```
(?i)reg(ular expressions?|ex(p|es)?)
```


WHENEVER I LEARN A NEW SKILL I CONCOCT ELABORATE FANTASY SCENARIOS WHERE IT LETS ME SAVE THE DAY.
OH NO! THE KILLER MUST HAVE FOLLOWED HER ON VACATION!
BUT TO FIND THEM WE'D HAVE TO SEARCH THROUGH 200 MB OF EMAILS LOOKING FOR SOMETHING FORMATTED LIKE AN ADDRESS!
IT'S HOPELESS!
EVERYBODY STAND BACK.
I KNOW REGULAR EXPRESSIONS.
PERL!
TAP TAP

Regex can be a pain

- “Some people, when confronted with a problem, think ‘I know, I'll use regular expressions.’ Now they have two problems.”

  - Jamie Zawinski

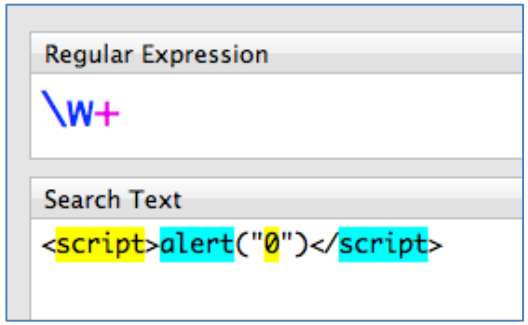
But…

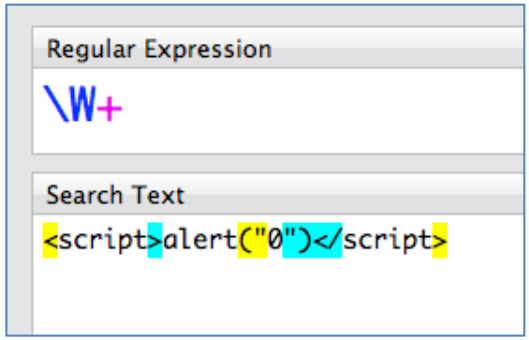
Regex is amazing

- How do you validate an email?

```
\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b
```

- How can you sanitize user input?
  - Only allow what matches: \w+
  - Strip what matches: \W+





Regex (Regular Expressions)

- A sequence of characters that form a search pattern, mainly used for pattern matching strings
- Every character in a regular expression is either a meta-character with a special meaning or a regular character with a literal meaning
- Concept arose in the 1950s when American mathematician Stephen Kleene formalized the description of a “regular language”

Basic concepts

- A regular expression (pattern) is an expression used to specify a set of strings
- Common operations used in construction:
  - Boolean “or”
    - A | to separate alternatives. grey|gray matches both grey and gray
  - Grouping
    - A () can be used to limit the scope of an operator.
    - gr(a|e)y matches gray and grey because () limits scope of |
  - Quantification
    - Specifies how often the preceding element is allowed to occur.
    - Common quantifiers are: ? (0|1) * (0|+) + (1+)
      - colou?r matches color and colour
      - ab*c matches ac, abc, abbc, abbbc, etc.
      - ab+c matches abc, abbc, abbbc, etc. but not ac

Example

- Match:
  - informatics
  - Information

- Match:
  - Handel
  - Haendel
  - Händel

Answer

- `informati(cs|on)`
- What about:
  - inFoRmation
  - `(?i)informati(cs|on)`

- H(ä|ae?)ndel

More syntax

- . Matches any single character
- [ ] Matches a single character or range of characters within the brackets
- [^] Matches a single character that is not contained within the brackets
- ^ Matches the starting position within the string
- $ Matches the ending position of the string
- ( ) Defines a marked subexpression.
  The string matched can be recalled later with \n (n = 0+)
- \n Matches the nth marked subexpression matched where 9 is a digit from 1-9
- {m,n} Matches the preceding element at least m and not more than n times

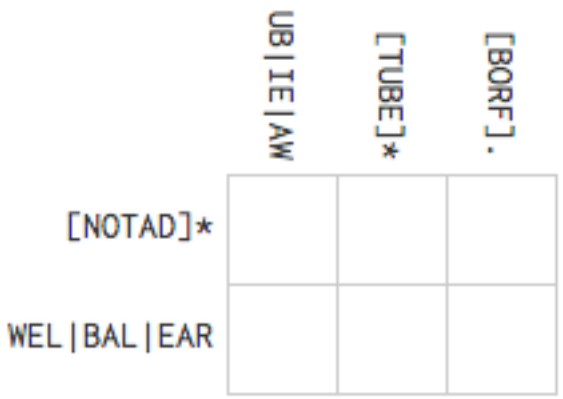
More examples

- .at Matches any three-character string ending with “at” - “hat”, “cat”, and “bat”
- [hc]at Matches “hat” and “cat”
- [^b]at Matches all strings matched by .at except “bat”
- [^hc]at Matches all strings matched by .at other than “hat” and “cat”
- ^[hc]at Matches “hat” and “cat”, but only at the beginning of the string or line
- [hc]at$ Matches “hat” and “cat”, but only at the end of the string or line
- \[.\] Matches any single character surrounded by “[“ and “]”
  Such as “[a]” and “[b]”
- s.* Matches any number of characters preceded by s
  Such as “saw” and “seed”

A shallow dip into how it works

When applying `cat` to `He captured a catfish for his cat.`, the engine tries to match the first token in the regex `c` to the first character in the match `H`. This fails. There are no other possible permutations of this regex, because it merely consists of a sequence of literal characters. So the regex engine tries to match the `c` with the `e`. This fails too, as does matching the `c` with the space. Arriving at the 4th character in the match, `c` matches `c`. The engine then tries to match the second token `a` to the 5th character, `a`. This succeeds too. But then, `t` fails to match `p`. At that point, the engine knows the regex cannot be matched starting at the 4th character in the match. So it continues with the 5th: `a`. Again, `c` fails to match here and the engine carries on. At the 15th character in the match, `c` again matches `c`. The engine then proceeds to attempt to match the remainder of the regex at character 15 and finds that `a` matches `a` and `t` matches `t`.

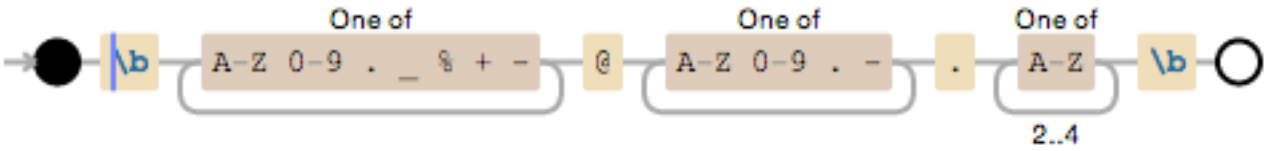
Practice



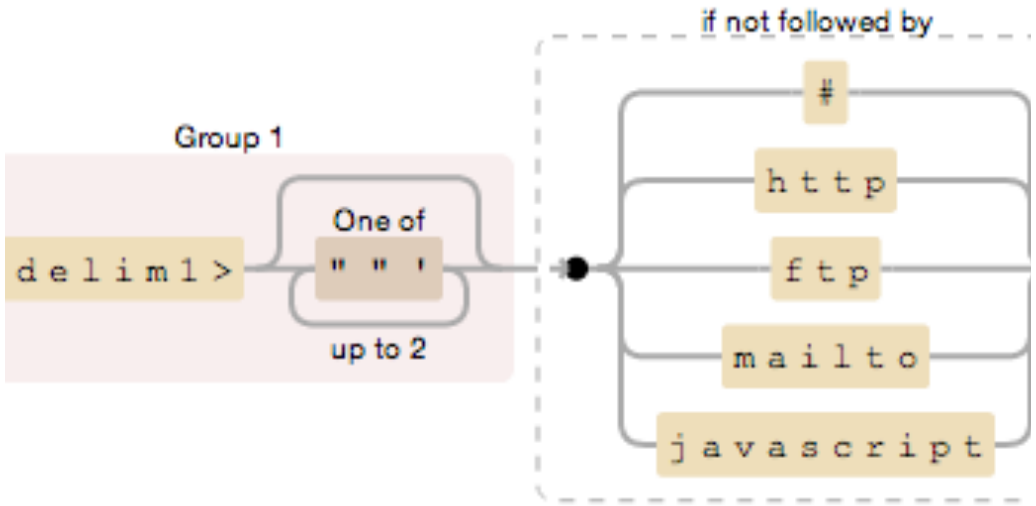
Tools

- https://www.debuggex.com/
- Validating email addresses:

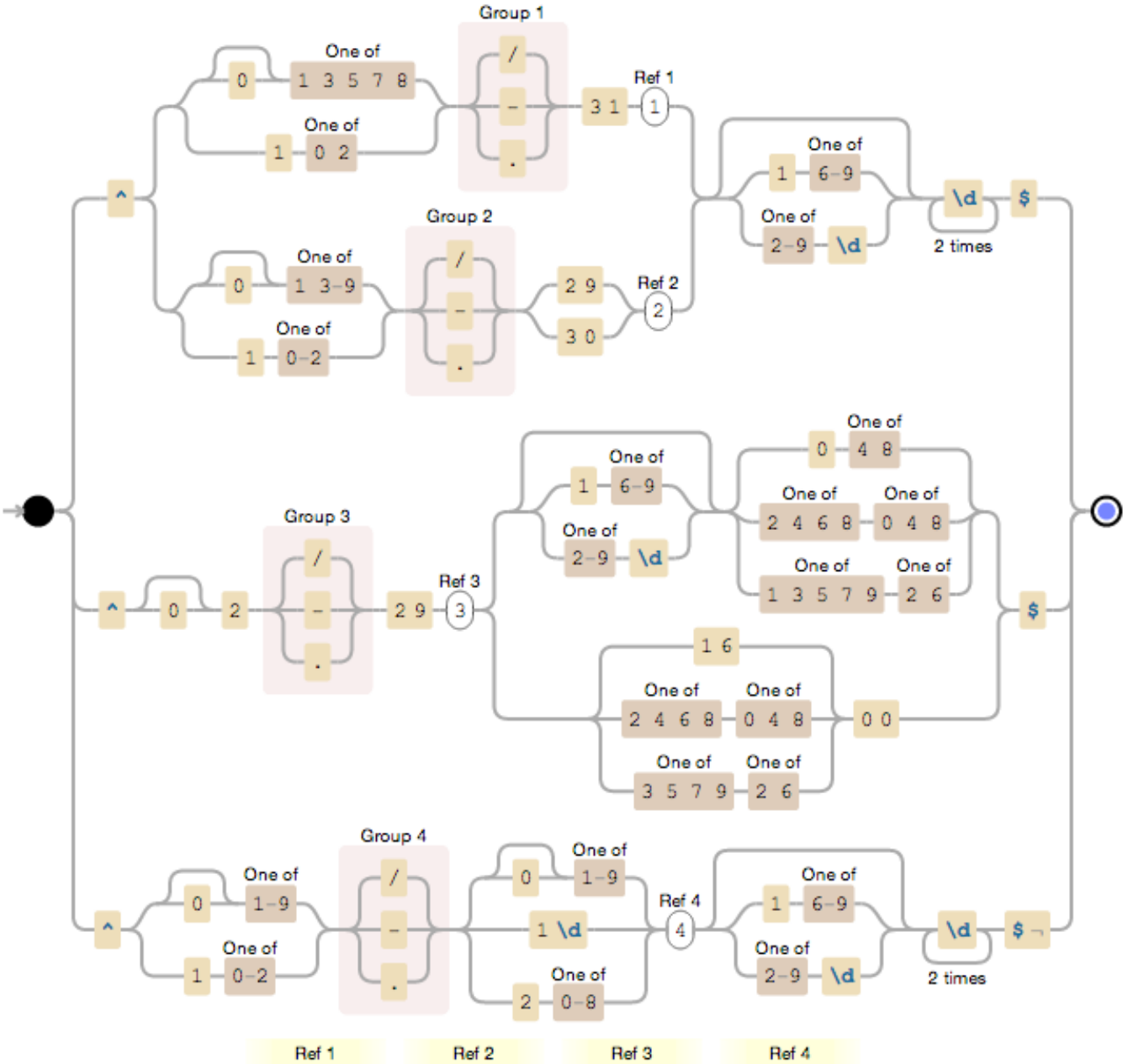
```
\b[A-Z0-9._%+-]+@[A-Z0-9.-]+\.[A-Z]{2,4}\b
```



```
(<delim1>[""']{0,2})(?!#|http|ftp|mailto|javascript)
```



```
^(?:(?:(?:0?[13578]|1[02])(\/|-|\.)31)\1|(?:(?:0?[13-
9]|1[0-2])(\/|-|\.)(?:29|30)\2))(?:(?:1[6-9]|[2-
9]\d)?\d{2})$|^(?:0?2(\/|-|\.)29\3(?:(?:(?:1[6-9]|[2-
9]\d)?(?:0[48]|[2468][048]|[13579][26])|(?:(?:16|[2468][0
48]|[3579][26])00))))$|^(?:(?:0?[1-9])|(?:1[0-2]))(\/|-
|\.)(?:0?[1-9]|1\d|2[0-8])\4(?:(?:1[6-9]|[2-9]\d)?\d{2})$
```


Group 1
One of
0
1 3 5 7 8
One of
1
0 2
/
-
.
3 1
Ref 1
1
Group 2
One of
0
1 3-9
One of
1
0-2
/
-
.
2 9
3 0
Ref 2
2
One of
1
6-9
One of
2-9
\d
\d
$
2 times
^
^
0
2
Group 3
/
-
.
2 9
Ref 3
3
One of
1
6-9
One of
2-9
\d
One of
0
4 8
One of
2 4 6 8
One of
0 4 8
One of
1 3 5 7 9
One of
2 6
1 6
One of
2 4 6 8
One of
0 4 8
One of
3 5 7 9
One of
2 6
0 0
$
^
Group 4
One of
0
1-9
One of
1
0-2
/
-
.
0
One of
1-9
1 \d
One of
2
0-8
Ref 4
4
One of
1
6-9
One of
2-9
\d
\d
$ ¬
2 times
Ref 1
Ref 2
Ref 3
Ref 4

Try this one ☺

```
(?:(?:\r\n)?[ \t])*(?:(?:(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[
\t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:\r\n)?[
\t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*))*@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-
\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[
\t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*)*\<(?:(?:\r\n)?[ \t])*(?:@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*)(?:,@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*)*:(?:(?:\r\n)?[ \t])*)?(?:[^()<>@,;:\\".\[\] \000-
\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[
\t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*))*@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[
\t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-
\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[
\t]))*"(?:(?:\r\n)?[ \t])*)*:(?:(?:\r\n)?[ \t])*(?:(?:(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[
\t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[
\t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
\t])*)*\>(?:(?:\r\n)?[ \t])*))*)?;\s*)
```

Regex crossword

- Give it a shot: http://regexcrossword.com/

Learn more

- http://regex.learncodethehardway.org/book/
- http://nbviewer.ipython.org/url/norvig.com/ipython/xkcd1313-part2.ipynb?create=1

References

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- https://programmers.stackexchange.com/questions/122440/how-do-regular-expressions-actually-work
- https://stackoverflow.com/questions/3622398/how-a-regex-engine-works
- http://www.regular-expressions.info/engine.html
- http://www.regular-expressions.info/tutorial.html