White Box Search Over Audio Synthesizer Parameters

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Goal

Match synth to specific target sound?

- Tedious, even for experts

Goal: ***automatically*** match synth parameters.

- Search in high dimension!

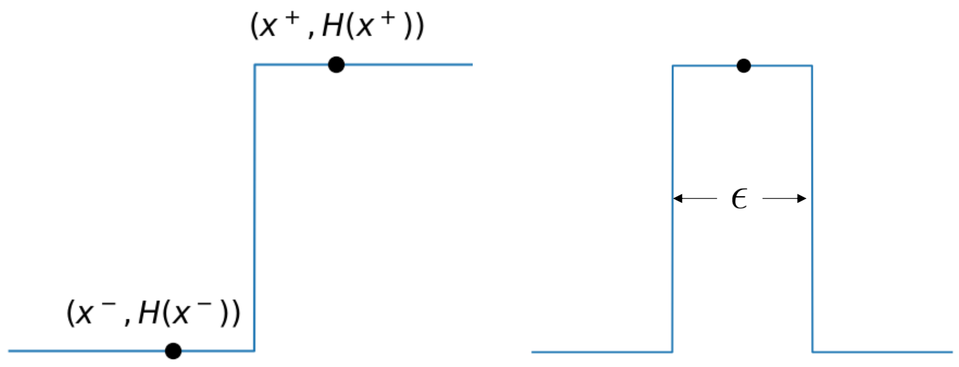
Challenges

Synth programs are discontinuous.

- Discontinuous waveforms.
  - ➢ Leverage techniques in differentiable rendering.
- Discrete knob choices.
  - ➢ Novel gradient rule for n-arg discrete operator.

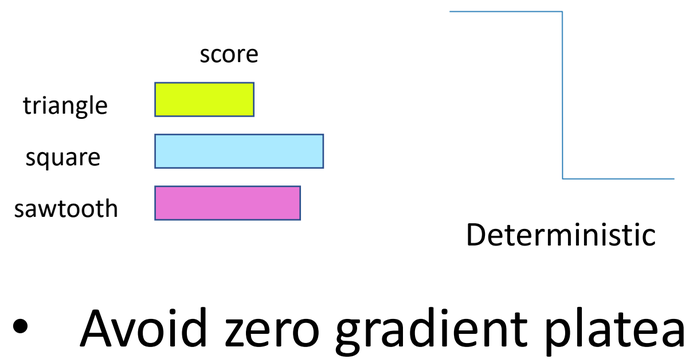
Method

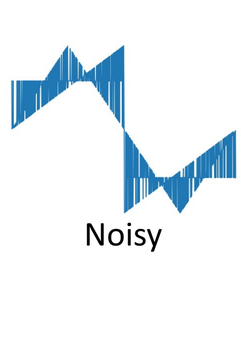
- Differentiating the waveform discontinuity.
  - ➢ Sample discontinuity with 2 evaluations.
  - ➢ Equivalent to differentiating after pre-filtering with 1D box



$$\frac{\partial_O H(x)}{\partial x} = \begin{cases} \frac{1}{|x^+ - x^-|} & \text{if } H(x^+) \neq H(x^-) \\ 0 & \text{otherwise} \end{cases} \qquad \phi(x;\epsilon)$$

- Differentiating the categorical choice.
  - ➢ During optimization: argmax scores are treated as random variables.



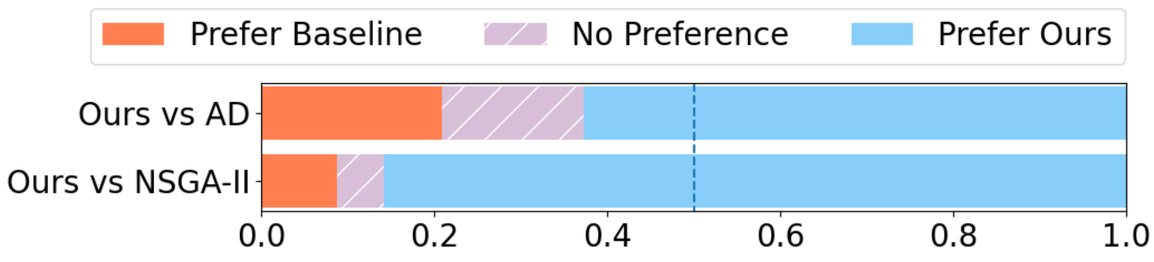


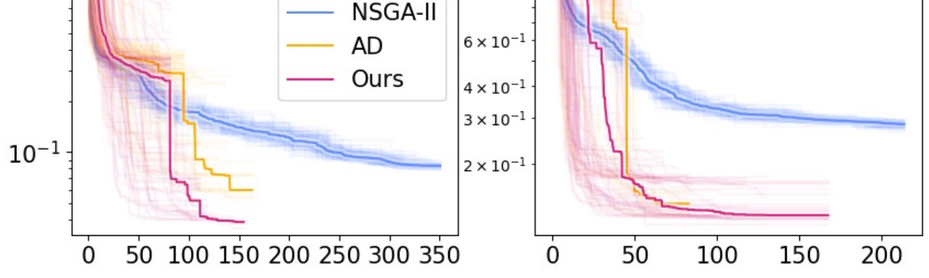
- Avoid zero gradient plateaus.
  - ➢ Novel reverse-mode AD rule for min/max.
- Identify perceptually similar results.

Evaluation

Match musical instrument targets with a simple FM synth.

- Ours is preferred by in the AMT listening test.





- Ours has higher MOS score in almost every target instrument.