Regular Expressions

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Updated based on original notes from Raj Sunderraman and Michael Weeks

Regular Expression

- A pattern describing a certain amount of text.
- A "match" is the piece of text that pattern was found to correspond to by the *regex* processing software.
- For example,

Pattern	Will Match
/\d{1,2}\/\d{1,2}\/\d{4}/	Date (e.g. 9/5/2016)
/\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3} /	IP Address (e.g. 255.255.0.0)

Different Regular Expression Engines

- A regular expression "engine" is a piece of software that can process regular expressions, trying to match the pattern to the given string.
- Different regular expression engines are not fully compatible with each other.
  - E.g. Perl, PHP, .NET, Java, JavaScript, Python, R, POSIX
- In this class, we learn **BREs**(Basic Regular Expression), and **EREs**(Extended Regular Expression), used by UINX utilities, such as ***grep***, ***egrep***, ***awk***, ***sed***, and ***vi***.

How to write a regular expression?

- A regular expression is composed of
  - Characters
  - Delimiters
  - Simple strings
  - Special characters
  - Other metacharacters
  - Character classes

Characters

- Any character on the keyboard (except newline character '\n')
- **Literals**
  - The characters represent themselves within a regex
- **Special characters**
  - The characters not represent themselves within a regex
  - E.g. **$** matches the end of a line only.
- In a regex, the literal characters can be treated as *words*, while the special characters can be treated as *grammar*.
- The most basic regex consists of a single literal character, e.g.: **a**

Delimiters

- Special characters used to mark the beginning and end of a regex.
- Any characters can be used as a delimiter.
- But most often, people use forward slash '/'
  - E.g. /\d{1,2}\/\d{1,2}\/\d{4}/
- Delimiters are not used with **grep** family of utilities

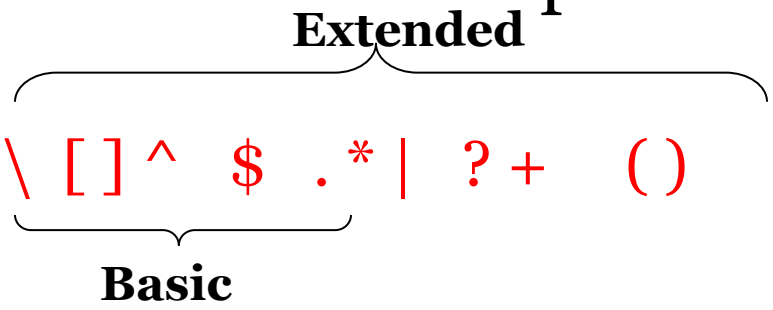
Simple Strings

- The most basic regular expression
- Matches only itself

Regex	Matches	Examples
/the/	the	So turn off the light, Say all your prayers and then, Beautiful mermaids will swim through the sea, And you will be swimming there too

Special Characters

- The metacharacters with special meaning are



- The dash (-) can only be considered as a metacharacter within the square brackets to indicate a range.
  - E.g. **[0-9]** matches the digits through 0 to 9
- The brace {} can only be considered as a metacharacter when it is part of repetition operator
  - E.g. **(cat){1,3}** matches the strings containing one to three "cat"

Special Characters

- To match any single character, use .
- To match any of the single characters in a range, use []
  - E.g. [a-z], [2-5], [abc]
  - Other metacharacters lose their special meanings inside square bracket
- To convert a metacharacter into a literal, use backslash \
  - E.g. \[, \/

Special Characters

Regex	Matches	Examples
/.nd/	All strings with any character preceding **nd**	Say all your prayers and then, Oh you sleepy young heads dream of wonderful things, And you will be swimming there too.
[A-D]	Member of the character class A through D	Beautiful mermaids will swim through the sea, And you will be swimming there too.
\.	A period	And you will be swimming there too.
a.	A string with prefix a	Say all your prayers and then, Oh you sleepy young heads dream of wonderful things, Beautiful mermaids will swim through the sea,

Special Characters

- **$** matches the end of a line only
  - E.g. >$
- **^** matches the beginning of a line only
  - E.g. ^ID
  - Note: **[^abc]** means any characters excluding a, b and c

Regex	Matches	Examples
/a.$/	A string with prefix **a** ends a line	Beautiful mermaids will swim through the sea,
/^.nd/	All strings with any character preceding **nd** and at beginning of a line	And you will be swimming there too.

Special Characters

- **?** matches **zero or one** occurrence of the single preceding character.
  - E.g. a?, abc?
- * matches **zero or more** occurrences of the character that precedes it.
  - E.g. a*, abc*
- + matches **one or more** occurrences of the single preceding character.
  - E.g. a+, abc+

Special Characters

Regex	Matches	Examples
/sw.*ng/	**sw** followed by zero or more other characters followed by **ng**	And you will be swimming there too.
/s.*w/	**s** followed by zero or more other characters followed by **w**	Oh you **sleepy young heads dream of** wonderful things, Beautiful mermaids **will s**wim through the sea, And you will be swimming there too.
/s.+w/	**s** followed by more other characters followed by **w**	Oh you **sleepy young heads dream of** wonderful things, Beautiful mermaids **will s**wim through the sea,
/s.?w/	**s** followed by zero or one other character follwed by **w**	And you will be swimming there too.

Special Characters

- **( )** group the matched string by regex inside it
  - E.g. (abc)* v.s. abc*
- **|** matches either expression, acts like an "or " operator
  - E.g. (a|b) , (a|bc), a|bc*

Regex	Matches	Examples
/off|will/	**off** or **will** may appear	And you **will** be swimming there too.
(ab){1,2}c	**ababc** **abc**	ababc Aababd This is abc

Character Classes

Character class	Matches
\s	White space
\S	Not white space
\d	Digit
\D	Not digit
\w	Word
\W	Not word
\x	Hexadecimal digit
\O	Octal digit

Rules

- Longest match possible
  - A regex always matches the longest possible string, starting as far towards the beginning of the line as possible
- Empty regular expressions
  - An empty regular expression always represents the last regular expression used
  - E.g. in vi editor
    - Try **:s/john/kate/**
    - If you want to make the same substitution again, use
    - **:s//kate**

Practices

- Write regular expressions for following patterns.
  - Phone number with the format ###-###-####
  - Date with the format MM/DD/YYYY
  - Passwords: strings with at least one upper case letter, one lower case letter, and one digit
- Choose all matched strings of the given extended regular expression.
  - (1) a(bc)+de
    A) abcde B) ade C) abcbcde D) abc
  - (2) [a-z\s]*hello
    A) Othello B) hello C) 2hello D) say hello