Programming in shell 1

Text processing.
Regular expressions.
Filter grep.

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Content

Text processing

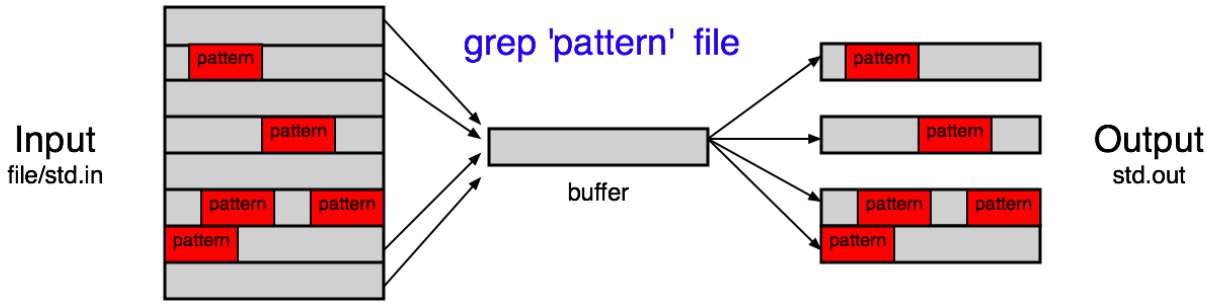
- The discipline of mechanising the creation or manipulation of electronic text.
- **Electronic text**
  - Character encoding
    - It defines how to interpret sequence of bits into real characters.
    - ASCI (using the bottom 7 bits of byte).
    - ANSI (using 8 bits with several different code pages for the symbols 128 to 255).
    - Unicode-based encodings: UTF8 (1 byte), UTF16 (2 bytes), UTF32 (4 bytes).
    - In different character codings, the characters can be in different order (abc...zABC...Z vs. aAbBcC...zZ).
  - Text
    - The sequence of abstract characters.
- **The most common text operations**
  - Find text containing pattern.
  - Find text containing pattern and replace it by a new text.

Pattern specification

- The pattern can be specified in several different ways.
- **Fixed-character string**
  - All characters are interpreted literally (no character has special meaning).
- **Regular expression**
  - The pattern may contain meta-characters that have special meaning to the application that interprets the regular expression.
  - According to the set of supported meta-characters we define
    - Basic regular expressions (BRE),
    - Extended regular expressions (ERE),
    - Perl Compatible Regular Expressions (PCRE).
  - Regular expressions can be interpreted by
    - library functions (`match`, `split`, `gsub`, ...) of different programming languages (Java, C#, Python, ...),
    - applications (`less`, `vi`, `grep`, `sed`, `awk`, ...).

Fixed-character pattern: `grep -F` / `fgrep`

`grep -F [options] patter [files]` (GNU implementation)
`fgrep [options] patter [files]`



- The `pattern` is is interpreted literally (fixed-character string).
- The filter `fgrep` (fast grep) searches standard input/text files for a character string and prints all lines that contain that string.
- Useful options
  - `-i` ... ignores upper/lower case.
  - `-v` ... prints all lines except those that contain the pattern.
  - `-c` ... prints only a count of the lines that contain the pattern.
  - `-l` ... prints only the names of files with matching lines.
  - `-n` ... precedes each line by its line number in the file (first line is 1).

Fixed-character pattern: `grep -F` / `fgrep`

- Examples
  - Print all lines from file `/etc/passwd`, that contain string "root".

```
grep -F 'root' /etc/passwd
```

  - Print all lines from file `/etc/passwd`, that don't contain string "root".

```
grep -F -v 'root' /etc/passwd
```

  - How many lines from the file `/etc/passwd` contain string "root".

```
grep -F -c 'root' /etc/passwd
```

  - How many lines from the file `/etc/passwd` don't contain string "root".

```
grep -F -vc 'root' /etc/passwd
```

Fixed-character pattern: `grep -F` / `fgrep`

- Examples
  - Print only names of files from the directory `/etc` that contain the string "root".

```
grep -F -l 'root' /etc/*  2>/dev/null
```

  - Print only name of file from the directory `/etc` that contains the string "root" and the string is located on the line with the highest number.

```
grep -F -n 'root' /etc/*  2>/dev/null | \
   sort -t':' -k2,2n | tail -1 | cut -d':' -f1
```

  - How many students have an account on the server `fray3.fit.cvut.cz`?

```
ssh $USER@fray3.fit.cvut.cz 'getent␣passwd' | \
   grep -Fc '␣student:'
```

    - Is it correct solution?

Extended regular expressions: grep -E / egrep

`grep -E [options] patter [files]` (GNU implementation)
`egrep [options] patter [files]`

- The filter searches standard input/text files for a `pattern` and prints all lines that contain that `pattern`.
- `Pattern` is defined as basic regular expression (ERE) in which the following meta characters are interpreted.
  - System V supports (in Solaris `/usr/bin/egrep`)
    - Disabling/enabling meta-character: `\`.
    - Anchoring : `^`, `$`.
    - Single character: `.`, `[ ]`, `[^ ]`.
    - Repetition: `?`, `+`, `*`.
    - Subexpressions: `( )`.
    - Alternation: `|`.
  - In addition, GNU supports (in Solaris `/usr/bin/ggrep -E`)
    - The backslash character: `\<`, `\>`.
    - Repetition: `{ }`.
    - Back references: `( )`, `\n`.

Extended regular expressions: grep -E / egrep

- Anchoring

^	The caret matches the the begin of a line.
$	The dollar sign matches the end of a line.

  - Examples
    - Print entries of the directory /etc that represent symbolic links.

```
ls -la /etc | grep -E '^l'
```

    - How many users who have an account on this system are named Jiri?

```
getent passwd | cut -d':' -f5 | grep -E '^Jiri␣'
```

    - Print login names of users that have bash set up as their login shell on this system?

```
getent passwd | grep -E '/bash$' | cut -d':' -f1
```

Extended regular expressions: grep -E / egrep

- The backslash character

\<	The symbol matches the begin of a word (only GNU).
\>	The symbol matches the end of a word (only GNU).

  - These meta-characters are not supported by egrep in Solaris.
  - Examples
    - Print all lines of command `man ls`, that contain the string "the".

```
man ls | grep -E 'the'
```

    - Print all lines of command `man ls`, that contain the word "the".

```
man ls | grep -E '\<the\>'
```

    - Copy the file `/usr/dict/words` from the server `fray1.fit.cvut.cz` to your working directory.
    - Print lines from the file `words`, that contain words starting with the character 'b'.

```
grep -E '\<b' words
```

```
grep -E '^b' words      # file has one word per line
```

Extended regular expressions: grep -E / egrep

- Single character

`.`	The period matches any single character.
`[ ]`	It matches any single character in the list/range expression.
`[^ ]`	It matches any single character not in the list/range expression.

  - Examples
    - Print all the words of length 4 from the file `words`.

```
grep -E '^....$' words
```

    - Print all the words of length 3 from the file `words`, that have in the middle the vowel (a, e, i, o, u, y).

```
grep -E '^.[aeiouy].$' words
```

    - Print all the words of length 3 from the file `words`, that have not in the middle the vowel (a, e, i, o, u, y).

```
grep -E '^.[^aeiouy].$' words
```

    - Print all words from the file `words`, that begin uppercase character.

```
export LC_ALL=C       # dependent on character encoding
grep -E '^[A-Z]' words
```

Extended regular expressions: grep -E / egrep

- Character classes
  - The set of characters, that are defined by a range of characters, depends on the locales (character encoding).
  - In order to avoid dependence on locales, character classes have been defined (not supported by egrep in Solaris).

[:digit:]	Digits: '0 1 2 3 4 5 6 7 8 9'.
[:lower:]	Lower-case letters: 'a b c ... x y z'.
[:upper:]	Upper-case letters: 'A B C ... X Y Z'.
[:alpha:]	Alphabetic characters.
[:alnum:]	Alphanumeric characters.
[:blank:]	Blank characters: space and tab.

  - Examples
    - Print all the words from the file words, that contain digit.

```
grep -E '[[:digit:]]' words
```

    - Print all the words from the file words, that have the digit only as the first character.

```
grep -E '^[[:digit:]][^[:digit:]]*$' words
```

Extended regular expressions: grep -E / egrep

- Repetition

?	The preceding item will be matched 0 or 1 times.
+	The preceding item will be matched one or more times.
*	The preceding item will be matched zero or more times.
$\{m\}$	The preceding item is matched exactly m times.
$\{m,\}$	The preceding item is matched m or more times.
$\{,n\}$,	The preceding item is matched at most n times.
$\{m,n\}$	The preceding item is matched at least m times, but not more than n times.

  - Meta-characters { } are not supported by egrep in Solaris.
  - Examples
    - Print all the words from the file `words`, that begin and end with the character 'a'.

```
grep -E '^a.*a$' words
```

    - Print all the words of length 3, 4 or 5 from the file `words`.

```
grep -E '^.{3,5}$' words
```

    - Which substring is found by grep?

```
echo "xAxAxAxAAxAAAxAxAAx" | grep -E 'A.*'
```

Extended regular expressions: grep -E / egrep

- Alternation, subexpressions and back references

|	Two regular expressions may be joined by this infix operator. The resulting regular expression matches any string matching either alternate expression.
( )	Defines a marked subexpression. The string matched within the parentheses can be recalled later.
\n	Matches what the *n*-th marked subexpression matched.

  - Meta-character \n is not supported by egrep in Solaris.
  - Examples
    - Print all the words from the file words, that begin with string "work" or end with string "work".

```
grep -E '^work.*|.*work$' words
```

    - Print all the words from the file words, that contain the following strings: "boy", "girl", "woman" or "man".

```
grep -E 'boy|girl|woman|man' words
```

    - Print all the words from the file words, that end with one of the following strings: "boy", "girl", "woman" or "man".

```
grep -E '(boy|girl|woman|man)$' words
```

Extended regular expressions: grep -E / egrep

- Subexpressions and back references
  - Examples
    - Print all the words from the file `words`, that begin and end with the same character.

```
grep -E '^(.).*\1$' words
```

    - Print all the words from the file `words`, that begin and end with the different character.

```
grep  -Ev '^(.).*\1$' words
```

    - Print all palindromes of the length 3 from the file `words`.

```
grep -E '^(.).\1$' words
```

    - Print all palindromes of the length 4 from the file `words`.

```
grep -E '^(.)(.)\2\1$' words
```

Basic regular expressions: grep

`grep [options] patter [files]`

- The filter `grep` searches standard input/text files for a `pattern` and prints all lines that contain that `pattern`.
- `Pattern` is defined as basic regular expression (BRE) in which the following meta characters are interpreted.
  - System V supports (in Solaris `/usr/bin/grep`)
    - Anchoring : `^`, `$`.
    - The backslash character: `\<`, `\>`.
    - Single character: `.`, `[ ]`, `[^ ]`.
    - Repetition: `*`, `\{ \}`.
    - Subexpressions and back references: `\( \)`, `\n`.
  - In addition, GNU supports (in Solaris `/usr/xpg4/bin/grep`)
    - Repetition: `\?`, `\+`.
    - Alternation: `\|`.
- Note
  - Originally, the characters `?`, `+`, `|`, `<`, `>`, `{ }` and `( )` were not meta-characters. Special meaning was added later.
  - Therefore, the character `\` allows the special meaning of these characters in BRE (backward compatibility).