Tutorial9: Regular Expressions

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USING REGULAR EXPRESSIONS

Main Objectives of this Practice Tutorial

- Define the term **Regular Expressions**
- Explain the difference between **Regular Expressions** and **Filename Expansion**
- Explain the purpose of **Literal (Simple)** Regular Expressions
- Understand and use common symbols for **Complex** Regular Expressions and their purpose
- Understand and use command symbols for **Extended** Regular Expressions and their purpose
- List several Linux commands that can use regular expressions

Tutorial Reference Material

Course Notes	Linux Command/Shortcut Reference		YouTube Videos
Slides:	**Regular Expressions:**	**Linux Commands:**	**Brauer Instructional Videos:**
• Week 9 Lecture 1 Notes: PDF	PPTX • Definition • Purpose (WIKI)	• egrep • man • more / less • vi / vim • sed • awk • wget	• Using grep Command with Regular Expressions
• Week 9 Lecture 2 Notes: PDF	PPTX		

KEY CONCEPTS

Regular Expressions

*A **regular expression** is a combination of two types of characters: **literals** and **special characters**.*
Strings of text can be compared to this pattern to see if there is a match.

This usually refers to text that is contained inside a **file** or text as a result of issuing Linux commands using a **Linux pipeline command**.

Literal (Simple) Regular Expressions

The simplest regular expression is a series of letters and numbers, (tabs or spaces).
A **simple** (**literal**) regular expression consists of normal characters, which used to match patterns.

Although there are many Linux commands that use regular expressions, the **grep** command is a useful command to learn how to display matches of patterns of strings within text files.

For example: `grep Linux document.txt`

```
cat document.txt
I like Linux
It is different than Windows
I find Linux useful

grep Linux document.txt
I like Linux
I find Linux useful
```

A **simple** (**literal**) regular expression is a series of letters and numbers (tabs or spaces).

Complex / Extended Regular Expressions

Complex Regular Expressions

The problem with just using **simple** (**literal**) regular expressions is that only simple or general patterns are matched.

Complex Regular Expressions use symbols to help match text for more precise (complex) patterns.
The most common complex regular expression symbols are displayed below:

Anchors: `^` , `$`
Match lines the begin (^) or end ($) with a pattern.
Single Character: `.` 點
Represents a single character that can be any type of character.
Character Class: `[ ]` , `[^ ]`
Represents a single character but with restrictions.
Zero or More Occurrence: `*`
Zero or more occurrences of previous character.

Examples of **complex regular expressions** are displayed below:

```
cat data.txt
Beginning of the line
This is not at the beginning
This is at the end
Beginning of line and the end
Not at beginning and end not so

grep "^Beginning" data.txt
Beginning of the line
Beginning of line and the end

grep "end$" data.txt
This is at the end
Beginning of line and the end
```

Example of using **anchors**.

```
cat data.txt
Hello
Therefore
Hi
I
isn't

grep "^.$" data.txt
I

grep "^.....$" data.txt
Hello
isn't
```

Example of matching by **character(s)**.

```
cat data.txt
abc123
12abcdef
abc.
XYZ
123abc+

grep "^[a-z][a-z][a-z]" data.txt
abc123
abc.

grep "[^a-zA-Z]$" data.txt
abc123
abc.
123abc+
```

Example of using **character class**.

```
data.txt
Linux is an OS
Linux iis and OS
Linux is a choice
is true
iis true
iiis true
true

grep "Linux i*" data.txt
Linux is an OS
Linux iis and OS
Linux is a choice

grep "i*s an" data.txt
Linux is an OS
Linux iis and OS
```

Example of matching **zero or more occurrence of preceding character**.

Extended Regular Expressions

Extended Regular Expressions consist of additional special characters to "extend" the capability of regular expressions. You must use the **egrep** or **grep -E** commands in order to properly use extended regular expressions.

Repetition: `{min,max}`
Allows for more precise repetitions. Using braces, you can specify the **minimum** and/or **maximum** number of repetitions.

Groups: `( )`
Allows you to search for repetition for a **group of characters**, a **word**, or a **phase**.
You enclose them within brackets `( )` to specify a **group**.

or Condition: `|`
Can be used with **groups** to match a variety of character(s), words or phases.
The | symbol is used to separate the variety of character(s) within a *group*.

Examples of how to use **extended regular expressions** with the **egrep** command are displayed below:

```
cat data.txt
123
+45
+++37
-67.89
--57.6
-78...4
12.6
+26.887

egrep "^[0-9]{1,}$" data.txt
123

egrep "^[+-]{0,1}[0-9]{1,}$" data.txt
123
+45

egrep "^[0-9]{1,}[.]{0,1}[0-9]{0,}$" data.txt
123
12.6
```

Example of using **repetition**.

```
cat data.txt
The lazy fox jumped over dog
Time to go to the the store
I like to go to the movies
I act like a lazy fox lazy fox lazy fox
Don't be a lazy fox

egrep "(the ){2,}" data.txt
Time to go to the the store

egrep "(lazy fox ){2,3}" data.txt
I act like a lazy fox lazy fox lazy fox
```

Example of using **groups**.

```
cat data.txt
I know this is the day
Because that is correct
We don't know that it is sunny
I know how to cccamp
I waaaaant a tissue
Can a bbborrow a cup of sugar?

egrep "(this | that ){1,}" data.txt
I know this is the day
Because that is correct
We don't know that it is sunny

egrep "(a|b|c){3,}" data.txt
I know how to cccamp
I waaaaant a tissue
Can a bbborrow a cup of sugar?
```

Example of using **or** condition with **groups**.

INVESTIGATION 1: SIMPLE & COMPLEX REGULAR EXPRESSIONS

ATTENTION: This online tutorial will be required to be completed by **Friday in week 10 by midnight** to obtain a grade of **2%** towards this course

In this investigation, you will learn how to use the **grep** command with **simple and complex regular expressions** to help search for *patterns* contained in text files.

Perform the Following Steps:

1. **Login** to your matrix account.

2. Issue a Linux command to **confirm** you are located in your **home** directory.

   The **wget** command is used to download files from the Internet to your shell.
   This will be useful to download **text files** and **data files** that we will be using in this tutorial.

```
This is the first line
The day is nice and warm
This may indeed be the end of the road
There are many types of clouds in the sky today
THE

Seven people are located near their car
THE RAIN IS HEAVY
Roger Water's movie "Us and Them" is great
123
Here are some letters: xxxxxxx
The broom is located near the closet
DOG
5 is a number just like 3
I like them a lot for their assistance
456
This is the day
23432 is a number greater than 45
The letter X is displayed more than the times: 2
The happy xxxx is interesting
The first thing to do is to read the instructions
789
the
This is the word: the
Cat
Testing testing 123

The happy xx is nice
```

3. Issue the following linux Linux command to **download** a text file to your **home** directory:
   `wget https://github.com/ULI101/labs/raw/main/textfile1.txt`

4. View the contents of the **textfile1.txt** file using the **more** command see what data is contained in this file.

   Although there are several Linux commands that use regular expressions,
   we will be using the **grep** command for this investigation.

5. Issue the following Linux command to match the pattern **the** within **textfile1.txt**:
   `grep "the" textfile1.txt` match all the phases which include "the". Example: I like **the**m a lot for **the**ir assistance

   Take a few moments to view the output and observe the matched patterns.

```
[ murray.saul ] grep "the" textfile1.txt
This is the first line
This may indeed be the end of the road
There are many types of clouds in the sky today
Seven people are located near their car
The broom is located near the closet
I like them a lot for their assistance
This is the day
The letter X is displayed more than the times: 2
The first thing to do is to read the instructions
the
This is the word: the
```
Output of **grep** command matching simple regular expression "**the**" (only lowercase). Notice the pattern matches larger words like "**their**" or "**them**".

6. Issue the grep Linux command with the `-i` option to ignore case sensitively:
   `grep -i "the" textfile1.txt`
   match all the phases which include case insensitive"the"
   What do you notice is different when issuing this command?

   Example:
   THE RAIN IS HEAVY
   There are many types of clouds in **the** sky today

   You will notice that the pattern "**the**" is matched including larger words like "**them**" and "**their**".
   You can issue the **grep** command with the `-w` option to only match the pattern as a **word**.

7. Issue the following Linux command:
   `grep -w -i "the" textfile1.txt`
   match all the words which include case-insentive "the"
   You should now see only strings of text that match the word **the** (upper or lower case).

   Example:
   This is **the** first line
   THE RAIN IS HEAVY

   Matching literal or simple regular expressions can be useful, but are **limited**
   in what pattens they can match. For example, you may want to
   search for a pattern located at the **beginning** or **end** of the string.

   There are other regular expression symbols that provide more **precise** search pattern matching.
   These special characters are known as **complex** and **extended** regular expressions symbols.

   For the remainder of this investigation, we will focus on **complex regular expressions** and then
   focus on *extended regular expressions* in INVESTIGATION 2.

8. Issue the following Linux command:
   `grep -w -i "^the" textfile1.txt`

   The **^** symbol is referred to as an **anchor**.
   In this case, it only matches
   the word **"the"** (both upper or lowercase) at the beginning of the string.

```
[ murray.saul ] grep -w -i "^the" textfile1.txt
The day is nice and warm
THE
THE RAIN IS HEAVY
The broom is located near the closet
The letter X is displayed more than the times: 2
The happy xxxx is interesting
The first thing to do is to read the instructions
the
The happy xx is nice
```
Anchoring regular expressions at the **beginning** of text.

9. Issue the following Linux command:
   `grep -w -i "the$" textfile1.txt`

   The **$** symbol is used to anchor patterns at the end of the string.

```
[ murray.saul ] grep -w -i "the$" textfile1.txt
THE
the
This is the word: the
```
Anchoring regular expressions at the **ending** of text.

10. Issue the following Linux command to anchor the word **"the"**
    simultaneously at the beginning and end of the string:
    `grep -w -i "^the$" textfile1.txt`

    What do you notice?
    Only these two lines:
    THE
    the

    Anchoring patterns at both the beginning and ending of strings can greatly assist
    for more **precise** search pattern matching.

    We will now be demonstrate the **effectiveness** of combining
    anchors with other complex regular expressions symbols.

11. Issue the following Linux command to match strings that **begin with 3 characters**:
    `grep "^..." textfile1.txt`

    What do you notice? Can lines that contain **less than 3 characters** be displayed?
    No. at least 3 characters or more in a line will be displayed.

```
[ murray.saul ] grep "^..." textfile1.txt
This is the first line
The day is nice and warm
This may indeed be the end of the road
There are many types of clouds in the sky today
THE
Seven people are located near their car
THE RAIN IS HEAVY
Roger Water's movie "Us and Them" is great
123
Here are some letters: xxxxxxx
The broom is located near the closet
```
Anchoring regular expressions using **period** symbols at the **beginning** of text.

12. Issue the following Linux command to match strings that **begin and end with 3 characters**:
    `grep "^...$" textfile1.txt`

    What do you notice compared to the previous command? Exactly length of 3 characters in a line will be displayed.

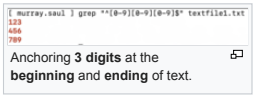
```
[ murray.saul ] grep "^...$" textfile1.txt
THE
123
DOG
456
789
the
Cat
```
Anchoring regular expressions using **period** symbols simultaneously at the **beginning** and **ending** of text.

13. Issue the following Linux command to match strings that **begin with 3 digits**:
    `grep "^[0-9][0-9][0-9]" textfile1.txt`

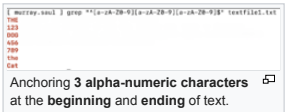
    What did you notice?
    123
    456
    23432 is a number greater than 45
    789

14. Issue the following Linux command to match strings that **end with 3 uppercase letters**:
    ```
    grep "[A-Z][A-Z][A-Z]$" textfile1.txt
    ```
    What type of strings match this pattern?

    THE
    THE RAIN IS HE**AVY**
    DOG



Anchoring **3 digits** at the **beginning** and **ending** of text.



Anchoring **3 alpha-numeric characters** at the **beginning** and **ending** of text.

15. Issue the following Linux command to match strings that **consist of only 3 digits**:
    ```
    grep "^[0-9][0-9][0-9]$" textfile1.txt
    ```
    What did you notice?

    123
    456
    789

16. Issue the following Linux command to match strings that **consist of only 3 alphanumeric digits**:
    ```
    grep "^[a-zA-Z0-9][a-zA-Z0-9][a-zA-Z0-9]$" textfile1.txt
    ```
    What did you notice?

    THE
    123
    DOG
    456
    789
    the
    Cat

    The "*" complex regular expression symbol is often confused with the "*" **filename expansion** symbol.
    In other words, it does NOT represent zero or more of **any character**, but zero or more **occurrences**
    of the character that comes **before** the "*" symbol.

17. To demonstrate, issue the following Linux command to display **zero or more occurrences** of the letter "**x**":
    ```
    grep "x*" textfile1.txt
    ```
    You will most likely notice most lines of the file is displayed.

18. Let's issue a Linux command to display strings that contain **more than one occurrence** of the letter "**x**":
    ```
    grep "xx*" textfile1.txt
    ```
    Here are some letters: xxxxxxx
    The happy xxxx is interesting
    The happy xx is nice

    Why did this work? because the pattern indicates one occurrence of the letter "x",
    followed by **zero or MORE occurrences** of the next letter "x".

    If you combine the complex regular expression symbols ".*" it will act like
    zero or more occurrences of any character (i.e. like "*" did in filename expansion).

19. Issue the following Linux command to match strings begin and end with a number with nothing or anything inbetween:
    ```
    grep "^[0-9].*[0-9]$" textfile1.txt
    ```
    Using **simultaneous anchors** combined with the ".*" symbol(s) can help you to refine your search patterns of strings.

    123
    5 is a number just like 3
    456
    23432 is a number greater than 45
    789

20. Issue the following Linux command to display strings that begin with a capital letter,
    end with a number, and contains a capital X somewhere inbetween:
    ```
    grep "^[A-Z].*X.*[0-9]$" textfile1.txt
    ```
    The letter X is displayed more than the times: 2

    Let's look at another series of examples involving searching for strings that only contain **valid numbers**.
    We will use **pipeline commands** to both display stdout to the screen and save to files
    for confirmation of running these pipeline commands when run a **checking-script** later in this investigation.

21. Issue the following Linux command to create the **regexps** directory: `mkdir ~/regexps`

22. Change to the **regexps** directory and confirm that you have moved to this directory.

23. First, issue the following Linux command to download another data file called **numbers1.dat**:
    ```
    wget https://github.com/ULI101/labs/raw/main/numbers1.dat
    ```
    123
    +123
    -34
    +17
    -45
    -56.336
    +45xx78

    4x
    67890
    w
    345ppp
    123rrt667
    45p8
    25.6
    1
    11
    34
    101

24. View the contents of the **numbers.dat** file using the **more** command and quickly view the contents of this file.
    You should notice **valid** and **invalid** numbers contained in this file. When finished, exit the more command.

25. Issue the following linux pipeline command to display only **whole** numbers (i.e. no **+** or **-** sign):
    ```
    grep "^[0-9]*$" numbers1.dat | tee faulty.txt
    ```
    You may have noticed that the command **does not entirely work**. You may notice an **empty line**
    (which is NOT a whole number). This occurs since the * regular expression symbol represents
    ZERO or MORE occurrences of a number. You can use an additional numeric character class
    with the * regular expression symbol to search for one or more occurrences of a number.

    123

    67890
    1
    11
    34
    101

26. Issue the following Linux pipeline command to display only whole numbers:
    ```
    grep "^[0-9][0-9]*$" numbers1.dat | tee whole.txt
    ```
    You should see that this now works.

    123
    67890
    1
    11
    34
    101

27. Issue the following Linux pipeline command to display only **signed** integers:
    ```
    grep "^[+-][0-9][0-9]*$" numbers1.dat | tee signed.txt
    ```
    What did you notice? Positive and negative numbers display, not **unsigned** numbers.

    +123
    -34
    +17
    -45

28. Issue the following Linux pipeline command to display **signed** or **unsigned integers**:
    ```
    grep "^[+-]*[0-9][0-9]*$" numbers1.dat | tee all.txt
    ```
    Did this command work? Yes, it works.

    123
    +123
    -34
    +17
    -45
    67890
    1
    11
    34
    101

29. Issue the following command to check that you created those hard links:
    `~uli101/week9-check-1`

    If you encounter errors, then view the feedback to make corrections, and then re-run the checking script. If you receive a congratulation message that there are no errors, then proceed with this tutorial.

    You can also use the **grep** command using *regular expression* as a **filter** in pipeline commands.

30. Issue the following Linux pipeline command:
    `ls | grep "[0-9].*dat$"`

    ls:
    all.txt faulty.txt numbers1.dat signed.txt whole.txt

    What did this pipeline display? numbers1.dat

31. Issue the following Linux pipeline command:
    `ls | grep "[a-z].*txt$"`

    all.txt
    faulty.txt
    signed.txt
    whole.txt

    What did this pipeline display?

Although very useful, **complex** regular expressions do NOT entirely solve our problem of displaying **valid** unsigned and signed numbers (not to mention displaying decimal numbers).

In the next investigation, you will learn how to use **extended** regular expressions that will completely solve this issue.

You can proceed to INVESTIGATION 2.

Simultaneous **anchoring** of regular expressions using **character class** and **zero or more occurrences** to display **signed** and **unsigned** integers.

INVESTIGATION 2: EXTENDED REGULAR EXPRESSIONS

In this investigation, you will learn how to use **extended regular expressions** with the **egrep** command to further refine your search patterns.

123
7
-123
67890
1
11
---123
---------67
34
101
++++++++56
+++34
123.76
45.7
456....89
23434---
456456++++56
567.05
+345345.67
-23.667

Perform the Following Steps:

1. Make certain that you are located in your **~/regexps** directory on your *Matrix* account.

2. Issue the following Linux command to download another data file called **numbers2.dat**:
   `wget https://github.com/ULI101/labs/raw/main/numbers2.dat`

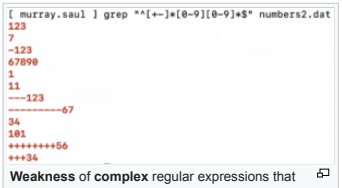
3. View the contents of the **numbers2.dat** file using the **more** command and quickly view the contents of this file. You should notice *valid* and *invalid* numbers contained in this file. When finished, exit the more command.

4. Issue the following Linux command to display **signed** or **unsigned integers**:
   `grep "^[+-]*[0-9][0-9]*$" numbers2.dat`

   123
   7
   -123
   67890
   1
   11
   ---123
   ---------67
   34
   101
   ++++++++56
   +++34

   You should notice **multiple +** or **- signs** appear prior to some numbers.
   This occurs since you are searching or one or MORE occurrences of a + or - sign.

   Using **extended regular expression** symbols to specify **minimum** and **maximum** repetitions: **{min,max}** can solve that problem.



Weakness of **complex** regular expressions that do not **limit** the number of **positive** or **negative** signs.

5. Issue the following Linux command (using extended regular expression symbols) to display **signed** or **unsigned integers**:
   `grep "^[+-]{0,1}[0-9]{1,}$" numbers2.dat`

   NOTE: No output will be displayed! Why?

   This is due to the fact that the **grep command was NOT issued correctly to use extended regular expression symbols**. You would need to issue either **grep -E**, or just issue the **egrep** command. The egrep command works with **all** regular expression symbols, and should be used in the future instead of the older grep command.

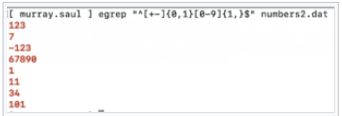
   We will use **pipeline commands** to both display stdout to the screen and save to files for confirmation of running these pipeline commands when run a **checking-script** later in this investigation.

6. Issue the following Linux pipeline command using **egrep** instead of *grep*:
   `egrep "^[+-]{0,1}[0-9]{1,}$" numbers2.dat | tee better-number1.txt`

   txt
   123
   7
   -123
   67890
   1
   11
   34
   101

   You should have noticed that the command worked correctly this time because you used the **egrep** command.

   NOTE: With extended regular expressions, the **?** symbol can be used to represent the **{0,1}** repetition symbols and the **+** symbol can be used to represent the **{1,}** repetition symbols



Using **extended** regular expression symbols (such as **repetition**) to refine matches of *signed* and *unsigned* integers.

7. Issue the following Linux pipeline command using the repetition shortcuts "+" and "?":
   `egrep "^[+-]?[0-9]+$" numbers2.dat | tee better-number2.txt`

   You should have seen the **same results**, but less typing was required.

8. Issue the following Linux pipeline command to display **signed**, **unsigned**, **whole**, and **decimal** numbers:
   `egrep "^[+-]{0,1}[0-9]{1,}[.]{0,1}[0-9]*$" numbers2.dat | tee better-number3.txt`

   123
   7
   -123
   67890
   1
   11
   34
   101
   123.76
   45.7
   567.05
   +345345.67
   -23.667

Were all signed and unsigned intergers and decimal numbers displayed? Yes, it works

9. Issue the follwoing command to check that you correctly issued those *Linux pipeline commands*:
   `~uli101/week9-check-2`

   If you encounter errors, then view the feedback to make corrections, and then re-run the checking script.
   If you receive a congratulation message that there are no errors, then proceed with this tutorial.

   You can also use extended regular expression symbols for **grouping**.
   For example, you can search for repetitions of GROUPS of characters (like a word)
   as opposed to just a single character or a GROUP of numbers as opposed to a single digit.

10. Issue the following linux pipeline command to download another data file called **words.dat**:
    `wget https://github.com/ULI101/labs/raw/main/words.dat`

```
Hello there
This and that
Goodbye
This and and that
This is an non empty line
This and and and that
I like the group called the the
The group the the is a group in the 80s
I like the group called the the the
The group the the the the was a group in the 80s
My brother and I are going to the store and and and and and movies
```

11. View the contents of the **words.dat** file using the **more** command and quickly view the contents of this file.
    Within this file, you should notice some lines that contain repetitions of words. When finished, exit the more command.

12. Issue the following linux pipeline command to display **two or more occurrences** of the word "the":
    `egrep -i "(the){2,}" words.dat | tee word-search1.txt more`

    NOTE: No output is displayed! Why?

    This is due to the fact that a space should be included at the end of the word "**the**".
    Usually words are separated by spaces; therefore, there were no matches since there were not occurrences of "thethe" as opposed to "**the the**" (i.e. no space after repetition of the pattern).

13. Reissue the previous pipeline command with the word the followed by a **space** within the brackets:
    `egrep -i "(the ){2,}" words.dat | tee word-search2.txt`

```
The group the the is a group in the 80s
I like the group called the the the
The group the the the the was a group in the 80s
```

    The "|" (or) symbol (same symbol as "pipe") can be used within the grouping symbols to allow matching of additional groups of characters.
    Again, it is important to follow the character groupings with the space character

```
[ murray.saul ] egrep -i "(the ){2,}" words.dat | tee word-search2.txt
The group the the is a group in the 80s
I like the group called the the the
The group the the the the was a group in the 80s
```

Using **extended** regular expression symbols (such as **grouping**) to refine matches of repetition of **words** (as opposed to *characters*).

14. Issue the following linux pipeline command to search for **two or more occurrences** of the word "**the** " or **two or more occurrences** of the word "**and** ":
    `egrep -i "(the |and ){2,}" words.dat | tee word-search3.txt`

```
This and and that
This and and and that
The group the the is a group in the 80s
I like the group called the the the
The group the the the the was a group in the 80s
My brother and I are going to the store and and and and and movies
```

15. Issue the following Linux command to check that you correctly issued those *Linux pipeline commands* using the **tee** command to create those text files:
    `~uli101/week9-check-3`

    If you encounter errors, then view the feedback to make corrections, and then re-run the checking script.
    If you receive a congratulation message that there are no errors, then proceed with this tutorial.

    Let's issue a Linux **pipeline** command using the **egrep** command as a **filter** using both **complex** and **extended** regular expressions.

```
ls:
all.txt           better-number3.txt  numbers1.dat  whole.txt        word-search2.txt
better-number1.txt  faulty.txt          numbers2.dat  words.dat        word-search3.txt
better-number2.txt  more                signed.txt    word-search1.txt
```

16. Issue the following Linux pipeline command:
    `ls | egrep "[a-z]{1,}.*[0-9]"`

    What did this Linux pipeline command display?

```
better-number1.txt
better-number2.txt
better-number3.txt
numbers1.dat
numbers2.dat
word-search1.txt
word-search2.txt
word-search3.txt
```

The **grep** and **egrep** Linux commands are NOT the only Linux commands that use regular expressions.
In the next investigation, you will apply regular expressions to a number of Linux commands that you already learned in this course.

You can proceed to INVESTIGATION 3

INVESTIGATION 3: OTHER COMMANDS USING REGULAR EXPRESSIONS

In this investigation, you will see commands other than **grep** or **egrep** that can use regular expressions.

Perform the Following Steps:

1. Make certain that you are located in your **~/regexps** directory on your *Matrix* account.

2. Let's look at using regular expressions with the **man** command.
   Issue the following linux command :
   `man ls`

3. We want to search for an option that can sort the file listing.
   Type the following regular expression below and press **ENTER**:
   `/sort`

   FYI: The **grep** and **egrep** Linux commands contain the regular expressions within quotes, but **most** other Linux commands specify regular expressions using

```
-S      sort by file size
--sort=WORD
              sort by WORD instead of name:
```

Entering **/sort** in the **man** command can search for the string "**sort**".

forward slashes (e.g. `/regular expression` or `/regular expression/`).

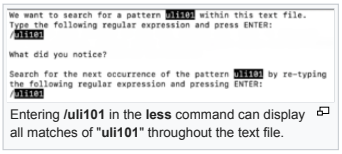
4. Scroll throughout the man pages for the ls command to view matches for the pattern "**sort**"
   (You can press **SPACE** or key combination **alt-b** to move forward and backwards one screen respectively).

5. Press the letter `q` to **exit** the *man* pages for **ls**.

   Let's use regular expressions with the **less** command.

6. Issue the following Linux command to download another data file called **large-file.txt**:
   `wget https://github.com/ULI101/labs/raw/main/large-file.txt`

7. Issue the following Linux command to view the contents of the **large-file.txt**:
   `less large-file.txt`



Entering **/uli101** in the **less** command can display all matches of "**uli101**" throughout the text file.

8. We want to search for a pattern **uli101** within this text file.
   Type the following regular expression and press ENTER:
   `/uli101`

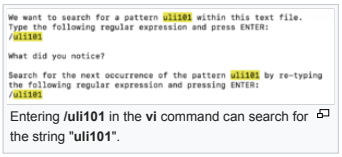
   You should see the pattern "uli101" throughout the text file.

9. Press the letter `q` to exit the **less** command.

10. Try the same search techniques with the **more** command.

    Does it work the same for the *less* command? No, it doesn't work the same for the less command.

    Let's learn how to perform a simple **search and replace** within the **vi** utility
    by using regular expressions.



Entering **/uli101** in the **vi** command can search for the string "**uli101**".

11. Issue the following Linux command to edit the **large-file.txt** file:
    `vi large-file.txt`

    Let's first perform a simple search within this text file.

12. Press the **ESC** key to make certain you are in **COMMAND** mode.

13. Type the following and press **ENTER**:
    `/uli101`

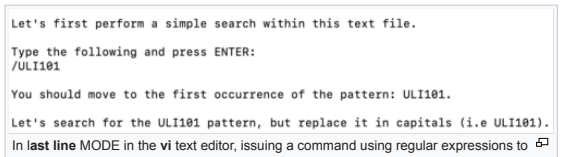
    You should notice the pattern "**uli101**" highlighted for ALL occurrences in this text file.

    Let's **search** for the **uli101** pattern, and **replace** it in capitals (i.e **ULI101**).

    In vi, to issue a command, you need to enter **LAST LINE** MODE then issue a command.
    Let's issue a command from **LAST LINE** MODE to search and replace **uli101** to **ULI101**.

14. Making certain that you are **COMMAND** MODE in vi,
    type the following and press **ENTER**:
    `:%s/uli101/ULI101/g`

    NOTE: The letter **g** after the replace regular expression represents "**global**" and will replace ALL occurrences of uli101 in the text document (as opposed to replacing the first occurrence for every line).



In **last line** MODE in the **vi** text editor, issuing a command using regular expressions to convert **uli101** to **ULI101**.

15. Type the following (in uppercase letters) and press **ENTER**:
    `/ULI101`

    You should notice the pattern "**ULI101**" highlighted for ALL occurrences in this text file.

16. Navigate throughout the text file to confirm that ALL occurrences of **uli101** have been replaced with **ULI101**.

17. Save changes to your vi editing session and exit by typing the following and pressing ENTER:
    `:x`

LINUX PRACTICE QUESTIONS

The purpose of this section is to obtain **extra practice** to help with **quizzes**, your **midterm**, and your **final exam**.

REVIEW QUESTIONS: SIMPLE & COMPLEX REGULAR EXPRESSIONS

Here is a link to the MS Word Document of ALL of the questions displayed below but with extra room to answer on the document to simulate a quiz:

https://github.com/ULI101/labs/raw/main/uli101_command_practice_9a.docx

Your instructor may take-up these questions during class. It is up to the student to attend classes in order to obtain the answers to the following questions. Your instructor will NOT provide these answers in any other form (eg. e-mail, etc).

Part A: Display Results from Linux Commands using Simple & Complex Regular Expressions

Note the contents from the following tab-delimited file called **~uli101/cars**:

```
Plym    fury    77      73      2500
chevy   nova    79      60      3000
ford    mustang 65      45      10003
volvo   gl      78      102     9850
ford    ltd     83      15      10507
chevy   nova    80      50      3503
fiat    600     65      115     450
honda   accord  81      30      6000
ford    thundbd 84      10      17000
toyota  tercel  82      180     755
chevy   impala  65      85      1553
ford    bronco  83      25      9505
```

Write the results of each of the following Linux commands using regular expressions for the above-mentioned file.

1. **grep plym ~uli101/cars**
2. **grep -i fury ~uli101/cars**
3. **grep "^[m-z]" ~uli101/cars**
4. **grep -i "^[m-z]" ~uli101/cars**
5. **grep "3$" ~uli101/cars**
6. **grep -i "c.*5$" ~uli101/cars**

Part B: Writing Linux Commands Using Regular Expressions

Write a single Linux command to perform the specified tasks for each of the following questions.

7. Write a Linux command to display all lines in the file called **~/text.txt** that contains the pattern: the
8. Write a Linux command to display all lines in the file called **~/text.txt** that contains the word: the
9. Write a Linux command to display all lines in the file called **~/text.txt** that begin with a number.
10. Write a Linux command to display all lines in the file called **~/text.txt** that end with a letter (either upper or lowercase).
11. Write a Linux command to display all lines in the file called **~/text.txt** that begin and end with a number.
12. Write a Linux command to display all lines in the file called **~/text.txt** that contains exactly 3 characters that can be anything.
13. Write a Linux command to display all lines in the file called **~/text.txt** that contains exactly 3 numbers.
14. Write a Linux command to display all lines in the file called **~/text.txt** that contains 1 or more "C" characters.

REVIEW QUESTIONS: REGULAR EXPRESSIONS (INCLUDING EXTENDED REGULAR EXPRESSIONS)

Here is a link to the MS Word Document of ALL of the questions displayed below but with extra room to answer on the document to simulate a quiz:

https://github.com/ULI101/labs/raw/main/uli101_command_practice_9b.docx

Your instructor may take-up these questions during class. It is up to the student to attend classes in order to obtain the answers to the following questions. Your instructor will NOT provide these answers in any other form (eg. e-mail, etc).

Part A: Display Results from Linux Commands using Regular Expressions

Note the contents from the following tab-delimited file called **~uli101/numbers.txt**:

```
+123
---34
++++++++++17
-45
45p8
25.6
11
```

Write the results of each of the following Linux commands using regular expressions for the above-mentioned file.

1. **grep "^[-+]" ~uli101/numbers.txt**
2. **grep "^[-+]*.[0-9]" ~uli101/numbers.txt**
3. **grep "^[+-]?[0-9]" ~uli101/numbers.txt**
   (Why?)
4. **egrep "^[+-]?[0-9]" ~uli101/numbers.txt**
5. **egrep "^[+-]?[0-9]+$" ~uli101/numbers.txt**
6. **egrep "^[+-]?[0-9]+[.]?[0-9]+$" ~uli101/numbers.txt**

Part B: Writing Linux Commands Using Regular Expressions

Write a single Linux command to perform the specified tasks for each of the following questions.

7. Write a Linux command to display all lines in the file called **~/data.txt** that begins with 1 or more occurrences of an UPPERCASE letter.
8. Write a Linux command to display all lines in the file called **~/data.txt** that ends with 3 or more occurrences of the number 6
9. Write a Linux command to display all lines in the file called **~/data.txt** that begins with 2 or more occurrences of the word "the" (upper or lower case).
10. Write a Linux command to display all lines in the file called **~/data.txt** that begins with 2 or more occurrences of the word "the" or the word "but" (upper or lower case).
11. Write a Linux command to display all lines in the file called **~/data.txt** that begins with a minimum of 2 occurrences and a maximum of 4 occurrences of the word "the" or the word "but" (upper or lower case).

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Category: ULI101