

Vowel Overlap

- **Vowel overlap:** degree of similarity between underlying distributions of vowel categories
- Multiple proposed measures
 - Spectral overlap assessment metric (**SOAM**) (Wassink, 2006)
 - *A posteriori* probability-based metric (**APP**) (Morrison, 2008)
 - Vowel overlap analysis with convex hulls (**VOACH**) (Haynes & Taylor, 2014)
 - Pillai score from MANOVA (Hay & Drager, 2006)
- Generally, approximate and compare underlying distributions of **F1**, **F2**, and (optionally) **duration**
- 2D visualizations in Figures 1–4

Critiques & Questions

- SOAM and VOACH do not account for density of data
- SOAM cuts off outlying data
- VOACH depends on outliers

Research questions:

- Which of these measures is the most accurate? (Gives desired answer)
- Which of these measures is the most precise? (Gives similar results for similar data)

Hypothesis: APP and Pillai will perform better than SOAM and VOACH

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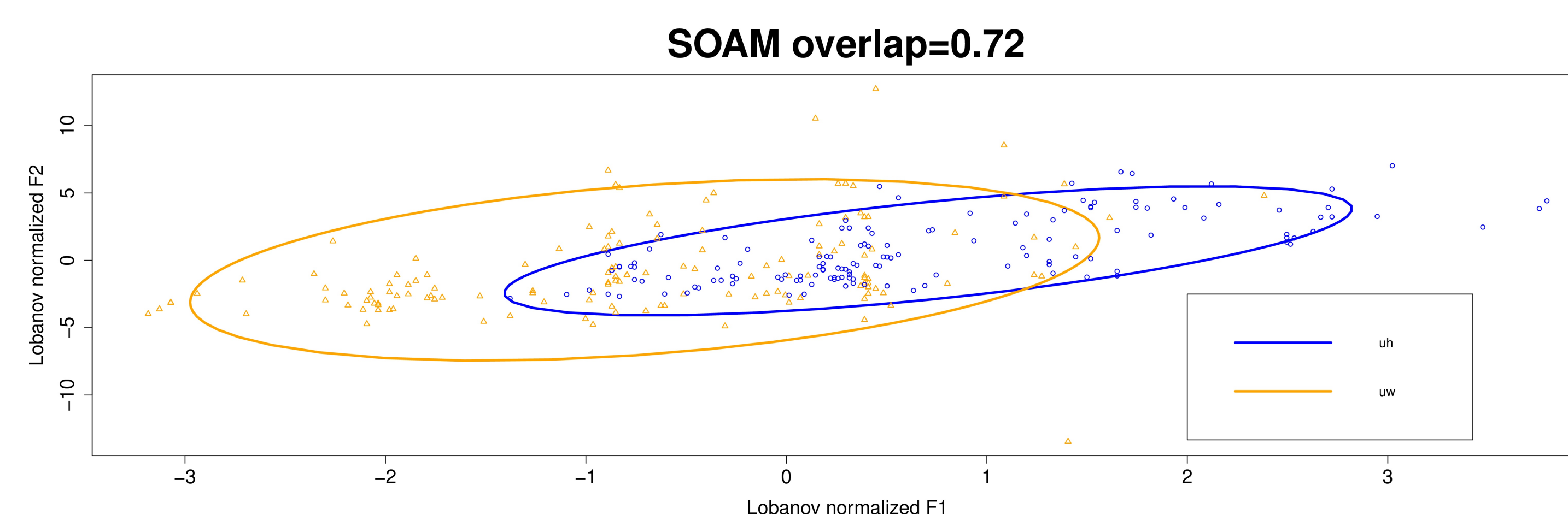


Figure 1. SOAM on [ʊ] & [u].

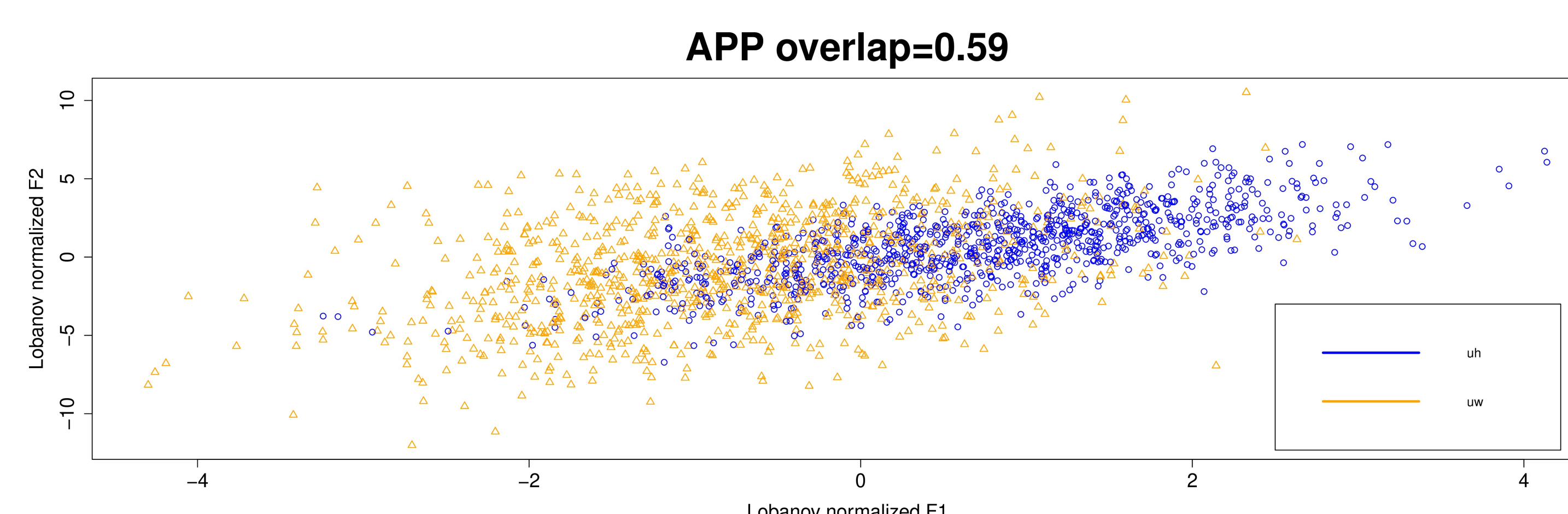


Figure 2. APP generated data for [ʊ] & [u].

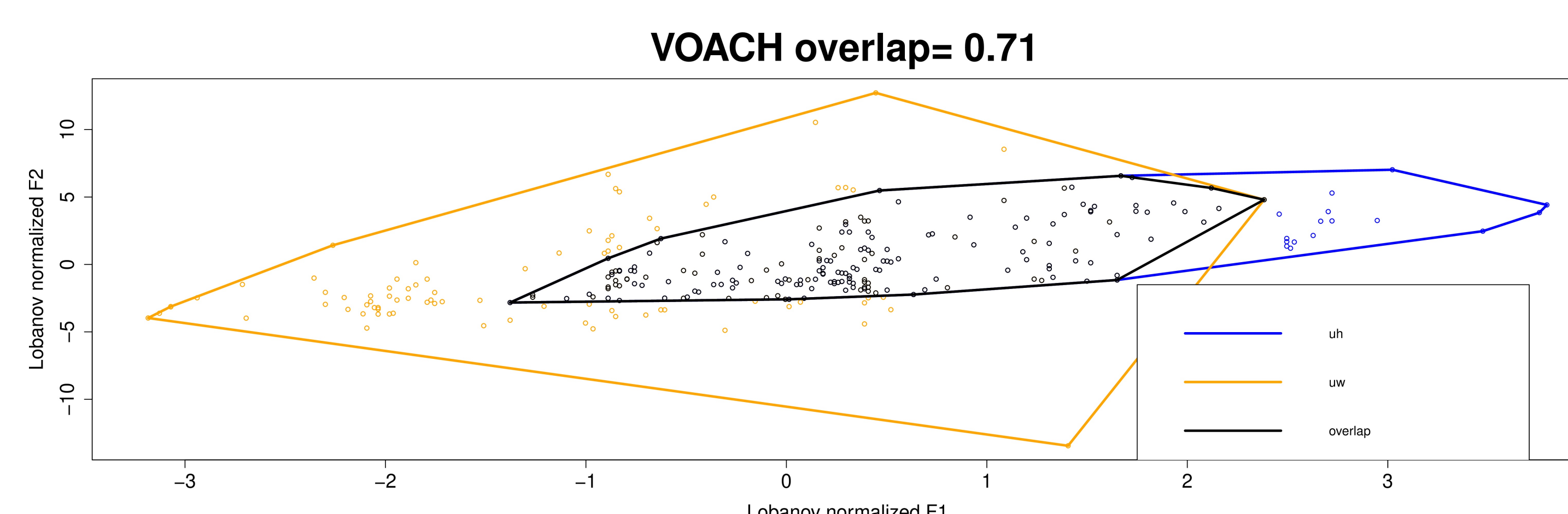


Figure 3. VOACH on [ʊ] & [u].

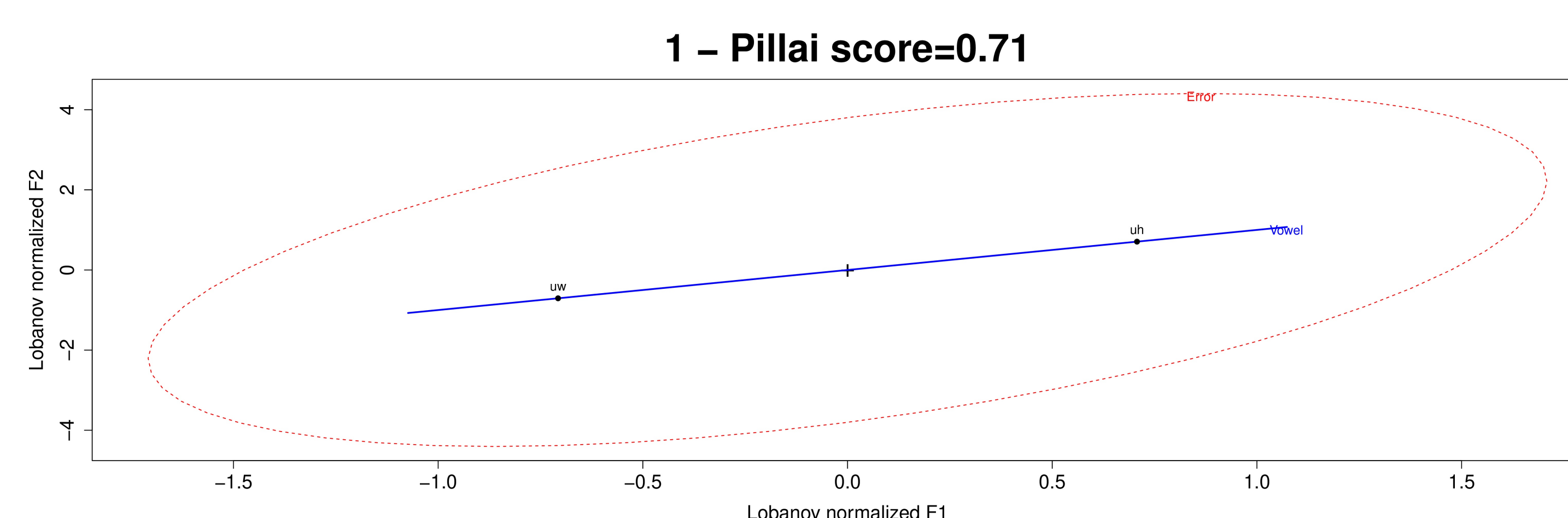


Figure 4. MANOVA HE plot for [ʊ] & [u]. The larger the error ellipse is in comparison to the vowel ellipse, the greater the amount of overlap suggested by the Pillai score.

Simulations

- Monte Carlo simulations on data from Hillenbrand et al. (1995)
 - Calculate measures on 30 Lobanov normalized points for each vowel category, drawn from multivariate Gaussians
 - Compare to target values
- 3 conditions to test in 2D and 3D
 - **No overlap:** [i] and [ɑ]
 - **Partial overlap:** [u] and [ʊ]; generate 1000 points for targets
 - **Full overlap:** [i] and [i]
- **Accuracy:** mean absolute error (MAE)
- **Precision:** standard deviation (SD)

	No overlap		Partial overlap		Full overlap	
	MAE	SD	MAE	SD	MAE	SD
SOAM	0	0	0.10	0.12	0.08	0.06
APP	0.00003	0.0001	0.10	0.095	0.07	0.04
VOACH	0	0	0.21	0.16	0.29	0.10
Pillai	0.05	0.01	0.08	0.092	0.03	0.03

Table 1. 2D simulation results. Best results shaded green. Errors shaded red. 3D simulations showed the same patterns.

Conclusion

- **Pillai best overall measure**, followed by APP
 - Evidence in favor of hypothesis
- SOAM and VOACH likely less accurate for not factoring in density
 - Further testing required

References

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