Graphical Control of a Parametric Equalizer

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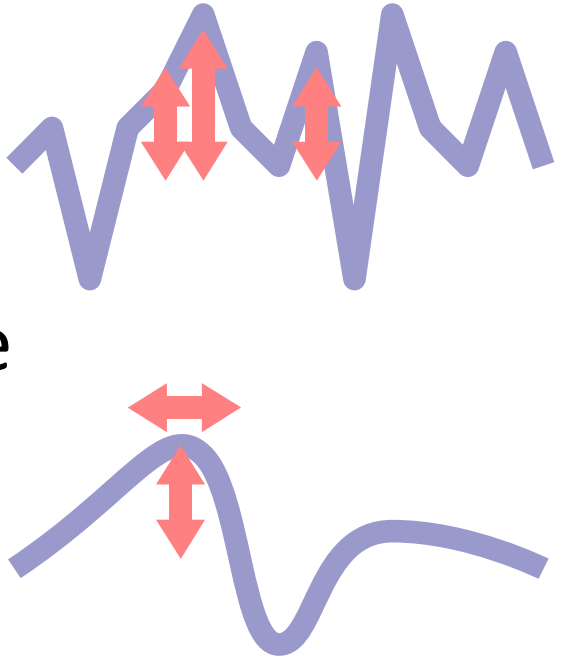
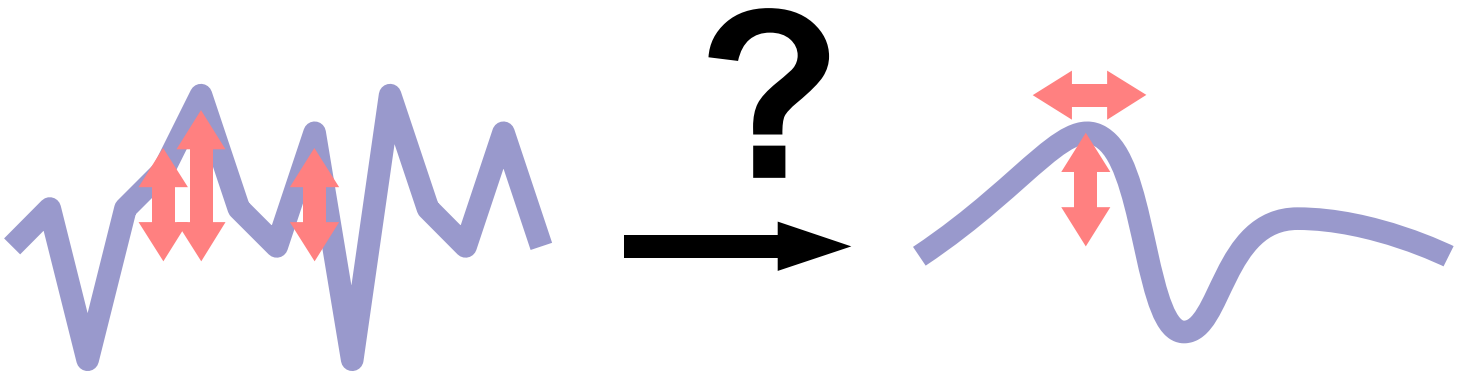
Problem Setting



- Graphic EQ
  - Versatile magnitude response
  - Easy-to-understand interface
- Parametric EQ
  - Minimally invasive: naturally soft magnitude and phase response
  - Low computational load
- Combine the best of both worlds!

Objective

- On the outside: graphic EQ
- On the inside: parametric EQ

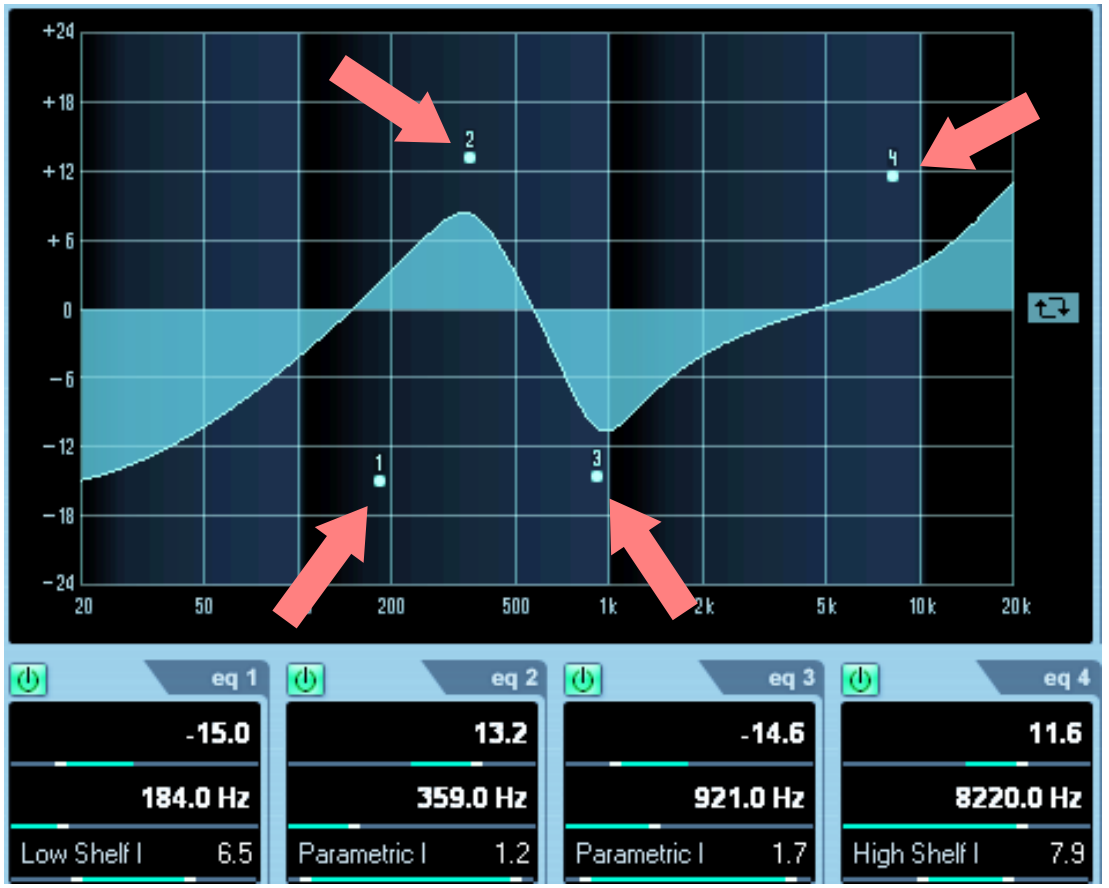


- Demo

Outline

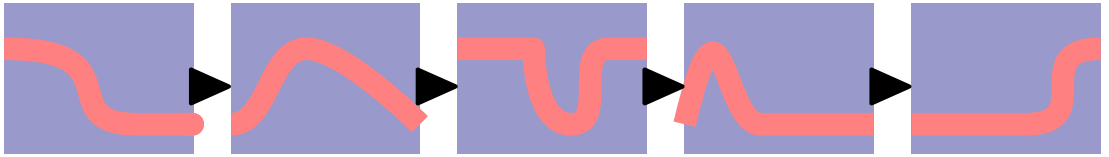
- Related work
- Architecture
- Optimization process
- Five user interface modes
- Optimization speed
- Conclusion

Related Work



- Standard UI for Parametric EQ with movable dots: only approximation
- Optimization of filters (in particular Ramos/López 2006)
- Genetic optimization of a mix (Kolasinski, this AES Convention)

Architecture



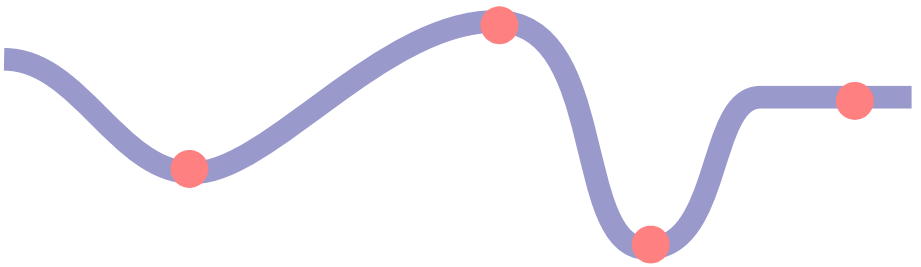
- Model a standard parametric EQ
- Up to five bands
- One band may be low-shelving, one may be high-shelving
- Optimization can control all parameters including the number and types of bands
- User may override the optimization through standard controls

Optimization Process

- Minimize deviation of magnitude response from user input
- Evolution; population: 100; seeding; tournaments; crossover of EQ bands
- Mutation: slightly vary f, Q/slope, gain
- In parallel: real-time audio processing
  - Uses current best genotype
  - Which may be affected by mutations or may be superseded

Mode 1:
Automatic Gain Adaptation

- User input:
  - One dot per EQ band
  - One additional dot to control the overall level
- Optimize gain settings only
- Types, f and Q/slope as set by the user
- Doesn't actually require genetics



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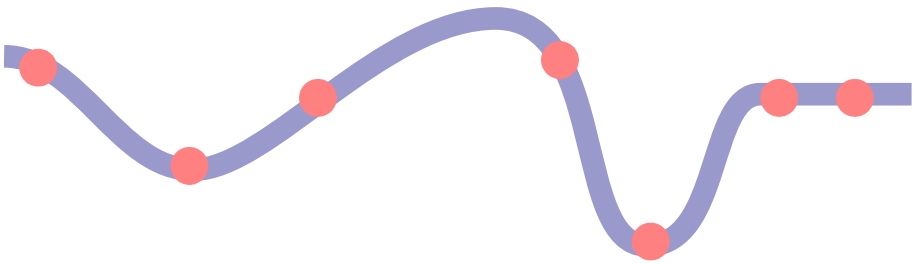
Mode 2:
Connecting the Dots

- User input: any number of dots
- Optimize for f, Q/slope, gain
- Optimize for the number and type of bands: If RMS error in magnitude response is < 1 dB, error measure favors simpler EQ



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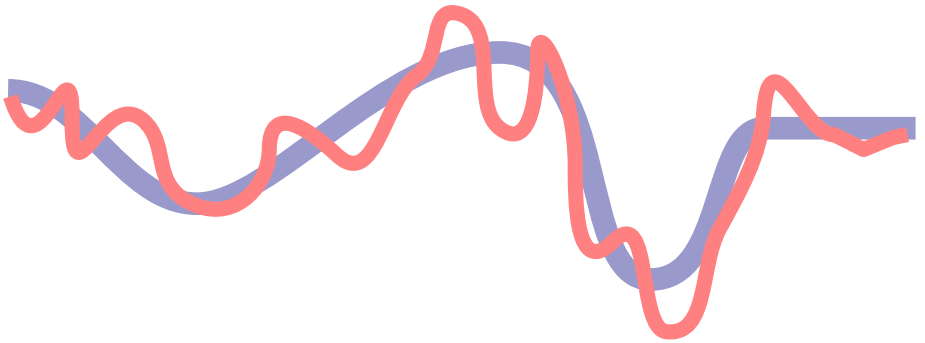
Mode 3: Freehand Curve

- User input: freehand curve
- Optimize for f, Q/slope, gain
- Optimize for the number and type of bands
- Multiscale analysis to seed genetic algorithm



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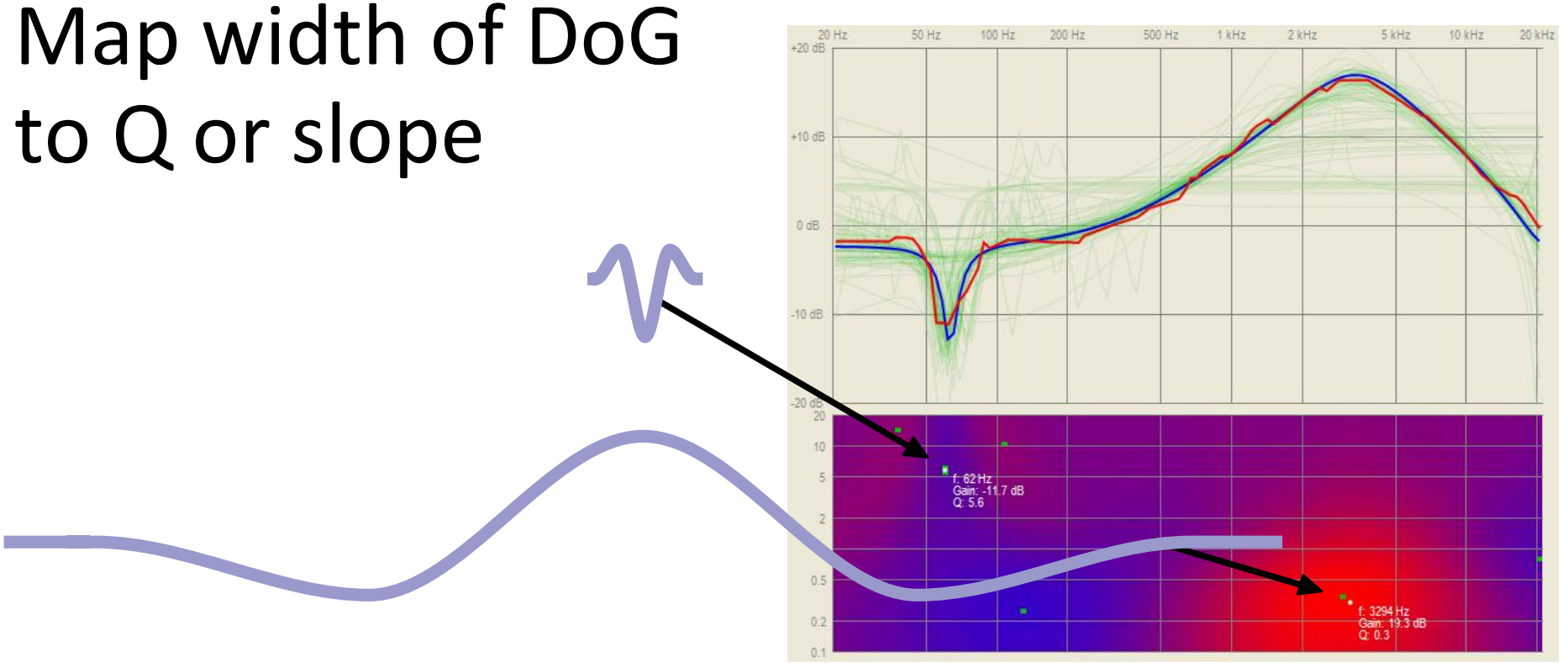
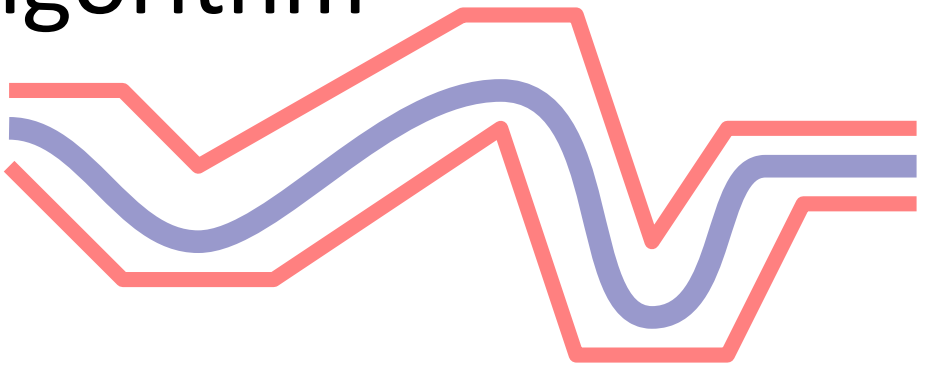
Detour: Multiscale Analysis

- Convolve with Difference of Gaussians (DoG) at “all” widths
- Look for extrema (after correct scaling)
- Map width of DoG to Q or slope



Mode 4:
Lower and Upper Bounds

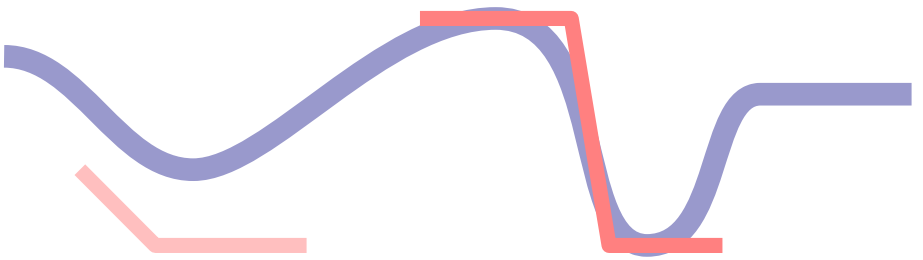
- User input: freehand corridor
- Optimize for f, Q/slope, gain
- Penalize magnitude responses that leave the corridor
- Multiscale analysis of midline to seed genetic algorithm



- Demo

Mode 5:
Strokes plus Importance

- Specify response where it's important
- User input: partial curves with different importance (displayed as opacity)
- Error measure based on importance
- Optimize for f, Q/slope, gain, number and type of bands



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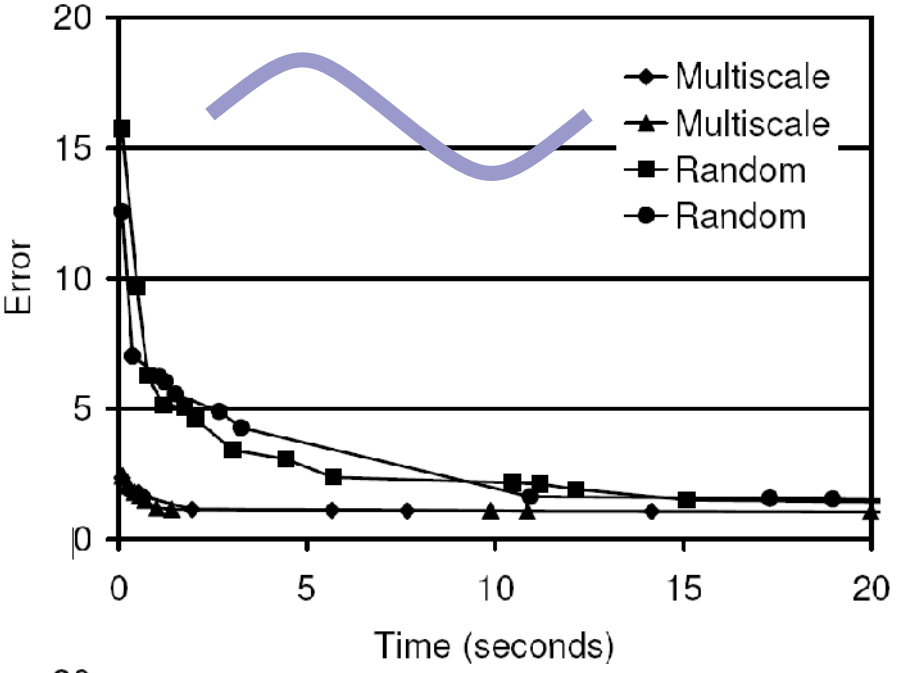
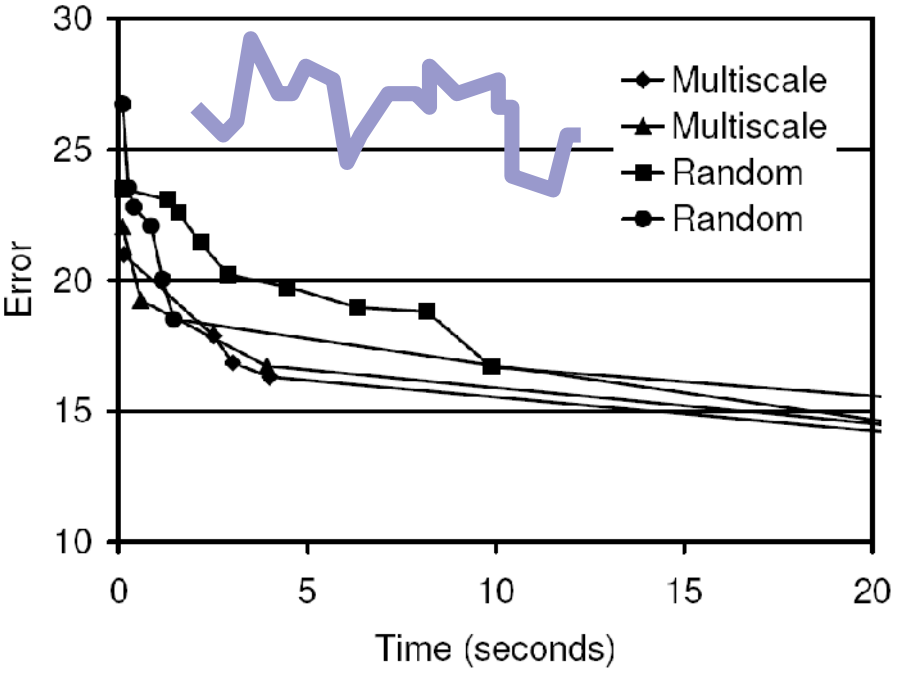
Optimization Results

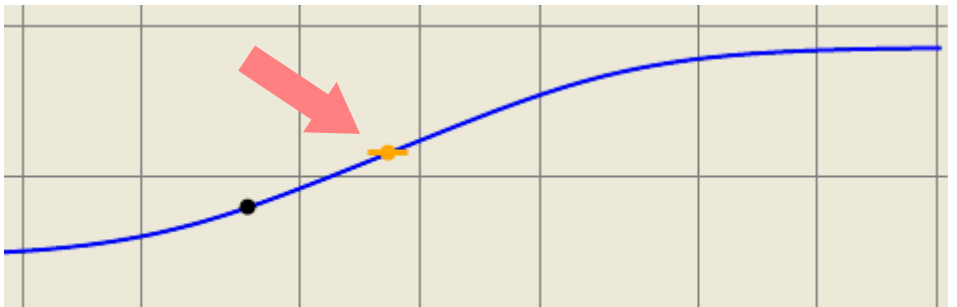
- Small tweaks incorporated within fractions of a second
- Coarse changes typically in less than one second
- Late changes occur
- Multiscale helps a lot





Conclusion

- Interactive control, real-time operation
- Unexpected solutions (benefit?)
- Future work:
  - Audio glitches when best filter is replaced: Blend? (Phase problems?)
  - Non-determinism: same input, different control
  - Interactive tweaking of curves: Smudge tool?
  - Better UI for shelving filter?



Questions?