Regex 101

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Regular expressions are:

patterns (e.g. like `kopytko`, `\w+` or `[^qwe](\d\w+)\s{3}`)

used to match character combinations...

...in strings (like in "look for `Mary` in *Mary had a little lamb...*")

RegExps are implemented in most programming languages

- Ruby (RegExp class, https://ruby-doc.org/core-2.7.1/Regexp.html)

```
foo = "faczynski ma malego kiutka"
foo =~ /iutka/
```

- Java

```
String str = "some string";
if (str.matches("^string")) { ... }
```

- JavaScript

```
'^some'.test("some string")
'^some'.exec("some string")
```

RegExp are commonly implemented in most programming languages

- Python

```
import re
re.search('^some', "some string")
```

- Rust

```
use regex::Regex;
Regex::new("^some").unwrap().is_match("some string")
```

Example in Ruby

ruby-doc.org/core-2.7.1/Regexp.html

Excerpt from the docs:

```
/hay/ =~ 'haystack'   #=> 0
/y/.match('haystack') #=> #<MatchData "y">
```

If a string contains the pattern it is said to match. A literal string matches itself.

Here 'haystack' does not contain the pattern 'needle', so it doesn't match:

```
/needle/.match('haystack') #=> nil
```

Here 'haystack' contains the pattern 'hay', so it matches:

```
/hay/.match('haystack')    #=> #<MatchData "hay">
```

What they can be used for?

- **validation** (e.g. check if a user input is well-formed or meets the defined criteria)
- **parsing** (e.g. to catch all URL parameters, capture text, etc.)
- **data scraping** (like in *web scraping*, find all pages that contain a certain set of keywords)
- **string replacement** (e.g. when coding - to rename a method or a variable)
- other **transformations** (e.g. to translate one form of text, like application output, to another)

Syntax: character classes

`.` matches *any* character

`\d` matches a single character that is a digit

`\w` matches a word character (alphanumeric character plus underscore)

`\s` matches a whitespace character (includes tabs and line breaks)

Negations:

`\D` is the negation of `\d`
`\W` is the negation of `\w`
`\S` is the negation of `\s`

Syntax: quantifiers (`*` , `+` , `?` and `{}`)

`abc*` matches a string that has `ab` followed by zero or more `c` 's

`abc+` matches a string that has `ab` followed by one or more `c` 's

`abc?` matches a string that has `ab` followed by zero or one `c` 's

`abc{2}` matches a string that has `ab` followed by 2 `c` 's

`abc{2,}` matches a string that has `ab` followed by 2 or more `c` 's

`abc{2,5}` matches a string that has `ab` followed by 2 up to 5 `c` 's

`a(bc)*` matches a string that has `a` followed by zero or more copies of the sequence `bc`

`a(bc){2,5}` matches a string that has `a` followed by 2 up to 5 copies of the sequence `bc`

Syntax: anchors (`^` and `$`)

`^The` matches any string that starts with `The`

`end$` matches a string that ends with `end`

`^The end$` exact string match (starts and ends with `The end`)

`roar` matches any string that has the text `roar` in it

Syntax: *or* operator (| or []), negation operator

`a(b|c)` matches a string that has `a` followed by `b` or `c` (and captures `b` or `c`)

`a[bc]` same as previous, but without capturing `b` or `c`

Example usages:

`[abc]` matches a string that has either an `a` or a `b` or a `c` -> is the same as `a|b|c`

`[a-c]` same as previous, but with range operator `-`

`[a-fA-F0-9]` a string that represents a single hexadecimal digit, case insensitively

`[0-9]%` a string that has a character from `0` to `9` before a `%` sign

Negation operator:
`[^a-zA-Z]` a string that has not a letter from `a` to `z` or from `A` to `Z`. In this case the `^` is used as **negation** of the expression

Syntax: flags

Most popular:

`g` - *global* - does not return after the first match, restarting the subsequent searches from the end of the previous match

`m` - *multi-line* - when enabled `^` and `$` will match the start and end of a line, instead of the whole string

`i` - *insensitive* - makes the whole expression case-insensitive (for instance `/aBc/i` would match `AbC`)

Caveat:

Flags are **language-specific**, e.g. in PHP you use `s` to enable multi-line mode.

Syntax: grouping and capturing: `()`

`a(bc)` parentheses create a capturing group with value `bc`

`a(?:bc)*` using `?:` we disable the capturing group, so here the match object will *not* contain `bc`

`a(?<foo>bc)` using `?<foo>` we put a name to the group

Syntax: greedy and lazy matching

The quantifiers (`*` `+` `{}`) are greedy operators - they expand the match as far as they can through the provided text.

E.g. `<.+>` matches `<div>simple div</div>` in `This is a <div> simple div</div> test`.

In order to catch only the div tag we can use a `?` to make it lazy:

`<.+?>` matches any character one or more times included inside < and >, expanding as needed

https://regex101.com/r/cO8lqs/24

Syntax: boundaries - `\b` and `\B`

`\babc\b` performs a "whole words only" search (here it won't match `aabcd` in "abc aabcd")

`\Babc\B` matches only if the pattern is fully surrounded by word characters (here it won't match `abc` in "abc aabcd")

Syntax: back-references - `\1` (`\2` and so on)

`([abc])\1` using `\1` it matches the same text that was matched by the first capturing group

`([abc])([de])\2\1` we can use `\2` (`\3`, `\4` etc.) to identify the same text that was matched by the second (third, fourth, etc.) capturing group

`(?<foo>[abc])\k<foo>` we add the name foo to the group and we reference it later (`\k<foo>`).
The result is the same as in the first regex.

Syntax: look-ahead, look-behind — `(?=)` and `(?<=)`

`d(?=r)` matches a `d` only if is followed by `r`, but `r` will not be part of the overall regex match

`(?<=r)d` matches a `d` only if is preceded by an `r`, but `r` will not be part of the overall regex match

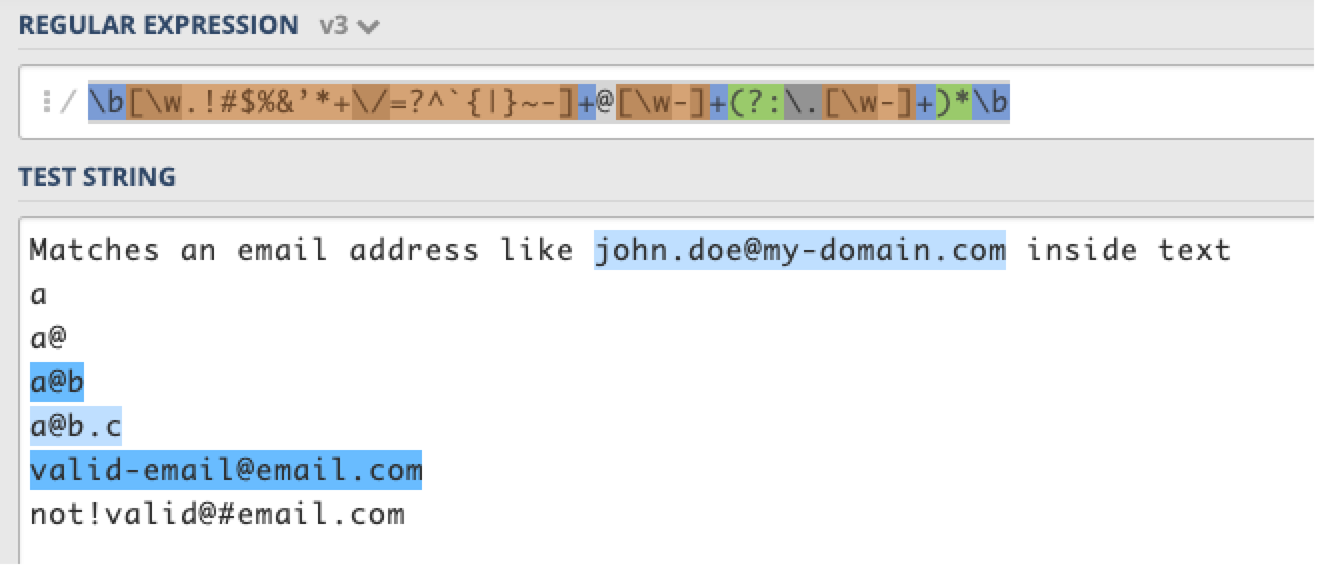
Example - email validation

- it ain't easy if you apply RFC822 strictly... https://stackoverflow.com/questions/201323/how-to-validate-an-email-address-using-a-regular-expression

```
(?:[a-z0-9!#$%&'*+/=?^_`{|}~-]+(?:\.[a-z0-9!#$%&'*+/=?^_`{|}~-]+)*|"(?:[\x01-\x08\x0b\x0c\x0e-\x1f\x21\x23-\x5b\x5d-\x7f]|\\[\x01-\x09\x0b\x0c\x0e-\x7f])*")@(?:(?:[a-z0-9](?:[a-z0-9-]*[a-z0-9])?\.)+[a-z0-9](?:[a-z0-9-]*[a-z0-9])?|\[(?:(?:(2(5[0-5]|[0-4][0-9])|1[0-9][0-9]|[1-9]?[0-9]))\.){3}(?:(2(5[0-5]|[0-4][0-9])|1[0-9][0-9]|[1-9]?[0-9])|[a-z0-9-]*[a-z0-9]:(?:[\x01-\x08\x0b\x0c\x0e-\x1f\x21-\x5a\x53-\x7f]|\\[\x01-\x09\x0b\x0c\x0e-\x7f])+)\])
```

- ...but can be quite simple if you're not paranoid

https://regex101.com/r/70ARRh/3



```
/ \b[\w.!#$%&’*+\/=?^`{|}~-]+@[\w-]+(?:\.[\w-]+)*\b
```

```
Matches an email address like john.doe@my-domain.com inside text
a
a@
a@b
a@b.c
valid-email@email.com
not!valid@#email.com
```

Examples from AH repo:

- Webapp: validation of bank details provided by PAX
  https://github.com/AirHelp/ah-webapp/blob/88dae720285026a9465f41a3f05bd91abe5ebaeb/app/services/validate_free_bank_transfer_details.rb
  regexps taken from private Ruby gem
  https://github.com/AirHelp/ah-payments-reference-data/blob/8c35f6133b55e2064ae2d20313e4aac3438bc6f3/lib/ah/payments/reference/data/fields.json

Examples from AH repo:

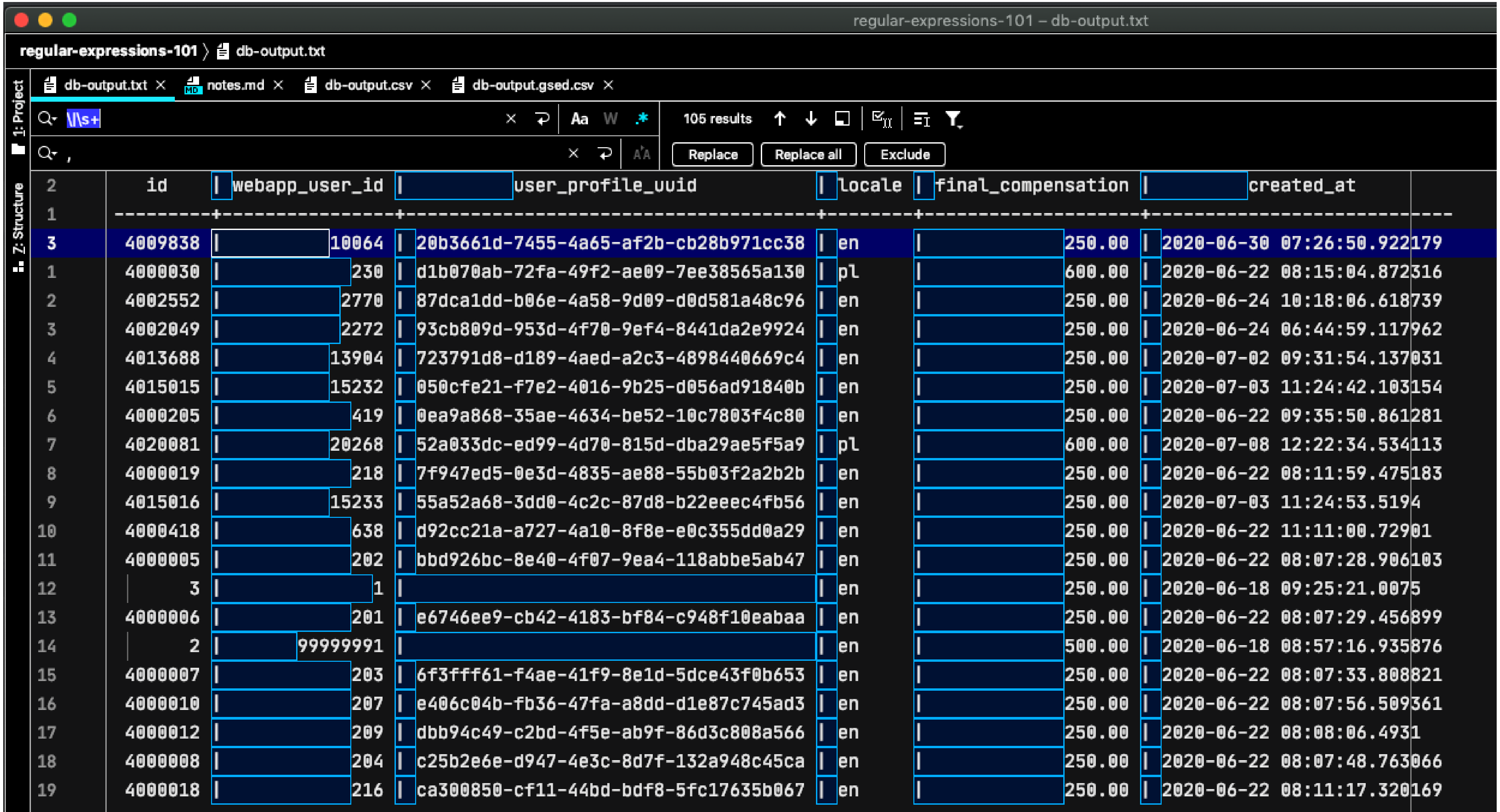
- Midass: validation of bank details provided by PAX https://github.com/AirHelp/ah-midass/blob/89b20280f782e68a2445d2fe966012fa0558365c/app/services/dlocal/validate_bank_transfer_details.rb

Examples from AH repo:

- Skynet: parsing Boarding Pass scan from mobile app https://github.com/AIrHelp/ah-skynet/blob/e8afa9087b19dce5a4596eb41c9d24c073400233/app/services/parse_boarding_pass.rb

Can be used in IDE to search & replace

IDE will highlight matches so you can test if your regex works as expected.



```
   id    | webapp_user_id |          user_profile_uuid           | locale | final_compensation |         created_at
---------+----------------+--------------------------------------+--------+--------------------+----------------------------
 4009838 |          10064 | 20b3661d-7455-4a65-af2b-cb28b971cc38 | en     |             250.00 | 2020-06-30 07:26:50.922179
 4000030 |            230 | d1b070ab-72fa-49f2-ae09-7ee38565a130 | pl     |             600.00 | 2020-06-22 08:15:04.872316
 4002552 |           2770 | 87dca1dd-b06e-4a58-9d09-d0d581a48c96 | en     |             250.00 | 2020-06-24 10:18:06.618739
 4002049 |           2272 | 93cb809d-953d-4f70-9ef4-8441da2e9924 | en     |             250.00 | 2020-06-24 06:44:59.117962
 4013688 |          13904 | 723791d8-d189-4aed-a2c3-4898440669c4 | en     |             250.00 | 2020-07-02 09:31:54.137031
 4015015 |          15232 | 050cfe21-f7e2-4016-9b25-d056ad91840b | en     |             250.00 | 2020-07-03 11:24:42.103154
 4000205 |            419 | 0ea9a868-35ae-4634-be52-10c7803f4c80 | en     |             250.00 | 2020-06-22 09:35:50.861281
 4020081 |          20268 | 52a033dc-ed99-4d70-815d-dba29ae5f5a9 | pl     |             600.00 | 2020-07-08 12:22:34.534113
 4000019 |            218 | 7f947ed5-0e3d-4835-ae88-55b03f2a2b2b | en     |             250.00 | 2020-06-22 08:11:59.475183
 4015016 |          15233 | 55a52a68-3dd0-4c2c-87d8-b22eeec4fb56 | en     |             250.00 | 2020-07-03 11:24:53.5194
 4000418 |            638 | d92cc21a-a727-4a10-8f8e-e0c355dd0a29 | en     |             250.00 | 2020-06-22 11:11:00.72901
 4000005 |            202 | bbd926bc-8e40-4f07-9ea4-118abbe5ab47 | en     |             250.00 | 2020-06-22 08:07:28.906103
       3 |              1 |                                      | en     |             250.00 | 2020-06-18 09:25:21.0075
 4000006 |            201 | e6746ee9-cb42-4183-bf84-c948f10eabaa | en     |             250.00 | 2020-06-22 08:07:29.456899
       2 |       99999991 |                                      | en     |             500.00 | 2020-06-18 08:57:16.935876
 4000007 |            203 | 6f3fff61-f4ae-41f9-8e1d-5dce43f0b653 | en     |             250.00 | 2020-06-22 08:07:33.808821
 4000010 |            207 | e406c04b-fb36-47fa-a8dd-d1e87c745ad3 | en     |             250.00 | 2020-06-22 08:07:56.509361
 4000012 |            209 | dbb94c49-c2bd-4f5e-ab9f-86d3c808a566 | en     |             250.00 | 2020-06-22 08:08:06.4931
 4000008 |            204 | c25b2e6e-d947-4e3c-8d7f-132a948c45ca | en     |             250.00 | 2020-06-22 08:07:48.763066
 4000018 |            216 | ca300850-cf11-44bd-bdf8-5fc17635b067 | en     |             250.00 | 2020-06-22 08:11:17.320169
```

Can be used in sed

Here we use 2 sed commands: *replace* and *delete*; also we apply *g* flag to apply to *all occurrences* in line

```
# redirect output of one gsed operation to another until desired effect is reached
gsed 's/|/,/g' db-output.txt | \   # replace pipes with commas in db-output.txt
  gsed 's/\s\+,/,/g'         | \   # replace spaces followed by comma with comma
  gsed 's/,\s\+/,/g'         | \   # replace comma followed by spaces with comma
  gsed 's/^\s\+//'           | \   # delete (replace by nothing) spaces at the beginning of line
  gsed '/--/d'                     # delete lines with '--'
```

```
# or use multiple gsed commands joined with semicolons in one invocation
gsed 's/|/,/g; s/\s\+,/,/g; s/,\s\+/,/g; s/^\s\+//; /--/d' db-output.txt
```

```
# the same as above but split to multiple lines for readability
gsed -e 's/|/,/g'       \
     -e 's/\s\+,/,/g'  \
     -e 's/,\s\+/,/g'  \
     -e 's/^\s\+//'    \
     -e '/--/d'        \
     db-output.txt
```

sed - caveats

- GNU sed & BSD/POSIX sed differ

  Rule of thumb: use the modern one, i.e. *GNU* sed

  ```
  brew install gsed # on OSX
  ```

- there are some syntactic differences programming language regex and GNU sed regexes
  - sed uses POSIX syntax (basic regular expressions),
    so some escape sequences (eg. `\|`, `\+`, `\?`) are not defined

    see *Regex syntax clashes* at http://www.gnu.org/software/sed/manual/sed.html
  - some macros/character classes don't work in sed
    eg. `\d`, https://stackoverflow.com/questions/14671293/why-doesnt-d-work-in-regular-expressions-in-sed)

Final notes

- try to *keep it simple* (for better performance & understandability)
- sometimes it's easier to use *or* operator (`|`) than creating more general regular expression
- read the *language documentation*
- (especially when re-using a regexp written in one programming language in a different language)

References:

- **The Stack Overflow Regular Expressions FAQ** https://stackoverflow.com/questions/22937618/reference-what-does-this-regex-mean/22944075#22944075
- MDN Regular Expressions (JavaScript) https://developer.mozilla.org/en-US/docs/Web/JavaScript/Guide/Regular_Expressions
- Lots of examples with explanations (kudos to Jonny Fox, I used lots of them in this presentation) https://medium.com/factory-mind/regex-tutorial-a-simple-cheatsheet-by-examples-649dc1c3f285
- Examples in various programming languages

  http://rosettacode.org/wiki/Regular_expressions