Features of the Bioconductor Packages

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## Objectives

* Explore features of the Bioconductor Packages
* Query/read/Analyze sequence data

## Description

Write R code to do each of the following tasks:

### Question 1:

Retrieve the sequence SARS coronavirus MA15 ExoN1 () with accession number FJ882953 from the ACNUC “genbank”.

# Choose the ACNUC  
choosebank("genbank")  
My\_Que <- query("My\_Que", "AC=FJ882953")  
  
# write to fasta file  
write.fasta(getSequence(My\_Que[['req']][[1]]),getName(My\_Que[['req']][[1]]),"SARS.fasta")

### Question 2:

Find and plot all potential start and stop codons in the first 1000 bases in the sequence. Use a blue color for the start codons and orange for the stop codons your plot.

Plot potential start and stop sequences.

# Get the sequence to vector of characters  
My\_Seq <- read.fasta("SARS.fasta", as.string = TRUE)  
  
# Convert vector of characters to string  
My\_SeqS <- My\_Seq$FJ882953[1:1000]  
  
# measure length  
length(My\_SeqS)

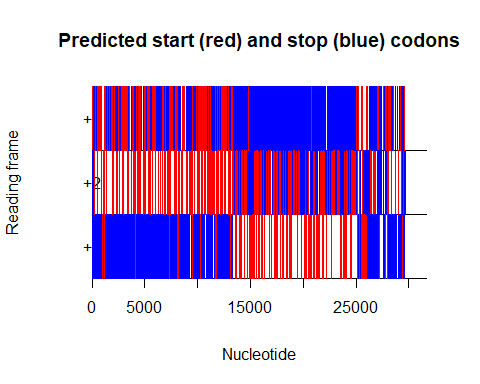
## [1] 1000

# conversion of a vector of chars into a string  
My\_SeqS <- c2s(My\_SeqS)  
  
# find potential start and stop  
findPotentialStartsAndStops2(My\_SeqS)

## $positions  
## [1] 13 26 37 48 66 71 89 96 99 115 129 195  
## [13] 212 223 227 295 306 355 369 384 387 418 429 439  
## [25] 448 450 456 484 500 523 531 555 585 598 607 610  
## [37] 628 633 645 654 655 660 664 679 688 696 697 715  
## [49] 720 739 751 759 780 807 820 860 883 922 927 928  
## [61] 933 934 952 961 964 997 1015 1033 1057 1090 1105 1115  
## [73] 1162 1169 1185 1187 1188 1192 1195 1206 1207 1216 1236 1249  
## [85] 1264 1272 1279 1294 1312 1314 1320 1323 1328 1333 1366 1372  
## [97] 1405 1429 1435 1438 1464 1477 1480 1507 1513 1546 1551 1563  
## [109] 1566 1567 1579 1587 1594 1603 1609 1632 1635 1636 1690 1698  
## [121] 1708 1735 1747 1753 1776 1815 1882 1884 1906 1936 1938 1948  
## [133] 1976 2018 2025 2028 2068 2089 2110 2113 2119 2131 2143 2157  
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## [2125] "atg" "tag" "taa" "tag" "tag" "atg" "taa" "taa" "taa" "taa" "taa" "tga"  
## [2137] "atg" "tag" "tga" "atg" "tag" "atg" "atg" "tga" "atg" "tga" "tga" "atg"  
## [2149] "tag" "tga" "taa" "tag" "tag" "tga" "taa" "taa" "tag" "tag" "taa" "tga"  
## [2161] "atg" "tga" "tag" "tga" "atg" "tga" "tga" "taa" "taa" "tag" "tga" "taa"  
## [2173] "taa" "taa" "tag" "atg" "tga" "atg" "tga" "atg" "tag" "taa" "atg" "tga"  
## [2185] "tag" "tga" "tga" "tag" "taa" "tga" "taa" "taa" "tag" "tga" "tag" "taa"  
## [2197] "taa" "atg" "tga" "atg" "tga" "taa" "tga" "tag" "taa" "taa" "atg" "tag"  
## [2209] "taa" "atg" "tga" "tga" "atg" "atg" "tag" "taa" "taa" "atg" "tga" "taa"  
## [2221] "tag" "taa" "tag" "tag" "tag" "atg" "atg" "atg" "taa" "atg" "tag" "tag"  
## [2233] "atg" "tga" "tag" "taa" "taa" "taa" "atg" "tga" "taa" "atg" "tag" "tga"  
## [2245] "taa" "atg" "atg" "taa" "atg" "tag" "tag" "atg" "tga" "tga" "atg" "tga"  
## [2257] "atg" "tag" "taa" "atg" "tga" "tga" "taa" "taa" "atg" "tag" "taa" "tag"  
## [2269] "atg" "tag" "tga" "tag" "tga" "tga" "taa" "taa" "tga" "taa" "taa" "tga"  
## [2281] "atg" "atg" "atg" "tga" "atg" "taa" "atg" "tga" "tga" "tga" "taa" "tga"  
## [2293] "atg" "tga" "tga" "tga" "atg" "atg" "tga" "atg" "tga" "tga" "taa" "atg"  
## [2305] "tga" "atg" "tga" "atg" "atg" "taa" "tag" "atg" "tga" "taa" "taa" "tag"  
## [2317] "tag" "taa" "taa" "tag" "taa" "atg" "taa" "tag" "tga" "tga" "taa" "atg"  
## [2329] "tag" "atg" "taa" "atg" "taa" "taa" "tag" "tag"

plotPotentialStartsAndStops(My\_SeqS)

## [1] 1 31646



### Question 3:

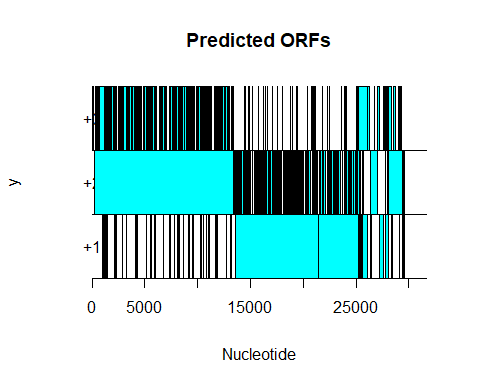
Find and Plot the potential ORF in the reverse complement of the last 1000 nucleotides in the sequence. Use a green shade in your plot.

findORFsinSeq(My\_SeqS)

## [[1]]  
## [1] 66 227 369 429 555 654 696 1033 1192 1206 1216 1294  
## [13] 1314 1333 1438 1464 1566 1635 1884 2113 2157 2254 2265 2466  
## [25] 2583 2658 2742 2766 2845 2922 2955 3270 3283 3336 3360 3399  
## [37] 3441 3507 3528 3834 3864 4020 4122 4153 4198 4215 4296 4327  
## [49] 4335 4407 4479 4518 4596 4926 4995 5122 5161 5229 5370 5484  
## [61] 5515 5623 5631 5751 5922 5950 6048 6378 6432 6531 6669 6784  
## [73] 6948 7336 7347 7440 7461 7650 7773 7788 7801 7932 8037 8116  
## [85] 8227 8241 8280 8412 8553 8665 8790 9018 9096 9121 9166 9180  
## [97] 9282 9384 9510 9538 9588 9660 9873 10029 10294 10302 10371 10378  
## [109] 10491 10554 10564 10629 10662 10683 10767 10776 10812 10843 10983 11026  
## [121] 11152 11211 11259 11295 11589 11664 11710 11827 11844 12018 12066 12111  
## [133] 12282 12387 12582 12651 12733 12924 13132 13150 13230 13341 13418 13511  
## [145] 13561 13577 13652 13718 13790 13856 13913 13970 14105 14150 14339 14405  
## [157] 14453 14514 14543 14666 14783 14856 14879 14894 14969 15155 15195 15353  
## [169] 15446 15488 15611 15704 15726 15803 15866 15926 16058 16203 16220 16271  
## [181] 16377 16385 16416 16433 16461 16475 16626 16667 16742 16787 16865 16907  
## [193] 17052 17060 17079 17115 17192 17210 17249 17291 17498 17538 17573 17750  
## [205] 17873 17915 18045 18131 18215 18302 18494 18602 18659 18765 18779 18833  
## [217] 18920 18972 18986 19040 19175 19202 19295 19325 19359 19391 19455 19523  
## [229] 19619 19796 19883 19928 20000 20168 20357 20379 20411 20483 20678 20811  
## [241] 20852 20919 20945 20978 21080 21114 21143 21209 21353 21454 21521 21584  
## [253] 21647 21818 21834 21917 22064 22250 22314 22442 22470 22577 22628 22694  
## [265] 22889 22967 23114 23219 23375 23643 23666 23888 23909 23916 23933 24054  
## [277] 24119 24332 24419 24572 24779 24980 25032 25140 25169 25230 25294 25361  
## [289] 25433 25555 25577 25607 25651 26079 26360 26413 26718 27036 27193 27235  
## [301] 27600 27604 27741 27776 27826 27921 27953 28016 28082 28092 28405 28477  
## [313] 28545 29071 29085 29214 29286 29357 29377 29507 29590  
##   
## [[2]]  
## [1] 98 13375 386 458 647 662 1187 1059 1197 1238 1251 1314  
## [13] 1322 1368 1479 1565 1589 1700 2030 2121 2252 2265 2342 2582  
## [25] 2600 2672 2747 2855 2892 2936 3257 3329 3291 3356 3374 3440  
## [37] 3458 3527 3743 3839 4016 4055 4133 4173 4239 4259 4319 4341  
## [49] 4349 4448 4514 4577 4661 4991 5108 5160 5169 5354 5444 5549  
## [61] 5532 5634 5675 5894 5981 5958 6059 6416 6503 6596 6812 6804  
## [73] 7034 7398 7388 7448 7646 7730 7781 7850 7821 8018 8147 8142  
## [85] 8235 8267 8303 8420 8717 8673 8975 9083 9140 9165 9177 9230  
## [97] 9299 9416 9578 9630 9608 9731 10007 10292 10344 10337 10478 10386  
## [109] 10547 10628 10593 10652 10673 10733 10775 10808 10913 10869 11138 11046  
## [121] 11160 11225 11291 11339 11627 11753 11739 11847 11933 12062 12098 12185  
## [133] 12350 12551 12590 12833 12741 12980 13149 13161 13328 13358 13480 13531  
## [145] 21447 13651 13690 13759 13831 13867 13939 14008 14146 14320 14386 14410  
## [157] 14500 14573 14644 14749 14812 14864 14890 14950 15004 15160 15200 15445  
## [169] 15478 15598 15658 15790 15737 15847 15898 16048 16135 16223 16252 16309  
## [181] 16385 16423 16430 16456 16466 16657 16646 16690 16786 16810 16870 17041  
## [193] 17072 17095 17084 17120 17209 17242 17281 17365 17512 17576 17608 17854  
## [205] 17899 17944 18053 18205 18259 18415 18517 18655 18760 18782 18829 18841  
## [217] 18970 19001 19021 19159 19195 19249 19309 19369 19400 19432 19475 19618  
## [229] 19765 19810 19906 19939 20014 20263 20395 20399 20428 20671 20713 20852  
## [241] 20884 20936 20968 21022 21142 21179 21169 21292 21361 25221 21565 21616  
## [253] 21775 21907 21839 22063 22069 22396 22325 22576 22493 22618 22636 22888  
## [265] 22945 23068 23167 23365 23497 23651 23689 23902 23923 23927 24007 24113  
## [277] 24277 24388 24424 24742 24979 25072 25115 25169 25291 26054 25416 25429  
## [289] 25453 25563 25594 25654 26115 26309 27025 26478 26744 27227 27216 27603  
## [301] 27734 27618 27860 27817 28080 27953 27997 28063 29350 28388 28461 28491  
## [313] 28757 29097 29144 29261 29318 29389 29454 29590 29625  
##   
## [[3]]  
## [1] 33 13149 18 30 93 9 492 27 6 33 36 21  
## [13] 9 36 42 102 24 66 147 9 96 12 78 117  
## [25] 18 15 6 90 48 15 303 60 9 21 15 42  
## [37] 18 21 216 6 153 36 12 21 42 45 24 15  
## [49] 15 42 36 60 66 66 114 39 9 126 75 66  
## [61] 18 12 45 144 60 9 12 39 72 66 144 21  
## [73] 87 63 42 9 186 81 9 63 21 87 111 27  
## [85] 9 27 24 9 165 9 186 66 45 45 12 51  
## [97] 18 33 69 93 21 72 135 264 51 36 108 9  
## [109] 57 75 30 24 12 51 9 33 102 27 156 21  
## [121] 9 15 33 45 39 90 30 21 90 45 33 75  
## [133] 69 165 9 183 9 57 18 12 99 18 63 21  
## [145] 7887 75 39 42 42 12 27 39 42 171 48 6  
## [157] 48 60 102 84 30 9 12 57 36 6 6 93  
## [169] 33 111 48 87 12 45 33 123 78 21 33 39  
## [181] 9 39 15 24 6 183 21 24 45 24 6 135  
## [193] 21 36 6 6 18 33 33 75 15 39 36 105  
## [205] 27 30 9 75 45 114 24 54 102 18 51 9  
## [217] 51 30 36 120 21 48 15 45 42 42 21 96  
## [229] 147 15 24 12 15 96 39 21 18 189 36 42  
## [241] 33 18 24 45 63 66 27 84 9 3768 45 33  
## [253] 129 90 6 147 6 147 12 135 24 42 9 195  
## [265] 57 102 54 147 123 9 24 15 15 12 75 60  
## [277] 159 57 6 171 201 93 84 30 123 825 123 69  
## [289] 21 9 18 48 465 231 666 66 27 192 24 369  
## [301] 135 15 120 42 255 33 45 48 1269 297 57 15  
## [313] 213 27 60 48 33 33 78 84 36

plotORFsinSeq(My\_SeqS)

## Contacting Delphi...the oracle is unavailable.  
## We apologize for any inconvenience.



### Question 4:

Extract and translate one potential gene. What is the length of the resultant protein sequence?

Seq\_T <- seqinr::translate(s2c(substring(My\_SeqS,66,98)))  
  
# get the Length of the potential sequences  
length(Seq\_T)

## [1] 11

### Question 5:

For the whole sequence, identify the significant ORFs. Use at least 20 random sequences. Justify your answer.

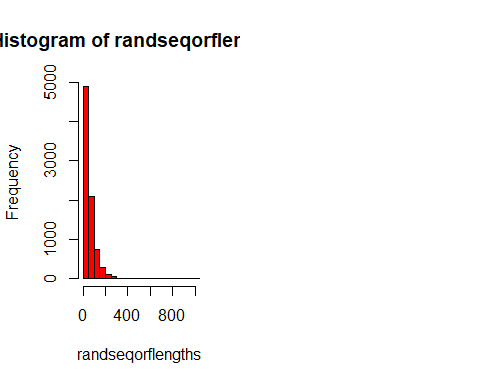
# sequences is pass a a DNA sequences  
generateSeqsWithMultinomialModel <- function(sequence, index)  
{  
 My\_Base1 <- count(sequence, 1)  
   
 # Calculate the percentage in sequences  
 Pro\_Seq <-  
 c((My\_Base1["a"] / sum(My\_Base1) \* 100),  
 (My\_Base1["g"] / sum(My\_Base1) \* 100),  
 (My\_Base1["c"] / sum(My\_Base1) \* 100),  
 (My\_Base1["t"] / sum(My\_Base1) \* 100)  
 )  
 My\_Rad\_Seq = {  
 }  
 for (i in 1:index) {  
 My\_Rad\_Seq <- c (My\_Rad\_Seq,  
 c2s(sample(  
 c('a', 'c', 'g', 't'),  
 length(sequence),  
 replace = TRUE,  
 prob = Pro\_Seq  
 )))  
 }  
 return (My\_Rad\_Seq)  
}

#generate random sequences  
randseqs <- generateSeqsWithMultinomialModel(getSequence(My\_Que$req[[1]]), 20)  
# find ORF  
randseqorflengths <- numeric() # Tell R that we want to make a new vector of numbers  
for (i in 1:20)  
{  
 # print(i) # Test the loop travelse  
 randseq <- randseqs[i] # Get the ith random sequence  
 mylist <- findORFsinSeq(randseq) # Find ORFs in "randseq"  
 lengths <- mylist[[3]] # Find the lengths of ORFs in "randseq"  
 randseqorflengths <- append(randseqorflengths, lengths, after=length(randseqorflengths))  
}  
  
# plot a histogram of the lengths of the ORFs real vs. random  
par(mfrow = c(1,2)) # Make a picture with two plots side-by-side (one row, two columns)  
bins <- seq(0,11000,50) # Set the bins for the histogram  
hist(randseqorflengths, breaks=bins, col="red", xlim=c(0,1000))  
  
#find the longest random gene  
x = max(randseqorflengths)  
  
#use it as a threshold, and discard all ORFs found in the real sequence that are shorter than this  
summary(randseqorflengths > x)

## Mode FALSE   
## logical 8119

#find and use the 99th quantile as a threshold  
quantile(randseqorflengths, probs=c(0.99))

## 99%   
## 225



## Hint:

define and use a function generateSeqsWithMultinomialModel

## Notes:

* Handwritten answers are not allowed!
* Use Rmarkdown (<https://rmarkdown.rstudio.com/>) and provide a neatly formatted “pdf” file showing both code and output.
* Include your name as a comment at the beginning of the script file.