Accelerating Information Technology

http://aiti.mit.edu

Ghana Summer 2012
Lecture 09 – Regular Expressions

MISTI

What do the following strings have in common?

- jovana@mit.edu
- louis.a.sobel@gmail.com
- tony.blair@mail.gov.uk
- 1luvbieber@teenagegirls.hotmail.com
- xyz123@ugl.edu.gh

What do the following strings have in common?

- {some letters or numbers or dots}
- @
- {some letters or numbers and at least one dot}

Regular Expressions

- Describes patterns of text
  - No meaning associated, just characters

Examples of Regular Expressions

- "All English words that have a q without a u following"
- "Words that start and end with the same letter"
- "What text is embedded in the <H3> tag?"
- Strings that are valid email addresses.

Pattern Matching

- A Regular expression matches the string if an instance of the pattern described by the regular expression can be found in the string.
- If we say “matches in the string” may make it a little more clearer.
- Sometimes people also say that the string matches the regular expression.

Pattern Matching

- We use REs to determine if a given String matches a pattern
  - RE will return all matches to pattern in the String
  - Example:
    - Pattern = "rose"
    - String = "A Rose is a rose is a rose."

Literal Patterns

- Plain, literal text look to match exactly with parts of the text.
  - Example:
    - Pattern = "rose"
    - String = "A Rose is a rose is a rose."
  - Example:
    - Pattern "e i"
    - String = "A Rose is a rose is a rose"

Character Classes

- We can group multiple characters into character classes

- Some classes are provided by Java:
  - . → matches any single character, only stops at newline
    - Example: ".ose" matches "Rose" "rose", not "ose"
  - \s → matches whitespace
    - newline (\n), space, tab (\t)
    - Example: ".\s." matches "a b", "a\tb", not "ab"

Character Classes

- \S → matches non-whitespace character
  - Example: "\S\S" matches "ab", "a!", not "a "
- \d → matches single digit
- \D → matches single non-digit (including whitespace)
- \w → matches word character
  - A-Z, a-z, 0-9, and '_' matched

Custom Character Classes

- You can define custom character classes
  - Match true if any character in custom class matched
  - Use [ ] to denote custom character class

- Example:
  - [aeiou]: vowels
    - "a", "e" match "x" does not
- Can also specify ranges:
  - [A-Z]: uppercase letter
  - [a-z]: lowercase letter

Anchors (Position Characters)

- Anchors allow you to designate where a match can occur
  - ^ → match to beginning of String
    - Example:
      - Pattern: "^[Aa] [Rr]ose"
      - "A Rose is a rose is a rose."
  - $ → match at end of String
    - Example
      - Pattern: "rose$"
      - "A Rose is a rose is a rose"

Anchors (Position Characters)

- \b matches at word boundary:
  - Pattern "\brose" matches "rose" "rosemary", but not "primrose"

Repetition Operators

- Repetition operators allow us to denote that a (sub)pattern may repeat
  - * → zero or more repetitions
    - Example: "0*\d" matches "05" "5" "0006"
  - + → One or more repetitions
    - Example: "de+r" matches "deer" "deeer" "der" not "debr"
  - ? → exactly zero or 1 occurrence
    - Example "de[ae]?r" matches "der" "deer" "dear" not "debr" "deeer"

Grouping

- Just like math expressions you can group subpatterns using ( )
  - Pattern "(word)+" matches "word" "wordword" "wordwordword" not "" "wordd"

Example: Valid Email Address

- aiti@mit.edu
  - one or more word characters
  - Followed by '@'
  - Followed by word characters that has to have at least one '.' somewhere
    - Since '.' is an operator in a RE, we need to escape it

Example: Valid Email Address

(\w)+@\w+(\.\w)+

Escaping

- If you want one of the RE reserved characters to appear in your pattern you must escape it:
  - \. → literal . in pattern
  - * → literal * in pattern
  - \ { } + ( ) are the others you must escape

Alternation

- | denotes logical OR operation
  - Think of || operator in Java
- Examples:
  - Pattern "soda|juice" matches "soda" "juice" "soda water", not "water"
  - "\w+@[\w\.]*\.(net|gov|edu)"
    - Good or bad RE for emails?
- | has lowest precedence (applied last)
  - Use ( ) to avoid confusion

Examples of Regular Languages

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- (0|1)*.(0|1)* - Binary floating point numbers

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- (00)* - even-length all-zero strings
- 1*(01*01*)* - strings with even number of zeros

Match Strings and Regular Expressions

1. 0(0|1)*0
2. ((|0)1*)*
3. ((0|1)0(0|1))*

a. 000000
b. 01010
c. 010101
d. 101010
e. 001100

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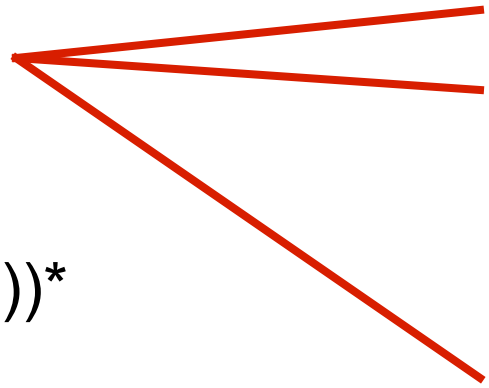

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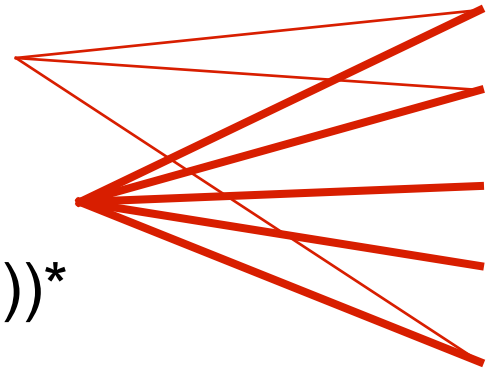

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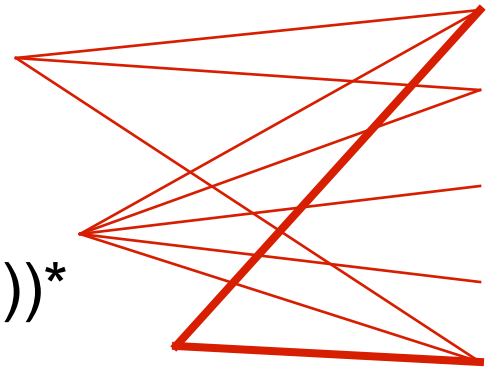

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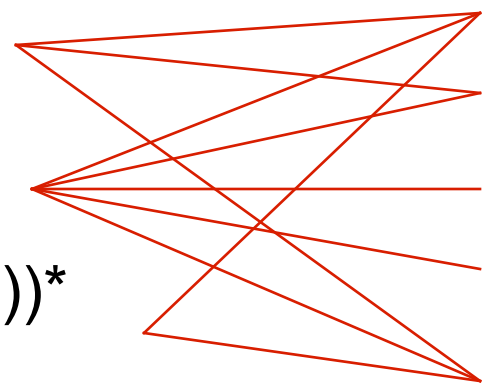

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b. 01010
c. 010101
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e. 001100

- All strings of 0's and 1's that does not contain the substring 011

Capture Groups

- ( ) also used to capture text to retrieve later
  - Latter in the RE pattern, or
  - After the matching is complete in your Java code

Capture Group used in Pattern

- All words that start and end with the same letter:
  - \b(\w)\w*\1\b
- \n references a capture group
  - numbered from left to right in pattern
  - \0 refers to the entire string that is matched
- All words that start and end with the same 2 letters:
  - \b(\w)(\w)\w*\1\2\b matches "boobo"

Named Capture Groups

- Capture groups can have names
- Easier to refer to than numbers
- “(P<first_name>) (P<last_name>)”

Greediness

- By default, repetition operators match as much text as possible.
- Example:
  - Want to match html tags.
  - Pattern "</?.*>"
  - String: "Some <bold>Bold</bold> text"
- Fix: be more specific of what can occur in the tag:
  - Pattern: "</?[^>]*>"

More Greediness Control

- By default repetition operators try to match as much text as possible:
  - Ex pattern: "bo*o" matches "booooo"

- You can use different form of operators that are not greedy by appending ? after operator
  - Ex pattern: "bo*?o" matches "booooo"

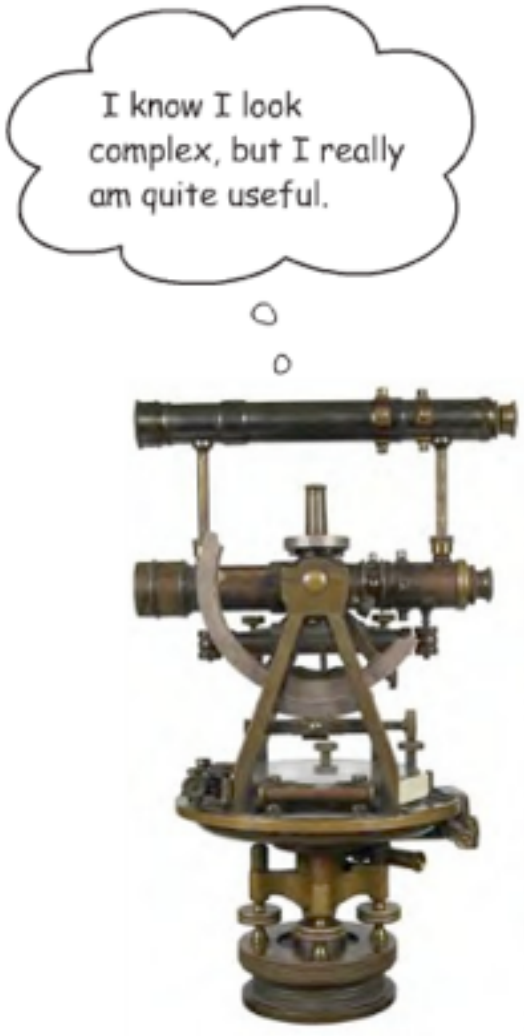
Matching Options

- Several options control how matching is performed:
  - These are passed to the Pattern.compile() method we will see later
- Important option:
  - (?m): Multiline mode, ^ and $ match at newline boundaries (every line) as well as beginning and end of input

Regular Expressions in Python

- Lab! :(

Questions?



Sorry…

- Confused?
- Questions?
- How can this help you parse html?
- How can this help you parse incoming SMS messages?
- Regular Expressions can also replace text
  - Self learning!

More Resources