UNIVERSITY OF MICHIGAN

Creative Coding (PAT 204/504, Fall 2025)

Lecture 20: Recording, Panning & Balancing

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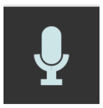
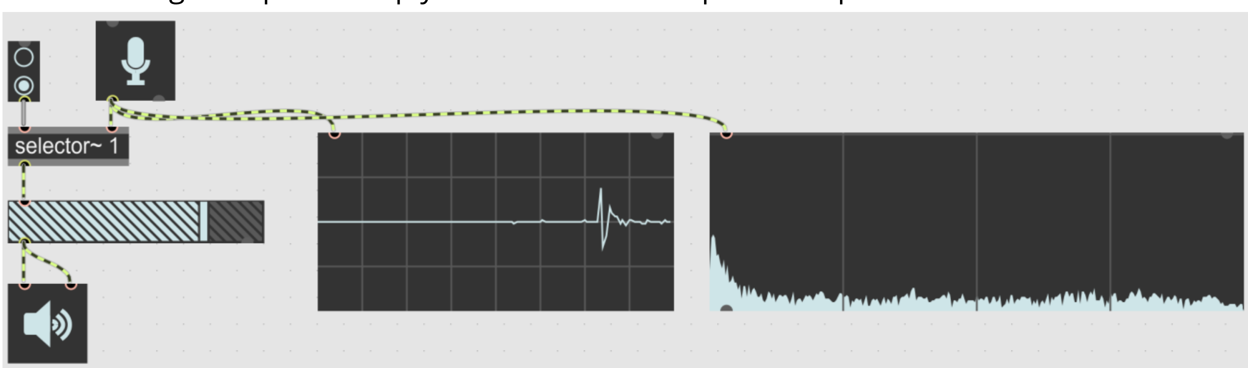
Example 1: Recording (“1_recording.maxpat”)

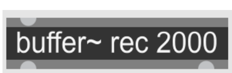
- Use the “ezadc~” to handle audio input



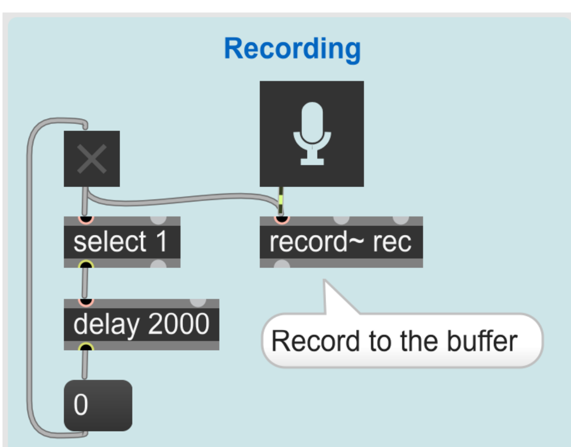
- The following MAX patch simply routes the audio input to output



- Use the “buffer~” object to store an audio sample

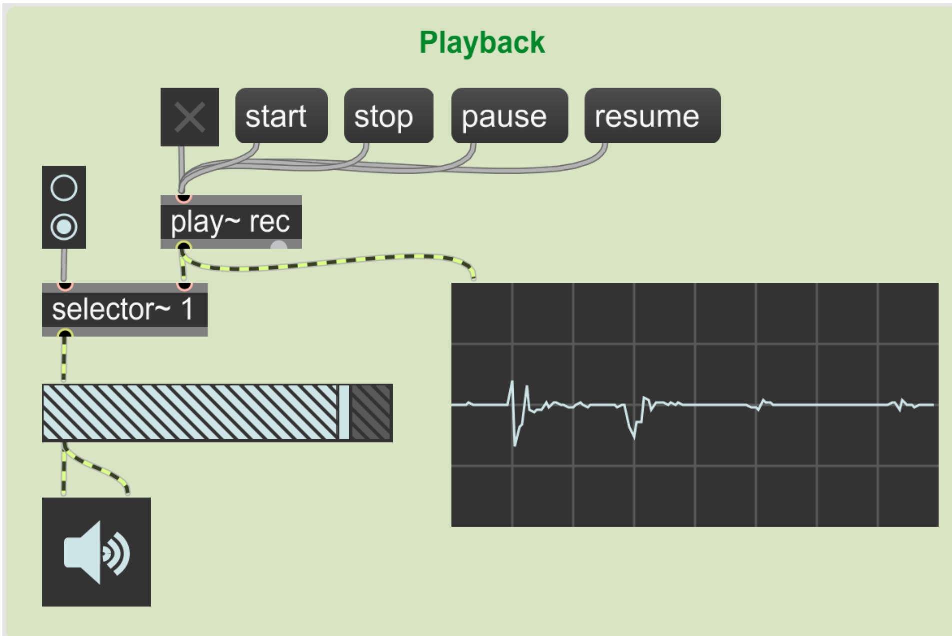


  - The “buffer~” object creates a buffer named “rec” with a length of 2000 ms
- Use the “record~” object to record the audio input from the “ezadc~” object to the buffer “rec”

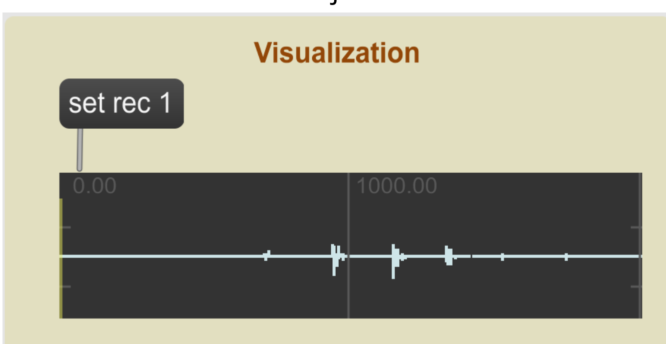


- When the toggle is clicked, it sends a “1” to “record~” that starts the recording and a “0” to “record~” after 2000 ms that stops the recording. Note that the “delay” object delays the bang message sent from the “select 1” object by 2000 ms.

- Use the “play~” object to play the recording stored in the audio buffer

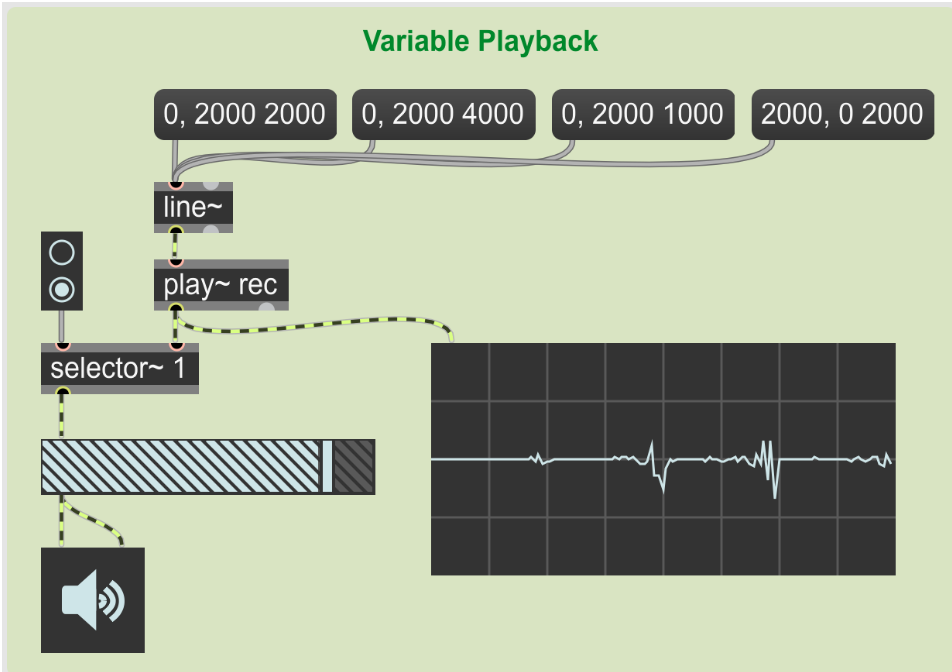


- Use the “waveform~” object to visualize an audio buffer



  - The “set rec 1” message set the content of the “waveform~” object to the 1st channel of the buffer named “rec”

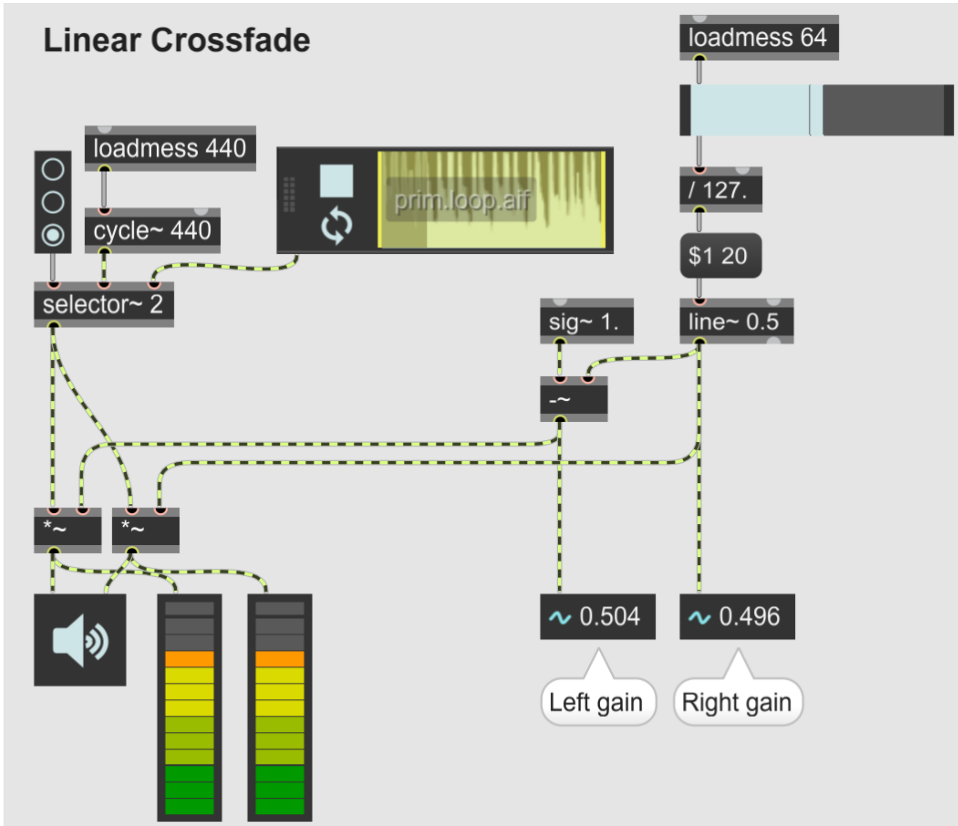
- Send a signal to the "play~" object, say a "line~" object for variable playback



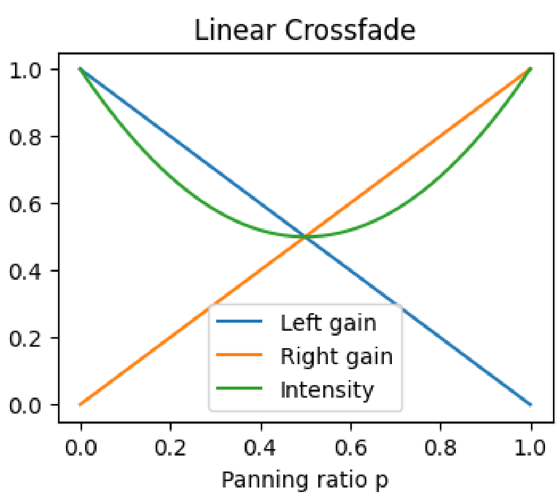
  - "0, 2000 2000" plays the sample normally
  - "0, 2000 4000" plays the sample with half speed
  - "0, 2000 1000" plays the sample with double speed
  - "2000, 0 2000" plays the sample backward

Example 2: Panning ("2_panning.maxpat")

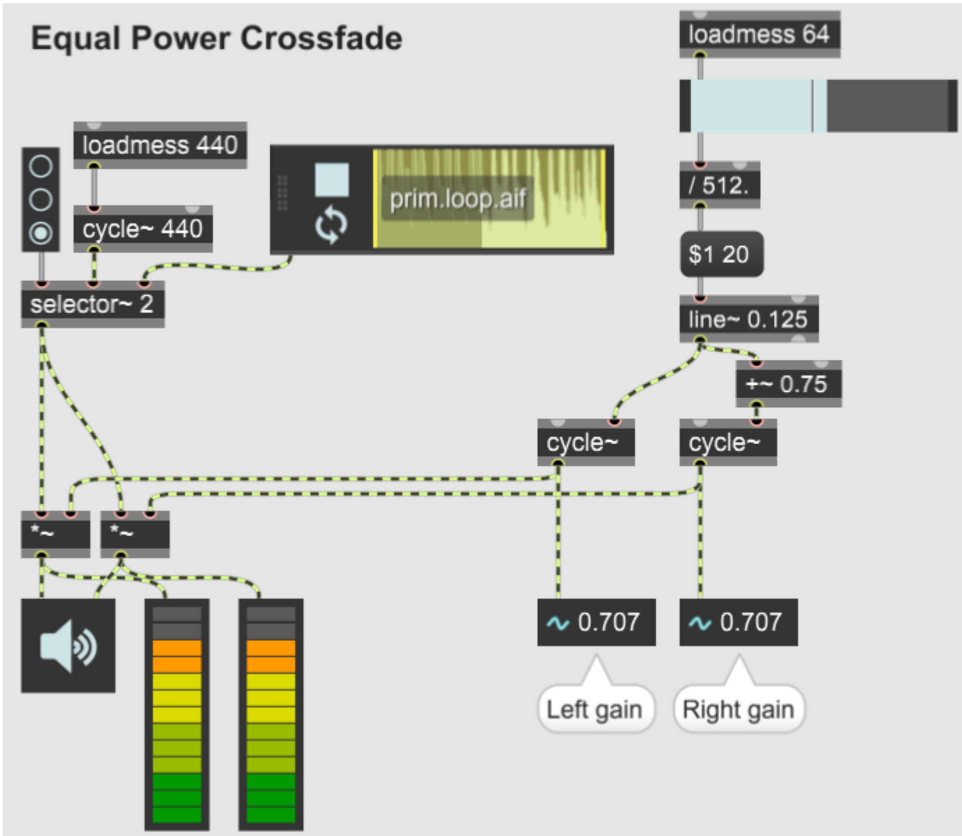
- Panning refers to the process of placing a monophonic sound source to a stereo/multichannel sound field.
- The first example shows the simplest form of panning -- linear crossfade, where the gains of the left channel and the right channel always sum to 1.



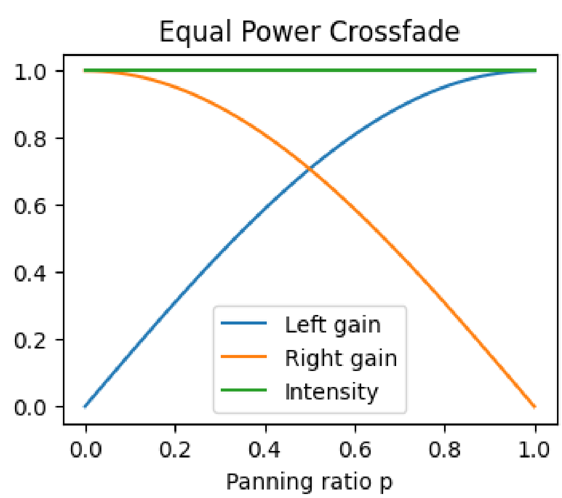
- Note that intensity is proportional to the square of the magnitude of a signal, and thus this creates a dip in power when it's panned to the center, as shown below. At the center, we have the left gain of 0.5 and right gain of 0.5, which leads to an intensity of $0.5^2 + 0.5^2 = 0.25 + 0.25 = 0.5$, half of the power of the original signal.



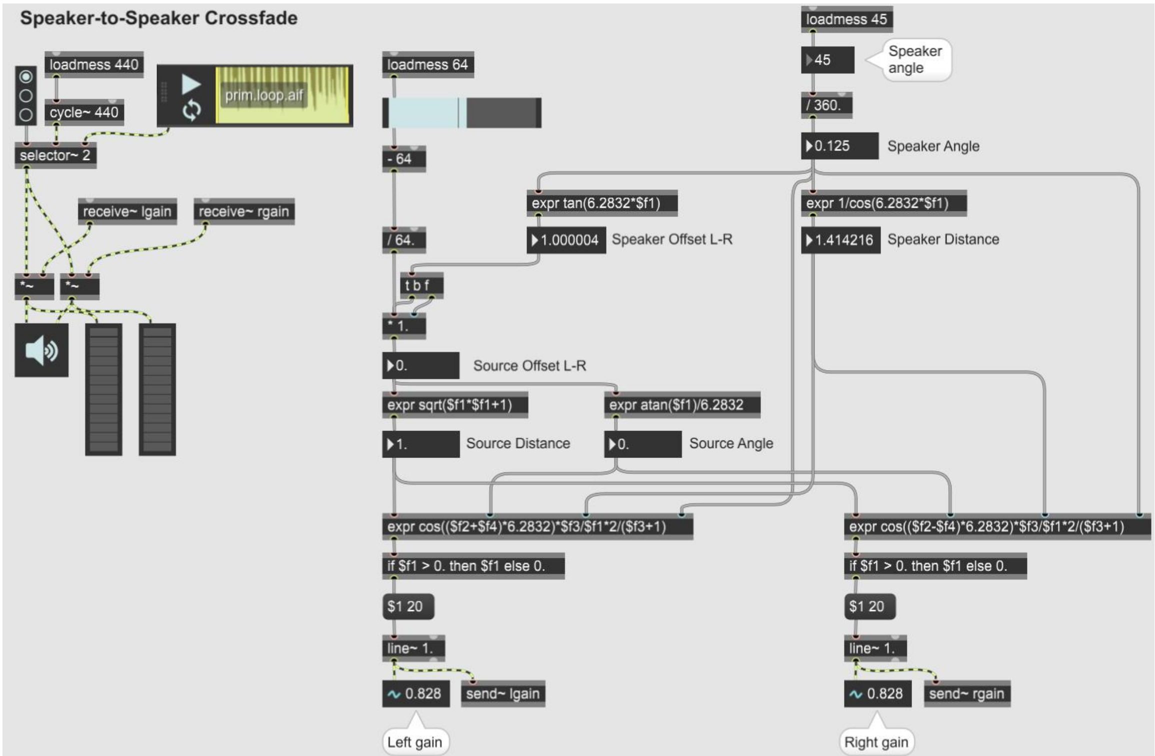
- The second example shows the equal power crossfade, where we aim to keep a constant power at different panning position.



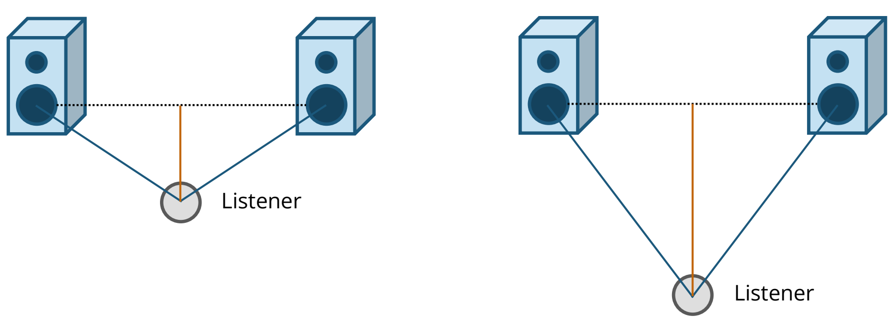
  - Equal power crossfade can be done using the formula $Gain_{Left} = \sin\frac{p\pi}{2}$ and $Gain_{Right} = \cos\frac{p\pi}{2}$, where $p \in [0, 1]$ is the panning ratio. This way, the power $Gain_{Left} + Gain_{Right} = \left(\sin\frac{p\pi}{2}\right)^2 + \left(\cos\frac{p\pi}{2}\right)^2 = 1$, thus maintaining a constant power for any panning ratio.



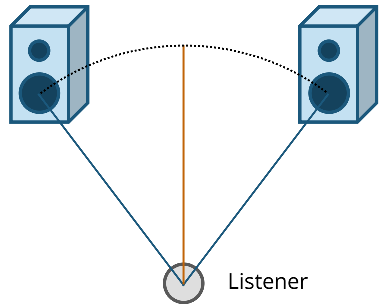
- The final sample shows the speaker-to-speaker crossfade, where we want to mimic a sound object moving from one speaker to the other. This requires some math, but the idea is to calculate the relative power at different panning position according to the distance to the listener.



    - Depending on the angle between the two speakers, the increase of power at the center will be different. For example, if the speaker angle is large, as shown in the left figure below, the sound object when placed at the center should sound louder than the case when the speaker is small, as shown in the right figure below.

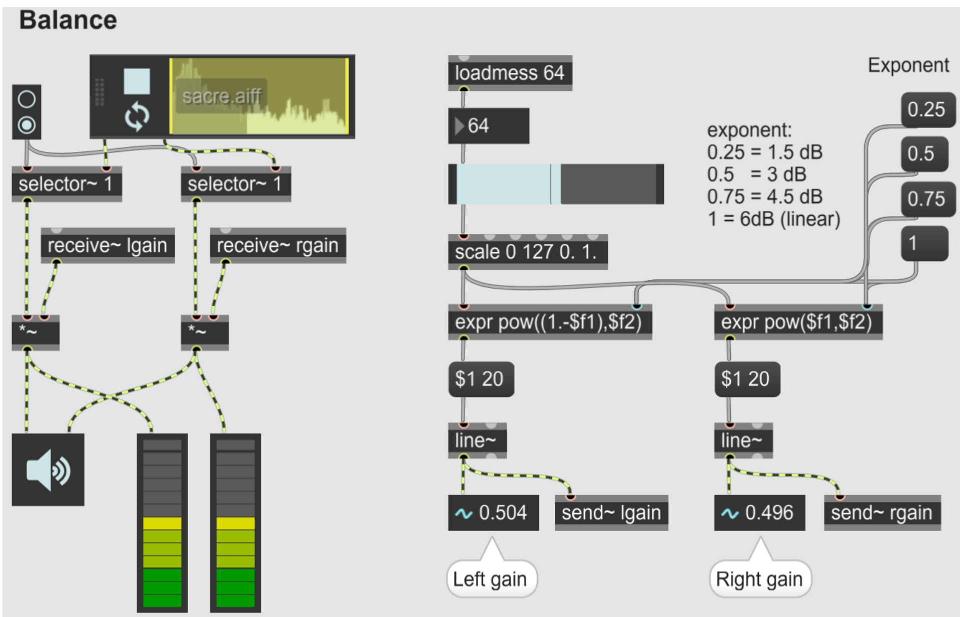


    - Unlike speaker-to-speaker crossfade, equal power crossfade mimics the case where the sound object travels between the two speakers in a curve and maintains an equal distance at different panning position, as shown below.

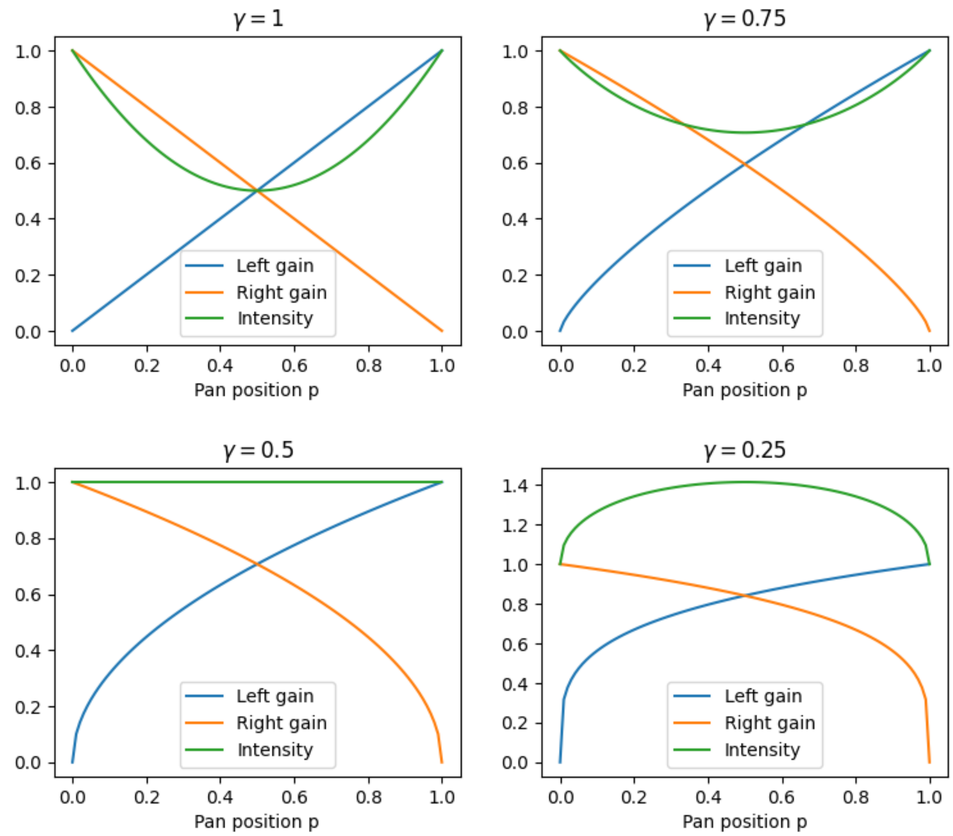


Example 3: Balancing ("3_balancing.maxpat")

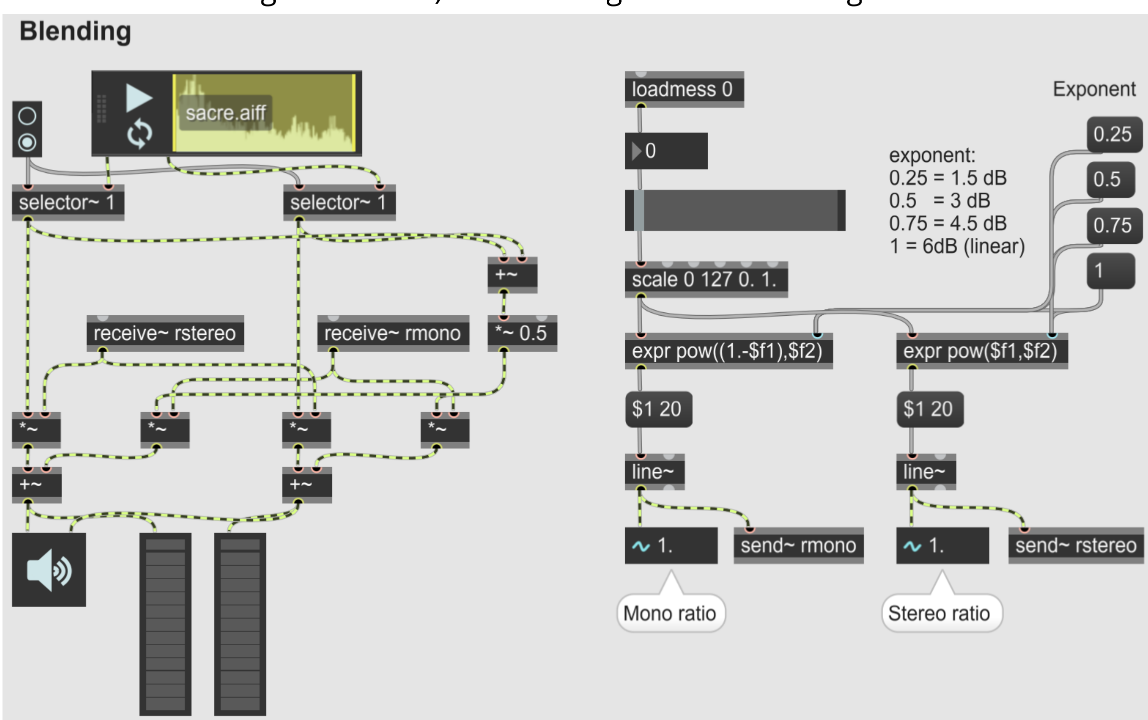
- Balancing refers to the process of adjusting the channel levels for a stereo or multichannel audio recording.



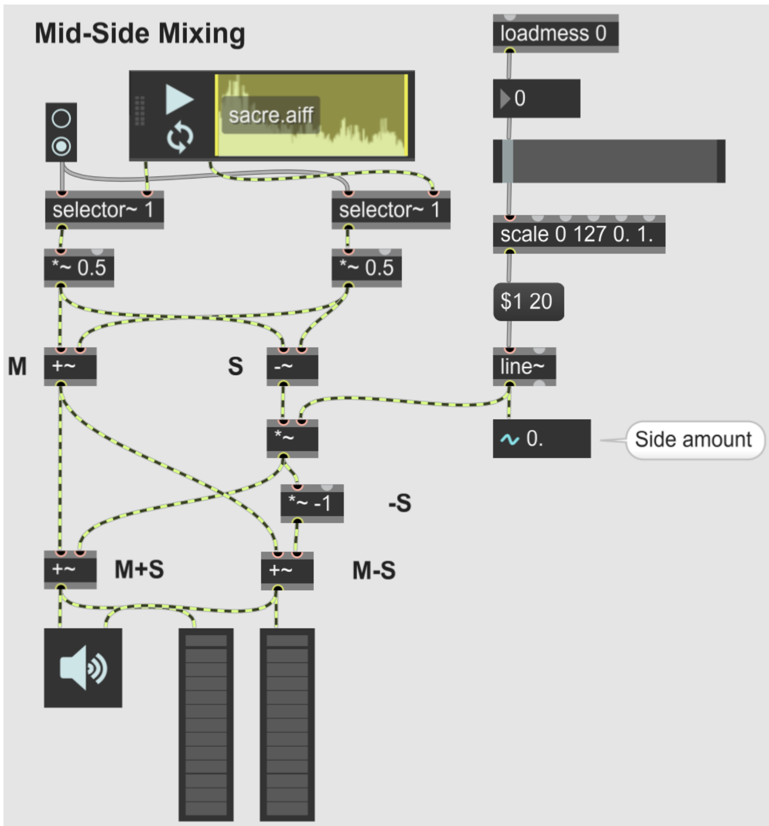
  - In this example, we apply a simple formula for balancing the two channels, where $Gain_{Left} = p^{\gamma}$ and $Gain_{Right} = p^{1-\gamma}$. The figures below show the left and right channel gains at different pan positions for $\gamma = 1, 0.75, 0.5, 0.25$. Note that $\gamma = 1$ leads to a linear balancing and a same reduction of half power at the center as linear crossfade for panning. Also, note that $\gamma = 0.5$ leads to equal power balancing. While $\gamma = 0.25$ leads to an increased power at the center position.



- Blending refers to the process of mixing the mono version (by averaging the signals from the left and right channels) with the original stereo L/R signals.



- The mid-side mixing adopts a more intuitive approach for stereo mixing. Here, we define the middle signal as the average of the left and right signals, i.e., $M = \frac{L+R}{2}$. Now, we define the side signal as the difference between the left and right signals, scaled by 0.5, i.e., $S = \frac{L-R}{2}$. Now the output signals for the left and right channel are defined as $L' = M + \alpha S$ and $L' = M - \alpha S$, where α determines the side signal amount.



    - When $\alpha = 0$, we have $L' = M + \alpha S = M$ and $R' = M - \alpha S = M$, so we have the same signal for the left and right channels, thus making it mono.
    - When $\alpha = 1$, we have $L' = M + \alpha S = M + S = \frac{L+R}{2} + \frac{L-R}{2} = L$ and $R' = M - \alpha S = M - S = \frac{L+R}{2} - \frac{L-R}{2} = R$, so we have the original stereo signals as outputs.
    - When α is in between 0 and 1, it creates a mixture of the stereo and mono signals. Intuitively, α corresponds to the "width" of the stereo sounds, where the sound stage will become wider as α increases.