## Discovering Language Structure in Speech Neural Networks: How Representational Geometry Captures Cross-Linguistic Variation

Badr M. Abdullah, Saarland University

Do deep neural networks (DNNs) trained on speech capture the (dis)similarity between languages? If they do, how do we look into their hidden internal representations? In this talk, I present two complementary studies that aim to answer these questions. In the first study, I present our work on probing the representations of neural systems for spoken language identification. We show that geometric distances between language representations strongly correlate with geographic proximity and genetic relatedness, despite the lack of explicit linguistic supervision during model training. In the second study, I present our work with neural models of spoken word representations (acoustic word embeddings) and how we applied analytic methods from neuroscience to study how they represent speech segments from unfamiliar languages. Using Representational Similarity Analysis, we demonstrate that cross-lingual representational similarity predicts the degree of mutual intelligibility between closely-related languages. Together, the findings from both studies demonstrate that neural speech models induce linguistically meaningful geometric structures that reflect objective linguistic similarities.

## References

[1] Rediscovering the Slavic Continuum in Representations Emerging from Neural Models of Spoken Language Identification, VarDial 2020

[2] How Familiar Does That Sound? Cross-Lingual Representational Similarity Analysis of Acoustic Word Embeddings, BlackboxNLP 2021