Multiple Speaker Feedback loops simulated within Python

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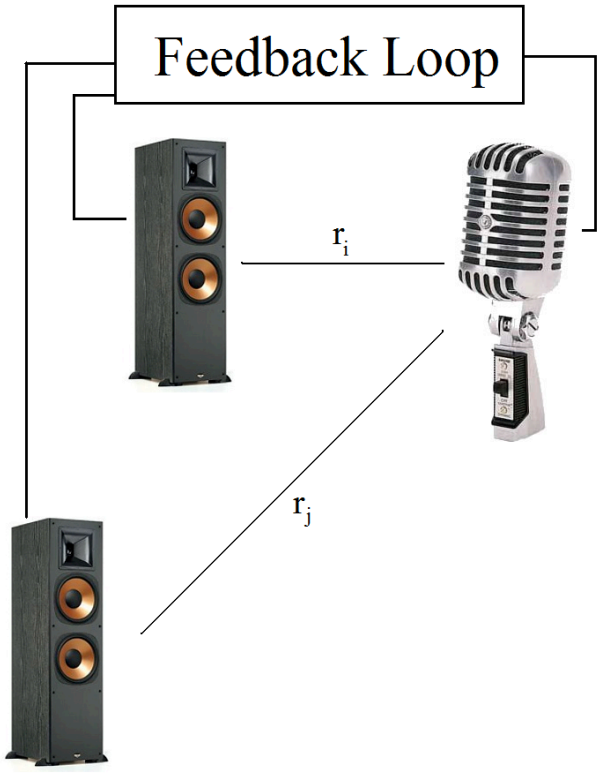
Overview

- System setup
- Ways to model it
- Some of the results
- Butchering of music
- Questions

System layout

- Multiple speakers at different distances from the microphone
- There could be n-speakers in the system
- Although not explored there could also be m-microphones in the system
- The Feedback Loop is not contained to be any one function (amplification, logistic map…)
- In theory you could make your own chorus/accapella with this setup



Modeling of the system

- Choose a simplest approach model to the system, viewing the distance as a time it takes for the sound to arrive at the microphone
- An initial signal will be inputted after that no other signal will be inputted

Modeling continued:

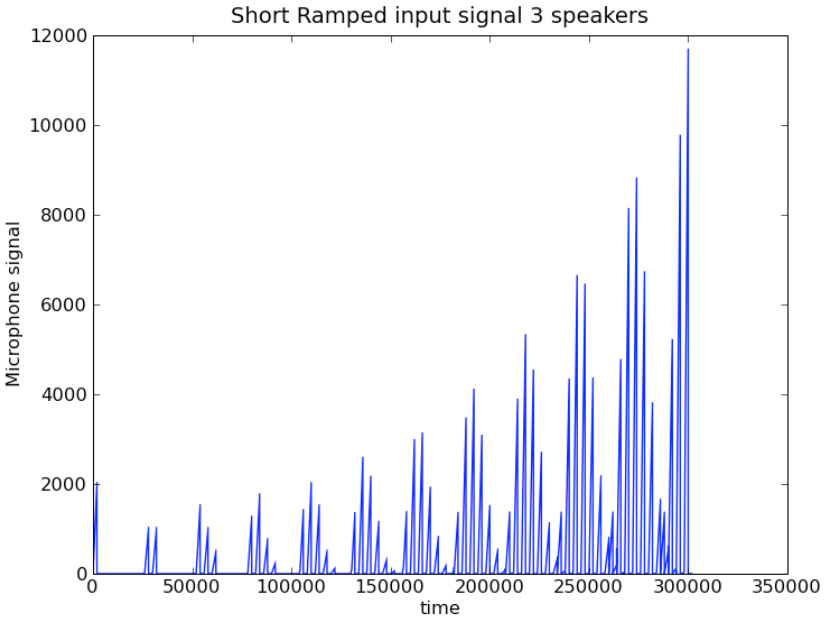
- If we call g(t) our microphone signal being received at a given time, τ being our delay and f(t) our original signal
- h(x,y) will return 0 if y < 0 otherwise it will perform an operator of our choosing on x
- We obtain the following expression

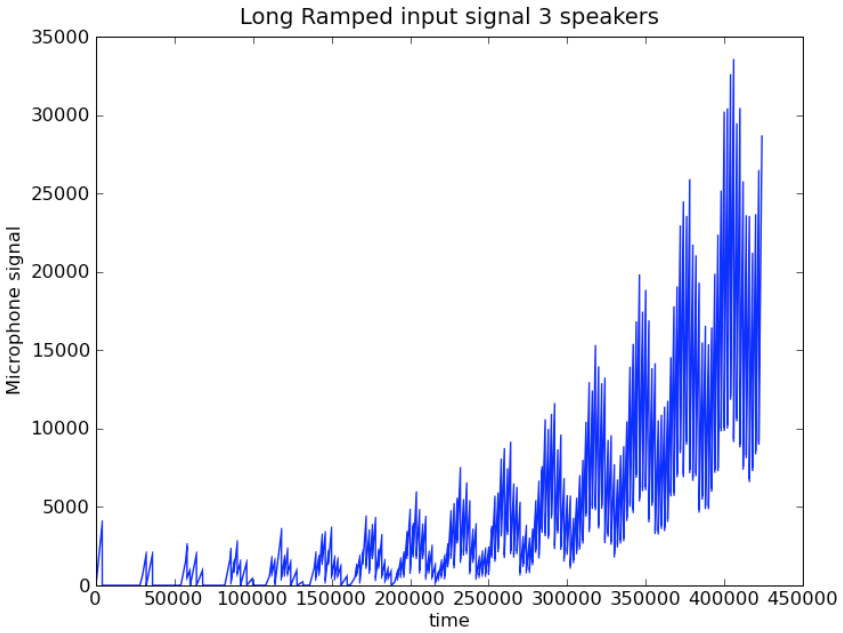
$$g(t) = \sum_i h_i(g(t-\tau_i), t-\tau_i) + f(t)$$

Some of the results

- For a simple feedback circuit of r*signal
- The first attempts show that we have an unstable fixed point at with two speakers r = 0.5 converging to some none-zero value at t = infinity, values less than 0.5 converge to zero and values greater than 0.5 go to infinity
- With three speakers the fixed point seems to move to r = 4/3
- There is evidence that a signal will also exhibit patterns of its inherited seeded signal such as a ramp function being evident as it explodes to infinity

3 Speaker ramped results:



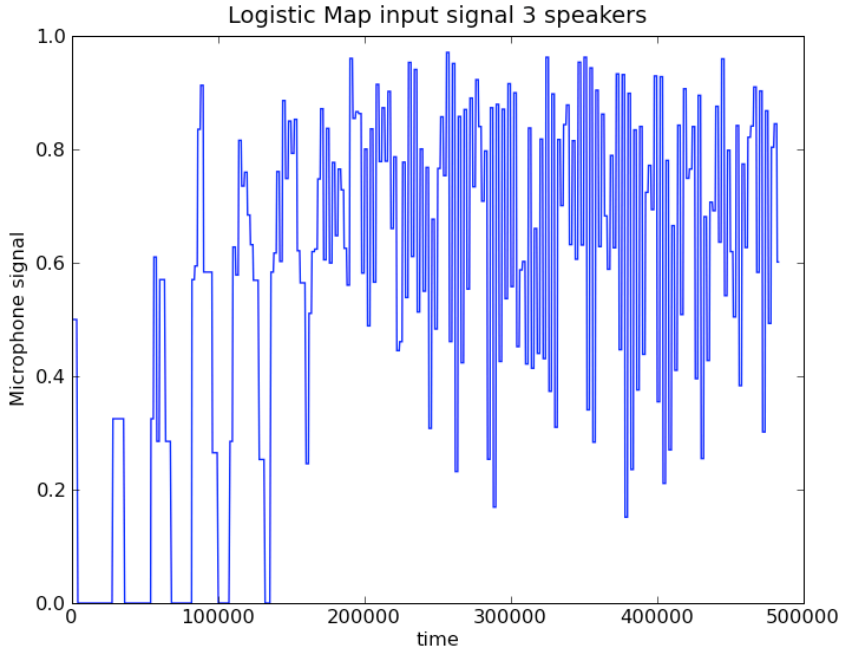


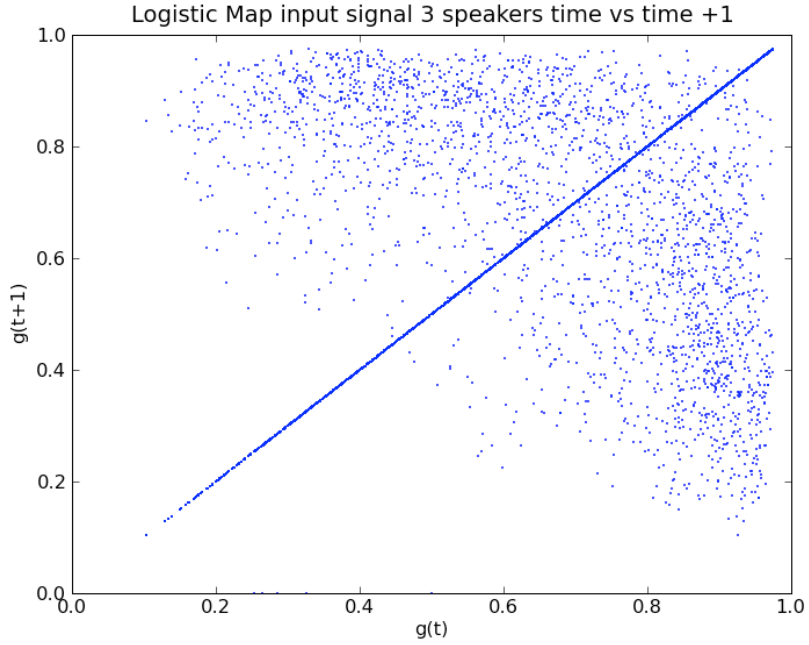
Duration of the ramped initial signal was doubled.
Also note that the second chart was run longer.

Logistic map findings

- When we pass our signal through the logistic map we have different findings
- We have another fixed point around r = 1.5 (in my case), for values less it converges and greater than it explodes
- But there is a region in which the fixed point neither explodes or converges for a 3 speaker setup, $1 < r < 1.4$

3 Logistic results:





Second graph was run 50 times longer than the first so we could view the final state would be more emphasized

Some sounds

- I’m going to play a 3 speaker setup with just a constant being multiplying it 
- Next I will butcher a classic piece of rock n roll in the name of science 

Questions

I would also like to thank Benny Brown and Ryan James for their help throughout the quarter