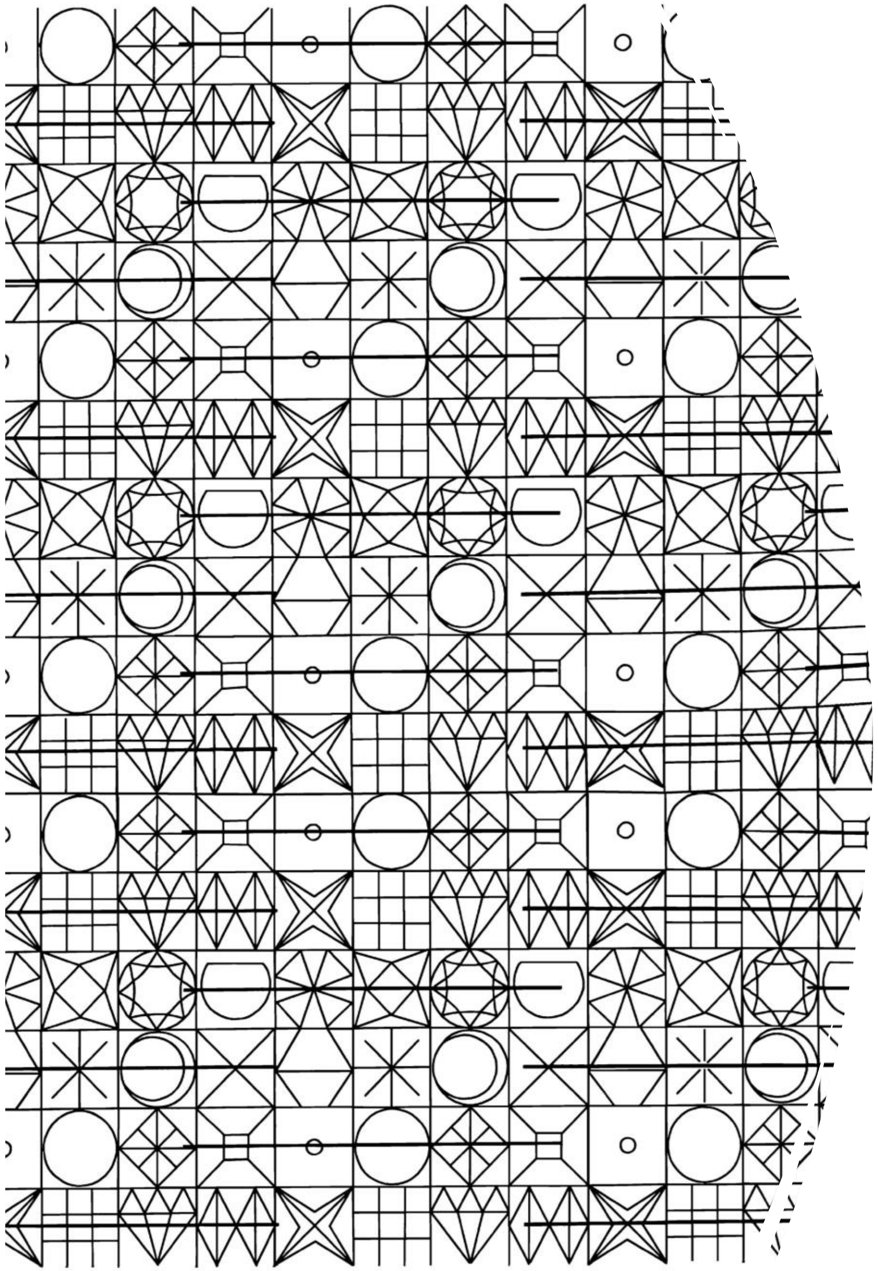
String Matching dengan Regular Expression

Masayu Leylia Khodra

Referensi:

Chapter 2 of *An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition,* by Daniel Jurafsky and James H. Martin

15-211 Fundamental Data Structures and Algorithms, by Ananda Gunawardena



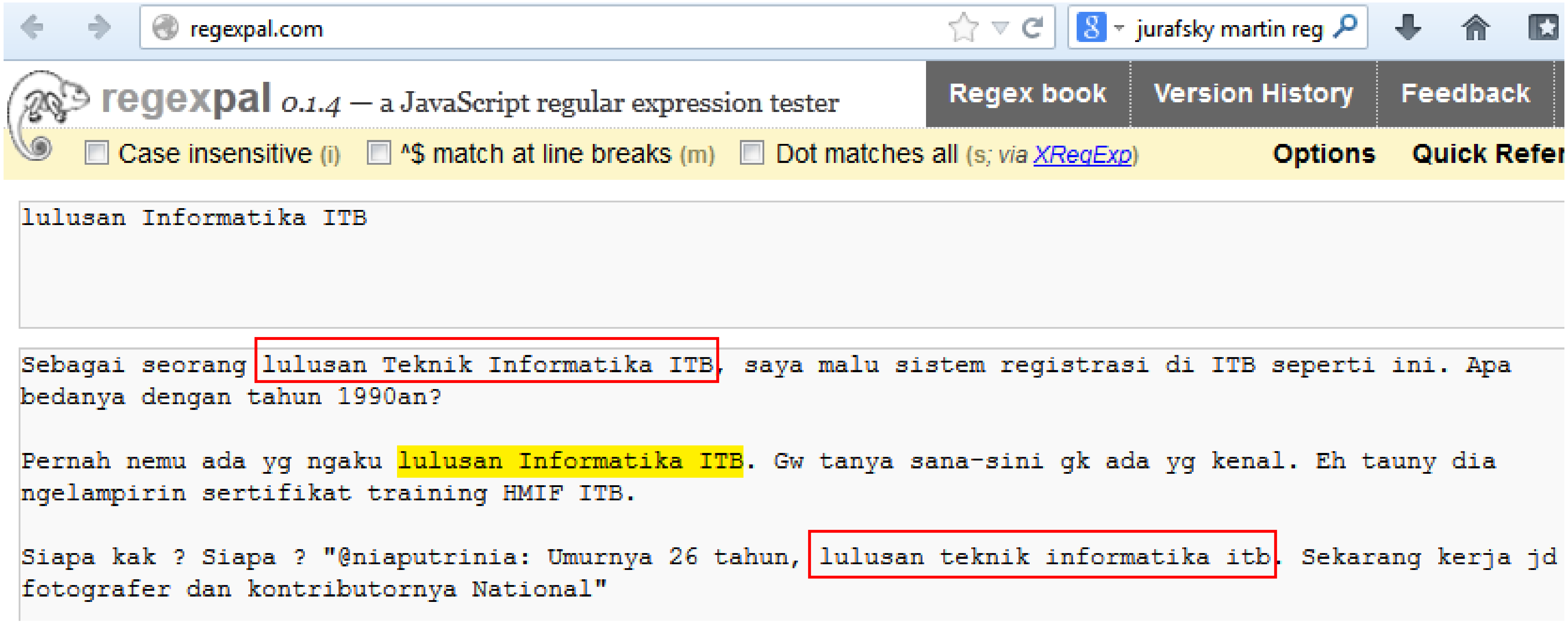
String Matching

Definisi:

- Diberikan:
  1. *T*: teks (*text*), yaitu (*long*) *string* yang panjangnya *n* karakter
  2. *P: pattern*, yaitu *string* dengan panjang *m* karakter (asumsi *m* <<< *n*) yang akan dicari di dalam teks.

Carilah (*find* atau *locate*) di dalam teks *T* yang bersesuaian dengan *pattern P*.

Contoh 1: Exact Matching



☐ Case insensitive (i) ☐ ^$ match at line breaks (m) ☐ Dot matches all (s; via XRegExp)

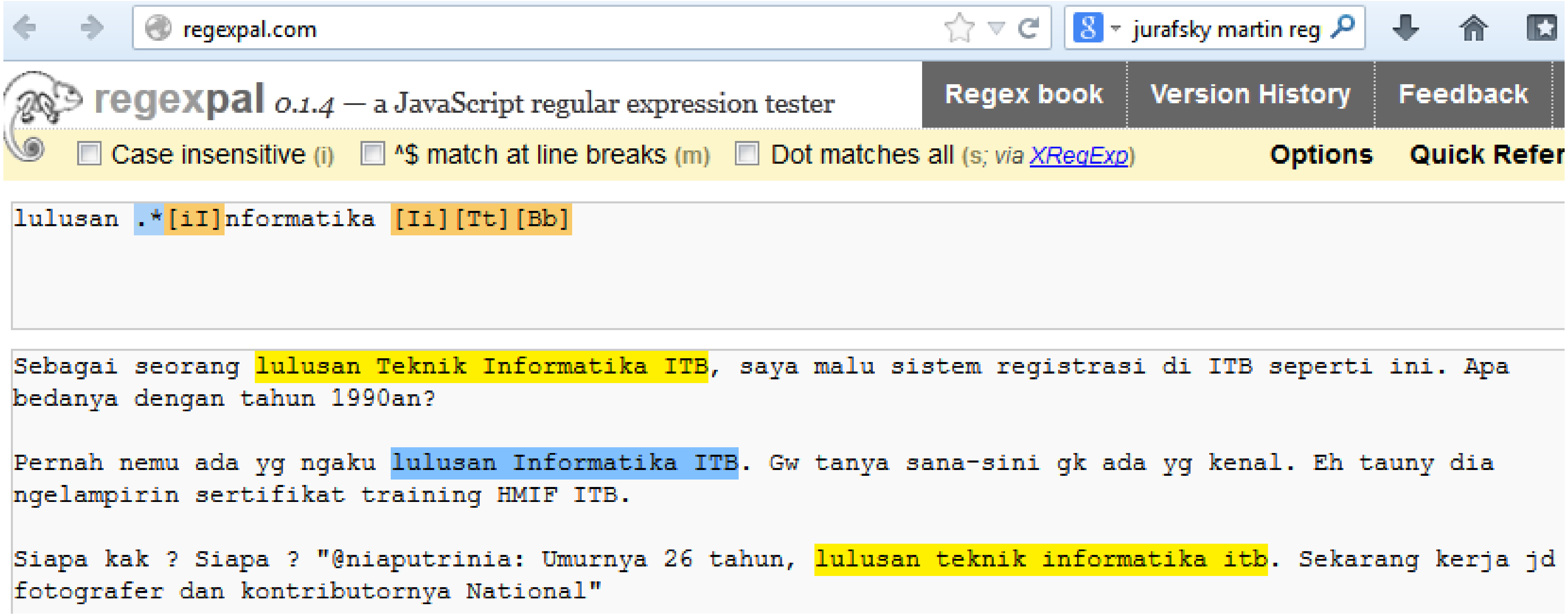
```
lulusan Informatika ITB
```

Sebagai seorang lulusan Teknik Informatika ITB, saya malu sistem registrasi di ITB seperti ini. Apa bedanya dengan tahun 1990an?

Pernah nemu ada yg ngaku lulusan Informatika ITB. Gw tanya sana-sini gk ada yg kenal. Eh tauny dia ngelampirin sertifikat training HMIF ITB.

Siapa kak ? Siapa ? "@niaputrinia: Umurnya 26 tahun, lulusan teknik informatika itb. Sekarang kerja jd fotografer dan kontributornya National"

Contoh 2: Regex Matching



☐ Case insensitive (i) ☐ ^$ match at line breaks (m) ☐ Dot matches all (s; via XRegExp)

```
lulusan .*[iI]nformatika [Ii][Tt][Bb]
```

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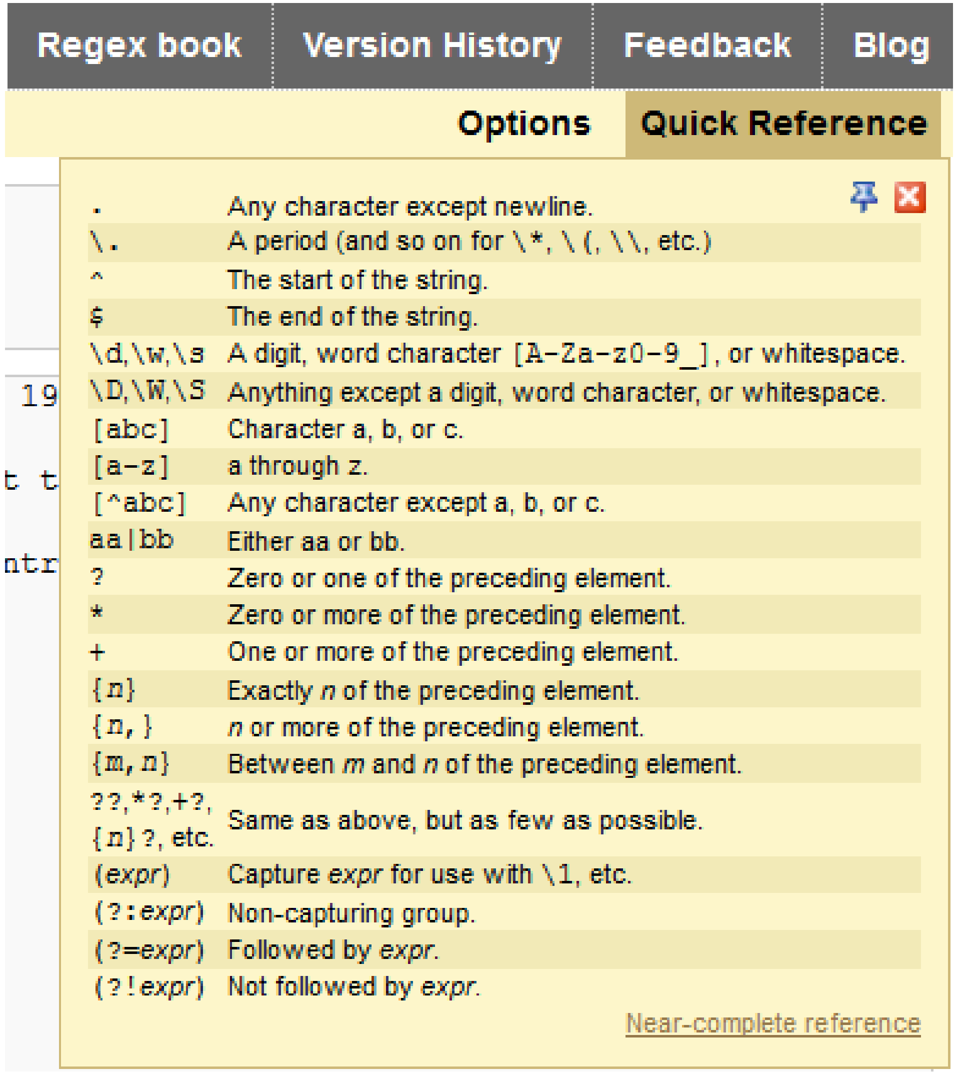
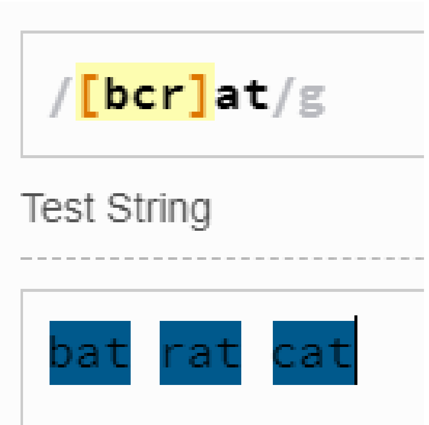
Siapa kak ? Siapa ? "@niaputrinia: Umurnya 26 tahun, lulusan teknik informatika itb. Sekarang kerja jd fotografer dan kontributornya National"

Notasi Umum Regex



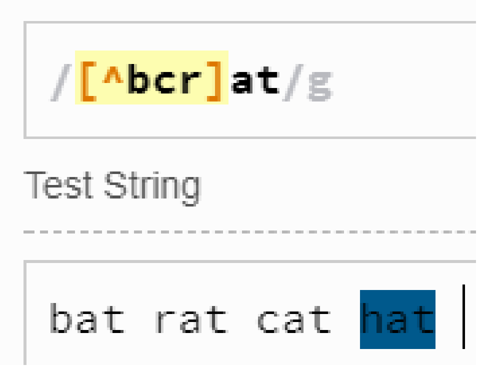
`.`	Any character except newline.
`\.`	A period (and so on for `\*`, `\(`, `\\`, etc.)
`^`	The start of the string.
`$`	The end of the string.
`\d`,`\w`,`\s`	A digit, word character `[A-Za-z0-9_]`, or whitespace.
`\D`,`\W`,`\S`	Anything except a digit, word character, or whitespace.
`[abc]`	Character a, b, or c.
`[a-z]`	a through z.
`[^abc]`	Any character except a, b, or c.
`aa|bb`	Either aa or bb.
`?`	Zero or one of the preceding element.
`*`	Zero or more of the preceding element.
`+`	One or more of the preceding element.
`{n}`	Exactly *n* of the preceding element.
`{n,}`	*n* or more of the preceding element.
`{m,n}`	Between *m* and *n* of the preceding element.
`??`,`*?`,`+?`, `{n}?`, etc.	Same as above, but as few as possible.
`(`*expr*`)`	Capture *expr* for use with `\1`, etc.
`(?:`*expr*`)`	Non-capturing group.
`(?=`*expr*`)`	Followed by *expr*.
`(?!`*expr*`)`	Not followed by *expr*.

Near-complete reference


`/[bcr]at/g`

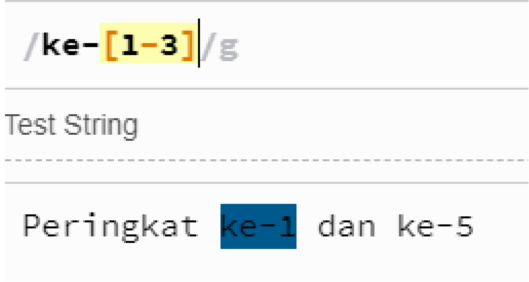
Test String

`bat rat cat`


`/[^bcr]at/g`

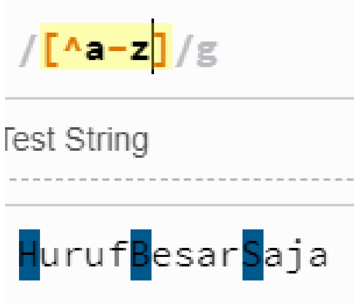
Test String

`bat rat cat hat`


`/ke-[1-3]/g`

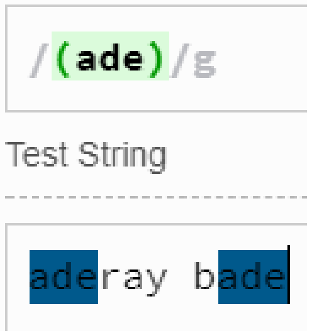
Test String

`Peringkat ke-1 dan ke-5`


`/[^a-z]/g`

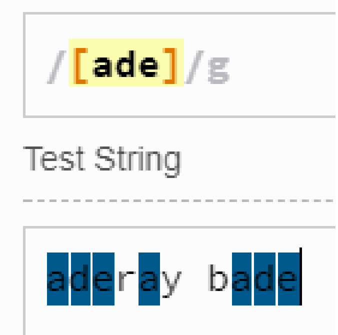
Test String

`HurufBesarSaja`


`/(ade)/g`

Test String

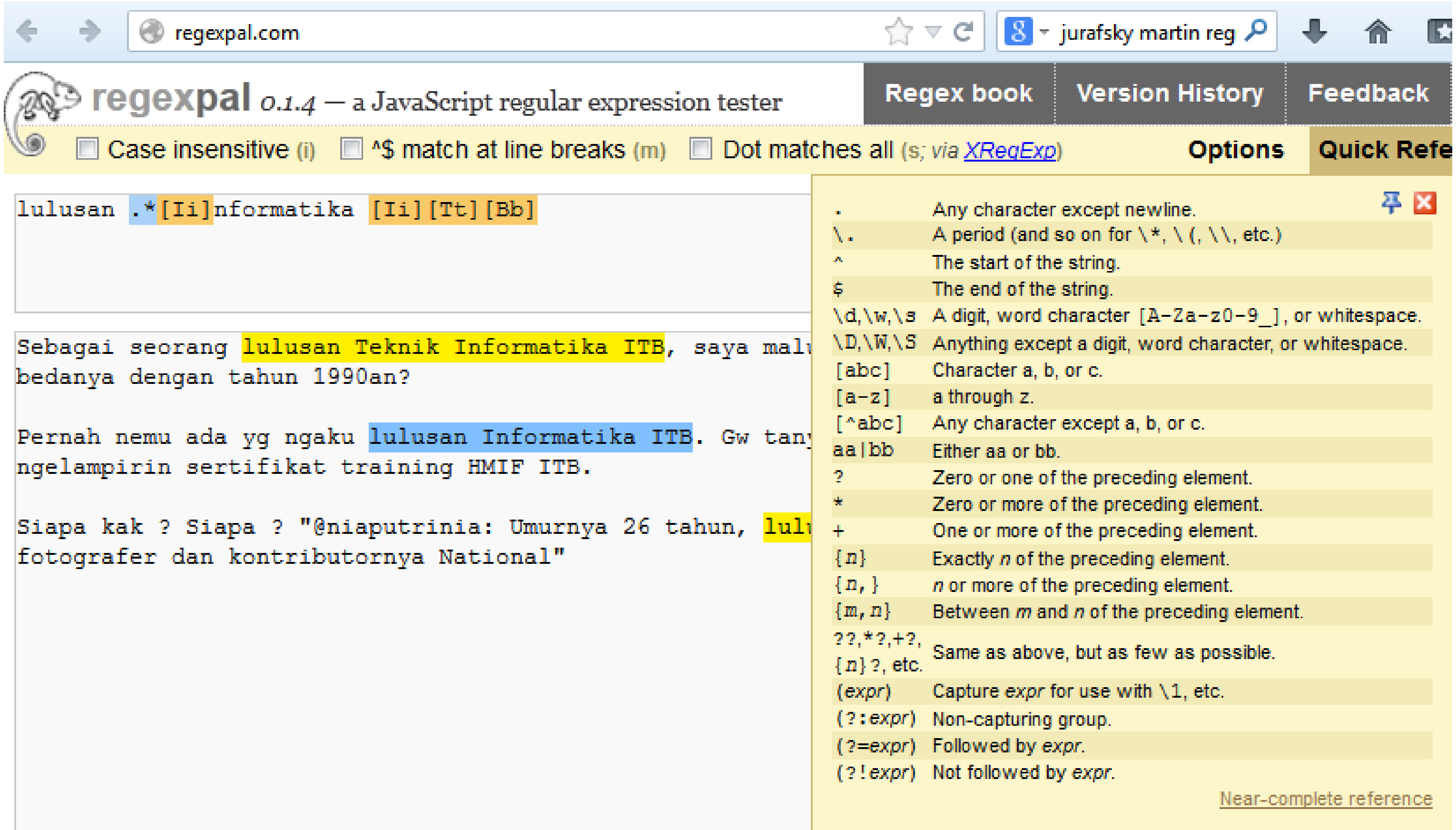
`aderay bade`


`/[ade]/g`

Test String

`aderay bade`

Contoh 2: Regex



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```
lulusan .*[Ii]nformatika [Ii][Tt][Bb]
```

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fotografer dan kontributornya National"

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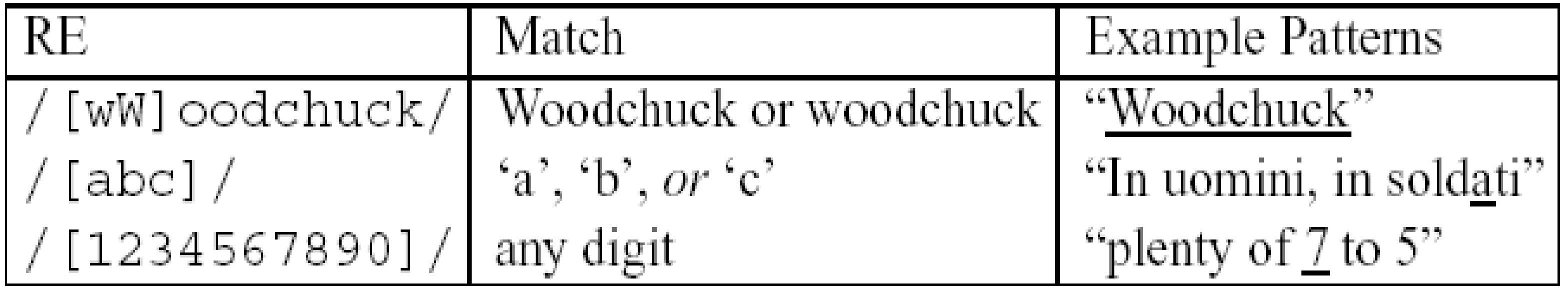
`+`	One or more of the preceding element.
`{`*n*`}`	Exactly *n* of the preceding element.
`{`*n*`,}`	*n* or more of the preceding element.
`{`*m*`,`*n*`}`	Between *m* and *n* of the preceding element.
`??`,`*?`,`+?`, `{`*n*`}?`, etc.	Same as above, but as few as possible.
`(`*expr*`)`	Capture *expr* for use with `\1`, etc.
`(?:`*expr*`)`	Non-capturing group.
`(?=`*expr*`)`	Followed by *expr*.
`(?!`*expr*`)`	Not followed by *expr*.

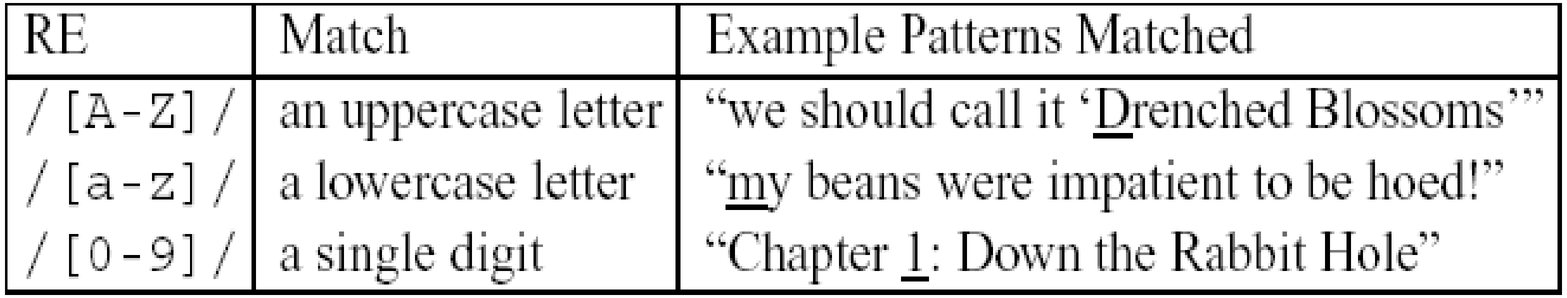
Basic Regular Expression Patterns

Brackets `[]`: `disjunction`



RE	Match	Example Patterns
`/[wW]oodchuck/`	Woodchuck or woodchuck	"Woodchuck"
`/[abc]/`	'a', 'b', *or* 'c'	"In uomini, in soldati"
`/[1234567890]/`	any digit	"plenty of 7 to 5"

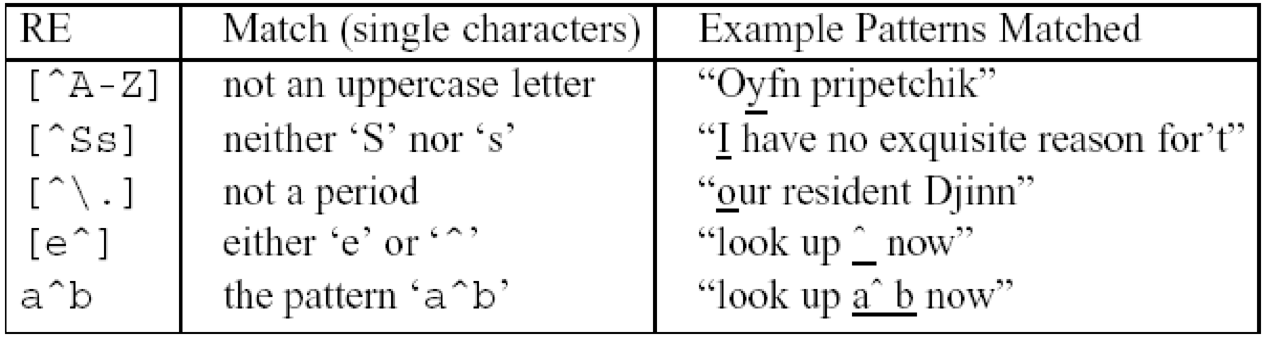
Brackets [ ] ditambah garis sambung: range



RE	Match	Example Patterns Matched
`/[A-Z]/`	an uppercase letter	"we should call it 'Drenched Blossoms'"
`/[a-z]/`	a lowercase letter	"my beans were impatient to be hoed!"
`/[0-9]/`	a single digit	"Chapter 1: Down the Rabbit Hole"

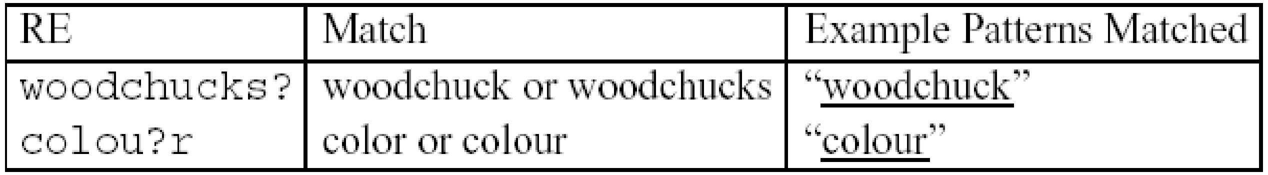
Basic Regular Expression
Patterns

- caret `^` : negasi



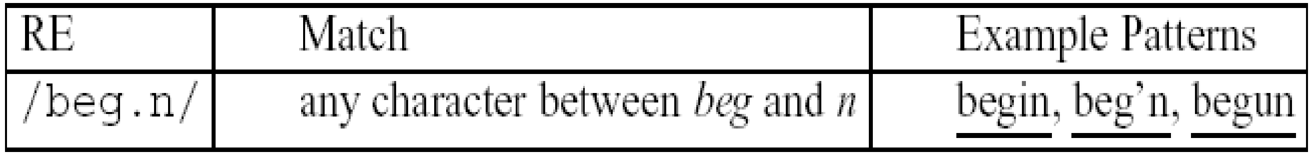
RE	Match (single characters)	Example Patterns Matched
`[^A-Z]`	not an uppercase letter	"Oyfn pripetchik"
`[^Ss]`	neither 'S' nor 's'	"I have no exquisite reason for't"
`[^\.]`	not a period	"our resident Djinn"
`[e^]`	either 'e' or '^'	"look up ^ now"
`a^b`	the pattern 'a^b'	"look up a^ b now"

- Tanda tanya `?` : bisa ada bisa tidak



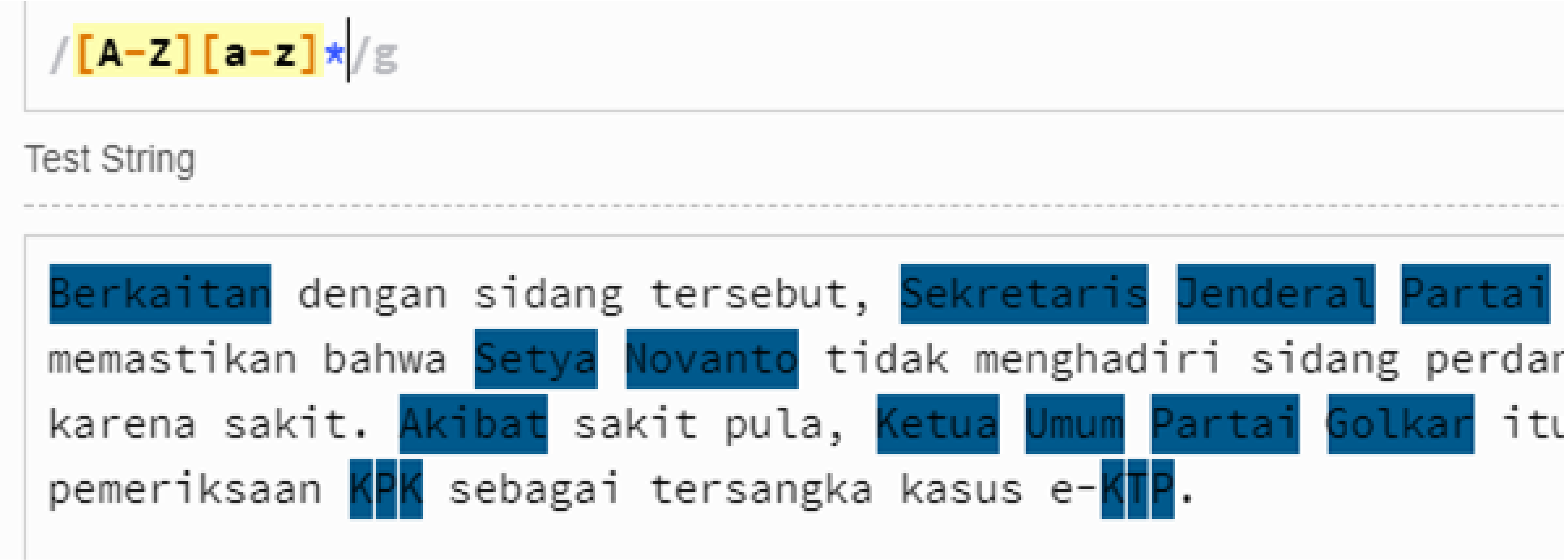
RE	Match	Example Patterns Matched
`woodchucks?`	woodchuck or woodchucks	"woodchuck"
`colou?r`	color or colour	"colour"

- Titik: `.` any character



RE	Match	Example Patterns
`/beg.n/`	any character between *beg* and *n*	begin, beg'n, begun

Regex Kata berawal Huruf Kapital



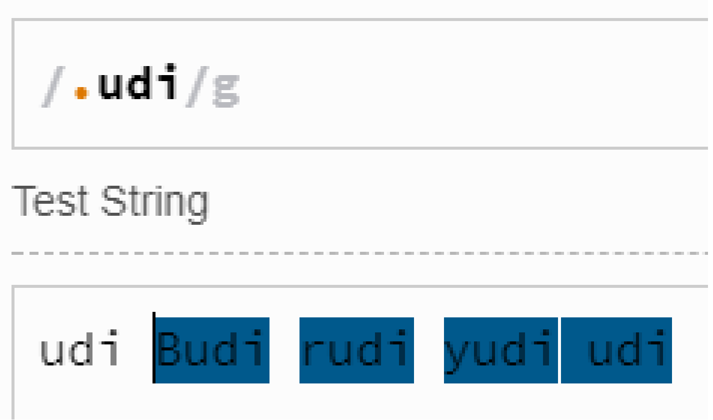
`/[A-Z][a-z]*/g`

Test String

Berkaitan dengan sidang tersebut, Sekretaris Jenderal Partai
memastikan bahwa Setya Novanto tidak menghadiri sidang perdan
karena sakit. Akibat sakit pula, Ketua Umum Partai Golkar itu
pemeriksaan KPK sebagai tersangka kasus e-KTP.

`[A-Z][a-z]*` : Alfabet huruf besar yang dilanjutkan dengan nol atau banyak huruf kecil

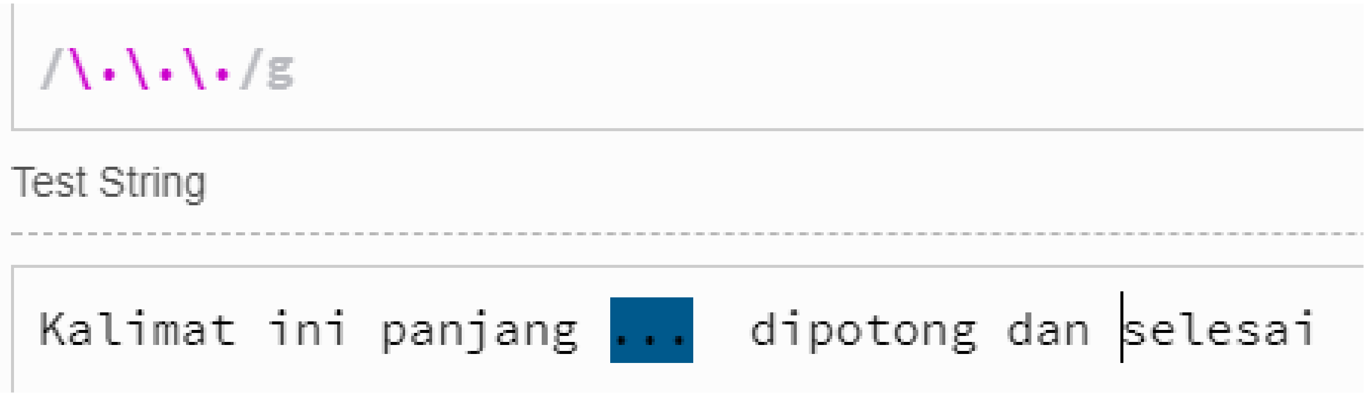
Notasi Regex: Contoh



`/.udi/g`

Test String

`udi Budi rudi yudi udi`

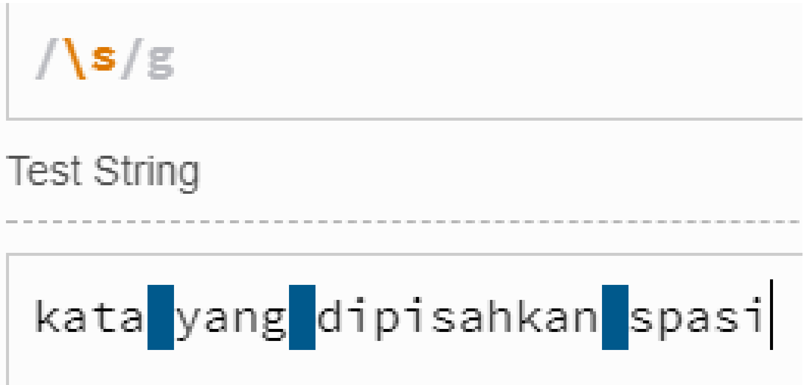


`/\.\.\./g`

Test String

`Kalimat ini panjang ... dipotong dan selesai`

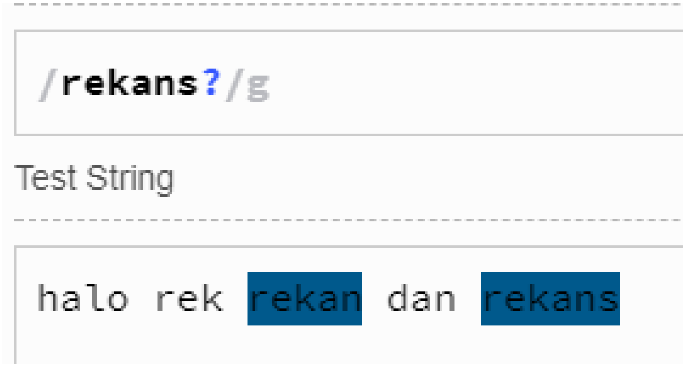
Metacharacter titik “.” menyatakan karakter apapun (kiri). Gunakanlah backslash ‘\’ untuk metacharacter.



`/\s/g`

Test String

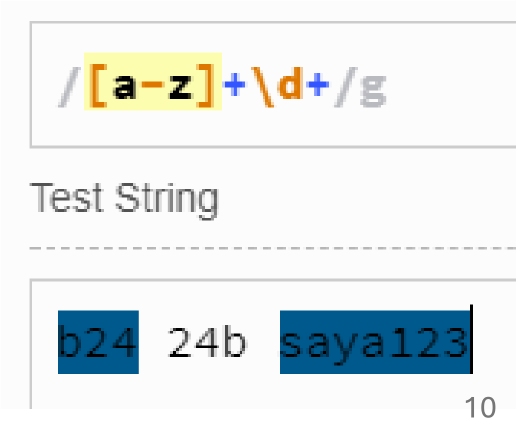
`kata yang dipisahkan spasi`



`/rekans?/g`

Test String

`halo rek rekan dan rekans`

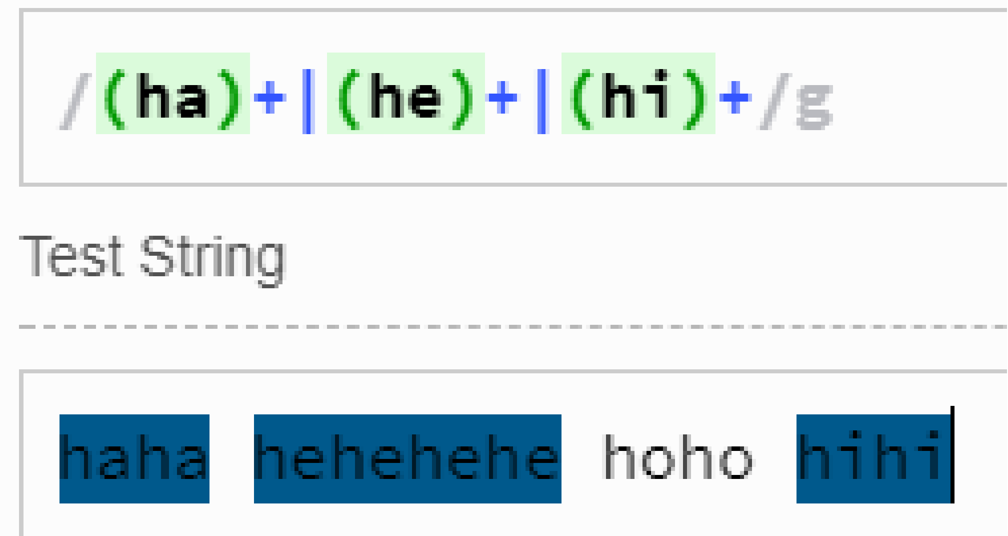


`/[a-z]+\d+/g`

Test String

`b24 24b saya123`

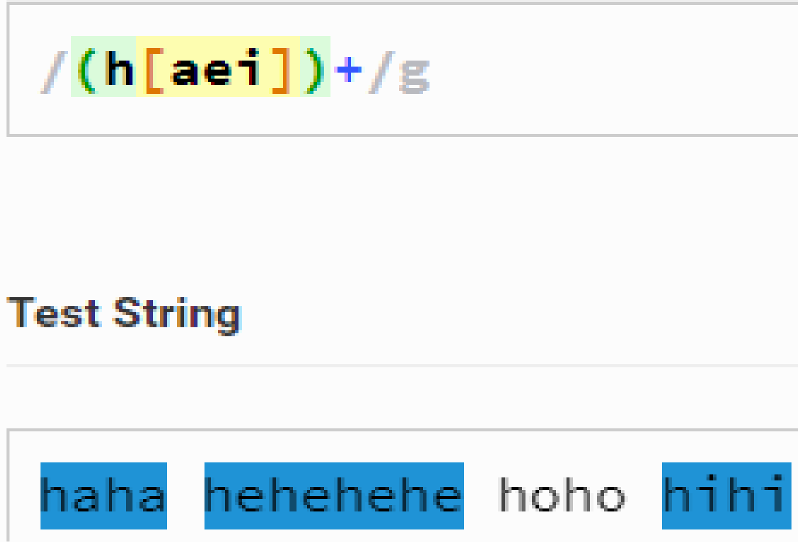
Notasi Regex: Contoh



```
/(ha)+|(he)+|(hi)+/g
```

Test String

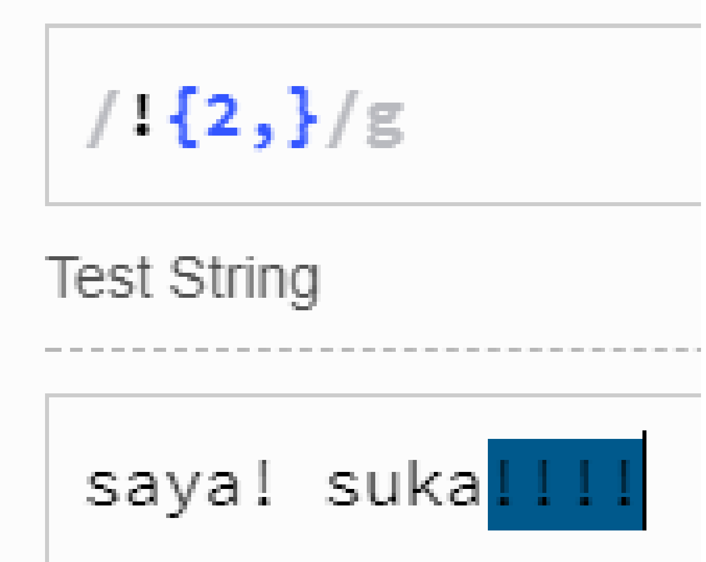
```
haha hehehehe hoho hihi
```



```
/(h[aei])+/g
```

Test String

```
haha hehehehe hoho hihi
```

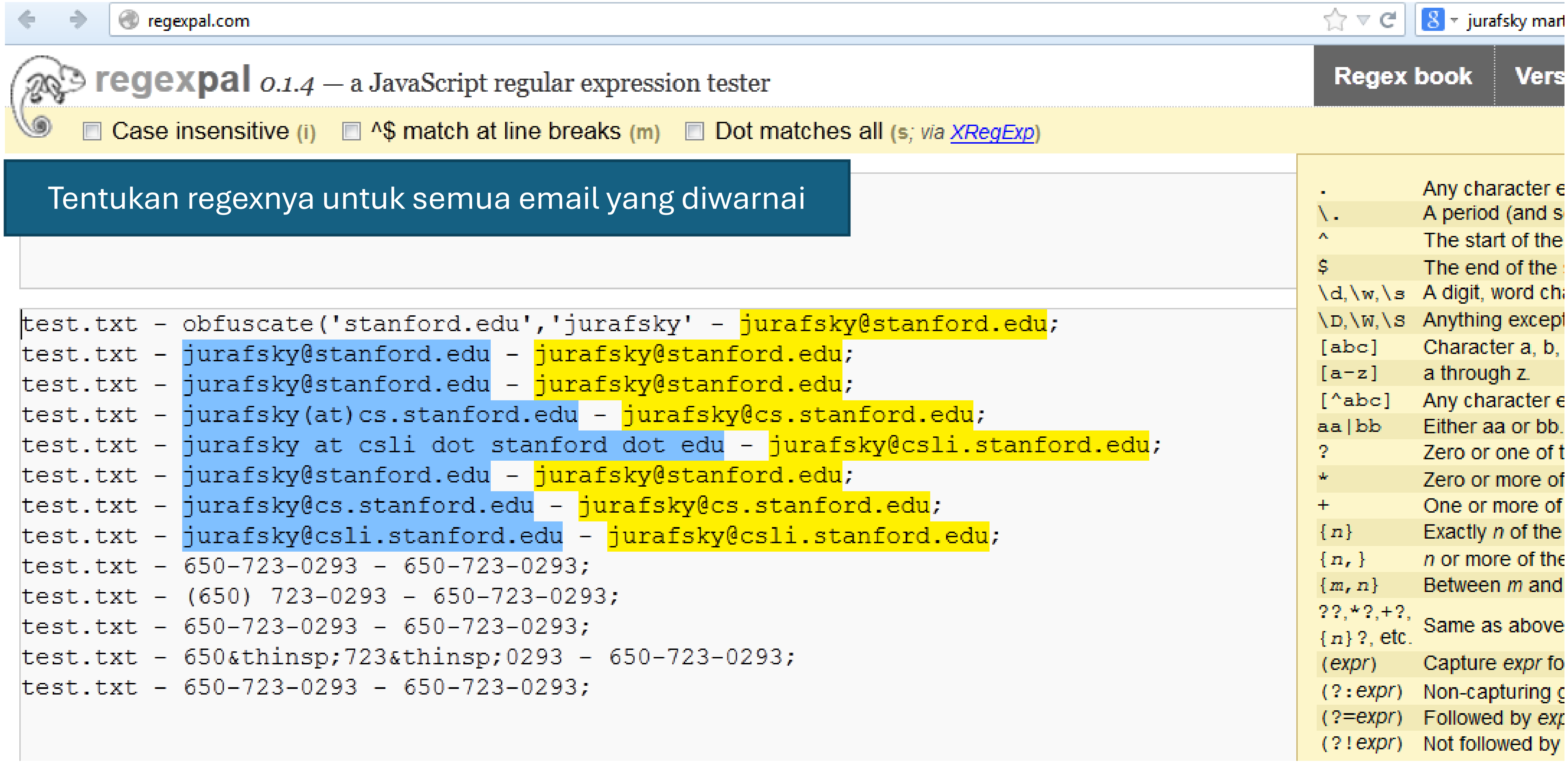


```
/!{2,}/g
```

Test String

```
saya! suka!!!!
```

Contoh 3: Regex for Email



Tentukan regexnya untuk semua email yang diwarnai

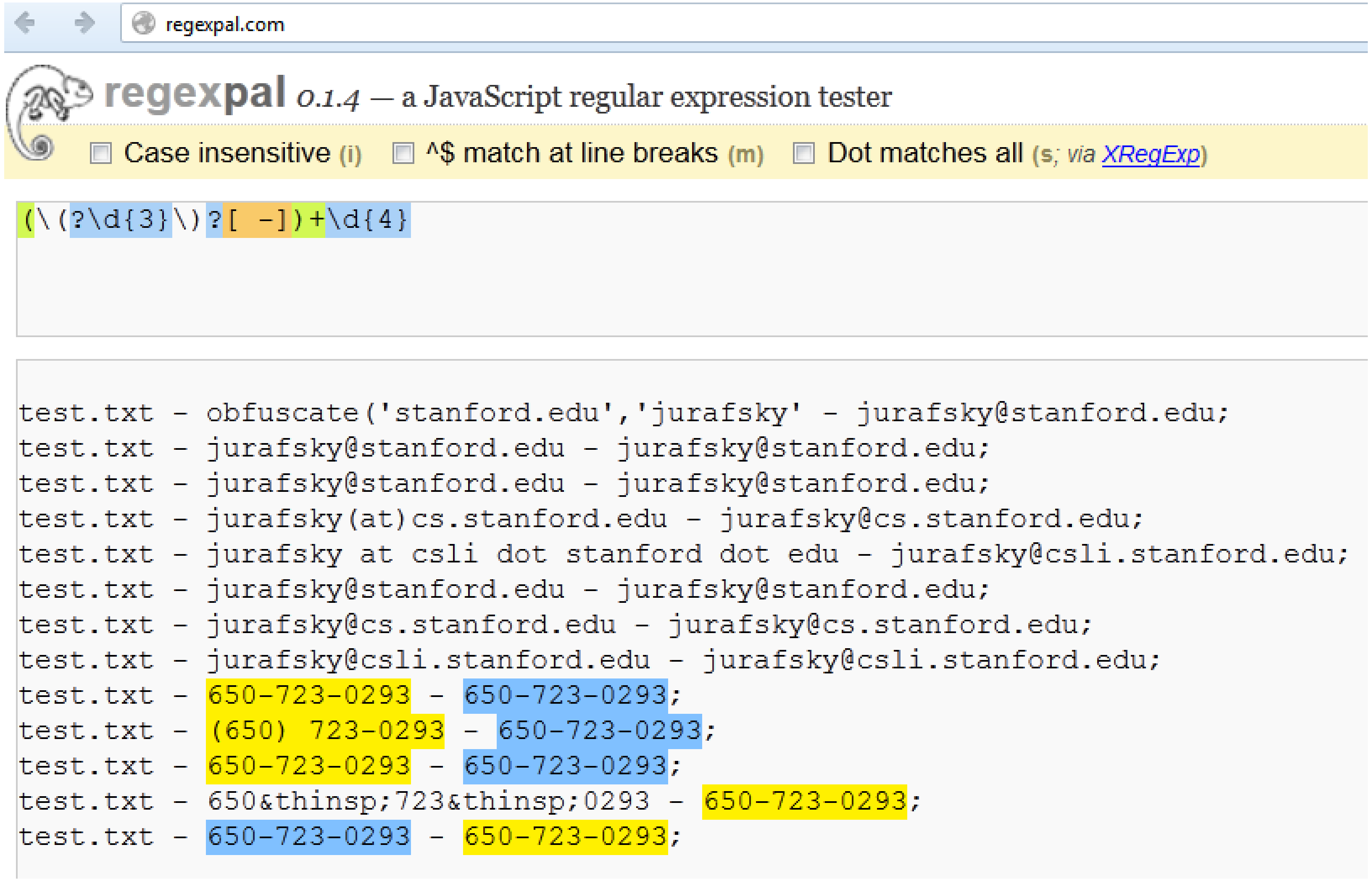
regexpal *0.1.4* — a JavaScript regular expression tester

☐ Case insensitive (i) ☐ ^$ match at line breaks (m) ☐ Dot matches all (s; via XRegExp)

```
test.txt - obfuscate('stanford.edu','jurafsky' - jurafsky@stanford.edu;
test.txt - jurafsky@stanford.edu - jurafsky@stanford.edu;
test.txt - jurafsky@stanford.edu - jurafsky@stanford.edu;
test.txt - jurafsky(at)cs.stanford.edu - jurafsky@cs.stanford.edu;
test.txt - jurafsky at csli dot stanford dot edu - jurafsky@csli.stanford.edu;
test.txt - jurafsky@stanford.edu - jurafsky@stanford.edu;
test.txt - jurafsky@cs.stanford.edu - jurafsky@cs.stanford.edu;
test.txt - jurafsky@csli.stanford.edu - jurafsky@csli.stanford.edu;
test.txt - 650-723-0293 - 650-723-0293;
test.txt - (650) 723-0293 - 650-723-0293;
test.txt - 650-723-0293 - 650-723-0293;
test.txt - 650&thinsp;723&thinsp;0293 - 650-723-0293;
test.txt - 650-723-0293 - 650-723-0293;
```

.	Any character e
\.	A period (and s
^	The start of the
$	The end of the
\d,\w,\s	A digit, word cha
\D,\W,\S	Anything except
[abc]	Character a, b,
[a-z]	a through z.
[^abc]	Any character e
aa|bb	Either aa or bb.
?	Zero or one of t
*	Zero or more of
+	One or more of
{*n*}	Exactly *n* of the
{*n*,}	*n* or more of the
{*m*,*n*}	Between *m* and
??,*?,+?, {*n*}?, etc.	Same as above
(*expr*)	Capture *expr* fo
(?:*expr*)	Non-capturing g
(?=*expr*)	Followed by *exp*
(?!*expr*)	Not followed by

Contoh 4: Regex for Phone Number



regexpal *0.1.4* — a JavaScript regular expression tester

☐ Case insensitive (i) ☐ ^$ match at line breaks (m) ☐ Dot matches all (s; *via* XRegExp)

```
(\(?\d{3}\)?[ -])+\d{4}
```

```
test.txt - obfuscate('stanford.edu','jurafsky' - jurafsky@stanford.edu;
test.txt - jurafsky@stanford.edu - jurafsky@stanford.edu;
test.txt - jurafsky@stanford.edu - jurafsky@stanford.edu;
test.txt - jurafsky(at)cs.stanford.edu - jurafsky@cs.stanford.edu;
test.txt - jurafsky at csli dot stanford dot edu - jurafsky@csli.stanford.edu;
test.txt - jurafsky@stanford.edu - jurafsky@stanford.edu;
test.txt - jurafsky@cs.stanford.edu - jurafsky@cs.stanford.edu;
test.txt - jurafsky@csli.stanford.edu - jurafsky@csli.stanford.edu;
test.txt - 650-723-0293 - 650-723-0293;
test.txt - (650) 723-0293 - 650-723-0293;
test.txt - 650-723-0293 - 650-723-0293;
test.txt - 650&thinsp;723&thinsp;0293 - 650-723-0293;
test.txt - 650-723-0293 - 650-723-0293;
```

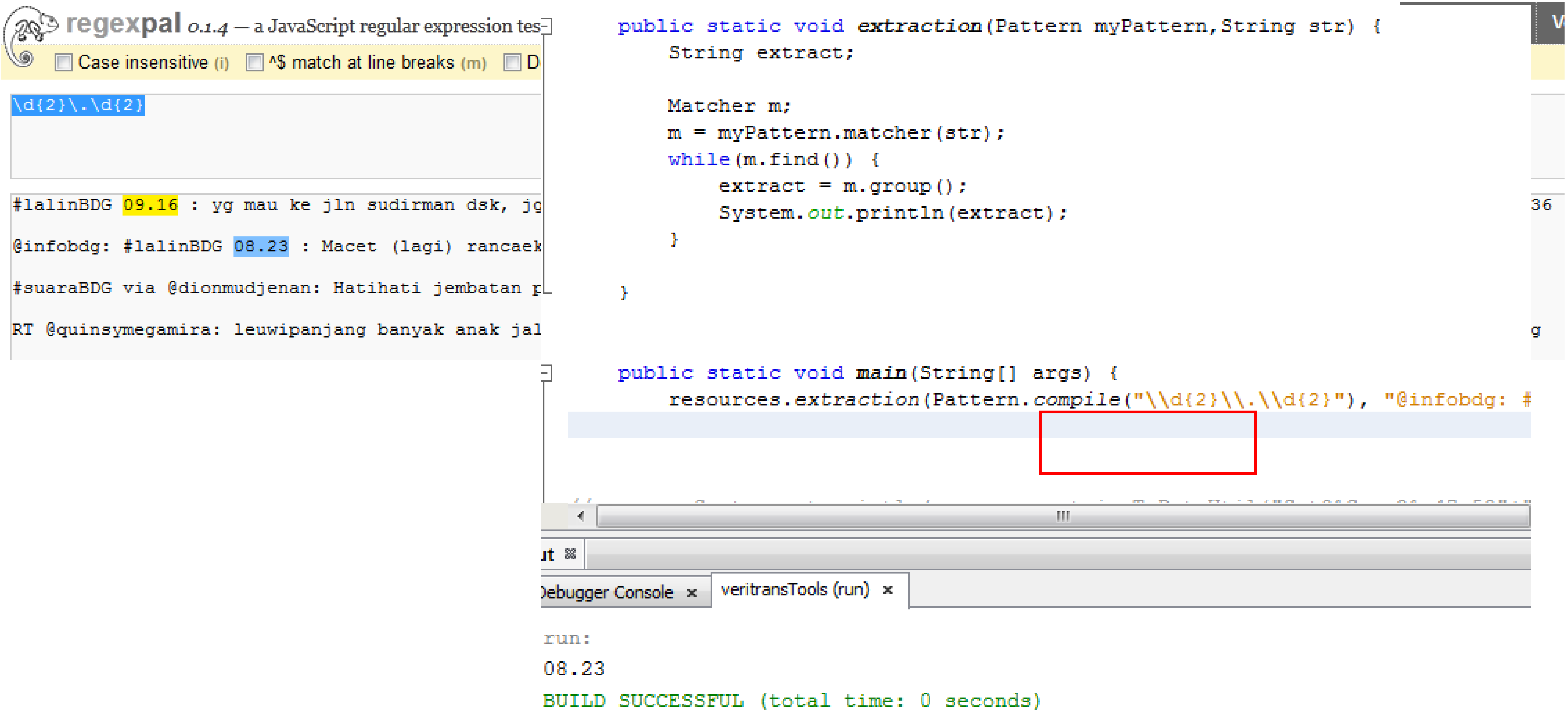
Knowledge check Regex

Pelajarilah modul regex:
https://docs.google.com/document/d/1ls6h1A6m-Zhzw6e5eriwMNUAG0D1iwL-eVmVMS2XQoc/edit?usp=sharing

Kerjakanlah Latihan 1-3 secara mandiri (tidak dikumpulkan).

Untuk Latihan 4, gunakanlah https://www.regexpal.com/ (tidak dikumpulkan)

Regex di dalam Bahasa Java



regexpal 0.1.4 — a JavaScript regular expression tes
☐ Case insensitive (i) ☐ ^$ match at line breaks (m) ☐ D

```
\d{2}\.\d{2}
```

```
#lalinBDG 09.16 : yg mau ke jln sudirman dsk, jg

@infobdg: #lalinBDG 08.23 : Macet (lagi) rancaek

#suaraBDG via @dionmudjenan: Hatihati jembatan p

RT @quinsymegamira: leuwipanjang banyak anak jal
```

```java
public static void extraction(Pattern myPattern,String str) {
    String extract;

    Matcher m;
    m = myPattern.matcher(str);
    while(m.find()) {
        extract = m.group();
        System.out.println(extract);
    }

}


public static void main(String[] args) {
    resources.extraction(Pattern.compile("\\d{2}\\.\\d{2}"), "@infobdg: #
```

```
run:
08.23
BUILD SUCCESSFUL (total time: 0 seconds)
```

Regex using Python

- re.**compile**(*pattern*, *flags=0*)
  Compile a regular expression pattern into a regular expression object, which can be used for matching using its match(), search() and other methods, described below.

- pattern.**search**(*string*[, *pos*[, *endpos*]])
  Scan through *string* looking for the **first location** where this regular expression produces a match, and return a corresponding match object. Return None if no position in the string matches the pattern; note that this is different from finding a zero-length match at some point in the string.
  The optional second parameter *pos* gives an index in the string where the search is to start; it defaults to 0.
  The optional parameter *endpos* limits how far the string will be searched;

https://docs.python.org/3/library/re.html

Regex using Python

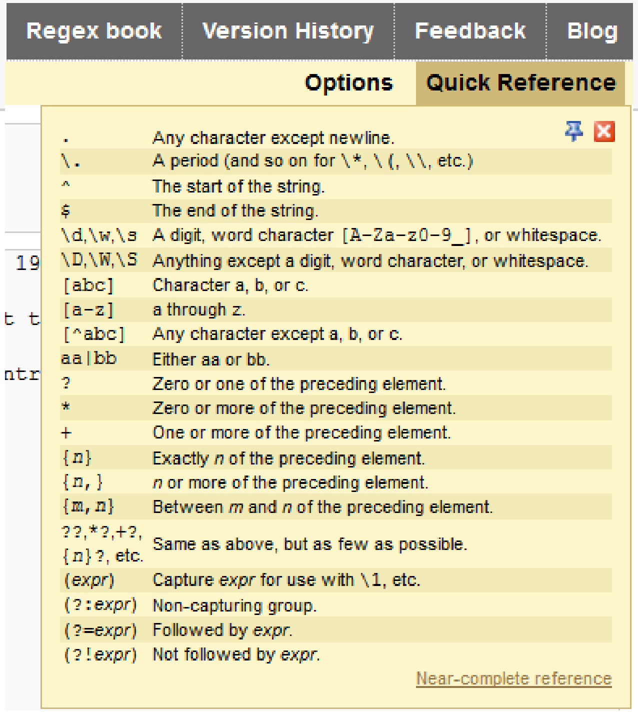
```
import re

#Compile a regular expression pattern into a regular expression object
pattern = re.compile(r"(\d{4})")

#Scan through str looking for 1st loc where this regex produces a match,
#and return a corresponding match object.
pattern.search("17 Agustus 1945 - 2022")
```

```
<re.Match object; span=(11, 15), match='1945'>
```

\d{4}: digit characters exactly 4 characters



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`^`	The start of the string.
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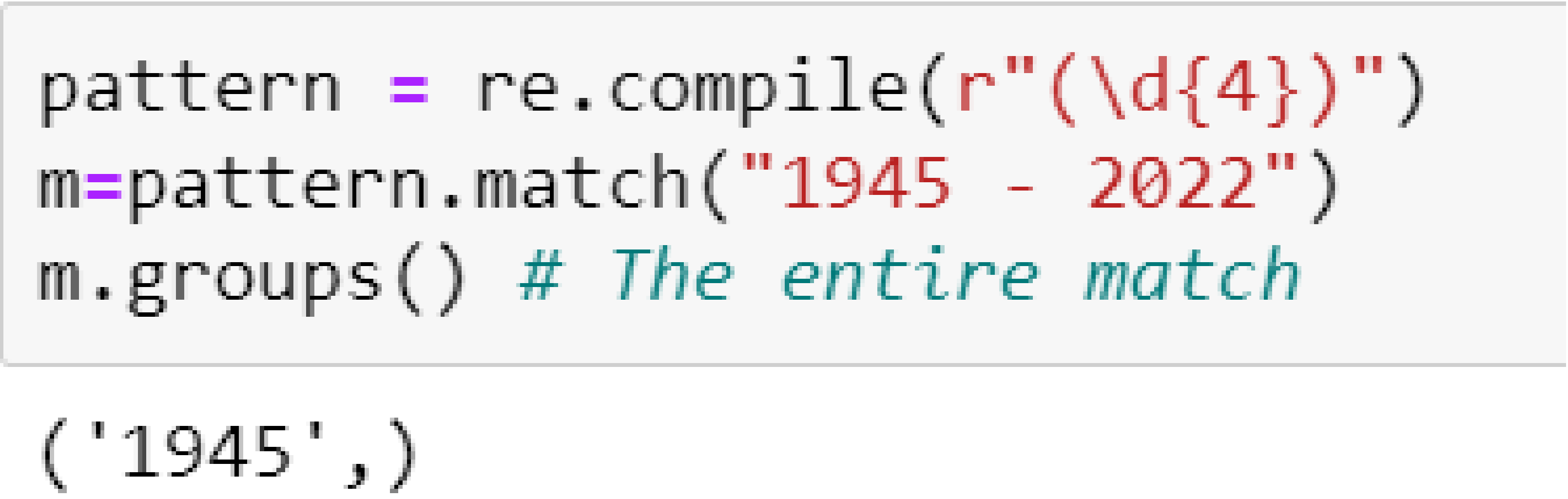
??,*?,+?, {*n*}?, etc.	Same as above, but as few as possible.
(*expr*)	Capture *expr* for use with \1, etc.
(?:*expr*)	Non-capturing group.
(?=*expr*)	Followed by *expr*.
(?!*expr*)	Not followed by *expr*.

Regex using Python

- pattern.**match**(*string*[, *pos*[, *endpos*]])
  If zero or more characters at the **beginning of str** match this regular expression, return a corresponding match object. Return None if the string does not match the pattern; note that this is different from a zero-length match.

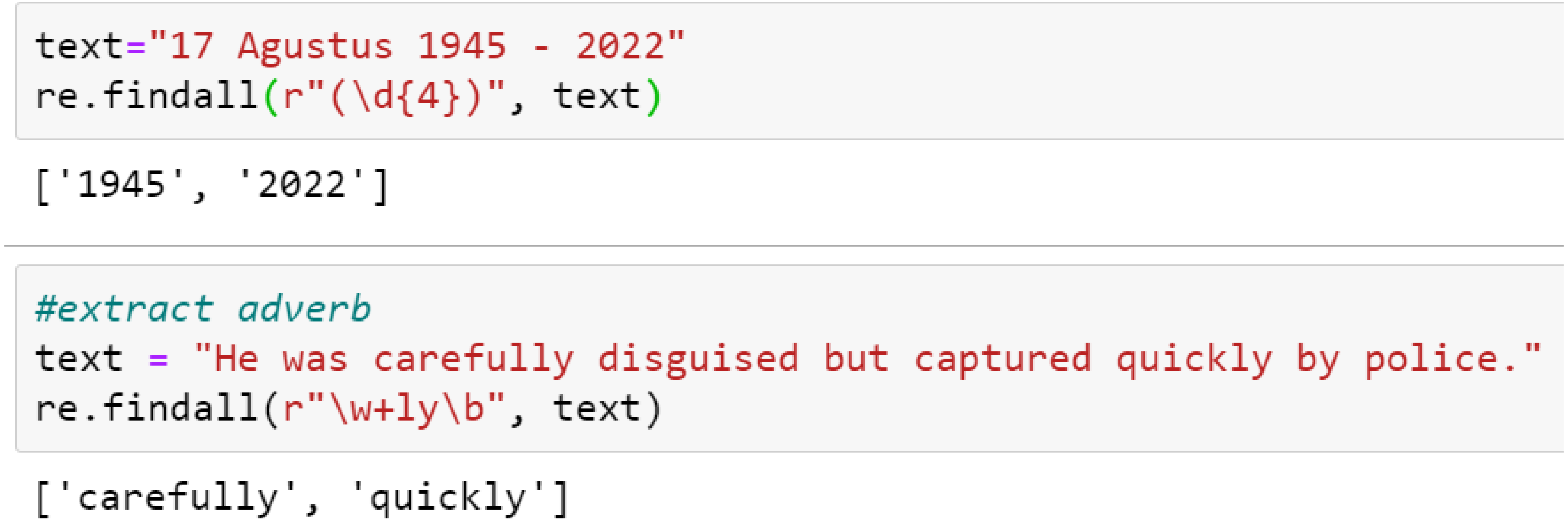


```
pattern = re.compile(r"(\d{4})")
m=pattern.match("1945 - 2022")
m.groups() # The entire match
```

```
('1945',)
```

Regex using Python

- re.findall(*pattern*, *string*, *flags=0*)
  Return all non-overlapping matches of *pattern* in *string*, as a **list of strings or tuples**. The *string* is scanned left-to-right, and matches are returned in the order found. Empty matches are included in the result.



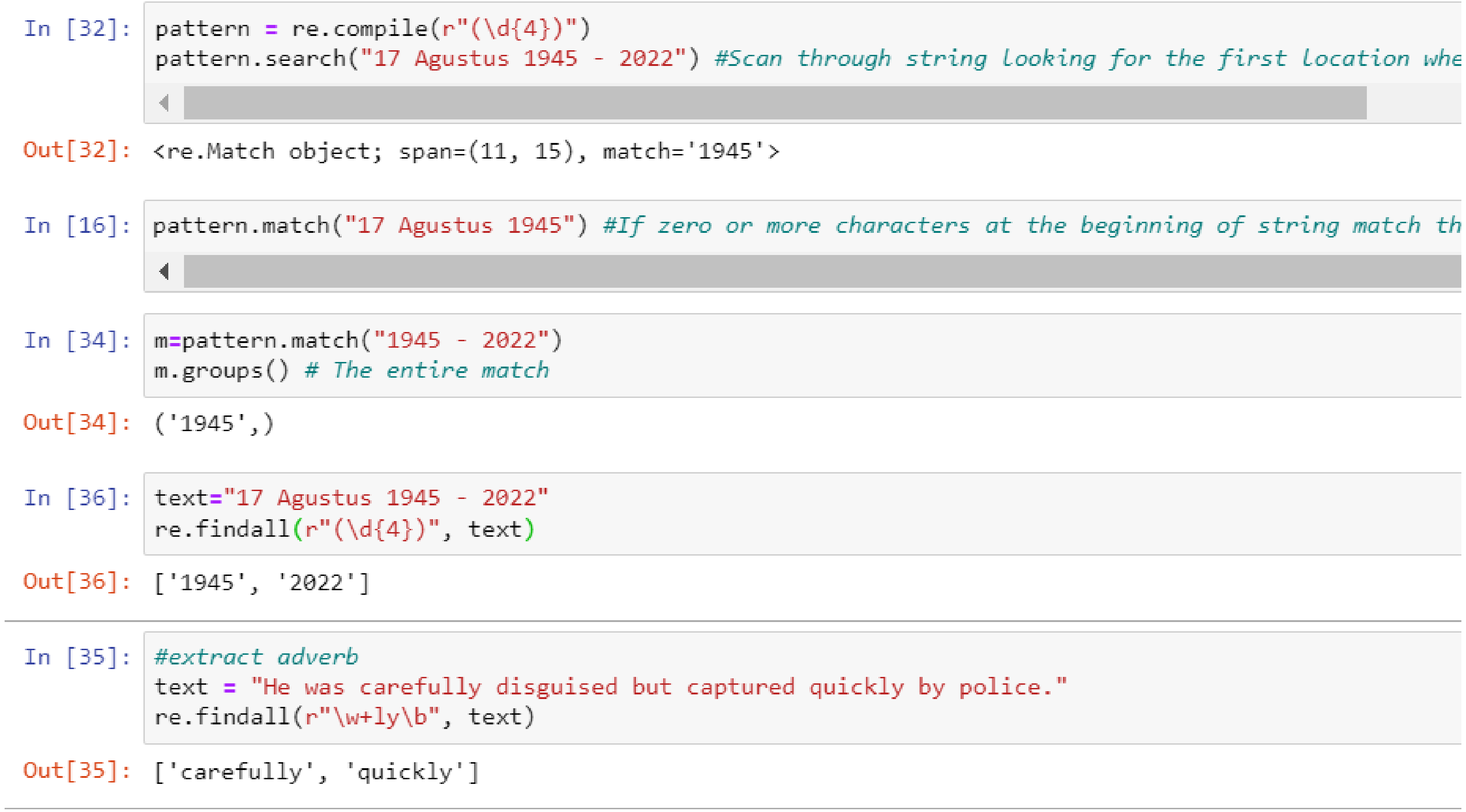
```
text="17 Agustus 1945 - 2022"
re.findall(r"(\d{4})", text)
```

```
['1945', '2022']
```

```
#extract adverb
text = "He was carefully disguised but captured quickly by police."
re.findall(r"\w+ly\b", text)
```

```
['carefully', 'quickly']
```

Regex using Python



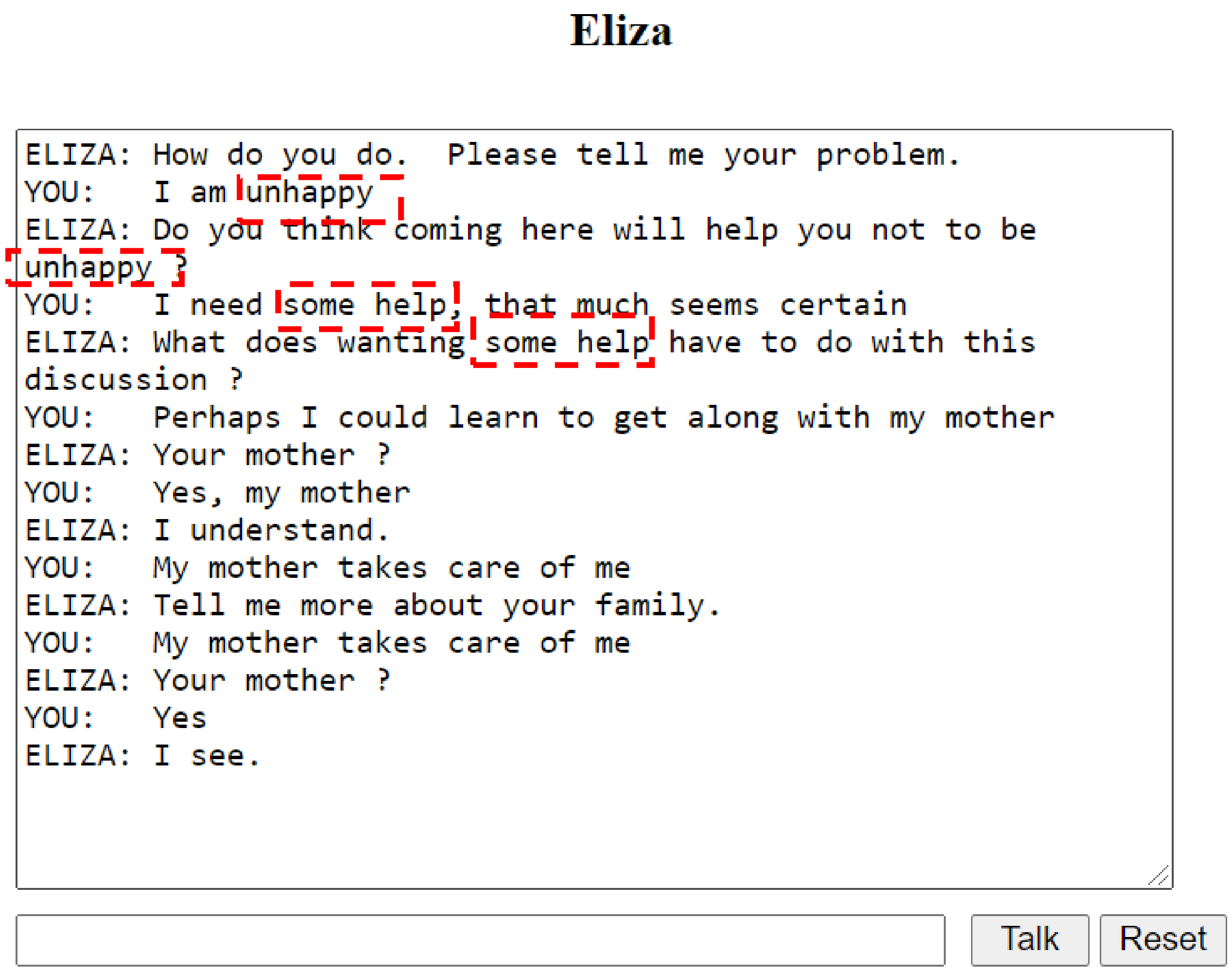
```
In [32]: pattern = re.compile(r"(\d{4})")
         pattern.search("17 Agustus 1945 - 2022") #Scan through string looking for the first location whe

Out[32]: <re.Match object; span=(11, 15), match='1945'>

In [16]: pattern.match("17 Agustus 1945") #If zero or more characters at the beginning of string match th

In [34]: m=pattern.match("1945 - 2022")
         m.groups() # The entire match

Out[34]: ('1945',)

In [36]: text="17 Agustus 1945 - 2022"
         re.findall(r"(\d{4})", text)

Out[36]: ['1945', '2022']

In [35]: #extract adverb
         text = "He was carefully disguised but captured quickly by police."
         re.findall(r"\w+ly\b", text)

Out[35]: ['carefully', 'quickly']
```

https://docs.python.org/3/library/re.html

Baca: https://www.guru99.com/python-regular-expressions-complete-tutorial.html

Eliza, simple pattern-based chatbot

ELIZA uses **pattern matching** to recognize phrases like “I need X” and translate them into suitable outputs like “What does wanting X have to do with this discussion ?” “What would it mean to you if you got X?”.

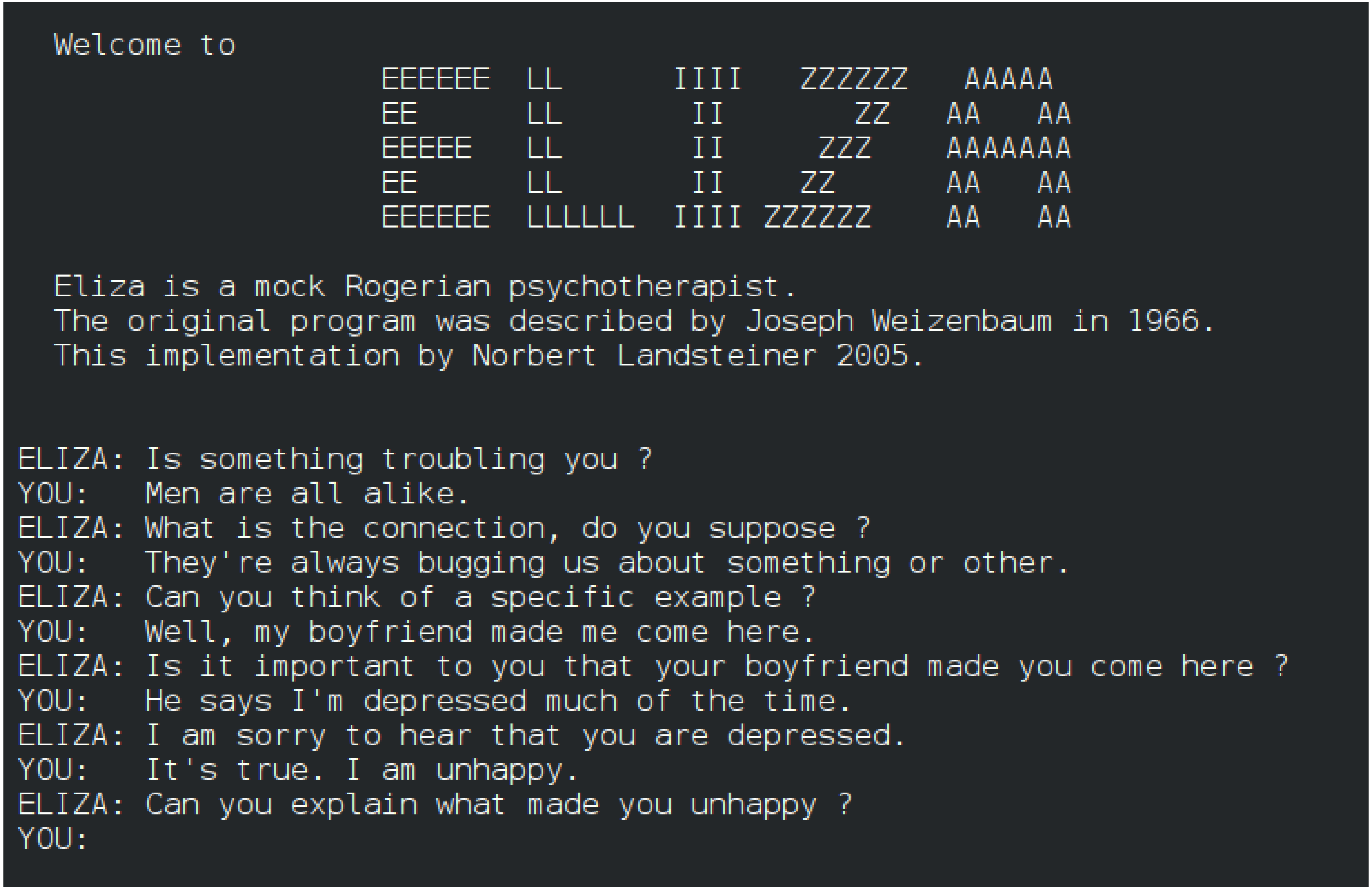


Eliza

```
ELIZA: How do you do.  Please tell me your problem.
YOU:   I am unhappy
ELIZA: Do you think coming here will help you not to be
unhappy ?
YOU:   I need some help, that much seems certain
ELIZA: What does wanting some help have to do with this
discussion ?
YOU:   Perhaps I could learn to get along with my mother
ELIZA: Your mother ?
YOU:   Yes, my mother
ELIZA: I understand.
YOU:   My mother takes care of me
ELIZA: Tell me more about your family.
YOU:   My mother takes care of me
ELIZA: Your mother ?
YOU:   Yes
ELIZA: I see.
```

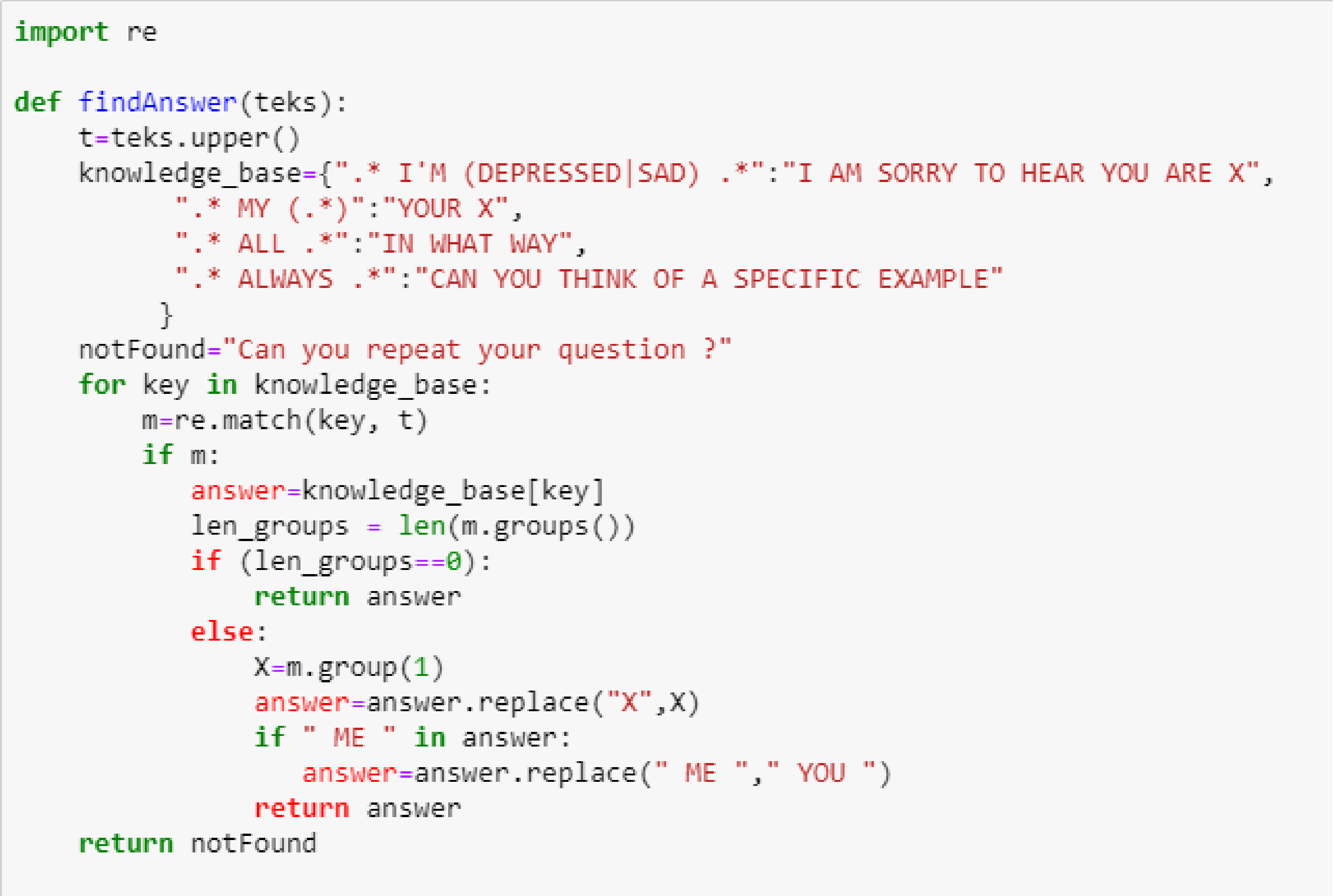
https://www.masswerk.at/elizabot/
http://psych.fullerton.edu/mbirnbaum/psych101/eliza.htm

Weizenbaum, J. (1966). ELIZA—a computer program for the study of natural language communication between man and machine. *Communications of the ACM*, *9*(1), 36-45.

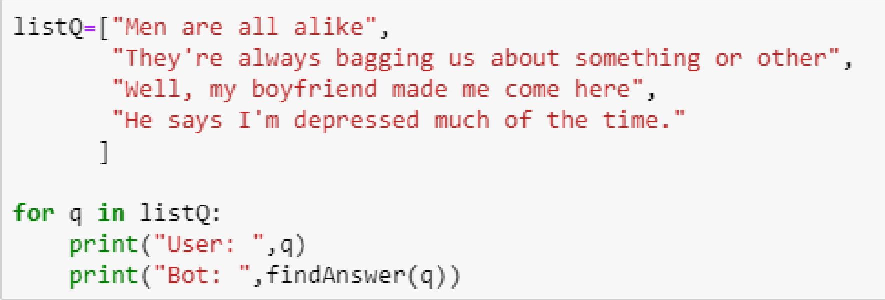


```
  Welcome to
                    EEEEEE  LL      IIII   ZZZZZZ   AAAAA
                    EE      LL       II       ZZ   AA   AA
                    EEEEE   LL       II     ZZZ    AAAAAAA
                    EE      LL       II    ZZ      AA   AA
                    EEEEEE  LLLLLL  IIII ZZZZZZ    AA   AA

  Eliza is a mock Rogerian psychotherapist.
  The original program was described by Joseph Weizenbaum in 1966.
  This implementation by Norbert Landsteiner 2005.


ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```

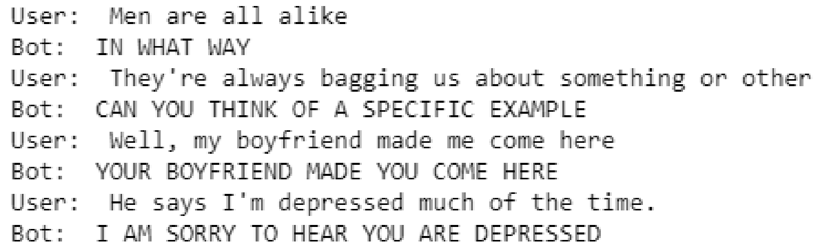
Eliza-like Chatbot using Regex



```python
import re

def findAnswer(teks):
    t=teks.upper()
    knowledge_base={".* I'M (DEPRESSED|SAD) .*":"I AM SORRY TO HEAR YOU ARE X",
          ".* MY (.*)":"YOUR X",
          ".* ALL .*":"IN WHAT WAY",
          ".* ALWAYS .*":"CAN YOU THINK OF A SPECIFIC EXAMPLE"
         }
    notFound="Can you repeat your question ?"
    for key in knowledge_base:
        m=re.match(key, t)
        if m:
            answer=knowledge_base[key]
            len_groups = len(m.groups())
            if (len_groups==0):
                return answer
            else:
                X=m.group(1)
                answer=answer.replace("X",X)
                if " ME " in answer:
                    answer=answer.replace(" ME "," YOU ")
                return answer
    return notFound
```



```python
listQ=["Men are all alike",
       "They're always bagging us about something or other",
       "Well, my boyfriend made me come here",
       "He says I'm depressed much of the time."
      ]

for q in listQ:
    print("User: ",q)
    print("Bot: ",findAnswer(q))
```



```
User:  Men are all alike
Bot:  IN WHAT WAY
User:  They're always bagging us about something or other
Bot:  CAN YOU THINK OF A SPECIFIC EXAMPLE
User:  Well, my boyfriend made me come here
Bot:  YOUR BOYFRIEND MADE YOU COME HERE
User:  He says I'm depressed much of the time.
Bot:  I AM SORRY TO HEAR YOU ARE DEPRESSED
```