



The Genetic Algorithm: A New Fitting Tool for Optimizing Hearing Aids' Advanced Features

Deniz Başkent, Cheryl Eiler, Brent Edwards, Nazanin Nooraei
 Starkey Hearing Research Center; Berkeley, CA (nazanin_nooraei@starkey.com)



Introduction

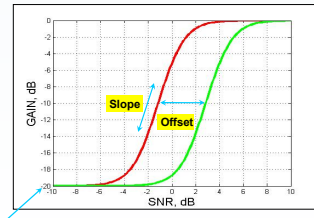
The Genetic Algorithm (GA), a method based on principles of evolution, can examine a vast number of parameters simultaneously and optimize the parameter settings in a quick and efficient manner. Optimization is performed based on subjective input through a simple A-B comparison. In the present study, the GA was applied to find the optimal parameter settings of an advanced Noise Reduction (NR) algorithm. The best solutions had been determined in a previous study by exhaustive listening (Woods, 2006). Specifically, the present study was attempted to answer the following research questions:

- 1) Can the GA produce acceptable solutions?
 - a) Are the best solutions produced by the GA similar to the solutions determined in the previous study?
 - b) Would the subjects like the GA solutions as well as the solutions reported in the previous study?
- 2) Is the GA a fast method in optimizing an advanced NR algorithm?

Background

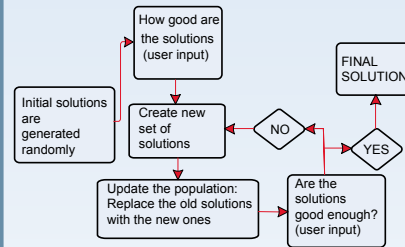
Parameters of an advanced NR algorithm:

- Slope
- Offset
- Time Constant (TC)
- Max Attenuation



Max Attenuation

How does the GA work?



Methods

Subjects:

- 13 normal-hearing subjects with average age of 25 years.
- Native English speakers.
- Nearly half of the subjects had participated in the previous study (Woods, 2006).

Stimuli:

- One HINT sentence presented over headphones at 75 dB SPL.
- The sentence was presented in babble background noise at SNR of 5 dB.

Stage 1

- Find the optimal parameters of NR by applying the GA.
 - 6600 possible solutions.
 - 3 NR parameters: slope, offset, and time constant for optimization.
 - 7-point scale A/B comparison between two genes.
 - Subjects were asked to choose the sentence that was preferred.
 - 5-6 paired comparisons in each iteration (10 iterations).
- Compare average GA solutions with the best settings from the previous study (Woods, 2006)

Stage 1 Results

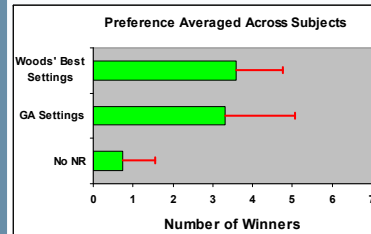
- GA Search Space:
 - Slope: 20 linear steps
 - Offset: 30 linear steps
 - TC: 11 log space
 Total of 6600 possible solutions
- Average GA solutions compared with the best settings from Woods' study:
 - Slope: 95% accuracy
 - Offset: 86% accuracy
 - TC: 100% accuracy

Stage 2

- Final Validation
 - 7-point scale paired comparison between the following settings:
 1. Original signal, i.e., no NR.
 2. NR parameter settings identified previously (Woods, 2006).
 3. NR parameter settings produced by the GA.
- Comparison between GA average running time and Woods' study.

Stage 2 Results

- Final Validation



Comparison between GA average running time and Woods' study

	Average Running Time	Minimum	Maximum
GA Study	18 minutes	10 minutes	34 minutes
Woods' Study	81 hours*	65 hours*	97 hours*

* This is an estimated time and not actually measured

Conclusions

- 1) Can the GA produce acceptable solutions?
 - a) Are the best solutions produced by the GA similar to the solutions determined in the previous study? **Yes. The settings produced by the GA were generally close to the best solutions produced in Woods' study.**
 - b) Would the subjects like the GA solutions as well as the solutions reported in the previous study? **Yes. Subjects generally preferred the GA solutions as well as the solutions reported by Woods.**
- 2) Is the GA a fast method in optimizing an advanced NR algorithm? **Yes. It is definitely a faster alternative to empirical methods. It is probably not sufficiently fast for clinical applications at this time.**

Future Applications of the GA

Presently, the GA is not fast enough to be applied in clinical settings. However, it serves as a very valuable tool for research purposes. Once the GA is applicable in clinical settings it can be utilized:

- in optimizing advanced features of hearing aids,
- in fine-tuning hearing aid parameters especially in difficult to fit hearing-impaired populations, and
- in fitting hearing aids to patients more efficiently; hence, offloading the hearing aid dispenser's time in the clinic.

References

- 1) Woods, W. (2006). "Single Microphone Noise Reduction Project Report," Starkey Labs.
- 2) Başkent, D. (2006). "Single Microphone Noise Reduction Fitting with the Genetic Algorithm Project Report," Starkey Labs.