



ACADGILD

SESSION 3: FOUNDATIONAL R PROGRAMMING

Assignment 2

Problem Statement

1. Create an $m \times n$ matrix with `replicate(m, rnorm(n))` with $m=10$ column vectors of $n=10$ elements each, constructed with `rnorm(n)`, which creates random normal numbers.
 - Then we transform it into a dataframe (thus 10 observations of 10 variables) and perform an algebraic operation on each element using a nested for loop: at each iteration, every element referred by the two indexes is incremented by a sinusoidal function, compare the vectorized and non-vectorized form of creating the solution and report the system time differences.

SOLUTION :

APPROACH-1: Using `rbenchmark` library

The R-script for the given problem is as follows:

```
m <- replicate(10, rnorm(10), simplify = "matrix")
m

m <- as.data.frame(m)
View(m)

library(rbenchmark)
benchmark(
  vect = as.vector(m), # vectorized form
  conc = (n <- as.vector(for (i in seq(nrow(m))) {
    for (j in seq(ncol(m))) {      # nested for
      print(2*sin(m[i, j]))        # performing algebraic function on each element
    }
  })))
)
```

The output of the R-Script is given as follows:

```
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Source
Console Terminal x
F:/ACADGILD - Online Course/ACAD Working Directory/
> # A. APPROACH-1: Using rbenchmark library
> # The R-script for the given problem is as follows:
> m <- replicate(10, rnorm(10), simplify = "matrix")
> m
      [,1]      [,2]      [,3]      [,4]      [,5]      [,6]      [,7]      [,8]      [,9]     [,10]
[1,] -2.0783644  0.4158127 -0.16456726 -0.54031936 -0.1615613 -0.79808944 -0.7348287 -1.29321094  0.97796315 -0.4508492
[2,]  1.6684468  0.5358463 -2.42898199  1.15718119  1.2904262 -0.51432856 -2.1653702  0.09372406 -0.85351633  0.4632697
[3,]  0.8634785  1.2837908  0.39123763 -2.17905789  1.6025895  0.27053967  1.2821700  1.67355007 -0.52810386  1.3482056
[4,] -1.1839604  0.7093035  1.44098522 -0.92526727  0.3703598  0.61888279 -0.5456540 -2.04335592  0.85536822 -0.5950407
[5,] -2.3136865 -0.5820998  0.84727300 -0.10671705 -0.1034519  1.31414038 -1.0227686 -0.30813614 -0.78906217  0.1030602
[6,] -1.1955667 -0.6526549 -0.17188615 -0.19562879  0.1539865 -2.20615329  1.0298210 -0.22599601  0.05175432 -0.1517225
[7,]  0.3401677  0.6224492  0.00212511 -1.42548333  0.6368811  1.41744565  0.3477261  0.03468110 -0.41766061  1.7340540
[8,] -2.6024077 -0.4571471  0.38864374  0.55190122 -0.9163641  1.08468660  0.5338568  0.75864326  0.83748428 -0.1974877
[9,]  0.2740521 -0.8346149 -1.03251296  0.01292755 -0.3728398 -0.06405902 -0.4298014 -0.24922728 -0.46019607  0.1162962
[10,]  0.5288015 -1.4921021  2.52108698 -0.70476742  0.5584440  0.51478264  0.3347482  0.73882498 -1.28291529  0.4567771
>
```

```
> m <- as.data.frame(m)
> view(m)
```

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Assignment 3.2_Benchmark.R x m x

Filter

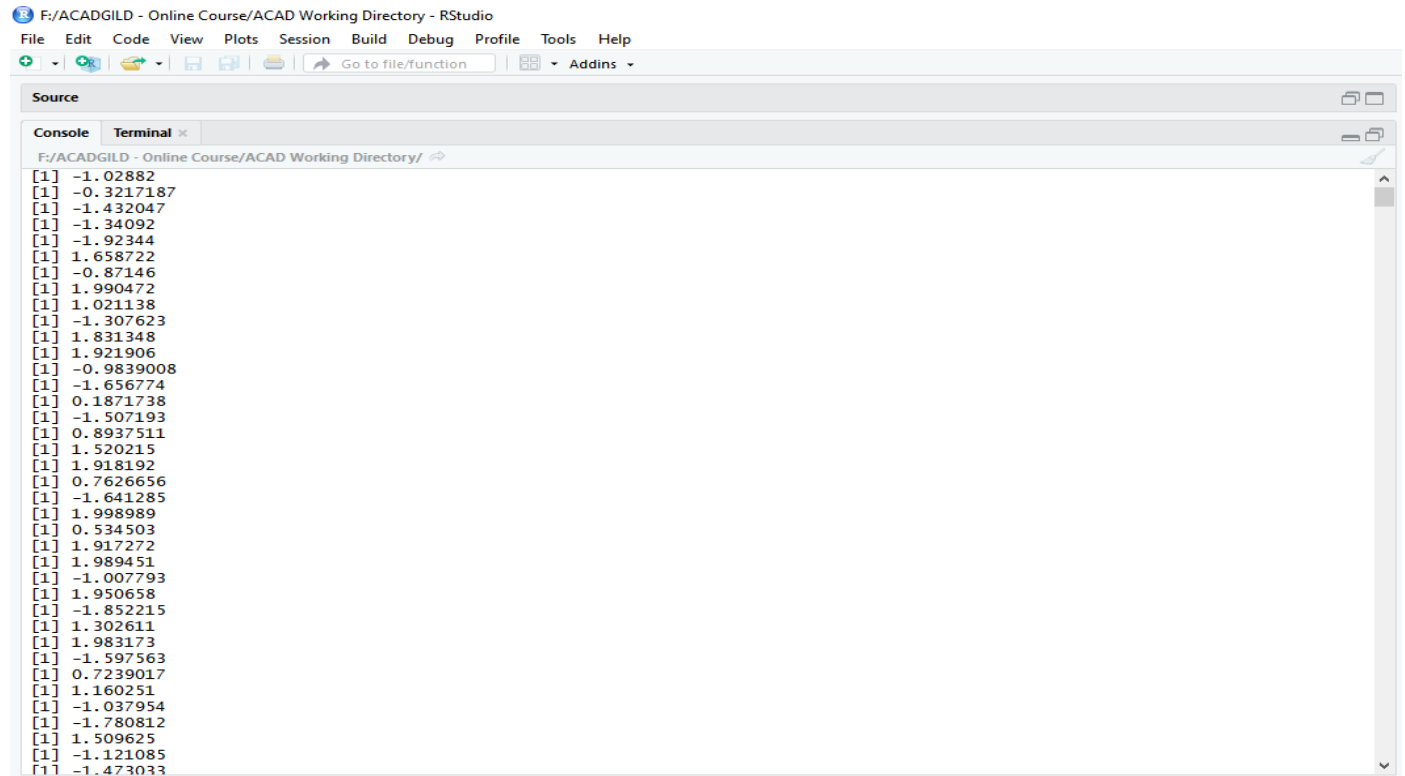
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4	-1.1839604	0.7093035	1.44098522	-0.92526727	0.3703598	0.61888279	-0.5456540	-2.04335592	0.85536822	-0.5950407
5	-2.3136865	-0.5820998	0.84727300	-0.10671705	-0.1034519	1.31414038	-1.0227686	-0.30813614	-0.78906217	0.1030602
6	-1.1955667	-0.6526549	-0.17188615	-0.19562879	0.1539865	-2.20615329	1.0298210	-0.22599601	0.05175432	-0.1517225
7	0.3401677	0.6224492	0.00212511	-1.42548333	0.6368811	1.41744565	0.3477261	0.03468110	-0.41766061	1.7340540
8	-2.6024077	-0.4571471	0.38864374	0.55190122	-0.9163641	1.08468660	0.5338568	0.75864326	0.83748428	-0.1974877
9	0.2740521	-0.8346149	-1.03251296	0.01292755	-0.3728398	-0.06405902	-0.4298014	-0.24922728	-0.46019607	0.1162962
10	0.5288015	-1.4921021	2.52108698	-0.70476742	0.5584440	0.51478264	0.3347482	0.73882498	-1.28291529	0.4567771

Showing 1 to 10 of 10 entries

```

library(rbenchmark)
benchmark(
  vect = as.vector(m), # vectorized form
  conc = (n <- as.vector(for (i in seq(nrow(m))) {
    for (j in seq(ncol(m))) { # nested for
      print(2*sin(m[i, j])) # performing algebraic function on each element
    }
  })))
)

```



```

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Source
Console Terminal
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```

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```

[1] -1.121085
[1] -1.473033
[1] -1.099558
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[1] 0.6570627
[1] 1.346839
[1] -1.917695
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```

	test	replications	elapsed	relative	user.self	sys.self	user.child	sys.child
2	conc	100	3.8	NA	3.77	0.09	NA	NA
1	vect	100	0.0	NA	0.00	0.00	NA	NA

B. APPROACH-2:

The R-script for the given problem is as follows:

#Vectorized form

```
set.seed(100)
```

```
#create matrix
```

```
mat_1<- replicate(10,rnorm(10))
```

```
#transform into data frame
```

```
df_1= data.frame(mat_1)
```

```
df_1<- df_1 + 2*sin(0.75*pi)
```

```
#non-vectorized form
```

```
set.seed(100)
```

```
#create matrix
```

```
mat_1<- replicate(10,rnorm(10))
```

```
#transform into data frame
```

```
df_1= data.frame(mat_1)
```

```
for(i in 1:10){
```

```
  for(j in 1:10){
```

```
    df_1[i,j]<- df_1[i,j] + 2*sin(0.75*pi)
```

```
    print(df_1)
```

```
  }
```

```
}
```

```
#time difference
```

```
system.time(
```

```
  df_1[i,j]<- df_1[i,j] + 2*sin(0.75*pi)
```

```
)
```

```
system.time(
```

```
  for(i in 1:10){
```

```
    for(j in 1:10){
```

```
      df_1[i,j]<- df_1[i,j] + 2*sin(0.75*pi)
```

```
    }
```

```
  }
```

```
)
```

The output of the R-Script is given as follows:

The screenshot shows a MATLAB R2020a interface with the following components:

- Title Bar:** F:\ACADGILD - Online Course\ACAD Working Directory - RStudio
- Menu Bar:** File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, Help
- Toolbar:** Icons for saving, opening, and navigating files.
- Main Window (Source):** Displays a script with a large table of numerical data. The script includes a loop that calculates time differences and system times.
- Console Window:** Shows the execution output, including the time difference and system time for each iteration.

The script content is as follows:

```

1 0.9120212 1.5040997 0.9761236 1.3231000 1.3125843 0.96715138 1.1522178 1.8631168 2.31103583 0.8570913
2 1.5457447 1.5104880 2.1782742 3.1715892 2.8174171 -0.32438438 1.3453695 0.3498579 1.36421780 2.8425150
3 1.3352965 1.2125796 1.6761749 1.2762840 -0.3625621 1.59307841 1.0353300 0.2517942 0.06886425 0.5212562
4 2.3009984 2.1540541 2.1876182 1.3030201 2.0370810 3.31167926 3.9961725 3.0627353 -0.51699797 0.2566423
5 1.5311848 1.5375931 0.5998344 0.7241992 0.8919302 -0.85771192 1.5440477 -0.6478825 2.12379515 0.8839171
6 1.7328436 1.3848969 0.9757630 1.1924193 2.7364445 2.39467770 0.7011886 1.4269633 1.25630853 3.8598963
7 0.8324229 1.0253593 0.6939920 1.5971212 1.0507732 0.01538795 2.0522078 0.3266852 1.63058144 0.5817178
8 2.1287463 1.9250698 1.6451581 1.8315368 2.7332793 3.23908599 1.6159052 1.6847531 2.23157564 1.8277334
9 0.5889541 0.5003994 0.2564841 2.4796159 1.4579926 2.79551229 1.3442966 2.4226654 3.14138932 0.2355304
10 1.0543514 3.7245104 1.6612896 2.3844156 -0.4644423 0.57536169 1.3217237 -0.6601912 1.31044327 -1.1740348
    x1      x2      x3      x4      x5      x6      x7      x8      x9      x10
1 0.9120212 1.5040997 0.9761236 1.3231000 1.3125843 0.96715138 1.1522178 1.8631168 2.31103583 0.8570913
2 1.5457447 1.5104880 2.1782742 3.1715892 2.8174171 -0.32438438 1.3453695 0.3498579 1.36421780 2.8425150
3 1.3352965 1.2125796 1.6761749 1.2762840 -0.3625621 1.59307841 1.0353300 0.2517942 0.06886425 0.5212562
4 2.3009984 2.1540541 2.1876182 1.3030201 2.0370810 3.31167926 3.9961725 3.0627353 -0.51699797 0.2566423
5 1.5311848 1.5375931 0.5998344 0.7241992 0.8919302 -0.85771192 1.5440477 -0.6478825 2.12379515 0.8839171
6 1.7328436 1.3848969 0.9757630 1.1924193 2.7364445 2.39467770 0.7011886 1.4269633 1.25630853 3.8598963
7 0.8324229 1.0253593 0.6939920 1.5971212 1.0507732 0.01538795 2.0522078 0.3266852 1.63058144 0.5817178
8 2.1287463 1.9250698 1.6451581 1.8315368 2.7332793 3.23908599 1.6159052 1.6847531 2.23157564 1.8277334
9 0.5889541 0.5003994 0.2564841 2.4796159 1.4579926 2.79551229 1.3442966 2.4226654 3.14138932 0.2355304
10 1.0543514 3.7245104 1.6612896 2.3844156 -0.4644423 0.57536169 1.3217237 -0.6601912 1.31044327 0.2401788
> #time difference
> system.time(
+ df_1[i,j]<- df_1[i,j] + 2*sin(0.75*pi)
+ )
    user    system elapsed
     0.00      0.00      0.00
> system.time(
+ for(i in 1:10){
+   for(j in 1:10){
+     df_1[i,j]<- df_1[i,j] + 2*sin(0.75*pi)
+   }
+ }
+ )
    user    system elapsed
    0.01     0.00     0.01

```