BSS EVAL OR PEASS? PREDICTING THE PERCEPTION OF SINGING-VOICE SEPARATION

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Audio Examples { bit.ly/2GutUKR }

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Objective Evaluation of Audio Source Separation

- Separating the singing-voice from music is a difficult task, however, deep-learning methods show significant improvements over traditional techniques such as NMF and ICA
- Source separation introduces distortions and artifacts, which degrades the perceived sound quality
- There is a trade-off between the degree of separation and sound quality

How to evaluate separation performance?

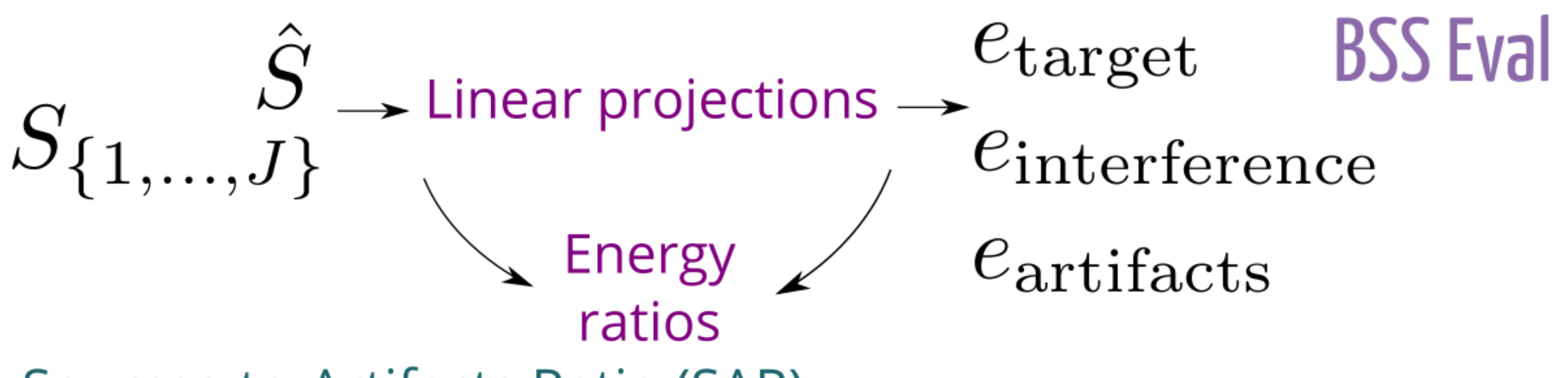
Few researchers conduct listening assessments, but instead resort to objective toolkits:

- BSS Eval[1]: Blind Source Separation Evaluation
- PEASS[2]: Perceptual Evaluation methods for Audio Source Separation

Both approaches based on distortion decomposition between estimated source $\hat{S}$ and target source S:

$$\hat{S} - S = e_{\text{target}} + e_{\text{interference}} + e_{\text{artifacts}}$$

Error components estimated through least-squares projections of estimated and true sources

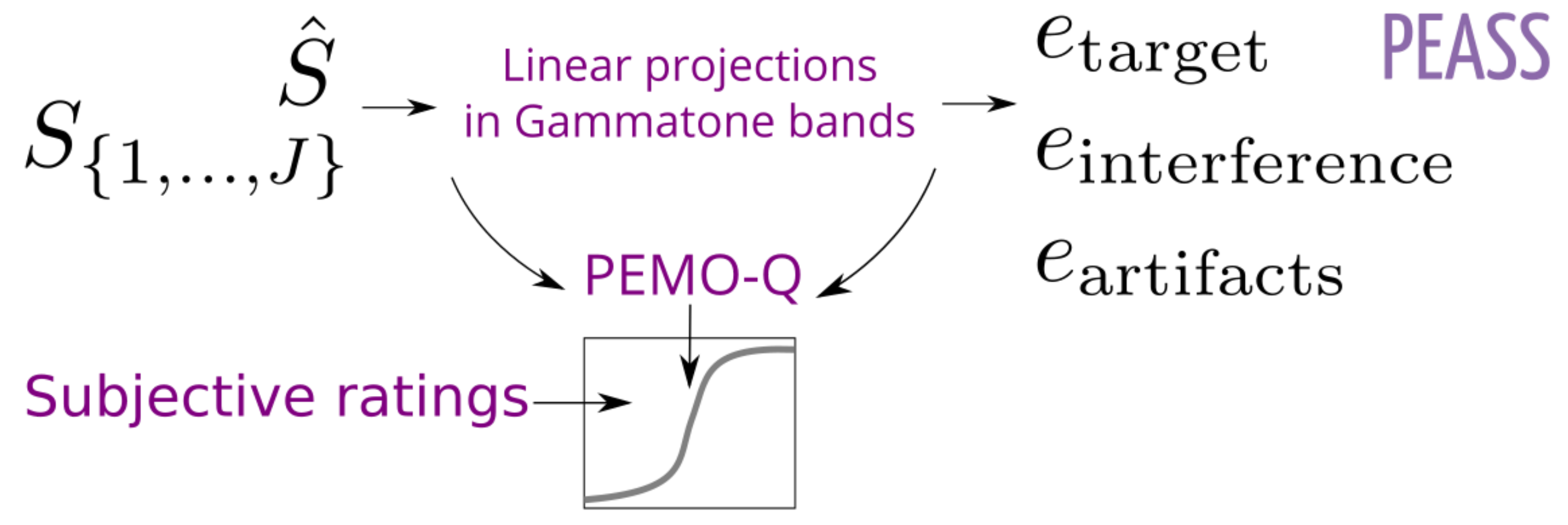


BSS Eval

$S_{\{1,\ldots,J\}}$ $\hat{S}$ → Linear projections → e_{target} $e_{\text{interference}}$ $e_{\text{artifacts}}$

Energy ratios

Sources-to-Artifacts Ratio (SAR)
Source Image-to-Spatial distortion Ratio (ISR)
Source-to-Interference Ratio (SIR)
Source-to-Distortion Ratio (SDR)



PEASS

$S_{\{1,\ldots,J\}}$ $\hat{S}$ → Linear projections in Gammatone bands → e_{target} $e_{\text{interference}}$ $e_{\text{artifacts}}$

PEMO-Q

Subjective ratings →

Artifacts-related Perceptual Score (APS)
Target-related Perceptual Score (TPS)
Interference-related Perceptual Score (IPS)
Overall Perceptual Score (OPS)

[1] Vincent et al. (2006) { 10.1109/tsa.2005.858005 }

[2] Emiya et al. (2012) { 10.1109/tasl.2011.2109381 }

Subjective Listening Assessment

Can these toolkits be used to predict the perception of singing-voices extracted by modern source separation systems?

- Need more evidence to address suitability of BSS Eval
- Few studies have investigated generalization of PEASS

Methodology

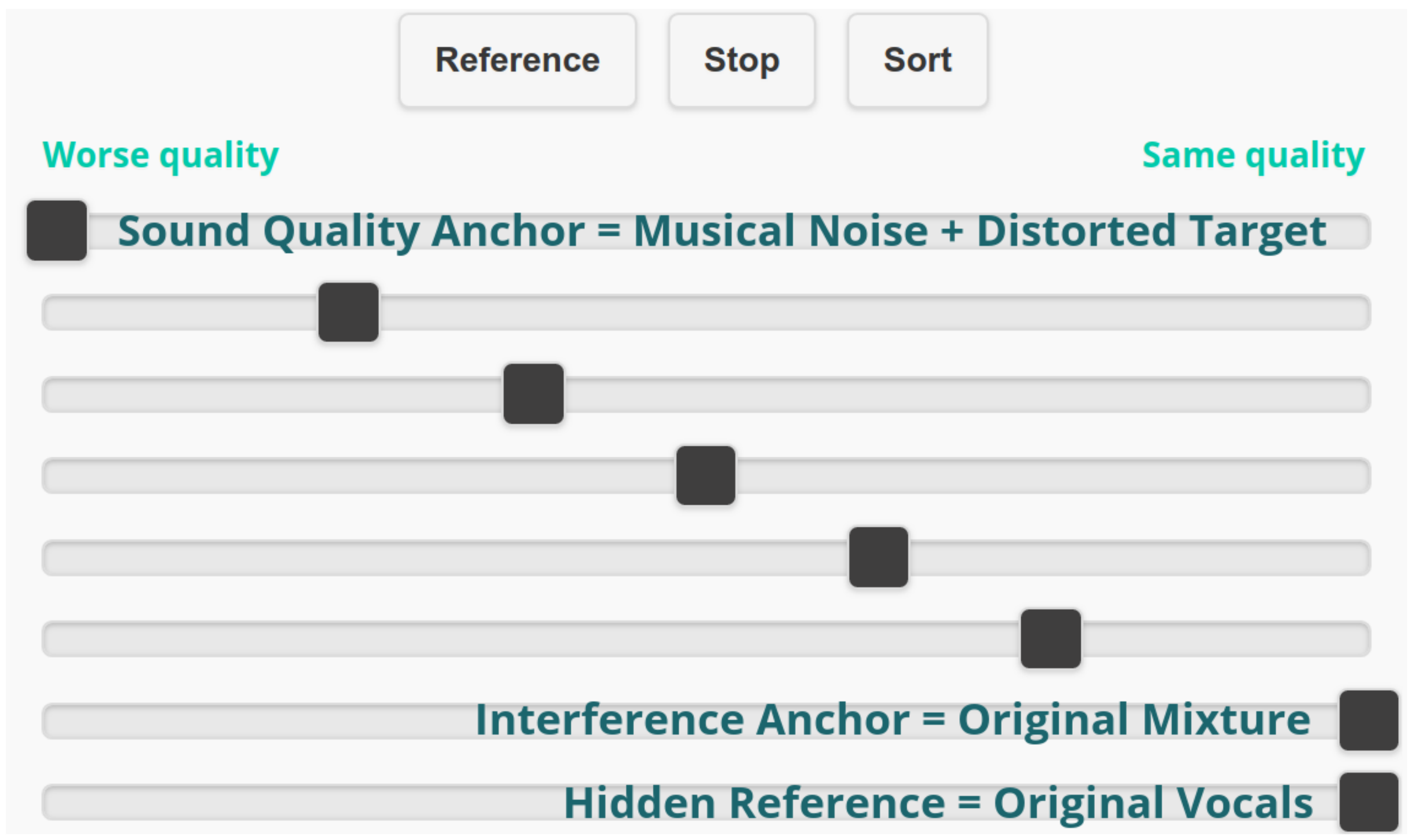
Task 1: Sound Quality

Sound quality relates to the amount of artifacts or distortions that you can perceive. These can be heard as tone-like additions, abrupt changes in loudness, or missing parts of the audio.

Task 2: Interference

Interference describes the loudness of the instruments compared to the loudness of the vocals. For example, 'strong interference' indicates a strong contribution from other instruments, whereas 'no interference' means that you can only hear the vocals. Interference does not include artifacts or distortions that you may perceive.

- 24 Listeners performed a MUSHRA-style experiment
- 16 songs, using *singing-voice* as the target source
- **Listeners compared 5 algorithms** selected pseudorandomly from 21 systems for each song [3]
- Hidden reference and hidden sound quality and interference anchors included



Reference
Stop
Sort

Worse quality
Same quality

Sound Quality Anchor = Musical Noise + Distorted Target

Interference Anchor = Original Mixture

Hidden Reference = Original Vocals

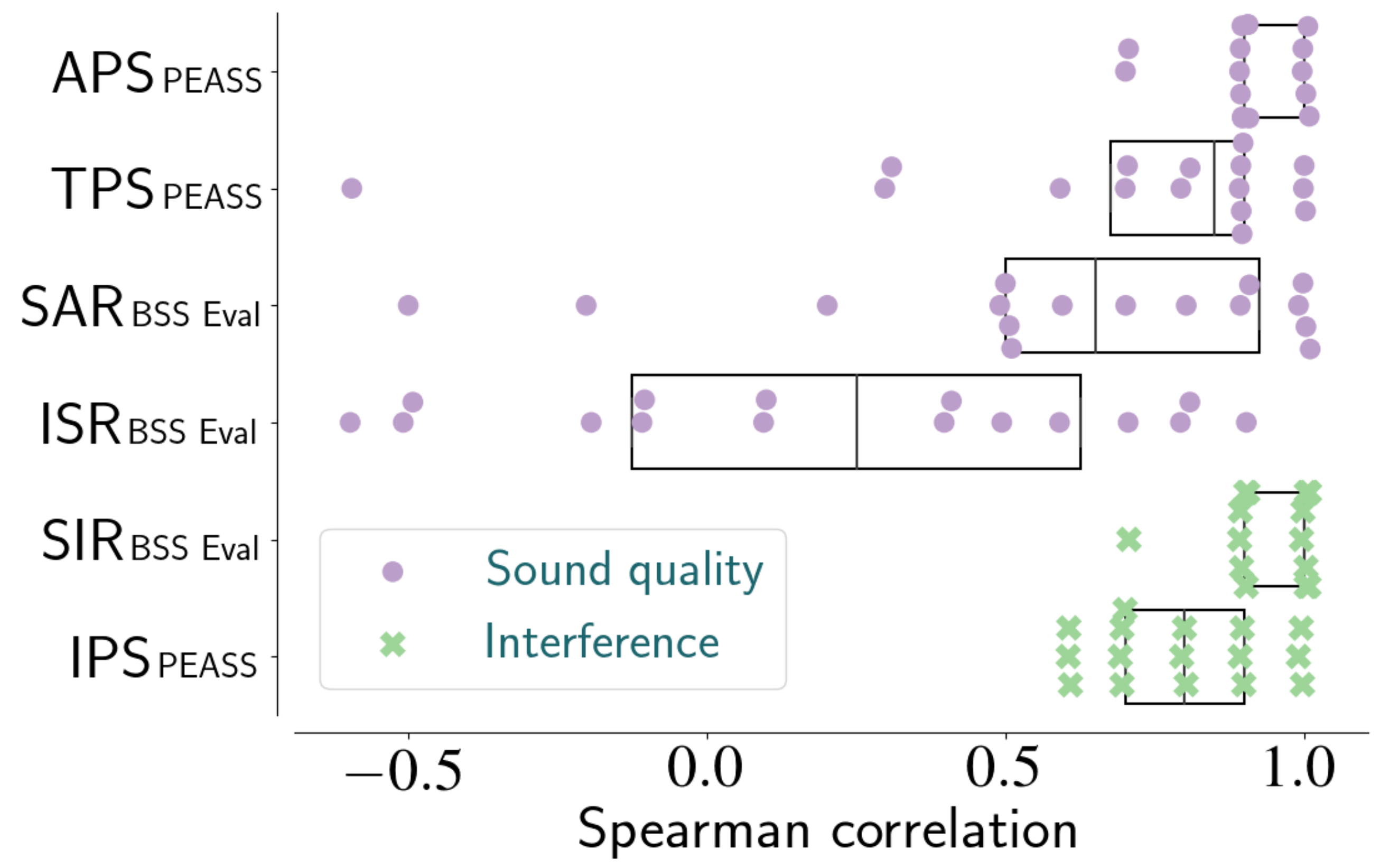
Interface for Task 1. Examples at { bit.ly/2GutUKR }

[3] SiSEC 2016 { http://sisec17.audiolabs-erlangen.de }

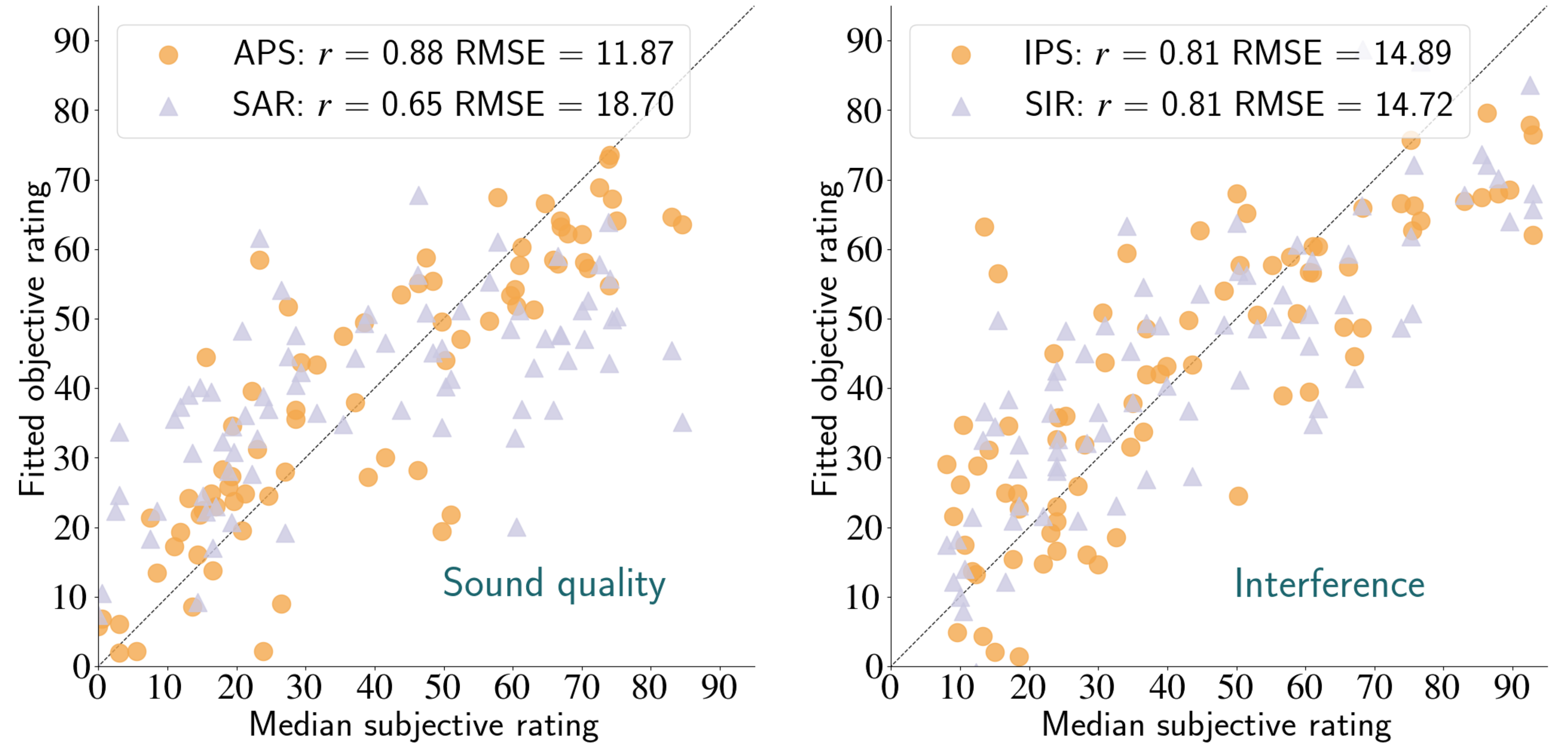
Results

Song-Wise Spearman Correlations

- Measures rank-order relationship between objective measures and medians of subjective ratings
- Performed on a per-song basis involving 5 algorithms
- 16 song-wise correlations per metric



Linear-Fitted Objective Measures vs Subjective Medians



Conclusions and Reflections

- Important to reinforce attribute definitions with audio examples
- APS of the PEASS toolkit showed the strongest predictive ability
- IPS (PEASS) and SIR (BSS Eval) were comparable in performance
- Metrics far from perfect (large RMSE) when considering the 100-point scale
- Remapping of features necessary to better predict the perceptual scales used here
- Need to assess metrics on other sources
- Next time, emphasize **overall sound quality** as some listeners focused only on the singing-voice
- We are currently running **similarity** experiments for assessing SDR and OPS