

Sound and waveforms

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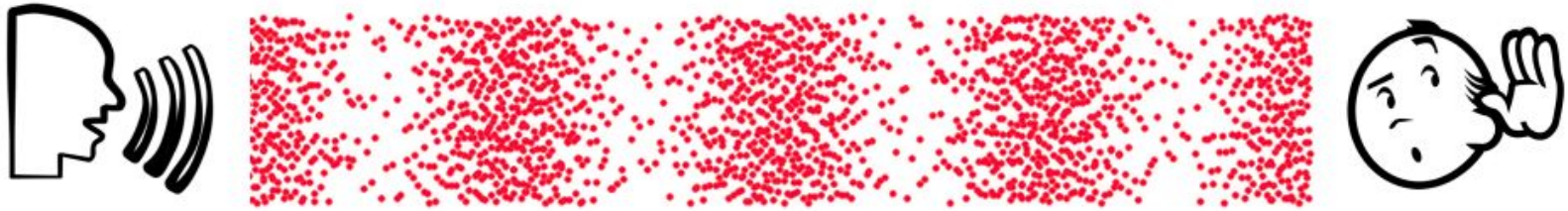
Sound

- Produced by vibration of an object
- Vibrations cause air molecules to oscillate
- Change in air pressure creates a wave

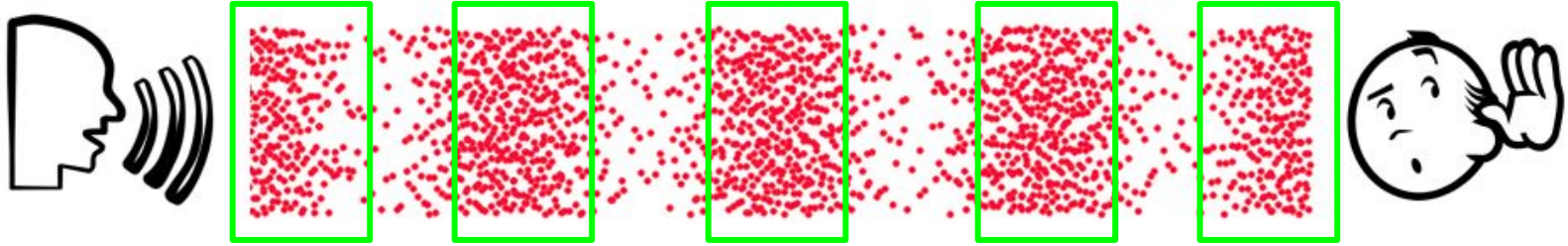
Mechanical wave

- Oscillation that travels through space
- Energy travels from one point to another
- The medium is deformed

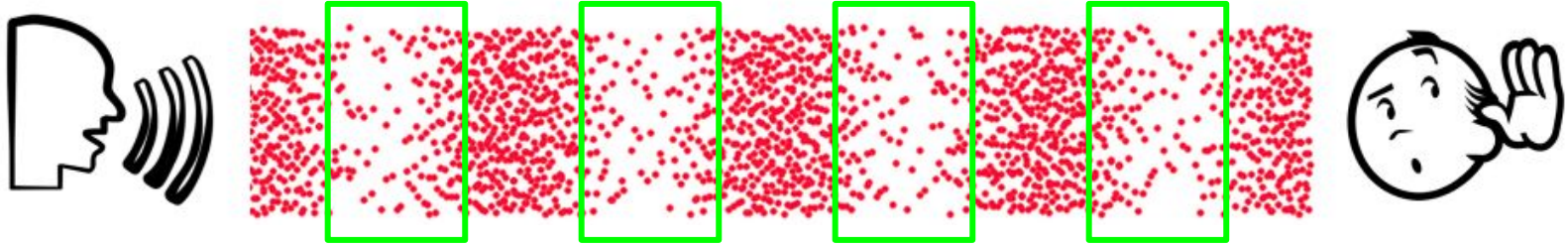
Sound wave



Sound wave



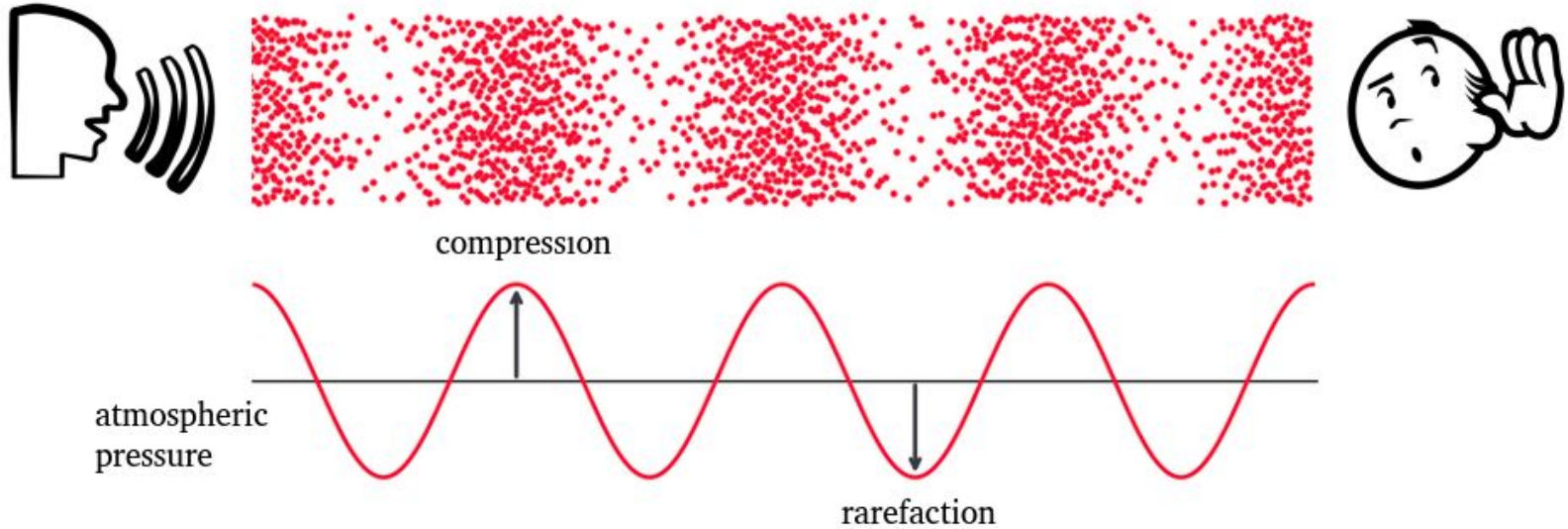
Sound wave



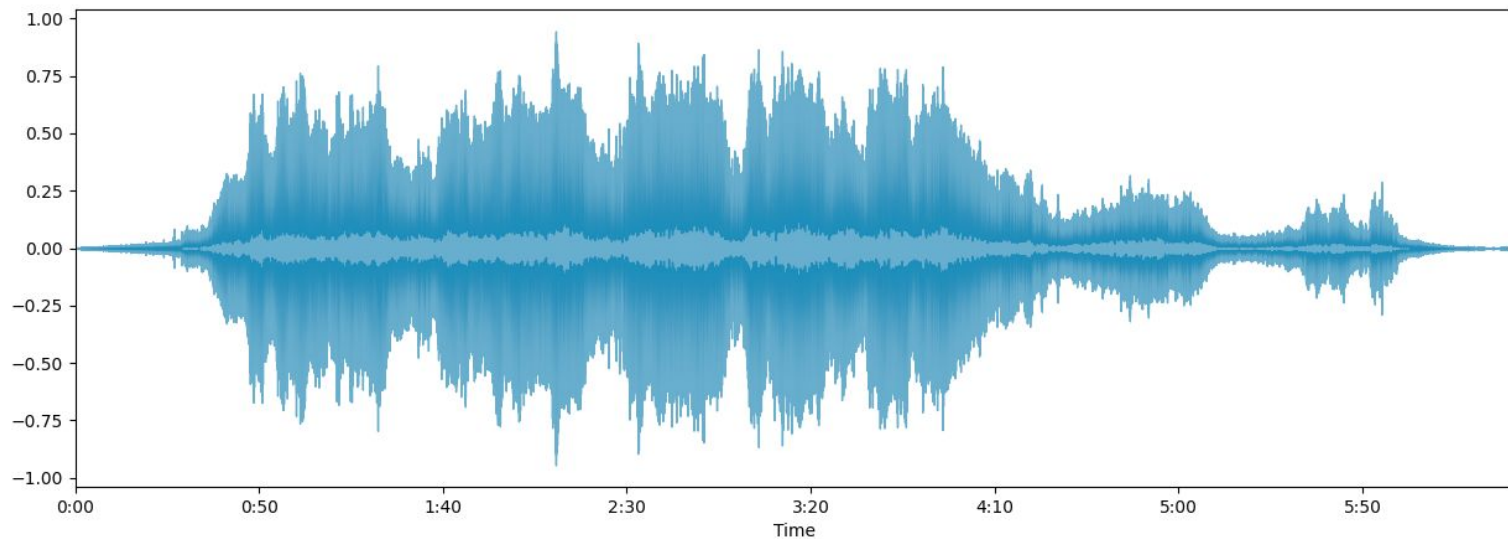
Sound wave



Sound wave



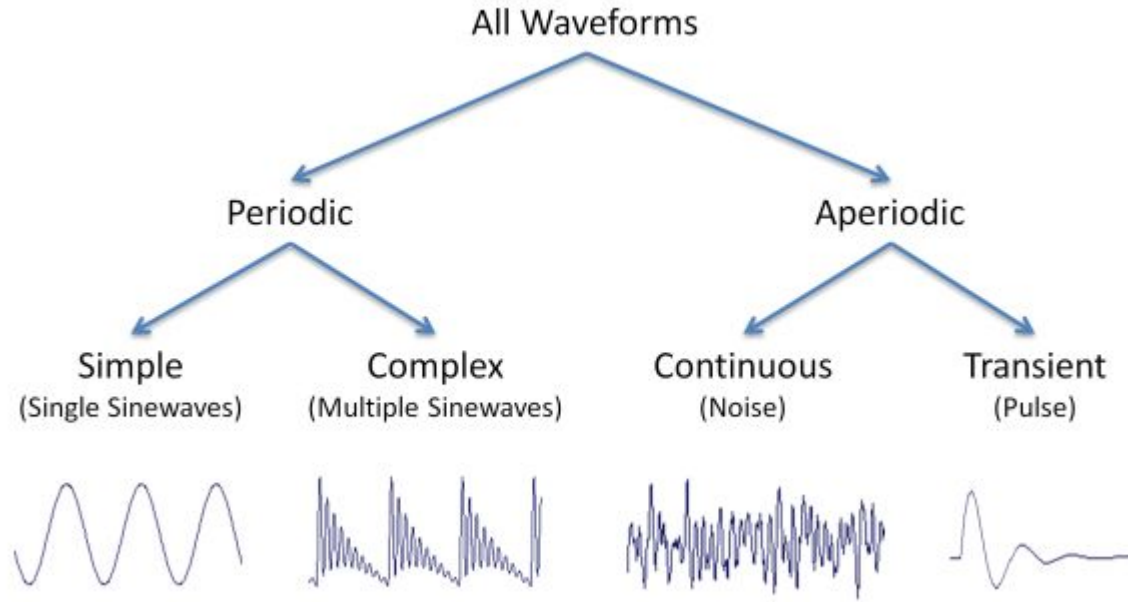
Waveform



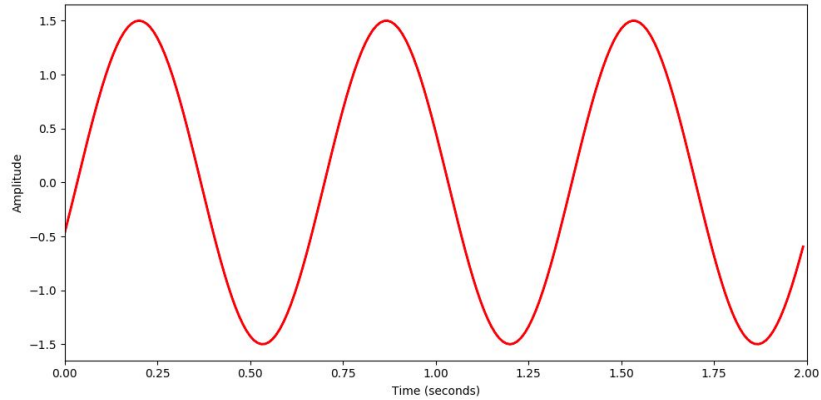
Waveform

- Carries multifactorial information:
 - Frequency
 - Intensity
 - Timbre

Periodic and aperiodic sound

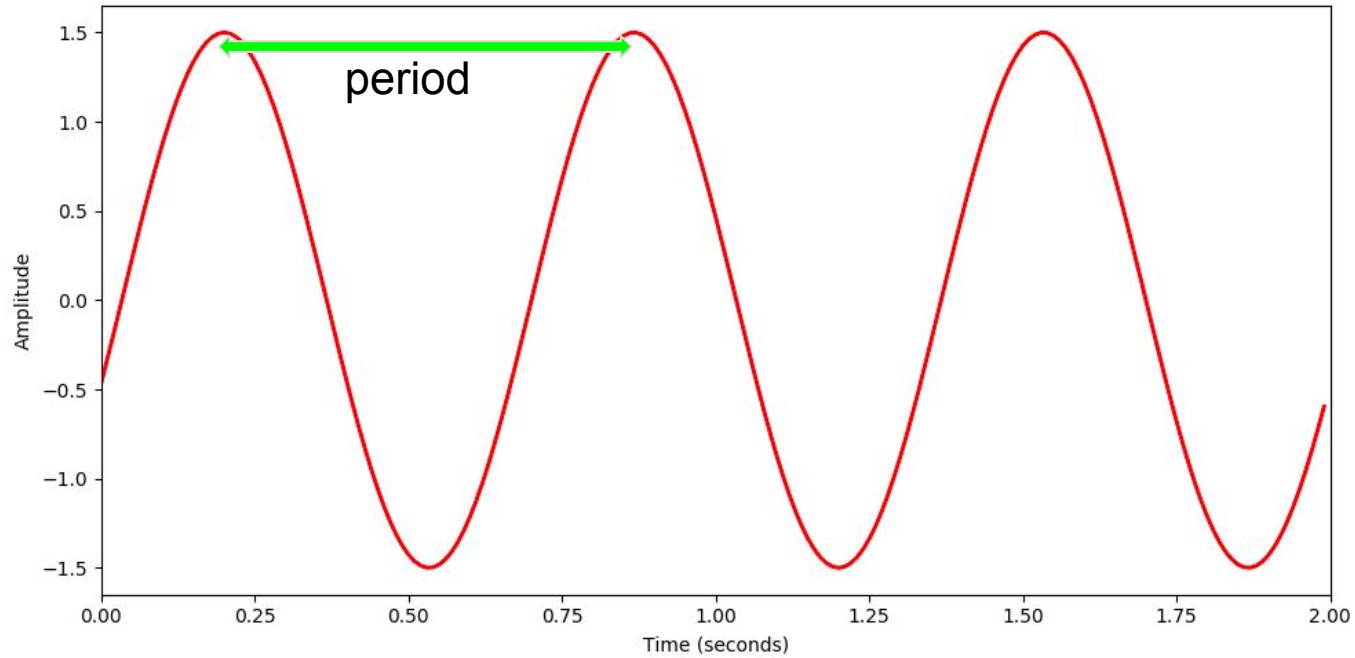


Waveform

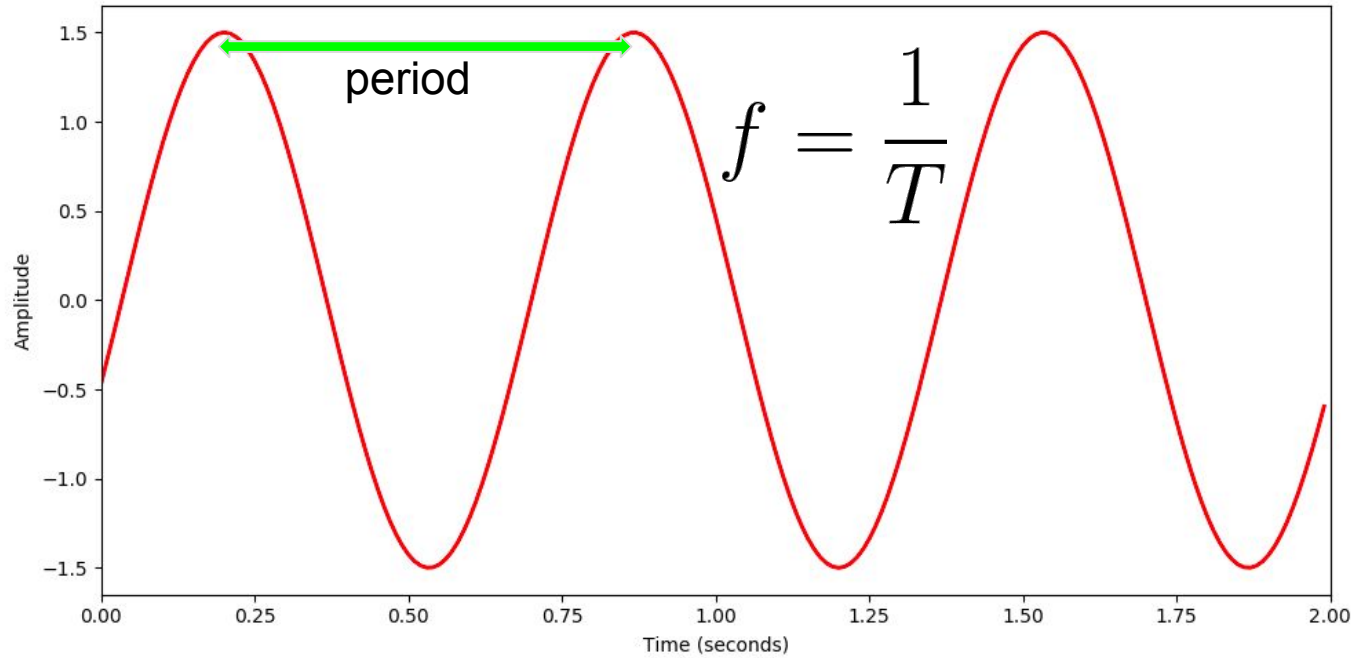


$$y(t) = A \sin(2\pi ft + \varphi)$$

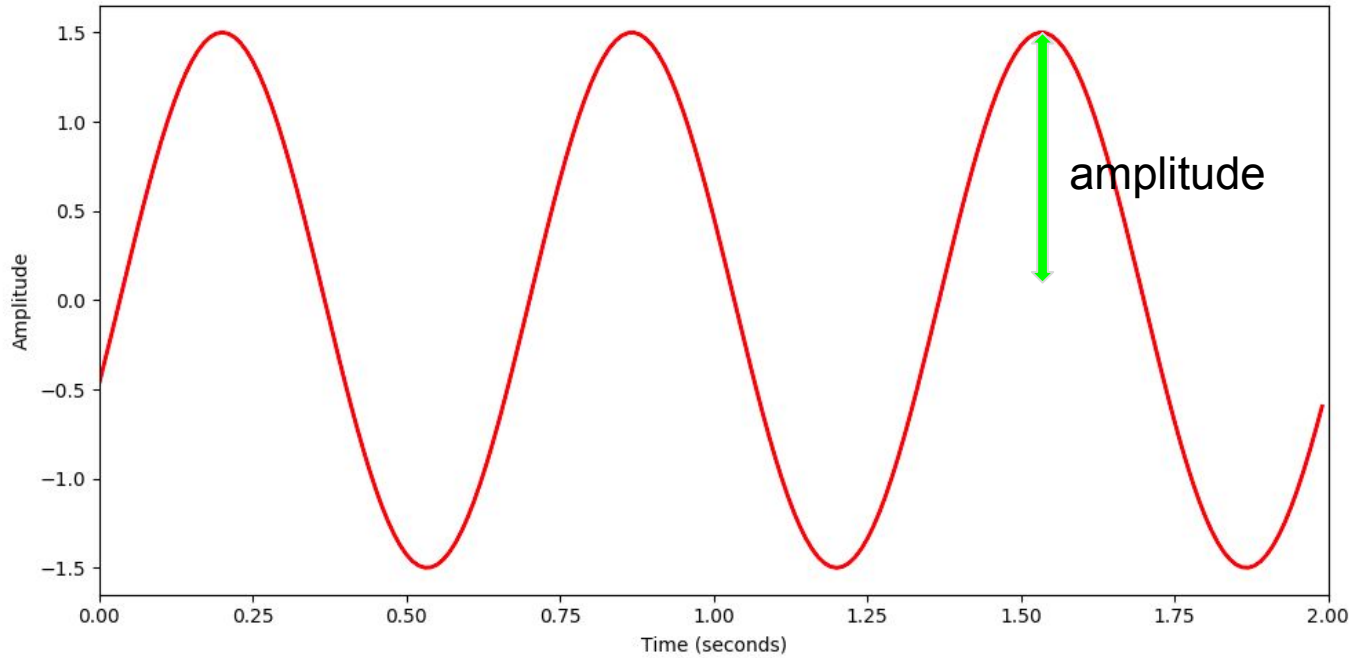
Frequency



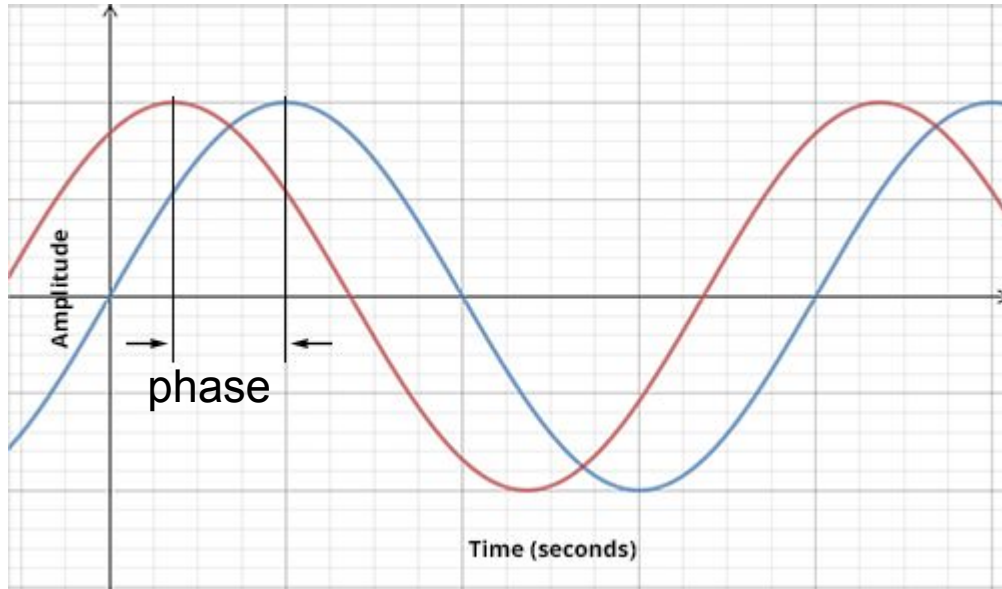
Frequency



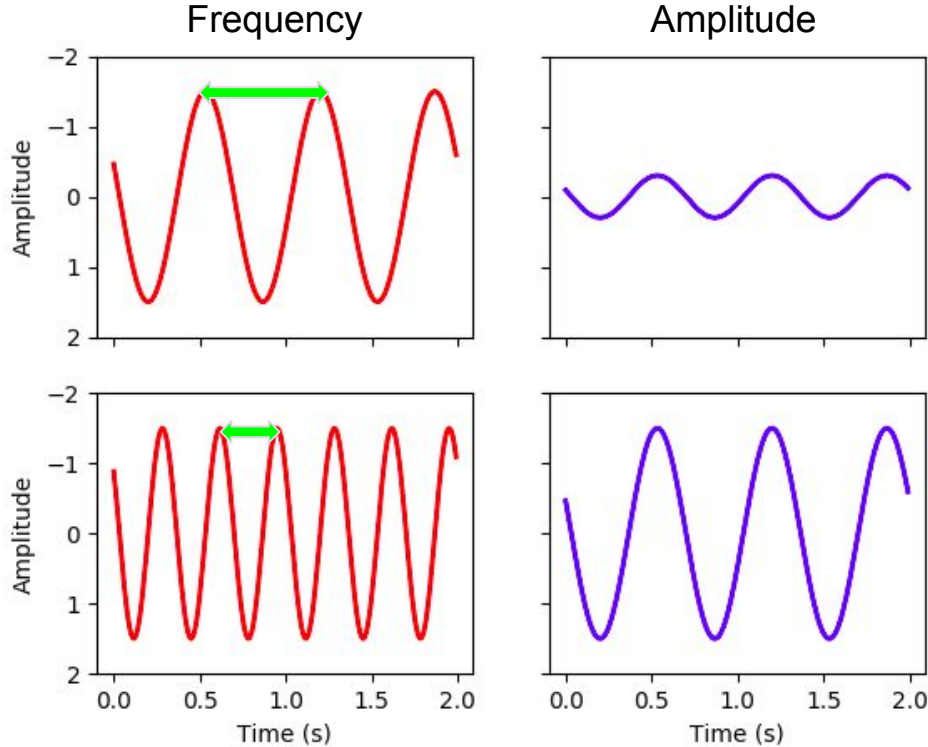
Amplitude



Phase

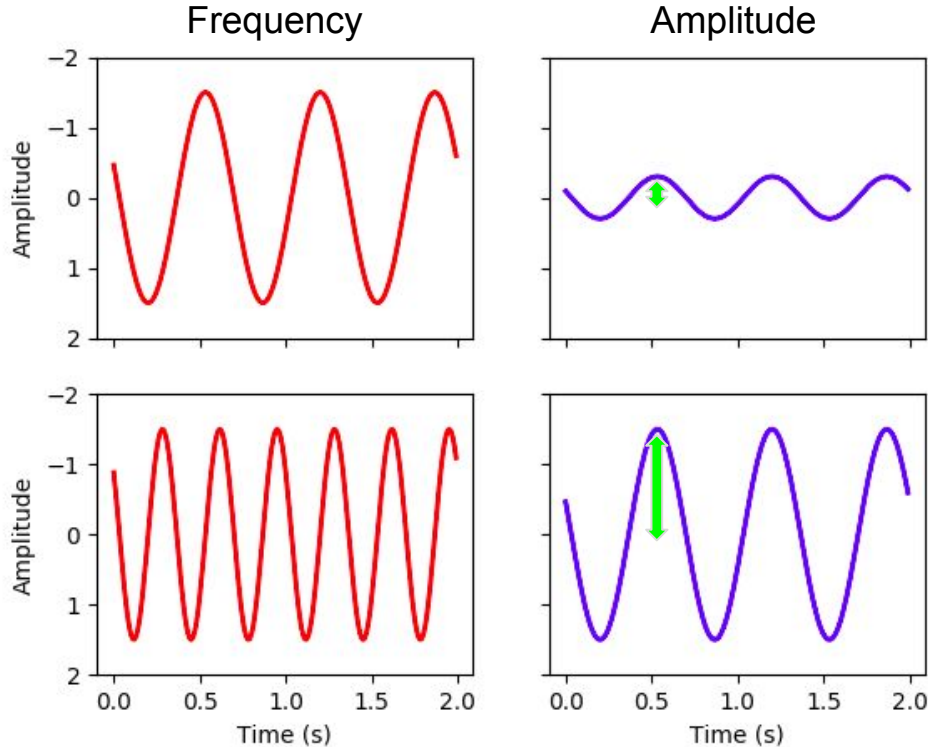


Frequency and amplitude



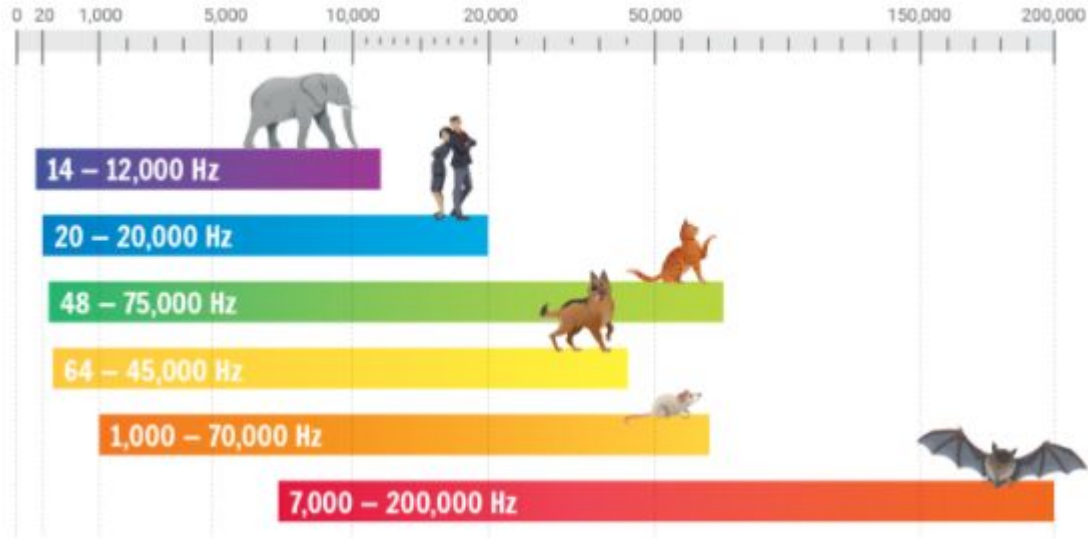
higher frequency -> higher sound

Frequency and amplitude

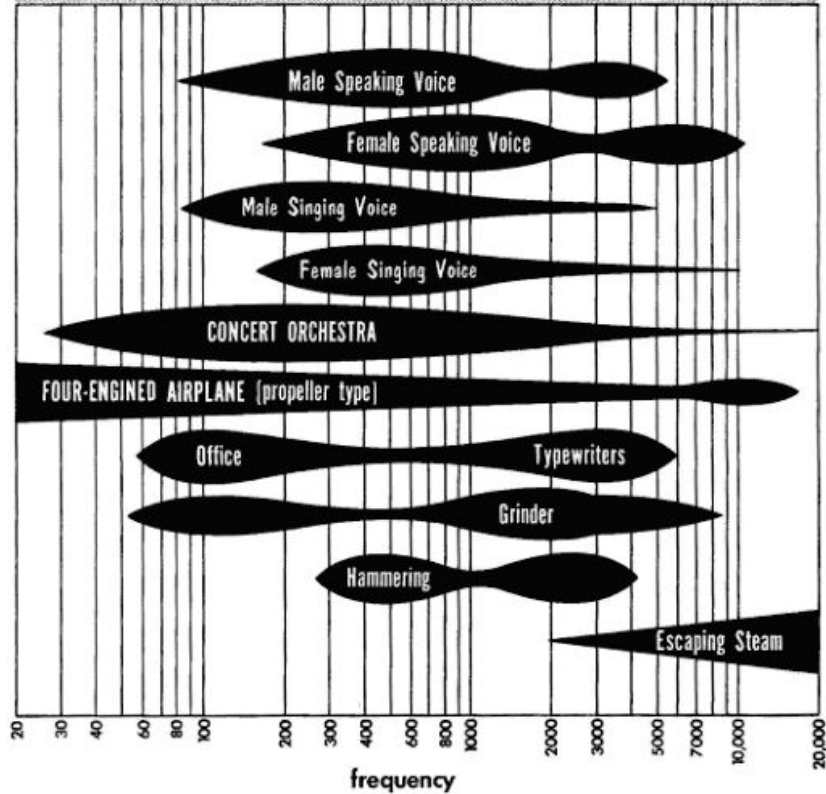


larger amplitude -> louder

Hearing range



Hearing range



Pitch

- Logarithmic perception
- 2 frequencies are perceived similarly if they differ by a power of 2

Midi notes

	108	C8
A7#	107	B7
G7#	106	A7
F7#	105	G7
	104	
	103	F7
	102	
D7#	101	E7
C7#	100	D7
	99	C7
	98	B7
	97	A7
	96	G7
A6#	95	F7
G6#	94	E7
F6#	93	D7
	92	C7
	91	B7
	90	A7
	89	G7
D6#	88	F7
C6#	87	E7
	86	D7
	85	C7
	84	B7
A5#	83	A7
G5#	82	G7
F5#	81	F7
	80	E7
	79	D7
	78	C7
	77	B7
D5#	76	A7
C5#	75	G7
	74	F7
	73	E7
	72	D7
A4#	71	C7
G4#	70	B7
F4#	69	A7
	68	G7
	67	F7
	66	E7
	65	D7
D4#	64	C7
C4#	63	B7
	62	A7
	61	G7
	60	F7
A3#	59	E7
G3#	58	D7
F3#	57	C7
	56	B7
	55	A7
	54	G7
	53	F7
D3#	52	E7
C3#	51	D7
	50	C7
	49	B7
	48	A7
A2#	47	G7
G2#	46	F7
F2#	45	E7
	44	D7
	43	C7
	42	B7
	41	A7
D2#	40	G7
C2#	39	F7
	38	E7
	37	D7
	36	C7
A1#	35	B7
G1#	34	A7
F1#	33	G7
	32	F7
	31	E7
	30	D7
D1#	29	C7
C1#	28	B7
	27	A7
	26	G7
	25	F7
	24	E7
A0#	23	D7
	22	C7
	21	B7

Midi notes

		108	C8
A7#	106	107	B7
G7#	104	105	A7
F7#	102	103	G7
		101	F7
D7#	99	100	E7
C7#	97	98	D7
		96	C7
A6#	94	95	B6
G6#	92	93	A6
F6#	90	91	G6
		89	F6
D6#	87	88	E6
C6#	85	86	D6
		84	C6
A5#	82	83	B5
G5#	80	81	A5
F5#	78	79	G5
		77	F5
D5#	75	76	E5
C5#	73	74	D5
		72	C5
A4#	70	71	B4
G4#	68	69	A4
F4#	66	67	G4
		65	F4
D4#	63	64	E4
C4#	61	62	D4
		60	C4
A3#	58	59	B3
G3#	56	57	A3
F3#	54	55	G3
		53	F3
D3#	51	52	E3
C3#	49	50	D3
		48	C3
A2#	46	47	B2
G2#	44	45	A2
F2#	42	43	G2
		41	F2
D2#	39	40	E2
C2#	37	38	D2
		36	C2
A1#	34	35	B1
G1#	32	33	A1
F1#	30	31	G1
		29	F1
D1#	27	28	E1
C1#	25	26	D1
		24	C1
A0#	22	23	B0
		21	A0

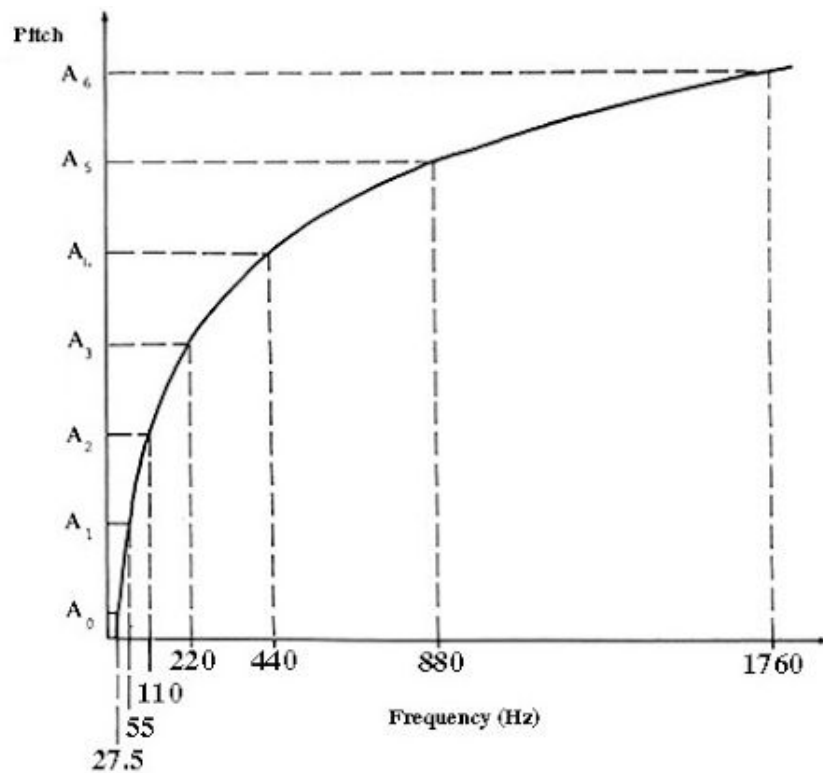
Midi notes

Note name	Midi number	Note name
A7#	106	C8
G7#	104	B7
F7#	102	A7
D7#	99	G7
C7#	97	F7
A6#	94	E7
G6#	92	D7
F6#	90	C7
D6#	87	B6
C6#	85	A6
A5#	82	G6
G5#	80	F6
F5#	78	E6
D5#	75	D6
C5#	73	C6
A4#	70	B5
G4#	68	A5
F4#	66	G5
D4#	63	F5
C4#	61	E5
A3#	58	D5
G3#	56	C5
F3#	54	B4
D3#	51	A4
C3#	49	G4
A2#	46	F4
G2#	44	E4
F2#	42	D4
D2#	39	C4
C2#	37	B3
A1#	34	A3
G1#	32	G3
F1#	30	F3
D1#	27	E3
C1#	25	D3
A0#	22	C3
	21	B2
		A2
		G2
		F2
		E2
		D2
		C2
		B1
		A1
		G1
		F1
		E1
		D1
		C1
		B0
		A0

Midi notes

Note name	A0#	C1#	D1#	F1#	A1#	G1#	F1#	C2#	D2#	F2#	A2#	G2#	C3#	D3#	F3#	A3#	G3#	C4#	D4#	F4#	A4#	G4#	C5#	D5#	F5#	A5#	G5#	C6#	D6#	F6#	A6#	G6#	C7#	D7#	F7#	A7#	G7#	A8#		
Midi number	22	25	27	30	34	32	30	37	39	42	46	44	49	51	54	58	56	61	63	66	70	68	73	75	78	80	82	85	87	90	92	94	97	99	102	104	106	108		
Note name	A0	B0	C1	D1	E1	F1	G1	B1	C2	D2	E2	F2	G2	C3	D3	E3	B3	C4	D4	E4	F4	G4	B4	C5	D5	E5	F5	G5	B5	C6	D6	E6	F6	G6	B6	C7	D7	E7	B7	C8

Pitch-frequency chart



Mapping pitch to frequency

$$F(p) = 2^{\frac{p-69}{12}} \cdot 440$$

Mapping pitch to frequency

$$F(60) = 2^{\frac{60-69}{12}} \cdot 440 = 261.6$$

Mapping pitch to frequency

$$F(p + 1) / F(p) = 2^{1/12} = 1.059$$

Cents

- Octave divided in 1200 cents
- 100 cents in a semitone
- Noticeable pitch difference: 10-25 cents

What's up next?

- Intensity, power, loudness
- Timbre

Join the community!



thesoundofai.slack.com