



# The Cochlear Implant Hackathon: A Scalable Web-Enabled Auditory Performance Judging Platform

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## Background and Objectives

Researchers actively pursuing signal processing strategies to improve auditory performance for CI users attempt to demonstrate performance improvement using a variety of auditory tasks. However, diverse strategies generated from independent groups are rarely directly compared to one another in any standardized fashion.

Our objective was to overcome these limitations by building a scalable platform that would permit the evaluation and comparison of any number of novel auditory CI processing strategies using common auditory tasks.

The Cochlear Implant Hackathon was a joint effort between University of California San Francisco, University of Minnesota, and Advanced Bionics with a goal to inspire members of the general public to improve cochlear implant (CI) sound processing, without necessitating prior knowledge of the field.

## Methods

We implemented a scalable web-based application featuring secure logins, validation for uploaded submissions, a vocoder for translating entries into audio output, two judging platforms, and a leaderboard for showing real-time results.

The web application was built to be scalable and extensible using AWS technologies including Amplify, DynamoDB, Lambda, S3, CloudWatch, and X-Ray. A companion website offered details and training to help participants learn about CIs and how to use the tools.

Participants received a baseline implementation of a fully-featured CI sound coding strategy provided by Advanced Bionics, a framework for developing and testing algorithms, and sample audio files representing words, sentences, sentences in noise, or music.

Figure 1: The Cochlear Implant Hackathon workflow.

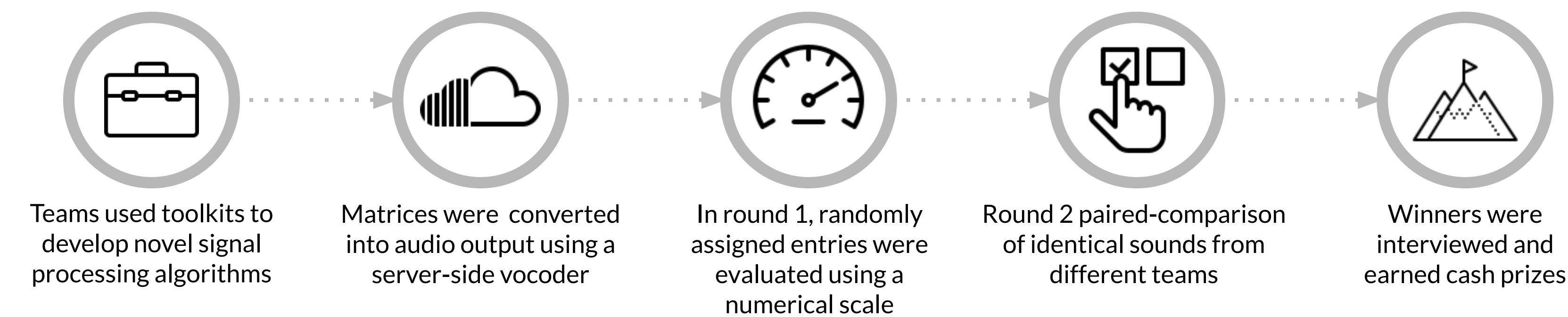


Figure 2: Round 1 judging interface.

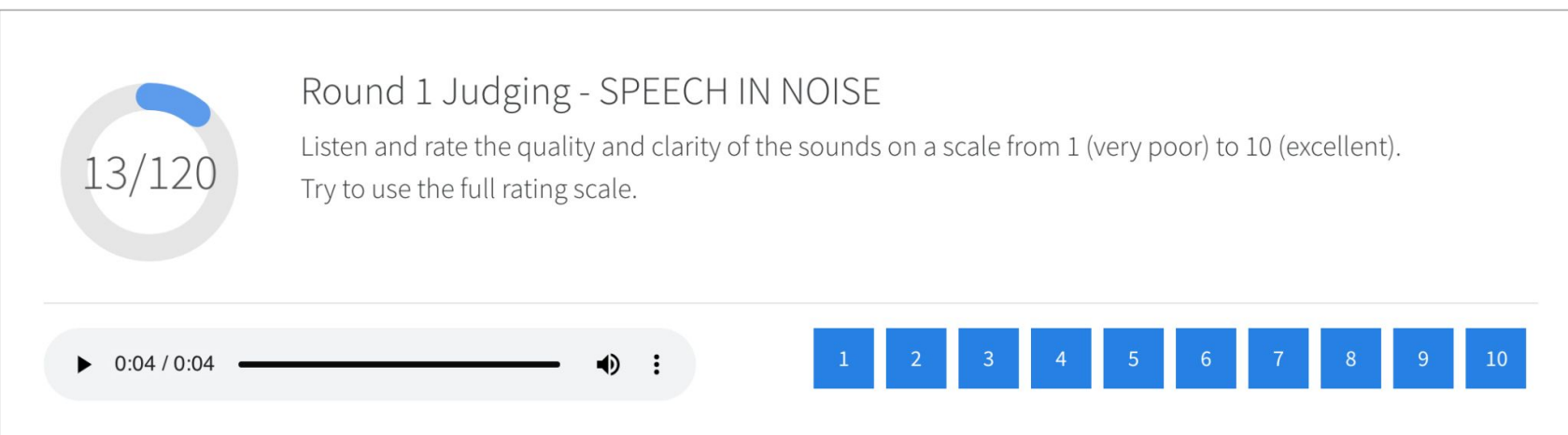


Figure 3: In round 1, entries and baseline audio outputs were randomized and rated using a numerical scale..

Z scores addressed variability in raw scores among different judges and standardized scoring to facilitate interpretation of winners.

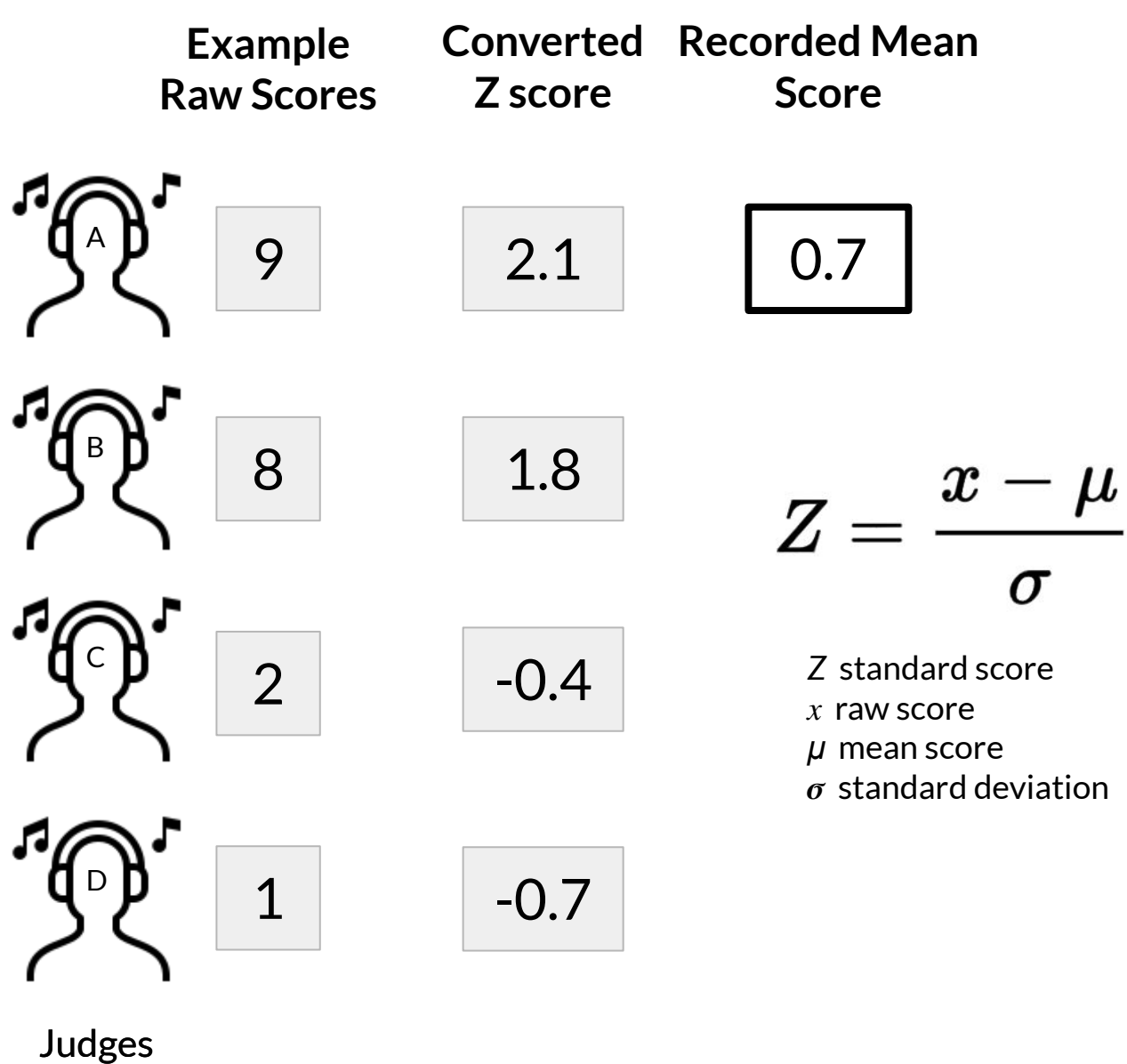


Figure 4: Round 2 judging interface.

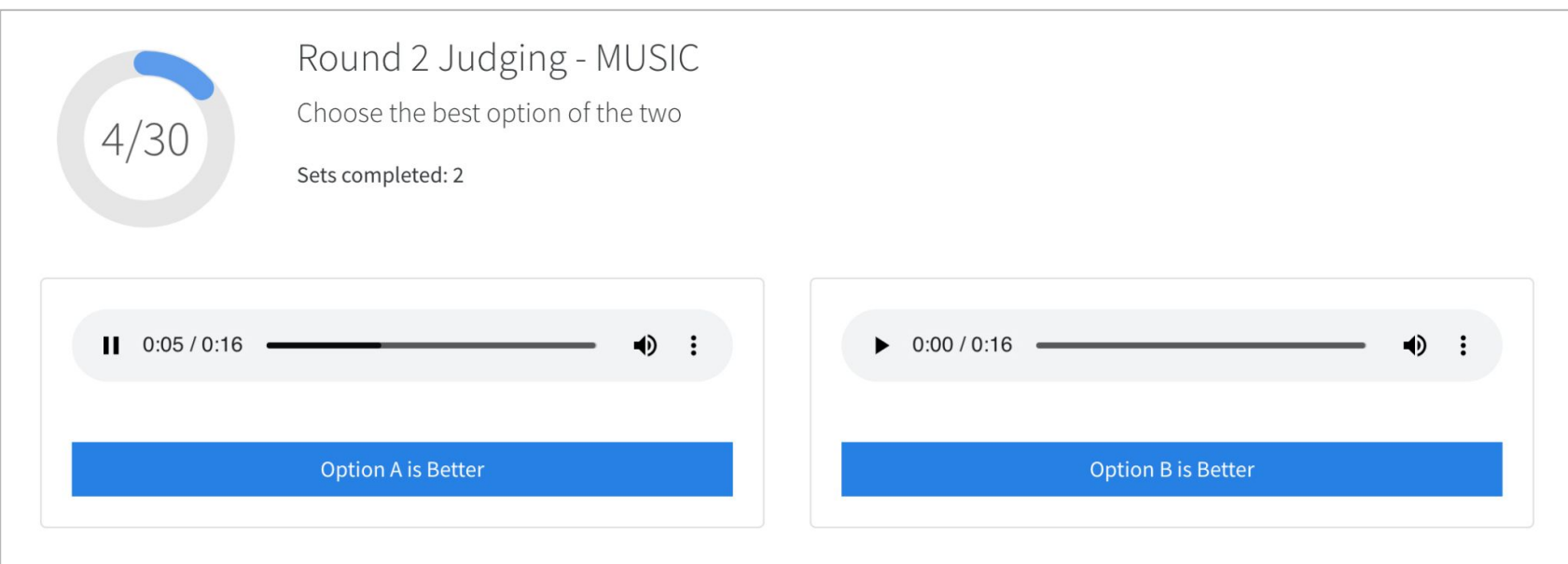


Figure 5: In round 2, pairs of sounds, including entries and the baseline, were randomly assigned for comparison.

The first sound played earned +1 if it won and a -1 if it lost. Overall and categorical scores were added and ranked for each team.

Round 2 Scores					
Team	Overall	CNC	Music	Natural Speech	Speech in Noise
Pepino-Barchi	124	38	22	42	22
GCI	114	31	15	16	52
Haphazard Hamming	113	21	35	39	18
Google (entry #2 of 2)	89	34	-16	30	41
Binding Hack	76	16	16	27	17
16-SAMurai	66	9	27	20	10
Steel City Sounds	61	10	19	23	9
ab-gold-standard	54	7	29	11	7
Formant-Locking Team	33	10	20	2	1
Southeaster_3	32	22	7	5	-2
CEA	5	1	-8	-9	21
SES	-6	-7	-8	-5	14
Acoustics Lab	-53	-1	0	-35	-17

## Results

**69** participants  
**17** teams  
**25** judges  
**8** winners

An electrodegram-based acoustic vocoder simulated CI output for normal-hearing listeners and was used as a basis for optimizing and judging the sound quality of the CI sound processing algorithms. Uploaded matrix files were validated and analyzed for errors before being processed into audio output via a backend vocoder optimized for speed and scalability. These sound files were randomly assigned to judges for each of the four sound categories along with baseline audio outputs from the AB standard for judging during two rounds of competition.

Figure 6: A leaderboard showed real-time results.

Participants	Hackathon Progress	Round 1 Judging	Round 1 Scores	Round 2 Judging	Round 2 Scores
Participant	Role	Round 2 Entries Judged	Round 2 Sets Completed	Total Scores for Team's Entries	
16-SAMurai 17ee927-437f-4564-bd0a-d8b03e5e3f66	hacker	150	5	11	
Southeastern_2 bd99440f-883d-42d5-89df-22078ed4974d	hacker	120	4	12	

Top tier entries represented academic institutions, commercial entities, and individuals. Winners earned cash prizes. Twelve teams' algorithms outperformed the Advanced Bionics baseline approximate of current technology in at least one category.

## Discussion and Conclusions

We demonstrated how a web-based platform can be used to identify innovative solutions for improving sound processing for cochlear implants and enable direct comparison of multiple CI signal processing algorithms via acoustic simulations.

## Acknowledgements

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