Principles of Computer Science II

Bash Shell Scripting

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Lecture 11

Introduction to Regular Expressions (1)

- A regular expression (regex) describes a set of possible input strings.
- Regular expressions descend from a fundamental concept in
- Computer Science called finite automata theory
- Regular expressions are endemic to Unix
  - vi, ed, sed, and emacs
  - awk, tcl, perl and Python
  - grep, egrep, fgrep
  - compilers

Introduction to Regular Expressions (2)

- The simplest regular expressions are a string of literal characters to match.
- The string matches the regular expression if it contains the substring.

Introduction to Regular Expressions (3)

UNIX Tools rocks.

match

UNIX Tools sucks.

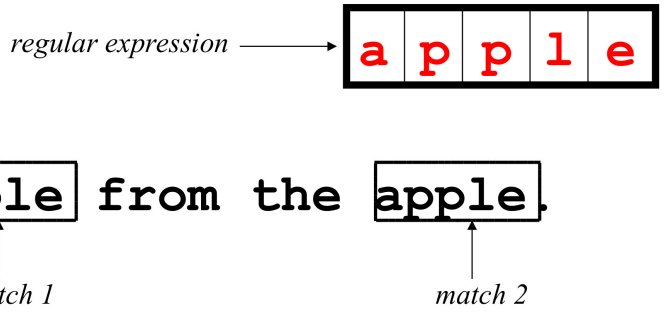
match

UNIX Tools is okay.

no match

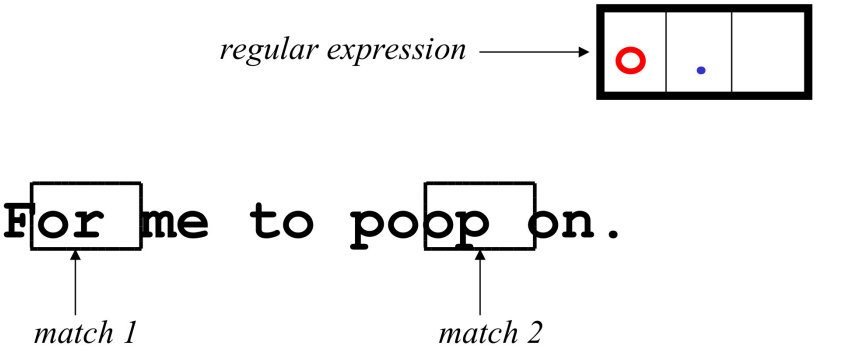
Introduction to Regular Expressions (4)

- A regular expression can match a string in more than one place.



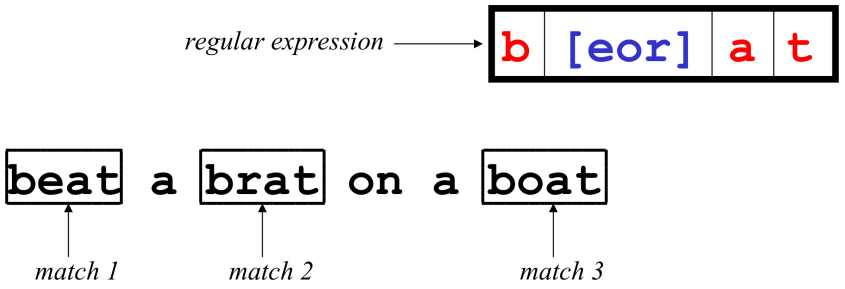
Introduction to Regular Expressions (5)

- The . regular expression can be used to match any character.



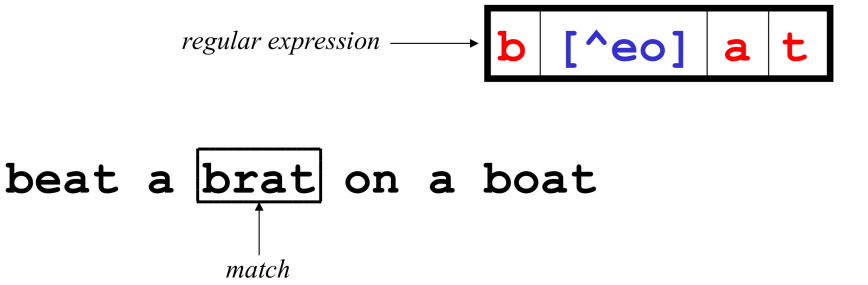
Character Classes (1)

- Character classes [] can be used to match any specific set of characters.



Character Classes (2)

- Character classes can be negated with the [^] syntax.



Character Classes (3)

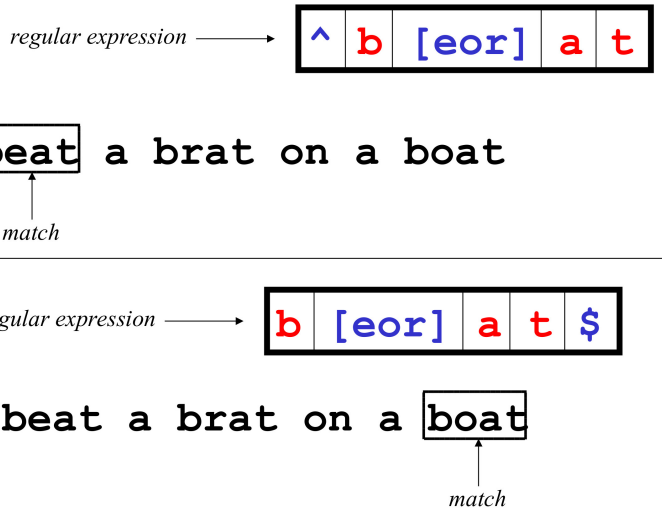
- [*aeiou*] will match any of the characters a, e, i, o, or u
- [*kK*]orn will match korn or Korn
- Ranges can also be specified in character classes
- [1 – 9] is the same as [123456789]
- [*abcde*] is equivalent to [*a* – *e*]
- You can also combine multiple ranges
- [*abcde*123456789] is equivalent to [*a* – *e*1 – 9]
- Note that the - character has a special meaning in a character class but only if it is used within a range,
- [–123] would match the characters -, 1, 2, or 3

Named Character Classes

- Commonly used character classes can be referred to by name (alpha, lower, upper, alnum, digit, punct, cntrl)
- Syntax [: *name* :]
- [*a* – *zA* – *Z*] is equivalent [[: *alpha* :]]
- [*a* – *zA* – *Z*0 – 9] is equivalent [[: *alnum* :]]
- [45*a* – *z*] is equivalent [45[: *lower* :]]
- Important for portability across languages

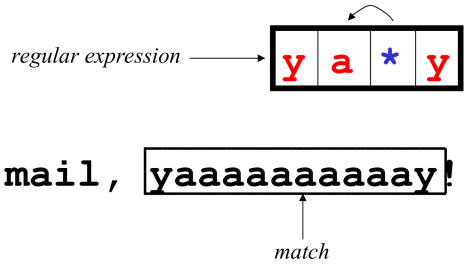
Anchor Characters

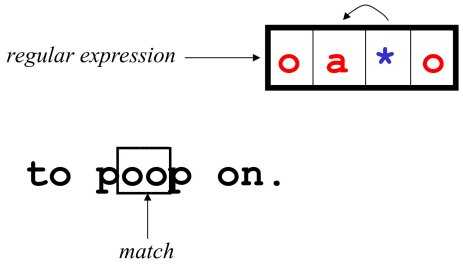
- Anchors are used to match at the beginning or end of a line (or both).
- ^ means beginning of the line
- $ means end of the line



Repetition

- The * is used to define zero or more occurrences of the single regular expression preceding it.

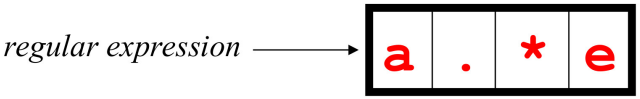


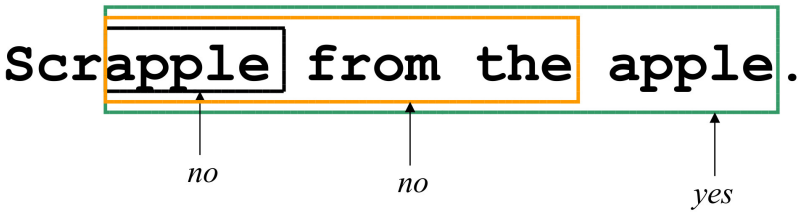


.*

Match Length

- A match will be the longest string that satisfies the regular expression.





Repetition Ranges

- Ranges can also be specified
- { } notation can specify a range of repetitions for the immediately preceding regex
- {n} means exactly n occurrences
- {n,} means at least n occurrences
- {n,m} means at least n occurrences but no more than m occurrences
- Example:
  .{0,} same as .*
  a{2,} same as aaa*

Subexpressions

- If you want to group part of an expression so that * or { } applies to more than just the previous character, use ( ) notation
- Subexpresssions are treated like a single character
- a* matches 0 or more occurrences of a
- abc* matches ab, abc, abcc, abccc, ...
- (abc)* matches abc, abcabc, abcabcabc, ...
- (abc)2,3 matches abcabc or abcabcabc

Global Regular Expressions Print – grep

- grep comes from the ed (Unix text editor) search command "global regular expression print" or g/re/p
- This was such a useful command that it was written as a standalone utility
- There are two other variants, egrep and fgrep that comprise the grep family
- grep is the answer to the moments where you know you want the file that contains a specific phrase but you cant remember its name

Syntax

- Regular expression concepts we have seen so far are common to grep
- grep: \(and \), \{ and \}

Introduction to sed (1)

sed: Stream Editor:

- Input from a file or from a pipe
- Output to a file or to a pipe
- Filters and edits the input text and produces the modified text as output
- Examines input line-by-line, searches for a pattern and makes a replace
- We usually use it when we know how content is structured (lines, columns)

Introduction to sed (2)

- Sed is very useful for simple operations, such as
  - replace or remove patterns,
  - when the operation is not necessarily related with the formatting of the input.
- We wish to repeat the operation over all the lines of the input text.

Main Concepts

pattern space = the data we wish to edit (data buffer)
while (readline) {

1. read the input one line at a time
2. for each line, sed executes a series of commands on the pattern space
3. outputs the resulting/modified text

}

Command Syntax

```
sed <options> '<address><command>'
```

1. address: the line number of the input text, the pattern to search, contained within slashes (/pattern/). Defines where the command will be applied, in which lines or to all lines.
2. The pattern is described using regular expressions,
3. We can provide a range of lines as comma separated values to execute the command over a given range of lines, including the lines defined.
4. ! = NOT (to apply the command to all lines excluding the range provided)

Common Commands

a\	Insert text after current line
c\	Change current text into (new text)
d	Delete text
i\	Insert text before current line
p	Print text
r	Read file
s	Search and replace text
w	Write to file
-e	To set multiple commands
-f SCRIPT_FILE	To use a sed file with commands
-n	Print only the p commands

Replace

Common usage:

```
sed s 'pattern/replacement/<flags>'
```

- pattern: search pattern
- replacement: the string with which to replace the pattern
- flags (optional):
  - **n** (number): number of occurance to replace
  - **g** (global): replace all occurances
  - **p** (print): print the content of the pattern space

Example file

```
bash-3.1$ cat -n example.sed

1 This is the first line of an example text.
2 It is a text with erors.
3 Lots of erors.
4 So many erors, all these erors are making me sick.
5 This is a line not containing any errors.
6 This is the last line.
```

Usage Example 1

```
bash-3.1$ sed 's/erors/errors/g' example.sed

This is the first line of an example text.
It is a text with errors.
Lots of errors.
So many errors, all these errors are making me sick.
This is a line not containing any errors.
This is the last line.
```

What if we replace the command g with number 2?
What if we remove command g completely?

Example 2

^ Start of line - $ End of line

```
bash-3.1$ sed 's/^/> /' example.sed

> This is the first line of an example text.
> It is a text with erors.
> Lots of erors.
> So many erors, all these erors are making me sick.
> This is a line not containing any errors.
> This is the last line.
```

What if we replace the command of ^ with $?

Example 3

```
bash-3.1$ sed -e 's/erors/errors/g' -e
          's/last/final/g' example.sed
(or, alternatively)
sed 's/erors/errors/g; s/last/final/g' example.sed

This is the first line of an example text.
It is a text with errors.
Lots of errors.
So many errors, all these errors are making me sick.
This is a line not containing any errors.
This is the final line.
```

Other special characters

- The characters _ or , (comma) may replace / for improved readability
- \: escape character
- **&** Signifies the pattern found (always referring to the current line)
- Take special care on those symbols that are part of the regular expression

One more example

```
bash-3.1$ sed 's/[^ ][^ ]*/(&)/' example.sed

(This) is the first line of an example text.
(It) is a text with erors.
(Lots) of erors.
(So) many erors, all these erors are making me sick.
(This) is a line not containing any errors.
(This) is the last line.
```

What if the pattern was

```
[a-z]\+\.     ?
s/[^ ]        ?
```

Yet another example

Print only lines that match the pattern after changing it, based on the conditions set:

```
bash-3.1$ sed -n 's/erors/errors/gp' example.sed

It is a text with errors.
Lots of errors.
So many errors, all these errors are making me sick.
```

What if there was a ! before p (print)?

Focus on specific lines (1)

We may focus the changes only in specific lines, declaring the lines with their number.

```
bash-3.1$ sed '1,3 s/erors/errors/g' example.sed

This is the first line of an example text.
It is a text with errors.
Lots of errors.
So many erors, all these erors are making me sick.
This is a line not containing any errors.
This is the last line.
```

Focus on specific lines (2)

We can do the same by providing the common pattern

```
bash-3.1$ sed '/^T/ s/\ is/\ was/g' example.sed

This was the first line of an example text.
It is a text with errors.
Lots of errors.
So many errors, all these erors are making me sick.
This was a line not containing any errors.
This was the last line.
```

What if we use the following command in a python file?

```
sed '/\/\*/,/\*\// s/.\+//' program.c
```

Delete

d	all lines
6d	line 6
/^$/d	all empty lines
/^\./d	all lines starting with .
1,10d	lines 1 -10
1,/^$/d	from the first line until the first empty line
/^$/,$d	from the first empty line until the last line

```
sed -e '/\/\*/,/\*\// s/.\+//' -e 's/^[ \t]\+//' -e'/^$/ d' file.c
```

sed – extra examples

- Replace "foo" with "bar" only in lines containing "baz"

```
sed '/baz/s/foo/bar/g'
```

- Remove empty space from the stand and end of each line

```
sed 's/^[ \t]*//;s/[ \t]*$//'
```

- Add 5 spaces at the start of each line

```
sed 's/^/     /'
```

- Remove all empty lines from a file

```
sed '/^$/d'
```