## **SESSION 3 – ASSIGNMENT 3.2**

Date: 29th December 2018

- 1. Create an m x 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.

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② Untitled1* × ② Untitled2* × ② Untitled3* ×
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  1 #Vectorized form
  2 set.seed(42)
  4 #create matrix
  5 mat_1<- replicate(10,rnorm(10))</pre>
  7 #transform into data frame
  8 df_1= data.frame(mat_1)
  9 df_1<- df_1 + 10*sin(0.75*pi)
 10
 11 #non-vectorized form
 12 set.seed(42)
 13 #create matrix
 14 mat_1<- replicate(10,rnorm(10))</pre>
 15 #transform into data frame
 16 df_1= data.frame(mat_1)
 17
 18 - for(i in 1:10)
 19 for(j in 1:10){
20 df_1[i,j]<- df_1[i,j] + 10*sin(0.75*pi)
         print(df_1)
 21
 22
 23 }
 24
 25 #time difference
 26
 27 system.time(
       df_1[i,j]<- df_1[i,j] + 10*sin(0.75*pi)
 28
 29 )
 30
 31 system.time(
      for(i in 1:10){
for(j in 1:10){
 33 +
 34
           df_1[i,j]<- df_1[i,j] + 10*sin(0.75*pi)
 35
 36
 37
 38
```

```
> #Vectorized form
> set.seed(42)
> #create matrix
> mat_1<- replicate(10,rnorm(10))
> #transform into data frame
> df_1= data.frame(mat_1)
> df_1<- df_1 + 10*sin(0.75*pi)
> #non-vectorized form
> set.seed(42)
> #create matrix
> mat_1<- replicate(10,rnorm(10))
> #transform into data frame
> df_1= data.frame(mat_1)
> |
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X1 X2 X3 X4 X5 X6 X7 X8 X9 X 1 8.44202626 8.3759375 6.764429 7.52651794 7.2770664 7.39299308 6.703832 6.0279489 8.58377482 8.463184 2 6.50636964 9.3577132 5.2897594 7.77590515 6.7100105 6.28722887 7.2562984 6.9808814 0.25792144 -0.476173 3 0.36312841 -1.3888607 -0.1719174 1.03510352 0.7581632 1.57572752 0.5818237 0.6235182 0.08844023 0.650348 4 0.63286260 -0.2787888 1.2146747 -0.60892638 -0.7267048 0.64289931 1.3997368 -0.9535234 -0.12089654 1.391110 5 0.40426832 -0.1333213 1.8951935 0.50495512 -1.3682810 0.08976065 -0.7272921 -0.5428288 -1.19432890 -1.110788 6 -0.10612452 0.6359504 -0.4304691 -1.71700868 0.4328180 0.27655075 1.3025426 0.5809965 0.61199690 -0.860792 7 1.5115200 -0.2842529 -0.2572694 -0.78445901 -0.8113932 0.67928882 0.3358481 0.7681787 -0.21713985 -1.131738 8 -0.09465904 -2.6564554 -1.7631631 -0.85090759 1.4441013 0.08983289 1.0385061 0.4637676 -0.18275671 -1.459214 9 2.01842371 -2.4404669 0.4600974 -2.41420765 -0.4314462 -2.99309008 0.9207286 -0.8857763 0.93334633 0.079982 10 -0.06271410 1.3201133 -0.6399949 0.03612261 0.6556479 0.28488295 0.7208782 -1.0997809 0.82177311 0.653204	9 2.	.01842371	-2.4404669	0.4600974	-2.41420765	-0.4314462	-2.99309008	0.9207286	-0.88577630	0.93334633	0.07998255
1       8.44202626       8.3759375       6.7644292       7.52651794       7.2770664       7.39299308       6.7038332       6.0279489       8.58377482       8.463184         2       6.50636964       9.3577132       5.2897594       7.77590515       6.7100105       6.28722887       7.2562984       6.9808814       0.25792144       -0.476173         3       0.36312841       -1.3888607       -0.1719174       1.03510352       0.7581632       1.57572752       0.5818237       0.6235182       0.08844023       0.650348         4       0.63286260       -0.2787888       1.2146747       -0.60892638       -0.7267048       0.64289931       1.3997368       -0.9535234       -0.12089654       1.391110         5       0.40426832       -0.1333213       1.8951935       0.50495512       -1.3682810       0.08976055       -0.7272921       -0.5428288       -1.19432890       -1.110788         6       -0.10612452       0.6339504       -0.4304691       -1.71700868       0.4328180       0.27655075       1.3025426       0.5809965       0.6119960       -0.860792         7       1.51152200       -0.2842529       -0.2572694       -0.78445901       -0.8113932       0.67928882       0.3358481       0.7681787       -0.21713985       -1.131738 <th>10 -0.</th> <th>.06271410</th> <th>1.3201133</th> <th>-0.6399949</th> <th>0.03612261</th> <th>0.6556479</th> <th>0.28488295</th> <th>0.7208782</th> <th>-1.09978090</th> <th>0.82177311</th> <th>0.65320434</th>	10 -0.	.06271410	1.3201133	-0.6399949	0.03612261	0.6556479	0.28488295	0.7208782	-1.09978090	0.82177311	0.65320434
2 6.50636964 9.3577132 5.2897594 7.77590515 6.7100105 6.28722887 7.2562984 6.9808814 0.25792144 -0.476173 0.36312841 -1.3888607 -0.1719174 1.03510352 0.7581632 1.57572752 0.5818237 0.6235182 0.08844023 0.650348 4 0.63286260 -0.2787888 1.2146747 -0.60892638 -0.7267048 0.6428931 1.3997368 -0.9535234 -0.12089654 1.391110 5 0.40426832 -0.133213 1.8951935 0.50495512 -1.3682810 0.08976065 -0.7272921 -0.5428288 -1.19432890 -1.110788 6 -0.10612452 0.6359504 -0.4304691 -1.71700868 0.4328180 0.27655075 1.3025426 0.5809965 0.61199690 -0.860792 7 1.51152200 -0.2842529 -0.2572694 -0.7844901 -0.8113932 0.67928882 0.3358481 0.7681787 -0.21713985 -1.131738 8 -0.09465904 -2.6564554 -1.7631631 -0.85090759 1.4441013 0.08983289 1.0385061 0.4637676 -0.18275671 -1.459214 9 2.01842371 -2.4404669 0.4600974 -2.41420765 -0.4314462 -2.99309008 0.9207286 -0.8857763 0.93334633 0.079982 10 -0.06271410 1.3201133 -0.639949 0.03612261 0.6556479 0.28488295 0.7208782 -1.0997809 0.82177311 0.653204		X1	X2	X3	X4	X5	x6	X7	X8	X9	X10
3         0.36312841         -1.3888607         -0.1719174         1.03510352         0.7581632         1.57572752         0.5818237         0.6235182         0.08844023         0.650348           4         0.63286260         -0.2787888         1.2146747         -0.60892638         -0.7267048         0.6428931         1.3997368         -0.9535234         -0.12089654         1.391110           5         0.40426832         -0.133213         1.8951935         0.50495512         -1.3682810         0.08976065         -0.7272921         -0.5428288         -1.9432890         -1.110788           6         -0.10612452         0.6359504         -0.4304691         -1.71700868         0.4328180         0.27655075         1.3025426         0.5809965         0.61199690         -0.860792           7         1.51152200         -0.2842529         -0.2572694         -0.7844901         -0.8113932         0.67928882         0.3358481         0.7681787         -0.21713985         -1.131738           8         -0.09465904         -2.6564554         -1.7631631         -0.85090759         1.4441013         0.08983289         1.0385061         0.4637676         -0.18275671         -1.459214           9         2.01842371         -2.4404669         0.4600974         -2.41420765         -	1 8.	.44202626	8.3759375	6.7644292	7.52651794	7.2770664	7.39299308	6.7038332	6.0279489	8.58377482	8.46318419
4         0.63286260         -0.2787888         1.2146747         -0.60892638         -0.7267048         0.64289931         1.3997368         -0.9535234         -0.12089654         1.391110           5         0.40426832         -0.1333213         1.8951935         0.50495512         -1.3682810         0.08976065         -0.7272921         -0.5428288         -1.19432890         -1.110788           6         -0.10612452         0.6359504         -0.4304691         -1.71700868         0.4328180         0.27655075         1.3025426         0.5809965         0.61199690         -0.860792           7         1.51152200         -0.2842529         -0.2572694         -0.78445901         -0.8113932         0.67928882         0.3358481         0.7681787         -0.21713985         -1.131738           8         -0.09465904         -2.6436691         -0.485090759         1.4441013         0.08983289         1.0385061         0.4637676         -0.18275671         -1.459214           9         2.01842371         -2.4404669         0.4600974         -2.41420765         -0.4314462         -2.99309008         0.9207286         -0.8857763         0.9334633         0.079982           10         -0.06271410         1.3201133         -0.639949         0.03612261         0.6556479	2 6.	. 50636964	9.3577132	5.2897594	7.77590515	6.7100105	6.28722887	7.2562984	6.9808814	0.25792144 -0	0.47617392
5       0.40426832       -0.1333213       1.8951935       0.50495512       -1.3682810       0.08976065       -0.7272921       -0.5428288       -1.19432890       -1.110788         6       -0.10612452       0.6359504       -0.4304691       -1.71700868       0.4328180       0.27655075       1.3025426       0.5809965       0.61199690       -0.860792         7       1.51152200       -0.2842529       -0.2572694       -0.78445901       -0.8113932       0.6792882       0.3358481       0.7681787       -0.21713985       -1.131738         8       -0.09465904       -2.6564554       -1.7631631       -0.85090759       1.4441013       0.08983289       1.0385061       0.4637676       -0.18275671       -1.459214         9       2.01842371       -2.4404669       0.4600974       -2.41420765       -0.4314462       -2.99309008       0.9207286       -0.8857763       0.93334633       0.079982         10       -0.06271410       1.3201133       -0.6399949       0.03612261       0.6556479       0.28488295       0.7208782       -1.0997809       0.82177311       0.653204         X1       X2       X3       X4       X5       X6       X7       X8       X9         1       8.44202626       8.3759375       6.	3 0.	. 36312841	-1.3888607	-0.1719174	1.03510352	0.7581632	1.57572752	0.5818237	0.6235182	0.08844023	0.65034856
6 -0.10612452	4 0.	. 63286260	-0.2787888	1.2146747	-0.60892638	-0.7267048	0.64289931	1.3997368	-0.9535234	-0.12089654	1.39111046
7 1.51152200 -0.2842529 -0.2572694 -0.78445901 -0.8113932 0.67928882 0.3358481 0.7681787 -0.21713985 -1.131738   8 -0.09465904 -2.6564554 -1.7631631 -0.85090759 1.4441013 0.08983289 1.0385061 0.4637676 -0.18275671 -1.459214   9 2.01842371 -2.4404669 0.4600974 -2.41420765 -0.43144462 -2.99309008 0.9207286 -0.8857763 0.93334633 0.079982   10 -0.06271410 1.3201133 -0.6399949 0.03612261 0.6556479 0.28488295 0.7208782 -1.0997809 0.82177311 0.653204	5 0.	.40426832	-0.1333213	1.8951935	0.50495512	-1.3682810	0.08976065	-0.7272921	-0.5428288	-1.19432890 -1	1.11078888
8 -0.09465904 -2.6564554 -1.7631631 -0.85090759 1.4441013 0.08983289 1.0385061 0.4637676 -0.18275671 -1.459214 9 2.01842371 -2.4404669 0.4600974 -2.41420765 -0.4314462 -2.99309008 0.9207286 -0.8857763 0.93334633 0.079982 10 -0.06271410 1.3201133 -0.6399949 0.03612261 0.6556479 0.28488295 0.7208782 -1.0997809 0.82177311 0.653204	6 -0.	.10612452	0.6359504	-0.4304691	-1.71700868	0.4328180	0.27655075	1.3025426	0.5809965	0.61199690 -	0.86079259
9 2.01842371 -2.4404669 0.4600974 -2.41420765 -0.4314462 -2.99309008 0.9207286 -0.8857763 0.93334633 0.079982   10 -0.06271410 1.3201133 -0.6399949 0.03612261 0.6556479 0.28488295 0.7208782 -1.0997809 0.82177311 0.653204	7 1.	. 51152200	-0.2842529	-0.2572694	-0.78445901	-0.8113932	0.67928882	0.3358481	0.7681787	-0.21713985 -1	1.13173868
10 -0.06271410 1.3201133 -0.6399949 0.03612261 0.6556479 0.28488295 0.7208782 -1.0997809 0.82177311 0.653204	8 -0.	. 09465904	-2.6564554	-1.7631631	-0.85090759	1.4441013	0.08983289	1.0385061	0.4637676	-0.18275671 -1	1.45921400
X1 X2 X3 X4 X5 X6 X7 X8 X9 X 1 8.44202626 8.3759375 6.7644292 7.52651794 7.2770664 7.39299308 6.7038332 6.0279489 8.58377482 8.463184 2 6.50636964 9.3577132 5.2897594 7.77590515 6.7100105 6.28722887 7.2562984 6.9808814 7.32898925 -0.476173	9 2.	.01842371	-2.4404669	0.4600974	-2.41420765	-0.4314462	-2.99309008	0.9207286	-0.8857763	0.93334633	0.07998255
1     8.44202626     8.3759375     6.7644292     7.52651794     7.2770664     7.39299308     6.7038332     6.0279489     8.58377482     8.463184       2     6.50636964     9.3577132     5.2897594     7.77590515     6.7100105     6.28722887     7.2562984     6.9808814     7.32898925     -0.476173	10 -0.	.06271410	1.3201133	-0.6399949	0.03612261	0.6556479	0.28488295	0.7208782	-1.0997809	0.82177311 (	0.65320434
2 6.50636964 9.3577132 5.2897594 7.77590515 6.7100105 6.28722887 7.2562984 6.9808814 7.32898925 -0.476173		X1	X2	X3	X4	X5	X6	x7	X8	X9	X10
	1 8.	.44202626	8.3759375	6.7644292	7.52651794	7.2770664	7.39299308	6.7038332	6.0279489	8.58377482	8.46318419
3 0.36312841 -1.3888607 -0.1719174 1.03510352 0.7581632 1.57572752 0.5818237 0.6235182 0.08844023 0.650348	2 6.	. 50636964	9.3577132	5.2897594	7.77590515	6.7100105	6.28722887	7.2562984	6.9808814	7.32898925 -0	0.47617392
3 0.303120-1 1.300000, 3.1/131/4 1.03310332 0.7301032 1.37372732 0.3010237 0.0233102 0.00044023 0.030340	3 0.	.36312841	-1.3888607	-0.1719174	1.03510352	0.7581632	1.57572752	0.5818237	0.6235182	0.08844023	0.65034856
4 0.63286260 -0.2787888 1.2146747 -0.60892638 -0.7267048 0.64289931 1.3997368 -0.9535234 -0.12089654 1.391110	4 0.	. 63286260	-0.2787888	1.2146747	-0.60892638	-0.7267048	0.64289931	1.3997368	-0.9535234	-0.12089654	1.39111046
5 0.40426832 -0.1333213 1.8951935 0.50495512 -1.3682810 0.08976065 -0.7272921 -0.5428288 -1.19432890 -1.110788	5 0.	.40426832	-0.1333213	1.8951935	0.50495512	-1.3682810	0.08976065	-0.7272921	-0.5428288	-1.19432890 -1	1.11078888

Con	sole Termin	al >												
~/														
_	-0.062714			201133						0.28488295		-1.0997809		
.0		K1	1.52	X2	-0.03	X3		X4	0.0330479 X5	X6		-1.0997809 X8		X10
	8,442026		8 37	759375	6.76		7.526517		7,2770664	7.39299308		6.0279489		
										6.28722887		6.9808814		
										8,64679533				7.72141637
										0.64289931				
5	0.404268	32	-0.13	333213	1.89	951935	0.504955	12	-1.3682810	0.08976065	-0.7272921	-0.5428288	-1.1943289	-1.11078888
5	-0.106124	52	0.63	359504	-0.43	304691	-1.717008	68	0.4328180	0.27655075	1.3025426	0.5809965	0.6119969	-0.86079259
	1.511522	00	-0.28	342529	-0.25	72694	-0.784459	01	-0.8113932	0.67928882	0.3358481	0.7681787	-0.2171398	-1.13173868
										0.08983289				-1.45921400
)										-2.99309008				0.07998255
.0			1.32		-0.63					0.28488295				
		KI.		X2		X3		X4	X5	X6				
										7.39299308				8.46318419
										6.28722887			7.3289892	
1										8.64679533 0.64289931				7.72141637 1.39111046
										0.04289931				
										0.27655075				
,										0.67928882				
										0.08983289				
,										-2,99309008				0.07998255
0										0.28488295				0.65320434
		ĸ		X2		х3		X4	X5	х6	X7	X8		X10
	8.442026	26	8.37	759375	6.76	544292	7,526517	94	7,2770664	7.39299308	6,7038332	6.0279489	8,5837748	8.46318419
2	6.506369	54	9.35	577132	5.28	397594	7.775905	15	6.7100105	6.28722887	7.2562984	6.9808814	7.3289892	6.59489389
3	7.434196	22	5.68	322071	6.89	991505	8.106171	33	7.8292310	8.64679533	7.6528915	7.6945860	7.1595080	7.72141637
ļ										0.64289931				
5										0.08976065				
										0.27655075				
7										0.67928882				
										0.08983289				-1.45921400
,										-2.99309008				
.0			1.34	201133 X2	-0.6:	399949 X3		ь1 х4	0.65564/9 X5	0.28488295 X6		-1.099/809 X8	0.8217731 X9	
		KI	0 27		6 76					7.39299308			8, 5837748	X10 8,46318419
	6.506369									6.28722887			7.3289892	
										8,64679533				7.72141637
										0.64289931				
										0.08976065				
,										0.27655075				-0.86079259
	1.511522	00	-0.28	342529	-0.25	72694	-0.784459	01	-0.8113932	0.67928882	0.3358481	0.7681787	-0.2171398	-1.13173868
3	-0.094659	04	-2.65	564554	-1.76	531631	-0.850907	59	1.4441013	0.08983289	1.0385061	0.4637676	-0.1827567	-1.45921400
)	2.018423	71	-2.44	104669	0.46	500974	-2.414207	65	-0.4314462	-2.99309008	0.9207286	-0.8857763	0.9333463	0.07998255
.0	-0.062714	LO	1.32							0.28488295				0.65320434
		KI.		X2		X3			X5	X6				X10
	8.442026			759375						7.39299308			8.5837748	
										6.28722887			7.3289892	
3	7.434196			322071						8.64679533				7.72141637
1	7.703930									0.64289931				
	0.404268								-1.3682810					-1.11078888
7										0.27655075				
	1.011022	υU	-0.28	342329	-0.25	1/2094	-0./64459	U.L	-0.0113932	0.0/928882	0.3338481	0./001/8/	-0.21/1398	-1.131/3868

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Console
       Terminal ×
0 0.904943 /./0/018 0.040399 3.334039 /.303800 /.34/019 8.3/3010 /.032004 /.083003 0.2102/32
  8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.406916 7.839247 6.853928 5.9393291
 6.976409 4.414612 5.307905 6.220160 8.515169 7.160901 8.109574 7.534835 6.888311 5.6118538
  9.089492 4.630601 7.531165 4.656860 6.639622 4.077978 7.991796 6.185292 8.004414 7.1510504
10 7.008354 8.391181 6.431073 7.107190 7.726716 7.355951 7.791946 5.971287 7.892841 0.6532043
                           X3
                                    X4
                                             X5
                                                      X6
                                                               X7
                                                                        X8
                                                                                 X9
                                                                                          X10
         X1
                 X2
   8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.703833 6.027949 8.583775 8.463184
  6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.256298 6.980881 7.328989 6.594894
  7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.652892 7.694586 7.159508 7.721416
  7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.470805 6.117544 6.950171 8.462178
  7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.343776 6.528239 5.876739 5.960279
   6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.373610 7.652064 7.683065 6.210275
  8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.406916 7.839247 6.853928 5.939329
  6.976409 4.414612 5.307905 6.220160 8.515169 7.160901 8.109574 7.534835 6.888311 5.611854
9 9.089492 4.630601 7.531165 4.656860 6.639622 4.077978 7.991796 6.185292 8.004414 7.151050
10 7.008354 8.391181 6.431073 7.107190 7.726716 7.355951 7.791946 5.971287 7.892841 7.724272
> system.time(
    df_1[i,j] \leftarrow df_1[i,j] + 10*sin(0.75*pi)
        system elapsed
   user
      0
              0
> system.time(
   for(i in 1:10){
      for(j in 1:10){
        df_1[i,j] \leftarrow df_1[i,j] + 10*sin(0.75*pi)
   user
        system elapsed
   0.02
           0.00
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            Ħ
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0
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