

filetypes

operating systems & open source group

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what are some filetypes?

■ audio

- mp3
- flac
- wav
- m4a
- ogg
- opus

■ image

- png
- jpeg
- avif
- heic
- svg
- webp
- gif

■ video

- mp4
- mov

■ document

- pdf
- html
- docx
- pptx
- xlsx
- gdoc
- gslides
- gsheets
- epub
- mobi

■ container

- mkv
- zip
- tar
- riff

■ program

- jar
- exe
- apk
- apkm
- apks

■ text

- txt
- md
- adoc

■ code

- c
- java
- ...

■ data

- json

■ ???

- xml

common types

■ riff

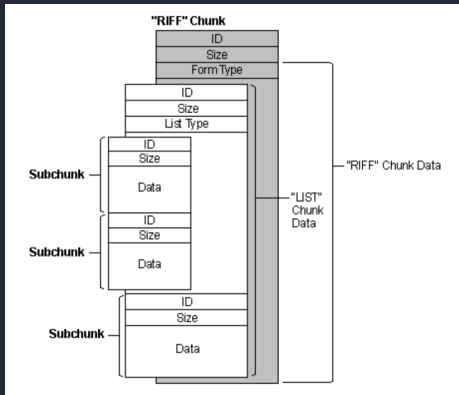
- resource interchange file format
- full of "chunks" of data (in bits)
- each chunk header contains the chunk's type and size

■ xml

- full of "tags" which contain data (strings)
- tags open and close themselves and have attributes
- `<html><head></head><body></body></html>`

■ zip

- compresses data using one of many algorithms
- primarily `deflate` (also `FILETYPES : MD : FEB 11 2026 pngs!`)



how does your computer know a file's type?

■ file extension

- easily fooled

■ guess

- based on the file contents
- not always accurate or possible

■ type signatures

- also called magic numbers
- opening x bits of the file

inside a pdf

```
%PDF-1.7
1 %đ<9f><96>¤
2 6 0 obj
3 <</Filter /FlateDecode/Length 395>>
4 stream
5 xÚ<95><93>ÍjÃ0^LÇi~
6 ¿ÀRI<96>ü^Ac<87>Á^NÝ@<85><8c>^MÆ^Ne¬=u<90>íyaRêti;          ]^[ă8<96>¬^?¤_^Tô ă^Nő
F^\üçpu^N<9a>$½ùôĐ<9b>; ·Ø`^C~÷£'Pb<8e>Á0^_ ^N;g^Q<82>â^C±?|¹W÷}nÚ°μ<8e>@<8e>?Ùp
e^đ0°§¶÷aÉ^^<99>=<82>@4Èuÿd0^_5μ^Ny<8c>
7 K¤2ÅJ^Ov<99> ^W <9a>^U^N,z-I
8 ``¤^X}»w<8b>ÕÛrđ²ô^D¾Ý°÷{^@<8d>^Cpô¹Õ<99>^A$éÔ½<84>°<8f>^O^_¾}¶R-<8d><8b>^X,i<9
8>=^QÝ<82>a6jj<9d>Á ^X^RéÇo''^Pă!%BÊ^S^N&<96>R<93>3<84><84>c^Nxâ 4^Ytă#^Kc#``ë^
F^@<82>ñ``|böÛy8îÍ^O¥<9e>^[ěá(ÖiĂ;âÑo>Ó7ÚÉ^_@æn<8c>^HØě'¾^^ûlĐĂ8^C½(ĂBÖ{<8c><98
>¢<89>f^NĖÇĐ{-^L<97>¡W^@^FĖ BÇ
9 ^D^U^F^Nk¾^^F^O<9a>^VßÒ<83>³A^Să^L<8c>^\\<84>
10 ^[^L<95>¢d ^X')Ă^D<86>ie¹^H<83>k^GÉ|p<91>
11 <82> K@+~=<8c>_F^R^R)
12 endstream
13 endobj
```

inside a png

```
1 <89>PNG^M
2 ^Z
3 ^@^@^@^M IHDR^@^@^E^P^@^@^B^J^H^B^@^@^@^@
>iYw|\W<99>7ðçÎ<9d>ršw<8d>Ê"÷nY²â<9a>è
ÛP^C<9b><84><92>p^\',÷"ÛÊ²zo#iz<9f>yÿ,
İaRİÂ^D^@^@^@^@^@^@^@^@<97>^S-t^@^@^@^@^@
R^@^@^@^@^@^@x'ó^FÃÑ/1Â^L^@^@^@^@^@^@^@
^@Ã<81><84>^Y^@^@^@^@^@^@ ^N$İ^@^@^@^@
Ãá<81>á@óm<83>¼<83>Ój¥$7ÓP]<96>@<94>sd
¾T»!úv<9e>'ðîóöÛ o^M^N¾2>6·ý_oØR¾Öİ^_ç
gÆG?uúD2^Mò~°v]<9d>)í^Õ¬^î<9d>^?Ý<9d>î
Ä{7iT²Ä^[^Q³¬<98>eµ^\W@7pfiúü@ã£~^?Ü<9
_İİ¿+7_#<99>İG<81>âÖd<99>XÁ»^C^@^@^@^@
<ë<8b>æ¿Öé÷^] ^_]æË2<91>([@ÈT" ^X<86>)E
#ç2¾ñ<87>^[¶|èð~W(4÷^V^G<86>ú^Cñ<8e>^S
8b>Û^]spKz|<98>e<89>hİ`^?¾<8b>^@^@^@^@
<88>@æöø¾<9c>8æZW ðÖ|óÑGİOMûdU^Mç
3 Ku<86>Û^MÆÝ<93><97>^Mç^N:îÑó?<94><95>ÿ
```

0x89 : 0b10001001, can't be 7-bit

0x504e47 : ascii for png

0x0d0a : dos-style line ending

0x1a : dos-style end-of-file

0x0a : unix-style line ending

- eight byte signature
- 0x89504e470d0a1a0a

files that lie to you

■ how

- file extensions that don't match the file signature
- file extensions that do match, but take advantage of how a parser works

■ why

- malicious intent
- completely normal reasons

■ examples

- arbitrarily rename text files
- html vs xml
- svg vs xml
- wav vs riff
- jar vs zip
- gdoc vs json
- docx vs xml
- docx vs zip
- pptx vs xml
- pptx vs zip
- opf vs xml
- opf vs zip
- epub vs xml
- epub vs zip
- mobi vs xml
- mobi vs zip
- azw vs xml
- azw vs zip
- 2026 vs xml
- kf8 vs zip

everything is a zip file of xml

- turns out making your file format is hard
- using an existing one is easy
- but, you don't want your files getting read by the wrong software
- the practice goes back to at least 1991 w/ wav
- most filetypes are like this

real filetypes

■ mkv

- from matroska (pronounced matryoshka, the word for russian nesting doll)
- released 2002
- container for unlimited audio, video, images, and subtitles
- commonly used as output from video/audio creation software, and you then strip out what you need
- honorary zip file of xml, but for extensible binary meta language
- ebml is xml but binary, with opening/closing tags, created for mkvs
- arbitrary-length "tags" in binary with clever trick



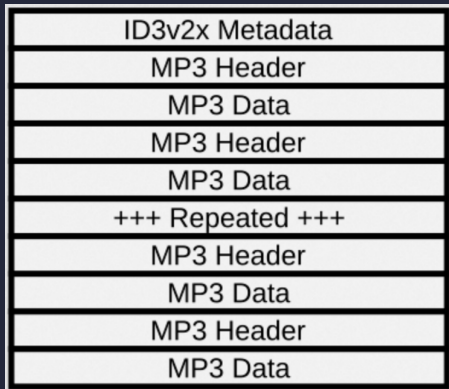
real filetypes

■ mp3

- lossy compression format that commonly achieves 75%--95% reduction in size
- revolutionized music distribution
- designed by the moving picture experts group, developed largely in germany by the fraunhofer society
- released 1991
- objectively very cool

real filetypes

■ mp3 file structure



■ mp3 encoding

1. divide the audio into small, overlapping pieces
1. convert each piece into a sum of cos functions
1. perform the fourier transform on each piece
1. remove sounds humans can't hear
1. encode each piece according to the bitrate
1. format each piece into an mp3 header/data block

math stuff

■ laplace

$$\mathcal{L}\{1\} = \frac{1}{s}$$

$$\mathcal{L}\{t\} = \frac{1}{s^2}$$

$$\mathcal{L}\{e^{at}\} = \frac{1}{s - a}$$

$$\mathcal{L}\left\{\frac{df(t)}{dt}\right\} = sF(s)$$

■ fourier

$$\mathcal{F}\{\cos(at)\} = \pi\delta_a + \pi\delta_{-a}$$

■ dct

- discrete cosine transform
 - type i : dct
 - type ii : idct
 - type iii : dst
 - **type iv : mdct**

■ fft

- fast fourier transform
- equivalent to discrete fourier transform
- mathematically the same, faster, and more accurate

real filetypes



■ png

- lossless compression format
- pronounced "ping" apparently
- created to be an improved version of gif (pronounced "jif" apparently)
- designed by the portable network graphics development group
- released 1996



real filetypes

■ png file structure

- type signature: `0x89504e470d0a1a0a`
- made up of "chunks", like mp3s and riffs
- but png's headers are more fun
 - 4 bytes for size
 - 4 bytes for type
 - x bytes for data
 - 4 bytes for checksum

■ png headers

- chunk types are given as ascii words
 - `IHDR`
 - `PLTE`
 - `IDAT`
 - `IEND`
 - `bKGD`
 - `gAMA`
 - `eXIf`
- the case of each letter gives additional info
 - 1st = critical
 - 2nd = public
 - 3rd = reserved
 - 4th = dependent

real filetypes

■ png compression

- uses deflate
 - deflate really likes zeros
- first uses one of a number of prediction methods
 - that number is 1
- called method 0
 1. do nothing
 1. $\text{next} = \text{prev}$
 1. $\text{next} = \text{upper}$
 1. $\text{next} = \text{prev} \text{ upper}$
 1. $\text{next} = \text{closest to } \text{prev} + \text{upper} - \text{prev upper}$
- intended to get everything close to 0 for deflate's benefit
- basically, take the derivative of the image



closing

- most filetypes are fake
- basically just different ways of telling the computer to stop reading
- the real ones are normally for media
 - and use scary math like derivatives and transforms

in many ways they are very simple --- computers have to read them really fast, and complication costs a lot

fin.

any questions?

activity

■ write a little parser

don't worry it's not that hard. trust

■ riff

```
id   : 4 bytes
size : 4 bytes (little-endian)
data : size bytes
pad  : 1 or 0 bytes (total must be
even)
```

if id is **RIFF** or **LIST** then the first 4 bytes of data will be a name, and the rest of data is more chunks

