AUDIO FINGERPRINTING

PRACTICAL EXPERIMENT

NOUR SAFFAF – [15/MAR/2018]

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THEORY QUICK SKETCH

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THEORY QUICK SKETCH

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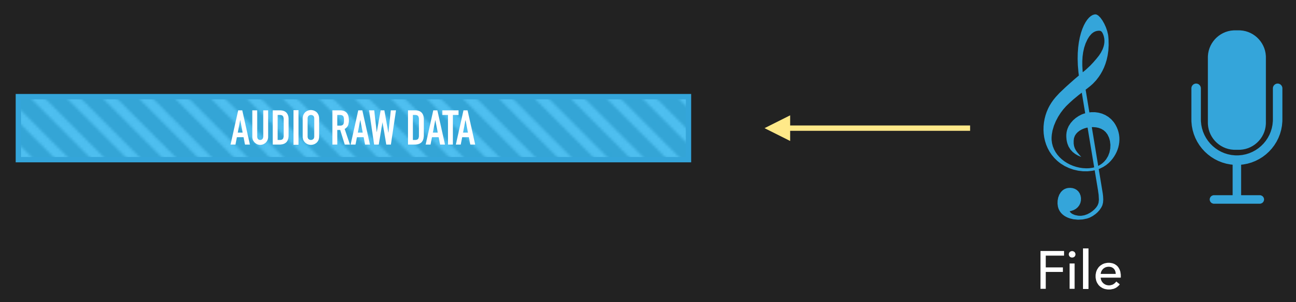

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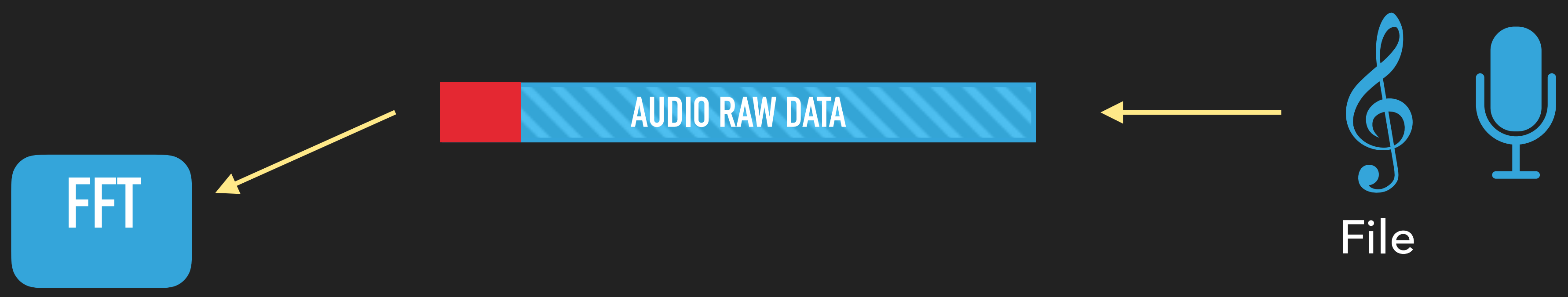

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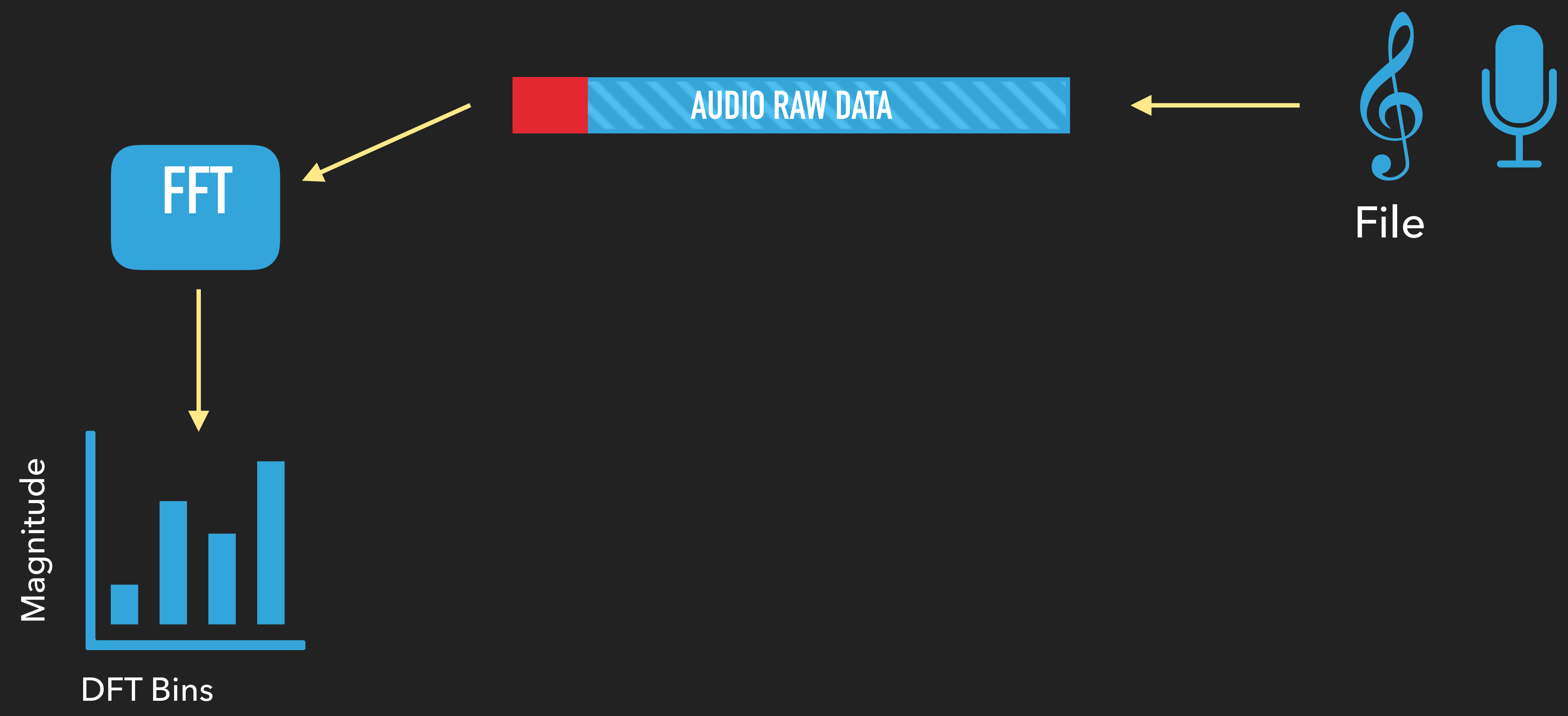

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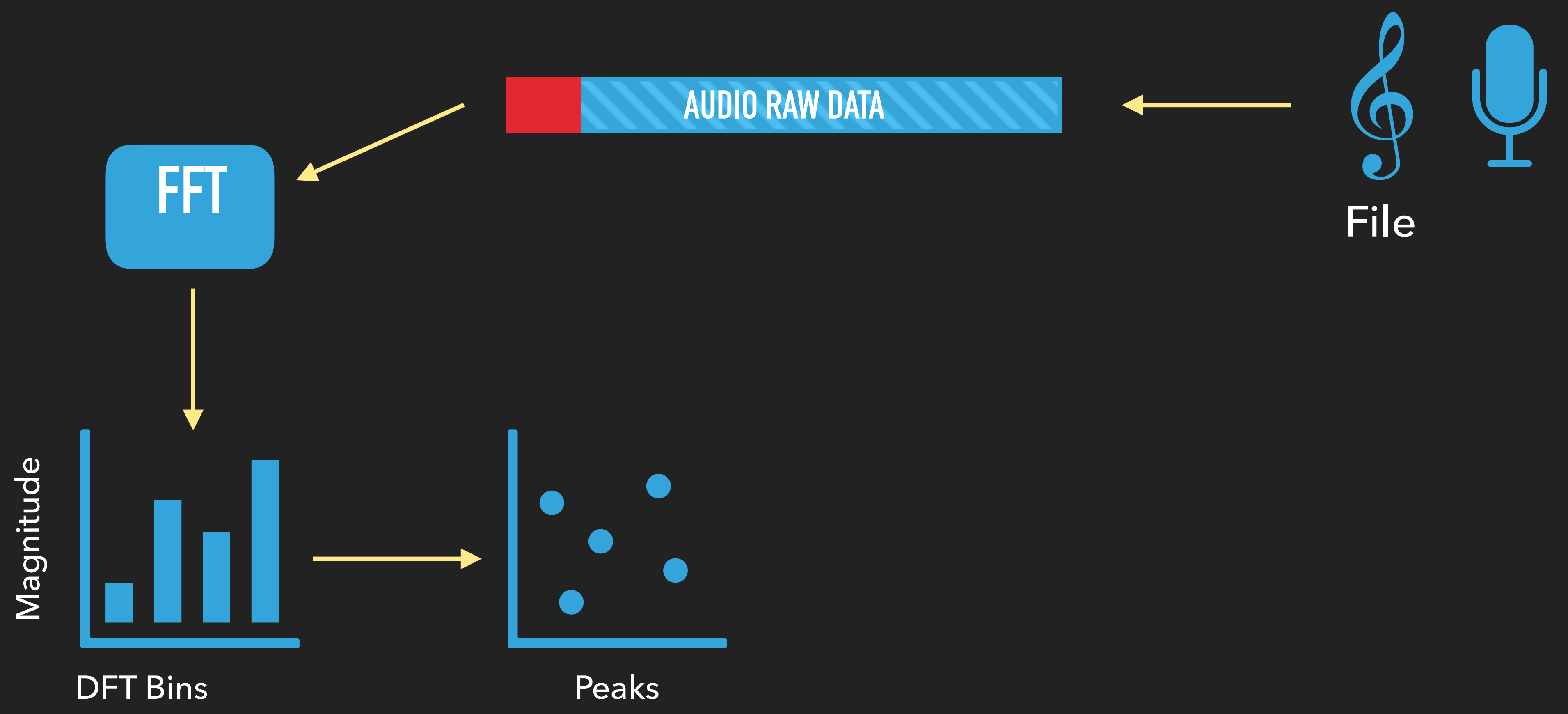

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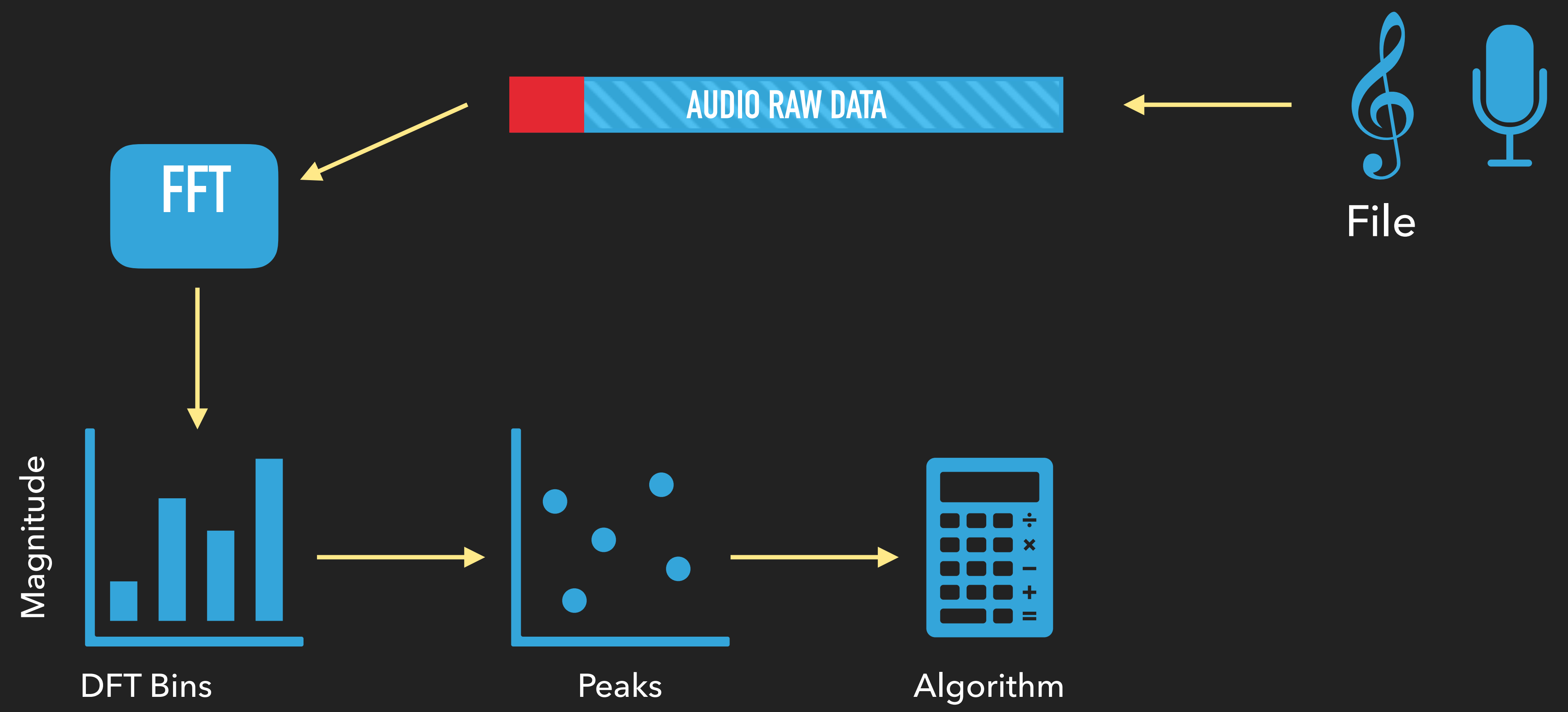

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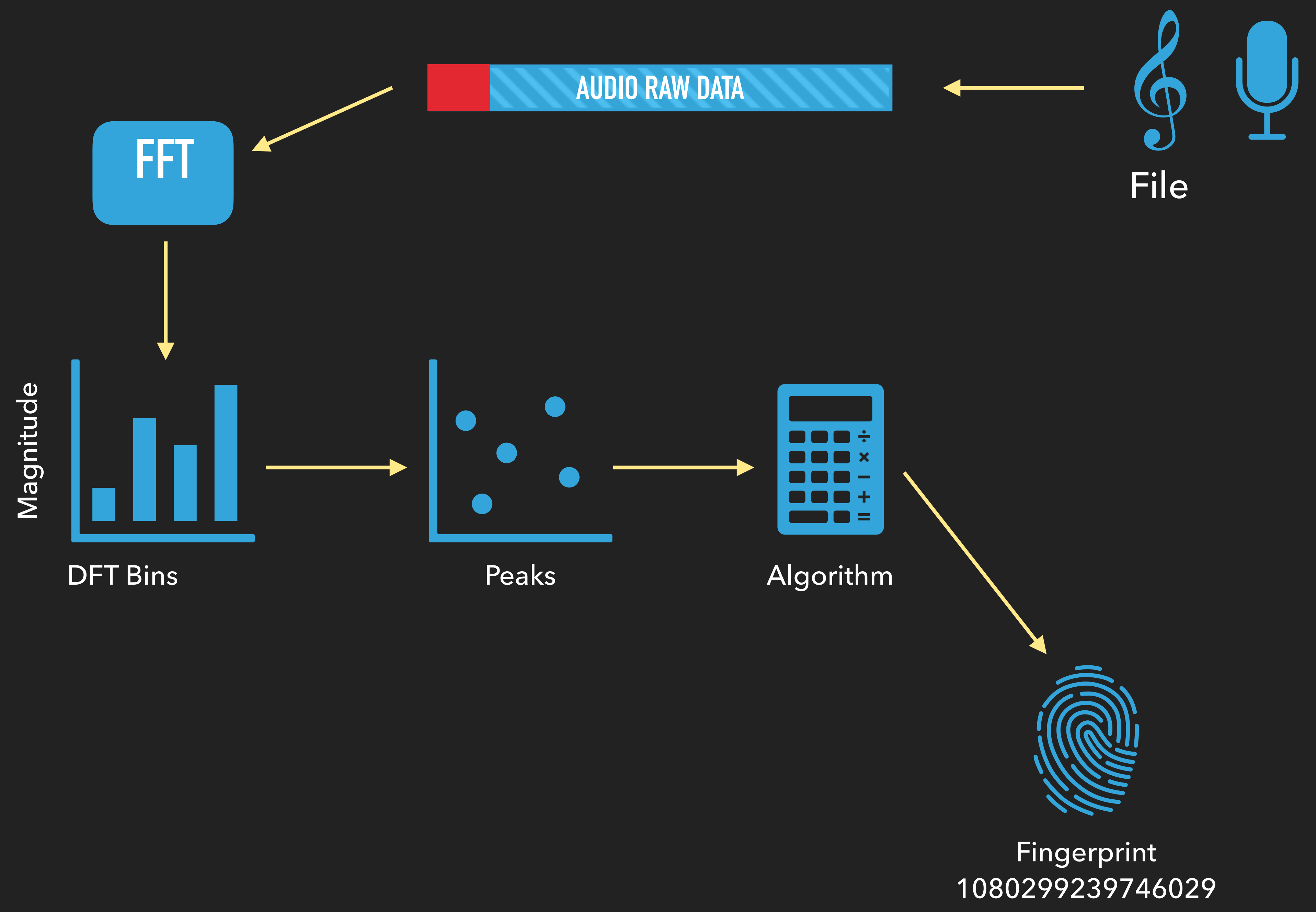

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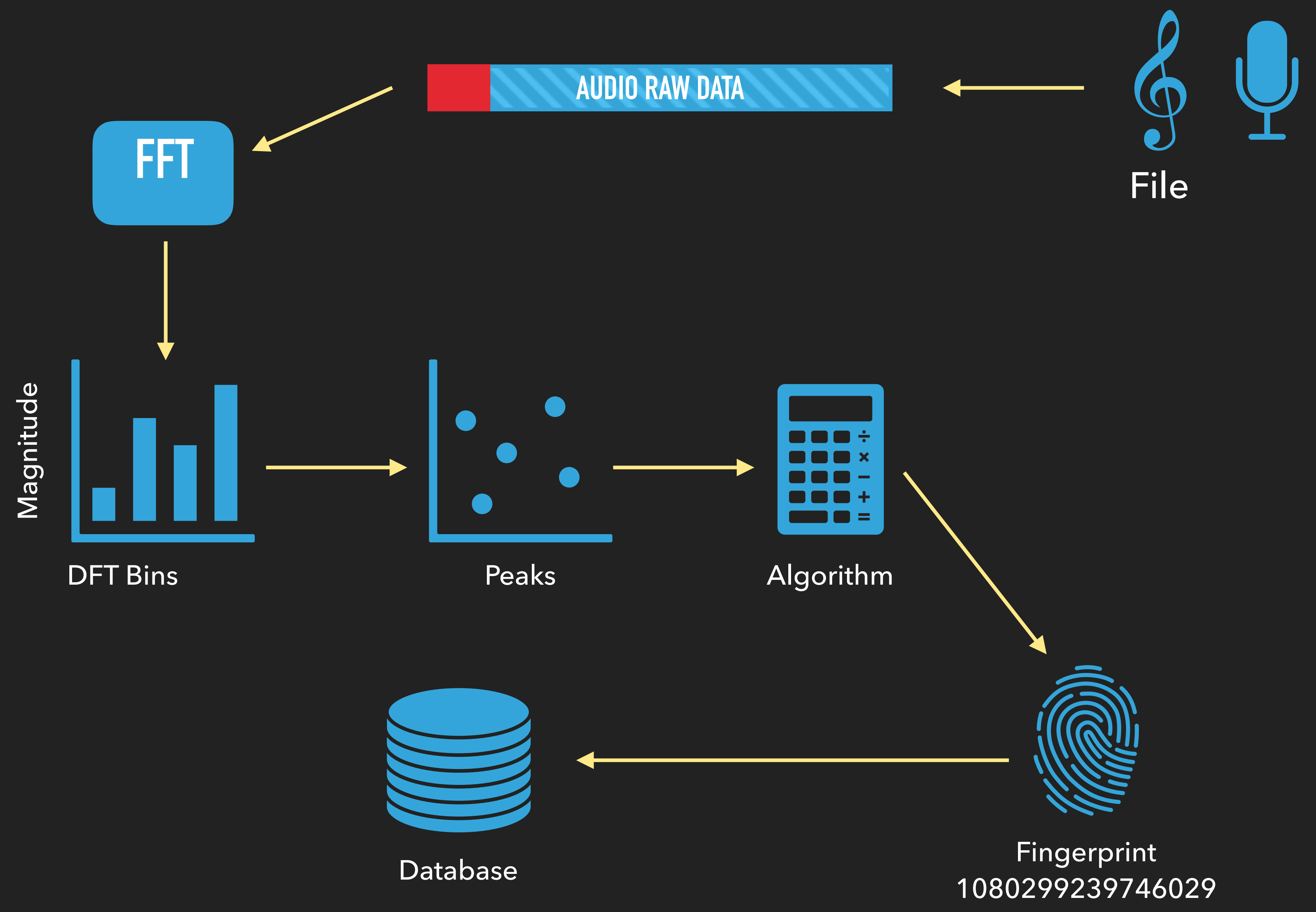

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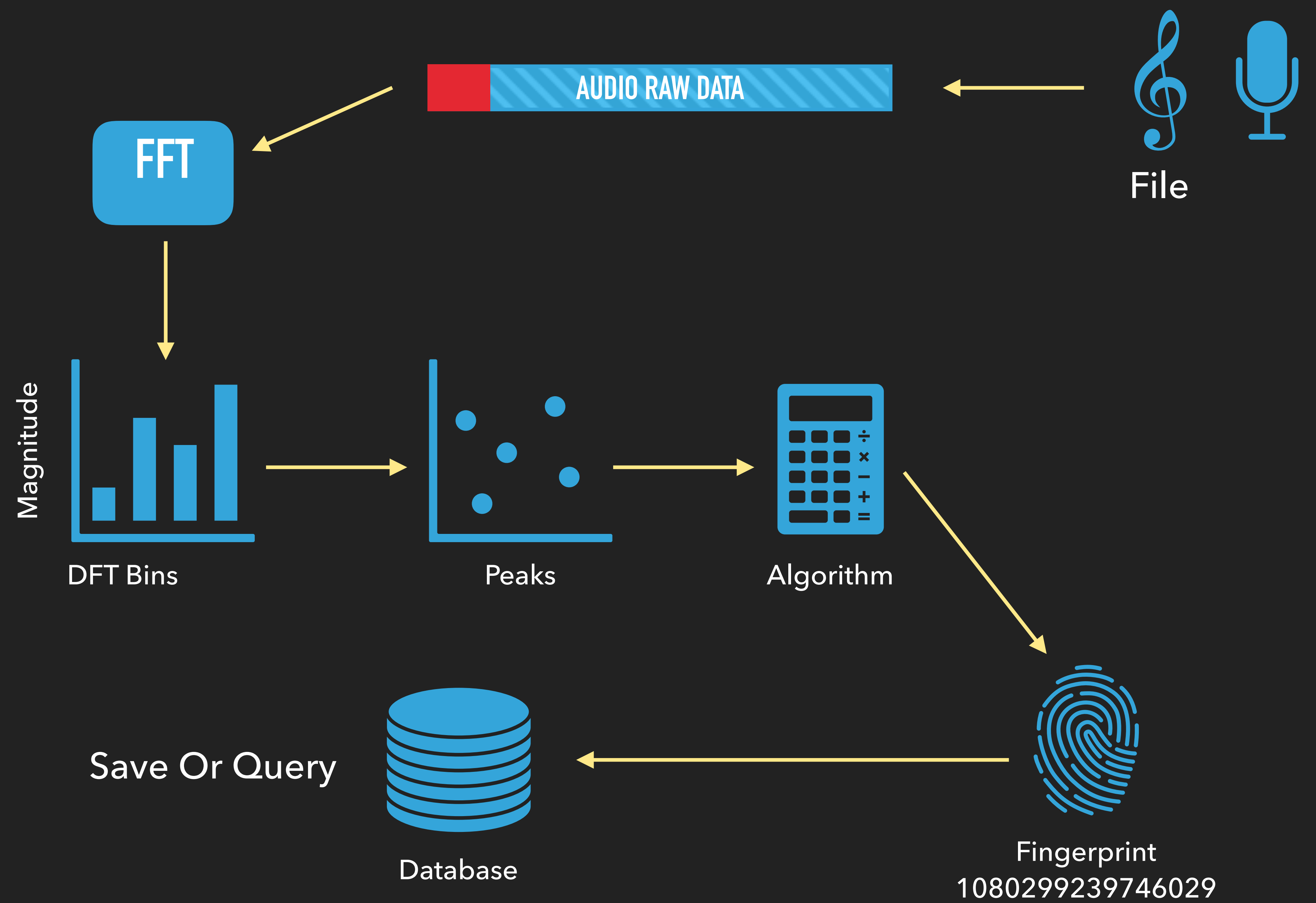

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- What to present now?

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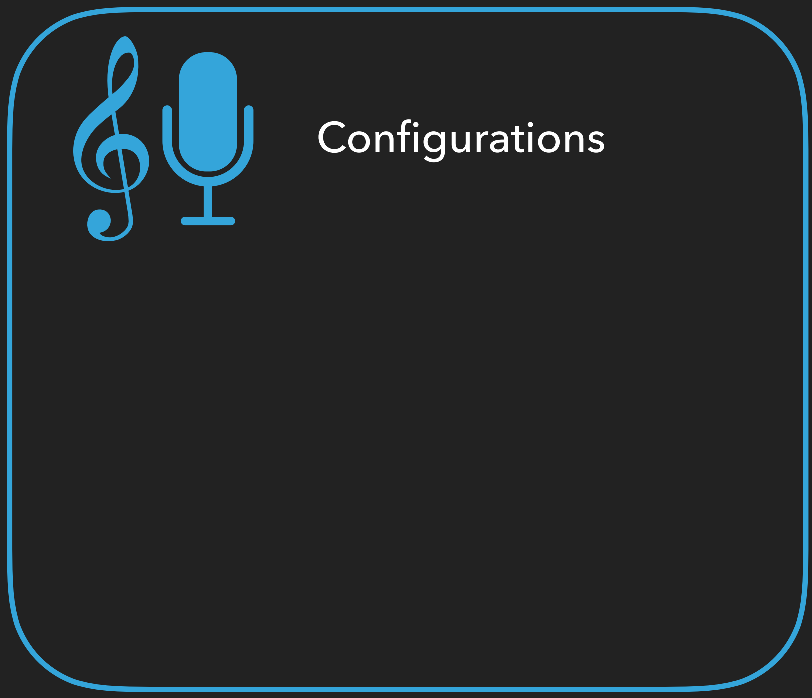

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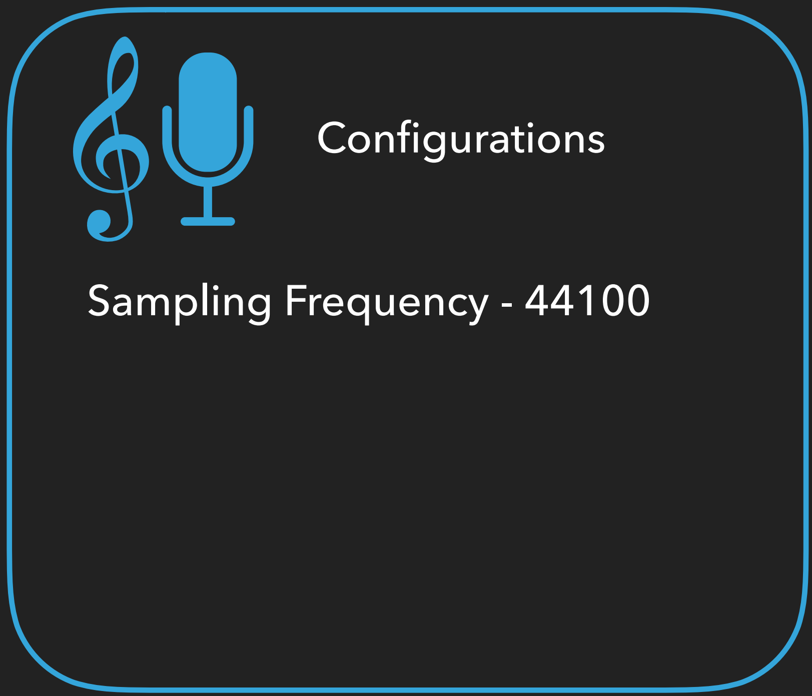

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- Tip: work on wav audio files

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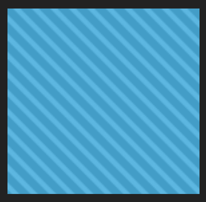

Chunk / Buffer

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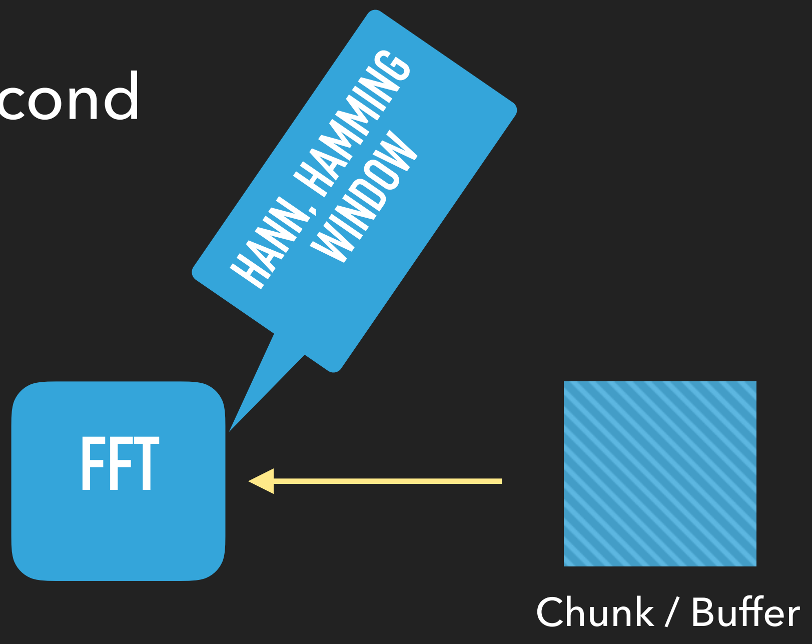

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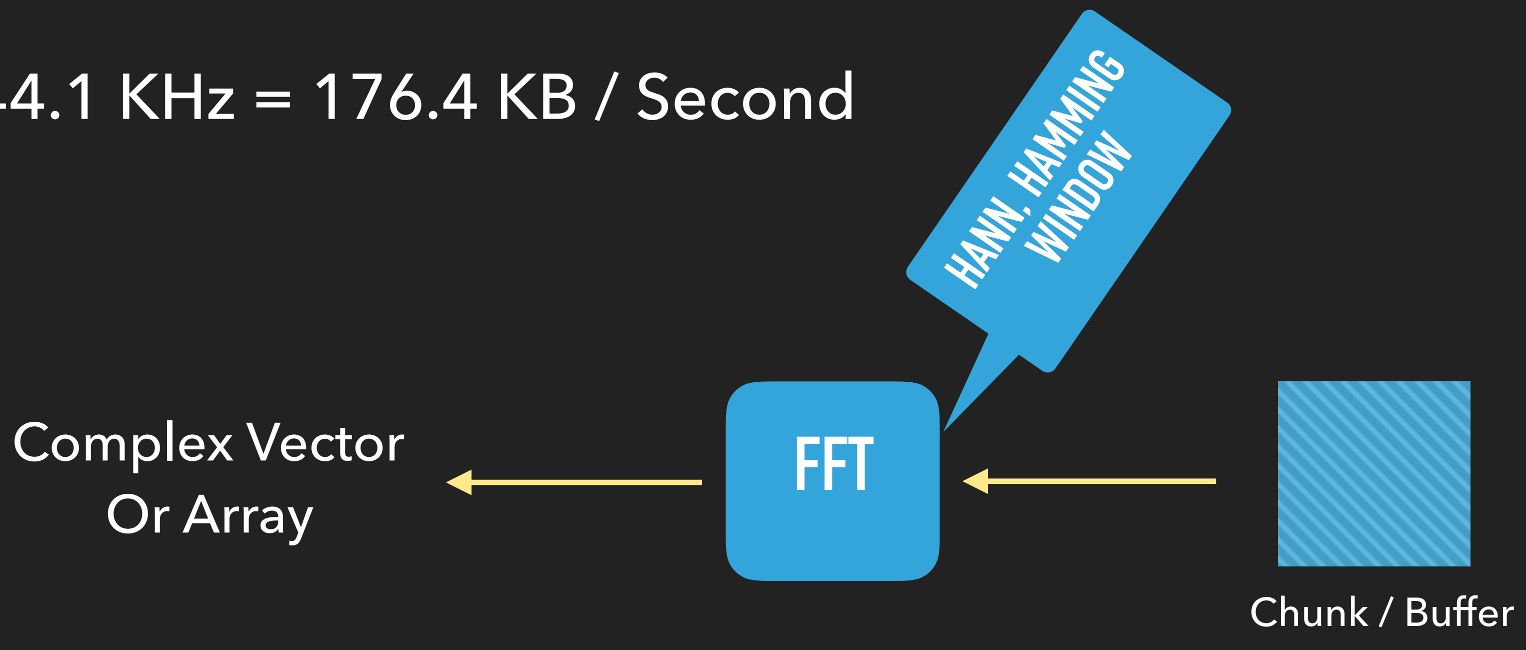

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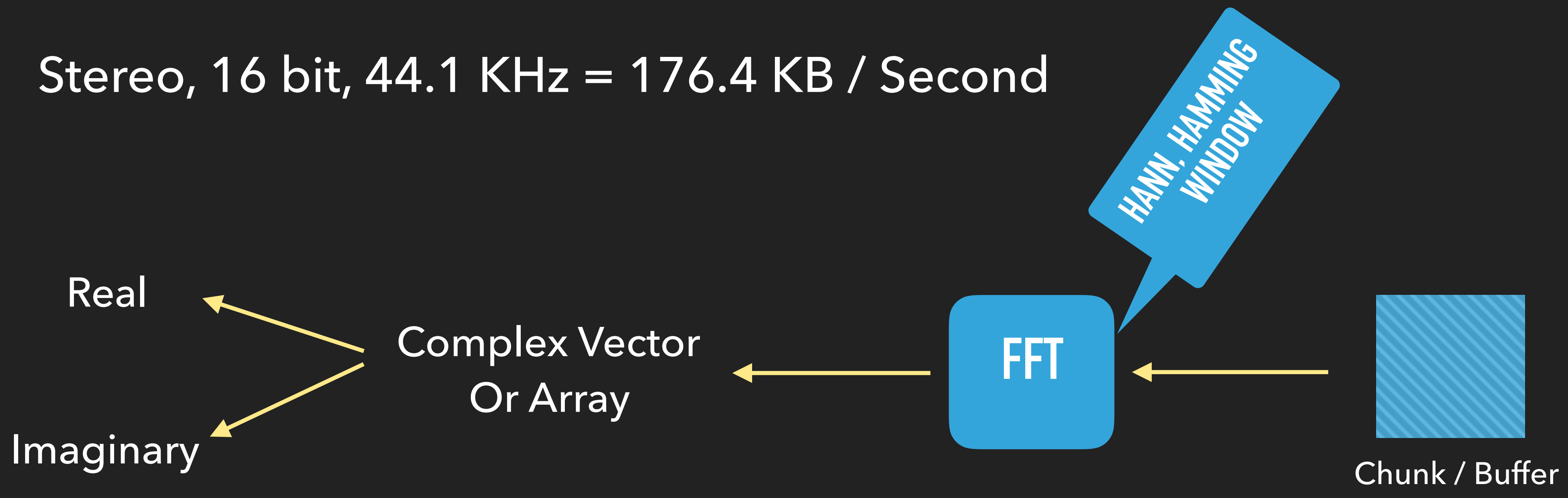

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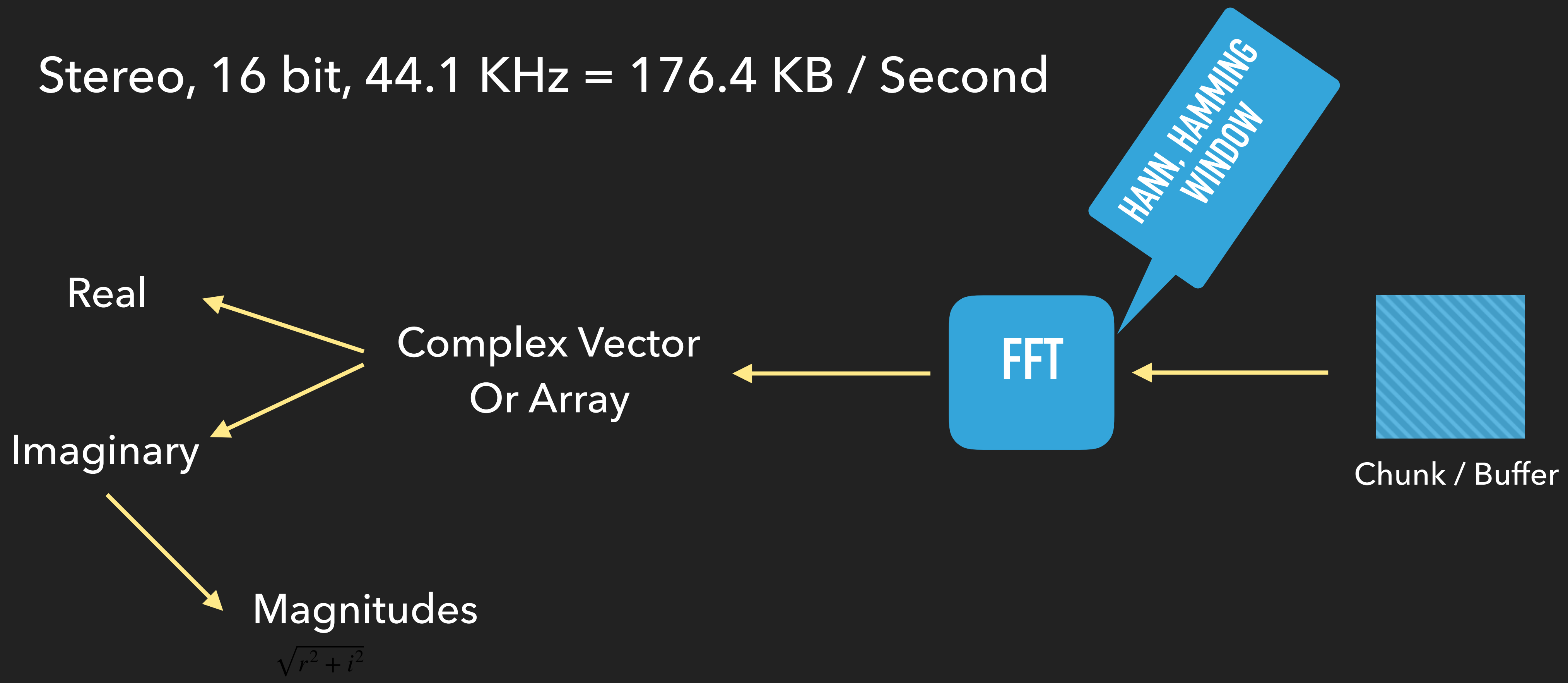

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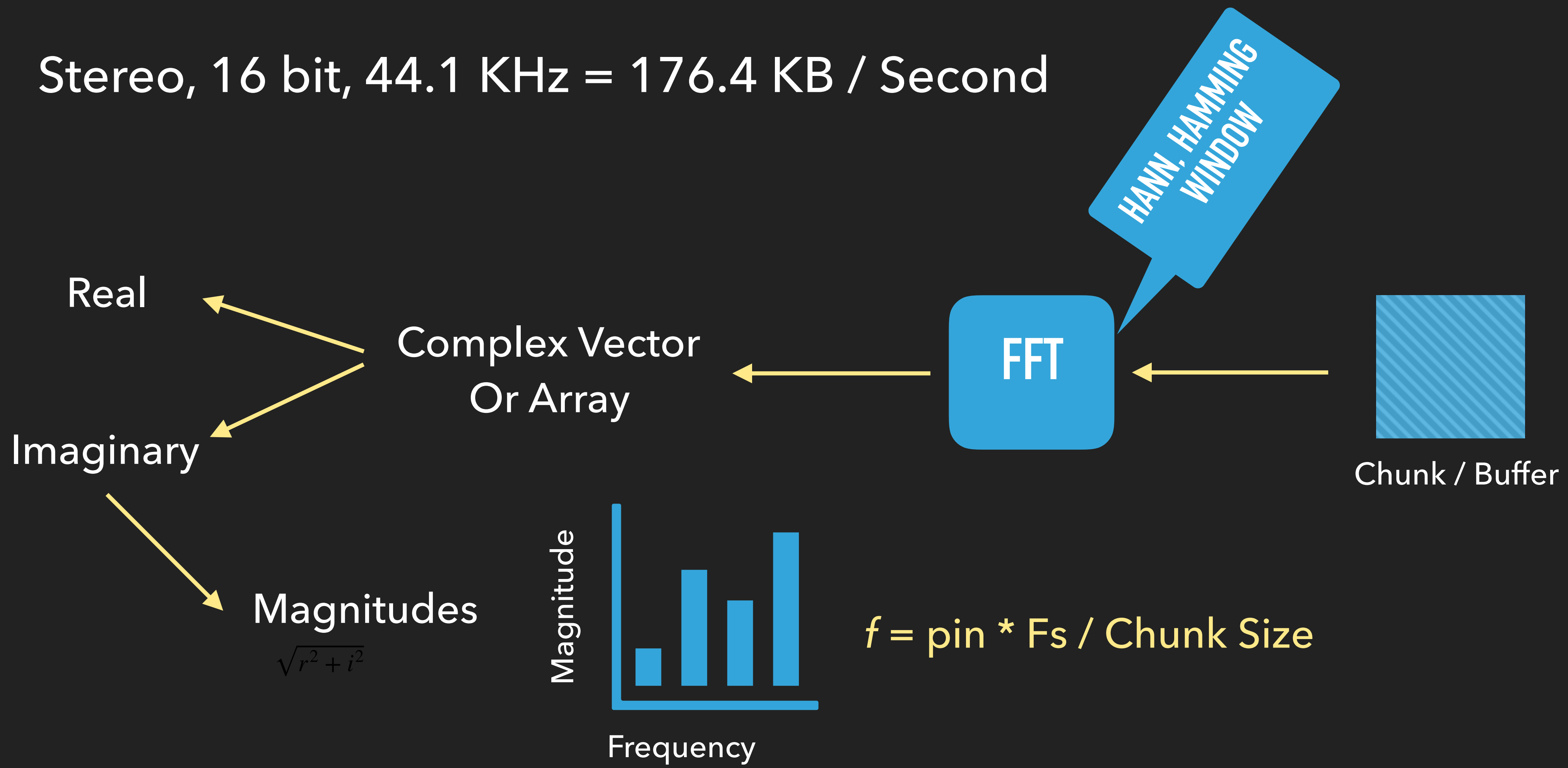

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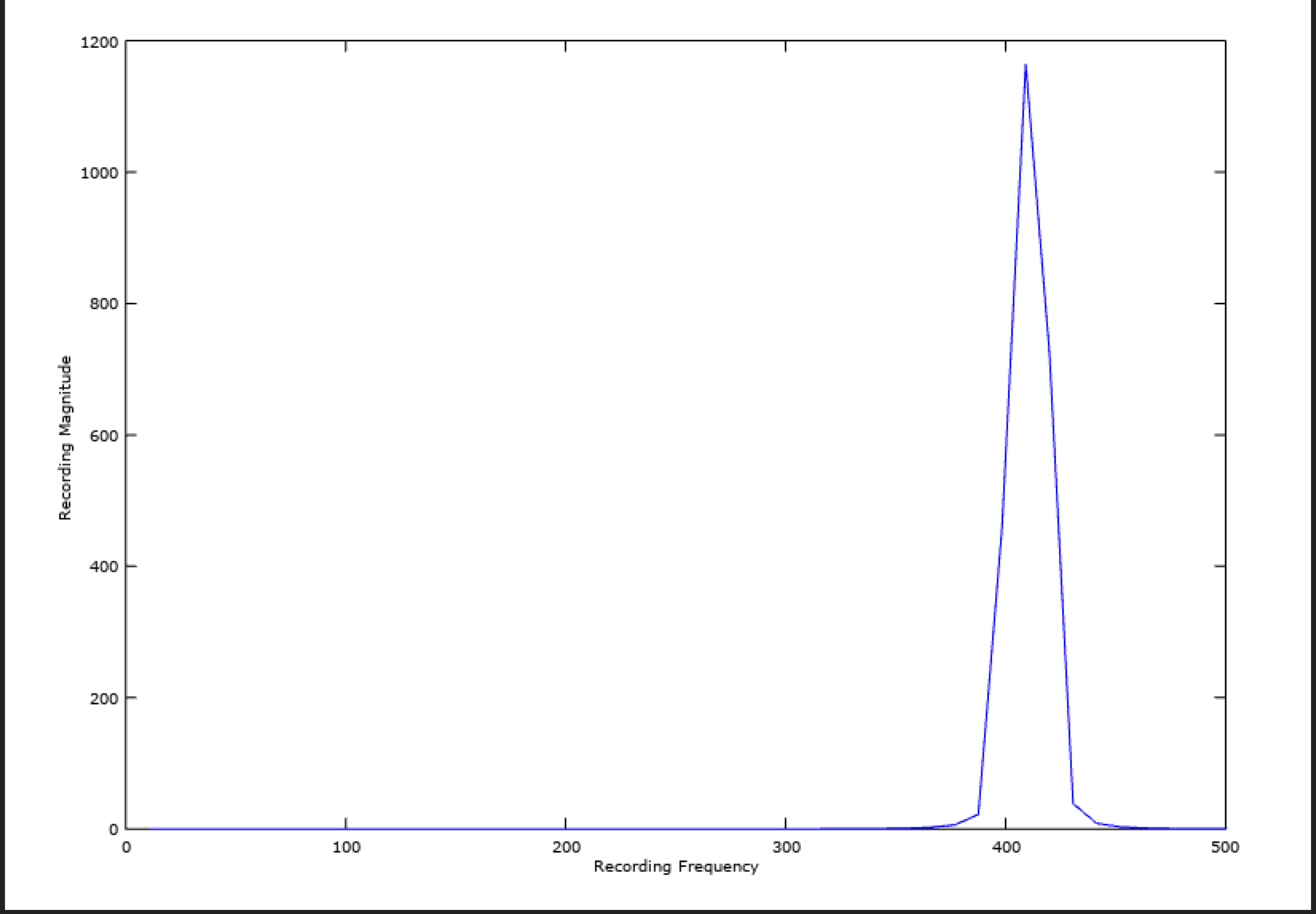

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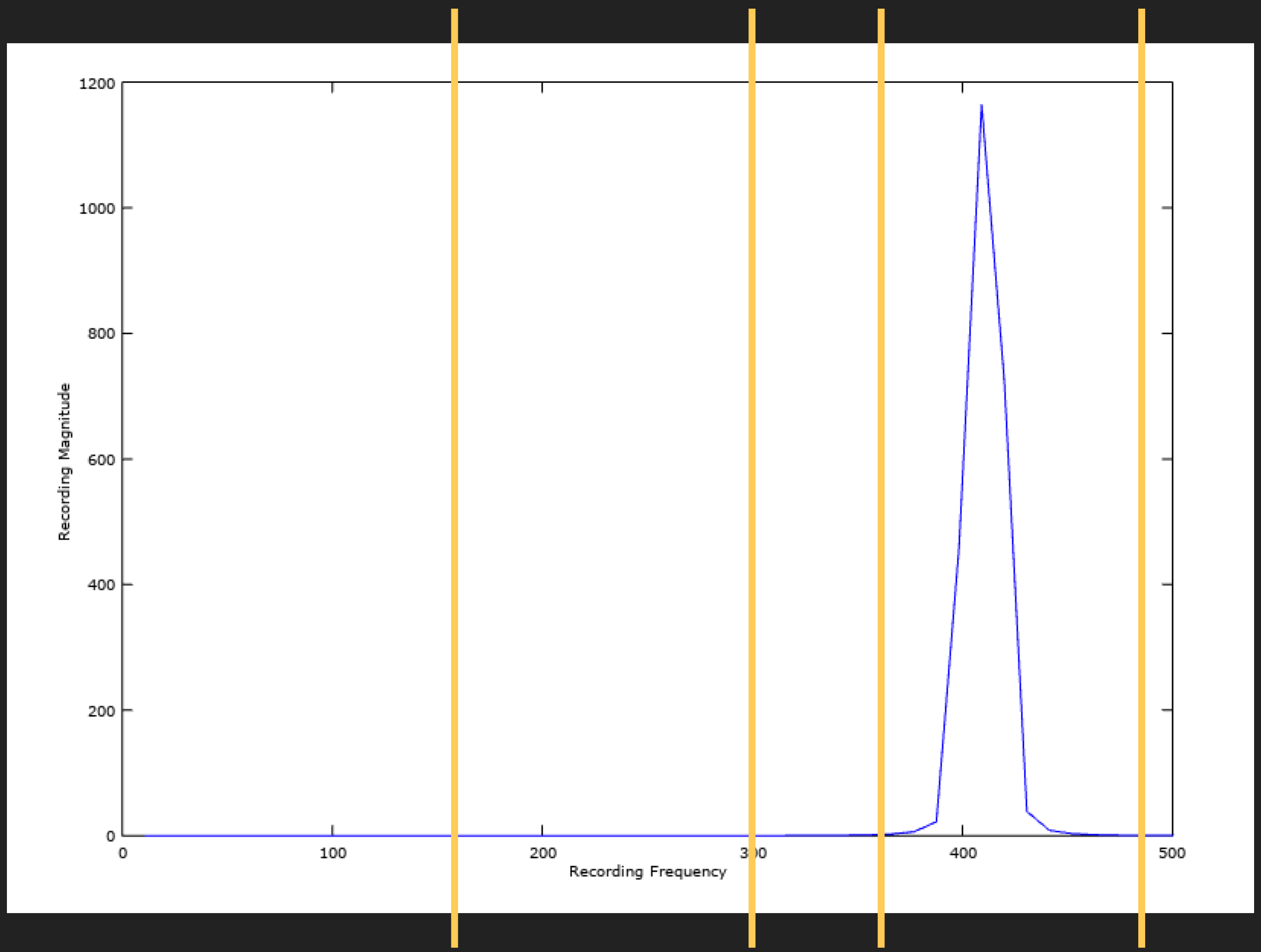

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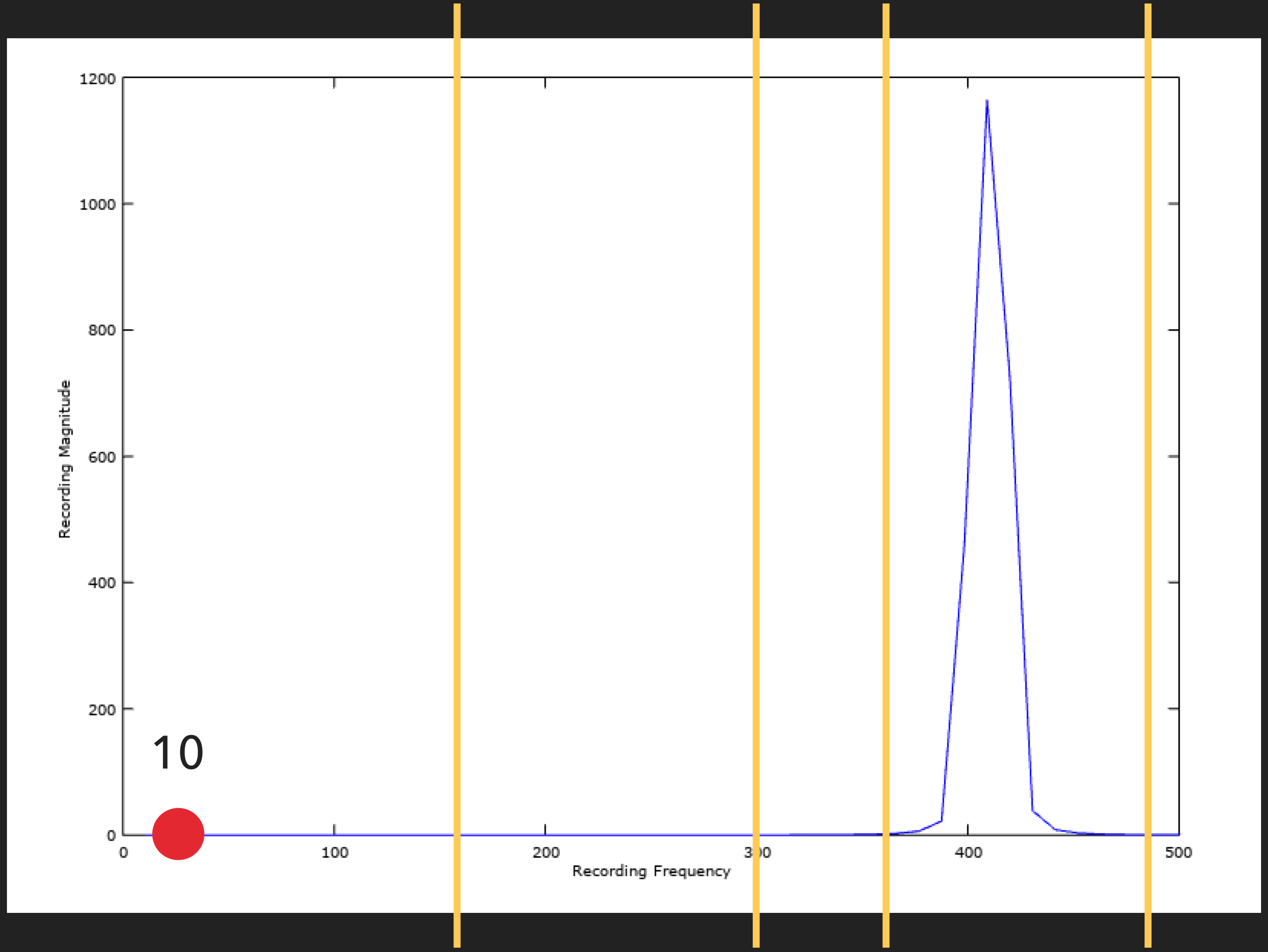

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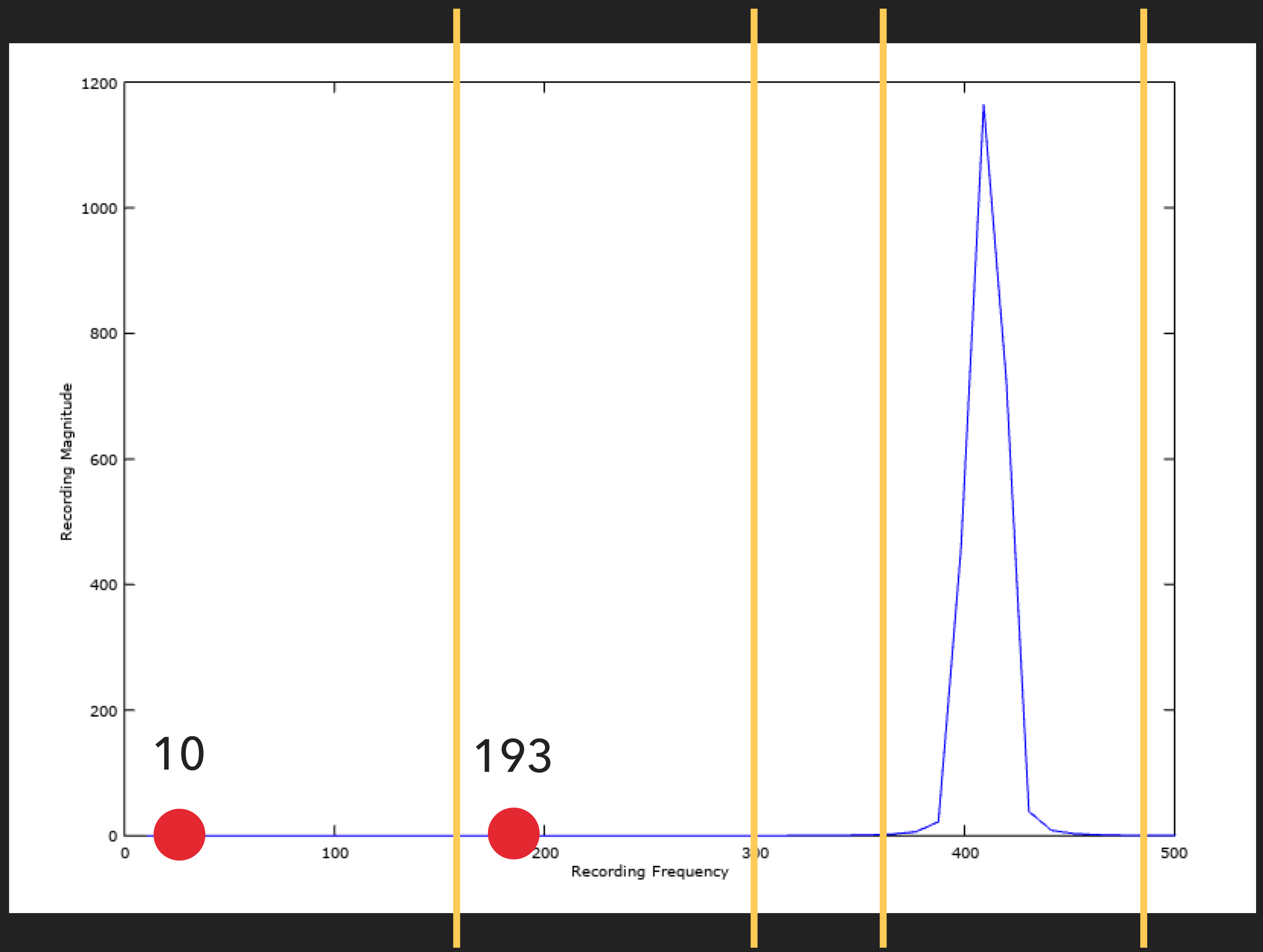

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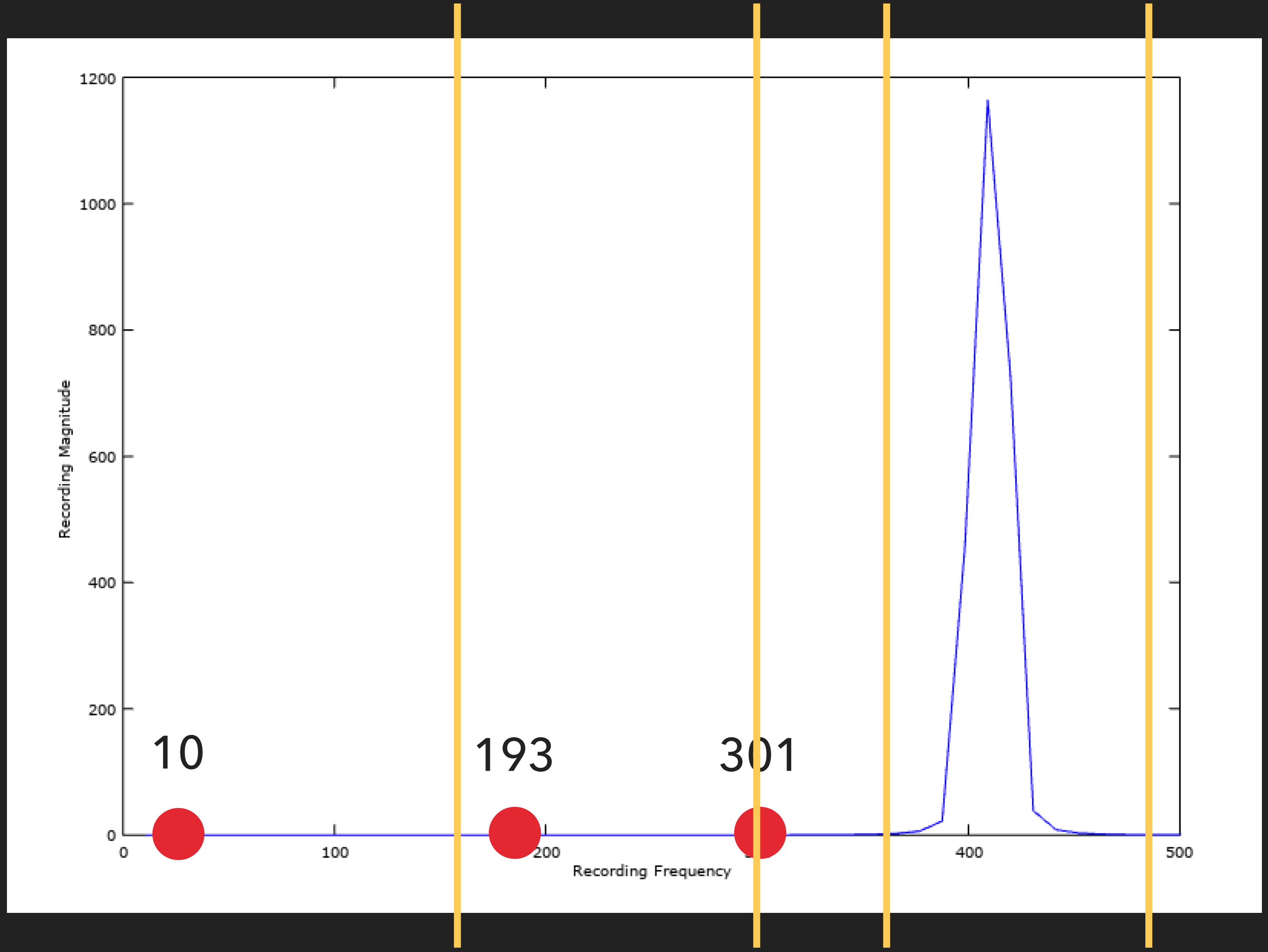

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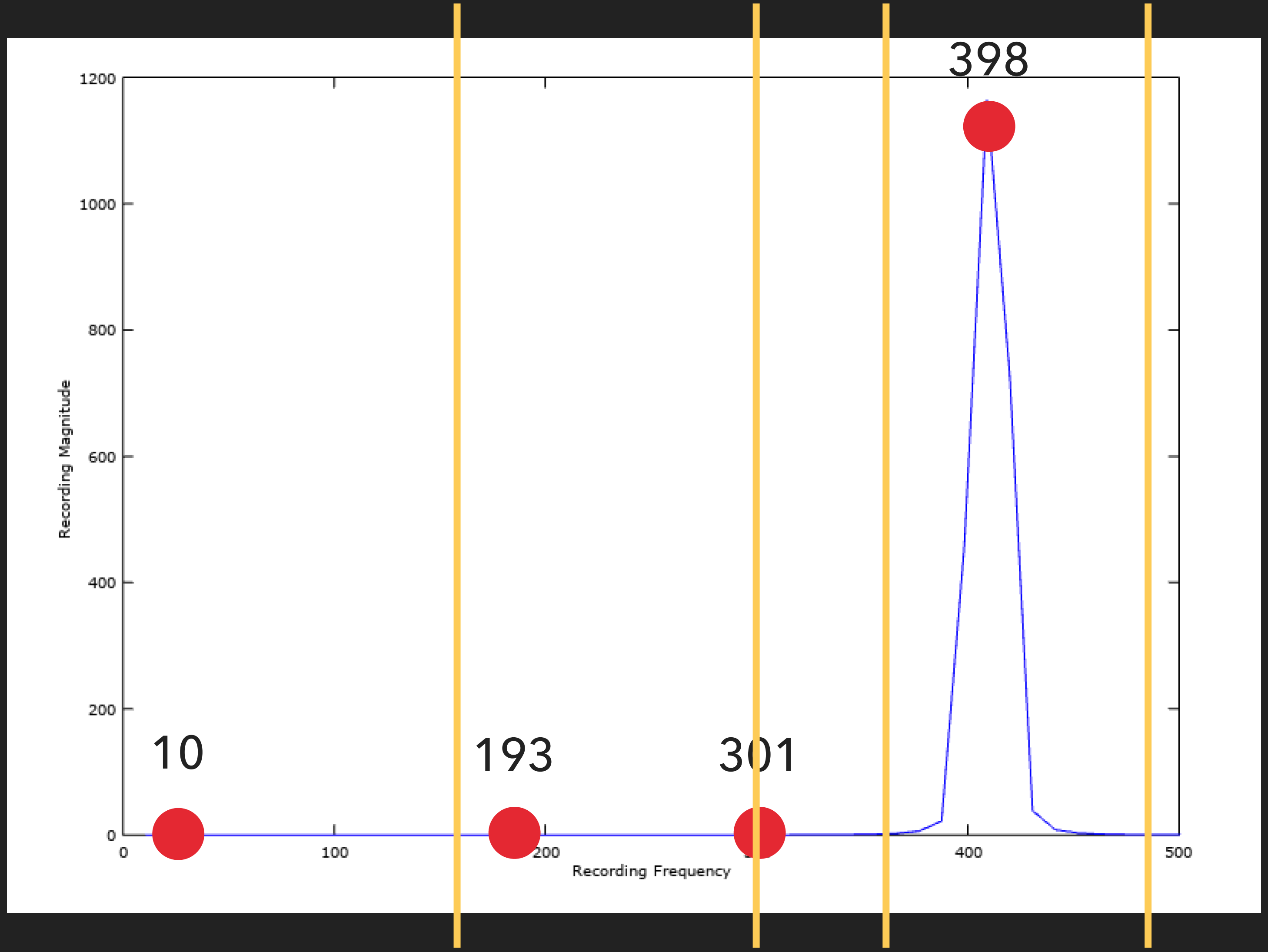

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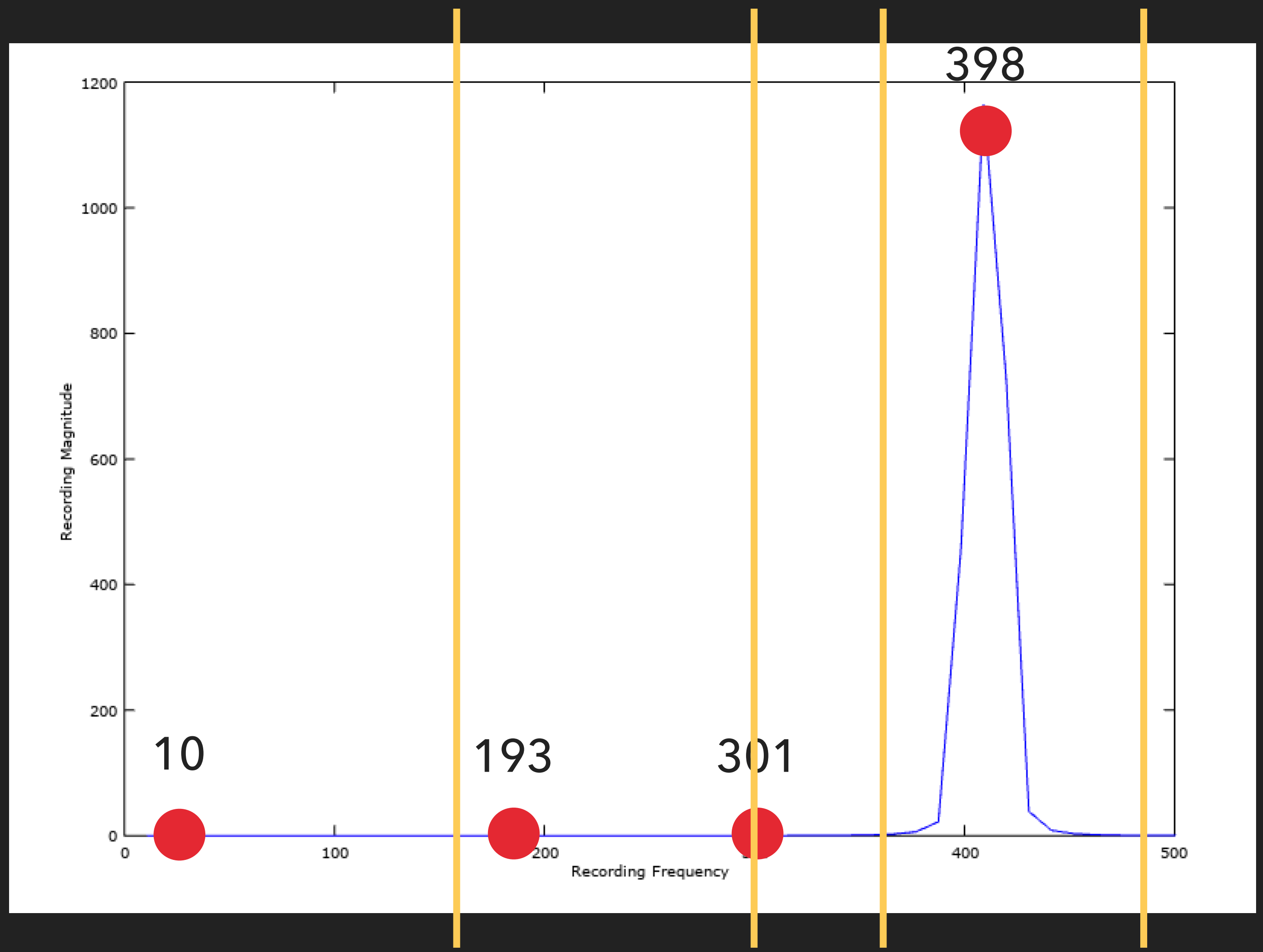
[10, 193, 301, 398]
for all chunks



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- Recording peak [10, 193, 301, 398]
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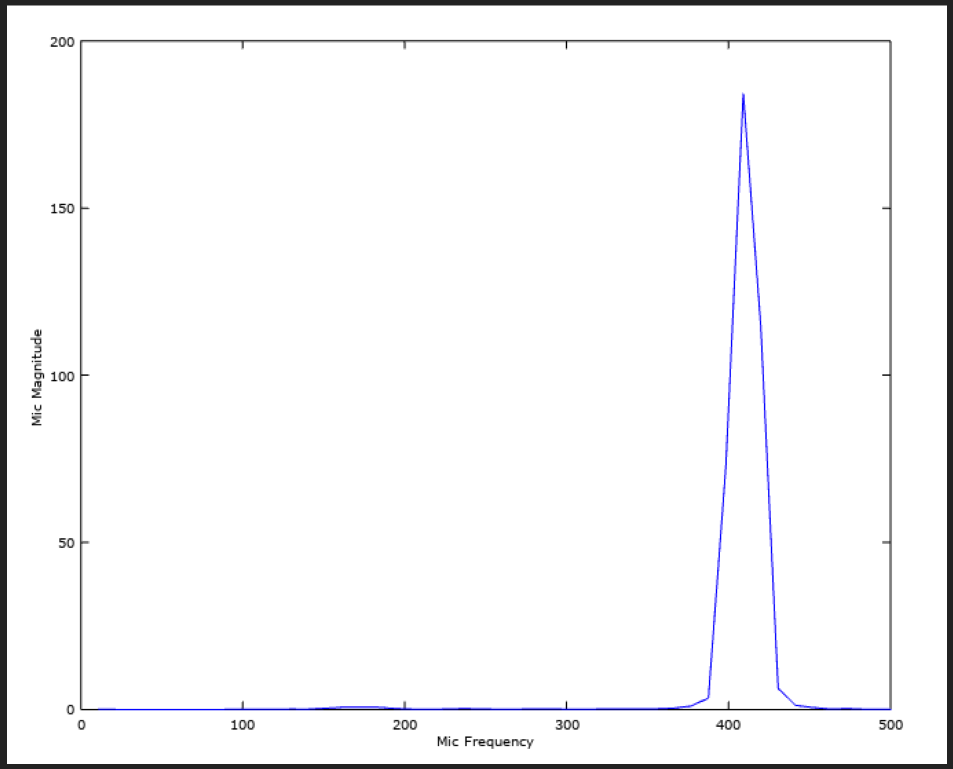

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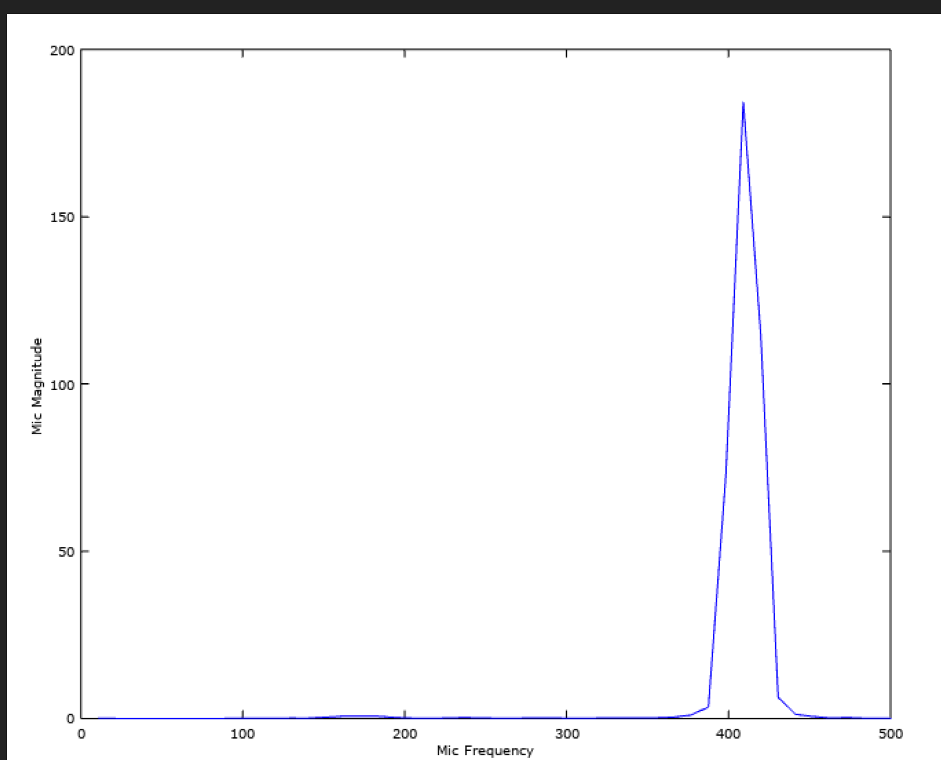

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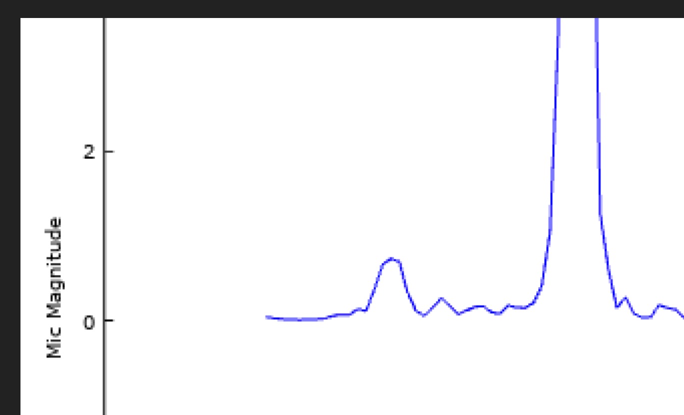

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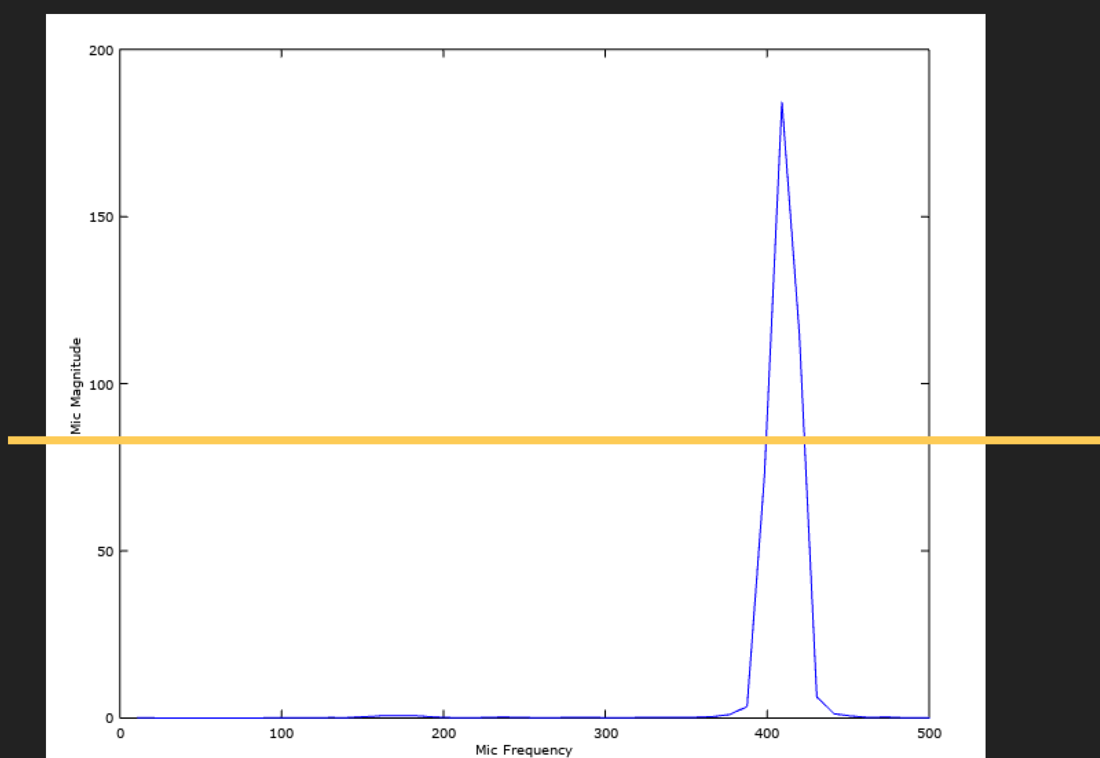
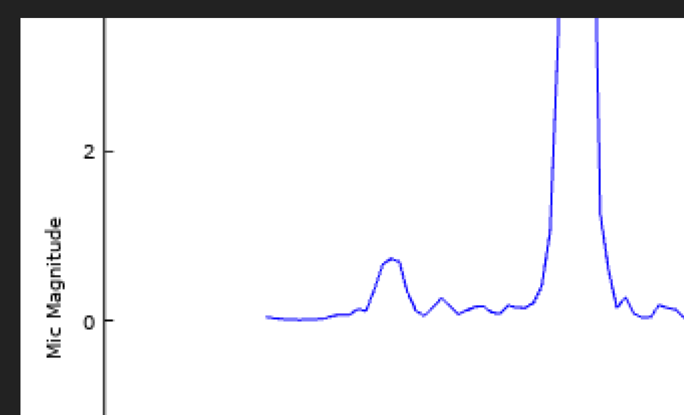


Normalisation/Silence
Threshold



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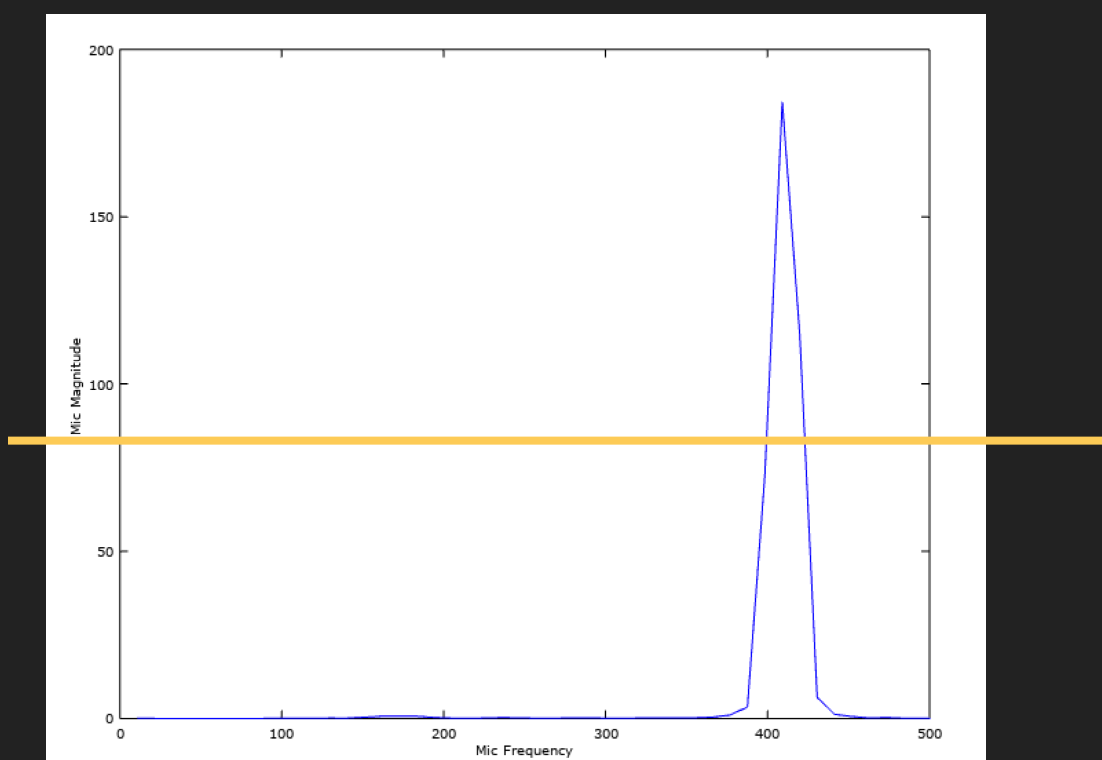
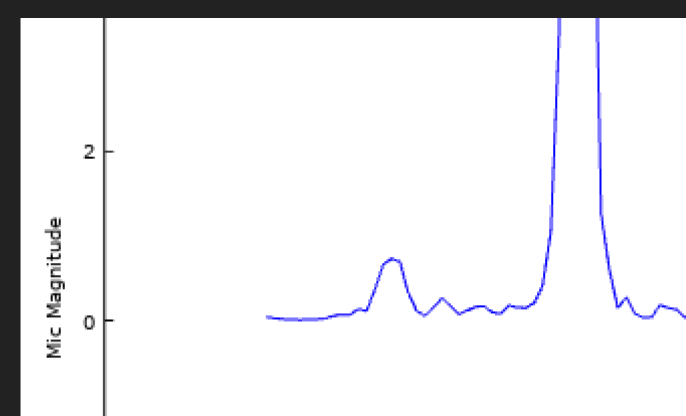


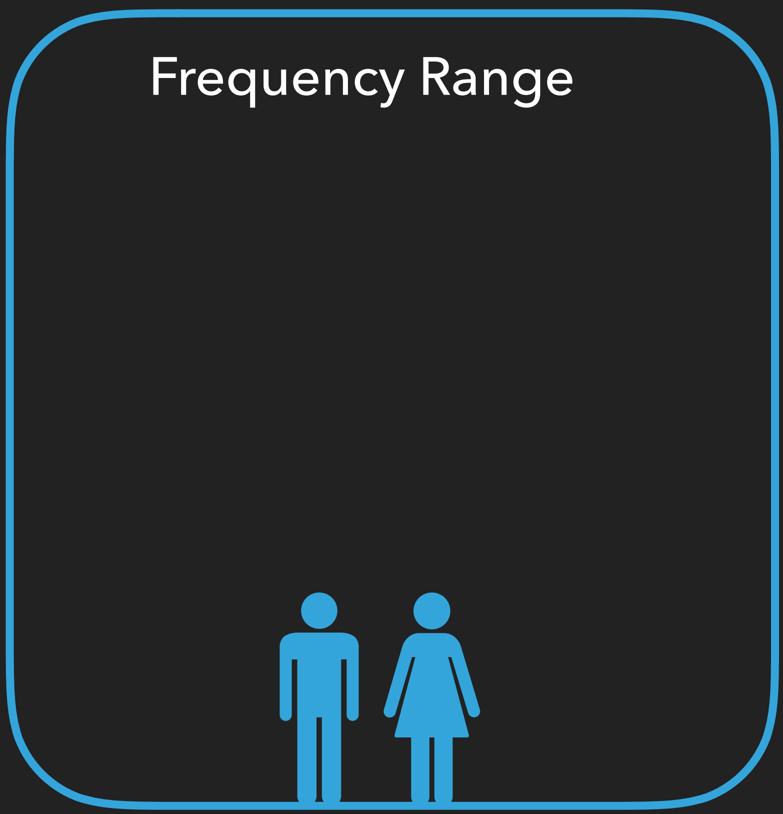


Normalisation/Silence Threshold

[0,0,0,1]

STAGE 3 – FREQUENCY BANDS

- What frequency bands should I choose?



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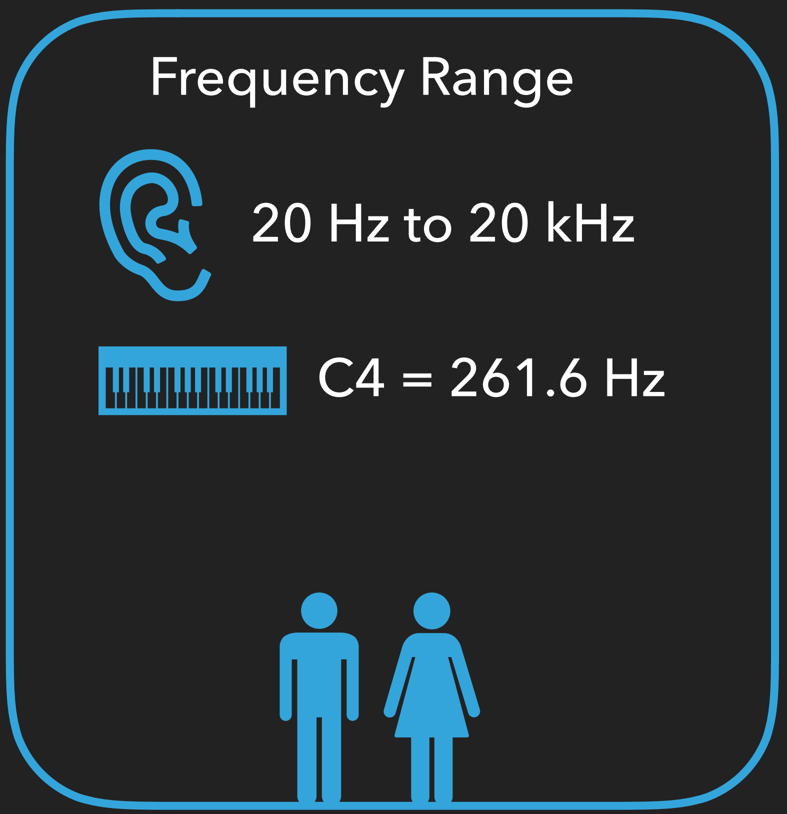

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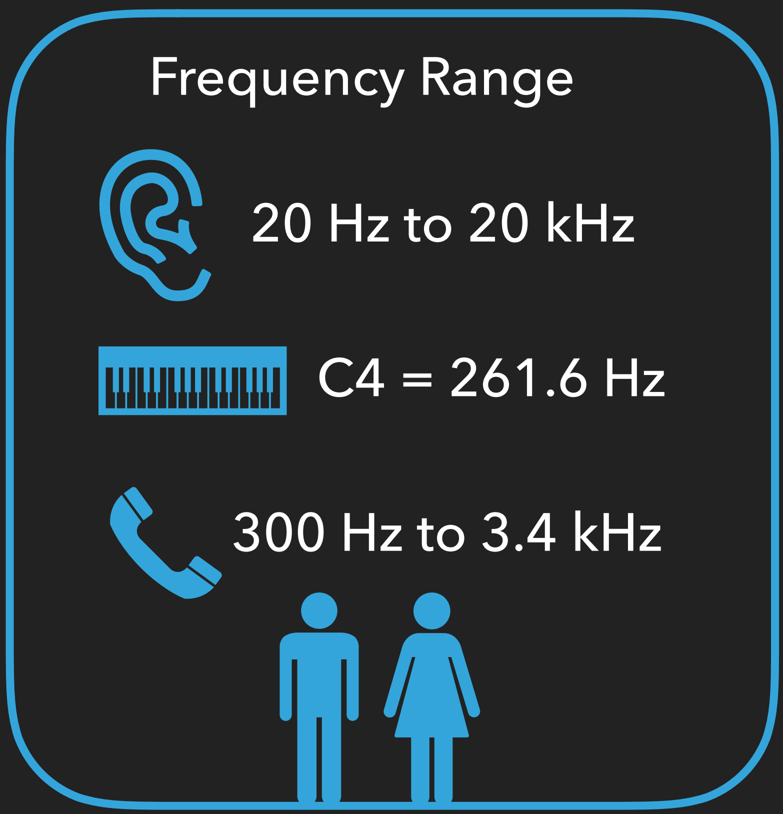

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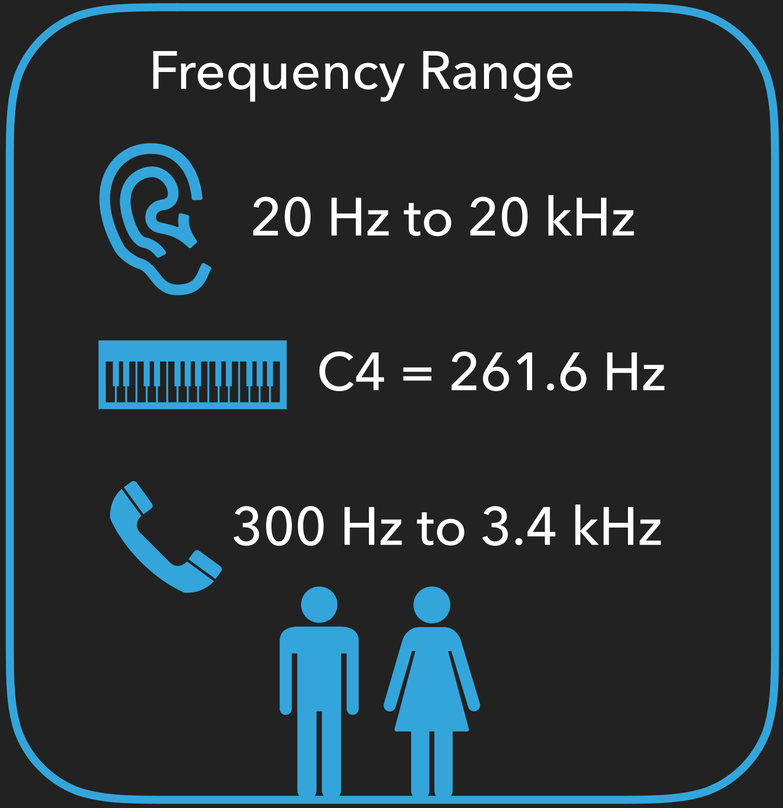
- What frequency bands should I choose?
- Need help? Create the Peaks Map



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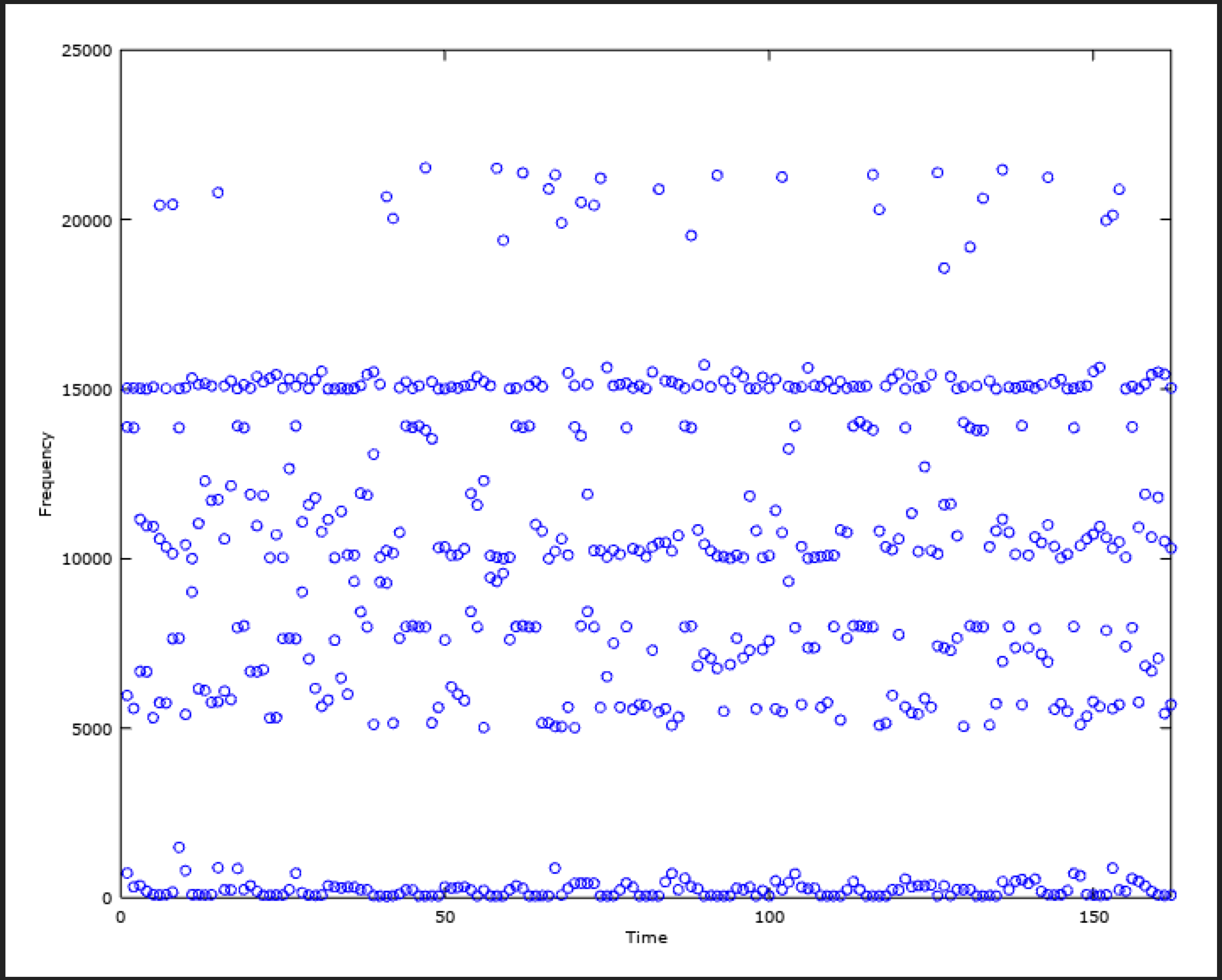

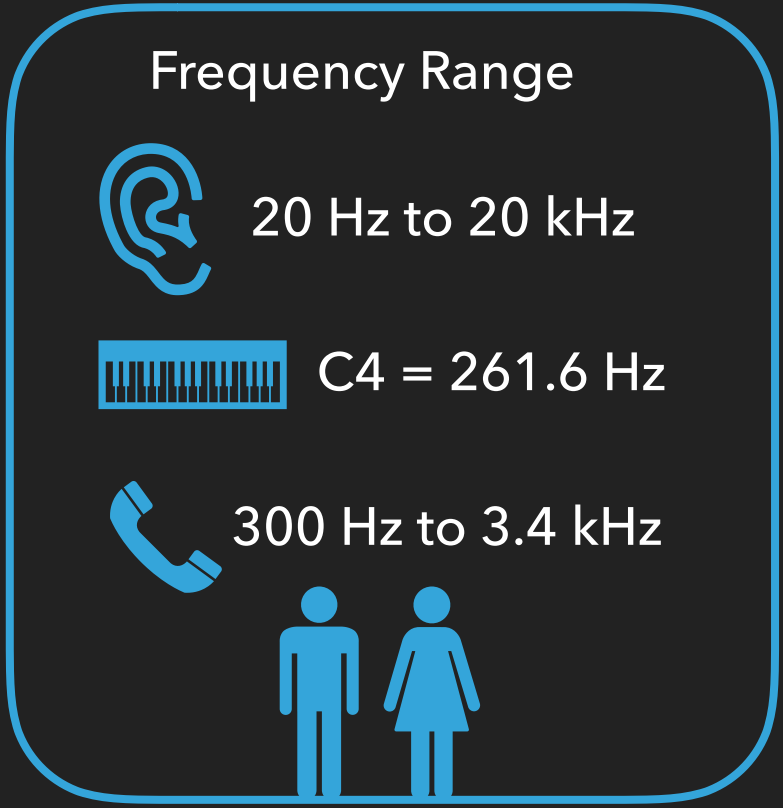

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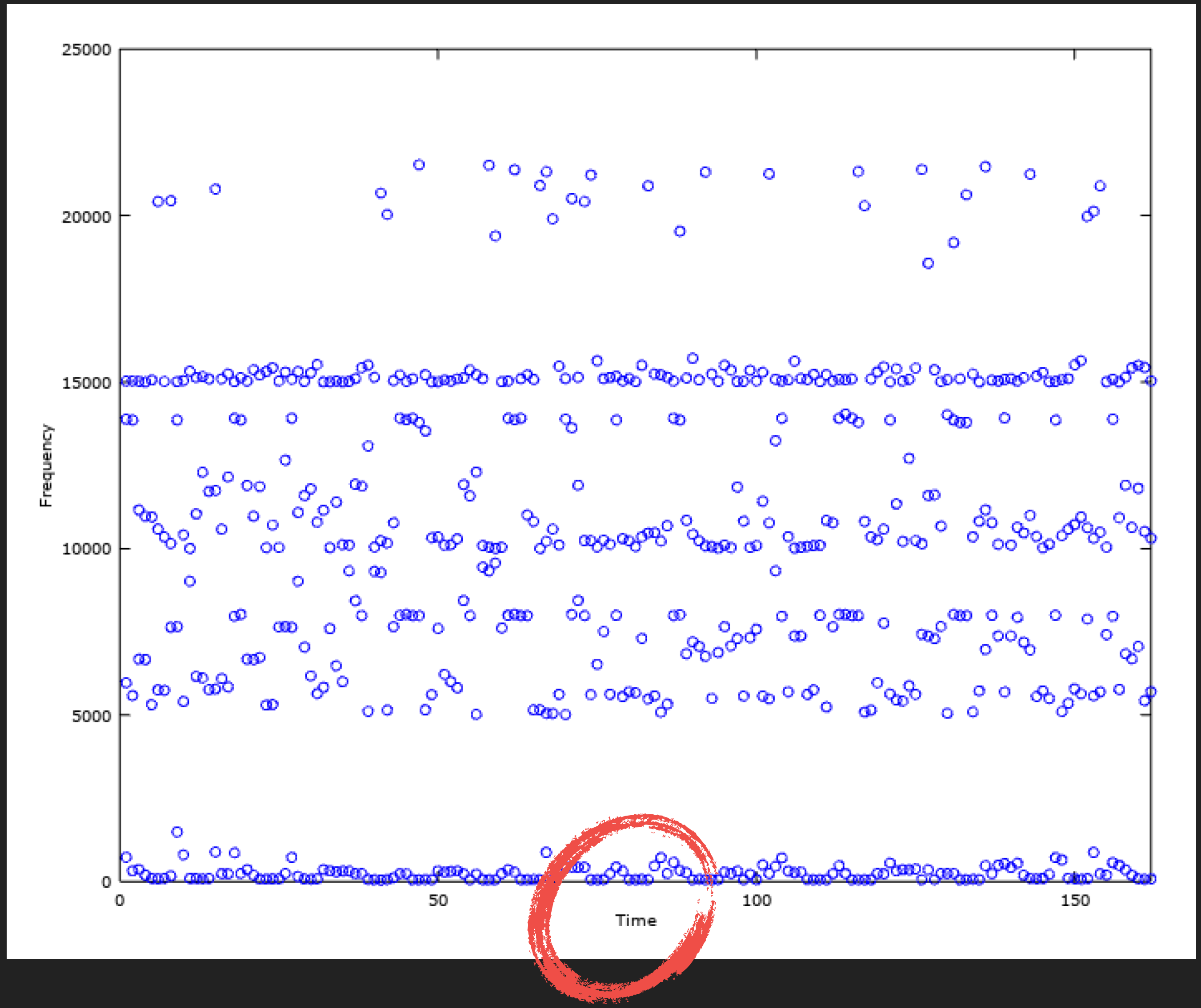

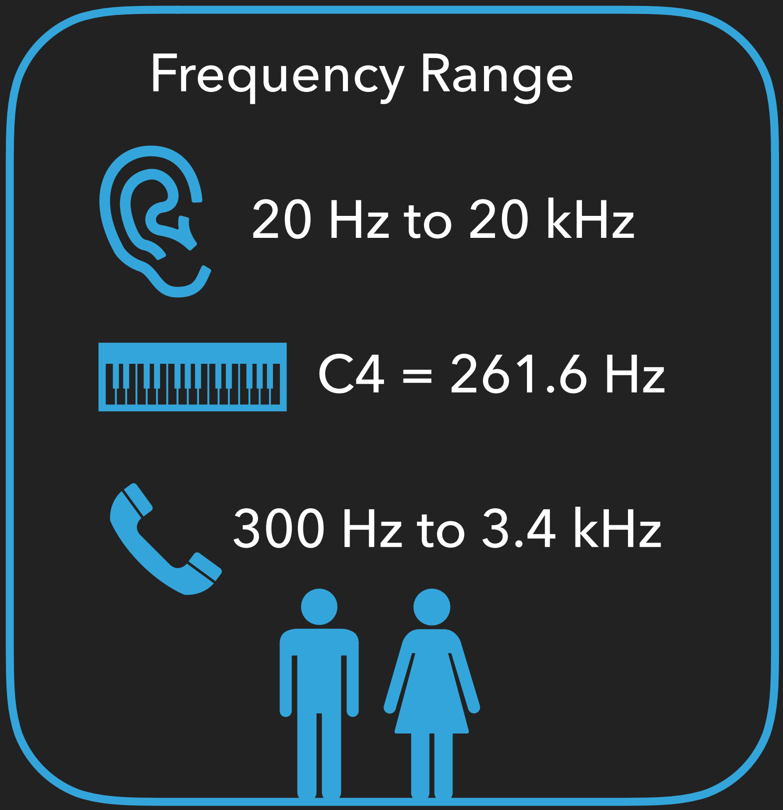

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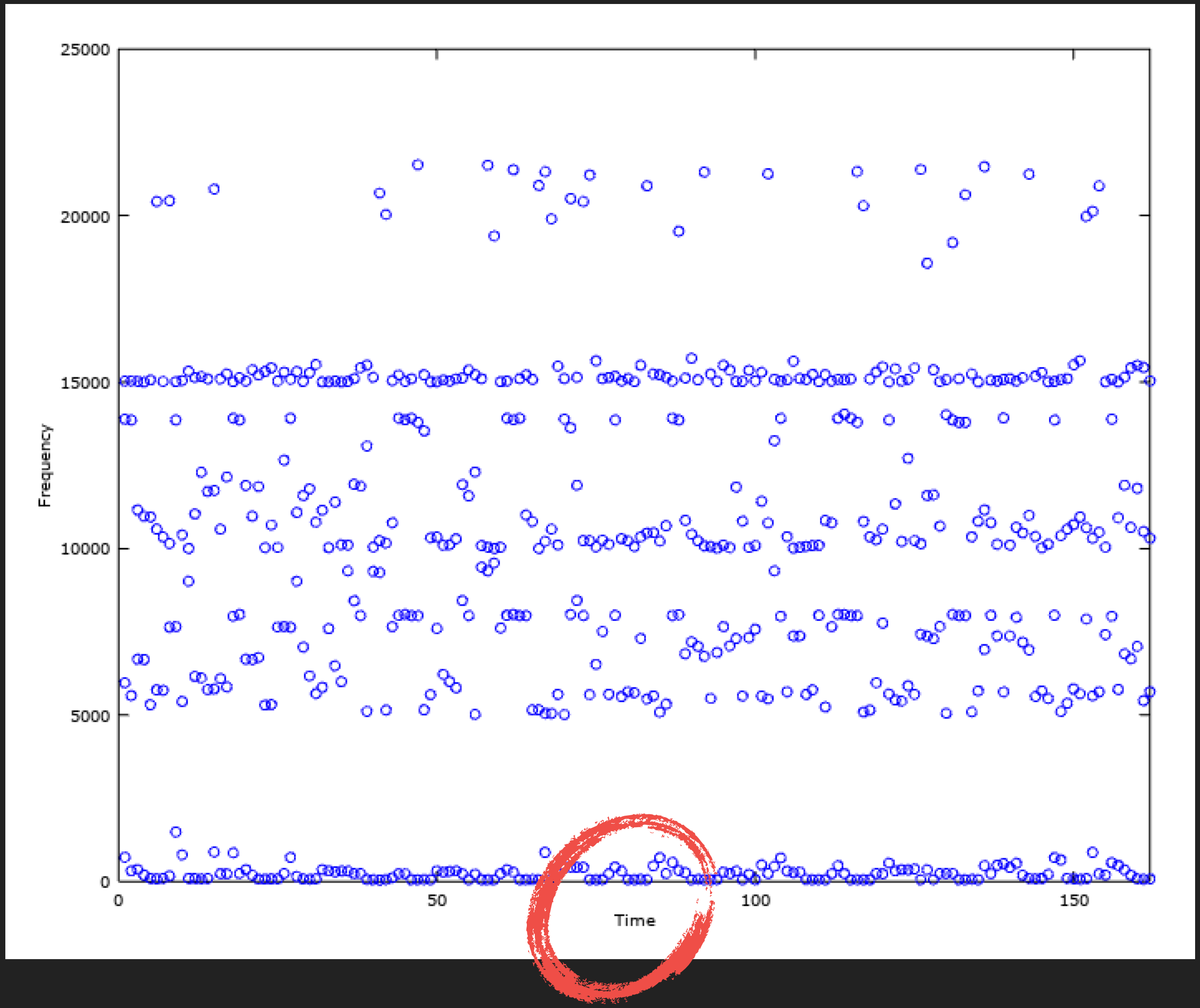

Frequency Range

20 Hz to 20 kHz

C4 = 261.6 Hz

300 Hz to 3.4 kHz

Compare To Your Mic

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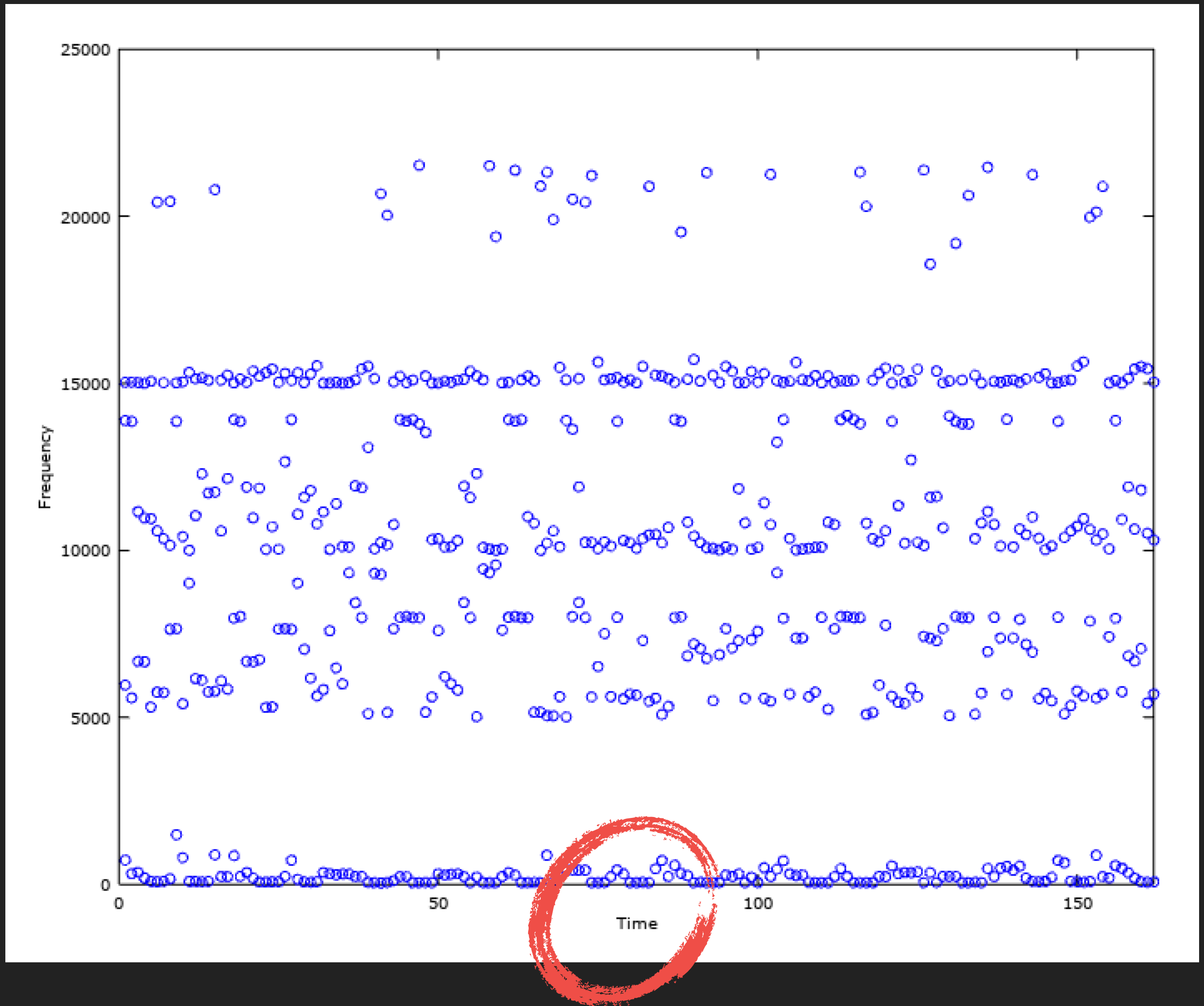

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Compare To Your Mic

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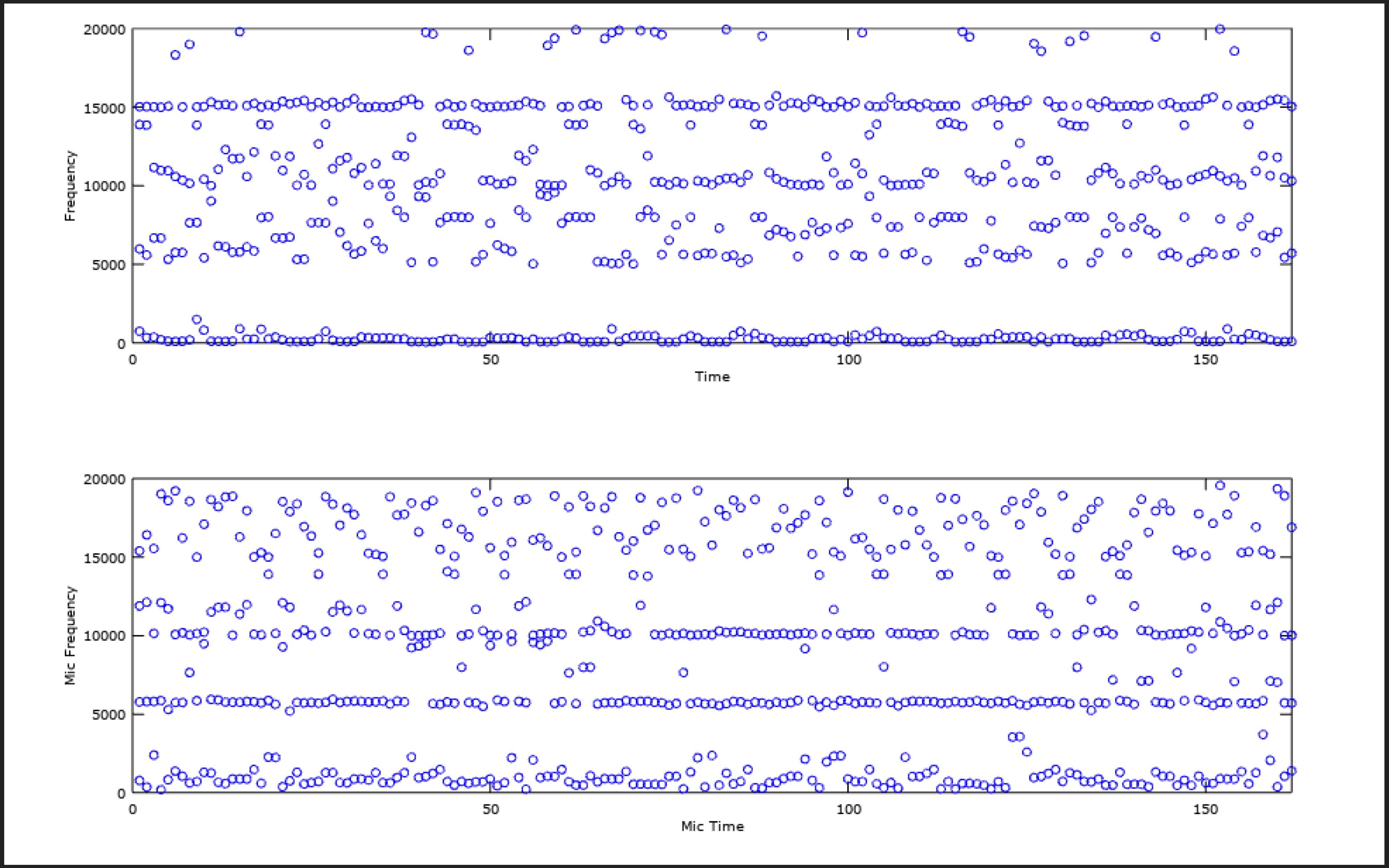
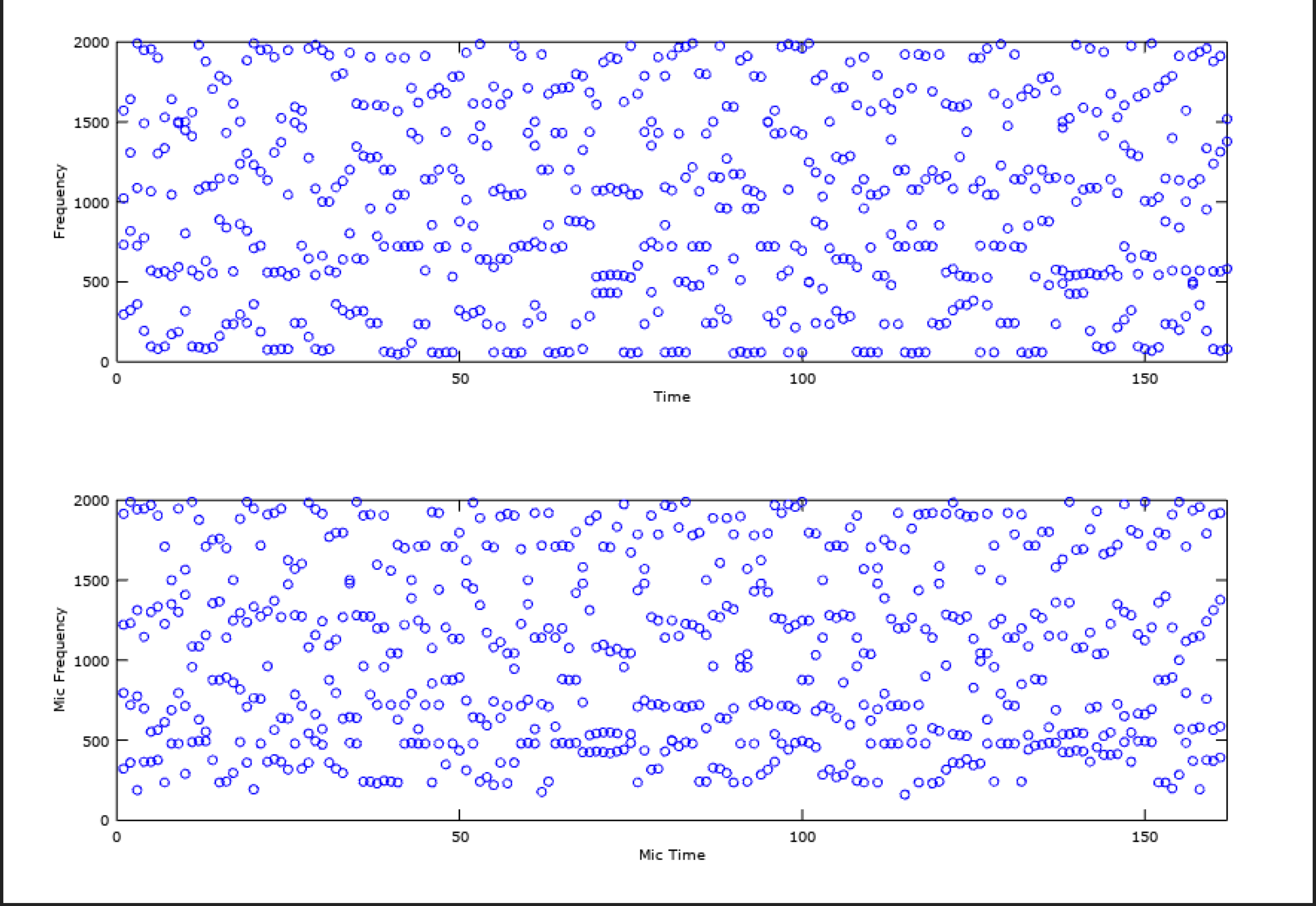
STAGE 3 – AUDIO VS MIC PEAKS MAP – 5K BANDS



Bands

~5k Hz

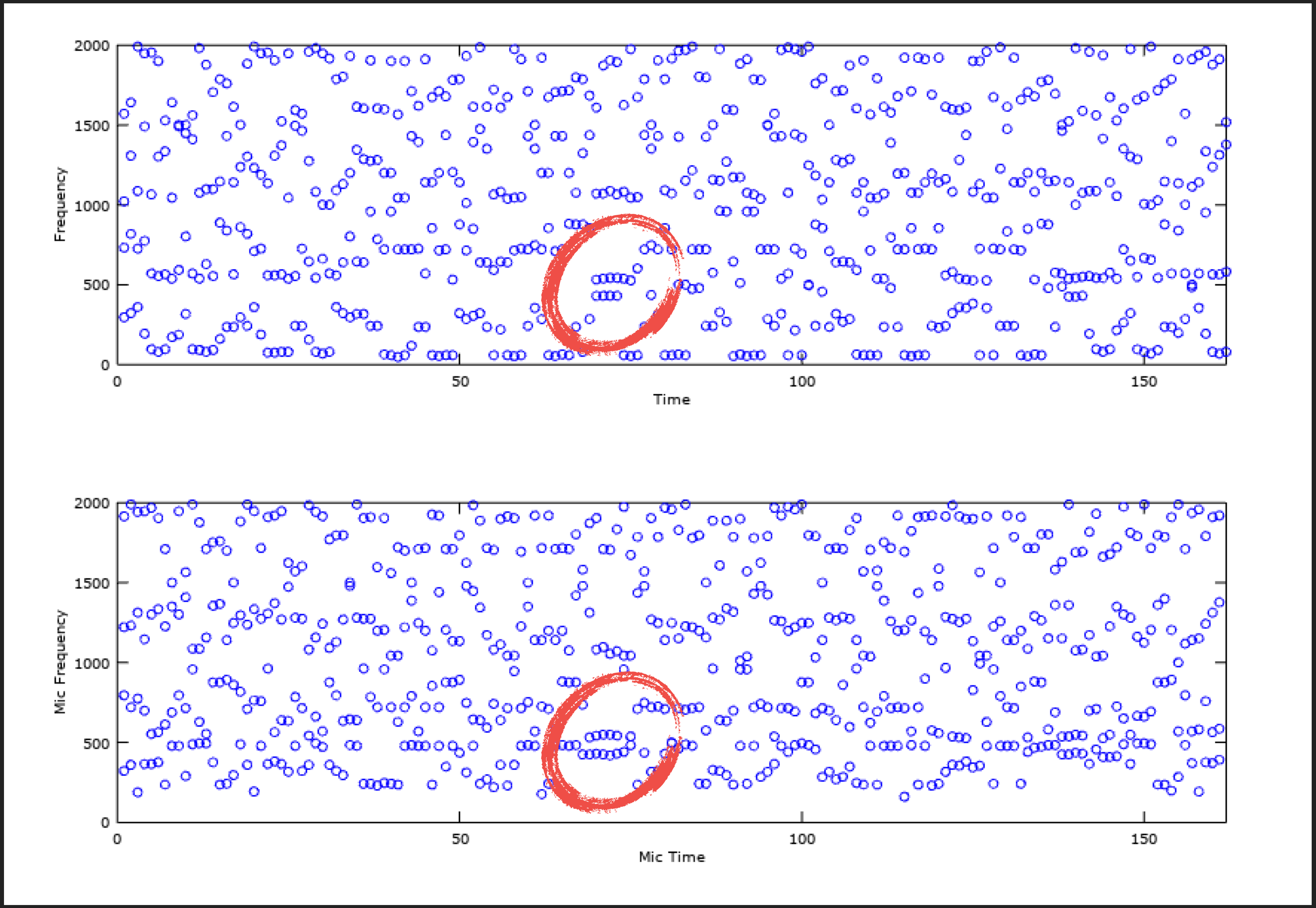
STAGE 3 - AUDIO VS MIC PEAKS MAP - 500 BANDS



Bands

~500 Hz

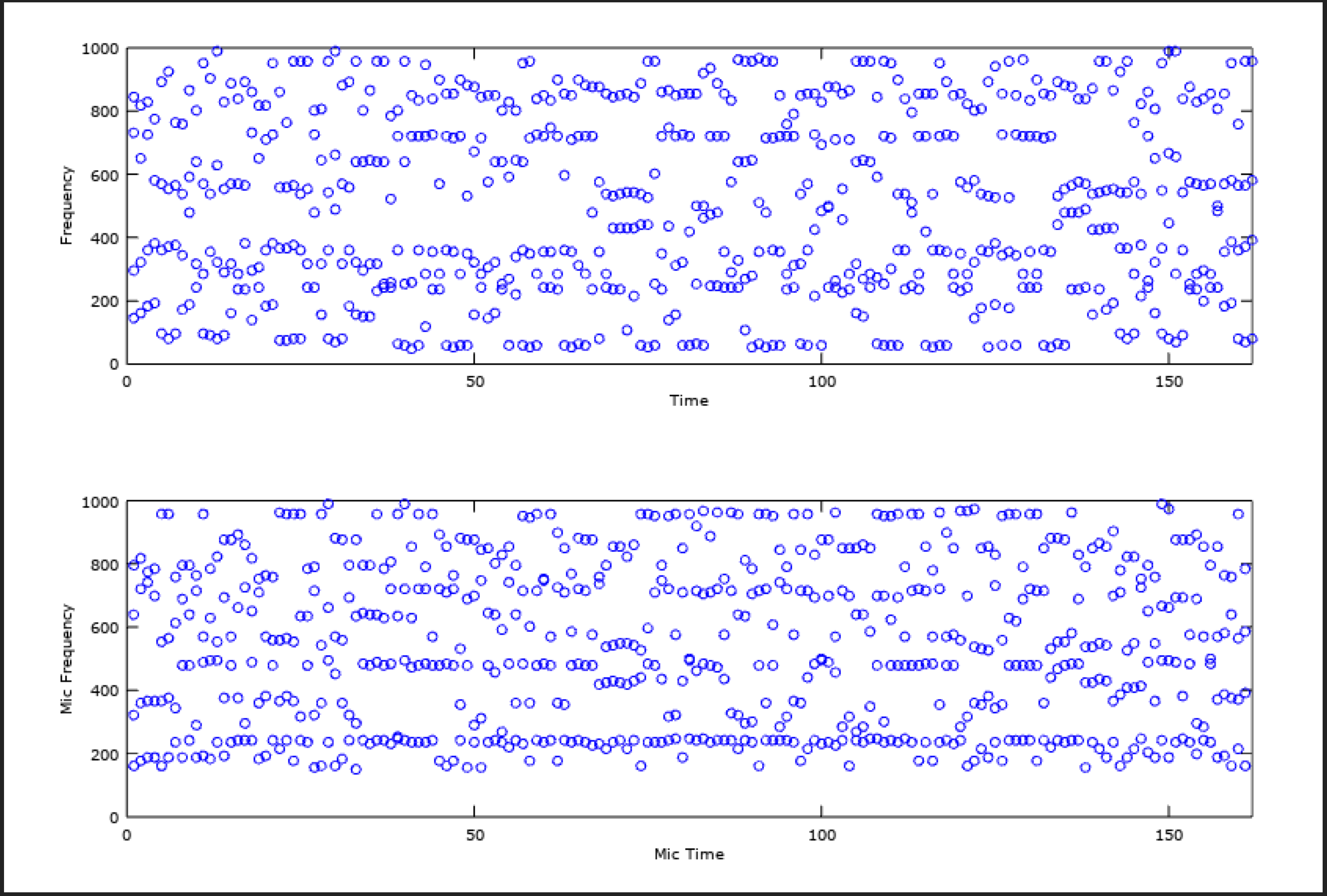
STAGE 3 - AUDIO VS MIC PEAKS MAP - 500 BANDS



Bands

~500 Hz

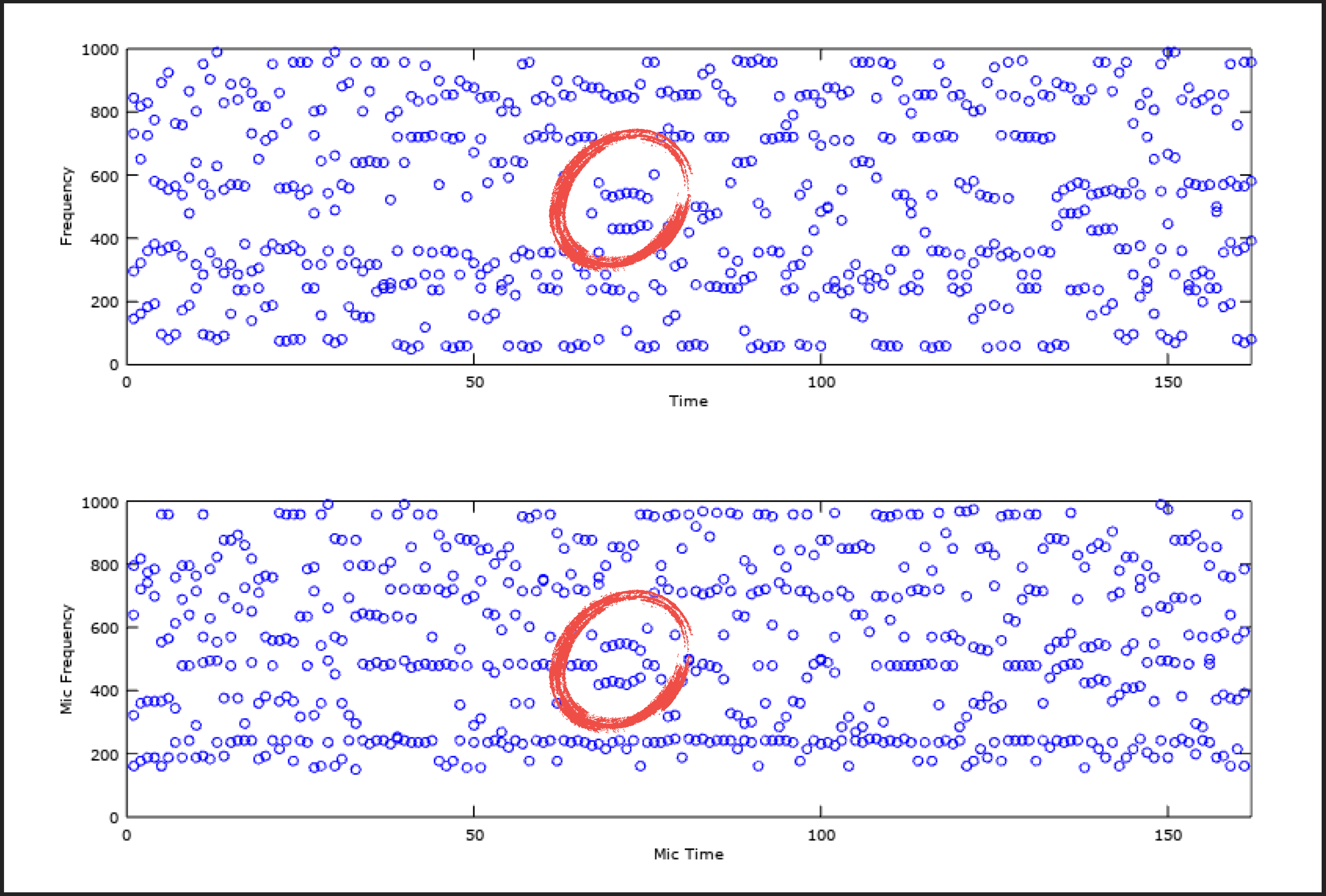
STAGE 3 - AUDIO VS MIC PEAKS MAP - 250 BANDS



Bands

~250 Hz

STAGE 3 – AUDIO VS MIC PEAKS MAP – 250 BANDS



Bands

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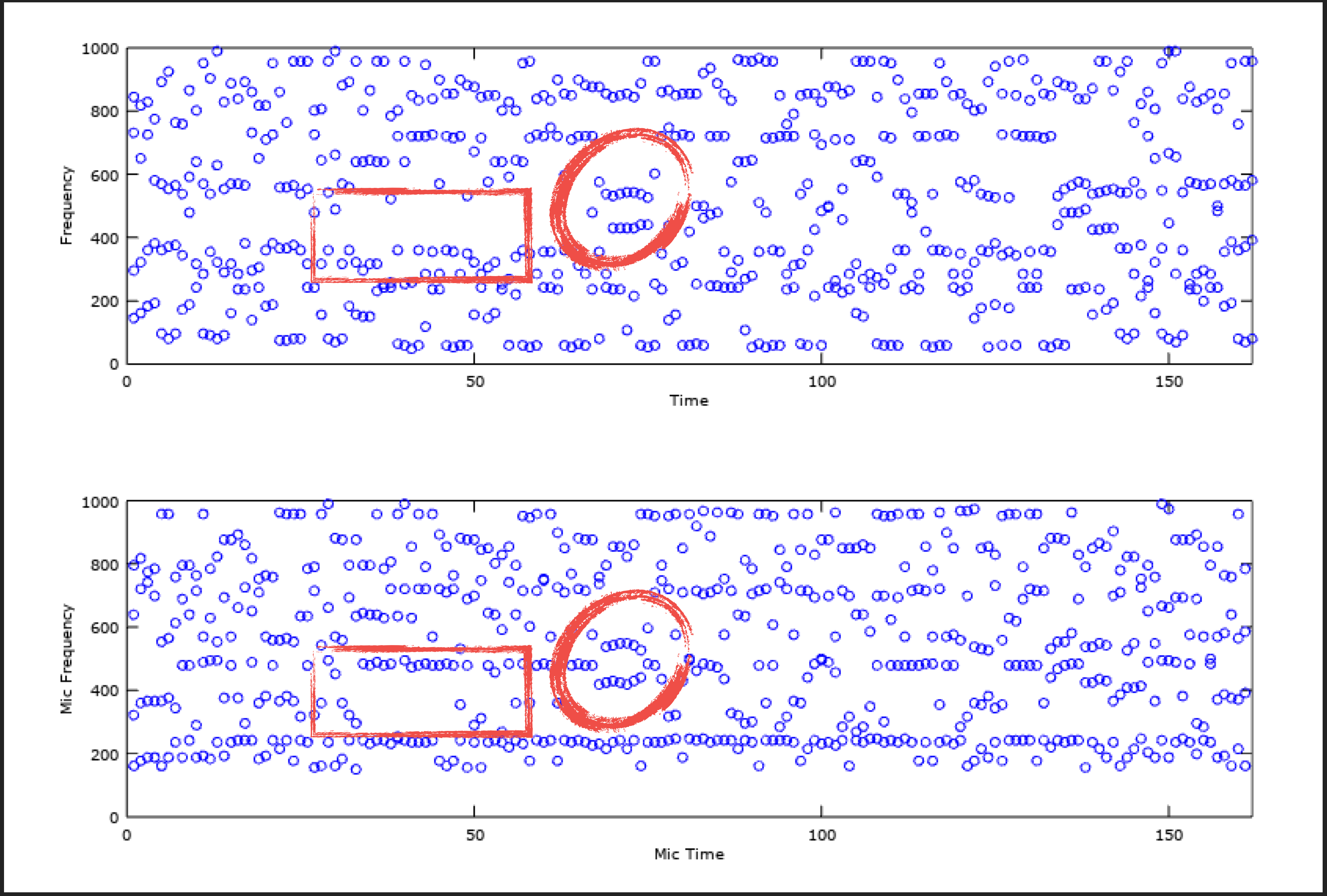

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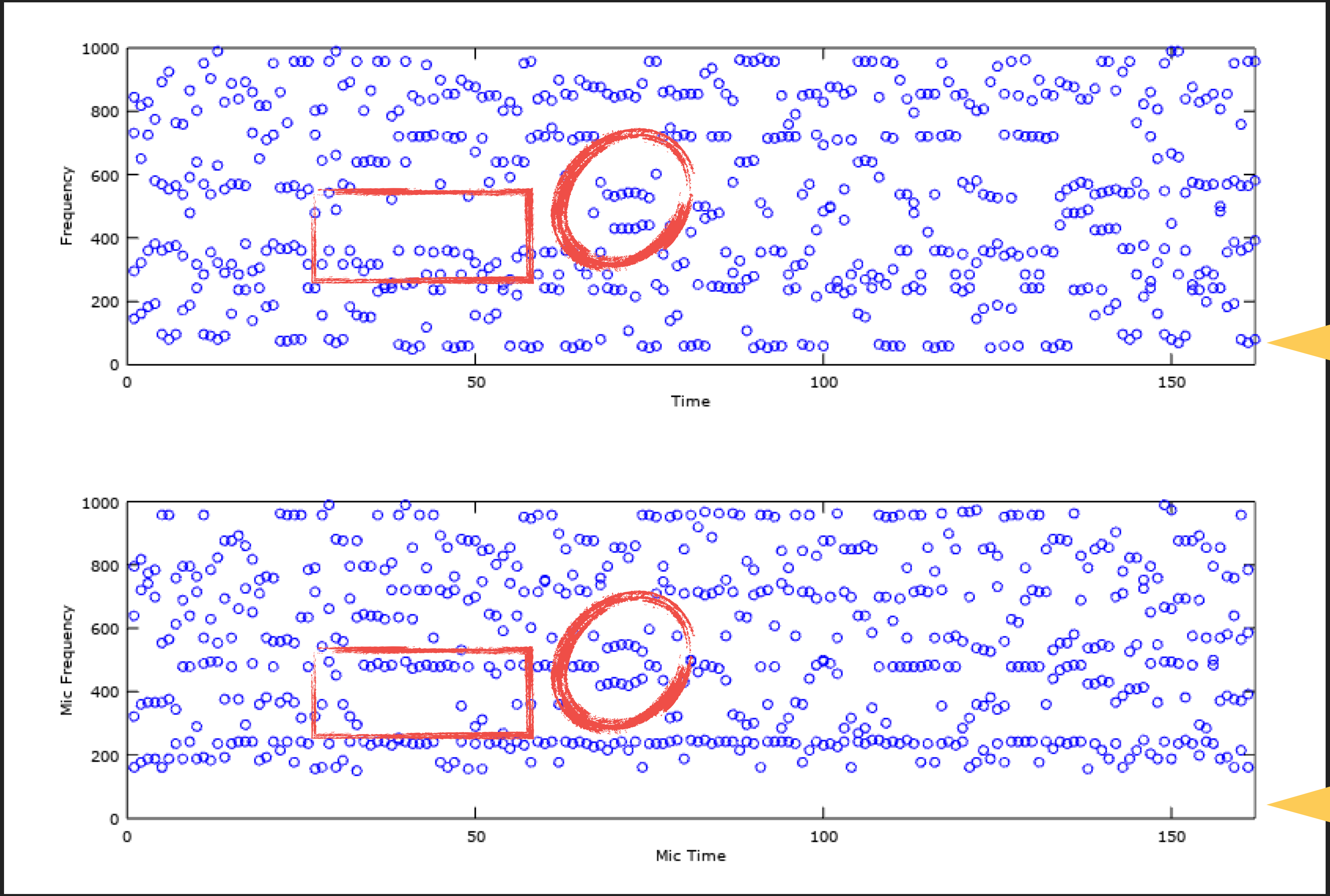

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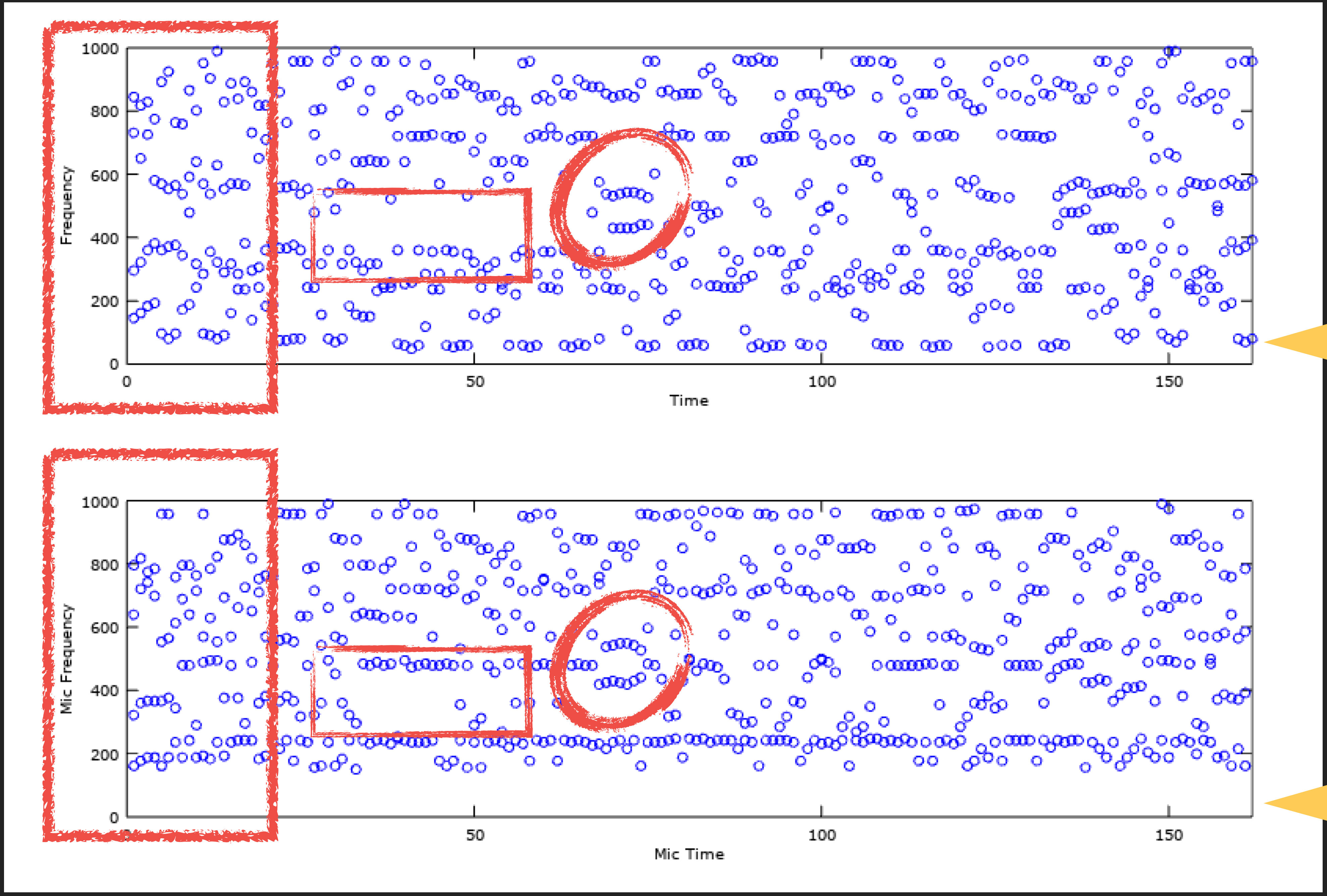

Bands

~250 Hz

STAGE 3 - FREQUENCY BANDS SELECTION

- From the visualisations we conclude:
- Narrowing the frequency bands results in more peak matches
- Narrowing the frequency bands may result in higher duplicate peaks (smaller DFT bins)
- Narrow frequency band is needed for Mic recording to capture peaks at specific low frequencies, for example 170 Hz
- In my opinion, better detection and less duplicates could be achieved using dynamic frequency bands based on the chunk magnitude's average
- The choice of the fingerprinting algorithm may influence the bands selection
- For this experiment, I selected fixed 4 frequency bands between 20 Hz and 1k Hz

STAGE 4 – FINGERPRINTING

- Now we selected the bands, so what next?

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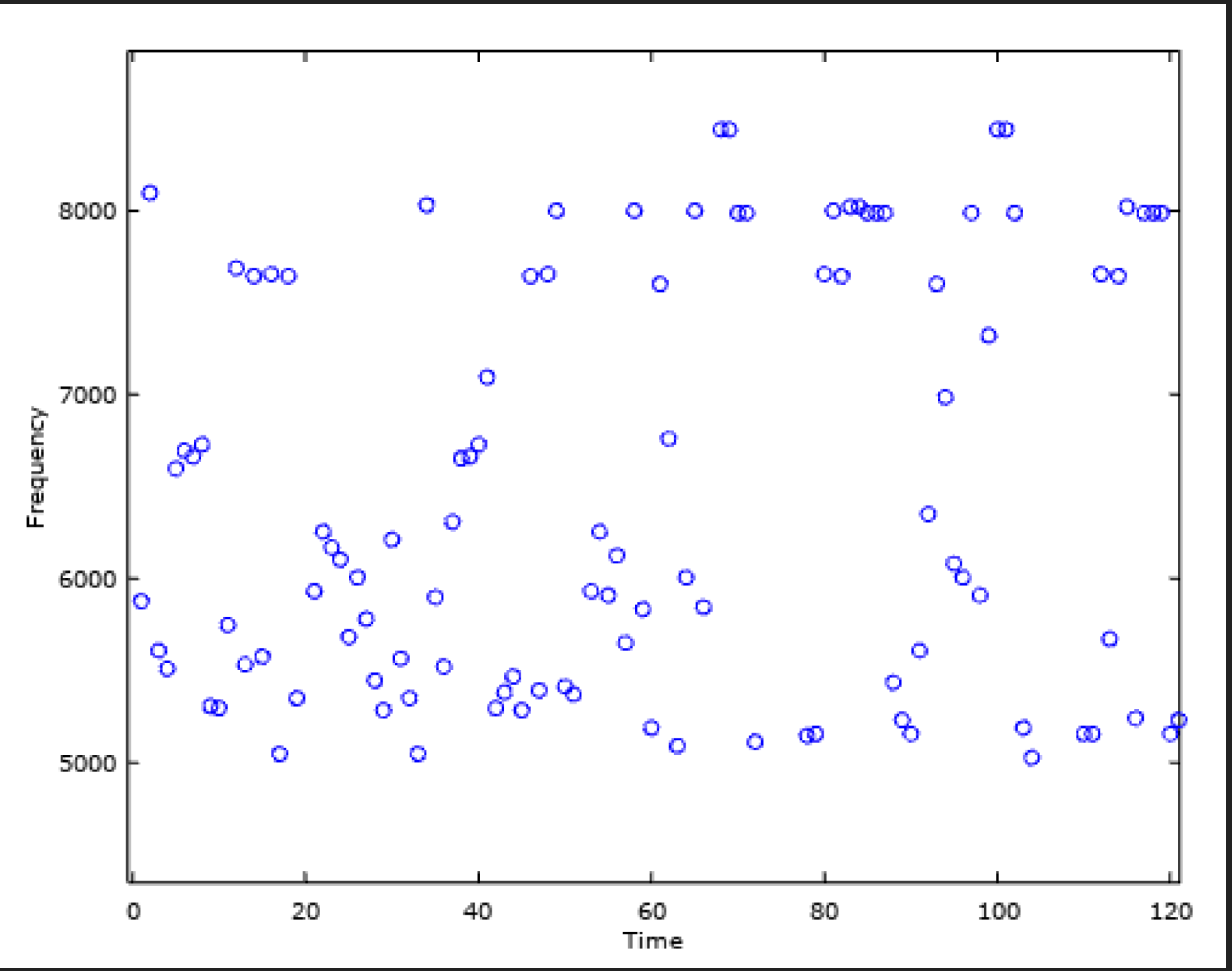

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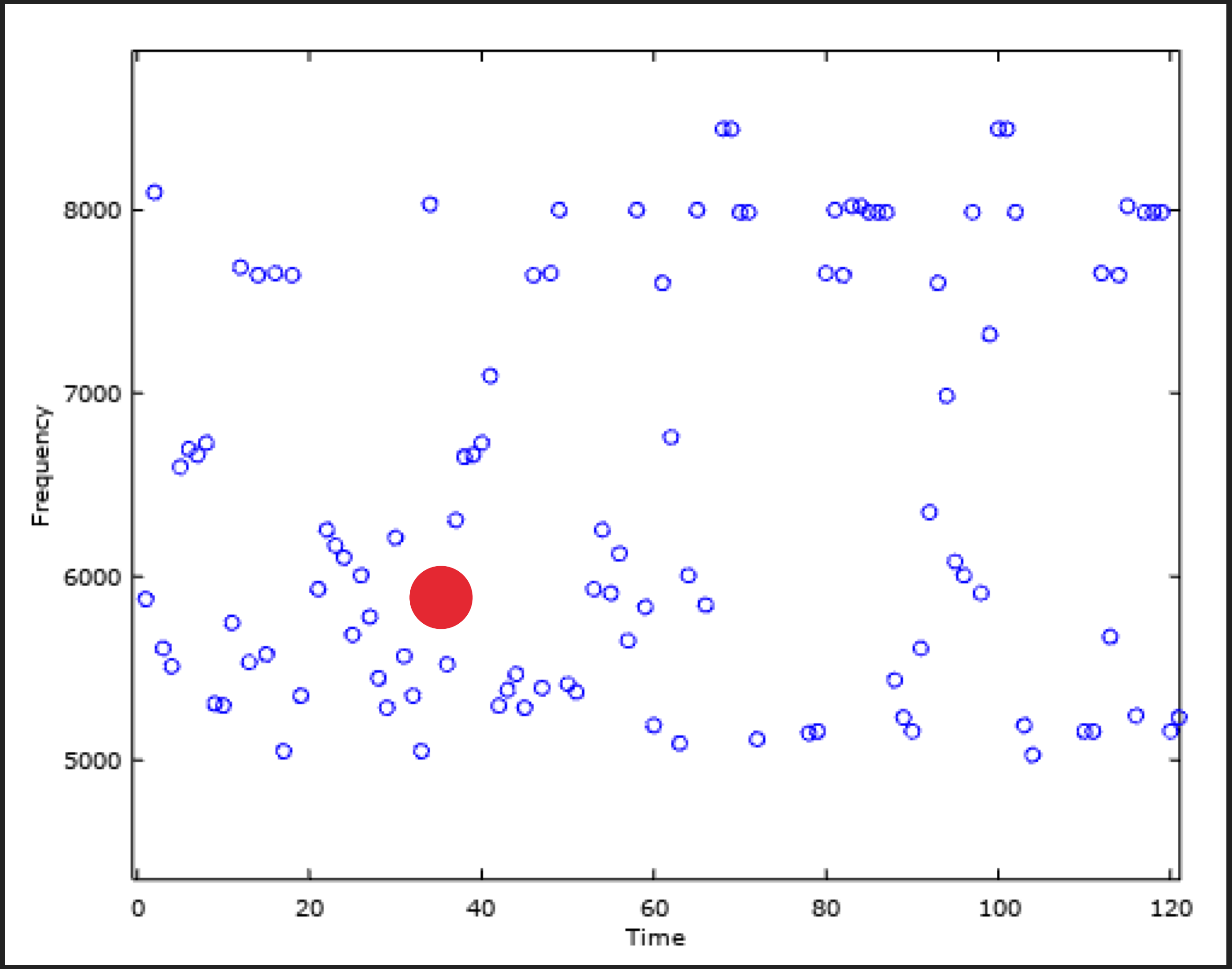

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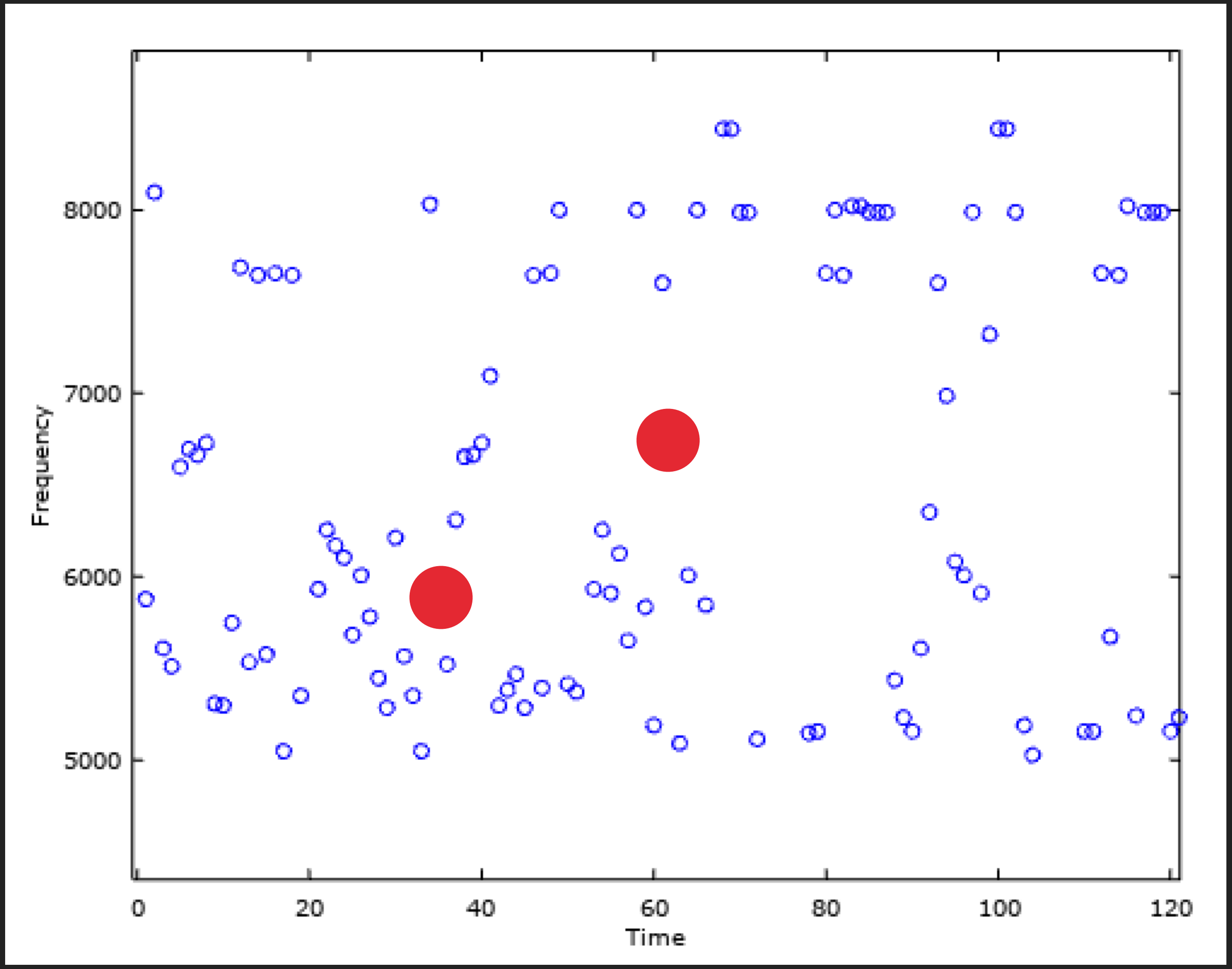

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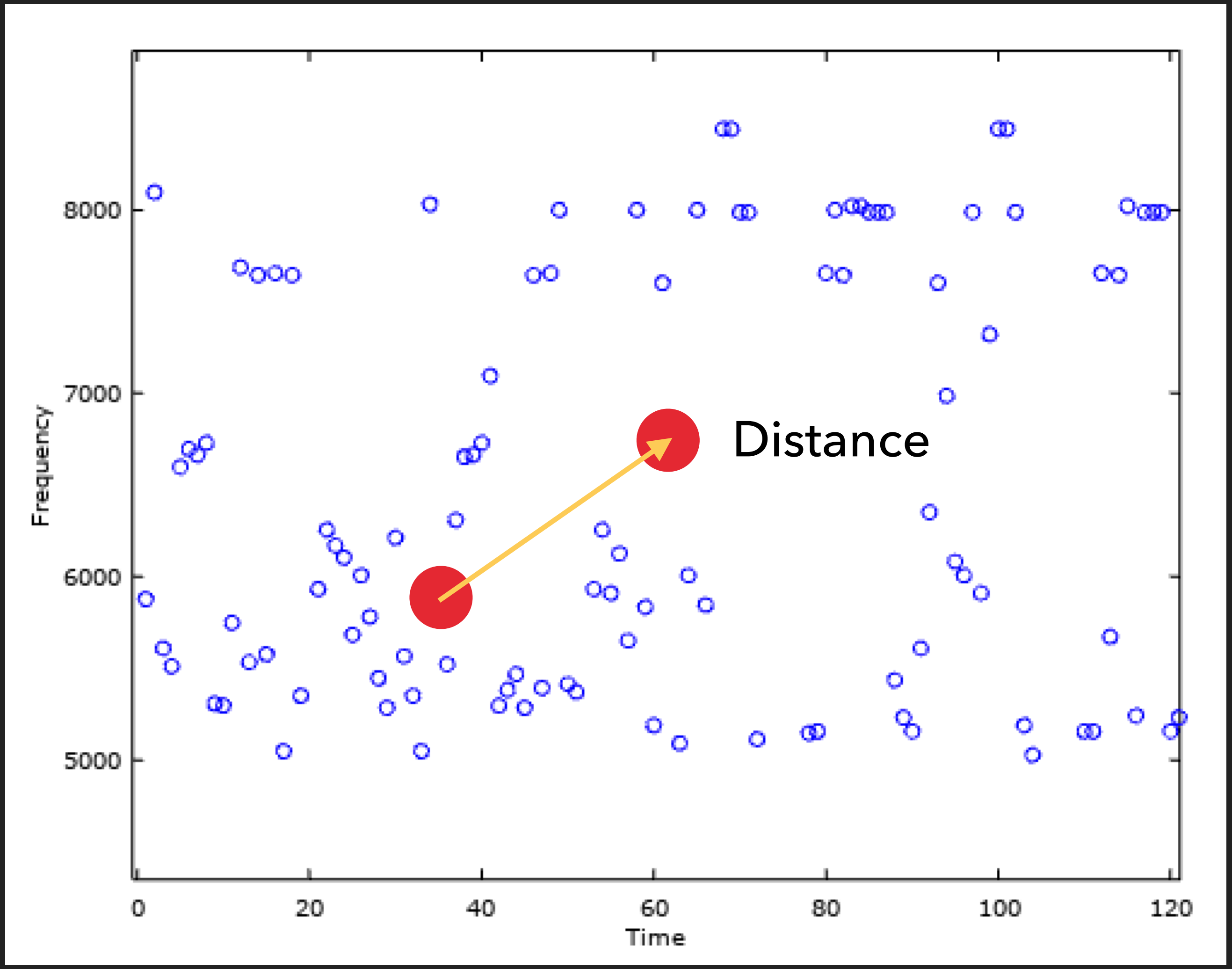

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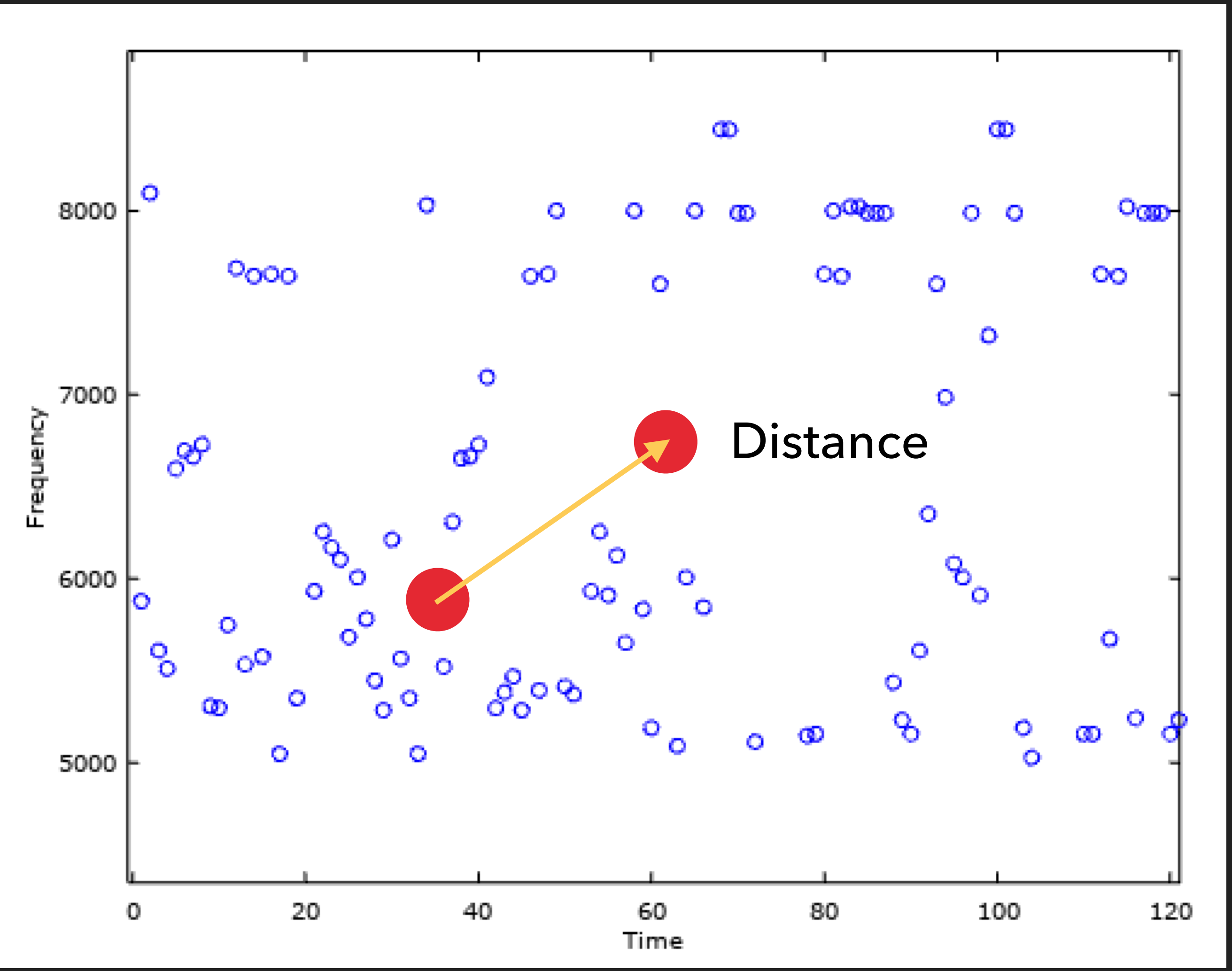

Information

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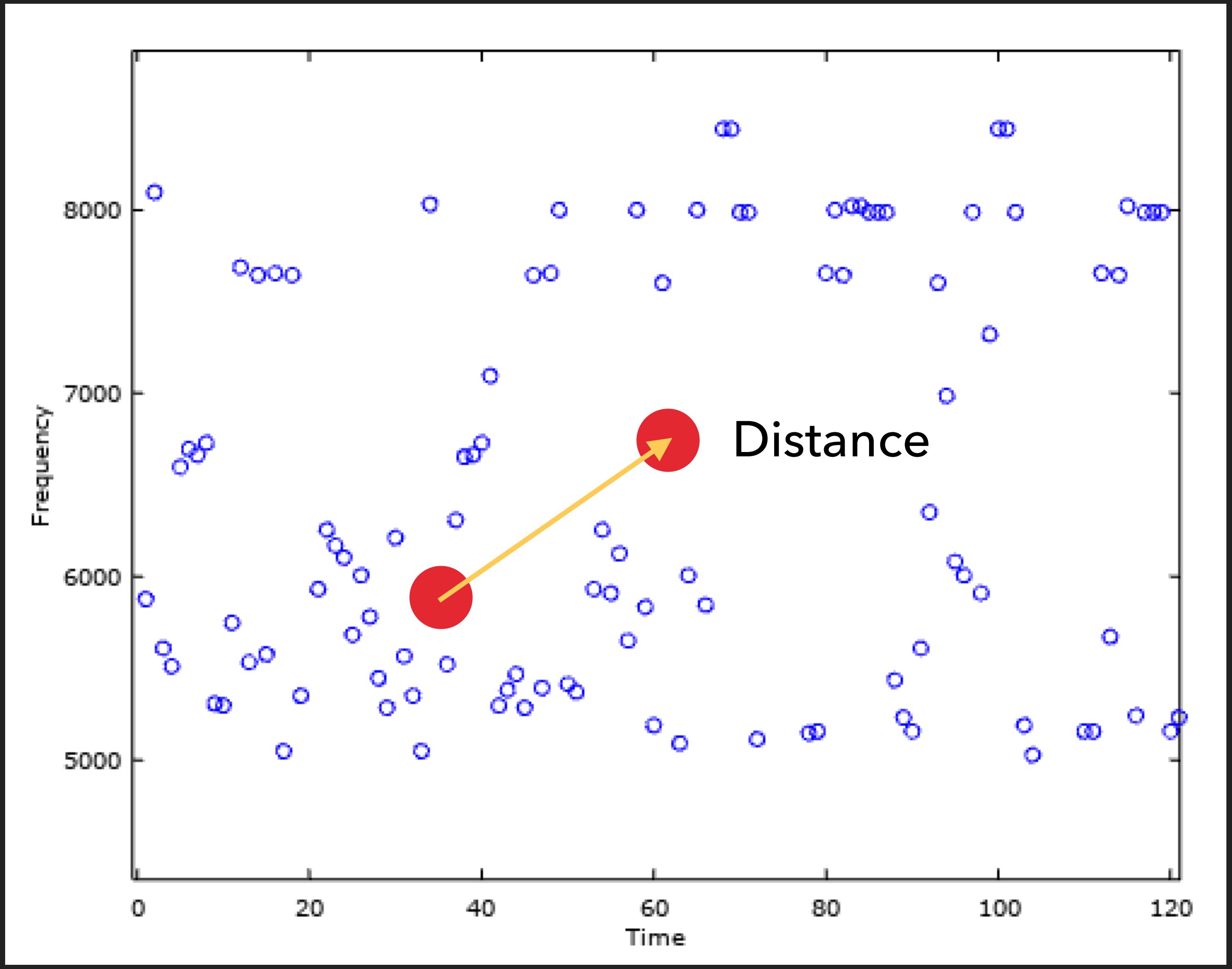

Information

Point 1 Frequency 5800 Hz

Point 2 Frequency 6700 Hz

Distance 60 - 35 = 25 ms

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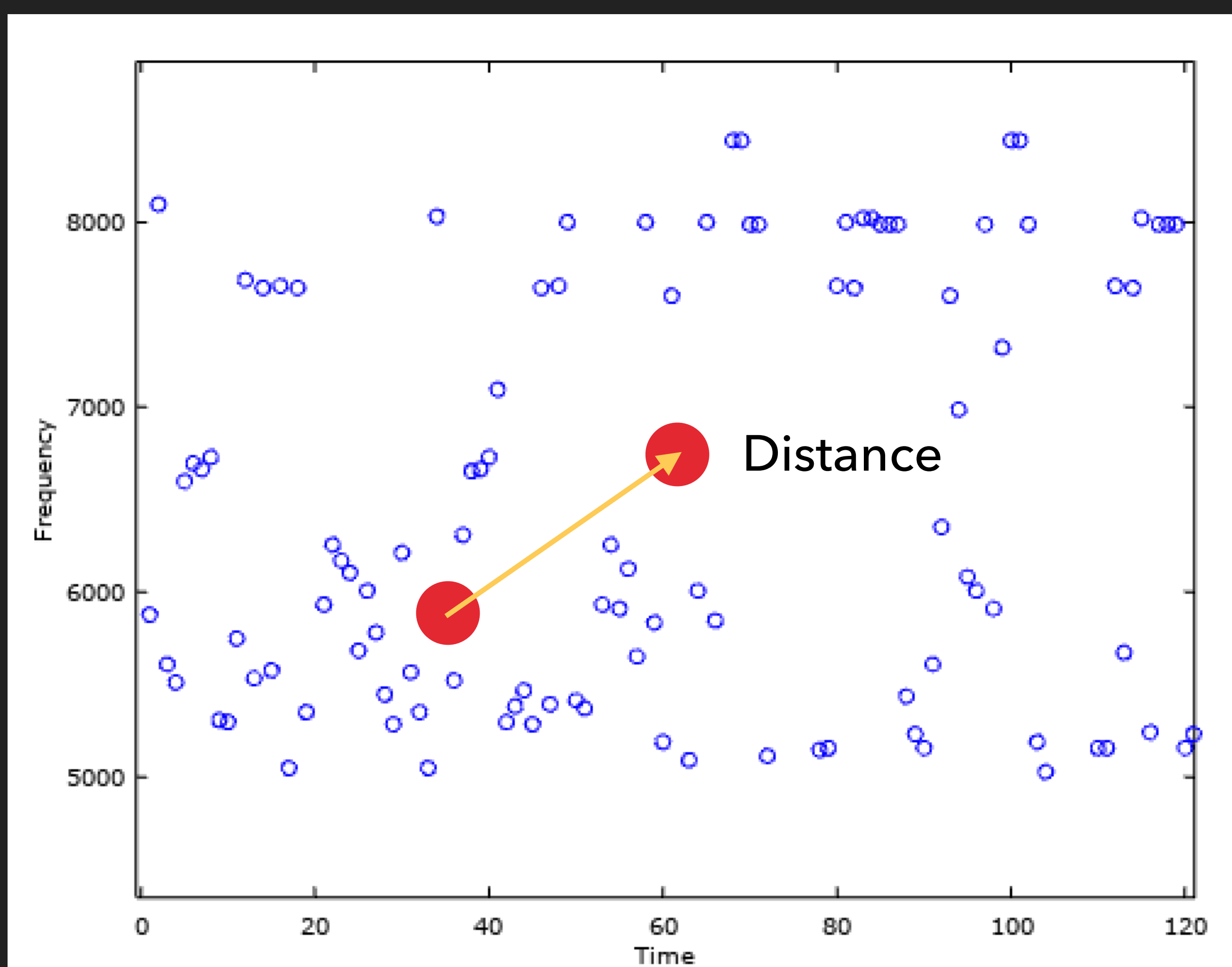

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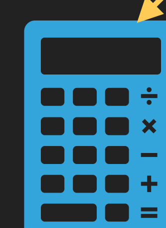

Algorithm

Hashing Technique

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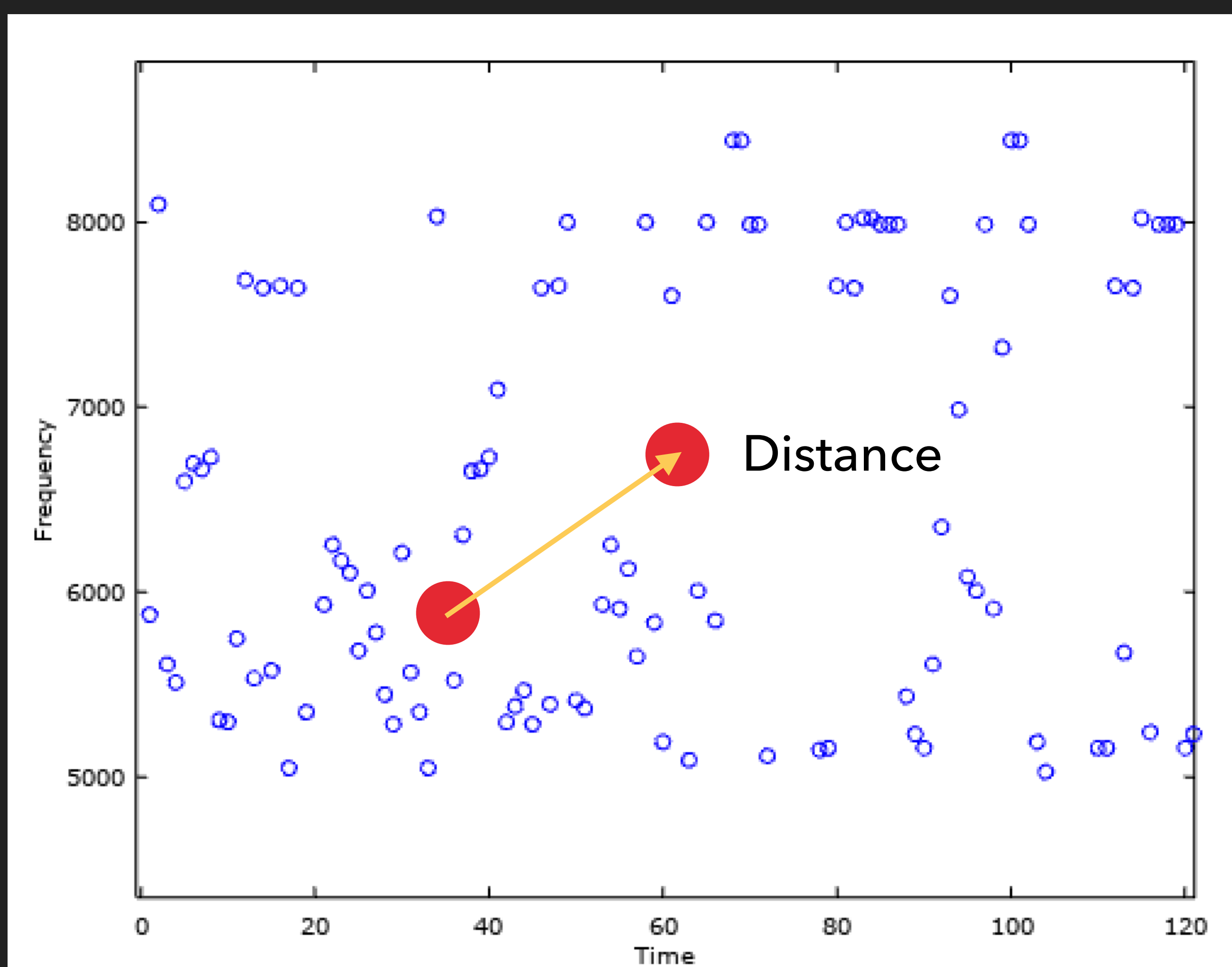

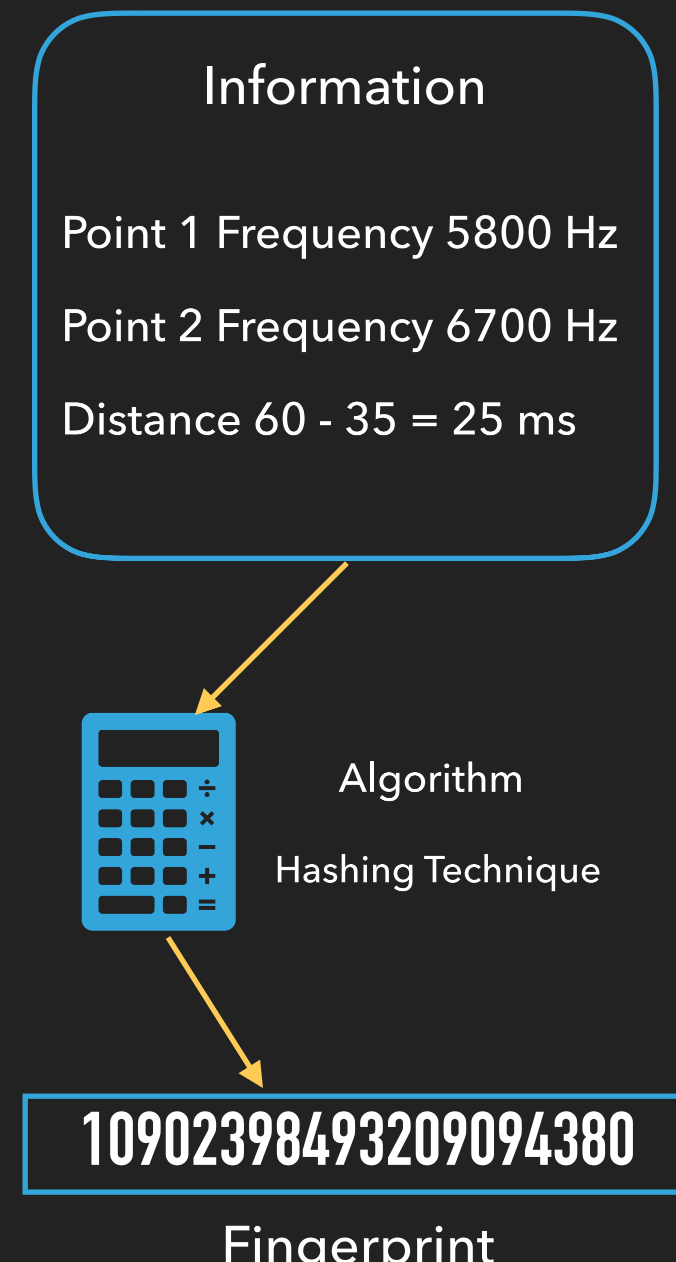

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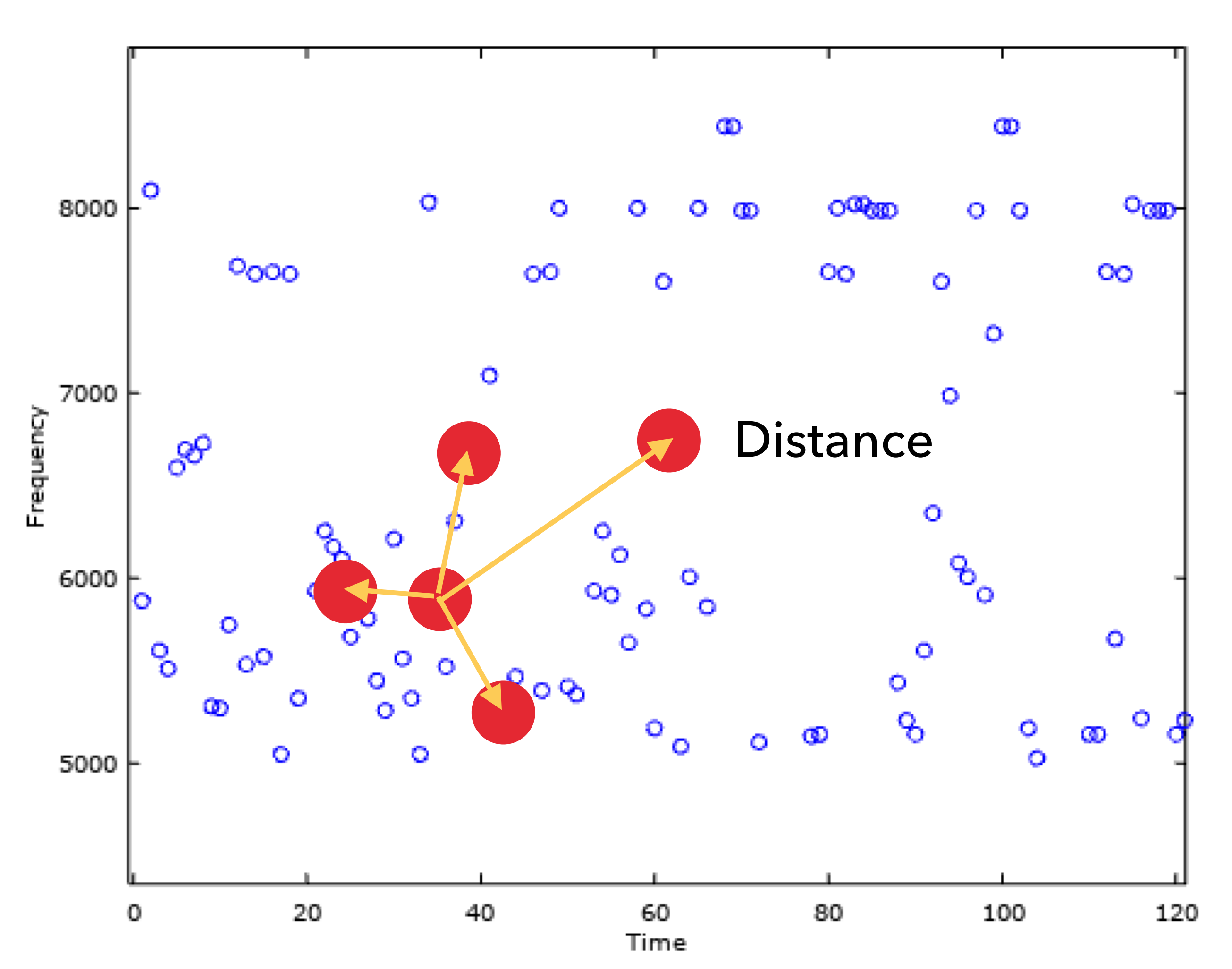

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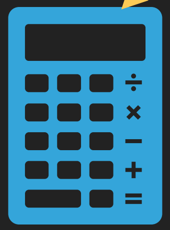

Algorithm

Hashing Technique

1090239849320909094380

Fingerprint

STAGE 5 – DATABASE

- Unique fingerprints or Duplicates?

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FingerPrints FPs	Time	Song Id
10902398493209094380	0.2s	Song_1
20802367543209094534	1.3s	Song_2
68780279824398492094	19.4s	Song_100

Unique FingerPrints Table

SHA-1
Will Drevo

377 MB

5.4 million FPs

45 songs

STAGE 5 - DATABASE

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FingerPrints FPs	Songs Id
10902398493209094380	Song_1, Song_10
20802367543209094534	Song_2, Song_13
68780279824398492094	Song_7

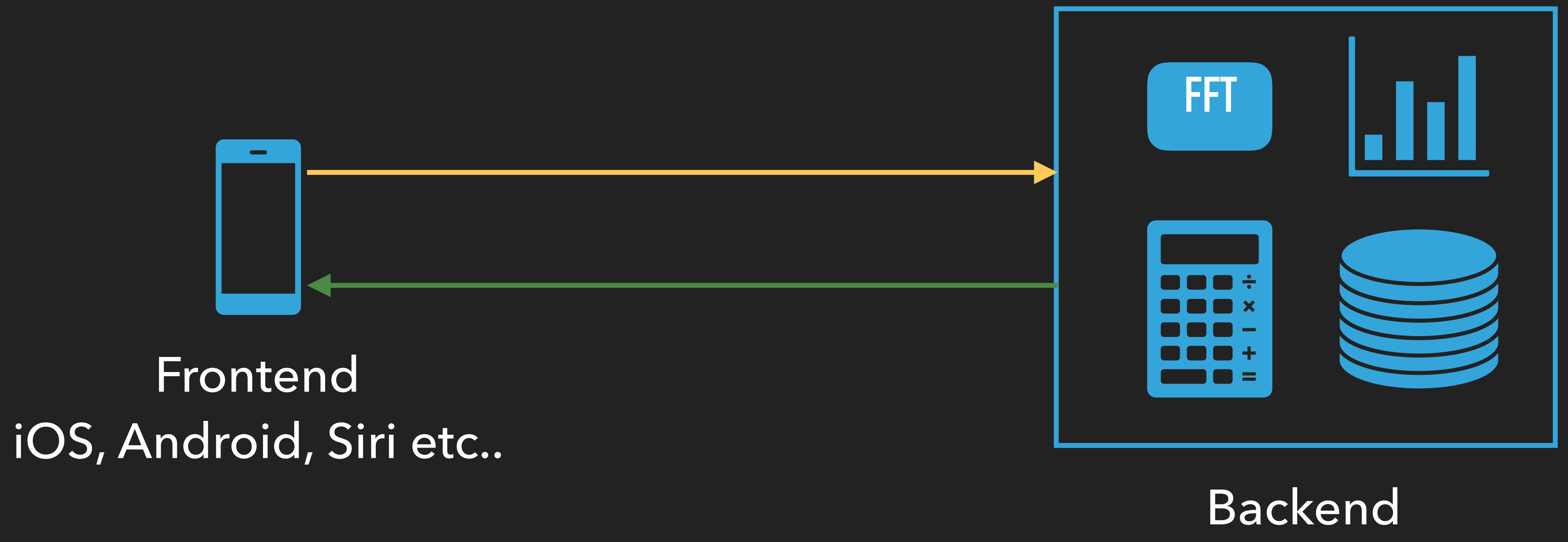
Duplicates FingerPrints Table

My Experiment
18.9 MB
64699 FPs
15 songs

size is not linear

FRONTEND & BACKEND

- Fingerprinting is a pre-processing step
- Mobile app needs only to send the chunks/buffers to the server
- Server computes the FFT, selects peaks, etc…
- Server queries the database - finds best match
- Server sends the result back to the app



SERVER-LESS DEVELOPMENT IN MOBILE

#	iOS	Android
1	Core Audio	InputStream, AudioRecord
2	vDSP	JTransforms, TarsosDSP … etc
3	Swift , Obj C	Java, Kotlin
4	Peak as a Struct	Peak as a Class
5	Core Data, realm	SQLite, Room, realm

EXPERIMENT RESULTS 97.3%

8 KB Chunk	30s	15s	10s	5s	3s
Song 1	✅	✅	✅	✅	✅
Song 2	✅	✅	✅	✅	✅
Song 3	✅	✅	✅	❌	❌
Song 4	✅	✅	✅	✅	✅
Song 5	✅	✅	✅	✅	✅
Song 6	✅	✅	✅	✅	✅
Song 7	✅	✅	✅	✅	✅
Song 8	✅	✅	✅	✅	✅
Song 9	✅	✅	✅	✅	✅
Song 10	✅	✅	✅	✅	✅
Song 11	✅	✅	✅	✅	✅
Song 12	✅	✅	✅	✅	✅
Song 13	✅	✅	✅	✅	✅
Song 14	✅	✅	✅	✅	✅
Song 15	✅	✅	✅	✅	✅

Failed first time due to noise, succeeded three times consecutively

Success with close score for next match

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- 4th problem: Marketing budget ($100 K)?
- Another problem: Why customers would migrate to your app?

REFERENCES & GOOD ARTICLES

- http://willdrevo.com/fingerprinting-and-audio-recognition-with-python/
- http://coding-geek.com/how-shazam-works/
- https://labrosa.ee.columbia.edu/matlab/fingerprint/
- https://www.theverge.com/2017/12/11/16761984/apple-shazam-acquisition

CONCLUSION

THE JOURNEY ENDS

FOR NOW!

ONE MORE THING - SAWTTI APP

- 1-Rag'n'Bone Man - I am Human
- 2-Ed Sheeran - Shape of you
- 3-Adele - Rolling in the deep
- 4-Mark Ronson - Uptown Funk
- 5-Earth, Wind & Fire - September
- 6- PSY - Gangnam Style
- 7- Sia - Cheap Thrills
- 8- Ariana Grande - Side To Side
- 9- The Chainsmokers - Closer
- 10- Shakira - Waka Waka
- 11- Lou Bega - Mambo No. 5
- 12- Luis Fonsi - Despacito
- 13- Major Lazer & DJ Snake - Lean On
- 14- Beyoncé - Naughty Girl
- 15- Los del Rio - Macarena

Q&A