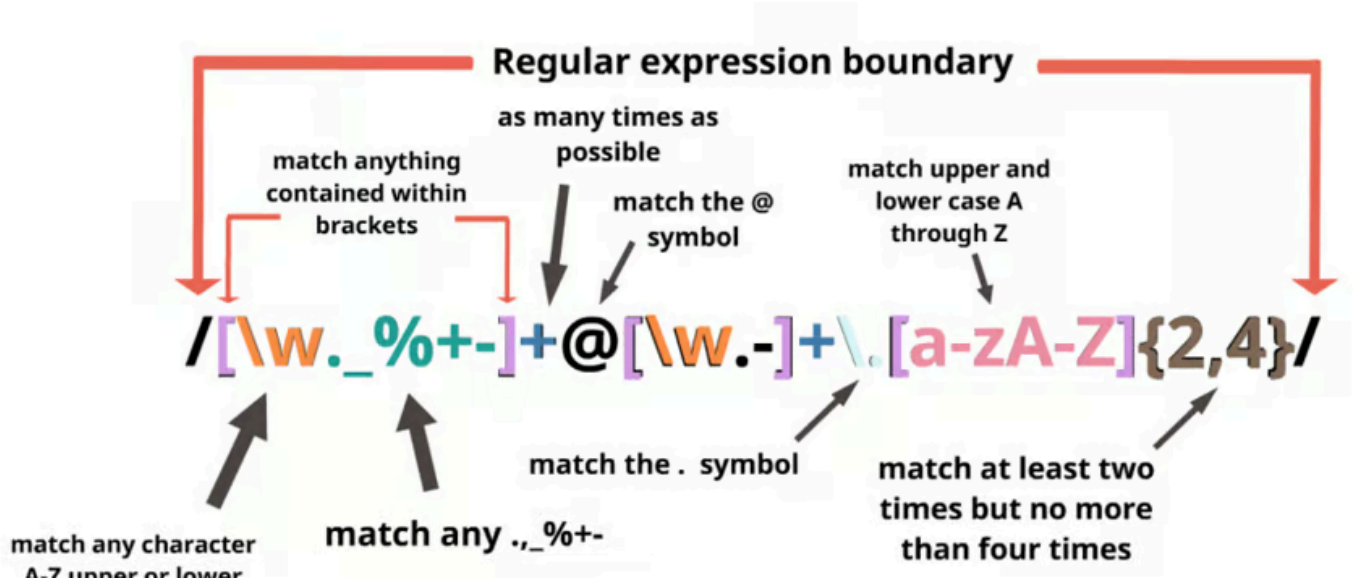
4.2 Regex Tutorial



Regular expressions (regex) are a powerful tool for pattern matching and text processing.

1. Basic Syntax

- **Literal Characters**: The simplest regex is just a string of literal characters. For example, `"cat"` matches the string "cat".
- **Metacharacters**: Characters that have special meaning in regex:
  - `.` : Matches any single character except a newline.
  - `^` : Matches the start of a string.
  - `$` : Matches the end of a string.
  - `\` : Escape character to treat special characters as literals (e.g., `\.` to match a period).

2. Character Classes

- **Square Brackets** `[]` : Match any one character inside the brackets.
  - `[abc]` : Matches "a", "b", or "c".
  - `[a-z]` : Matches any lowercase letter from "a" to "z".
  - `[^abc]` : Negated class; matches any character except "a", "b", or "c".

3. Quantifiers

Quantifiers specify how many times a character or group must be present.

- `*` : 0 or more times (e.g., `a*` matches "","a", "aa", "aaa").
- `+` : 1 or more times (e.g., `a+` matches "a", "aa", "aaa").

- `?`: 0 or 1 time (e.g., `a?` matches "" or "a").
- `{n}`: Exactly `n` times (e.g., `a{3}` matches "aaa").
- `{n,}`: `n` or more times (e.g., `a{2,}` matches "aa", "aaa", "aaaa").
- `{n,m}`: Between `n` and `m` times (e.g., `a{2,4}` matches "aa", "aaa", or "aaaa").

4. Anchors

- `^`: Asserts the position at the start of a line (e.g., `^cat` matches "cat" only at the start).
- `$`: Asserts the position at the end of a line (e.g., `cat$` matches "cat" only at the end).

5. Grouping and Alternation

- **Parentheses `()`**: Used for grouping and capturing.
  - `(abc)` captures "abc".
  - `(a|b|c)` matches "a", "b", or "c" (alternation).
- **Non-capturing group `(?:...)`**: Groups without capturing.

6. Common Functions in R

R has several functions for working with regex, primarily in the `stringr` and `base` packages:

`grep`: Search for patterns in strings

```
text <- c("cat", "bat", "rat")
grep("b", text)  # Returns indices of matches
```

```
[1] 2
```

`grepl`: Logical vector indicating matches

```
grepl("c", text)  # Returns TRUE or FALSE
```

```
[1]  TRUE FALSE FALSE
```

`gsub` / `sub`: Replace matches with a new string

```
gsub("c", "C", text)  # Replaces "c" with "C" in all elements
```

```
[1] "Cat" "bat" "rat"
```

`regexpr` / `gregexpr`: Returns the position and length of matches

```
regexpr("at", text)  # Returns the starting position and length of the match
```

```
[1] 2 2 2
attr(,"match.length")
```

```
[1] 2 2 2
attr(,"index.type")
[1] "chars"
attr(,"useBytes")
[1] TRUE
```

`str_extract` (from `stringr`): Extracts matching substrings

```
library(stringr)
str_extract("Price: $123.45", "\\$[0-9]+\\.[0-9]{2}")  # Extracts "$123.45"
```

```
[1] "$123.45"
```

7. Examples

- **Matching an email address**:

```
emails <- c("user@example.com", "another.user@domain.co")
email_pattern <- "[a-zA-Z0-9._%+-]+@[a-zA-Z0-9.-]+\\.[a-zA-Z]{2,}"
grep(email_pattern, emails)
```

```
[1] 1 2
```

`emails`: This is a character vector that contains two strings, each representing an email address.

- `"user@example.com"`
- `"another.user@domain.co"`

Let's break down the components of the regex pattern:

`[a-zA-Z0-9._%+-]+`:

- `[a-zA-Z0-9._%+-]`: This character class matches any of the following characters:
  - `a-z`: Any lowercase letter.
  - `A-Z`: Any uppercase letter.
  - `0-9`: Any digit.
  - `.`: A literal period (dot).
  - `_`: An underscore.
  - `%`: A percentage sign.
  - `+`: A plus sign.
  - `-`: A hyphen.

- `+`: This quantifier means “one or more” of the preceding characters.

This part of the pattern matches the local part of the email address (the part before the `@` symbol).

`@`:

- This matches the literal `@` symbol that separates the local part of the email from the domain part.

`[a-zA-Z0-9.-]+`:

- `[a-zA-Z0-9.-]`: This character class matches any of the following:
  - `a-z`: Any lowercase letter.
  - `A-Z`: Any uppercase letter.
  - `0-9`: Any digit.
  - `.`: A literal period (dot).
  - `-`: A hyphen.
- `+`: This quantifier means “one or more” of the preceding characters.

This part of the pattern matches the domain name part of the email address.

`\\.`:

- `\\.`: Matches a literal period (dot). The double backslash is used to escape the period in R, as the period is a special character in regex.

`[a-zA-Z]{2,}`:

- `[a-zA-Z]`: Matches any letter, either lowercase (`a-z`) or uppercase (`A-Z`).
- `{2,}`: This quantifier means “two or more” of the preceding character class.

This part of the pattern matches the top-level domain (TLD) part of the email address, which typically consists of two or more letters (like “.com” or “.co”).

- **Extracting phone numbers**:

```
text <- "Call me at 555-123-4567 or 555.987.6543"
phone_pattern <- "\\b[0-9]{3}[-.]?[0-9]{3}[-.]?[0-9]{4}\\b"
str_extract_all(text, phone_pattern)
```

```
[[1]]
[1] "555-123-4567" "555.987.6543"
```

Let’s break down the components of this pattern:

`\\b`:

- `\\b`: This is a word boundary anchor. It matches the position where a word starts or ends. This ensures that the phone number pattern is matched as a complete word, not as a part of a longer string of digits.

`[0-9]{3}`:

- `[0-9]`: This matches any digit from 0 to 9.
- `{3}`: This quantifier specifies that exactly three digits should be matched.

This part of the pattern matches the first three digits of the phone number.

`[-.]?`:

- `[-.]`: This matches either a hyphen (`-`) or a period (`.`).
- `?`: This quantifier specifies that the hyphen or period is optional (it can appear 0 or 1 time).

This part of the pattern matches the separator between the first three digits and the next three digits of the phone number. It allows for flexibility in formatting (e.g., “555-123-4567” or “555.987.6543”).

`[0-9]{3}`:

- Same as before, this matches the next three digits of the phone number.

`[-.]?`:

- Again, this matches an optional hyphen or period separator.

`[0-9]{4}`:

- This matches the final four digits of the phone number.

`\\b`:

- The word boundary anchor ensures that the pattern matches the end of a complete phone number.

8. Escape Characters

- The slashes (`\`) is used to escape certain characters in the regular expression so that they are treated as literal characters rather than as special regex symbols, for example the dollar sign $ is a special character in regex, typically used as an anchor to denote the end of a line or a string, therefore we escape it with a backslash if we want to capture the $ character in a string.
- The backslash itself is also a special character, so you need to escape the backslash. This means you write `\\$` to match a literal `$` in the string.
- So, `\\$` matches the literal dollar sign (`$`) in the string.

9. Advanced Topics

- **Lookahead and Lookbehind**: Zero-width assertions that allow you to match something only if it's preceded or followed by another pattern.
  - Positive Lookahead: `(?=...)`
  - Negative Lookahead: `(?!...)`
  - Positive Lookbehind: `(?<=...)`
  - Negative Lookbehind: `(?<!...)`
- **Lazy Quantifiers**: By default, quantifiers are greedy (they match as much as possible). Add `?` after a quantifier to make it lazy (e.g., `.*?`).

Summary

Regex in R is a versatile tool for text processing. The basics include character classes, quantifiers, and grouping. R provides several functions to work with regex effectively. With practice, you can craft complex patterns for searching, extracting, and manipulating text data.