Unicode Search of Dirty Data, Or: How I Learned to Stop Worrying and Love Unicode Technical Standard #18

By

Jon Stewart and Joel Uckelman

Presented At

The Digital Forensic Research Conference

DFRWS 2013 USA Monterey, CA (Aug 4th - 7th)

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Jon Stewart Joel Uckelman*

Lightbox Technologies
Arlington, VA
{jon,joel}@lightboxtechnologies.com

DFRWS 2013

A Motivating Example

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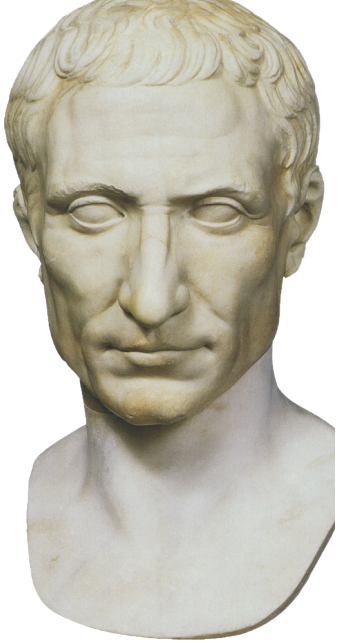

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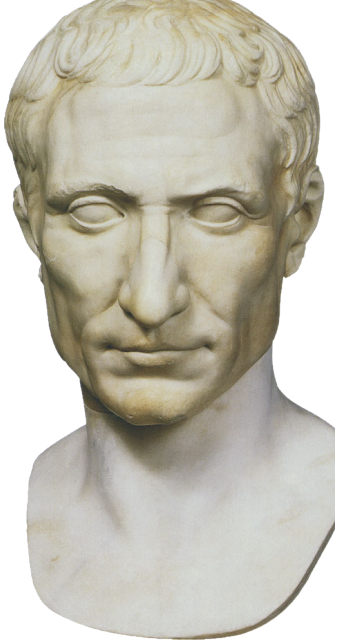

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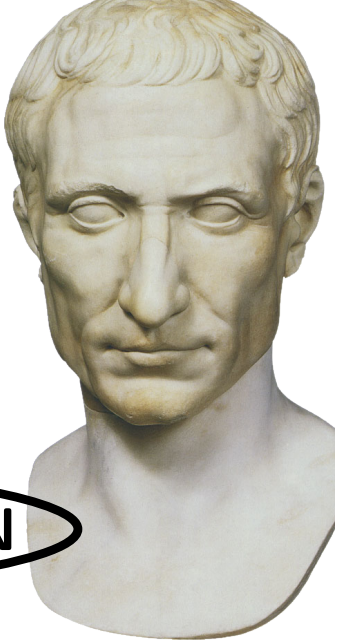

A T T A C K A T D A W N

41	54	54	41	43	4B	20	41	54	20	44	41	57	4E

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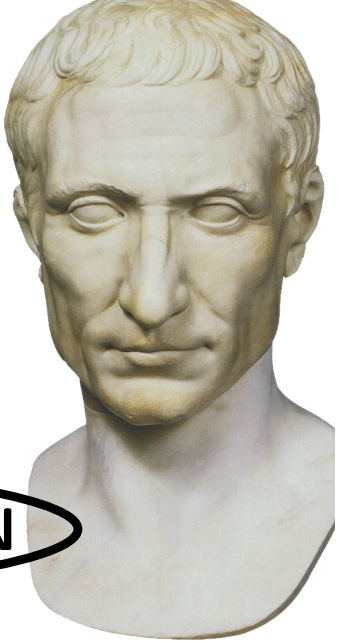

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latin1

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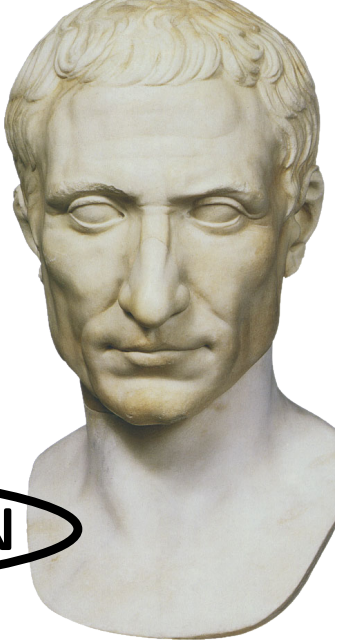

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41	54	54	41	43	4B	20	41	54	20	44	41	57	4E

D3	63	63	D3	51	9D	4C	D3	63	4C	45	D3	4B	09

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OCE(latin1)

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D3	63	63	D3	51	9D	4C	D3	63	4C	45	D3	4B	09

41	00	54	00	54	00	41	00	43	00	4B	00	20	00	41	00	54	00	20	00	44	00	41	00	57	00	4E	00

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UTF-16LE

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UTF-16LE

00	41	00	54	00	54	00	41	00	43	00	4B	00	20	00	41	00	54	00	20	00	44	00	41	00	57	00	4E

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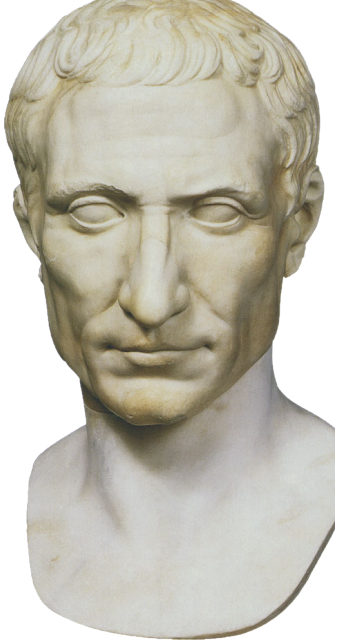

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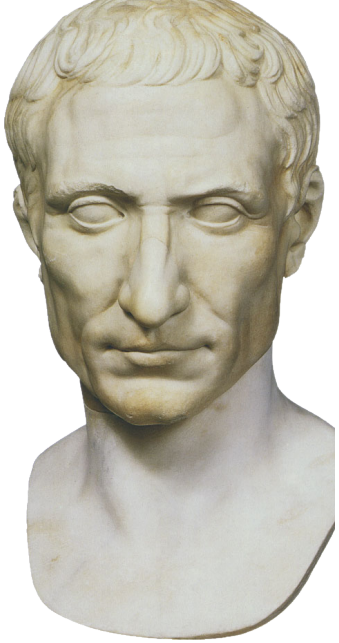

- Many possible encodings for text, all different

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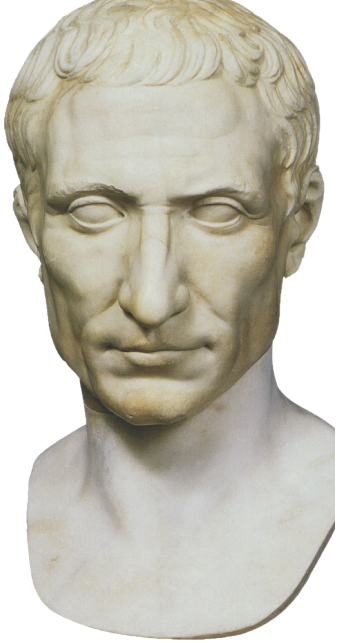

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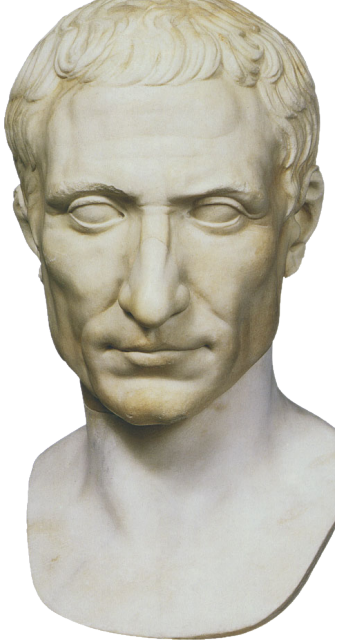

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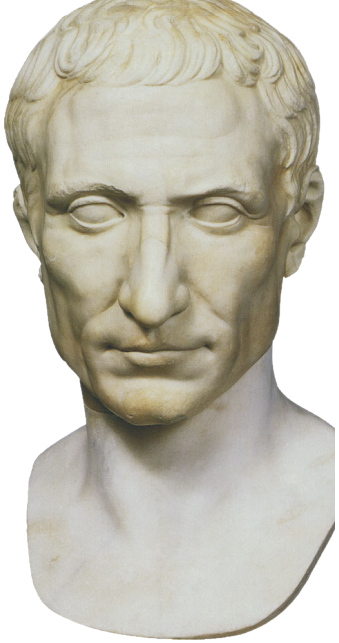

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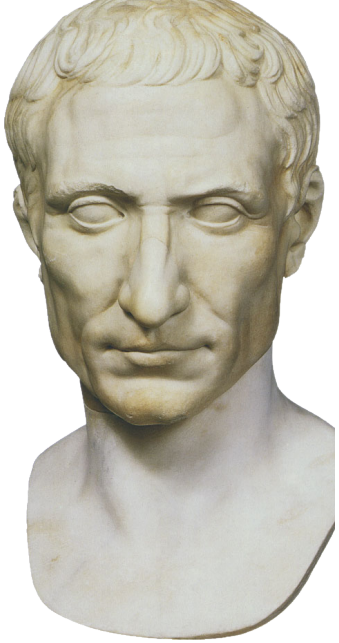

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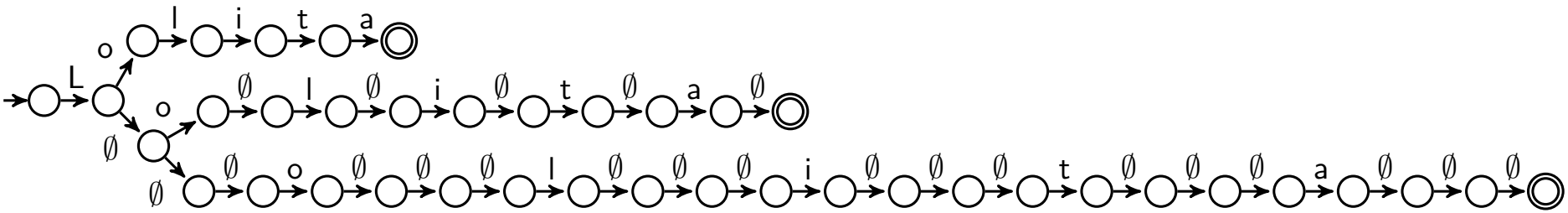
What to do?

Multiencoding search is multipattern search.



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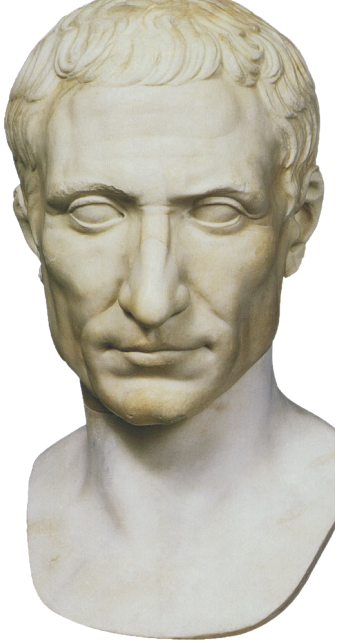

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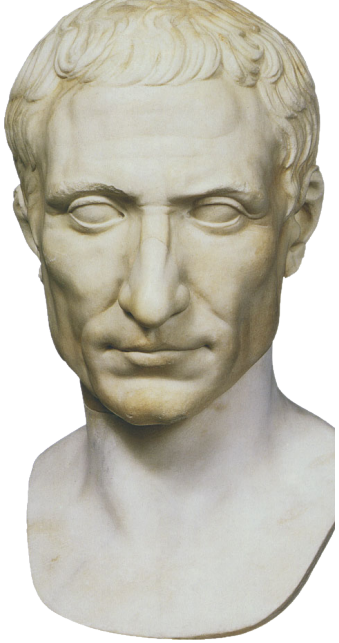

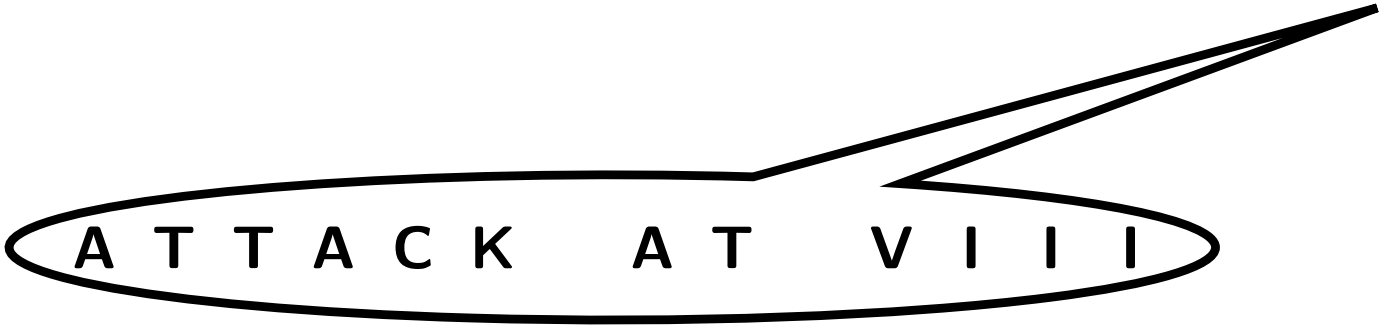

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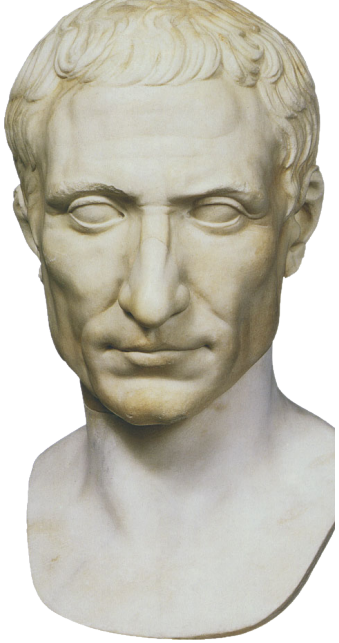

A T T A C K A T I V

A T T A C K A T V

A T T A C K A T V I

A T T A C K A T V I I

A T T A C K A T V I I I

A T T A C K A T I X

A T T A C K A T X

A T T A C K A T X I

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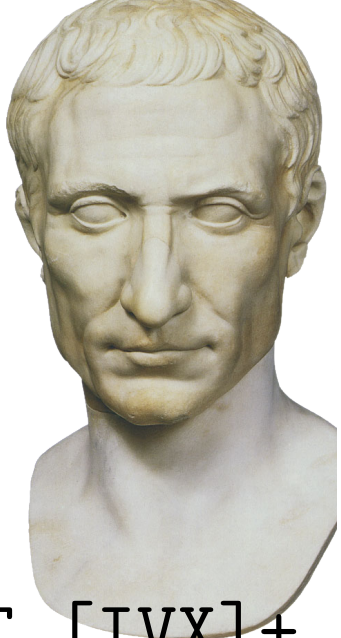

A T T A C K A T I V
A T T A C K A T V
A T T A C K A T V I
A T T A C K A T V I I
A T T A C K A T V I I I
A T T A C K A T I X
A T T A C K A T X
A T T A C K A T X I

ATTACK AT [IVX]+

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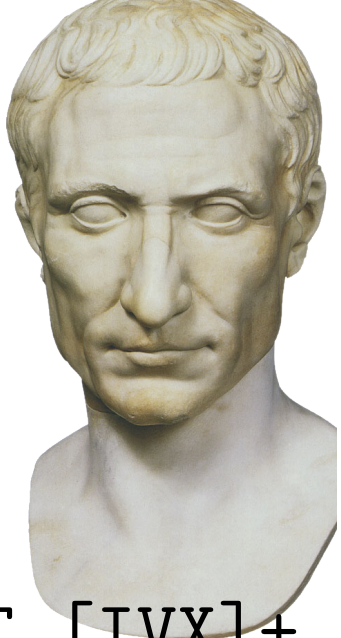

A T T A C K A T I V
A T T A C K A T V
A T T A C K A T V I
A T T A C K A T V I I
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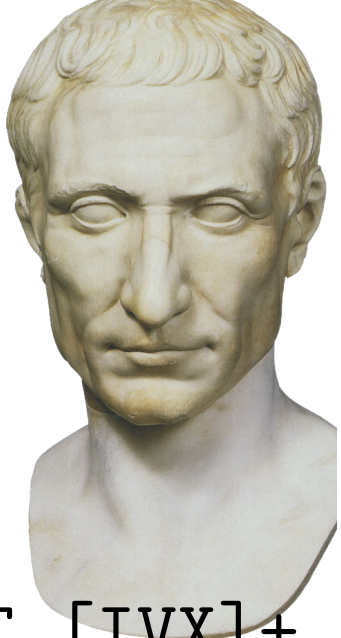

A T T A C K A T I V
A T T A C K A T V
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A T T A C K A T V I I
A T T A C K A T V I I I
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A T T A C K A T X
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ATTACK AT [IVX]+

VIII ROMAN NUMERAL EIGHT (U+2167)

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A T T A C K A T I V
A T T A C K A T V
A T T A C K A T V I
A T T A C K A T V I I
A T T A C K A T V I I I
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GORY DETAILS

VIII ROMAN NUMERAL EIGHT (U+2167)

What is Unicode?

Before Unicode:

- Hundreds of character encodings

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- Huge character set—space for 1.1m *code points*

Unicode Terminology

Code point A (possibly named) character, identified by a hex number

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E.g.: U+0058, LATIN CAPITAL LETTER X

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Code points range from U+0000 to U+10FFFF

Unicode and Regular Expressions

- Unicode contains many weird and wonderful things.

ð ऌ Д € 獼 Φ ﷺ Ꮹ ⁙ ∰ 💩 ☎

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- Regular expressions were designed for ASCII text.

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ð ऌ Д € 獼 Φ ﷺ [illegible] ⁙ ∰ 💩 ☎

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ð ऌ Д € 獮 Φ ﷺ դ ⡵ ∰ 💩 ☎

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    - Level 1: Basic Unicode Support

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ð ಠ_ಠ Д € 獼 Φ ﷺ ᘐ :: ∯ 💩 ☎

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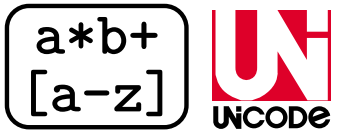
  - Level 1: Basic Unicode Support
  - Level 2: Extended Unicode Support
  - Level 3: Tailored Support

What is that? How do I type it?



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  K LATIN CAPITAL LETTER K (U+004B)
  K KELVIN SIGN (U+212A)

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  K KELVIN SIGN (U+212A)

tab (U+0009)
SPACE (U+0020)
MONGOLIAN VOWEL SEPARATOR (U+180E)
EN QUAD (U+2000)
EM QUAD (U+2001)
EN SPACE (U+2002)
EM SPACE (U+2003)
THREE-PER-EM SPACE (U+2004)
FOUR-PER-EM SPACE (U+2005)
SIX-PER-EM SPACE (U+2006)
FIGURE SPACE (U+2007)
PUNCTUATION SPACE (U+2008)
THIN SPACE (U+2009)
HAIR SPACE (U+200A)
NARROW NO-BREAK SPACE (U+202F)
MEDIUM MATHEMATICAL SPACE (U+205F)
IDEOGRAPHIC SPACE (U+3000)

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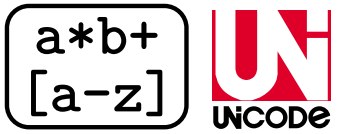

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- Some characters will be unfamiliar to you.

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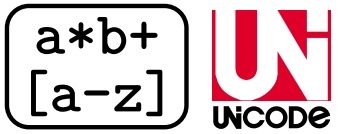

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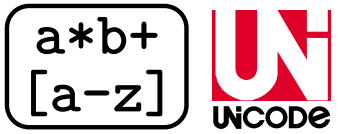

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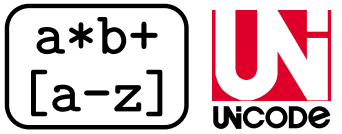

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UTS #18 requires:

- Code points can be specified by hex notation (RL1.2)

$$\texttt{\textbackslash x\{10DA\}} = \mathfrak{m}$$

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- Code points can be specified by name (RL2.5)

  `\N{latin small letter sharp s}` = ß

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- All code points are supported (RL1.7)

Adventures in Case Sensitivity

- How many characters match `[a-z]` case insensitively? 52

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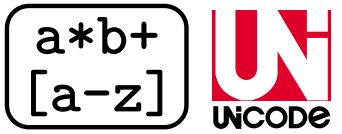
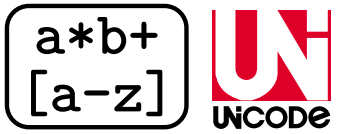


- How many characters match [a-z] case insensitively? ~~52~~ 54 !!!
- What?!
  - a–z and A–Z, as expected but also

Adventures in Case Sensitivity



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- No missed hits when case-insensitively searching unfamiliar scripts

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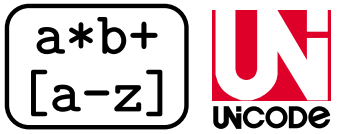
```
\p{Cyrillic}{4,}
[\p{Arabic}\p{Whitespace}\p{Punctuation}]+
```

Set Operations on Character Classes



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Level 1: Basic Unicode Support	○	●	○	●	●
RL1.1 Hex Notation	●	●	●	●	●
RL1.2 Properties	●	●	●	●	●
RL1.3 Subtraction and Intersection	●	●	○	●	●
RL1.4 Simple Word Boundaries		●	●	●	●
RL1.5 Simple Loose Matches	●	●	●	●	●
RL1.6 Line Boundaries		●	○	●	●
RL1.7 Supplementary Code Points	●	●	●	●	●
Level 2: Extended Unicode Support	○	○	○	○	○
RL2.1 Canonical Equivalents				●	
RL2.2 Extended Grapheme Clusters		○	○		●
RL2.3 Default Word Boundaries		●			
RL2.4 Default Case Conversion					
RL2.5 Name Properties	●	●	●		●
RL2.6 Wildcards in Property Values					
RL2.7 Full Properties	●		●		●
Level 3: Tailored Support	○		○		
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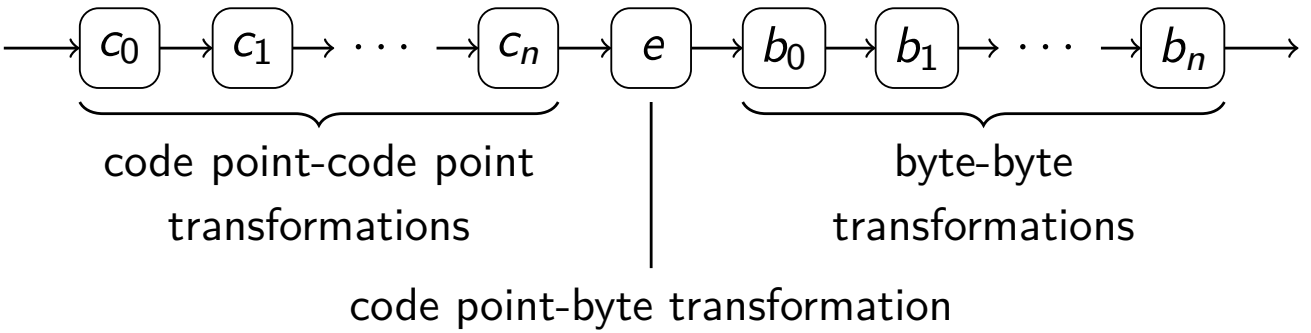

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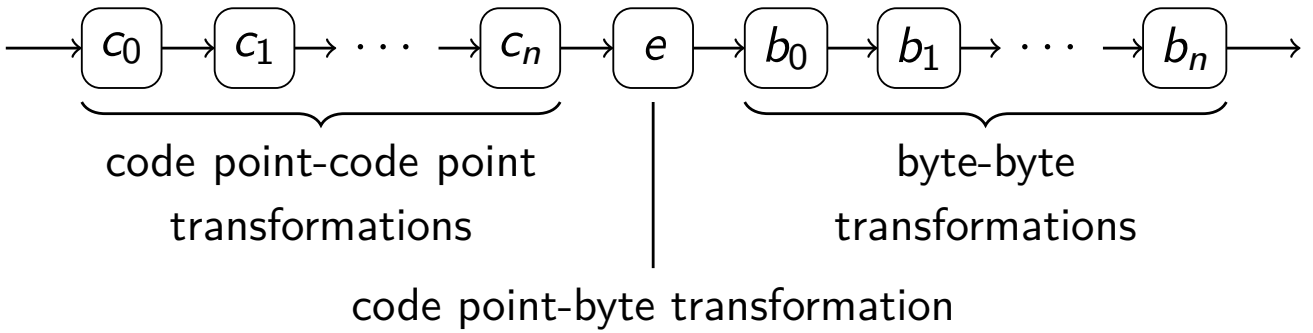

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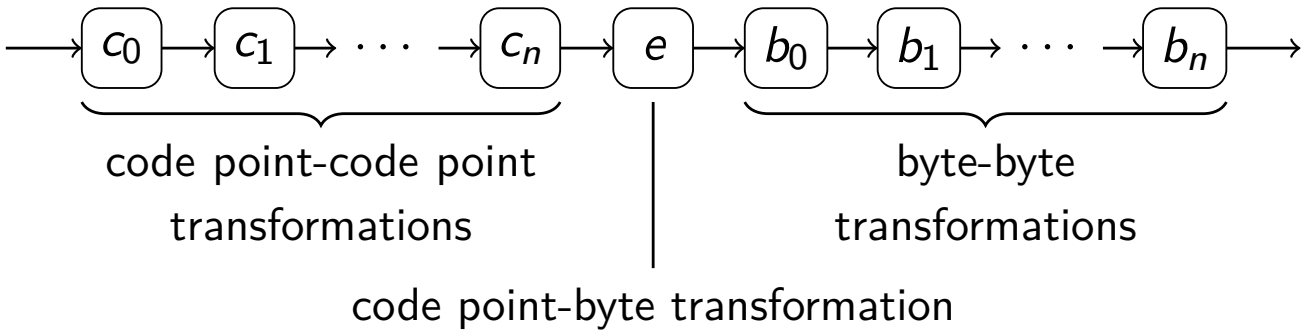

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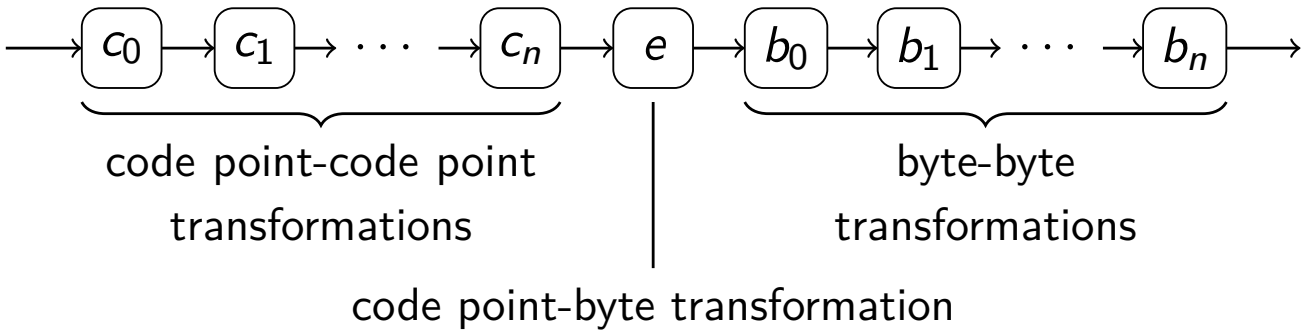

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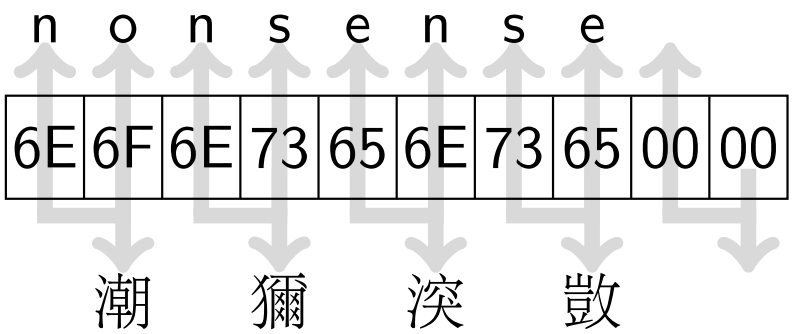

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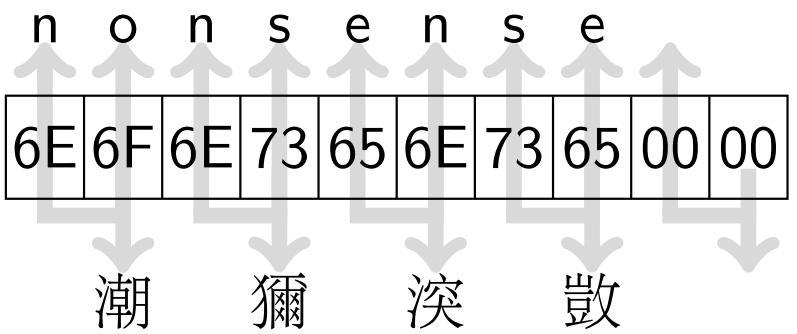

- User discretion is advised.

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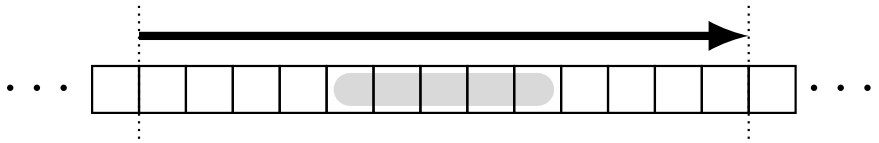

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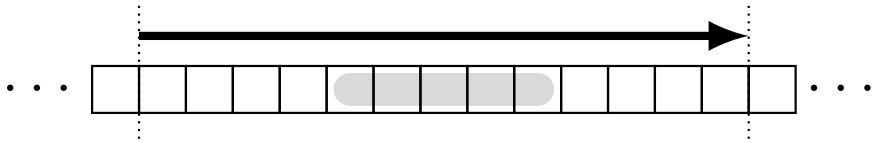

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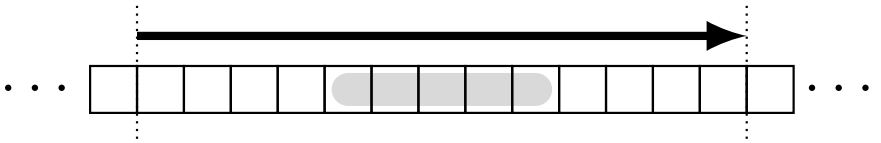
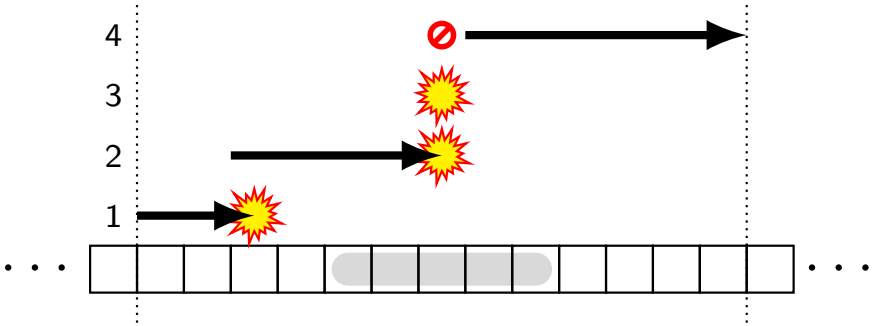


✘

Left to right, restarting on error



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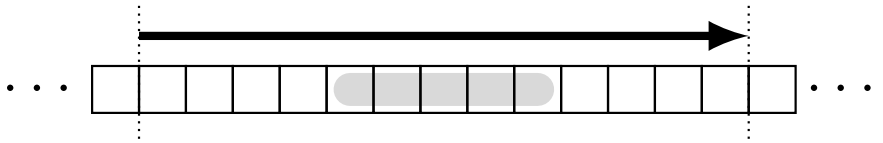

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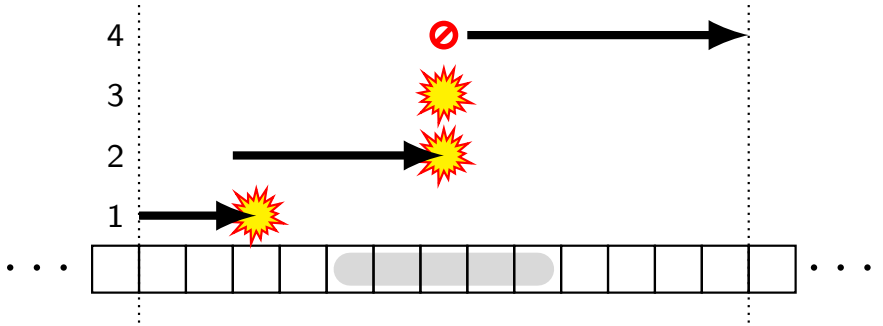

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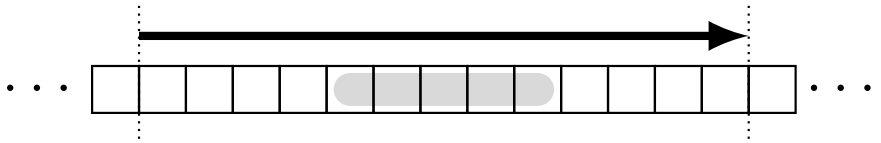

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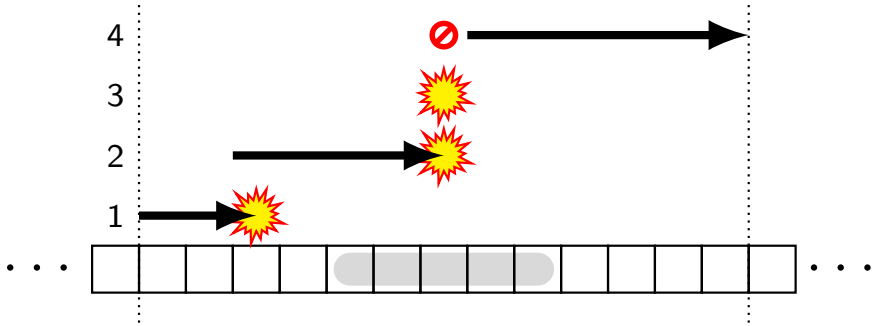

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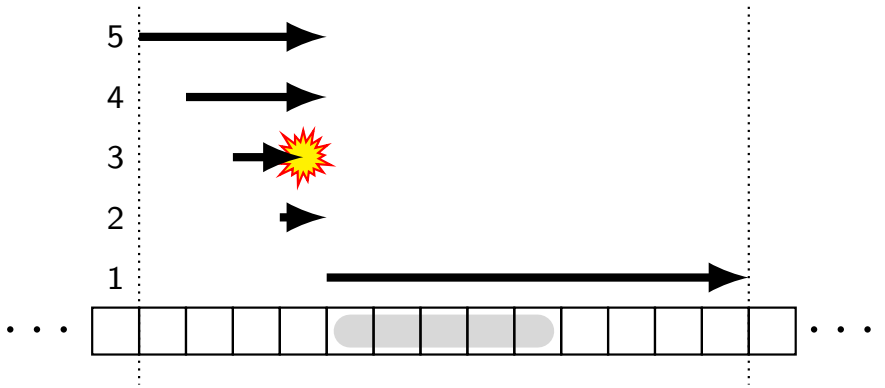

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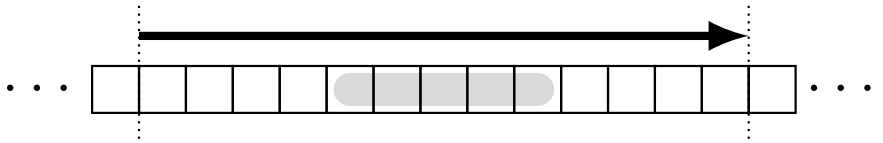

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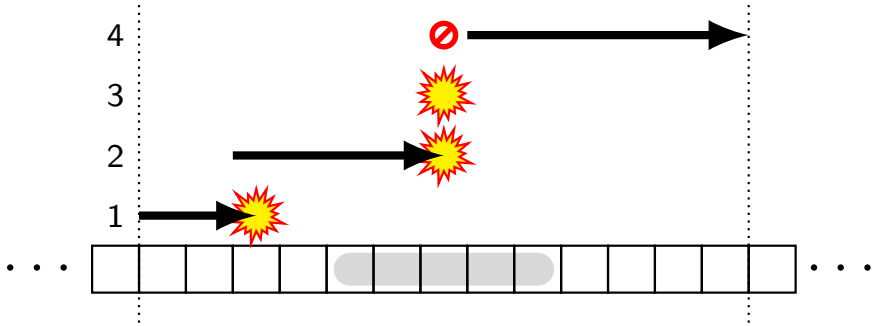

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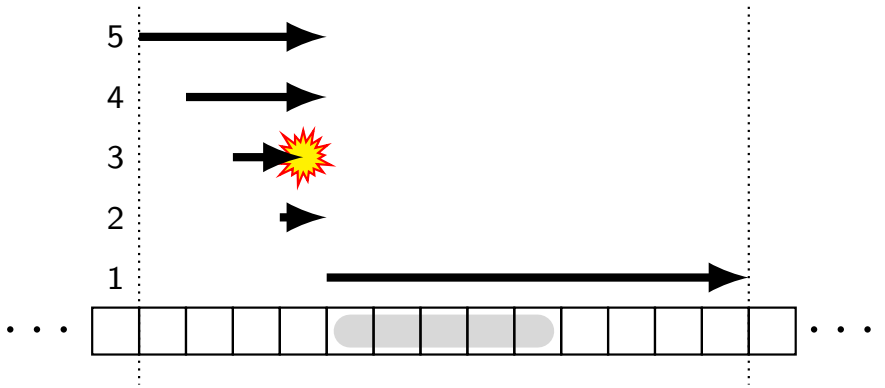

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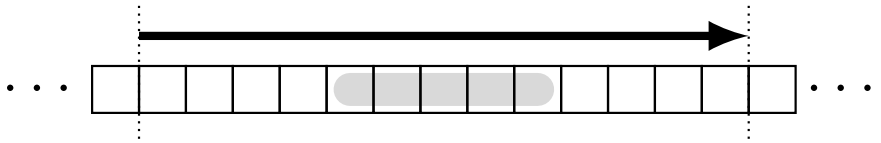

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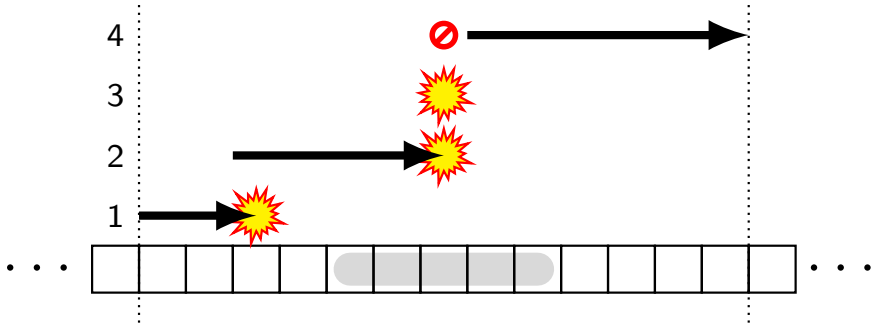

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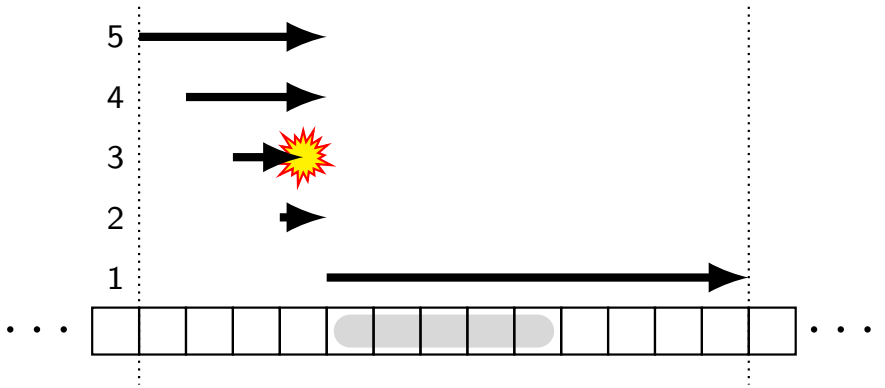

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$O(n^2)$ but can happen after (or in parallel with) search

How fast is search?

Image	Size	Hits	Bandwidth
Charlie-2009-11-12.E01	10GB	543,719	131.7 MB/s
Jo-2009-11-12.E01	14GB	536,906	123.8 MB/s
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Multiencoding/Unicode search can be fast.

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- Hit context is handy, not entirely trivial to produce

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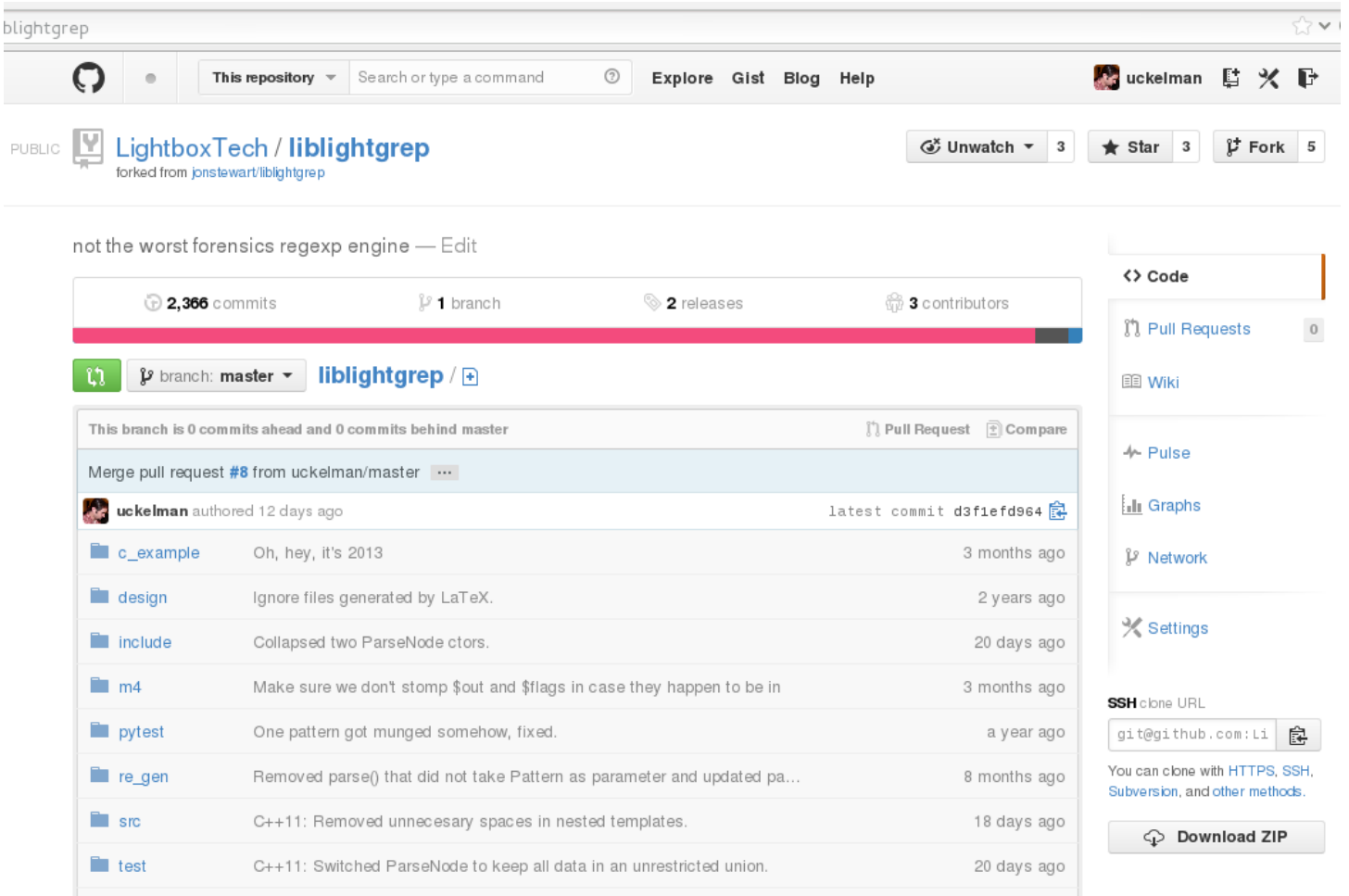
- Wouldn't it be neat to have a "looks-like" operator or mode?

`\L{e}` `\L{VIII}` `\L{UNDUTCHABLES}`

Where can I find this amazing software?

`https://github.com/LightboxTech/liblightgrep`



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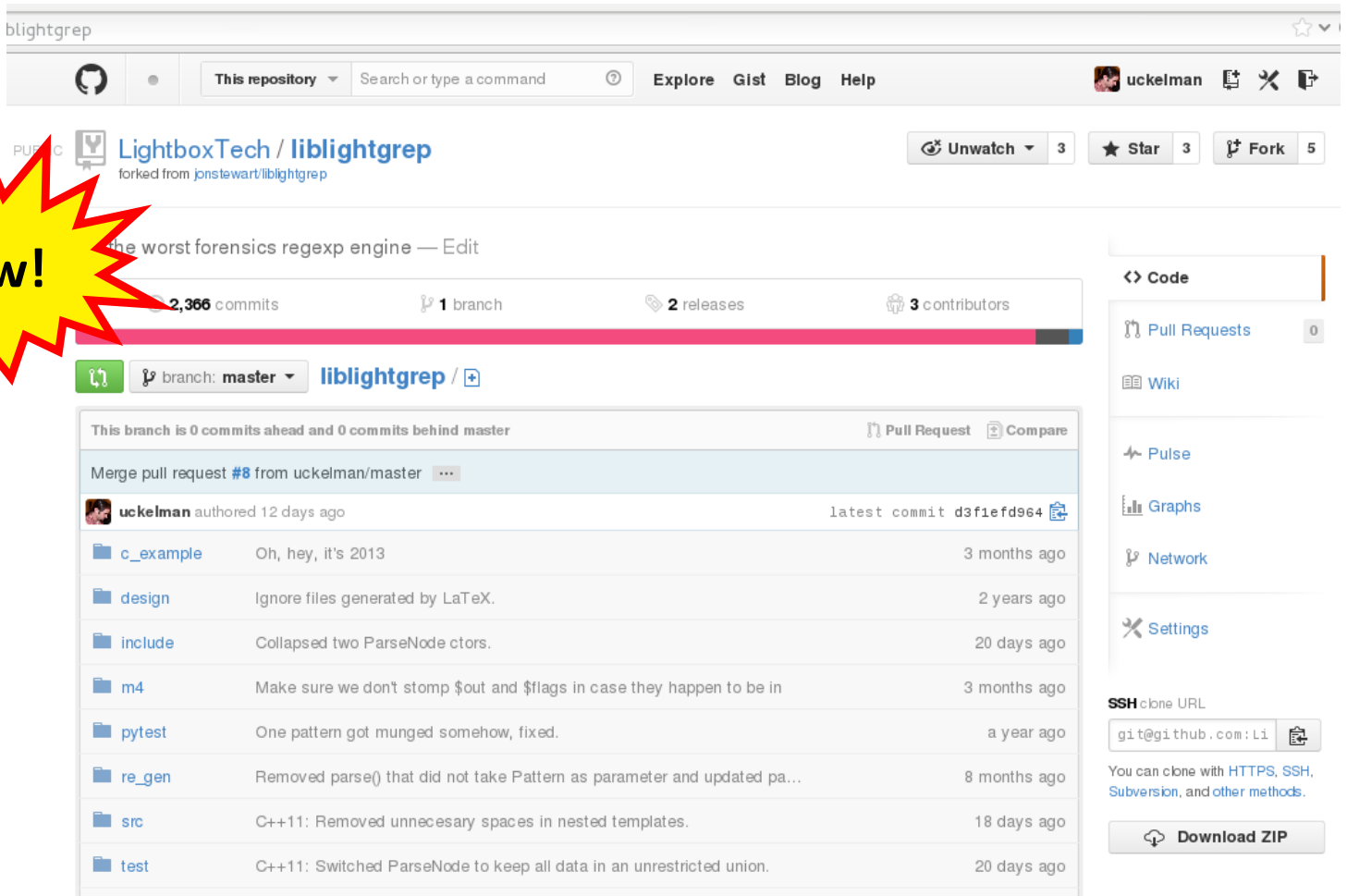

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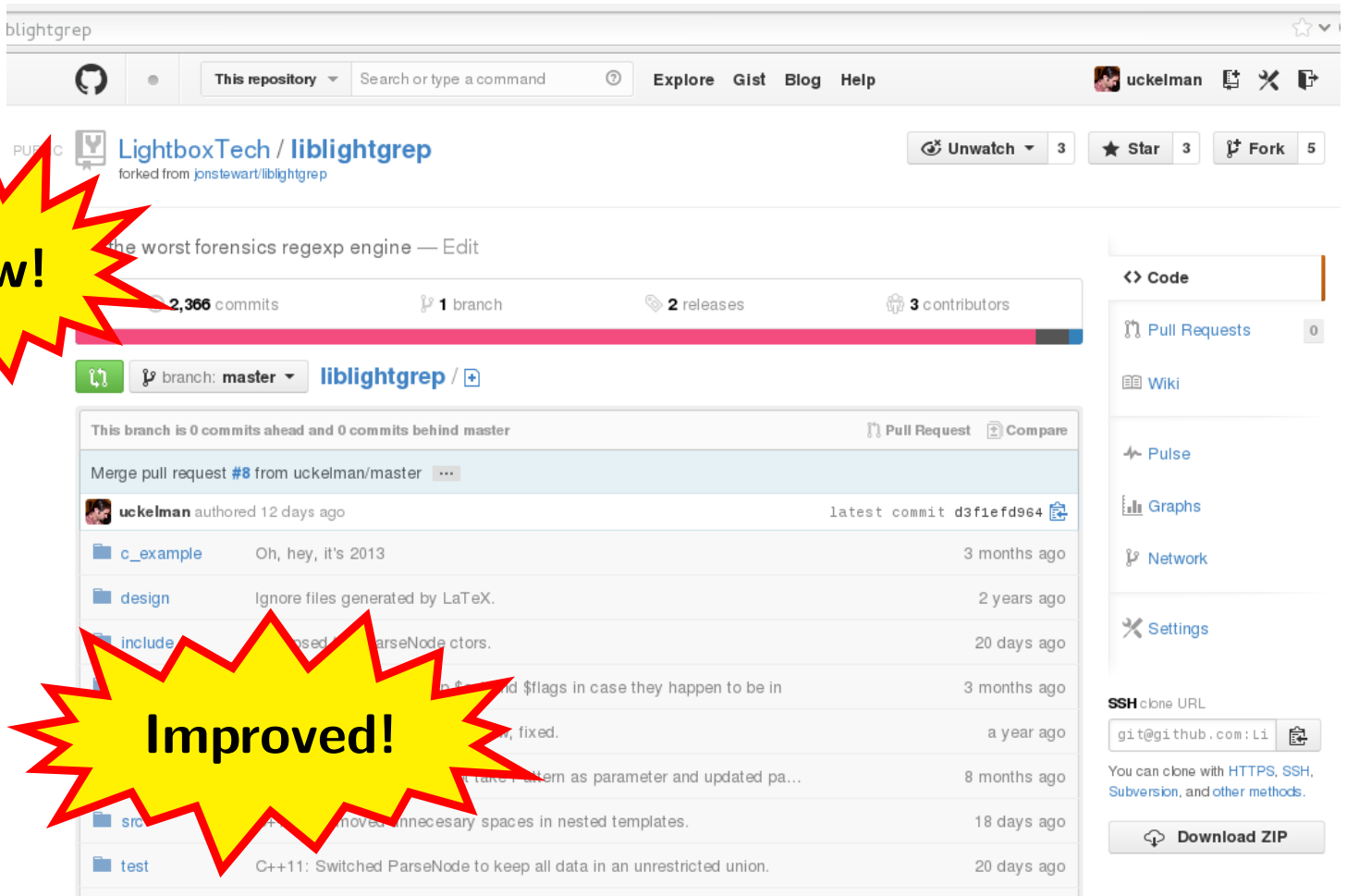

New!

Improved!

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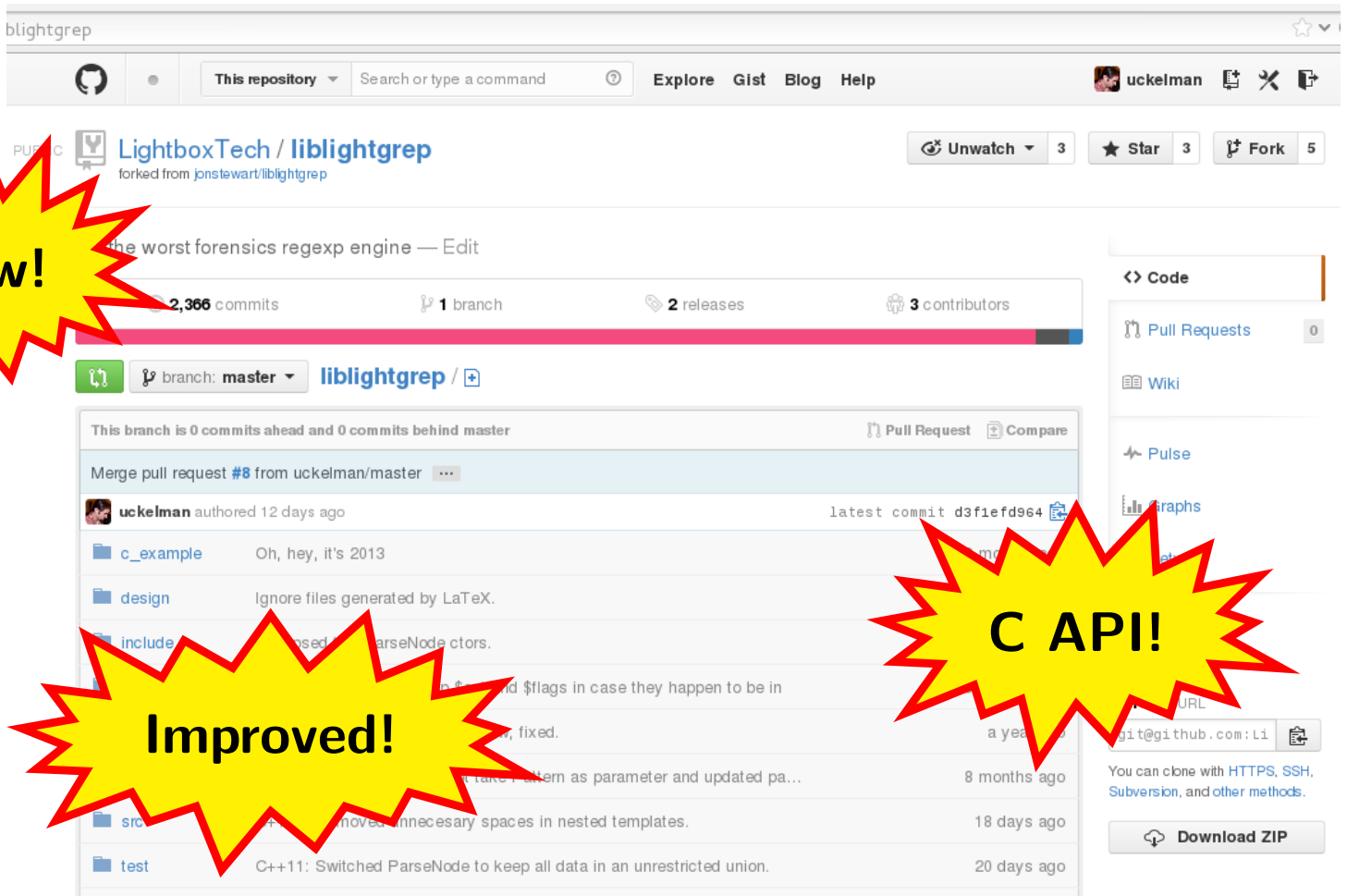

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