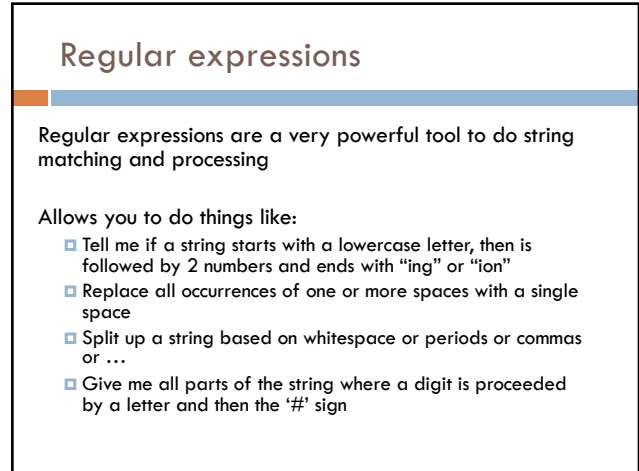




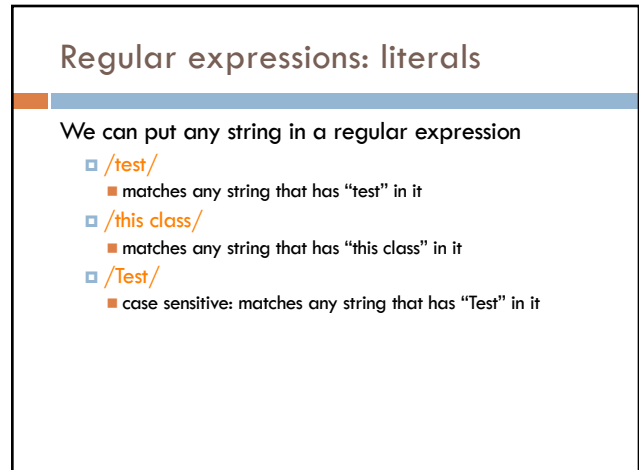
1



2



3



4

Regular expressions: character classes

A set of characters to match:

- ▣ put in brackets: []
- ▣ [abc] matches a single character a or b or c

What would the following match?

`/[Tt]est/` any string with "Test" or "test" in it

5

Regular expressions: character classes

A set of characters to match:

- ▣ put in brackets: []
- ▣ [abc] matches a single character a or b or c

Can use - to represent ranges

- ▣ [a-z] is equivalent to
- ▣ [A-D] is equivalent to
- ▣ [0-9] is equivalent to

6

Regular expressions: character classes

A set of characters to match:

- ▣ put in brackets: []
- ▣ [abc] matches a single character a or b or c

Can use - to represent ranges

- ▣ [a-z] is equivalent to [abcdefghijklmnopqrstuvwxyz]
- ▣ [A-D] is equivalent to [ABCD]
- ▣ [0-9] is equivalent to [0123456789]

7

Regular expressions: character classes

For example:

`/[0-9][0-9][0-9][0-9]/`
matches any four digits, e.g. a year

Can also specify a set NOT to match:

^ means all characters EXCEPT those specified

- ▣ [^a] all characters except 'a'
- ▣ [^0-9] all characters except numbers
- ▣ [^A-Z] ???

8

Regular expressions: character classes

For example:

```
/[0-9][0-9][0-9][0-9]/
```

matches any four digits, e.g. a year

Can also specify a set NOT to match:

^ means all characters EXCEPT those specified

- ▣ [^a] all characters except 'a'
- ▣ [^0-9] all characters except numbers
- ▣ [^A-Z] not an upper case letter (be careful, this will match **any** character that's not uppercase, not just letters)

9

Regular expressions: character classes

Meta-characters (not always available)

- ▣ \w - word character (a-zA-Z_0-9)
- ▣ \W - non word-character (i.e. everything else)
- ▣ \d - digit (0-9)
- ▣ \s - whitespace character (space, tab, newline, ...)
- ▣ \S - non-whitespace
- ▣ \b matches a word boundary (whitespace, beginning or end of line)
- ▣ . matches any character

10

What would the following match?

```
/19\d\d/
```

- ▣ would match any 4 digits starting with 19

```
/\s\s/
```

- ▣ matches anything with two adjacent whitespace characters (spaces, tabs, etc)

```
/\s[aeiou]..\s/
```

- ▣ any three letter word that starts with a vowel

11

Regular expressions: repetition

* matches zero or more of the preceding character

```
/ba*d/
```

matches any string with:

- ▣ b
- ▣ ba
- ▣ baad
- ▣ baaad

```
/A.*A/
```

matches any string starts and ends with A

+ matches one or more of the preceding character

```
/ba+d/
```

matches any string with

- ▣ ba
- ▣ baad
- ▣ baaad
- ▣ baaaad

12

Regular expressions: repetition

? zero or 1 occurrence of the preceding

`/fights?/`

matches any string with "fight" or "fights" in it

{n,m} matches n to m inclusive

`/ba{3,4}d/`

matches any string with

- baaad
- baaaaad

13

Regular expressions: beginning and end

^ marks the beginning of the line

\$ marks the end of the line

`/test/` test can occur anywhere

`/^test/` must start with test

`/test$/` must end with test

`/^test$/ ???`

14

Regular expressions: beginning and end

^ marks the beginning of the line

\$ marks the end of the line

`/test/` test can occur anywhere

`/^test/` must start with test

`/test$/` must end with test

`/^test$/` must be exactly test

15

Regular expressions: repetition revisited

What if we wanted to match:

This is very interesting

This is very very interesting

This is very very very interesting

Would `/This is very+ interesting/` work?

- No... + only corresponds to the 'y'
- `/This is (very)+interesting/`

Repetition operators only apply to a single character.
Use parentheses to group a string of characters.

16

Regular expressions: disjunction

| has the lowest precedence and can be used

`/cats|dogs/`

matches:

- cats
- dogs

does NOT match:

- catsogs

17

Regular expressions: disjunction

We want to match:

I like cats

I like dogs

Does `/^I like cats|dogs$/` work?

No! Matches:

- I like cats
- dogs

Solution?

18

Regular expressions: disjunction

We want to match:

I like cats

I like dogs

`/^I like (cats|dogs)$/`

matches:

- I like cats
- I like dogs

19

Some examples

All strings that start with a capital letter

IP addresses

- 255.255.122.122

Matching a decimal number

All strings that end in 'ing'

All strings that end in 'ing' or 'ed'

All strings that begin and end with the same character

20

Some examples

All strings that start with a capital letter

```
 /^[A-Z]/
```

IP addresses

```
 /\b\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\b/
```

Matching a decimal number

```
 /[-+]?[0-9]*\.[0-9]+/
```

All strings that end in 'ing'

```
 /ing$/
```

All strings that end in 'ing' or 'ed'

```
 /ing|ed$/
```

21

Regular expressions: memory

All strings that begin and end with the same character

Requires us to know what we matched already

```
 ()
```

- ▣ used for precedence
- ▣ also records a matched grouping, which can be referenced later

```
 /^(.)\.*\1$/
```

- ▣ all strings that begin and end with the same character

22

Regular expression: memory

```
 /She likes (\w+) and they like \1/
```

What would this match?

23

Regular expression: memory

```
 /She likes (\w+) and they like \1/
```

She likes bananas and they like bananas

She likes movies and they like movies

...

24

Regular expression: memory

`/She likes (\w+) and they like \1/`

We can use multiple matches

`/She likes (\w+) and (\w+) and they also like \1 and \2/`

25

Regular expressions: substitution

Most languages also allow for substitution

`s/banana/apple/`

substitute first occurrence banana for apple

`s/banana/apple/g`

substitute all occurrences (globally)

`s/^(.*)$/\1 \1/`

???

`s/\s+/ /g`

???

26

Regular expressions: substitution

Most languages also allow for substitution

`s/banana/apple/`

substitute first occurrence banana for apple

`s/banana/apple/g`

substitute all occurrences (globally)

`s/^(.*)$/\1 \1/`

duplicate the string, separated by a space

`s/\s+/ /g`

substitute multiple spaces to a space

27

Regular expressions by language

Java: as part of the String class

`String s = "this is a test"`

`s.matches("test")`

`s.matches(".*test.*")`

`s.matches("this\s\s.* test")`

`s.split("\s+")`

`s.replaceAll("\s+", " ");`

Be careful, matches must match the whole string (i.e. an implicit `^` and `$`)

28

Regular expressions by language

Java: `java.util.regex`

Full regular expression capabilities

Matcher class: create a matcher and then can use it

```
String s = "this is a test"
Pattern pattern = Pattern.compile("is\\s+")
Matcher matcher = pattern.matcher(s)
```

- `matcher.matches()`
- `matcher.find()`
- `matcher.replaceAll("blah")`
- `matcher.group()`

29

Regular expressions by language

Python:

```
import re
```

```
s = "this is a test"
p = re.compile("test")
p.match(s)
```

```
p = re.compile(".*test.*")
re.split('\\s+', s)
re.sub('\\s+', ' ', s)
```

30

Regular expressions by language

perl:

```
$s = "this is a test"
$s =~ /test/
$s =~ /^test$/
$s =~ /this\sis.*test/
split /\s+/, $s
$s =~ s/\s+//g
```

31

Regular expression by language

grep

- command-line tool for regular expressions (general regular expression print/parser)
- returns all lines that match a regular expression
- `grep "@" twitter.posts`
- `grep "http:" twiter.posts`
- can't used metacharacters (`\d`, `\w`), use `[]` instead
- Often want to use `"grep -E"` (for extended syntax)

32

Regular expression by language

sed

- ▣ another command-line tool that uses regular expressions to print and manipulate strings
- ▣ very powerful, though we'll just play with it
- ▣ Most common is substitution:
 - sed "s/ is a / is not a /g" twitter.posts
 - sed "s/ */ /g" twitter.posts
 - sed doesn't have +, but does have *
- ▣ Can also do things like delete all that match, etc.

33

Regular expression resources

General regular expressions:

- ▣ Ch 2.1 of the book
- ▣ <http://www.regular-expressions.info/>
 - good general tutorials
 - many language specific examples as well

Java

- ▣ <http://download.oracle.com/javase/tutorial/essential/regex/>
- ▣ See also the documentation for `java.util.regex`

Python

- ▣ <http://docs.python.org/howto/regex.html>
- ▣ <http://docs.python.org/library/re.html>

34

Regular expression resources

Perl

- ▣ <http://perldoc.perl.org/perlretut.html>
- ▣ <http://perldoc.perl.org/perlre.html>

grep

- ▣ See the write-up at the end of Assignment 1
- ▣ <http://www.panix.com/~elflord/unix/grep.html>

sed

- ▣ See the write-up at the end of Assignment 1
- ▣ <http://www.grymoire.com/Unix/Sed.html>
- ▣ <http://www.panix.com/~elflord/unix/sed.html>

35