Base R 1: Vectors

Natalya Shelchkova

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1. Create the vectors:

(a) (1, 2, 3, . . . , 19, 20)

```
1:20
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
```

(b) (20, 19, . . . , 2, 1)

```
20:1
```

```
##  [1] 20 19 18 17 16 15 14 13 12 11 10  9  8  7  6  5  4  3  2  1
```

(c) (1, 2, 3, . . . , 19, 20, 19, 18, . . . , 2, 1)

```
c(1:20, 19:1)
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 19 18 17
## [24] 16 15 14 13 12 11 10  9  8  7  6  5  4  3  2  1
```

(d) assign vector c(4, 6, 3) variable name tmp

Use tmp for parts (e), (f) and (g)

```
tmp <- c(4, 6, 3)
```

(e) (4, 6, 3, 4, 6, 3, . . . , 4, 6, 3) where there are 10 occurrences of 4.

```
rep(tmp, 10)
```

```
##  [1] 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3
```

(f) (4, 6, 3, 4, 6, 3, . . . , 4, 6, 3, 4) where there are 11 occurrences of 4, 10 occurrences of 6 and 10 occurrences of 3.

```
rep(tmp, length = 31)
```

```
##  [1] 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4 6 3 4
```

(g) (4, 4, . . . , 4, 6, 6, . . . , 6, 3, 3, . . . , 3) where there are 10 occurrences of 4, 20 occurrences of 6 and 30 occurrences of 3.

```
rep(tmp, times=c(10,20,30))
```

```
##  [1] 4 4 4 4 4 4 4 4 4 4 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 3 3 3 3 3
## [36] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
```

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2. Create a vector of the values of

$e^x cos(x)$ at x = 3, 3.1, 3.2, . . . ,6.

```r
# reset value of tmp

tmp <- seq(3,6, by = .01)

tmp1 <- exp(tmp)*cos(tmp)

head(tmp1, n = 30)
```

```
##  [1] -19.88453 -20.11200 -20.34000 -20.56850 -20.79745 -21.02684 -21.25660
##  [8] -21.48672 -21.71714 -21.94784 -22.17875 -22.40986 -22.64110 -22.87244
## [15] -23.10384 -23.33524 -23.56660 -23.79788 -24.02902 -24.25998 -24.49070
## [22] -24.72113 -24.95123 -25.18093 -25.41019 -25.63894 -25.86714 -26.09472
## [29] -26.32163 -26.54780
```

```r
# To keep the listing shorter
```

---

3. Create the following vectors:

(a) $(0.1^3 0.1^1, 0.1^6 0.2^4, ..., 0.1^{36} 0.234)$

```r
(0.1 ^ seq(3, 36, 3)) * (0.2 ^ seq(1, 34, 3))
```

```
##  [1] 2.000000e-04 1.600000e-09 1.280000e-14 1.024000e-19 8.192000e-25
##  [6] 6.553600e-30 5.242880e-35 4.194304e-40 3.355443e-45 2.684355e-50
## [11] 2.147484e-55 1.717987e-60
```

(b) $(2, \frac{2^2}{2}, \frac{2^3}{3}, ..., \frac{2^{25}}{25})$

```r
(2^(1:25))/(1:25)
```

```
##  [1] 2.000000e+00 2.000000e+00 2.666667e+00 4.000000e+00 6.400000e+00
##  [6] 1.066667e+01 1.828571e+01 3.200000e+01 5.688889e+01 1.024000e+02
## [11] 1.861818e+02 3.413333e+02 6.301538e+02 1.170286e+03 2.184533e+03
## [16] 4.096000e+03 7.710118e+03 1.456356e+04 2.759411e+04 5.242880e+04
## [21] 9.986438e+04 1.906502e+05 3.647221e+05 6.990507e+05 1.342177e+06
```

---

4. Calculate the following:

(a) $\sum_{i=10}^{100} (i^3 + 4i^2)$

```r
sum((10:100) ^ 3 + (4 * ((10:100) ^ 2)))
```

```
## [1] 26852735
```

(b) $\sum_{i=1}^{25} (\frac{2^i}{i} + \frac{3^i}{i^2})$

```r
tmp = 1:25

sum((2^tmp)/tmp + 3^tmp/(tmp^2))
```

```
## [1] 2129170437
```

---

5. Use the function paste() to create the following character vectors of length 30:

(a) ("label 1", "label 2", ..., "label 30"). Note that there is a single space between label and the number following.

```
paste("label", 1:30)
```

```
##  [1] "label 1"  "label 2"  "label 3"  "label 4"  "label 5"  "label 6"
##  [7] "label 7"  "label 8"  "label 9"  "label 10" "label 11" "label 12"
## [13] "label 13" "label 14" "label 15" "label 16" "label 17" "label 18"
## [19] "label 19" "label 20" "label 21" "label 22" "label 23" "label 24"
## [25] "label 25" "label 26" "label 27" "label 28" "label 29" "label 30"
```

(b) ("fn1", "fn2", . . . , "fn30").

In this case, there is no space between fn and the number following.

```
paste("fn", 1:30, sep="" )
```

```
##  [1] "fn1"  "fn2"  "fn3"  "fn4"  "fn5"  "fn6"  "fn7"  "fn8"  "fn9"  "fn10"
## [11] "fn11" "fn12" "fn13" "fn14" "fn15" "fn16" "fn17" "fn18" "fn19" "fn20"
## [21] "fn21" "fn22" "fn23" "fn24" "fn25" "fn26" "fn27" "fn28" "fn29" "fn30"
```

---

6. Execute the following lines which create two vectors of random integers which are chosen with replacement from the integers 0, 1, . . . , 999. Both vectors have length 250.

```
set.seed(50)
xVec <- sample(0:999, 250, replace=T)
yVec <- sample(0:999, 250, replace=T)
```

Suppose $x = (x_1, x_2, ..., x_n)$ denotes the vector xVec and $y = (y_1, y_2, .., y_n)$ denotes the vector yVec.

(a) Create the vector $(y_2 - x_1, ..., y_n - x_{n-1})$.

```
tmp1 <- yVec[-1] - xVec[-length(xVec)]

head(tmp1, n = 30)
```

```
##  [1]  163 -122  317 -146  417  393  249 -489  741  771   81  402 -549  338
## [15]  583 -403  -67  217  307 -121 -269   36 -706 -563  102   48  397  297
## [29]  -45 -152
```

(b) Create the vector $(\frac{sin(y_1)}{cos(x_2)}, \frac{sin(y_2)}{x_3}, ..., \frac{y_{n-1}}{cos(x_n)})$.

```
# yVec[-length(yVec)] results in an array of elements 1:249 (excludes the last element)

# xVec[-1] excludes the first element

tmp2 <- sin(yVec[-length(yVec)])/cos(xVec[-1])

head(tmp2, n = 30)
```

```
##  [1]  0.8860340 -1.4418482  0.8280726 -1.6159172 -0.8601734 20.2635647
##  [7] -0.7993041  1.7241444 -0.0809424 -0.7489563 -2.5986696 -0.3736105
## [13] 31.1147158  0.1235592 -0.3592523 -0.9074361  0.3437444  5.7820592
## [19] -2.5741856 -0.7866133 -0.5985541  0.9893626  0.3304293 -1.7512465
```

```
## [25] -0.5943555  1.0537469  0.6549740 -0.1159658 -0.9717654  0.5718027
```

(c) Create the vector $(x_1 + 2x_2 - x_3, x_2 + 2x_3 - x_4, ..., x_{x-2} + 2x_{n-1} - x_n)$

```
tmp3 <- xVec[1:248] + (2 * xVec[2:249]) - xVec[3:250]

head(tmp3, n = 30)
```

```
##  [1] 1382   70 1221 1749  -98  796 1949  623 -134  618  288 1472  517  -45
## [15]  794 1982 1489  344 -206 1207  292  771 2085  810 1032 1547  767  537
## [29]  702  676
```

(d) Calculate $\sum_{i=1}^{n-1} \frac{e^{-x_{i+1}}}{x_i+10}$

```
sum((exp(-xVec[2:250])) / (xVec[1:249] + 10))
```

```
## [1] 0.01269872
```

7. This question uses the vectors xVec and yVec created in the previous question and the functions sort,

order, mean, sqrt, sum, and abs.

(a) Pick out the values in yVec which are > 600.

```
tmp5 <- yVec[yVec > 600]
head(tmp5, n = 30)
```

```
##  [1] 709 871 621 930 948 783 878 671 860 768 698 974 855 813 776 721 917
## [18] 985 705 884 840 687 957 955 786 938 930 641 615 988
```

(b) What are the index positions in yVec of the values which are > 600?

```
y_idx <- match(yVec[yVec > 600], yVec)
```

(c) What are the values in xVec which correspond to the values in yVec which are > 600? (By correspond, we mean at the same index positions.)

```
tmp6 <- xVec[y_idx]
head(tmp6, n = 30)
```

```
##  [1] 708 437 513  44 646 107 390 640 676 364 577 257 408 437 618 627 836
## [18] 278  55 458 803 358 525 511 266 578  44  38 724  61
```

(d) Create the vector $(|x_1 - \bar{x}|^{1/2}, |x_2 - \bar{x}|^{1/2}, ..., |x_n - \bar{x}|^{1/2})$

```
x_mean <- mean(xVec)
tmp7 <- abs(xVec - x_mean) ^ 0.5
head(tmp7, n= 30)
```

```
##  [1] 16.004499  3.854348 15.869972 17.752296  7.819463 20.195445 15.720814
##  [8] 13.933557 20.244901 18.570299  7.864859 13.522426 13.716559 19.361198
## [15] 13.223313 14.971439 19.574064  9.373153 19.438518 16.848027 12.811869
## [22] 16.089002 16.066860 19.752063 11.952238 14.076363 11.186778 13.959083
## [29] 11.307343  9.157292
```

(e) How many values in yVec are within 200 of the maximum value of the terms in yVec?

```
length(yVec[yVec >= (max(yVec) - 200)])
```

```
## [1] 57
```

(f) How many numbers in xVec are divisible by 2? (Note that the modulo operator is denoted %%.)

```
sum(xVec %% 2)
```

```
## [1] 126
```

(g) Sort the numbers in the vector xVec in the order of increasing values in yVec.

```
tmp8 <- xVec[order(yVec)]
head(tmp8, n = 30)
```

```
##  [1] 405 842 308 572 461   8 256 507 373 639  42 616  29 645 376 669 688
## [18] 197  63 638 862  77 996  93  59 585 661  72 339  20
```

(h) Pick out the elements in yVec at index positions 1, 4, 7, 10, 13, . . .

```
tmp9 <- yVec[seq(1, length(yVec), 3)]
head(tmp9, n = 30)
```

```
##  [1] 709 517 437 783 671 860 581 347 279 974 216 776 538 460 985 248 317
## [18] 288 687 957 938 101 615 285 106 414 881 488 484 791
```

---

8. By using the function cumprod or otherwise, calculate

$1 + \frac{2}{3} + (\frac{2}{3}\frac{4}{5}) + (\frac{2}{3}\frac{4}{5}\frac{6}{7} + ... + (\frac{2}{3}\frac{4}{5}...\frac{38}{39}))$

```
1 + sum(cumprod(2:38/3:39))
```

```
## [1] 6.507086
```