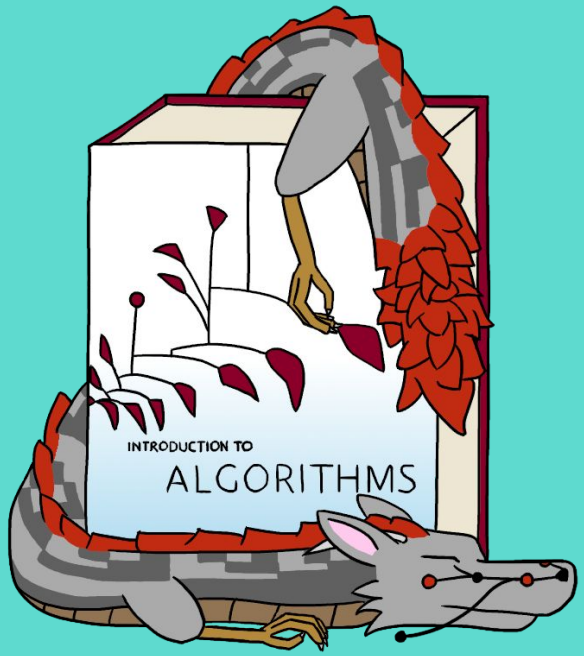
Data Structures and Algorithms

By Unsigned Long

@InverseHackermann

Overview

- This is a comedic/informative look at overlaps between furry and computer science
    - There will be puns ^w^



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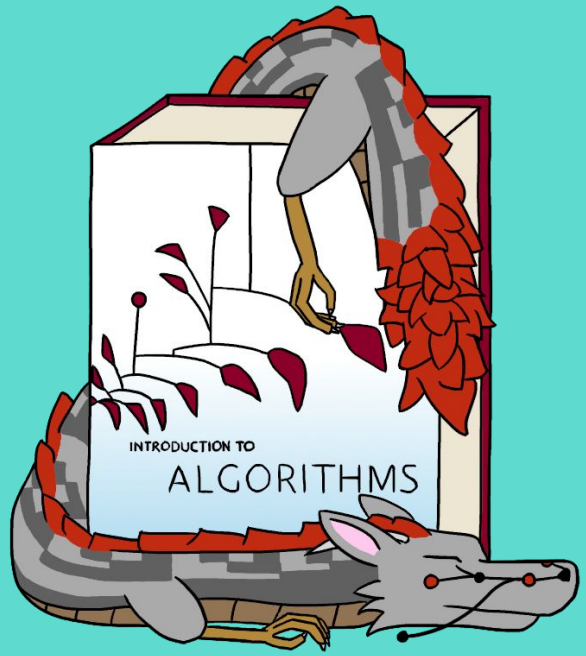

Overview

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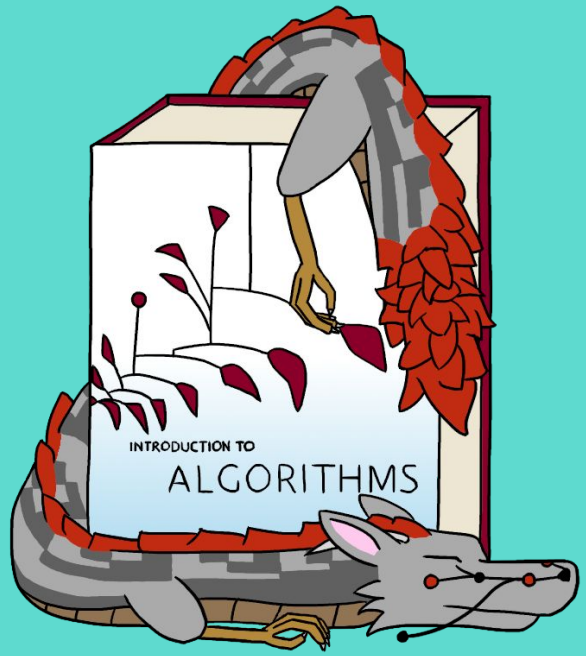
  - There will be puns ^w^
- This is **not** a rigorous lecture
  - We're trying to have fun here :3
- Ask questions!
  - I've been coding for most of my life
  - If you don't understand things, **that's on me**
  - I'm out of touch with reality



About Me

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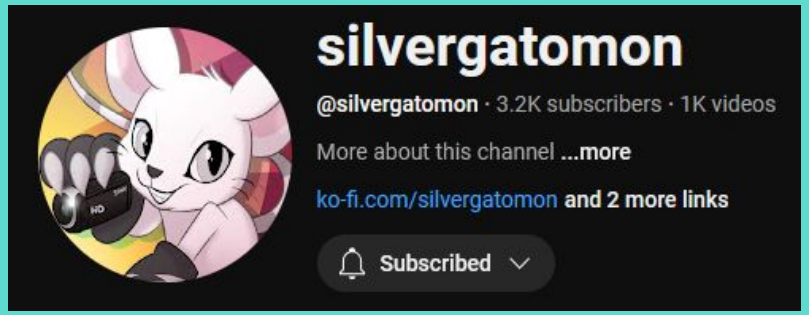

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https://www.furaffinity.net/user/tienlong/

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lóng

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`short`
`short int`
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	Short signed integer type. Capable of containing at least the [−32 767, +32 767] range.[3][a]

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`long`
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- Pun was too good to do nothing with, so I made a fursona

Measuring Information

- Bit: stores 0 or 1
- Byte: 8 bits
- Nibble: 4 bits = half a byte
    - Not commonly used

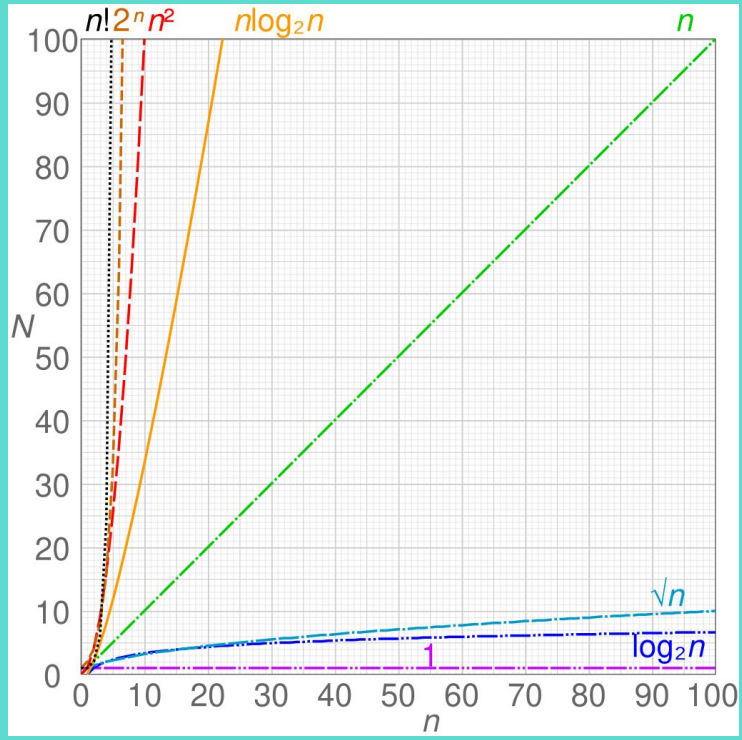
https://www.corgibeansshop.com/

Order Notation

Oops I forgot to go over this in previous iterations of this panel

Order Notation

- Formally ignore constant factors
  - $n,\ 5n+3,\ 0.1n-9$ are all $O(n)$



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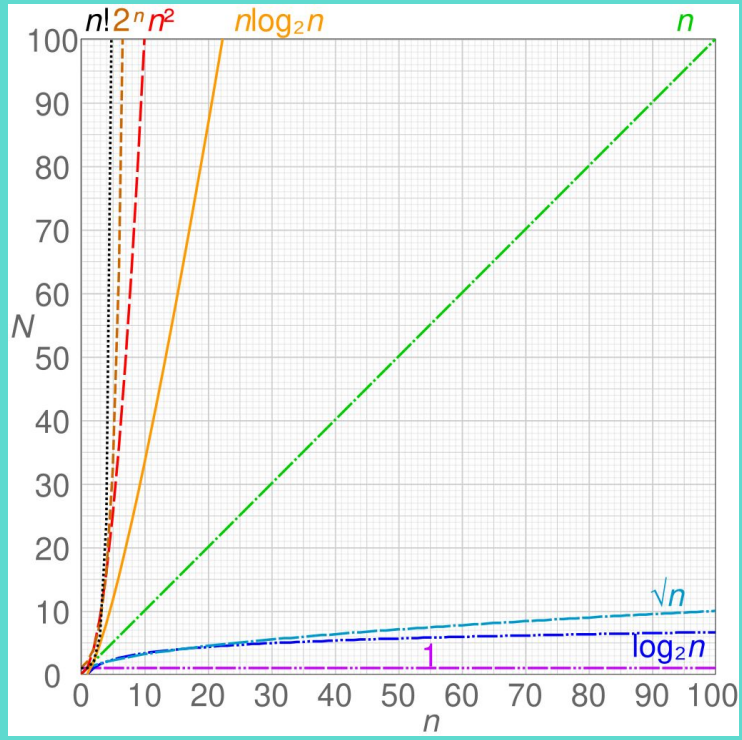
  - Eventually, $100n < n^2$



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Order Notation

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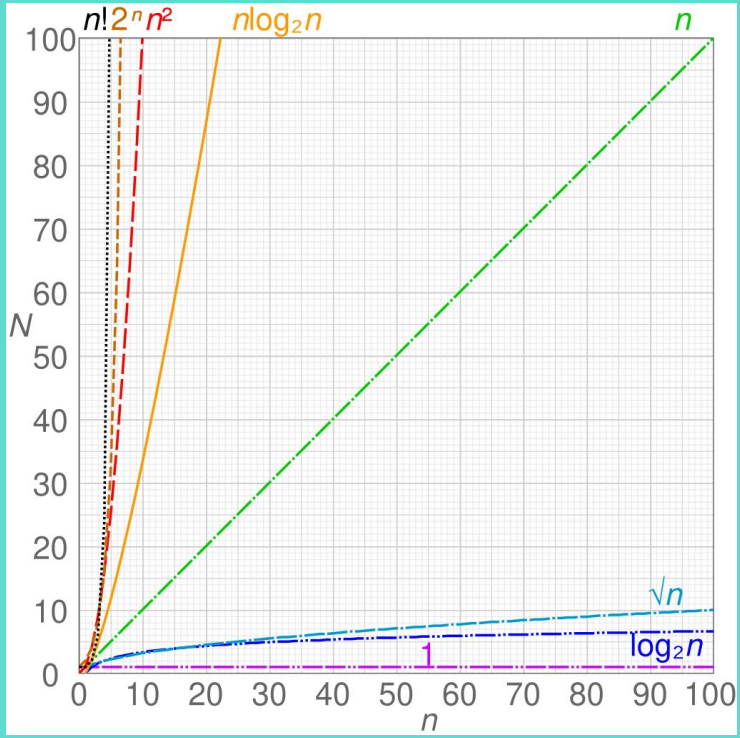
  - $n,\ 5n+3,\ 0.1n-9$ are all $O(n)$
- Only care about long-term growth
  - Eventually, $100n < n^2$
- Some people ignore bigger factors
  - $n^3 \log^4(n) = \widetilde{O}\left(n^3\right) = O\left(n^c\right)$
  - The more you ignore, the more theoretical your analysis is



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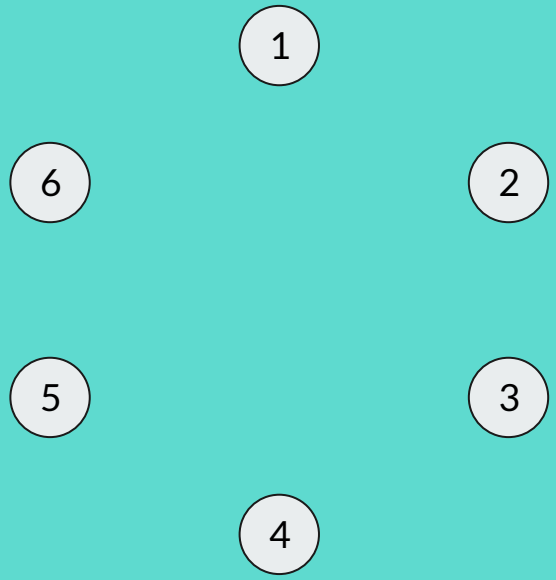
Planar Graphs

Thank you Euler :3

Planar Graph Complexity

- Vertices V, often labeled 1, 2, …, n



Planar Graph Complexity

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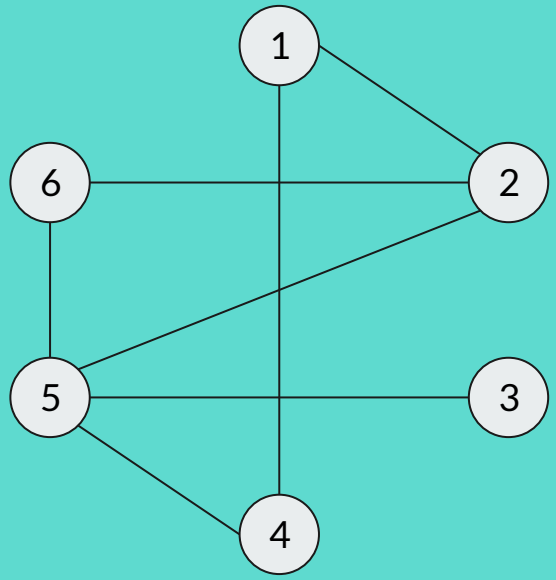
- Edges are between two vertices
  - Worst case m = O(n^2) edges



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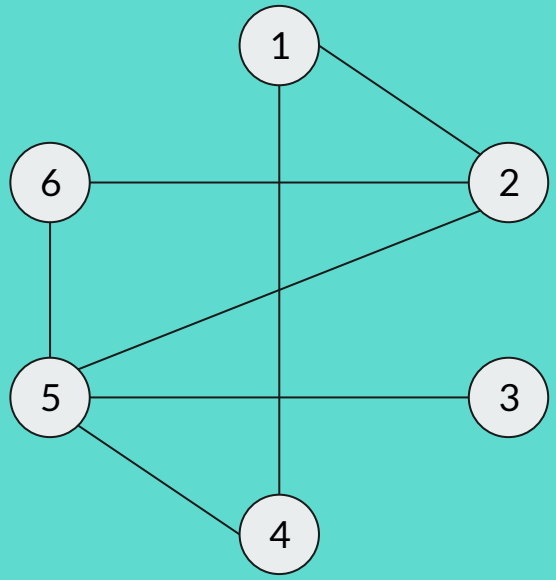

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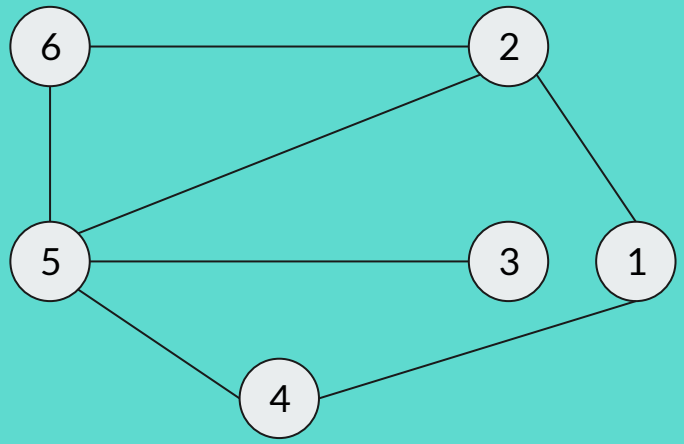

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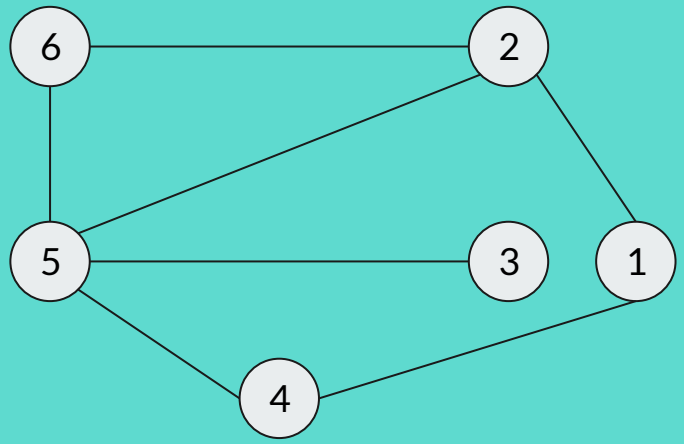

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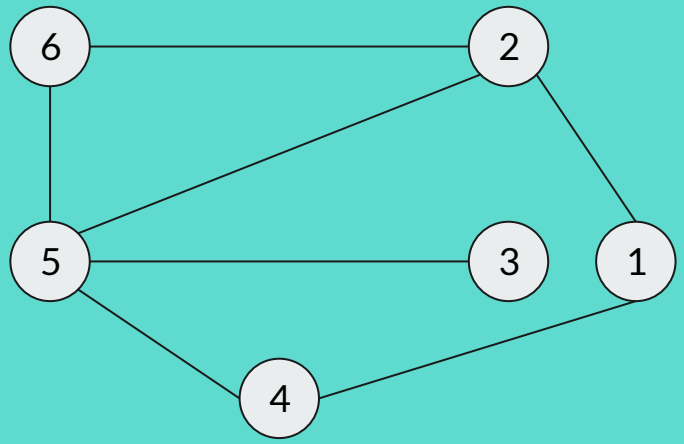
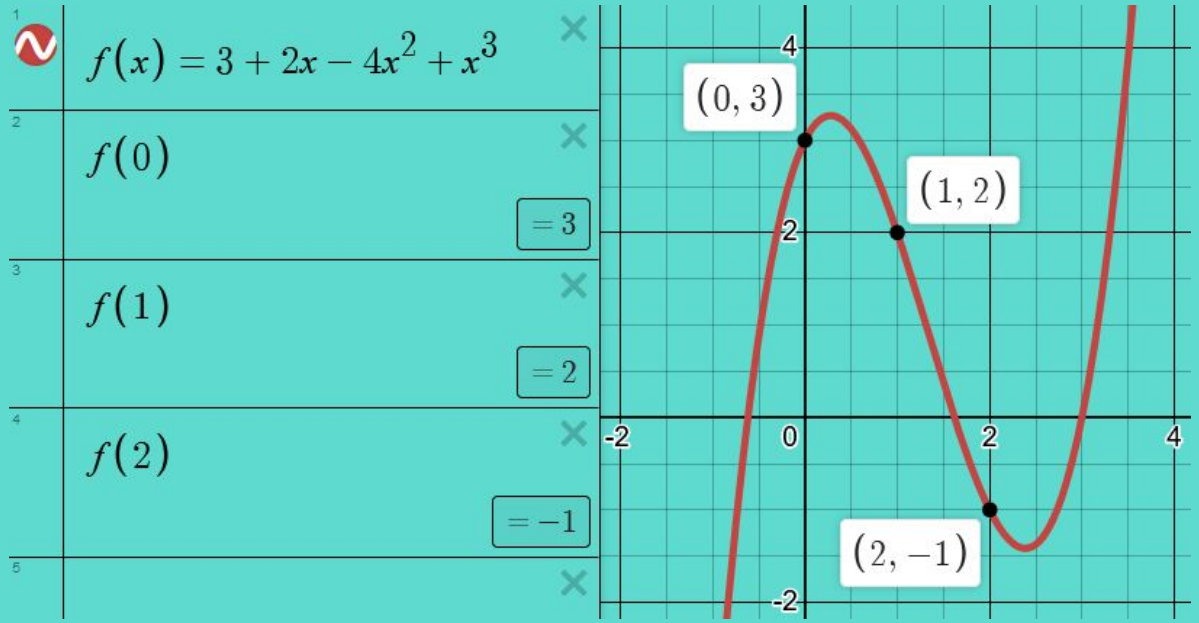
- Fursuits are planar graphs
  - Vertices are fabric patches
  - Edges are seams
  - Number of seams is O(n)



Fast Fourier Transform (FFT)

I have butterflies in my stomach >w<

Polynomials



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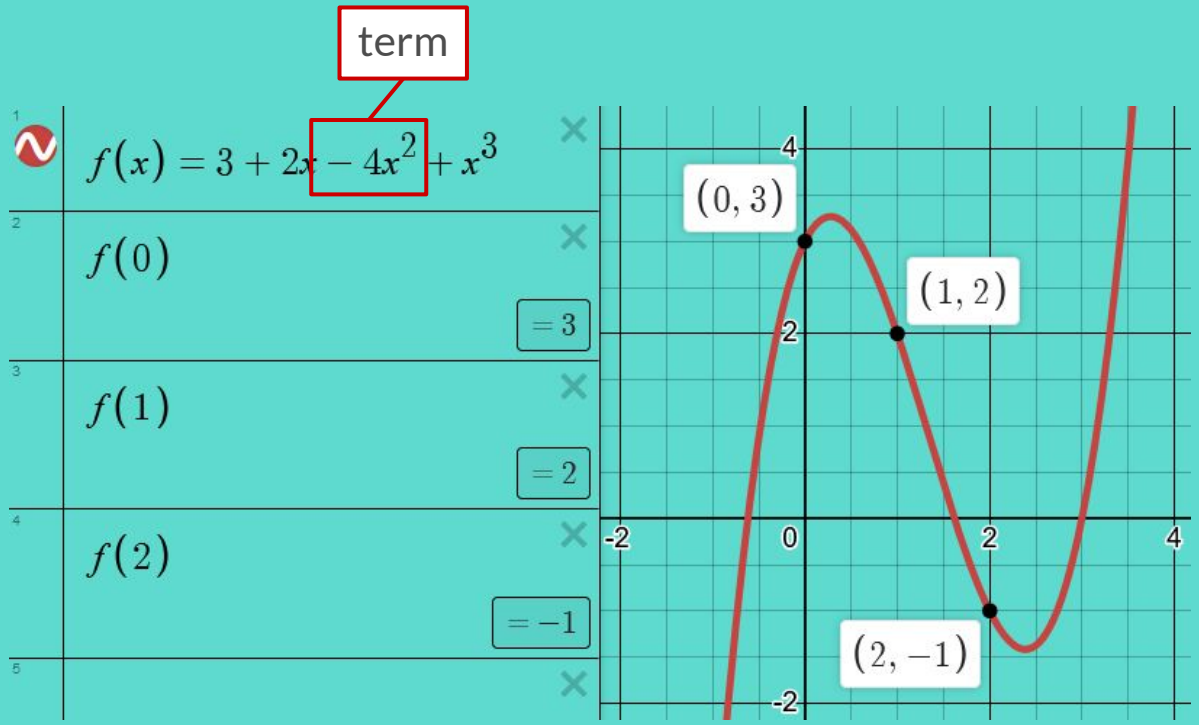

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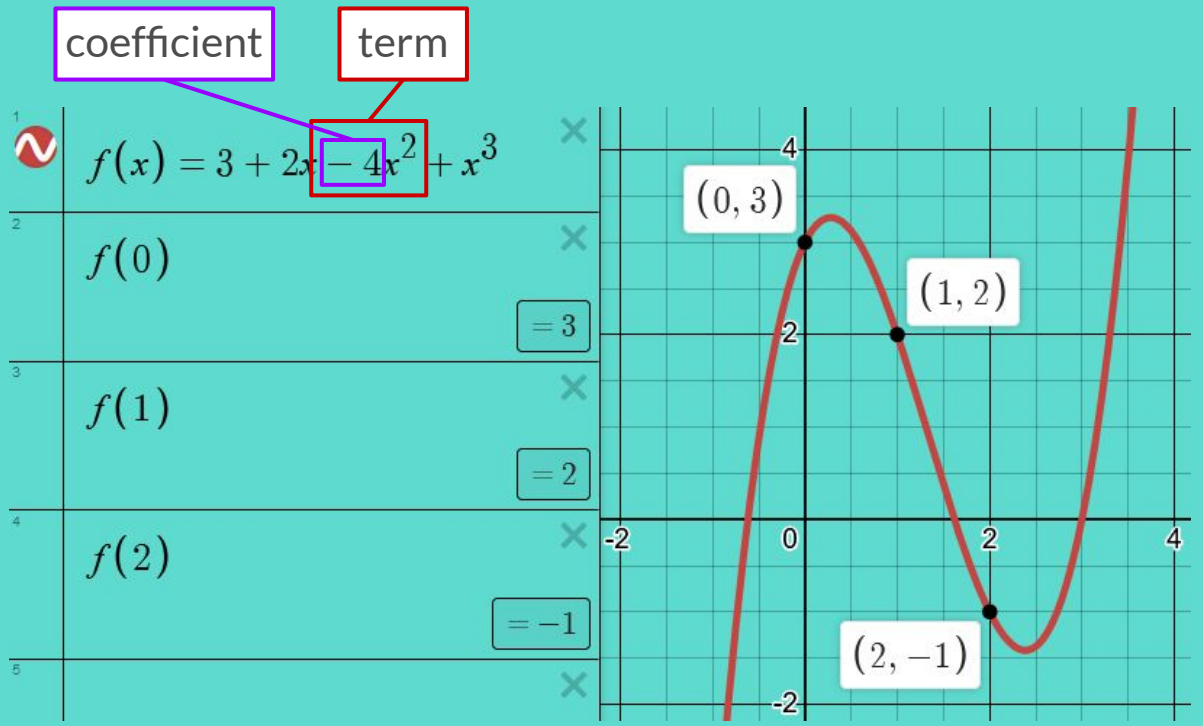

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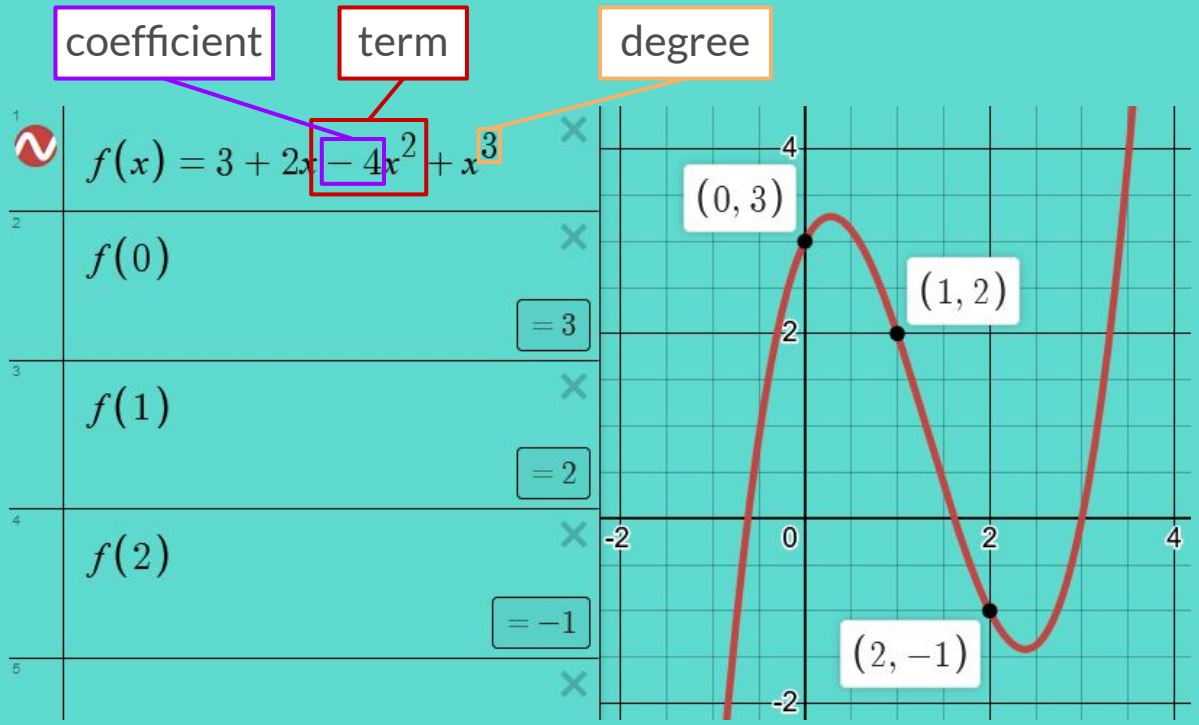

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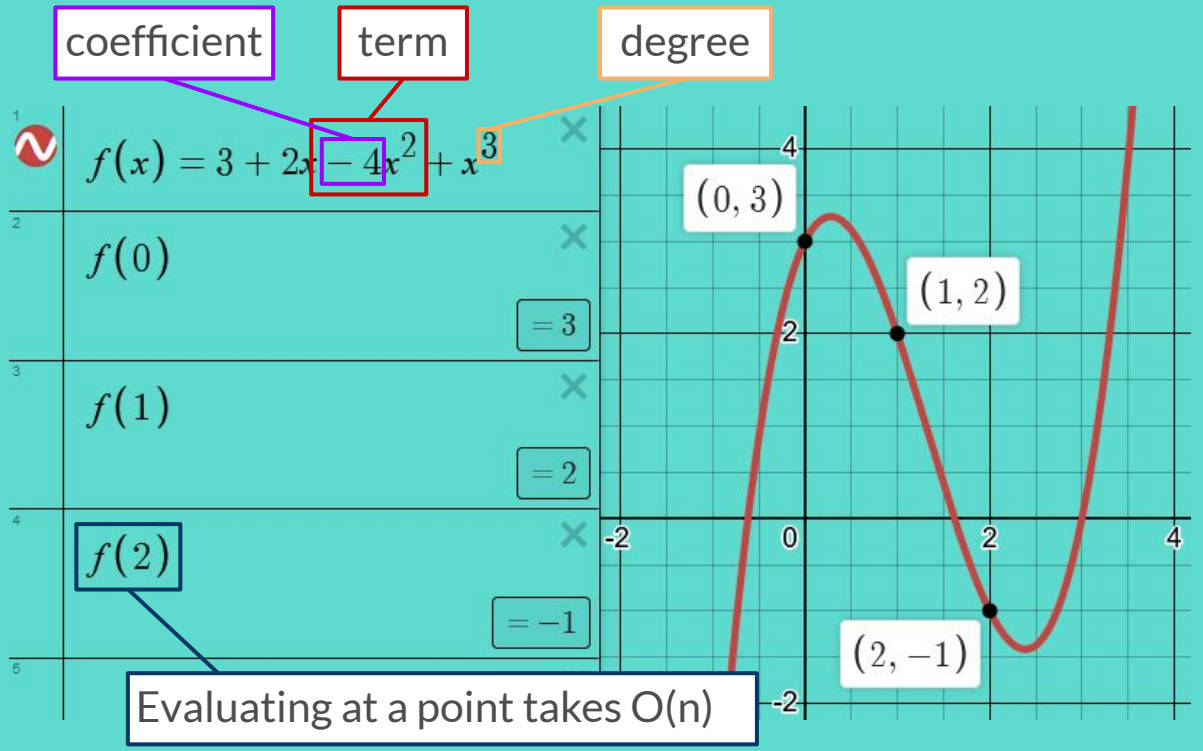
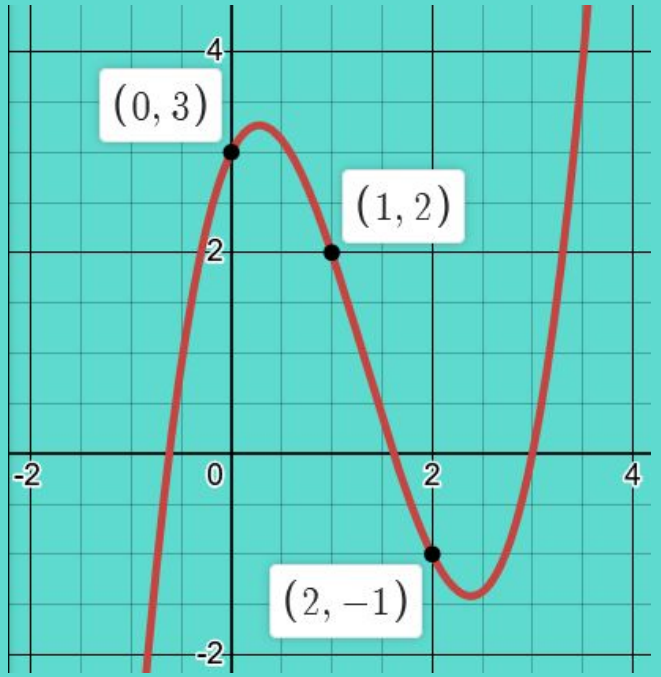


Polynomial Interpolation/Evaluation

- For n points, there is a unique polynomial with degree less than n that passes through all the points
- Evaluating the polynomial to find these points typically takes O(n^2), but if we choose points cleverly, we can do better



Evaluating at x=-1 and x=1

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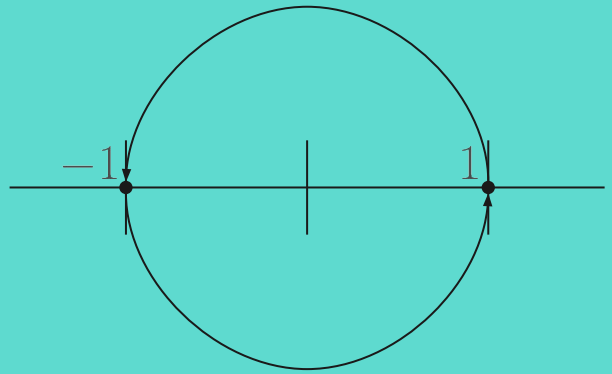
Reduces number of operations by a half!

More x values to evaluate at

- The even/odd trick works because repeatedly multiplying by -1 cycles between -1 and 1



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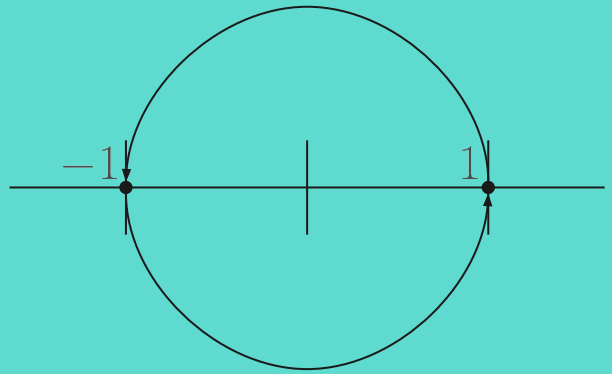

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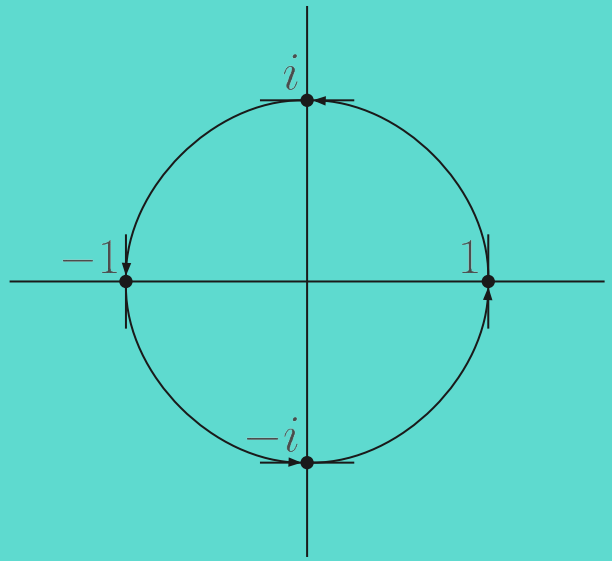

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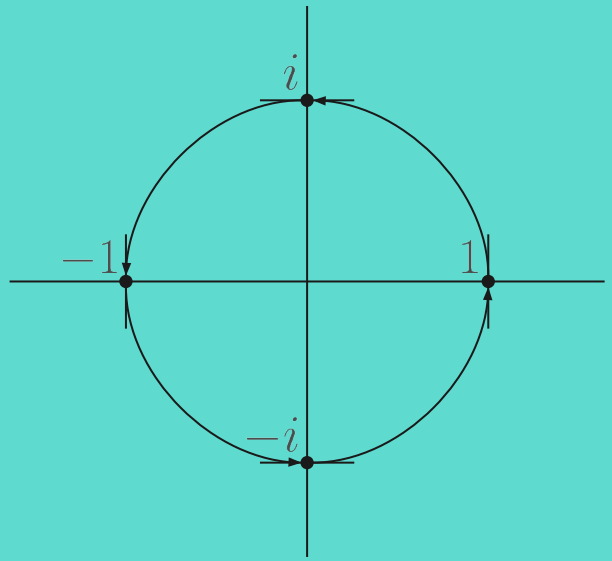

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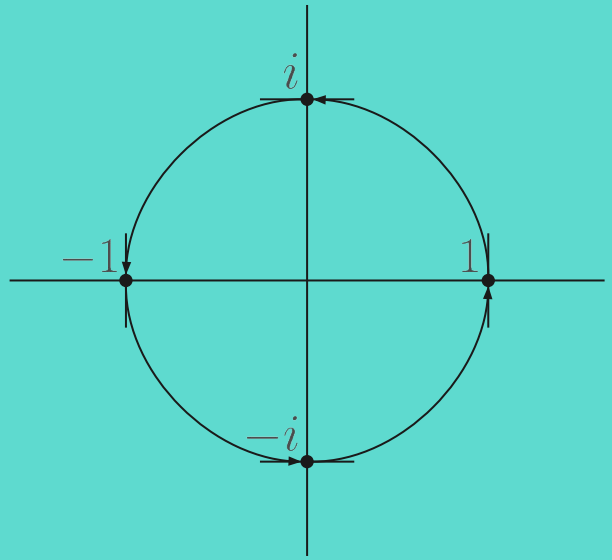
- FFT evaluates f at $1, r, r^2, \ldots, r^{n-1}$



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$$g_e(y) = a_0 + a_2 y + a_4 y^2 + \cdots + a_{n-2} y^{n/2-1}$$

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$$f(x) = g_e(x^2) + x g_o(x^2)$$

Divide and Conquer

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- We need to evaluate g at

$$(1)^2,\ (r)^2,\ (r^2)^2, \ldots,\ (r^{n/2-1})^2,\ (r^{n/2})^2,\ (r^{n/2+1})^2, \ldots,\ (r^{n-1})^2$$

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- Recursion! $T(n) = 2T(n/2) + n = O(n \log n)$

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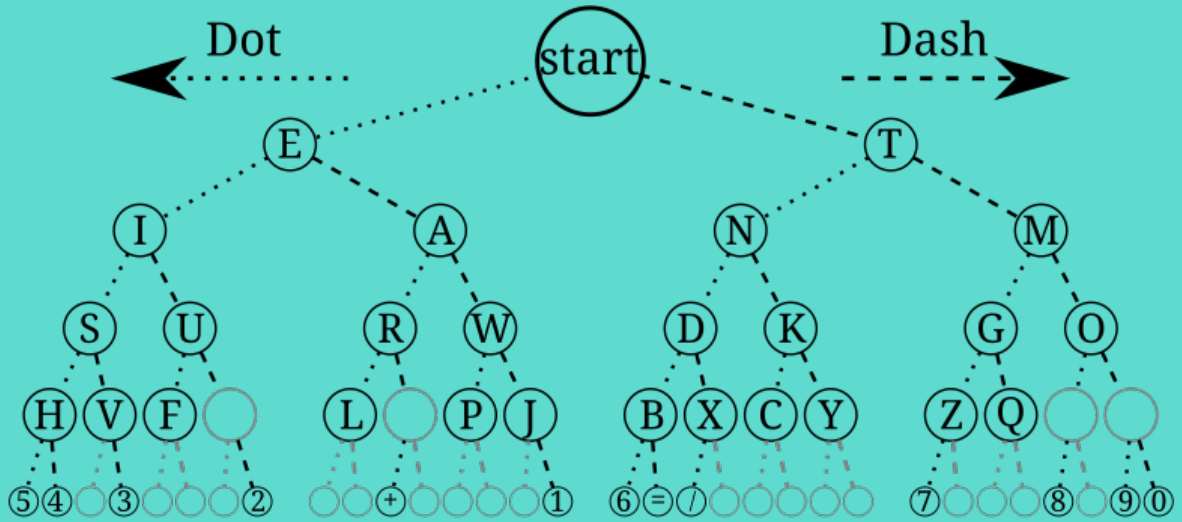
- I think FFT being its own inverse is related to why anti-furries eventually become furries

Morse Code, Braille, and Connections to Coding Theory

Morse Code



https://commons.wikimedia.org/wiki/File:Morse-code-tree.svg

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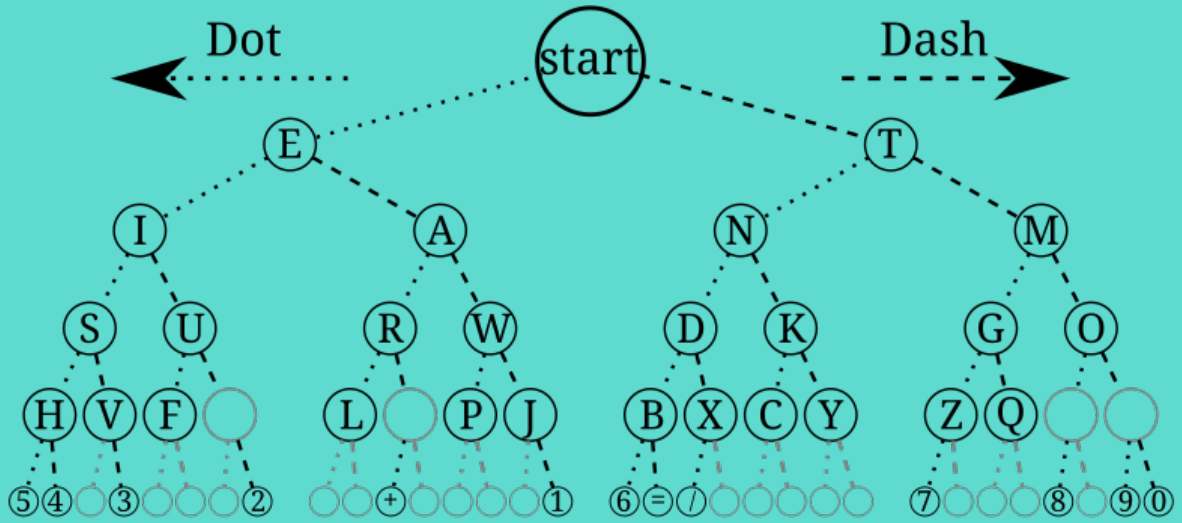

Letter	Relative frequency in the English language[1] (Texts)
E	12.7%
T	9.1%
A	8.2%
O	7.5%
I	7.0%
N	6.7%
S	6.3%
H	6.1%
R	6.0%
D	4.3%
L	4.0%

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https://en.wikipedia.org/wiki/Letter_frequency

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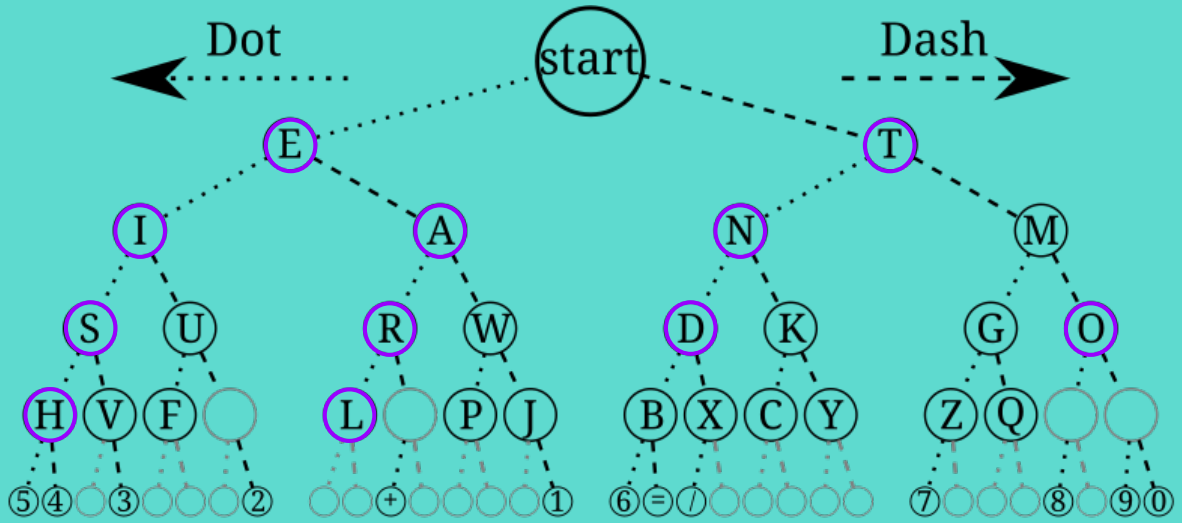

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More frequently used characters are given shorter encodings

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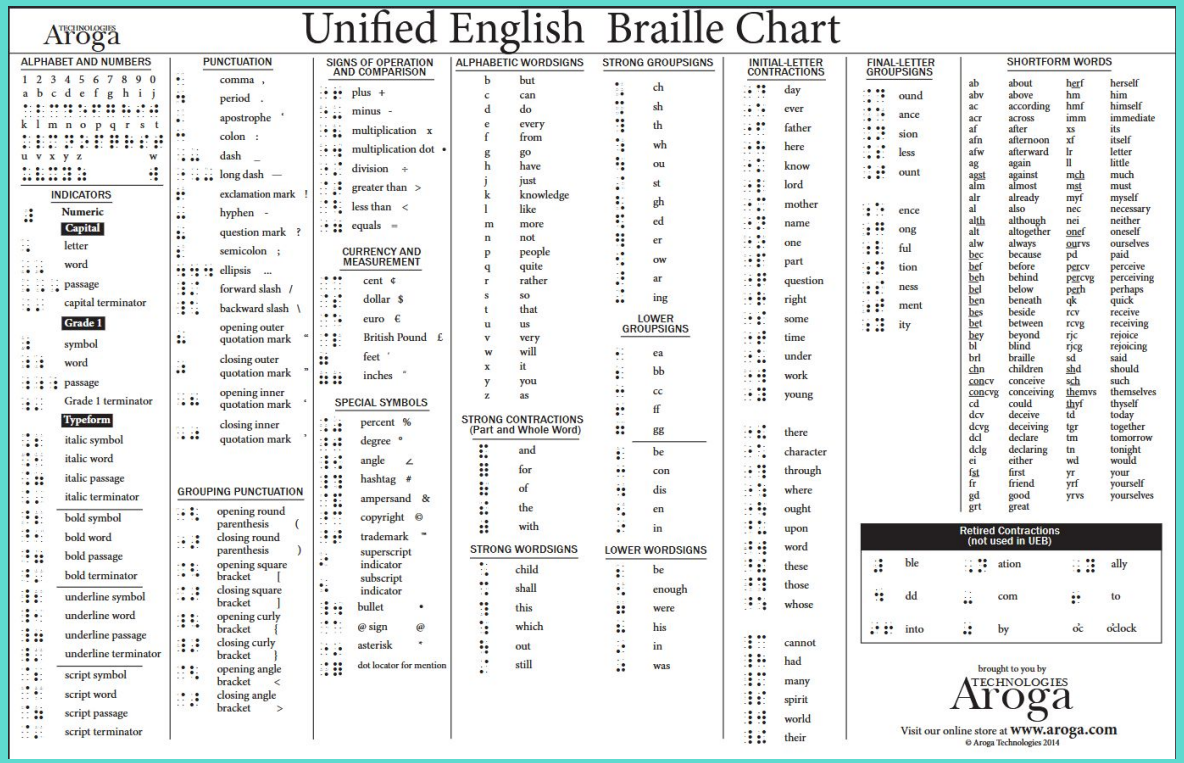
Braille



Unified English Braille Chart

TECHNOLOGIES Aroga

ALPHABET AND NUMBERS

1 2 3 4 5 6 7 8 9 0
a b c d e f g h i j
k l m n o p q r s t
u v x y z w

INDICATORS

Numeric
Capital
letter
word
passage
capital terminator
Grade 1
symbol
word
passage
Grade 1 terminator
Typeform
italic symbol
italic word
italic passage
italic terminator
bold symbol
bold word
bold passage
bold terminator
underline symbol
underline word
underline passage
underline terminator
script symbol
script word
script passage
script terminator

PUNCTUATION

comma ,
period .
apostrophe '
colon :
dash -
long dash —
exclamation mark !
hyphen -
question mark ?
semicolon ;
ellipsis ...
forward slash /
backward slash \
opening outer quotation mark "
closing outer quotation mark "
opening inner quotation mark '
closing inner quotation mark '

GROUPING PUNCTUATION

opening round parenthesis (
closing round parenthesis)
opening square bracket [
closing square bracket]
opening curly bracket {
closing curly bracket }
opening angle bracket <
closing angle bracket >

SIGNS OF OPERATION AND COMPARISON

plus +
minus -
multiplication x
multiplication dot ·
division ÷
greater than >
less than <
equals =

CURRENCY AND MEASUREMENT

cent ¢
dollar $
euro €
British Pound £
feet '
inches "

SPECIAL SYMBOLS

percent %
degree °
angle ∠
hashtag #
ampersand &
copyright ©
trademark ™
superscript indicator
subscript indicator
bullet •
@ sign @
asterisk *
dot locator for mention

ALPHABETIC WORDSIGNS

b but
c can
d do
e every
f from
g go
h have
j just
k knowledge
l like
m more
n not
p people
q quite
r rather
s so
t that
u us
v very
w will
x it
y you
z as

STRONG CONTRACTIONS (Part and Whole Word)

and
for
of
the
with

STRONG WORDSIGNS

child
shall
this
which
out
still

STRONG GROUPSIGNS

ch
sh
th
wh
ou
st
gh
ed
er
ow
ar
ing

LOWER GROUPSIGNS

ea
bb
cc
ff
gg

be
con
dis
en
in

LOWER WORDSIGNS

be
enough
were
his
in
was

INITIAL-LETTER CONTRACTIONS

day
ever
father
here
know
lord
mother
name
one
part
question
right
some
time
under
work
young

there
character
through
where
ought
upon
word
these
those
whose

cannot
had
many
spirit
world
their

FINAL-LETTER GROUPSIGNS

ound
ance
sion
less
ount

ence
ong
ful
tion
ness
ment
ity

SHORTFORM WORDS

ab	about	herf	herself
abv	above	hm	him
ac	according	hmf	himself
acr	across	imm	immediate
af	after	xs	its
afn	afternoon	xf	itself
afw	afterward	lr	letter
ag	again	ll	little
agst	against	mch	much
alm	almost	mst	must
alr	already	myf	myself
al	also	nec	necessary
alth	although	nei	neither
alt	altogether	onef	oneself
alw	always	ourvs	ourselves
bec	because	pd	paid
bef	before	pgrcv	perceive
beh	behind	pgrcvg	perceiving
bel	below	pgrh	perhaps
ben	beneath	qk	quick
bes	beside	rcv	receive
bet	between	rcvg	receiving
bey	beyond	rjc	rejoice
bl	blind	rjcg	rejoicing
brl	braille	sd	said
chn	children	shd	should
concv	conceive	sch	such
concvg	conceiving	themvs	themselves
cd	could	thyf	thyself
dcv	deceive	td	today
dcvg	deceiving	tgr	together
dcl	declare	tm	tomorrow
dclg	declaring	tn	tonight
ei	either	wd	would
fst	first	yr	your
fr	friend	yrf	yourself
gd	good	yrvs	yourselves
grt	great		

Retired Contractions (not used in UEB)

ble	ation	ally	
dd	com	to	
into	by	oc	oclock

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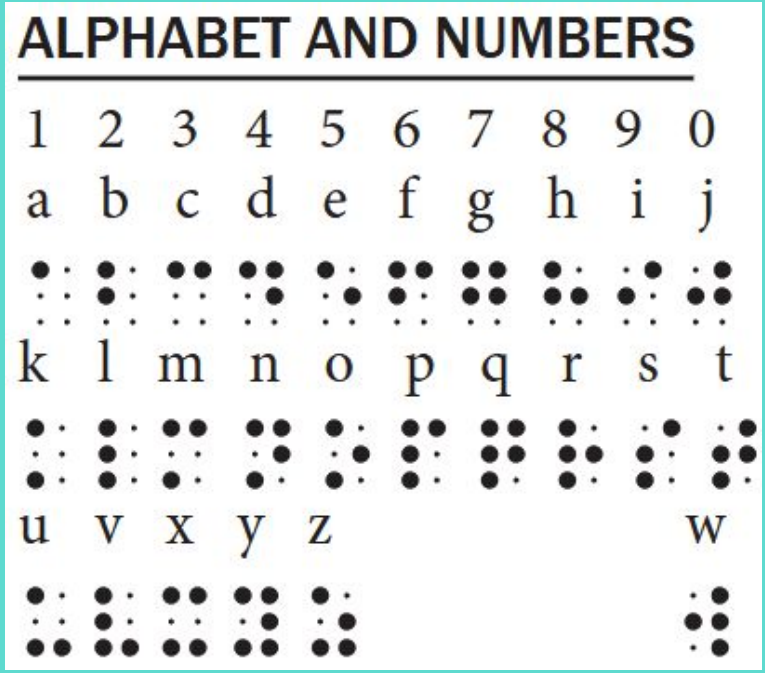
https://www.teachingvisuallyimpaired.com/uploads/1/4/1/2/14122361/ueb_braille_chart.pdf

Braille



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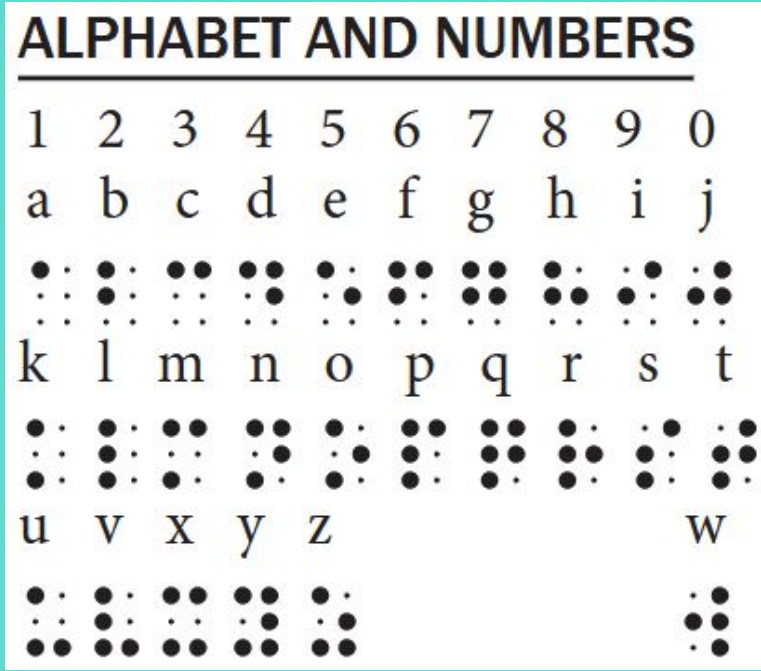

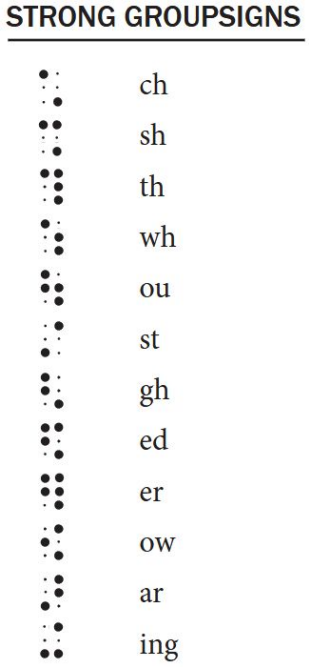

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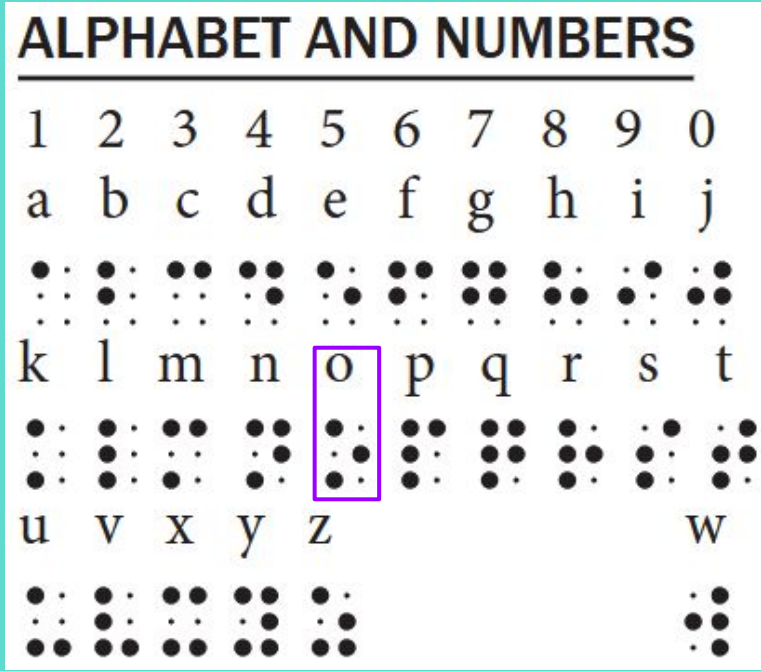

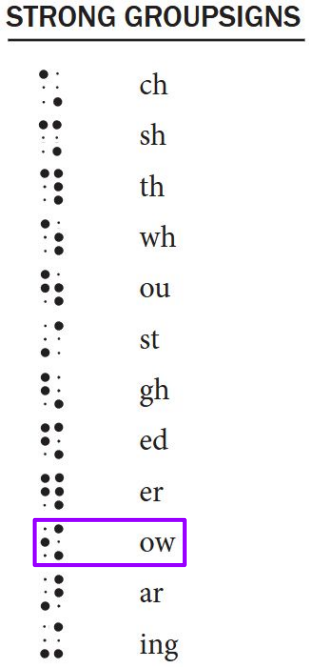

“owo” is ⠪⠺⠕

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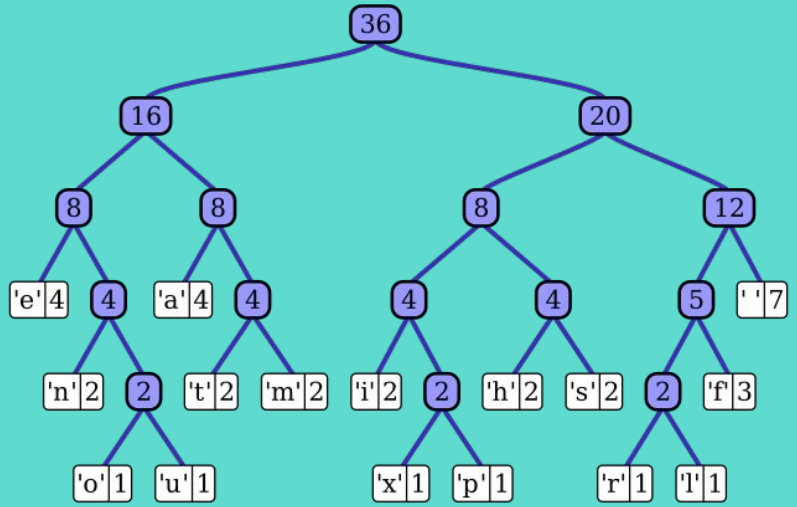
Huffman Coding

- More frequent characters get shorter encodings
- Used in .zip files and other compression algorithms
- Won't go over details due to time



Macro-Micro Tree Decomposition

Four russians removing logs in a tree

Macro-Micro Tree Decomposition

- Trees
  - Begin with root node
  - Nodes can have child nodes
  - Repeat
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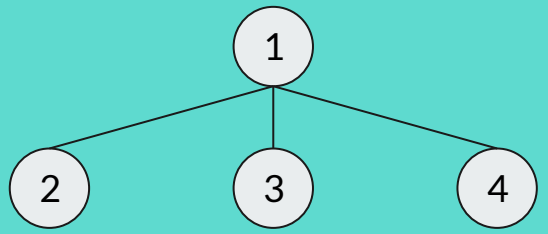

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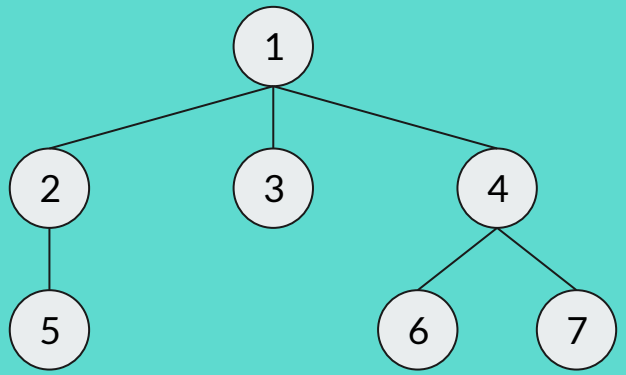

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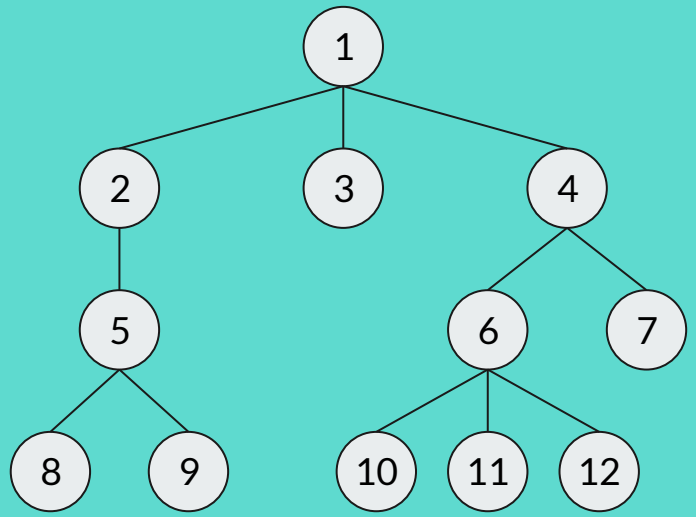

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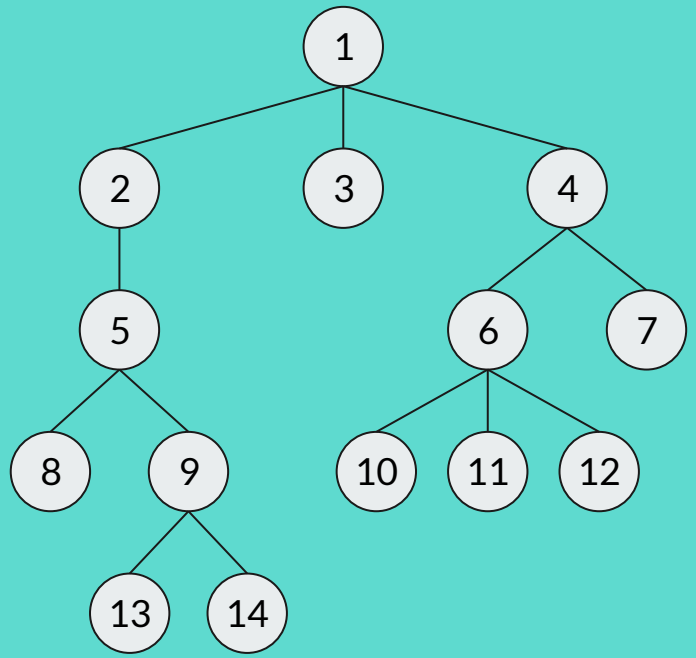

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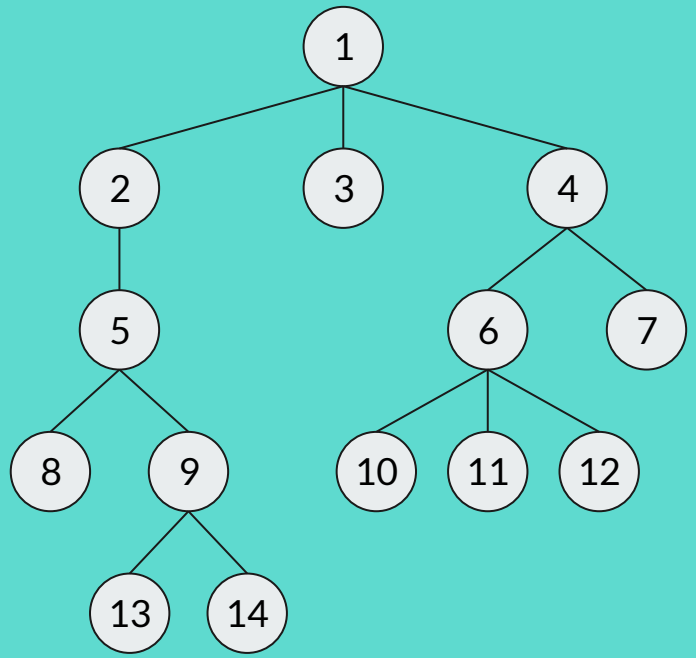

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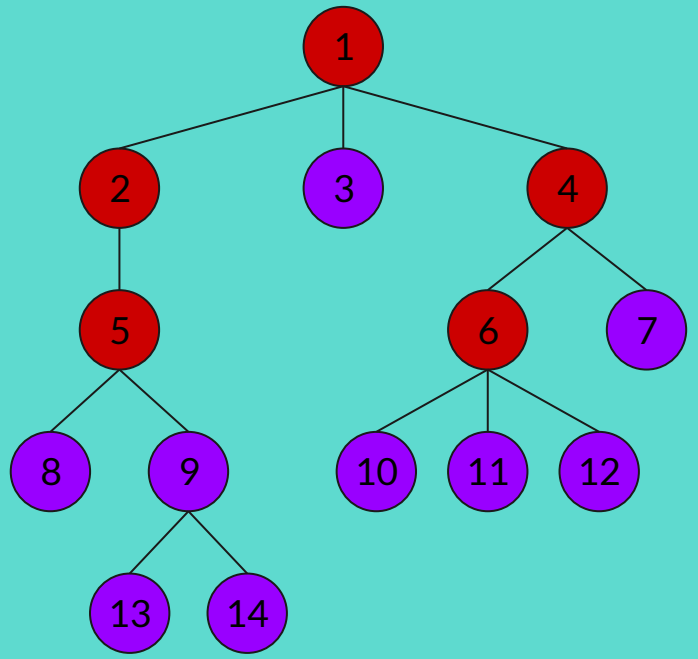

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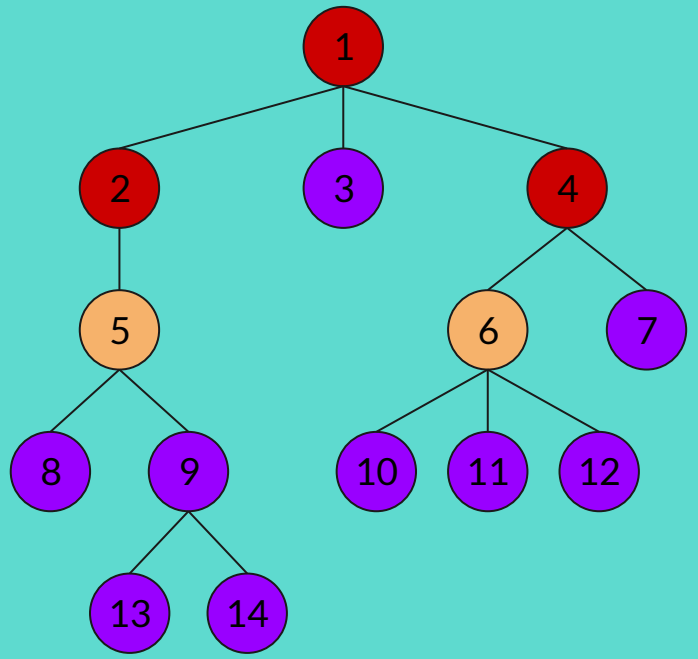

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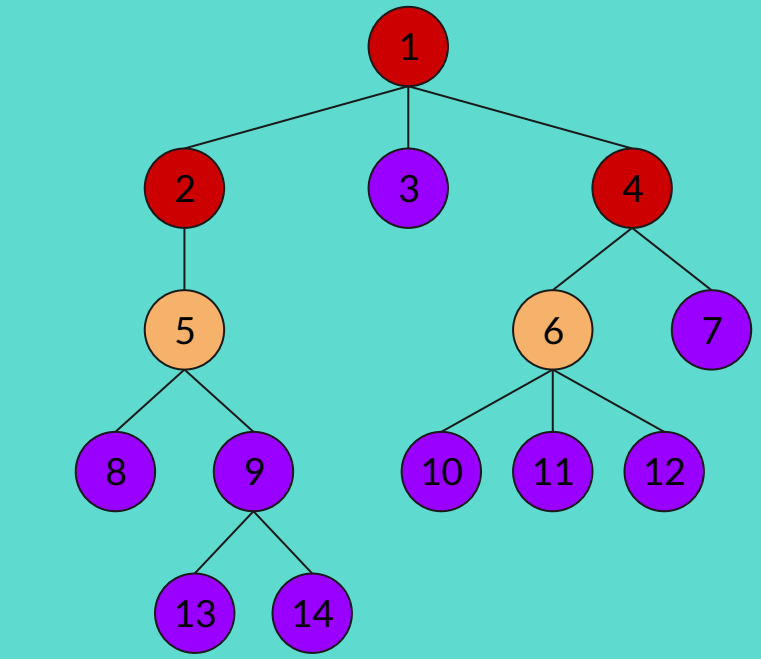

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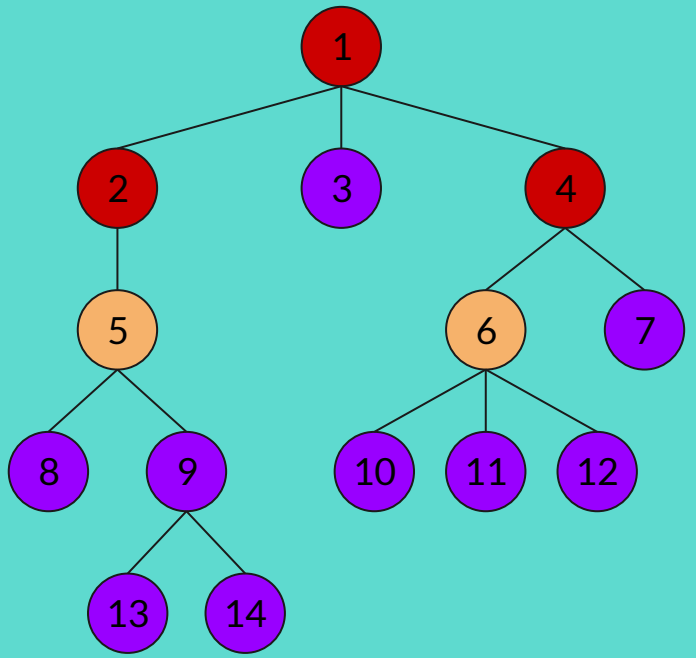


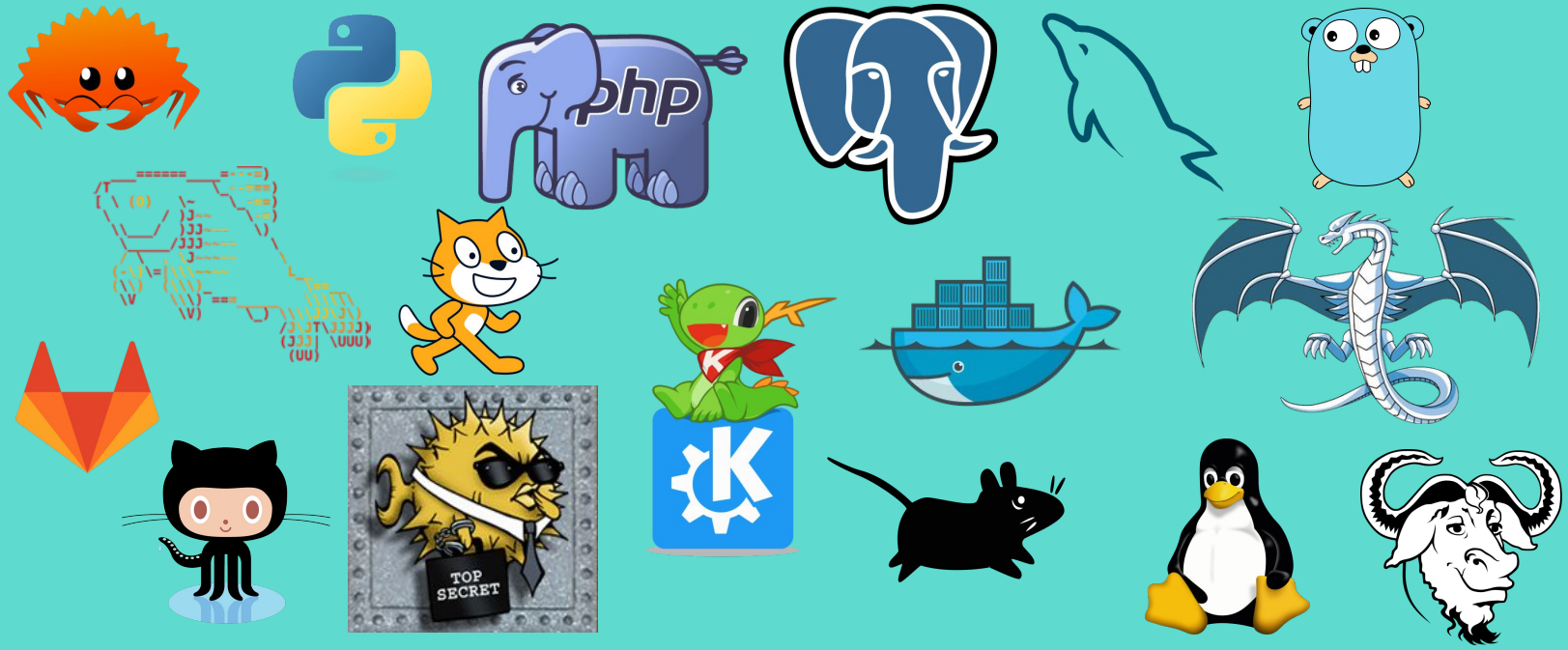
At most O(n/log(n)) macro leaves

Only O(n^(1/c)) distinct microtrees

Animal Computing Mascots

The true meaning of ACM

Animal Computing Mascots



Trans Rights!

https://xenia-linux-site.glitch.me/

Powershell

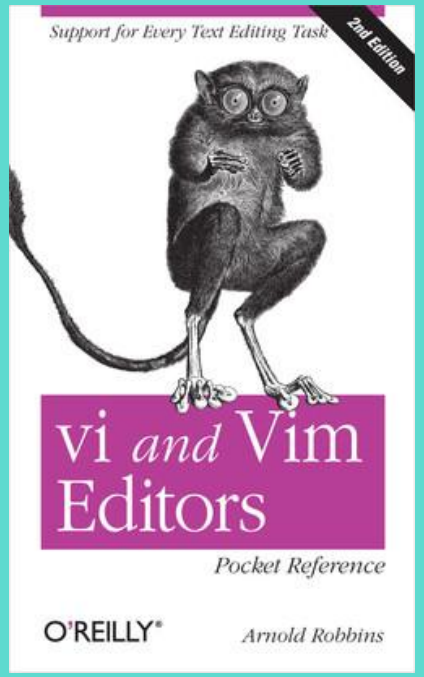
WSL

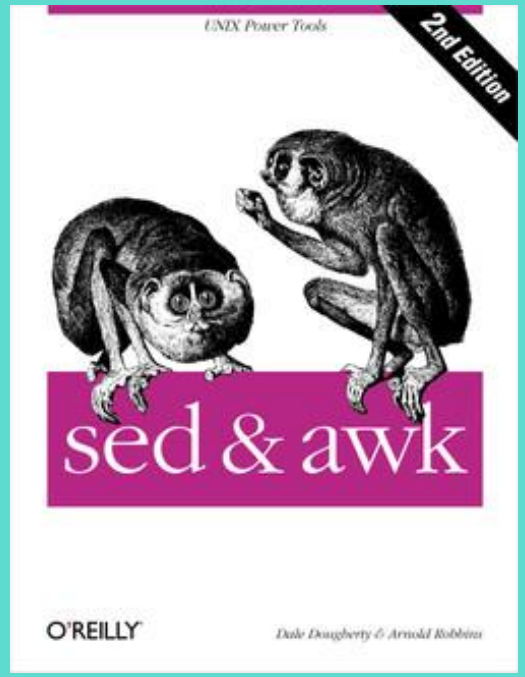
From: Richard Stallman
Subject: WSL
Date: Mon, 23 Jan 2023 22:50:01 -0500

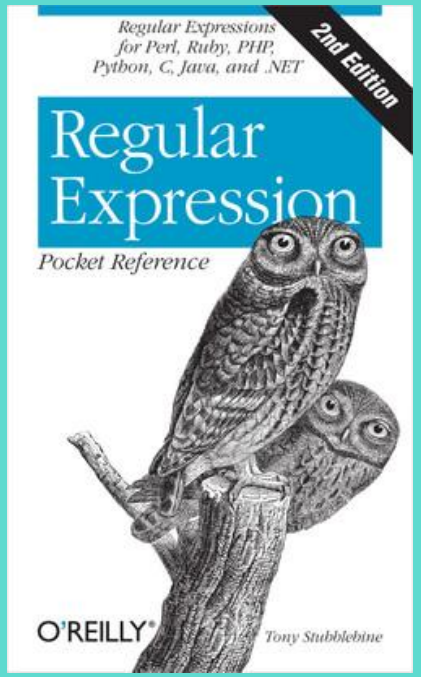
```
[[[ To any NSA and FBI agents reading my email: please consider    ]]]
[[[ whether defending the US Constitution against all enemies,     ]]]
[[[ foreign or domestic, requires you to follow Snowden's example. ]]]

How about pronouncing (and writing) "WSL" as "weasel"?

--
Dr Richard Stallman (https://stallman.org)
Chief GNUisance of the GNU Project (https://gnu.org)
Founder, Free Software Foundation (https://fsf.org)
Internet Hall-of-Famer (https://internethalloffame.org)
```

https://github.com/codetent/weasel

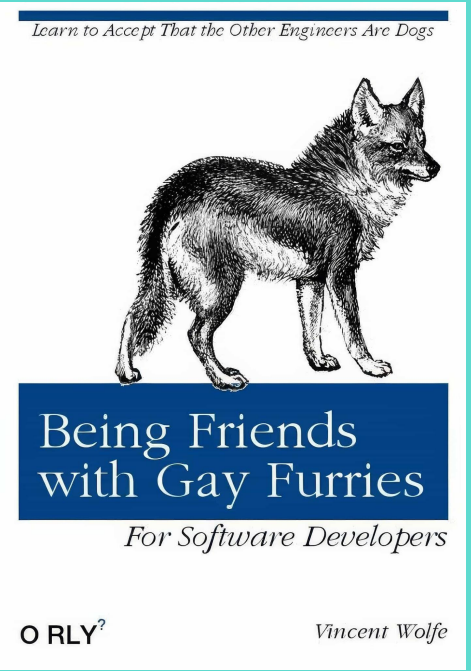
O'Reilly Book Covers

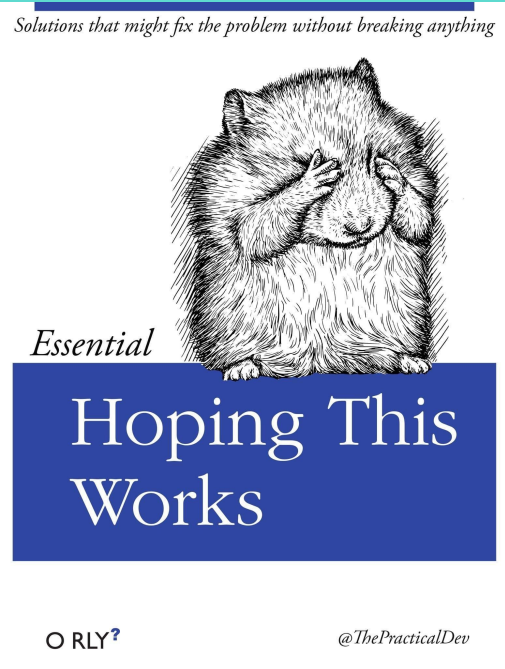






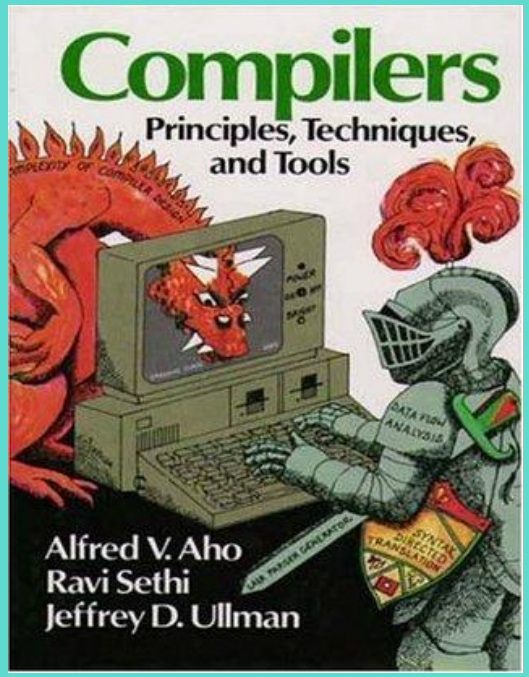
O'RLY Book Covers

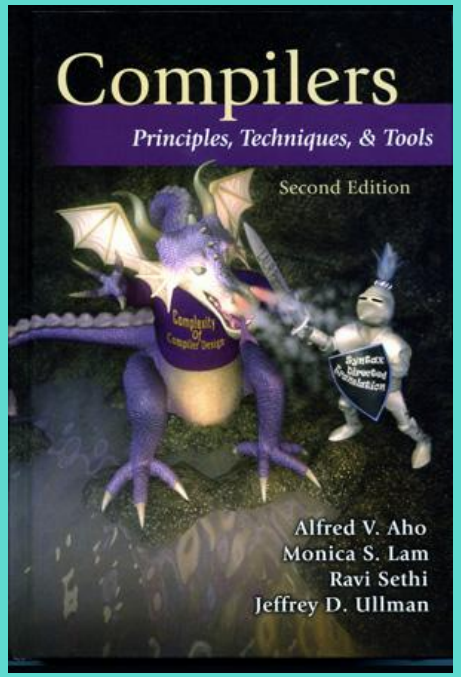




https://orlybooks.com/

Dragon Books





Primal Dual Methods

Lagrange Multipliers

- Suppose we're minimizing $f(x)$ subject to $g(x) = 0$

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  - Otherwise, maximum is infinite

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$$\min_{x|g(x)=0} f(x) = \min_{x}(\max_{\lambda}(f(x) + \lambda g(x)))$$

$$\mathcal{L}(x, \lambda) = f(x) + \lambda g(x))$$

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- There's more cool math here, but we'll skip it for time

$$\min_{x|g(x)=0} f(x) = \min_{x}(\max_{\lambda}(f(x) + \lambda g(x)))$$

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Duality in Linear Programming

$$\min_{Ax \leq b} c^\intercal x$$

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$$\min_{x} \max_{\lambda \leq 0} (c^\intercal x + \lambda^\intercal (b - Ax))$$

Duality in Linear Programming

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$$\min_{x} \max_{\lambda \leq 0} (c^\intercal x + \lambda^\intercal (b - Ax))$$

$$\min_{x} \max_{\lambda \leq 0} (c^\intercal x + \lambda^\intercal b - \lambda^\intercal Ax)$$

Duality in Linear Programming

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$$\min_{x} \max_{\lambda \leq 0} (c^\intercal x + \lambda^\intercal b - \lambda^\intercal Ax) \quad \max_{\lambda \leq 0} \min_{x} (b^\intercal \lambda + x^\intercal c - x^\intercal A^\intercal \lambda)$$

Duality in Linear Programming

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Duality in Linear Programming

$$\min_{Ax \leq b} c^\intercal x$$

$$\min_{0 \leq b - Ax} \quad c^\intercal x \qquad\qquad \max_{\lambda \leq 0, (c - A^\intercal \lambda) = 0} \quad b^\intercal \lambda$$

$$\min_x \max_{\lambda \leq 0} (c^\intercal x + \lambda^\intercal (b - Ax)) \qquad \max_{\lambda \leq 0} \min_x (b^\intercal \lambda + x^\intercal (c - A^\intercal \lambda))$$

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Duality in Linear Programming

$$\min_{Ax \leq b} c^\intercal x \qquad \max_{\lambda \leq 0, A^\intercal \lambda = c} b^\intercal \lambda$$

$$\min_{0 \leq b - Ax} c^\intercal x \qquad \max_{\lambda \leq 0, (c - A^\intercal \lambda) = 0} b^\intercal \lambda$$

$$\min_{x} \max_{\lambda \leq 0} (c^\intercal x + \lambda^\intercal (b - Ax)) \qquad \max_{\lambda \leq 0} \min_{x} (b^\intercal \lambda + x^\intercal (c - A^\intercal \lambda))$$

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Fuzzing

bottom text

American Fuzzy Lop

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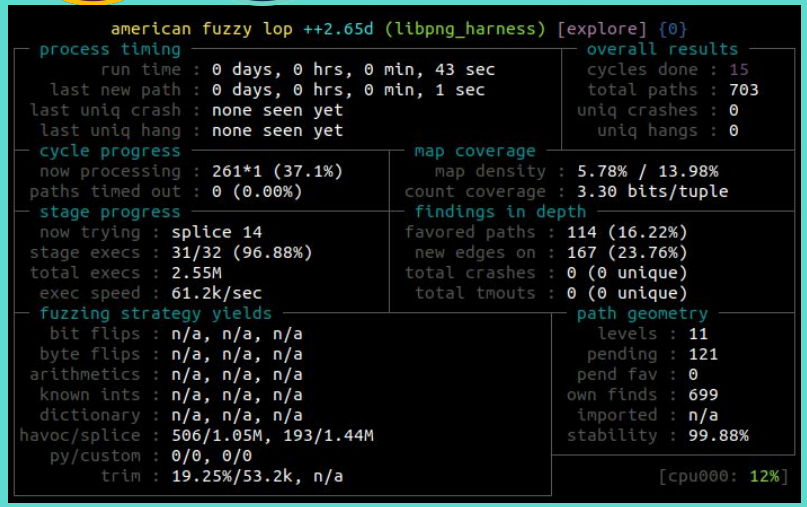
- Fuzzer: program that automatically searches for buggy input
- Initial idea: purely random input
- Add rules/strategies/heuristics to increase chance of buggy input



https://aflplus.plus/

Data Structures and Algorithms

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