

# Lab: Week 3

36-350 – Statistical Computing

Week 3 – Spring 2022

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## Basic Strings

### Question 1

*(4 points)*

*Notes 3A (4)*

Make a single string with your first and last names, and (programmatically) count the number of characters.

```
s <- "Ethan Vertal"
nchar(s)
```

```
## [1] 12
```

### Question 2

*(4 points)*

*Notes 3A (4)*

Make a vector of strings of length two, with your first name first and then last name, and (programmatically) count the number of characters in each.

```
ss <- c("Ethan", "Vertal")
nchar(ss)
```

```
## [1] 5 6
```

### Question 3

*(4 points)*

*Refer Back to Week 1*

Output the vector with the second element removed. Do this *two* different ways: by indicating which element you want, in square brackets; and by indicating which element you *don't* want, in square brackets with a minus sign.

```
ss[1]
```

```
## [1] "Ethan"
```

```
ss[-2]
```

```
## [1] "Ethan"
```

## Question 4

*(4 points)*

*Notes 3A (5)*

Transform the vector so that the words have all uppercase characters.

```
toupper(ss)
```

```
## [1] "ETHAN" "VERTAL"
```

## Question 5

*(4 points)*

*Not Covered in Notes*

Make a string with “Regards,” and then your first name, separated by a newline character. Print it to the console via `print()` and then via `cat()`. Comment on the difference.

```
sss <- "Regards, \nEthan"  
print(sss)
```

```
## [1] "Regards, \nEthan"
```

```
cat(sss)
```

```
## Regards,  
## Ethan
```

Print outputs the escape character and `cat` uses it as its intended purpose.

## Question 6

*(4 points)*

*Notes 3A (4)*

Count the number of characters in the string in the last question. Is the comma counted? The newline counted?

```
nchar(sss)
```

```
## [1] 15
```

Yes both are counted.

---

```
bill = "Bill Clinton"
others = c("George Bush", "Ronald Reagan", "Jimmy Carter", "Gerald Ford")
```

---

## Question 7

*(4 points)*

*Notes 3A (6)*

Display the first five characters of the string `bill`.

```
substr(bill, 1, 5)
```

```
## [1] "Bill "
```

## Question 8

*(4 points)*

*Refer Back to Week 1*

Join `bill` and `others` together into one vector of strings, called `presidents`.

```
presidents <- union(c(bill), others)
presidents
```

```
## [1] "Bill Clinton" "George Bush" "Ronald Reagan" "Jimmy Carter"
## [5] "Gerald Ford"
```

## Question 9

*(4 points)*

*Notes 3A (6)*

Display the last three letters of each of the strings in the vector `presidents`.

```
substr(presidents, nchar(presidents)-2, nchar(presidents))
```

```
## [1] "ton" "ush" "gan" "ter" "ord"
```

## Regular Expressions + Extraction

Below, we read in lines from Hillary Clinton's speech at the 2016 Democratic National Convention. (The `readLines()` function reads in a text file line-by-line: each line is a character string, and the vector of strings makes up the entire file.)

```
clinton.lines = readLines("http://www.stat.cmu.edu/~mfarag/350/clinton.txt")
```

```
## Warning in readLines("http://www.stat.cmu.edu/~mfarag/350/clinton.txt"):  
## incomplete final line found on 'http://www.stat.cmu.edu/~mfarag/350/clinton.txt'
```

### Question 10

(4 points)

Notes 3B (2-3)

Using a regex literal and `grep()`, display the line numbers in `clinton.lines` that contain “Bill”. Also, display the lines of text that contain “Bill”. (Hint: try setting `value=FALSE` and `value=TRUE`.)

```
grep("Bill", clinton.lines, value=FALSE)
```

```
## [1] 4 9
```

```
grep("Bill", clinton.lines, value=TRUE)
```

```
## [1] "And Bill, that conversation we started in the law library 45 years ago  
... it is still going strong."  
## [2] "We heard the man from Hope, Bill Clinton, and the man of hope, Barack  
Obama. America is stronger because of President Obama's leadership. And I'm  
better because of his friendship."
```

### Question 11

(4 points)

Notes 3B (3) and Refer Back to Week 1

Show, using the line numbers from the last problem from `grep()` with `value=FALSE`, how the lines of text containing “Bill” can be retrieved from `clinton.lines` through direct indexing, i.e., without a call to `grep()` with `value=TRUE`. Note: this is just to check your understanding of indexing; when it comes to retrieving and displaying matched text, using `grep()` with `value=TRUE` is easier; you should stick to it as the default, below.

```
clinton.lines[4]
```

```
## [1] "And Bill, that conversation we started in the law library 45 years ago  
... it is still going strong."
```

```
clinton.lines[9]
```

```
## [1] "We heard the man from Hope, Bill Clinton, and the man of hope, Barack Obama. America is stronger because of President Obama's leadership. And I'm better because of his friendship."
```

## Question 12

*(4 points)*

*Notes 3B (2-3)*

Display the lines of text in `clinton.lines` that contain “Bill” or “Chelsea”. Also, display the lines of text that contain “Bill” or “Chelsea” or “Tim”.

```
grep("(Bill | Chelsea)", clinton.lines, value = TRUE)
```

```
## [1] "And Chelsea, thank you. I am so proud to be your mother and so proud of the woman you've become. Thank you for bringing Mark into our family and Charlotte and Aidan into the world."
## [2] "We heard the man from Hope, Bill Clinton, and the man of hope, Barack Obama. America is stronger because of President Obama's leadership. And I'm better because of his friendship."
```

```
grep("(Bill | Chelsea | Tim)", clinton.lines, value = TRUE)
```

```
## [1] "We heard the man from Hope, Bill Clinton, and the man of hope, Barack Obama. America is stronger because of President Obama's leadership. And I'm better because of his friendship."
## [2] "And for those of you out there who are just getting to know Tim Kaine you will soon understand why the people of Virginia keep promoting him from city council and mayor to governor and now senator. And he will make our whole country proud as our vice president."
## [3] "Well, I've had the privilege to work closely with our troops and our veterans for many years, including as a senator on the Armed Services Committee, and I know how wrong he is. Our military is a national treasure. We entrust our commander in chief to make the hardest decisions our nation faces, decisions about war and peace, life and death. A president should respect the men and women who risk their lives to serve our country...including Captain Khan and the sons of Tim Kaine and Mike Pence, both Marines."
```

## Question 13

*(4 points)*

*Notes 3B (4-5)*

Display the lines of text in `clinton.lines` that contain “Trump” and then a punctuation mark.

```
grep("Trump[[:punct:]]", clinton.lines, value = TRUE)
```

```
## [1] "Well, we heard Donald Trump's answer last week at his convention. He
wants to divide us from the rest of the world and from each other. He's betting
that the perils of today's world will blind us to its unlimited promise. He's
taken the Republican Party a long way, from morning in America to midnight in
America."
## [2] "Yes, those were actually Donald Trump's words in Cleveland. And they
should set off alarm bells for all of us. Really? I alone can fix it? Isn't he
forgetting troops on the front lines, police officers and firefighters who run
toward danger, doctors and nurses who care for us, teachers who change lives,
entrepreneurs who see possibilities in every problem, mothers who lost children
to violence and are building a movement to keep other kids safe? He's
forgetting every last one of us."
## [3] "But then I also imagine people are thinking out there, but Trump, he's
a businessman, he must know something about the economy."
## [4] "Now, Donald Trump, Donald Trump says, and this is a quote, \"I know
more about ISIS than the generals do.\" No, Donald, you don't."
## [5] "And we will stand up against mean and divisive rhetoric wherever it
comes from. You know, for the past year many people made the mistake of
laughing off Donald Trump's comments, excusing him as an entertainer just
putting on a show."
## [6] "Now, at first, at first, I admit, I couldn't he meant it either. It was
just too hard to fathom that someone who wants to lead our nation could say
those things, could be like that. But here's the sad truth: There is no other
Donald Trump, this is it."
## [7] "So enough with the bigotry and the bombast. Donald Trump's not offering
real change, he's offering empty promises. And what are we offering? A bold
agenda to improve the lives of people across our country to keep you safe, to
get you good jobs, to get your kids the opportunities they deserve."
```

## Question 14

*(4 points)*

*Notes 3B (4-5)*

Display the lines of text in `clinton.lines` that contain "Trump" and then anything but a punctuation mark.

```
grep("Trump[^[:punct:]]", clinton.lines, value = TRUE)
```

```
## [1] "He wants us to fear the future and fear each other. Well, you know, a
great Democratic President Franklin Delano Roosevelt came up with the perfect
rebuttal to Trump more than 80 years ago during a much more perilous time: The
only thing we have to fear is fear itself!"
## [2] "Now, you didn't hear any of this, did you, from Donald Trump at his
convention? He spoke for 70-odd minutes-and I do mean odd-and he offered zero
solutions. But we already know he doesn't believe these things. No wonder he
doesn't like talking about his plans. You might have noticed I love talking
about mine."
## [3] "It's just not right that Donald Trump can ignore his debts and students
and families can't refinance their debts."
## [4] "Well, let's take a closer look, shall we? In Atlantic City, 60 miles
from here, you will find contractors and small businesses who lost everything
because Donald Trump refused to pay his bills."
```

```
## [5] "But think of this. People who did the work and needed the money, not
because he couldn't pay them, but because he wouldn't pay them. He just stiffed
them. And you know that sales pitch he's making to be president, put your faith
in him and you'll win big? That's the same sales pitch he made to all those
small businesses. Then Trump walked away and left working people holding the
bag."
## [6] "He also talks a big game about putting America first. Well, please
explain what part of \"America first\" leads him to make Trump ties in China,
not Colorado, Trump suits in Mexico, not Michigan, Trump furniture in Turkey,
not Ohio, Trump picture frames in India, not Wisconsin?"
## [7] "Donald Trump says he wants to make America great again. Well, he could
start by actually making things in America again."
## [8] "Now, Donald Trump, Donald Trump says, and this is a quote, \"I know
more about ISIS than the generals do.\" No, Donald, you don't."
## [9] "So just ask yourself, do you really think Donald Trump has the
temperament to be commander in chief? Donald Trump can't even handle the rough
and tumble of a presidential campaign. He loses his cool at the slightest
provocation, when he's gotten a tough question from a reporter, when he's
challenged in a debate, when he sees a protester at a rally. Imagine, if you
dare, imagine, imagine him in the Oval Office facing a real crisis."
## [10] "And in the end, it comes down to what Donald Trump doesn't get:
America is great because America is good!"
```

## Question 15

(4 points)

Notes 3B (4-5)

Display the lines of text in `clinton.lines` that contain “Bill” without a following punctuation mark, or “Trump” with a following punctuation mark.

```
grep("(Bill[^[:punct:]] | Trump[[:punct:]])", clinton.lines, value = TRUE)
```

```
## [1] "Well, we heard Donald Trump's answer last week at his convention. He
wants to divide us from the rest of the world and from each other. He's betting
that the perils of today's world will blind us to its unlimited promise. He's
taken the Republican Party a long way, from morning in America to midnight in
America."
## [2] "Yes, those were actually Donald Trump's words in Cleveland. And they
should set off alarm bells for all of us. Really? I alone can fix it? Isn't he
forgetting troops on the front lines, police officers and firefighters who run
toward danger, doctors and nurses who care for us, teachers who change lives,
entrepreneurs who see possibilities in every problem, mothers who lost children
to violence and are building a movement to keep other kids safe? He's
forgetting every last one of us."
## [3] "But then I also imagine people are thinking out there, but Trump, he's
a businessman, he must know something about the economy."
## [4] "Now, Donald Trump, Donald Trump says, and this is a quote, \"I know
more about ISIS than the generals do.\" No, Donald, you don't."
## [5] "And we will stand up against mean and divisive rhetoric wherever it
comes from. You know, for the past year many people made the mistake of
laughing off Donald Trump's comments, excusing him as an entertainer just
putting on a show."
```

```
## [6] "Now, at first, at first, I admit, I couldn't he meant it either. It was just too hard to fathom that someone who wants to lead our nation could say those things, could be like that. But here's the sad truth: There is no other Donald Trump, this is it."
```

```
## [7] "So enough with the bigotry and the bombast. Donald Trump's not offering real change, he's offering empty promises. And what are we offering? A bold agenda to improve the lives of people across our country to keep you safe, to get you good jobs, to get your kids the opportunities they deserve."
```

## Question 16

*(4 points)*

*Notes 3B (7-9)*

Display the lines of text in `clinton.lines` that contain numbers with at least three digits.

```
grep("[1-9]{3,}", clinton.lines, value = TRUE)
```

```
## [1] "I have to tell you, as your secretary of state I went to 112 countries. When people hear those words, they hear America!"
```

```
## [2] "So let's keep going. Let's keep going until every one of the 161 million women and girls across America has the opportunity she deserves to have!"
```

## Question 17

*(4 points)*

*Notes 3B (4,7)*

Display the lines of text in `clinton.lines` that contain a number, then “%” (a percent symbol).

```
grep("[1-9]+%", clinton.lines, value = TRUE)
```

```
## [1] "This is not because we resent success. But when more than 90% of the gains have gone to the top 1%, that's where the money is. And we are going to follow the money."
```

## Question 18

*(4 points)*

*Notes 3B (6)*

Display the lines of text in `clinton.lines` that contain “!”, an exclamation mark.

```
grep("!", clinton.lines, value = TRUE)
```

```
## [1] "Thank you all very, very much! Thank you for that amazing welcome!"
```

```
## [2] "To all of you whose hard work brought us here tonight and to those of you who joined this campaign this week, thank you. What a remarkable week it's been!"
```



## [3] "Our country needs your ideas, energy and passion. That is the only way we can turn our progressive platform into real change for America. We wrote it together, now let's go out and make it happen together!"

## [4] "He wants us to fear the future and fear each other. Well, you know, a great Democratic President Franklin Delano Roosevelt came up with the perfect rebuke to Trump more than 80 years ago during a much more perilous time: The only thing we have to fear is fear itself!"

## [5] "I have to tell you, as your secretary of state I went to 112 countries. When people hear those words, they hear America!"

## [6] "Americans don't say \"I alone can fix it.\" We say \"we'll fix it together!\""

## [7] "That's the country we're fighting for. That's the future we're working toward. And so, my friends, it is with humility, determination and boundless confidence in America's promise that I accept your nomination for president of the United States!"

## [8] "And you heard from Republicans and independents who are supporting our campaign. Well, I will be a president for Democrats, Republicans, independents, for the struggling, the striving, the successful, for all those who vote for me and for those who don't. For all Americans together!"

## [9] "Tonight we've reached a milestone in our nation's march toward a more perfect union. The first time that a major party has nominated a woman for president!"

## [10] "After all, when there are no ceilings, the sky's the limit!"

## [11] "So let's keep going. Let's keep going until every one of the 161 million women and girls across America has the opportunity she deserves to have!"

## [12] "And if necessary, we will pass a constitutional amendment to overturn Citizens United!"

## [13] "And I believe in science!"

## [14] "If you believe that companies should share profits, not pad executive bonuses, join us!"

## [15] "If you believe the minimum wage should be a living wage and no one working full time should have to raise their children in poverty, join us!"

## [16] "If you believe that every man, woman and child in America has the right to affordable health care, join us!"

## [17] "If you believe that we should say no to unfair trade deals, that we should stand up to China, that we should support our steelworkers and autoworkers and home-grown manufacturers, then join us!"

## [18] "If you believe we should expand Social Security and protect a woman's right to make her own health care decisions, then join us!"

## [19] "And yes, yes, if you believe that your working mother, wife, sister or daughter deserves equal pay, join us!"

## [20] "And we will help you balance family and work. And you know what? If fighting for affordable child care and paid family leave is playing the woman card, then deal me in!"

## [21] "Now, remember what the president said last night: Don't boo; vote!"

## [22] "A man you can bait with a tweet is not a man we can trust with nuclear weapons!"

## [23] "And that starts with listening, listening to each other, trying as best we can to walk in each other's shoes. So let's put ourselves in the shoes of young black and Latino men and women who face the effects of systemic racism and are made to feel like their lives are disposable!"

## [24] "And in the end, it comes down to what Donald Trump doesn't get: America is great because America is good!"

```
## [25] "Yes, the world is watching what we do. Yes, America's destiny is ours
to choose. So let's be stronger together, my fellow Americans!"
## [26] "Let's look to the future with courage and confidence. Let's build a
better tomorrow for our beloved children and our beloved country. And when we
do, America will be greater than ever!"
## [27] "Thank you, and may God bless you and the United States of America!"
```

## Question 19

(4 points)

Notes 3B (4,6-7)

Display the lines of text in `clinton.lines` that contain a capitalized word followed by a period.

```
grep("[A-Z]+\.", clinton.lines, value = TRUE)
```

```
## [1] "In my first 100 days, we will work with both parties to pass the
biggest investment in new, good-paying jobs since World War II. Jobs in
manufacturing, clean energy, technology and innovation, small business and
infrastructure. If we invest in infrastructure now, we'll not only create jobs
today, but lay the foundation for the jobs of the future. And we will also
transform the way we prepare our young people for those jobs."
## [2] "I've laid out my strategy for defeating ISIS. We will strike their
sanctuaries from the air and support local forces taking them out on the
ground. We will surge our intelligence so we detect and prevent attacks before
they happen. We will disrupt their efforts online to reach and radicalize young
people in our country."
```

---

Below, we read in lines of data from the Advanced National Seismic System (ANSS), on earthquakes of magnitude 6+, between 2002 and 2017. We display the first 15 lines. (You don't have to do anything yet.)

```
anss.lines = readLines("http://www.stat.cmu.edu/~mfarag/350/anss.htm")
head(anss.lines,15)
```

```
## [1] ""
## [2] "<!-- saved from
url=(0047)http://www.ncedc.org/cgi-bin/catalog-search2.pl -->"
## [3] "<html><head><meta http-equiv=\"Content-Type\" content=\"text/html;
charset=windows-1252\"><title>NCEDC_Search_Results</title></head><body>Your
search parameters are:<ul>"
## [4] "<li>catalog=ANSS"
## [5] "</li><li>minimum_magnitude=6.0"
## [6] "</li><li>maximum_magnitude=10"
## [7] "</li><li>event_type=E"
## [8] "</li></ul>"
## [9] "<pre>Date Time Lat Lon Depth Mag Magt Nst Gap Clo RMS SRC Event ID"
## [10]
"-----"
## [11] "2002/01/01 10:39:06.82 -55.2140 -129.0000 10.00 6.00 Mw 78 1.07 NEI"
```

```

200201014017"
## [12] "2002/01/01 11:29:22.73 6.3030 125.6500 138.10 6.30 Mw 236 0.90 NEI
200201014018"
## [13] "2002/01/02 14:50:33.49 -17.9830 178.7440 665.80 6.20 Mw 215 1.08 NEI
200201024034"
## [14] "2002/01/02 17:22:48.76 -17.6000 167.8560 21.00 7.20 Mw 427 0.90 NEI
200201024041"
## [15] "2002/01/03 07:05:27.67 36.0880 70.6870 129.30 6.20 Mw 431 0.87 NEI
200201034024"

```

---

## Question 20

(4 points)

Notes 3B (4,7-9)

This looks like webpage code mixed in with earthquake data. We don't care about the first nine lines, and it looks as if the data we want starts on line 10. Importantly, every line of data contains a date, of the form YYYY/MM/DD, as in "2002/01/01". Design a regular expression, call it `date.pattern`, to match to these dates. (Hint: use quantifiers to make `date.pattern` concise.). Use this and `grep()` to retrieve the lines of text containing earthquake data. Call the result `date.lines`. How many lines of data are there? Show the first 2 and the last 2 lines (via the use of `head()` and `tail()`). When was the last earthquake recorded and what was its magnitude?

```

date.pattern <- regexpr("[1-9][0-9]{3}/[0-1][0-9]/[0-3][0-9]", anss.lines, useBytes = TRUE)
date.lines <- regmatches(anss.lines, date.pattern)
date.lines

```

```

## [1] "2002/01/01" "2002/01/01" "2002/01/02" "2002/01/02" "2002/01/03"
## [6] "2002/01/03" "2002/01/10" "2002/01/13" "2002/01/15" "2002/01/15"
## [11] "2002/01/15" "2002/01/16" "2002/01/22" "2002/01/28" "2002/01/28"
## [16] "2002/01/30" "2002/02/03" "2002/02/03" "2002/02/05" "2002/02/15"
## [21] "2002/02/19" "2002/02/28" "2002/03/03" "2002/03/03" "2002/03/05"
## [26] "2002/03/08" "2002/03/09" "2002/03/17" "2002/03/19" "2002/03/25"
## [31] "2002/03/26" "2002/03/28" "2002/03/31" "2002/04/07" "2002/04/08"
## [36] "2002/04/11" "2002/04/18" "2002/04/18" "2002/04/20" "2002/04/24"
## [41] "2002/04/26" "2002/05/08" "2002/05/14" "2002/05/15" "2002/05/23"
## [46] "2002/05/25" "2002/05/28" "2002/05/28" "2002/06/06" "2002/06/10"
## [51] "2002/06/13" "2002/06/16" "2002/06/17" "2002/06/17" "2002/06/18"
## [56] "2002/06/21" "2002/06/22" "2002/06/27" "2002/06/27" "2002/06/28"
## [61] "2002/06/29" "2002/06/30" "2002/07/03" "2002/07/19" "2002/07/30"
## [66] "2002/07/31" "2002/08/02" "2002/08/04" "2002/08/07" "2002/08/09"
## [71] "2002/08/12" "2002/08/14" "2002/08/14" "2002/08/15" "2002/08/19"
## [76] "2002/08/19" "2002/08/19" "2002/08/20" "2002/08/24" "2002/09/01"
## [81] "2002/09/06" "2002/09/07" "2002/09/08" "2002/09/08" "2002/09/13"
## [86] "2002/09/15" "2002/09/16" "2002/09/17" "2002/09/20" "2002/09/20"
## [91] "2002/09/24" "2002/09/24" "2002/09/24" "2002/09/24" "2002/10/03"
## [96] "2002/10/03" "2002/10/04" "2002/10/06" "2002/10/08" "2002/10/10"
## [101] "2002/10/10" "2002/10/10" "2002/10/10" "2002/10/12" "2002/10/12"
## [106] "2002/10/13" "2002/10/14" "2002/10/16" "2002/10/16" "2002/10/17"
## [111] "2002/10/17" "2002/10/18" "2002/10/19" "2002/10/19" "2002/10/22"
## [116] "2002/10/23" "2002/10/24" "2002/10/31" "2002/11/02" "2002/11/02"

```

## [121] "2002/11/03" "2002/11/03" "2002/11/07" "2002/11/09" "2002/11/12"  
 ## [126] "2002/11/15" "2002/11/17" "2002/11/20" "2002/11/26" "2002/12/10"  
 ## [131] "2002/12/10" "2002/12/11" "2002/12/12" "2002/12/17" "2002/12/18"  
 ## [136] "2002/12/20" "2002/12/23" "2002/12/30" "2003/01/04" "2003/01/06"  
 ## [141] "2003/01/09" "2003/01/10" "2003/01/16" "2003/01/20" "2003/01/21"  
 ## [146] "2003/01/22" "2003/01/27" "2003/01/27" "2003/02/10" "2003/02/12"  
 ## [151] "2003/02/15" "2003/02/19" "2003/02/24" "2003/03/01" "2003/03/02"  
 ## [156] "2003/03/09" "2003/03/10" "2003/03/11" "2003/03/12" "2003/03/14"  
 ## [161] "2003/03/14" "2003/03/15" "2003/03/17" "2003/03/17" "2003/03/19"  
 ## [166] "2003/03/25" "2003/03/28" "2003/03/30" "2003/03/31" "2003/04/02"  
 ## [171] "2003/04/11" "2003/04/17" "2003/04/17" "2003/04/24" "2003/04/27"  
 ## [176] "2003/04/27" "2003/04/29" "2003/05/01" "2003/05/03" "2003/05/04"  
 ## [181] "2003/05/04" "2003/05/04" "2003/05/05" "2003/05/05" "2003/05/09"  
 ## [186] "2003/05/11" "2003/05/13" "2003/05/14" "2003/05/14" "2003/05/19"  
 ## [191] "2003/05/19" "2003/05/21" "2003/05/26" "2003/05/26" "2003/05/26"  
 ## [196] "2003/05/28" "2003/06/03" "2003/06/07" "2003/06/10" "2003/06/12"  
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 ## [2111] "2014/11/07" "2014/11/13" "2014/11/15" "2014/11/16" "2014/11/17"  
 ## [2116] "2014/11/21" "2014/11/22" "2014/11/26" "2014/12/02" "2014/12/06"  
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 ## [2136] "2015/02/13" "2015/02/16" "2015/02/16" "2015/02/18" "2015/02/19"  
 ## [2141] "2015/02/20" "2015/02/21" "2015/02/22" "2015/02/27" "2015/03/03"  
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## [2341] "2016/07/13" "2016/07/20" "2016/07/25" "2016/07/25" "2016/07/29"
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## [2361] "2016/09/05" "2016/09/08" "2016/09/10" "2016/09/14" "2016/09/14"
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## [2391] "2016/11/21" "2016/11/24" "2016/11/25" "2016/12/01" "2016/12/05"
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## [2411] "2016/12/24" "2016/12/25" "2016/12/29" "2017/01/02" "2017/01/03"
## [2416] "2017/01/03" "2017/01/08" "2017/01/10" "2017/01/10" "2017/01/19"
## [2421] "2017/01/22" "2017/02/07" "2017/02/10" "2017/02/18" "2017/02/21"
## [2426] "2017/02/24"
```

FILL ME IN: utilize line breaks for PDF output

## Question 21

(4 points)

Notes 3B (4,6-9)

Look back at the lines of earthquake data printed above. The columns for **Lat** and **Lon** give the latitude and longitude, respectively, of the earthquake. Importantly, this takes the form X.XXXX, XX.XXXX, XXX.XXXX, or any of these forms with a leading minus sign, where X is a number. Design a regular expression to match these entries, call it **geo.pattern**. Test it out on the trial string vector below, with **grep()**, and make sure that you match all the strings. (Hint: build the regular expression, “left to right”, following this logic: an optional minus sign, 1 to 3 digits, a period, then exactly 4 digits.)

```
trial.str.vec = c("-55.2140", "-129.0000", "6.3030", "125.6500", "-17.9830")
# FILL ME IN
```

## Question 22

(4 points)

Notes 3B (4,6-9) and Notes 3C (2-3)

Design a regular expression `geo.pattern.sp` that captures not only the latitude/longitude pattern (like `geo.pattern`), but additionally, any number of leading spaces (1 or more). Test it out on the trial string vector below, with `regexpr()` and `regmatches()`. Make sure that you match all the strings, and in each case the extracted text is the entire string.

```
trial.str.vec.sp = c(" -55.2140", " -129.0000", "    6.3030", " 125.6500", " -17.9830")  
# FILL ME IN
```

## Question 23

(4 points)

Notes 3B (4,6-9) and Notes 3C (2-3)

Finally, design a regular expression `geo.pattern.pair` that captures a latitude pattern, then any number of spaces (1 or more), then a longitude pattern. Really, this is just the concatenation of the regexes you already designed, `geo.pattern` and `geo.pattern.sp`. Use `geo.pattern.pair`, with `regexpr()` and `regmatches()`, in order to extract the latitude/longitude pairs from each line of earthquake data in `date.lines`. Call the result `lat.lon.pairs`, and display the first 3 entries, checking visually that it matches the results printed at the top of this lab.

```
# FILL ME IN
```

## Question 24

(4 points)

Notes 3B (7-8,11)

Apply `strsplit()` to `lat.lon.pairs[1:2]` with `split` set equal to a regex that captures any number of spaces (1 or more), and show the results. Check that the two elements of the return list have the same number of strings. Utilize `unlist()` to place the values of `lat.lon.pairs[1:2]` into a vector, then restructure that vector as a matrix in which each pair occupies one row. Display that matrix (and make sure that, e.g., “-55.2140” and “-129.0000” occupy the first row). Note: you may have to make use of the transpose function `t()` when creating the matrix!

```
# FILL ME IN
```

## Question 25

(4 points)

Notes 3B (3-9)

Design a regex to match all patterns of the following form: any letter (1 or more), then a punctuation mark, then “ve” or “ll” or “t”, then a space or a punctuation mark. Call it `my.pattern`. Check, with `grep()`, that it matches all the strings below.

```
trial.str.vec = c("we've.", "I'll ", "don't!")  
# FILL ME IN
```