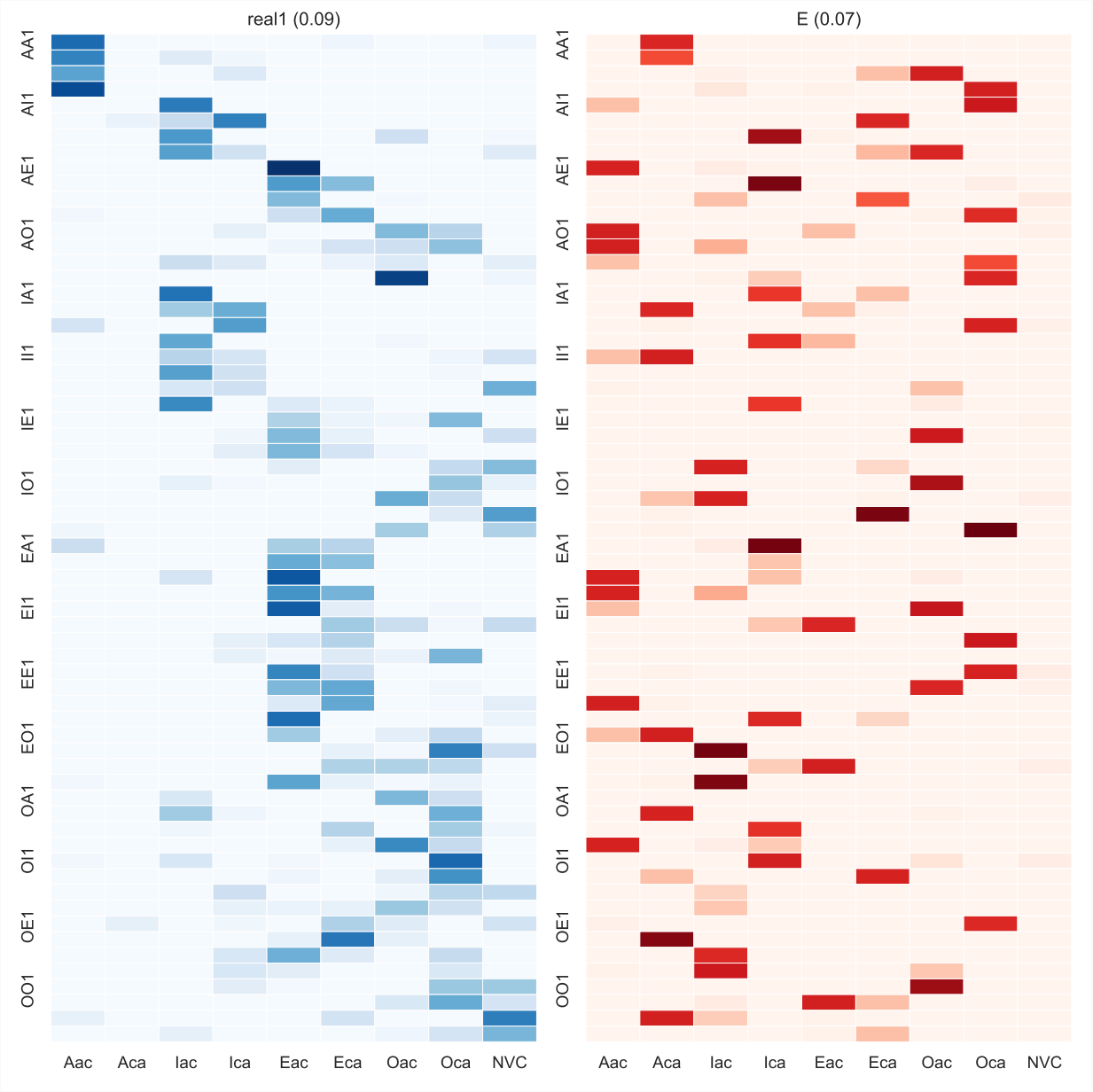
Contrasting data: Dataset C



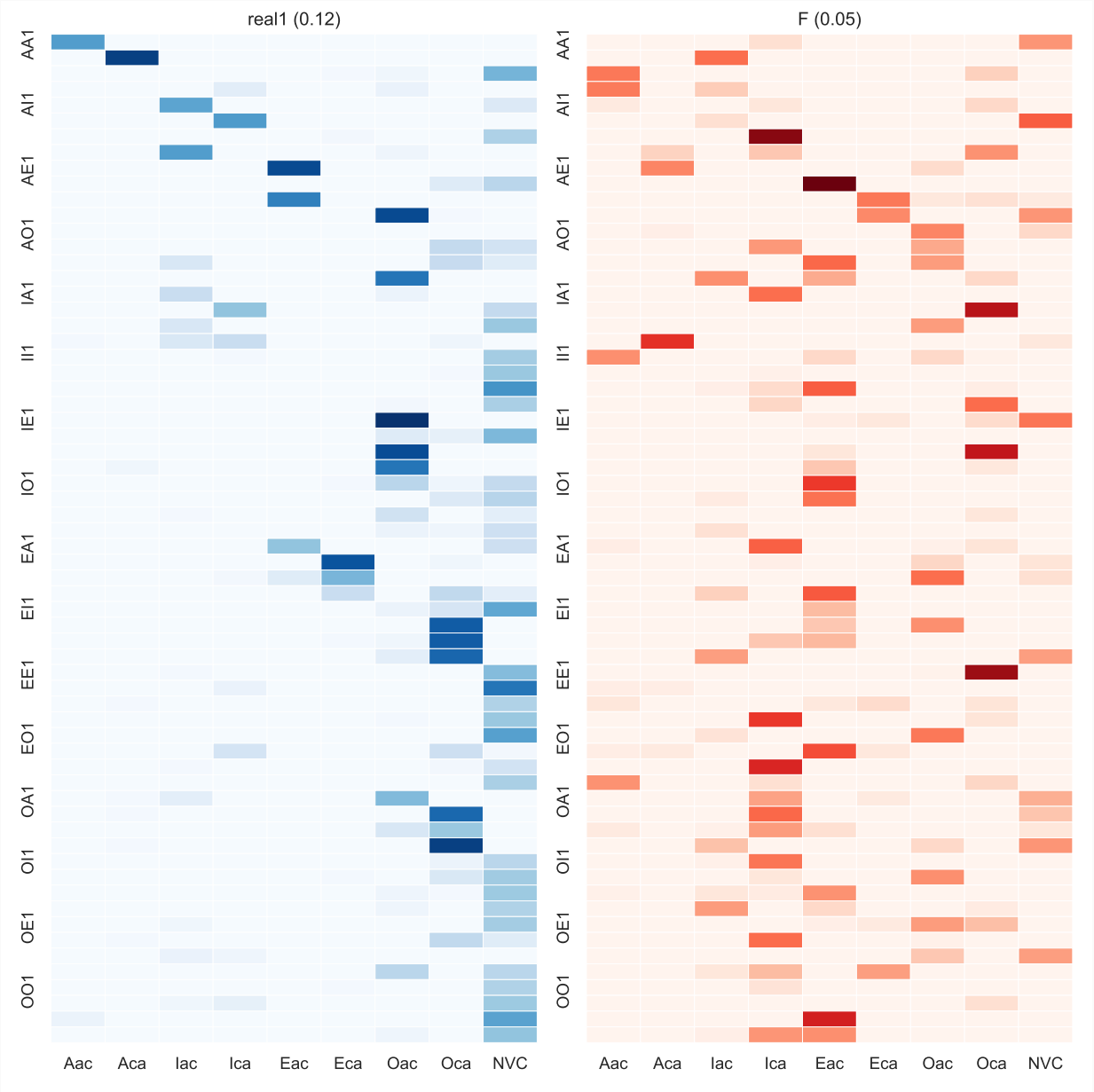
Contrasting data: Dataset D



Contrasting data: Dataset E



Contrasting data: Dataset F



Contrasting data - Conclusions

Dataset	Importance	Decision	Truth
A	0.22	Artificial	Artificial
B	0.17	Artificial	Artificial
C	0.12	Real	Real
D	0.18	Artificial	Artificial
E	0.09	Real	Real
F	0.08	Real	Artificial

- Use mean importance of both reference datasets
- Base rate is expected to be about 0.1
- Significantly higher values are suspicious

Next Steps

- Improve your classifiers by integrating knowledge about artificial datasets
- Tip: You can generate artificial data by yourself
- We will provide new unlabeled data for you to predict
- Keep in mind that this is a real-world problem and some fake datasets are really hard to detect

Upcoming Deadlines

- December 15th, 23:59: Deadline for final models & written report
- December 20th-21st, 09:00-17:00, room TBA: Blockseminary