

LECTURE 8

REGULAR EXPRESSIONS

Definition

Regular expressions are a mini-language for text pattern matching.

Example

Q: Find all occurrences of the word “memory” in the files in this directory.

```
grep 'memory' *
```

MATCHING

The grep command

```
grep [OPTION...] PATTERNS [FILE...]
```

Options:

- -E: “extended” regular expressions (we will use this syntax)
- -R: recursive (if a directory is given, look all files in it, incl. subdirectories)
- -i: case insensitive (a same as A)

Patterns:

Use **single-quotes** (') to avoid shell interference

Files:

if no file provided, grep reads its (piped) input

Piping to grep

Q: Find all files in the current directory whose name contains the letter L

```
ls | grep -E -i `L`
```

Introduction to regular expressions

- by default, patterns are looked for line-by-line
- strings of “normal” characters are matched

```
grep -E 'memory' *
```


Anchors

- the ^ character at the beginning of a regex matches the beginning of a line
- the \$ character at the end of a regex matches the end of a line

Examples:

```
grep -E '^int' *
```

```
grep -E '$' *
```

Repetitions

- ? indicates that the previous character may or may not occur (once)
- * indicates that the previous character may occur zero or multiple times
- + indicates that the previous character may occur one or more times
- {4} indicates that the previous character must occur 4 times
- {4, } indicates that the previous character must occur 4 or more times
- {4, 8} indicates that the previous character must occur between 4 and 8 times

Examples:

```
grep -E 's?printf' *
```

```
grep -E '^ *print' *
```

```
grep -E '0b0+' *
```

```
grep -E 'e{2,}' *
```

Grouping

Any part of a regex can be grouped using parentheses.
Repetitions then apply to the group instead of a single character.

Examples:

```
grep -E '(Abc)+'
```

```
# matches 'Abc', 'AbcAbc',  
# 'AbcAbcAbc', ...
```

Match any character

The dot (“.”) matches any character:

Examples:

```
grep -E 'X.Y'           # matches 'XaY', 'XbY', 'X+Y',  
    ...  
grep -E 'X.*Y'          # matches 'XabcY', 'X+ -* /Y',  
    ...
```

Bracket expressions

- One character can be matched to multiple options using square brackets:

```
grep -E '[abc]XY'           # matches aXY or bXY or cXY
grep -E '0b[01]+'          # matches binary numbers
```

- We can express ranges of characters using a dash:

```
grep -E '[0123456789]+'     # matches decimal numbers
grep -E '[0-9]+'            # ^ equivalent
grep -E '0x[0-9a-fA-F]+'    # matches hexadecimal numbers
grep -E '[A-Z][a-z]*'       # matches words that start with a capital letter
```

- Bracket expressions are negated if the first character is ^:

```
grep -E '[^s]printf'        # matches " printf", "aprintf" ... but not
                             "sprintf"
```

Disjunctions

Multiple options can be given using the “|” character:

```
grep -E 'system_(startup|shutdown)'    # matches "system_startup" or  
                                         "system_shutdown"
```

Special characters

Special characters can be “escaped” using a backslash (“\”):

```
grep -E 'printf\(.*\) '    # matches "printf("Hello %s", name) "
```

Using regular expressions in less

Searching for patterns in the less pager is performed by typing “/”.

Patterns are specified using regular expressions

SEARCH AND REPLACE: `sed`

```
sed [OPTION...] SCRIPT [FILE...]
```

- Options:
 - -E: “extended” regular expressions (we will use this syntax)
 - -i: edit file in-place (instead of printing)
- Script: Use **single-quotes** (') to avoid shell interference
- Files: if no file provided, sed reads its (piped) input

Basic search and replace

```
sed -E 's/REGEX/REPLACEMENT/ '
```

- Examples:

```
sed -E 's/python/Python/'           # replace "python" with "Python"  
sed -E 's/printf\(/fprintf(stderr, /' # replace "printf(a)" with "fprintf(stderr, a)"
```

- Allow multiple replacements per line:

```
sed -E 's/REGEX/REPLACEMENT/g'      # g stands for global
```

- Use delimiter different from “/”:

```
sed -E 's|REGEX|REPLACEMENT| '  
sed -E 's_REGEX_REPLACEMENT_'
```

Advanced search and replace

- In the replacement string, \1 indicate the first parenthesized group, \2 the second, etc.:

```
# replace "Hello, World!" with "Bye, World!"  
sed -E 's/Hello, ([A-Za-z]*)!/Bye, \1!/'
```

- Groups are numbered in the order of the opening parentheses from the left:

```
sed -E 's/(a(b|z)+)(c+)/{\1}{\3}/g'  
#           ^  ^           ^  
#           1  2           3
```

REGULAR EXPRESSIONS IN PROGRAMMING LANGUAGES

Using regular expressions in C

```
#include <stdio.h>
#include <regex.h>

int main()
{
    regex_t re;

    // REG_EXTENDED: POSIX extended regular expression
    // REG_NOSUB: do not report position of matches
    if (regcomp(&re, "0x[0-9a-fA-F]*", REG_EXTENDED | REG_NOSUB)) {
        error();
        return 1;
    }

    int r = regexec(&re, "Does this contain a hex number, like 0xff ?", 0, NULL, 0);

    if (r == 0) {
        printf("Found\n");
    } else if (r == REG_NOMATCH) {
        printf("Not found\n");
    }

    regfree(&re);

    return r;
}
```

See: `man regex`

Using regular expressions in Python

```
>>> import re
>>> m = re.search(r'0x[0-9a-fA-F]*', 'Does this contain a hex number, like 0xff ?')
>>> m.group(0)
'0xff'
```

> [documentation](#)

