

Level 0x08



Moar Steganography



Topics

- Hacker History
- Audio Steg
- Printer Steg

Upcoming Events

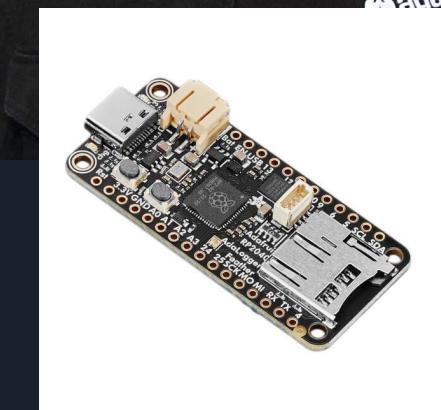
- December hacking contests
 - Advent of Cyber - [TryHackMe.com](https://tryhackme.com)
 - Sans Institute [Holiday Hack Challenge](#) - Less CTF, more game, probably more incident responder and defender focused
 - [Advent of Code](#) - Programming challenges. Used to be 25 2-parters, now reducing down to 12 days of challenges
 - [Pwn.College](#) is going to do an Advent of Pwn



Lady Ada - Limor Fried



- Bachelors and Masters in Electrical Engineering and Computer Science from MIT
- Founded Adafruit Industries in 2005
- Champion of
 - Maker movement
 - Open Source HW
 - Wearable electronics
- Adafruit sells the best electronic kits
- Best tutorials on how to use new kits / hardware
- Libraries for arduino / Raspberry Pi

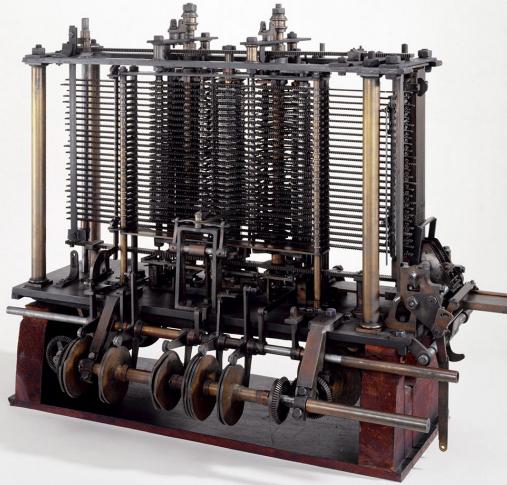


Ada King, Countess of Lovelace

- 1815 - 1852
- First computer programmer (disputed?)
 - Charles Babbage's Analytical Engine

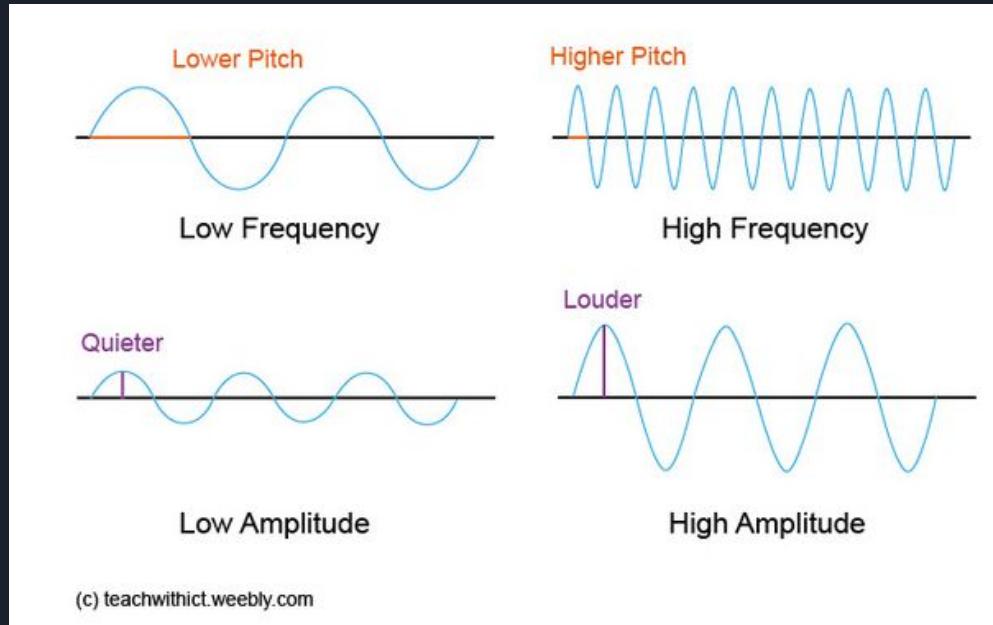
Diagram for the computation by the Engine of the Numbers of Bernoulli. See Note G. (page 722 of seq.)		
Number of Operations.	Value of Variables.	Variables after computing results.
		Indication of change in value on any Variable.
		Working Variables.
		Result Variables.
		Data.
		Statement of Results.
		V_1 V_2 V_3 V_4 V_5 V_6 V_7 V_8 V_9 V_{10} V_{11} V_{12} V_{13} V_{14} V_{15} V_{16} V_{17} V_{18} V_{19} V_{20} V_{21} V_{22} V_{23} V_{24} V_{25}
		B_1 B_2 B_3 B_4 B_5 B_6 B_7 B_8 B_9 B_{10} B_{11} B_{12} B_{13} B_{14} B_{15} B_{16} B_{17} B_{18} B_{19} B_{20} B_{21} B_{22} B_{23} B_{24} B_{25}
1	$\times V_1 \times V_2 \times V_3$	$(V_1 \times V_2) \times V_3$
		$= 2x$
2	$- V_1 + V_2 \times V_3$	$(V_2 \times V_3) - V_1$
		$= 2x - 1$
3	$+ V_1 + V_2 \times V_3$	$(V_2 \times V_3) + V_1$
		$= 2x + 1$
4	$- V_1 \times V_2 \times V_3$	$(V_2 \times V_3) \times V_1$
		$= 2x - 1$
5	$- V_1 \times V_2 \times V_3 \times V_4$	$(V_2 \times V_3 \times V_4) \times V_1$
		$= 2x - 1$
6	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5$	$(V_2 \times V_3 \times V_4 \times V_5) \times V_1$
		$= 2x - 1$
7	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6) \times V_1$
		$= 2x - 1$
8	$+ V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6) + V_1$
		$= 2x + 1$
9	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7) \times V_1$
		$= 2x - 1$
10	$\times V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7) \times (V_1 \times V_2)$
		$= 2x - 1$
11	$+ V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8) + V_1$
		$= 2x + 1$
12	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8) \times V_1$
		$= 2x - 1$
13	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9) \times V_1$
		$= 2x - 1$
14	$+ V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9) + V_1$
		$= 2x + 1 - 3$
15	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9) \times V_1$
		$= 2x - 1$
16	$\times V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9) \times (V_1 \times V_2)$
		$= 2x - 1$
17	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10}) \times V_1$
		$= 2x - 2$
18	$+ V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10}) + V_1$
		$= 2x + 1 - 4$
19	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11}) \times V_1$
		$= 2x - 2$
20	$\times V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11}) \times (V_1 \times V_2)$
		$= 2x - 2$
21	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12}) \times V_1$
		$= 2x - 3$
22	$\times V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12}) + V_1$
		$= 2x - 2$
23	$- V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12} \times V_{13}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12} \times V_{13}) \times V_1$
		$= 2x - 3$
24	$+ V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12} \times V_{13}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12} \times V_{13}) + V_1$
		$= 2x + 1 - 4 + 1 - 5$
25	$+ V_1 \times V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12} \times V_{13}$	$(V_2 \times V_3 \times V_4 \times V_5 \times V_6 \times V_7 \times V_8 \times V_9 \times V_{10} \times V_{11} \times V_{12} \times V_{13}) + V_1$
		$= 2x + 1$

Here follows a repetition of Operations thirteen to twenty-three.



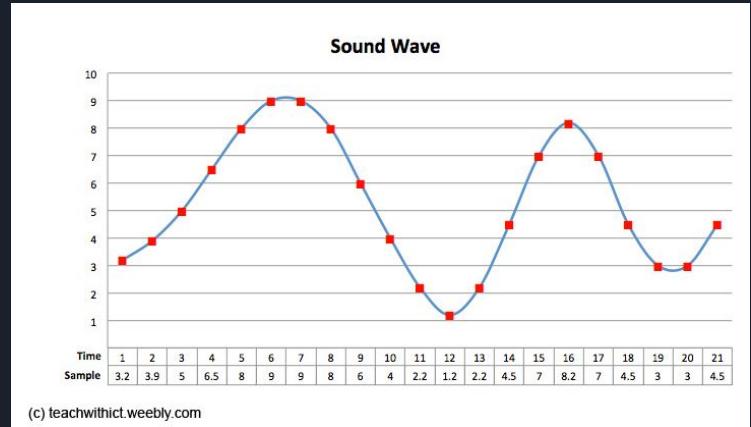
Ada
In Strong Typing We Trust

What is sound?



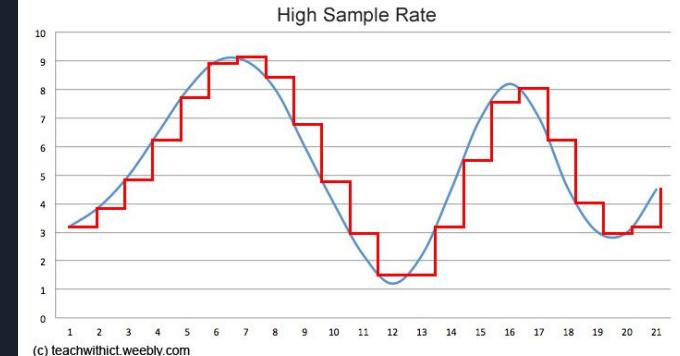
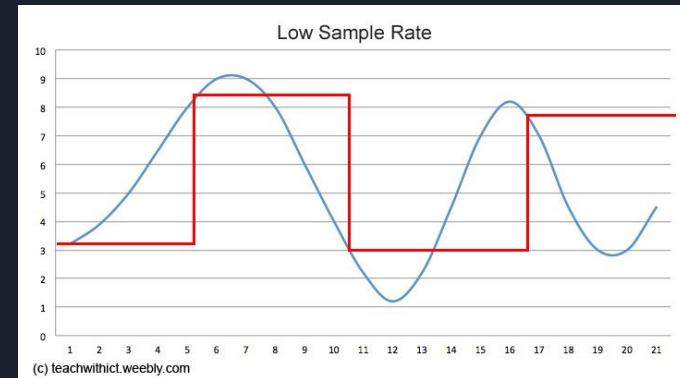
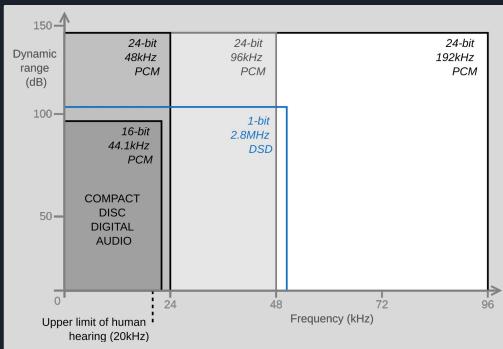
How does a computer encode sound?

- Plots the points on the waveform (just like Algebra 2?)
- Sample Rate: Number of points per second
- Amplitude: From -1.0 to +1.0



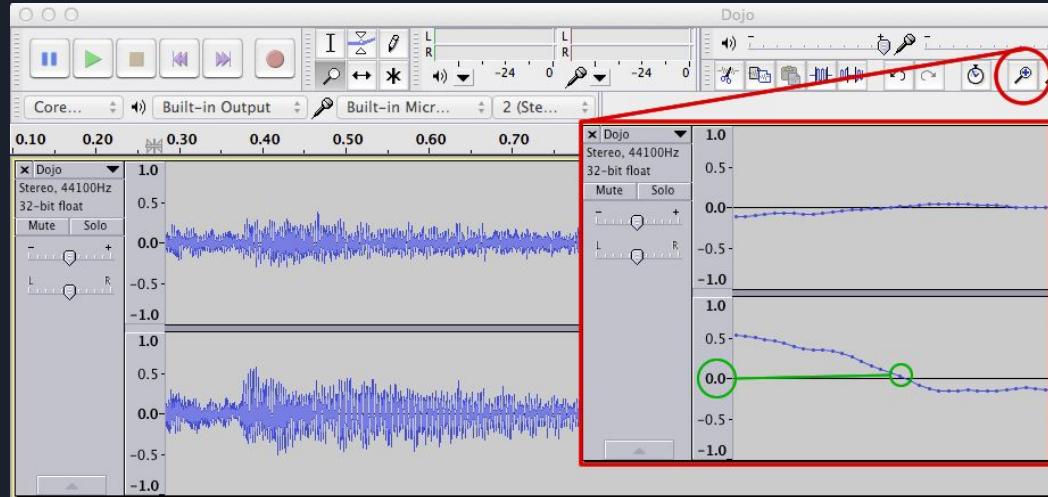
Tradeoffs on audio encoding

- High sample rate
 - Better quality sound
 - Larger data file
- Accuracy of the amplitude
 - Quality of the Analog-to-Digital converter (ADC) used (or DAC during playback)
 - Raspberry Pi Pico is 12-bit
- What is loss-less audio?



Audio LSB Steganography

- Would a listener know the difference in 11-bit DAC vs 12-bit DAC?
 - Least Significant Bit



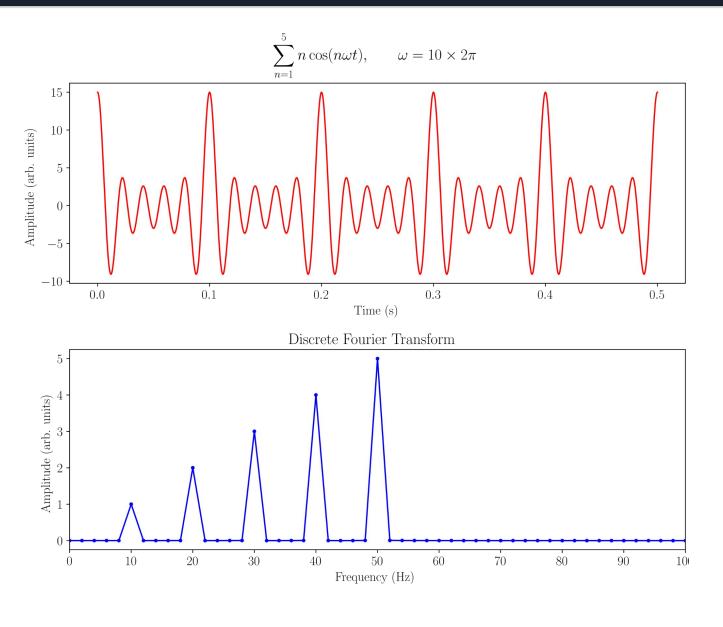
Audio Data Compression

Audio CD Specs: 650MB, 44.1kHz, 16-bit

- 70 min of stereo audio

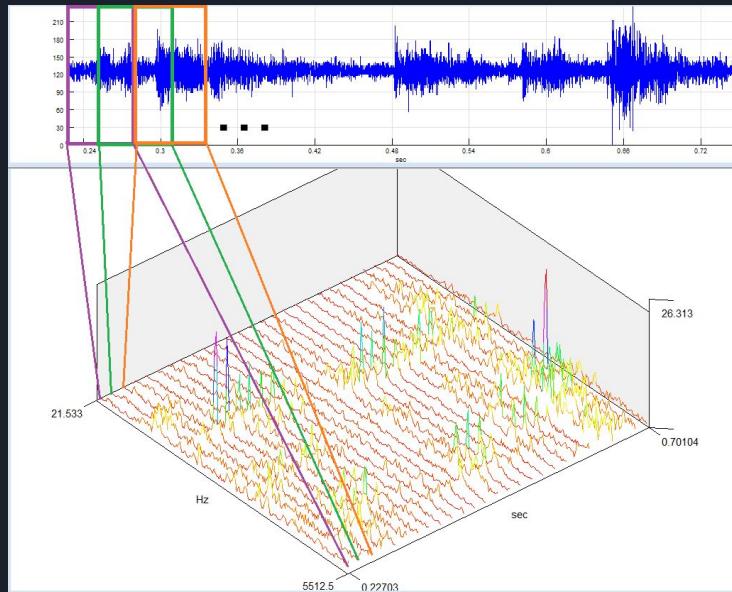
How else could we represent that sound wave?

- Think back to math class...
- Divide audio into small samples / frames
- FFT/DFT/MDCT to determine frequencies



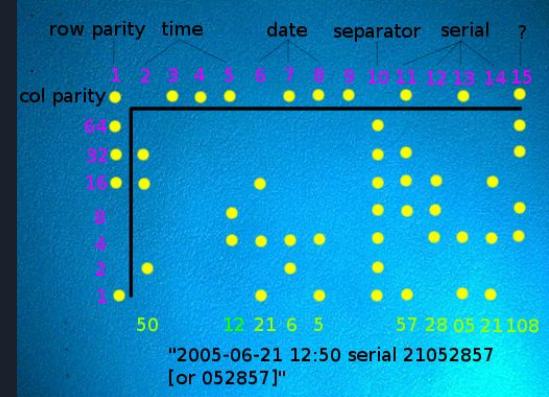
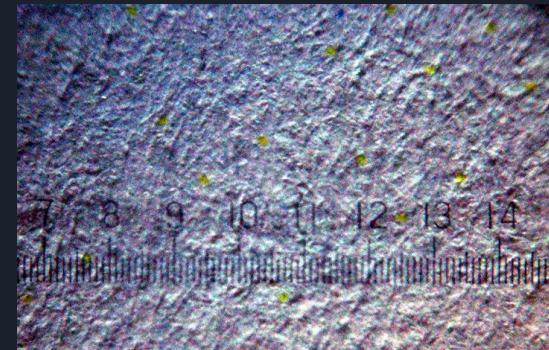
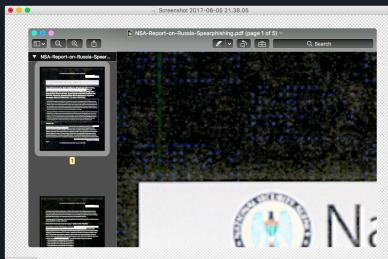
FFT vs time / Spectrogram

- Do frequencies change over time?



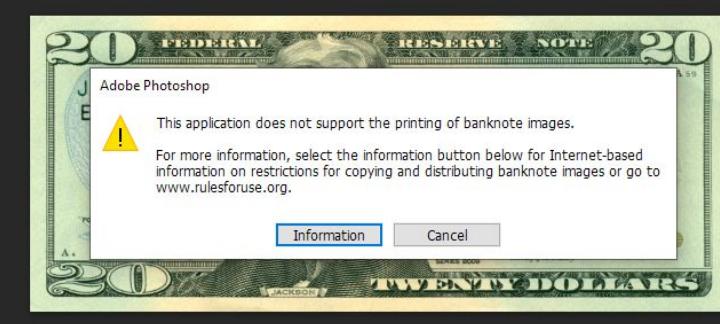
Printer Steganography

- Printer tracking dots created by Xerox in mid 1980s
 - Discovered publicly in 2004
- Used to detect counterfeit currency / track culprits
- Intercept publishes leaked data about Russian interference in US elections
 - Posted PDFs of the scanned in documents (fold marks visible)
 - Identified the printer owned by the government that they were printed from, leading to arrest of Reality Winner



Secret Messages in Money!?

- Eurion constellation prevents scanning, editing, copying





Links

- <https://www.teachwithict.com/binary-representation-of-sound.html>
- <https://sigview.com/help/Time-FFTSpectrogram.html>
- https://en.wikipedia.org/wiki/Fast_Fourier_transform
- https://en.wikipedia.org/wiki/Ada_Lovelace
- <https://blog.erratasec.com/2017/06/how-intercept-outed-reality-winner.html>
- <https://www.bbc.com/culture/article/20201112-the-eye-of-providence-the-symbol-with-a-secret-meaning>
- https://en.wikipedia.org/wiki/EURion_constellation
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