Lecture 09
regular expressions (intro)

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Lecture 09 outline

Last time: sequence alignment

This time: regular expressions

- uses of regex
- basic syntax
- examples

Regular expressions

A ***regular expressions*** (or *regex*) defines a pattern to search (and capture) text

Regular expressions are useful to

- ***collect*** information
- ***navigate*** and ***parse*** text
- ***search*** and ***replace*** complex text patterns
- ***condense*** your code

Regex use

Regex statements have a pre-defined but flexible grammatical structure, and make use of special characters to define text patterns

A regex statement is applied to a body of text, then ***matches*** text that fits the regex pattern.

Example:

regex	text
[br]at	bat (match)
	hat (skip)
	rat (match)

Using regex with *grep*

global ***r***egular ***e***xpression ***p***rint

```
# list file contents
$ cat file.txt
bat
brat
chat
yacht
# regex for a simple match
# -P : use Perl-Compatible Regex
$ grep -P "chat" file.txt
```

Regex is supported for many programming languages, but how they implement regex may differ.

We'll use ***Perl-Compatible Regular Expressions*** (PCRE)

Any character, .

. will match exactly *one* character with any value

```
# list file contents
$ cat file.txt
Mr. Brown
Miss Blue
Mrs. Green
# regex match using .
$ grep -P "Mr." file.txt
Mr. Brown
Mrs. Green
$ grep -P "Mr\." file.txt
Mr. Brown
$ grep -P "M.s" file.txt
Miss Blue
Mrs. Green
```

Any digit, \d

\d will match exactly *one* character with any numerical value in 0..9

```
# list file contents
$ cat file.txt
King Richard III
King Henry the 8th
King Susie the 72nd
# regex match using \d
$ grep -P "\d" file.txt
King Henry the 8th
King Susie the 72nd
$ grep -P "\d\d" file.txt
King Susie the 72nd
```

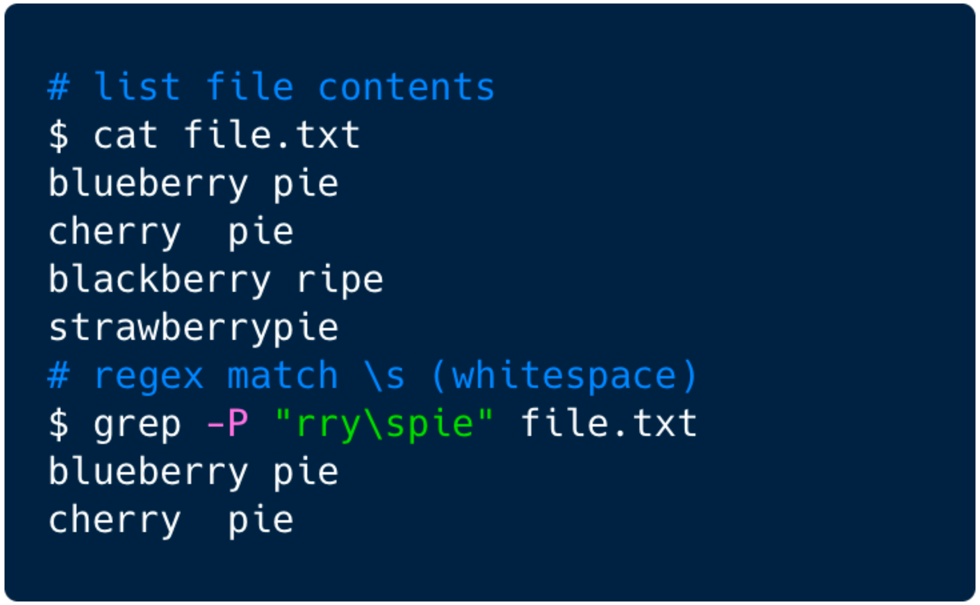
Any alphanumeric, \w

\w will match exactly *one* character with any numerical value from A..Z, a..z, or 0..9

```
# list file contents
$ cat file.txt
skateboard
sk!board
skiboard
sk0%tboard
# regex match for digits (0-9)
$ grep -P "sk\w" file.txt
skateboard
skiboard
sk0%tboard
$ grep -P "sk.\w.board" file.txt
skateboard
```

Any whitespace, \s

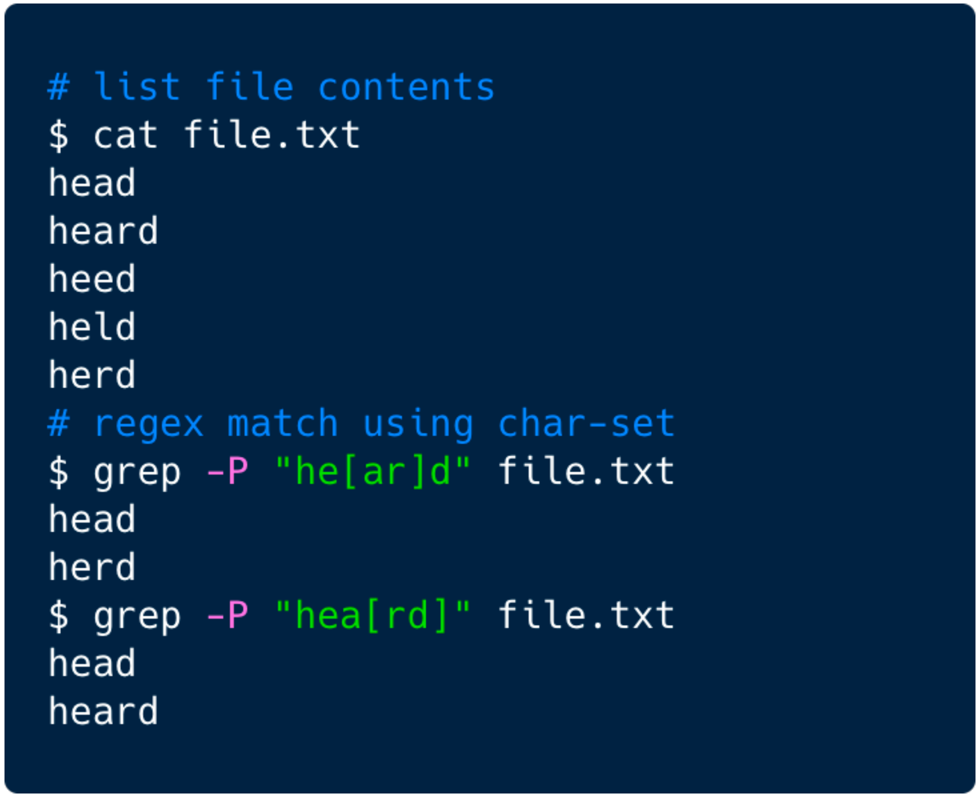
\s will match exactly *one* character with any whitespace value: [space], [tab], [newline]



```
# list file contents
$ cat file.txt
blueberry pie
cherry  pie
blackberry ripe
strawberrypie
# regex match \s (whitespace)
$ grep -P "rry\spie" file.txt
blueberry pie
cherry  pie
```

Character-set, *[ab]*

[ab] will match with *one* character that is a member of the set *a* or *b*



```
# list file contents
$ cat file.txt
head
heard
heed
held
herd
# regex match using char-set
$ grep -P "he[ar]d" file.txt
head
herd
$ grep -P "hea[rd]" file.txt
head
heard
```

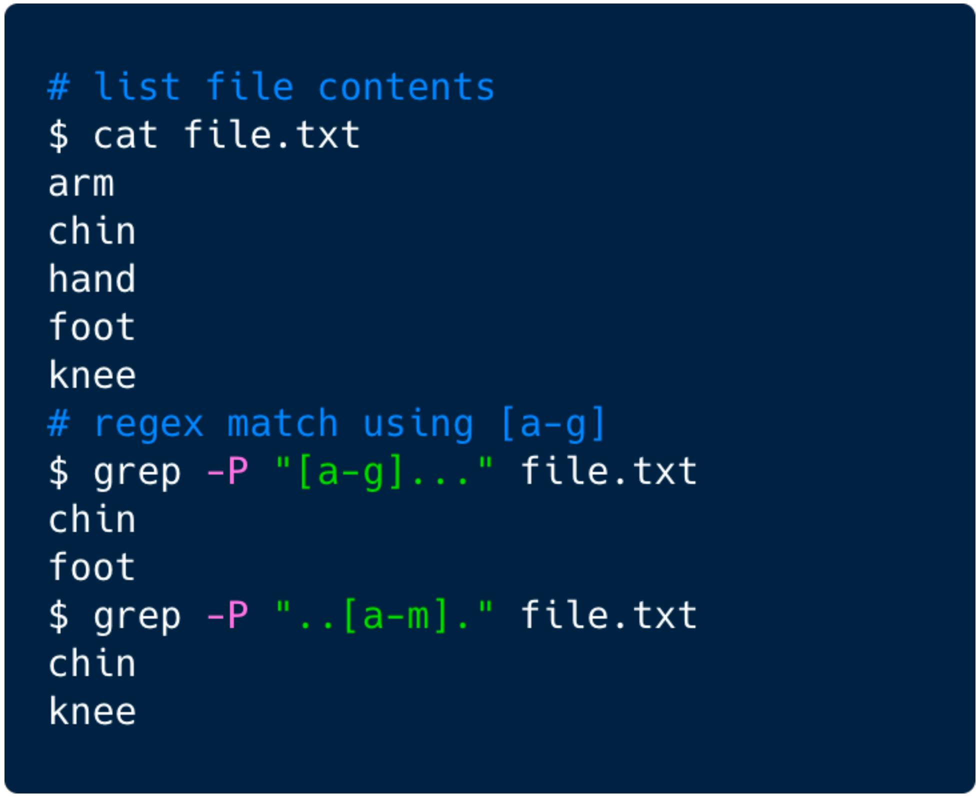
Anti-set, *[^ab]*

[^ab] will match with *one* character that is ***not*** a member of the set *a* or *b*

```
# list file contents
$ cat file.txt
skateboard
sk8board
skiboard
sk00tboard
# regex match using .
$ grep -P "sk[^8]board" file.txt
skiboard
$ grep -P "sk[^0ate]board" file.txt
sk8board
skiboard
```

Character ranges, *[m-z]*

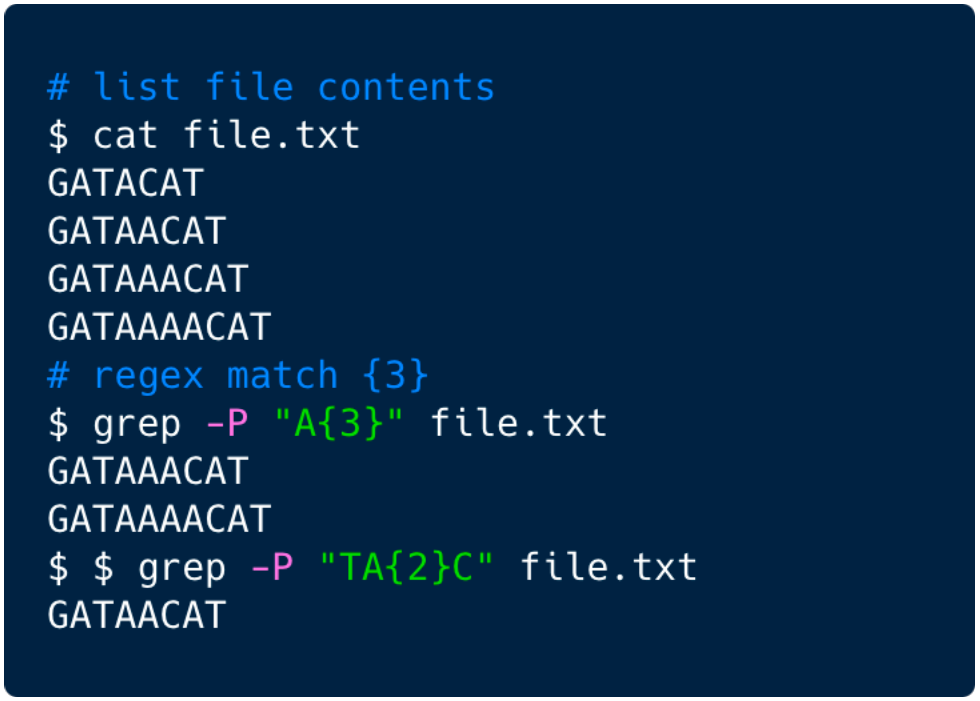
[m-z] will match with *one* character that is in the character range *m..z*



```
# list file contents
$ cat file.txt
arm
chin
hand
foot
knee
# regex match using [a-g]
$ grep -P "[a-g]..." file.txt
chin
foot
$ grep -P "..[a-m]." file.txt
chin
knee
```

Repetitions, {*m*}

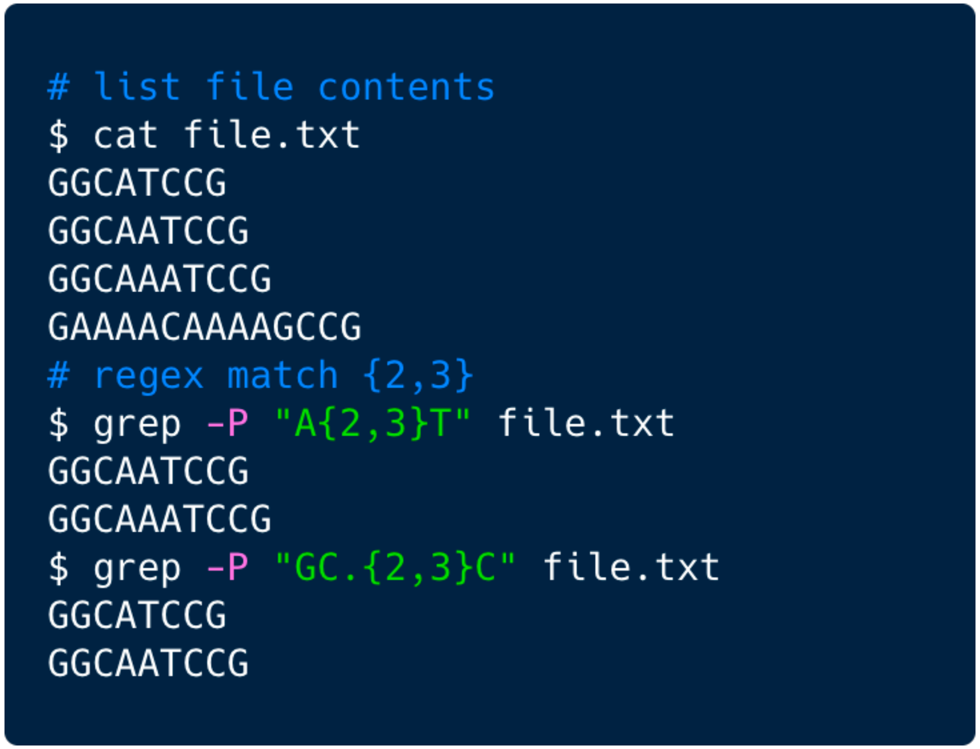
{*m*} will match the preceding pattern if it appears *exactly m times* in the text



```
# list file contents
$ cat file.txt
GATACAT
GATAACAT
GATAAACAT
GATAAAACAT
# regex match {3}
$ grep -P "A{3}" file.txt
GATAAACAT
GATAAAACAT
$ $ grep -P "TA{2}C" file.txt
GATAACAT
```

Repetition range, {*m*,*n*}

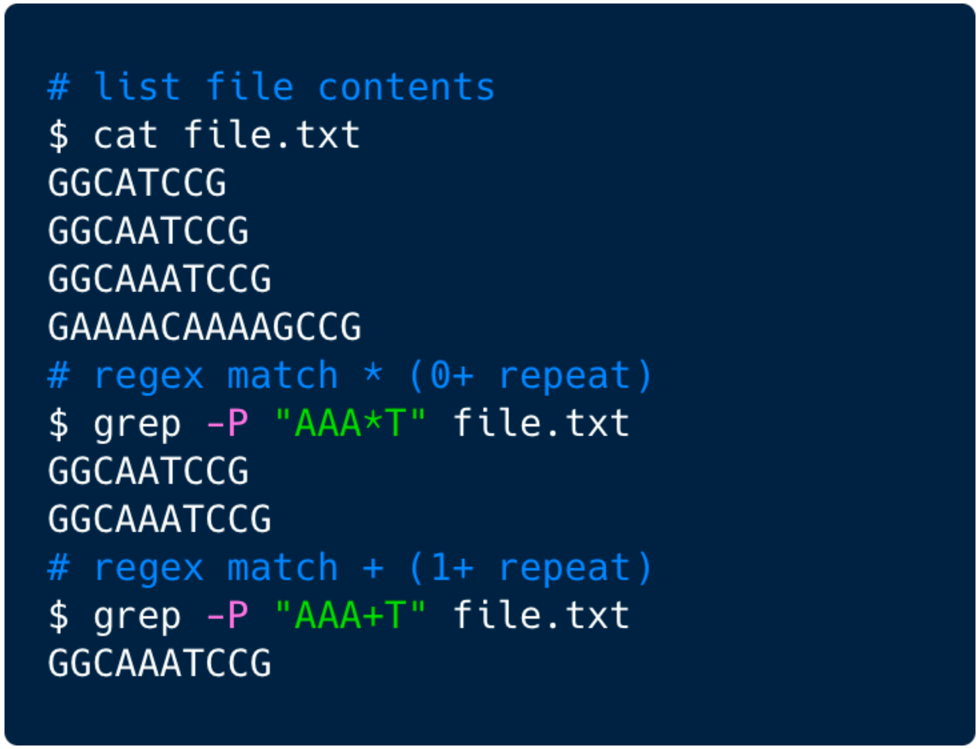
{*m*,*n*} will match the preceding pattern
if it appears *between m and n times* in the text



```
# list file contents
$ cat file.txt
GGCATCCG
GGCAATCCG
GGCAAATCCG
GAAAACAAAAGCCG
# regex match {2,3}
$ grep -P "A{2,3}T" file.txt
GGCAATCCG
GGCAAATCCG
$ grep -P "GC.{2,3}C" file.txt
GGCATCCG
GGCAATCCG
```

Kleene repetitions, * *and* +

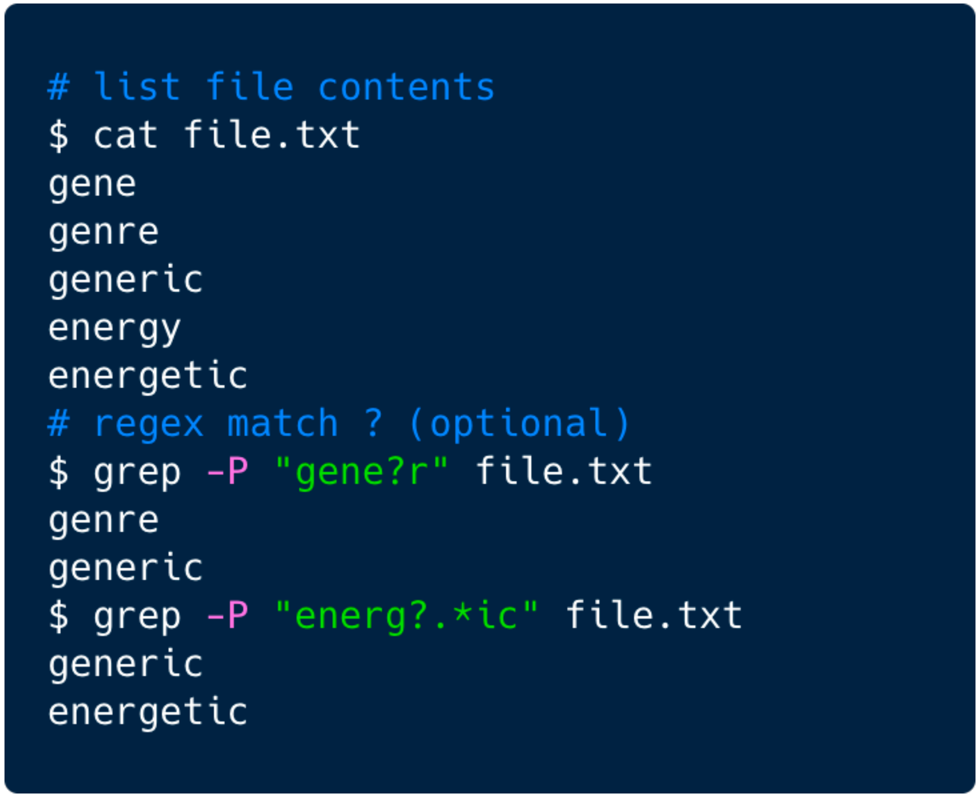
* will match the preceding pattern 0+ times
+ will match the preceding pattern 1+ times



```
# list file contents
$ cat file.txt
GGCATCCG
GGCAATCCG
GGCAAATCCG
GAAAACAAAAGCCG
# regex match * (0+ repeat)
$ grep -P "AAA*T" file.txt
GGCAATCCG
GGCAAATCCG
# regex match + (1+ repeat)
$ grep -P "AAA+T" file.txt
GGCAAATCCG
```

Optional character, *?*

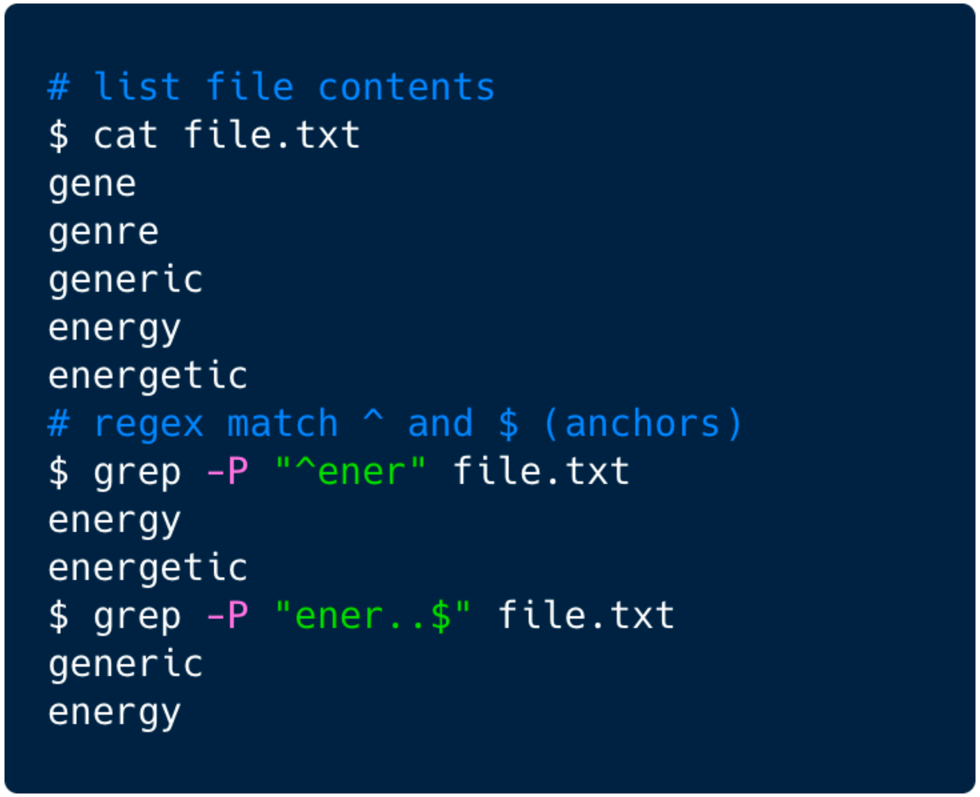
? will match the preceding pattern either exactly 0 or 1 time



```
# list file contents
$ cat file.txt
gene
genre
generic
energy
energetic
# regex match ? (optional)
$ grep -P "gene?r" file.txt
genre
generic
$ grep -P "energ?.*ic" file.txt
generic
energetic
```

Anchors, ^ and $

^ indicates the *start* of the matched string
$ indicates the *end* of the matched string



```
# list file contents
$ cat file.txt
gene
genre
generic
energy
energetic
# regex match ^ and $ (anchors)
$ grep -P "^ener" file.txt
energy
energetic
$ grep -P "ener..$" file.txt
generic
energy
```

Managing *ssh* sessions

Each *ssh* will generally terminate all processes it initiated when it ends

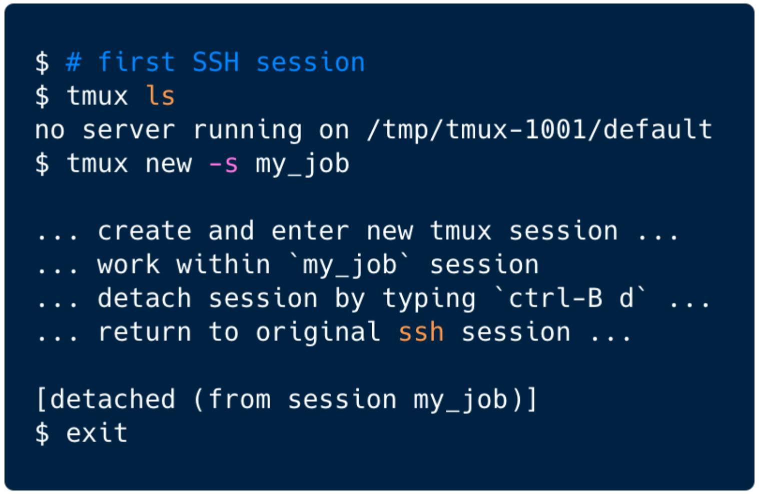
Terminal multiplexers create shell sessions that persist after log-off and that can be resumed from other log-ons

Popular tools include *tmux*, *screen*

Using *tmux*

list *tmux* sessions
(none found)

create and enter
a new session,
do work, and then
detach from session

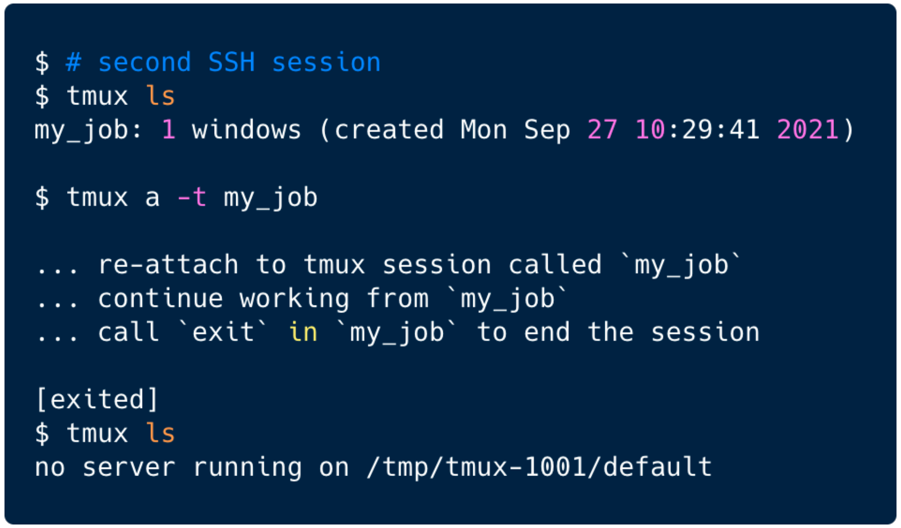


```
$ # first SSH session
$ tmux ls
no server running on /tmp/tmux-1001/default
$ tmux new -s my_job

... create and enter new tmux session ...
... work within `my_job` session
... detach session by typing `ctrl-B d` ...
... return to original ssh session ...

[detached (from session my_job)]
$ exit
```

list *tmux* sessions
(*my_job* found)

attach to *my_job*
session, complete work
then close *my_job*

list *tmux* sessions
(none found)



```
$ # second SSH session
$ tmux ls
my_job: 1 windows (created Mon Sep 27 10:29:41 2021)

$ tmux a -t my_job

... re-attach to tmux session called `my_job`
... continue working from `my_job`
... call `exit` in `my_job` to end the session

[exited]
$ tmux ls
no server running on /tmp/tmux-1001/default
```

Overview for Lab 09