

# Level 0x08



Moar Steganography



# Topics

- Hacker History
- Audio Steg
- Printer Steg

# Upcoming Events

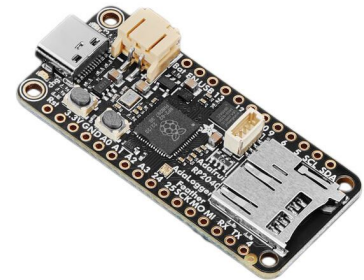
- December hacking contests
  - Advent of Cyber - [TryHackMe.com](https://tryhackme.com)
  - Sans Institute [Holiday Hack Challenge](#) - Less CTF, more game, probably more incident responder and defender focused
  - [Advent of Code](#) - Programming challenges. Used to be 25 2-parters, now reducing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

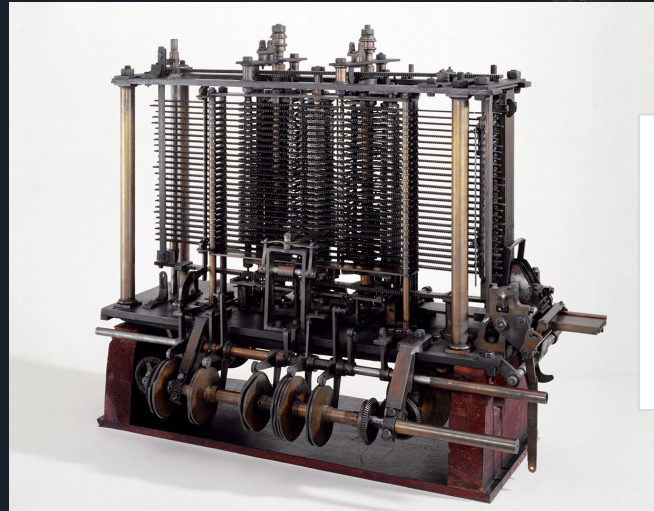
- 1815 - 1852
- First computer programmer (disputed?)
  - Charles Babbage's Analytical Engine



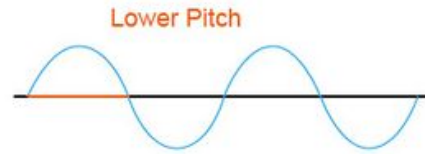
Diagram for the computation by the Engine of the Numbers of Bernoulli. See Note G. (page 722 of seq.)

| Number of Operations. | Variables used upon. | Variables receiving results. | Indication of change in the values of any Variable. | Statement of Results. | Data. | Working Variables. | Result Variables. |
|-----------------------|----------------------|------------------------------|-----------------------------------------------------|-----------------------|-------|--------------------|-------------------|
|                       |                      |                              |                                                     |                       |       |                    |                   |
| 1                     | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 1$                     | ...                   | 2     | $\times$           | $2 \times 2 = 4$  |
| 2                     | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1$                               | ...                   | 1     | ...                | $2 - 1 = 1$       |
| 3                     | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 1$                               | ...                   | 1     | ...                | $2 + 1 = 3$       |
| 4                     | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 1$                     | ...                   | 1     | ...                | $2 \times 1 = 2$  |
| 5                     | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1$                               | ...                   | 2     | ...                | $2 - 1 = 1$       |
| 6                     | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 1$                               | ...                   | 1     | ...                | $2 + 1 = 3$       |
| 7                     | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1$                               | ...                   | 1     | ...                | $2 - 1 = 1$       |
| 8                     | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 0 = 0$                 | ...                   | 2     | ...                | $2 \times 0 = 0$  |
| 9                     | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 0 = 2$                           | ...                   | 2     | ...                | $2 - 0 = 2$       |
| 10                    | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 0 = 2$                           | ...                   | 2     | ...                | $2 + 0 = 2$       |
| 11                    | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 1 = 2$                 | ...                   | 2     | ...                | $2 \times 1 = 2$  |
| 12                    | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1 = 1$                           | ...                   | 1     | ...                | $2 - 1 = 1$       |
| 13                    | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 1 = 3$                           | ...                   | 1     | ...                | $2 + 1 = 3$       |
| 14                    | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 1 = 2$                 | ...                   | 1     | ...                | $2 \times 1 = 2$  |
| 15                    | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1 = 1$                           | ...                   | 1     | ...                | $2 - 1 = 1$       |
| 16                    | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 1 = 3$                           | ...                   | 1     | ...                | $2 + 1 = 3$       |
| 17                    | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 1 = 2$                 | ...                   | 1     | ...                | $2 \times 1 = 2$  |
| 18                    | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1 = 1$                           | ...                   | 1     | ...                | $2 - 1 = 1$       |
| 19                    | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 1 = 3$                           | ...                   | 1     | ...                | $2 + 1 = 3$       |
| 20                    | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 1 = 2$                 | ...                   | 1     | ...                | $2 \times 1 = 2$  |
| 21                    | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1 = 1$                           | ...                   | 1     | ...                | $2 - 1 = 1$       |
| 22                    | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 1 = 3$                           | ...                   | 1     | ...                | $2 + 1 = 3$       |
| 23                    | $\times$             | $V_1 \times V_2$             | $(V_1 \times V_2) = 2 \times 1 = 2$                 | ...                   | 1     | ...                | $2 \times 1 = 2$  |
| 24                    | $-$                  | $V_1 - V_2$                  | $(V_1 - V_2) = 2 - 1 = 1$                           | ...                   | 1     | ...                | $2 - 1 = 1$       |
| 25                    | $+$                  | $V_1 + V_2$                  | $(V_1 + V_2) = 2 + 1 = 3$                           | ...                   | 1     | ...                | $2 + 1 = 3$       |

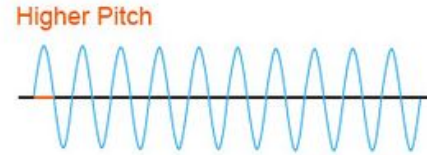
Here follows a repetition of Operations thirteen to twenty-three.



# What is sound?



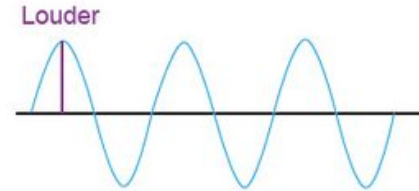
Low Frequency



High Frequency



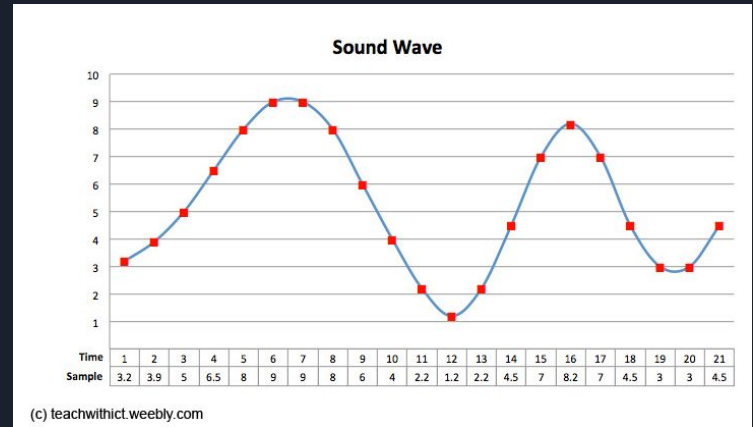
Low Amplitude



High Amplitude

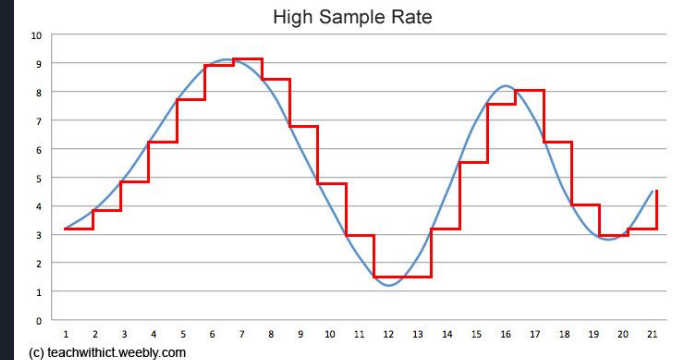
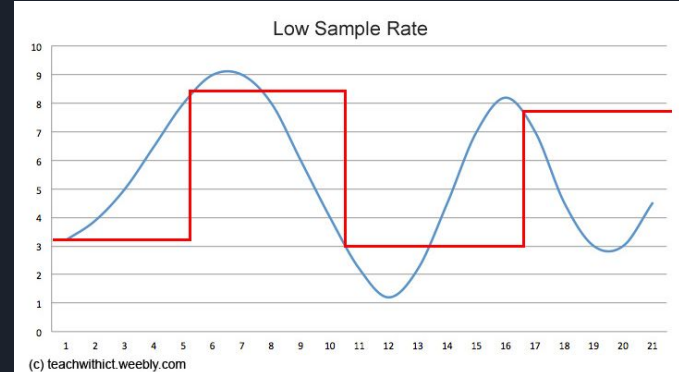
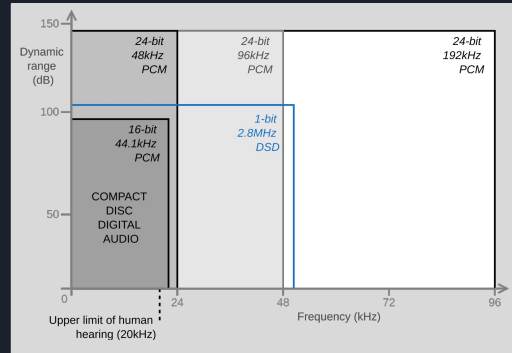
# How does a computer encode sound?

- 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

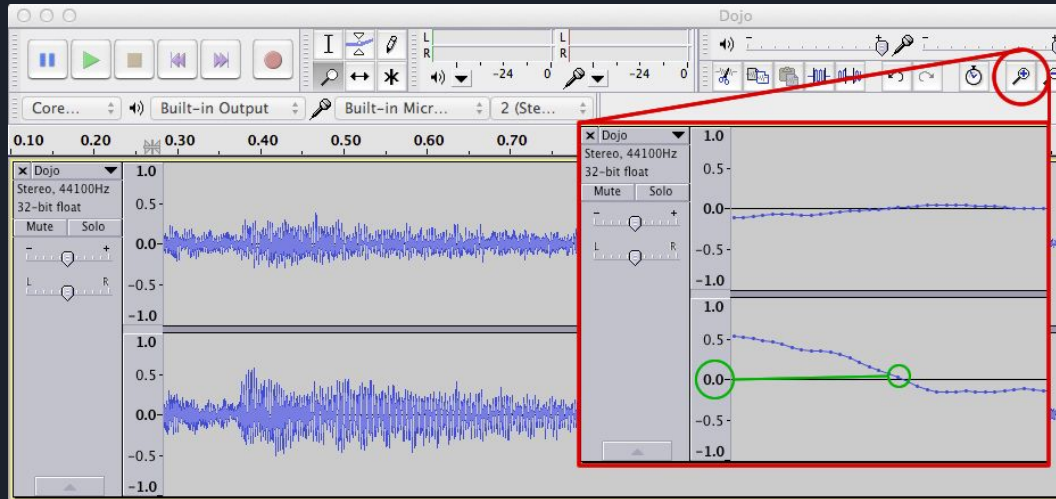
- High sample rate
  - Better quality sound
  - Larger data file
- Accuracy of the amplitude
  - Quality of the Analog-to-Digital converter (ADC) used (or DAC during playback)
  - Raspberry Pi Pico is 12-bit
- What is loss-less audio?





# Audio LSB Steganography

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



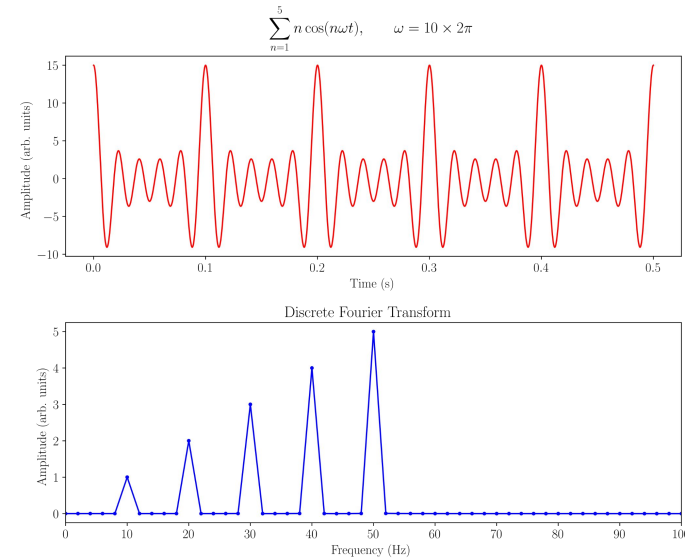
# Audio Data Compression

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

- 70 min of stereo audio

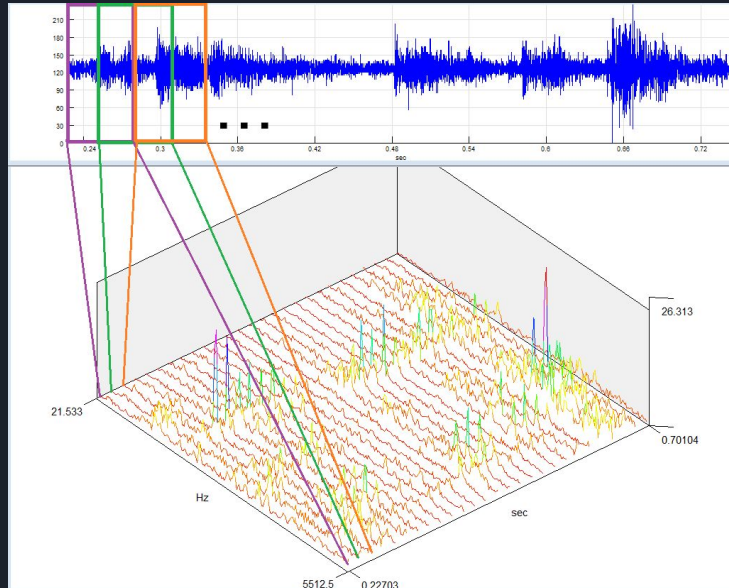
How else could we represent that sound wave?

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



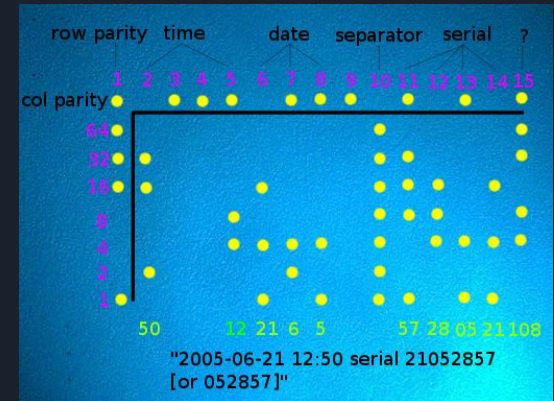
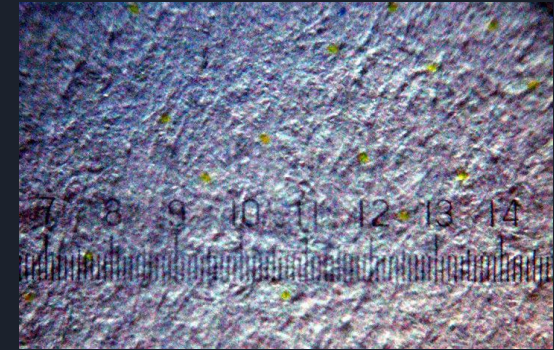
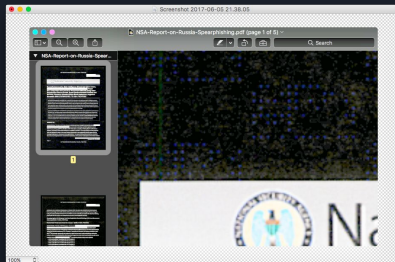
# FFT vs time / Spectrogram

- 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!?

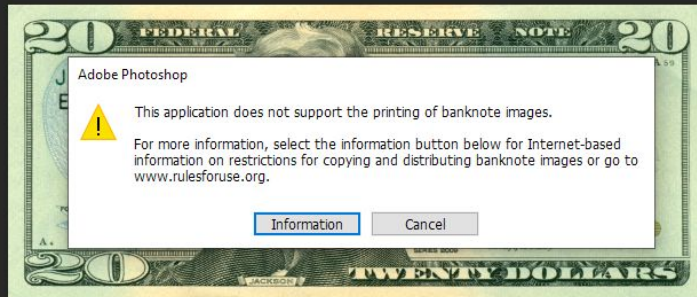
- Eurion constellation prevents scanning, editing, copying

## The Eye of Providence: The symbol with a secret meaning?

13 November 2020

Share < Save

Matthew Wilson  
Features correspondent





# 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/Fast_Fourier_transform)
- [https://en.wikipedia.org/wiki/Ada\\_Lovelace](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](https://en.wikipedia.org/wiki/EURion_constellation)
-