CONSTRUCTING SEARCHES

Introduction to Regular Expressions

Tools & Techniques in DH

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Practicum files are on Course website

- **On Windows**
  - Install **EditPad Pro or Lite**
  - Alternatively, **Sublime Text**
  - Open the practicum file
- **On Mac**
  - Install **Sublime Text**
  - Open the practicum file

What are Regular Expressions?

- very small language for describing textual patterns
- not a programming language, yet a part of each one
- incredibly powerful tool for find/replace operations
- old (1950s-60s)
- arcane art
- ubiquitous

WHENEVER I LEARN A NEW SKILL I CONCOCT ELABORATE FANTASY SCENARIOS WHERE IT LETS ME SAVE THE DAY.
OH NO! THE KILLER MUST HAVE FOLLOWED HER ON VACATION!
BUT TO FIND THEM WE'D HAVE TO SEARCH THROUGH 200 MB OF EMAILS LOOKING FOR SOMETHING FORMATTED LIKE AN ADDRESS!
IT'S HOPELESS!
EVERYBODY STAND BACK.
I KNOW REGULAR EXPRESSIONS.
PERL!
TAP TAP

Why Use Regular Expressions?

To search:

- all spelling variations of the same word:
  - Österreich, Osterreich or Oesterreich?
- words of specific morphological patterns:
  - [*root*]*er*, [*root*]*ed*, [*root*]*ing* [*root*]*s*: all derivatives from the same word
- entities that may be referred to differently:
  - references to Austria? (Vienna, Wien, Salzburg, etc.)
  - references to education in biographies

To search and replace:

- reformat "dirty"/inconsistent data

To tag:

- make texts navigable and more readable
- tag information relevant to your research

and many other uses…

The Basics

- a **regular expression** is a pattern enclosed within delimiters
  - delimiters will differ depending on a programming language or software that you use; you may also not see them at all
  - most text editors that support RE do not display delimiters (*EditPad Pro*, *Sublime Text, TextMate*)
- most characters match themselves
- there are also special characters

Example:

- `**Vienna**` is a regular expression that matches "**Vienna**"
  - ` (*tick*) is the delimiter enclosing the expression (*you do not need them in text editors*)
  - "**Vienna**" is the pattern

/at/

- Matches strings with “a” followed by “t”.

at	hat
that	atlas
aft	Athens

/at/

- Matches strings with “a” followed by “t”.

at	h***at***
th***at***	***at***las
aft	Athens

Characters & Special Characters

- most characters match themselves
- matching is case sensitive
- special characters: **`() ^ $ { } [ ] \ | . + ? *`**
- to match a special character in your text, you need to "escape it", i.e. precede it with "****" in your pattern:

  - **`` `Osterreich [sic]` ``**
    does not match "**`Osterreich [sic]`**"

  - **`` `Osterreich \[sic\]` ``**
    matches "**`Osterreich [sic]`**"

Character Classes: **[ ]**

- Characters within **[]** are choices for a single-character match.
- Think of a type of ***or***.
- Order within **[]** is unimportant.
- `**x[01]**` matches >>> "**x0**" and "**x1**".
- `**[10][23]**` matches >>>
  >>> "**02**", "**03**", "**12**" and "**13**".
- Initial **^** negates the class:
  - `**[^45]**` matches any character except 4 or 5.

`/[ch]at/`

- Matches strings with “c” or “h”, followed by “a”, followed by “t”.

that	at
chat	cat
fat	phat

`/[ch]at/`

- Matches strings with “c” or “h”, followed by “a”, followed by “t”.

t***hat***	at
c***hat***	***cat***
fat	p***hat***

Ranges (within classes)

- Ranges define sets of characters within a class.

  - `` `[1-9]` `` matches any non-zero digit
  - `` `[a-zA-Z]` `` matches any letter of the English alphabet
  - `` `[12][0-9]` `` matches numbers between 10 and 29

Ranges shortcuts

Shortcut	Name	Equivalent Class
`\d`	digit	`[0-9]`
`\D`	not digit	`[^0-9]`
`\w`	word	`[a-zA-Z0-9_]` (*actually more!*)
`\W`	not word	`[^a-zA-Z0-9_]`
`\s`	space	`[\t\n\r\f\v ]`
`\S`	not space	`[^\t\n\r\f\v ]`
`.`	everything	`[^\n]` (depends on mode)

`/\d\d\d[- ]\d\d\d\d/`

- Matches strings with:
  - Three digits
  - Space or dash
  - Four digits

```
501-1234     234 1252

652.2648     713-342-7452

PE6-5000     653-6464x256
```

`/\d\d\d[- ]\d\d\d\d/`

- Matches strings with:
  - Three digits
  - Space or dash
  - Four digits

501-1234	**234 1252**
652.2648	713-**342-7452**
PE6-5000	**653-6464**x256

Repeaters

- Symbols indicating that the preceding element of the pattern can repeat.
- `` `runs?` `` matches *runs* or *run*
- `` `1\d*` `` matches any number beginning with "`1`".

Repeater	Count
`?`	zero or one
`+`	one or more
`*`	zero or more
`{n}`	exactly *n*
`{n,m}`	between *n* and *m* times
`{,m}`	no more than *m* times
`{n,}`	at least *n* times

Repeaters

Strings:

```
1: "at"       2: "art"
3: "arrrrt"   4: "aft"
```

Patterns:

```
A: `ar?t`     B: `a[fr]?t`
C: `ar*t`     D: `ar+t`
E: `a.*t`     F: `a.+t`
```

Repeater	Count
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Repeaters

```
1: "at"       2: "art"
3: "arrrrt"   4: "aft"
```

- `ar?t` matches "at" and "art" but not "arrrt".
- `a[fr]?t` matches "at", "art", and "aft".
- `ar*t` matches "at", "art", and "arrrrt"
- `ar+t` matches "art" and "arrrt" but not "at".
- `a.*t` matches anything with an 'a' eventually followed by a 't'.

Lab: Intro (`in the practicum file`)

Repeater	Count
`?`	zero or one
`+`	one or more
`*`	zero or more
`{`*`n`*`}`	exactly *n* times
`{`*`n`*`,`*`m`*`}`	between *n* and *m* times
`{,`*`m`*`}`	no more than *m* times
`{`*`n`*`,}`	at least *n* times

Shortcut	Name
`\d`	digit
`\D`	not digit
`\w`	word
`\W`	not word
`\s`	space
`\S`	not space
`.`	any symbol

Anchors

- Anchors match between characters.
- Used to assert that the characters you're matching must appear in a certain place.
- `\bat\b` matches "`at work`" but not "`batch`".

Anchor	Matches
`^`	start of line
`$`	end of line
`\b`	*word boundary*
`\B`	not boundary
`\A`	start of string (rare)
`\Z`	end of string (rare)
`\z`	raw end of string (rare)

ALTERNATION – "|" (pipe)

- In **`RE`**, "|" means "or".
- You can put a full expression on the left and another full expression on the right.
- Either can match.
- **`` `seek|seeks|sought` ``**
  - matches "seek", "seeks", or "sought".
- **`` `seeks?|sought` ``**
  - matches "seek", "seeks", or "sought".

Grouping

- Everything within `( … )` is grouped into a single element for the purposes of *repetition* and *alternation*.
- The expression `` `(la)+` `` matches "**`la`**", "**`lala`**", "**`lalalala`**" but not "**`all`**".
- `` `schema(ta)?` `` matches "**`schema`**" and "**`schemata`**" but not "**`schematic`**".

Grouping Example

- What regular expression matches “**`eat`**”, “**`eats`**”, “**`ate`**” and “**`eaten`**”?

Grouping Example

- What regular expression matches “**`eat`**”, “**`eats`**”, “**`ate`**” and “**`eaten`**”?
- **`` `eat(s|en)?|ate` ``**

- Add word boundary anchors to exclude “**`sate`**” and “**`eating`**”:
- **`` `\b(eat(s|en)?|ate)\b` ``**

Lab: Part I (`in the practicum file`)

Repeater	Count
`?`	zero or one
`+`	one or more
`*`	zero or more
`{n}`	exactly *n* times
`{n,m}`	between *n* and *m* times
`{,m}`	no more than *m* times
`{n,}`	at least *n* times

Shrtct	Name
`\d`	digit
`\D`	not digit
`\w`	word
`\W`	not word
`\s`	space
`\S`	not space
`.`	any symbol

Anchor	Matches
`^`	start of line
`$`	end of line
`\b`	word boundary
`\t`	TAB symbol
`\n`	new line
`|`	"or" alternation
`(…)`	capture group
`[…]`	class

Replacement

- Regex most often used for search/replace
- Text editors:
  - Search Window: **`pattern`**
  - Replace Window: **`replacement`**

Capture

- During searches, `( … )` groups capture patterns for use in replacement.
- Special variables `\1`, `\2`, `\3` etc. contain the capture
  - in *Sublime Text*: `$1`, `$2`, `$3`
- `` `(\d\d\d)-(\d\d\d\d)` `` “`123-4567`”
  - `\1` (`$1`) contains “`123`”
  - `\2` (`$2`) contains “`4567`”

Capture & Reformat

- How to convert “Schwarzenegger, Arnold” to “Arnold Schwarzenegger”?

-
-
-
-

Capture & Reformat

- How to convert “Schwarzenegger, Arnold” to “Arnold Schwarzenegger”?

- Search: `` `(\w+), (\w+)` ``
- Replace (a): `` `\2 \1` ``
- Replace (b): `` `$2 $1` ``

- **(!) Before hitting “Replace”, make sure that your match does not catch what you do NOT want to change**

Lab: Part II (`in the practicum file`)

Repeater	Count
`?`	zero or one
`+`	one or more
`*`	zero or more
`{`*n*`}`	exactly *n* times
`{`*n*`,`*m*`}`	between *n* and *m* times
`{,`*m*`}`	no more than *m* times
`{`*n*`,}`	at least *n* times

Shrtct	Name
`\d`	digit
`\D`	not digit
`\w`	word
`\W`	not word
`\s`	space
`\S`	not space
`.`	any symbol

Anchor	Matches
`^`	start of line
`$`	end of line
`\b`	word boundary
`\t`	TAB symbol
`\n`	new line
`|`	"or" alternation
`(…)`	capture group
`[…]`	class

Finding Toponyms

- *Very Simple*: Construct regular expressions that finds references all Austrian cities.

Finding Toponyms

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- Simply connect all toponyms from the list with a pipe symbol “|”

Finding Toponyms

- *A Bit Tricky*: Construct regular expression that finds only cities from 1) Lower Austria; 2) Salzburg.

Finding Toponyms

- *A Bit Tricky*: Construct regular expression that finds only cities from 1) Lower Austria; 2) Salzburg.

- Option I:

```
\b([\w ]+) \(Lower Austria\)
\b([\w ]+) \(Salzburg\)
```

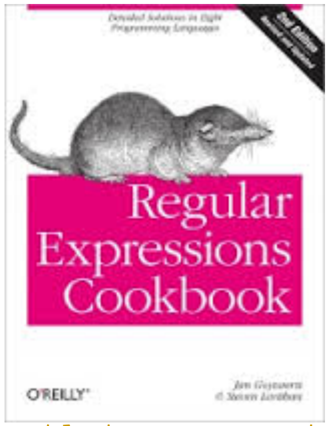
- Option II (cooler):

```
\b([\w ]+)(?=( \(Lower Austria\)))
\b([\w ]+)(?=( \(Salzburg\)))
```

To keep in mind

- RE are “greedy,” i.e. they tend to catch more than you may need. Always test!
- Test before applying! (In text editors *Ctrl+Z* (*Win*), *Cmd+Z* (*Mac*) can help to revert changes)
- Check the language/application-specific documentation: some common shortcuts are not universal (**`\1`** vs **`$1`**, for example)

Some readings


Detailed Solutions in Eight Programming Languages
2nd Edition
Regular Expressions Cookbook
O'REILLY
Jan Goyvaerts & Steven Levithan

- Amazon.com
  - http://www.amazon.com/Regular-Expressions-Cookbook-Jan-Goyvaerts/dp/1449319432/
  - http://www.amazon.com/Mastering-Regular-Expressions-Jeffrey-Friedl/dp/0596528124/
- Free Online Readings
  - http://www.regular-expressions.info/
  - http://ruby.bastardsbook.com/chapters/regexes/
- Cheat Sheets
  - http://krijnhoetmer.nl/stuff/regex/cheat-sheet/
  - http://www.rexegg.com/regex-quickstart.html
- Interactive tutorial
  - http://regexone.com/