Assignment 2.3

Name : Y Vasudev

Batch : DA with R , Excel and Tableau

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.

> set.seed(42) # Set the seed of R‘s random number generator, which is useful for creating simulations or random objects that can be reproduced.

> rnorm(42)

[1] 1.37095845 -0.56469817 0.36312841 0.63286260 0.40426832 -0.10612452 1.51152200

[8] -0.09465904 2.01842371 -0.06271410 1.30486965 2.28664539 -1.38886070 -0.27878877

[15] -0.13332134 0.63595040 -0.28425292 -2.65645542 -2.44046693 1.32011335 -0.30663859

[22] -1.78130843 -0.17191736 1.21467470 1.89519346 -0.43046913 -0.25726938 -1.76316309

[29] 0.46009735 -0.63999488 0.45545012 0.70483734 1.03510352 -0.60892638 0.50495512

[36] -1.71700868 -0.78445901 -0.85090759 -2.41420765 0.03612261 0.20599860 -0.36105730

> m=10

> n=10

> print(mymat)

[,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8]

[1,] 1.37095845 1.3048697 -0.3066386 0.45545012 0.2059986 0.32192527 -0.3672346 -1.04311894

[2,] -0.56469817 2.2866454 -1.7813084 0.70483734 -0.3610573 -0.78383894 0.1852306 -0.09018639

[3,] 0.36312841 -1.3888607 -0.1719174 1.03510352 0.7581632 1.57572752 0.5818237 0.62351816

[4,] 0.63286260 -0.2787888 1.2146747 -0.60892638 -0.7267048 0.64289931 1.3997368 -0.95352336

[5,] 0.40426832 -0.1333213 1.8951935 0.50495512 -1.3682810 0.08976065 -0.7272921 -0.54282881

[6,] -0.10612452 0.6359504 -0.4304691 -1.71700868 0.4328180 0.27655075 1.3025426 0.58099650

[7,] 1.51152200 -0.2842529 -0.2572694 -0.78445901 -0.8113932 0.67928882 0.3358481 0.76817874

[8,] -0.09465904 -2.6564554 -1.7631631 -0.85090759 1.4441013 0.08983289 1.0385061 0.46376759

[9,] 2.01842371 -2.4404669 0.4600974 -2.41420765 -0.4314462 -2.99309008 0.9207286 -0.88577630

[10,] -0.06271410 1.3201133 -0.6399949 0.03612261 0.6556479 0.28488295 0.7208782 -1.09978090

[,9] [,10]

[1,] 1.51270701 1.39211638

[2,] 0.25792144 -0.47617392

[3,] 0.08844023 0.65034856

[4,] -0.12089654 1.39111046

[5,] -1.19432890 -1.11078888

[6,] 0.61199690 -0.86079259

[7,] -0.21713985 -1.13173868

[8,] -0.18275671 -1.45921400

[9,] 0.93334633 0.07998255

[10,] 0.82177311 0.65320434

> mymat <- replicate(m, rnorm(n)) # Create matrix of normal random numbers

> mydframe <- data.frame(mymat) # Transform into data frame

> print(mydframe)

X1 X2 X3 X4 X5 X6 X7 X8

1 8.44202626 8.3759375 6.7644292 7.52651794 7.2770664 7.39299308 6.7038332 6.0279489

2 6.50636964 9.3577132 5.2897594 7.77590515 6.7100105 6.28722887 7.2562984 6.9808814

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10 0.8217731 0.65320434

X1 X2 X3 X4 X5 X6 X7 X8

1 8.44202626 8.375937 6.7644292 7.52651794 7.2770664 7.39299308 6.7038332 6.0279489

2 6.50636964 9.357713 5.2897594 7.77590515 6.7100105 6.28722887 7.2562984 6.9808814

3 7.43419622 5.682207 6.8991505 8.10617133 7.8292310 8.64679533 7.6528915 7.6945860

4 7.70393042 6.792279 8.2857425 6.46214144 6.3443630 7.71396712 8.4708046 6.1175445

5 7.47533614 6.937746 8.9662613 7.57602294 5.7027868 7.16082846 6.3437758 6.5282390

6 6.96494330 7.707018 6.6405987 5.35405913 7.5038858 7.34761856 8.3736104 7.6520643

7 8.58258981 6.786815 6.8137984 -0.78445901 -0.8113932 0.67928882 0.3358481 0.7681787

8 -0.09465904 -2.656455 -1.7631631 -0.85090759 1.4441013 0.08983289 1.0385061 0.4637676

9 2.01842371 -2.440467 0.4600974 -2.41420765 -0.4314462 -2.99309008 0.9207286 -0.8857763

10 -0.06271410 1.320113 -0.6399949 0.03612261 0.6556479 0.28488295 0.7208782 -1.0997809

X9 X10

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2 7.3289892 6.59489389

3 7.1595080 7.72141637

4 6.9501713 8.46217827

5 5.8767389 5.96027893

6 7.6830647 6.21027522

7 -0.2171398 -1.13173868

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X1 X2 X3 X4 X5 X6 X7 X8

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4 7.70393042 6.792279 8.2857425 6.46214144 6.3443630 7.71396712 8.4708046 6.1175445

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X9 X10

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X9 X10

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X9 X10

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7 8.58258981 6.786815 6.8137984 6.28660880 6.2596746 7.75035663 7.4069159 0.7681787

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X9 X10

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X1 X2 X3 X4 X5 X6 X7 X8

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X9 X10

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X1 X2 X3 X4 X5 X6 X7 X8

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X9 X10

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X1 X2 X3 X4 X5 X6 X7 X8

1 8.4420263 8.375937 6.7644292 7.52651794 7.2770664 7.39299308 6.7038332 6.0279489

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X1 X2 X3 X4 X5 X6 X7 X8

1 8.4420263 8.375937 6.7644292 7.52651794 7.2770664 7.392993 6.7038332 6.0279489

2 6.5063696 9.357713 5.2897594 7.77590515 6.7100105 6.287229 7.2562984 6.9808814

3 7.4341962 5.682207 6.8991505 8.10617133 7.8292310 8.646795 7.6528915 7.6945860

4 7.7039304 6.792279 8.2857425 6.46214144 6.3443630 7.713967 8.4708046 6.1175445

5 7.4753361 6.937746 8.9662613 7.57602294 5.7027868 7.160828 6.3437758 6.5282390

6 6.9649433 7.707018 6.6405987 5.35405913 7.5038858 7.347619 8.3736104 7.6520643

7 8.5825898 6.786815 6.8137984 6.28660880 6.2596746 7.750357 7.4069159 7.8392465

8 6.9764088 4.414612 5.3079047 6.22016022 8.5151691 7.160901 1.0385061 0.4637676

9 2.0184237 -2.440467 0.4600974 -2.41420765 -0.4314462 -2.993090 0.9207286 -0.8857763

10 -0.0627141 1.320113 -0.6399949 0.03612261 0.6556479 0.284883 0.7208782 -1.0997809

X9 X10

1 8.5837748 8.46318419

2 7.3289892 6.59489389

3 7.1595080 7.72141637

4 6.9501713 8.46217827

5 5.8767389 5.96027893

6 7.6830647 6.21027522

7 6.8539280 5.93932913

8 -0.1827567 -1.45921400

9 0.9333463 0.07998255

10 0.8217731 0.65320434

X1 X2 X3 X4 X5 X6 X7 X8

1 8.4420263 8.375937 6.7644292 7.52651794 7.2770664 7.392993 6.7038332 6.0279489

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3 7.4341962 5.682207 6.8991505 8.10617133 7.8292310 8.646795 7.6528915 7.6945860

4 7.7039304 6.792279 8.2857425 6.46214144 6.3443630 7.713967 8.4708046 6.1175445

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7 8.5825898 6.786815 6.8137984 6.28660880 6.2596746 7.750357 7.4069159 7.8392465

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9 2.0184237 -2.440467 0.4600974 -2.41420765 -0.4314462 -2.993090 0.9207286 -0.8857763

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X9 X10

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X9 X10

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9 2.0184237 -2.440467 0.4600974 -2.41420765 -0.4314462 -2.993090 0.9207286 -0.8857763 0.9333463

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9 9.0894915 4.630601 0.4600974 -2.41420765 -0.4314462 -2.993090 0.9207286 -0.8857763 0.9333463

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X1 X2 X3 X4 X5 X6 X7 X8 X9

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6 6.9649433 7.707018 6.6405987 5.35405913 7.5038858 7.347619 8.3736104 7.652064 7.6830647

7 8.5825898 6.786815 6.8137984 6.28660880 6.2596746 7.750357 7.4069159 7.839247 6.8539280

8 6.9764088 4.414612 5.3079047 6.22016022 8.5151691 7.160901 8.1095739 7.534835 6.8883111

9 9.0894915 4.630601 7.5311652 4.65686016 6.6396216 4.077978 7.9917964 6.185292 8.0044141

10 -0.0627141 1.320113 -0.6399949 0.03612261 0.6556479 0.284883 0.7208782 -1.099781 0.8217731

X10

1 8.46318419

2 6.59489389

3 7.72141637

4 8.46217827

5 5.96027893

6 6.21027522

7 5.93932913

8 5.61185381

9 0.07998255

10 0.65320434

X1 X2 X3 X4 X5 X6 X7 X8 X9

1 8.4420263 8.375937 6.7644292 7.52651794 7.2770664 7.392993 6.7038332 6.027949 8.5837748

2 6.5063696 9.357713 5.2897594 7.77590515 6.7100105 6.287229 7.2562984 6.980881 7.3289892

3 7.4341962 5.682207 6.8991505 8.10617133 7.8292310 8.646795 7.6528915 7.694586 7.1595080

4 7.7039304 6.792279 8.2857425 6.46214144 6.3443630 7.713967 8.4708046 6.117544 6.9501713

5 7.4753361 6.937746 8.9662613 7.57602294 5.7027868 7.160828 6.3437758 6.528239 5.8767389

6 6.9649433 7.707018 6.6405987 5.35405913 7.5038858 7.347619 8.3736104 7.652064 7.6830647

7 8.5825898 6.786815 6.8137984 6.28660880 6.2596746 7.750357 7.4069159 7.839247 6.8539280

8 6.9764088 4.414612 5.3079047 6.22016022 8.5151691 7.160901 8.1095739 7.534835 6.8883111

9 9.0894915 4.630601 7.5311652 4.65686016 6.6396216 4.077978 7.9917964 6.185292 8.0044141

10 -0.0627141 1.320113 -0.6399949 0.03612261 0.6556479 0.284883 0.7208782 -1.099781 0.8217731

X10

1 8.4631842

2 6.5948939

3 7.7214164

4 8.4621783

5 5.9602789

6 6.2102752

7 5.9393291

8 5.6118538

9 7.1510504

10 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9

1 8.442026 8.375937 6.7644292 7.52651794 7.2770664 7.392993 6.7038332 6.027949 8.5837748

2 6.506370 9.357713 5.2897594 7.77590515 6.7100105 6.287229 7.2562984 6.980881 7.3289892

3 7.434196 5.682207 6.8991505 8.10617133 7.8292310 8.646795 7.6528915 7.694586 7.1595080

4 7.703930 6.792279 8.2857425 6.46214144 6.3443630 7.713967 8.4708046 6.117544 6.9501713

5 7.475336 6.937746 8.9662613 7.57602294 5.7027868 7.160828 6.3437758 6.528239 5.8767389

6 6.964943 7.707018 6.6405987 5.35405913 7.5038858 7.347619 8.3736104 7.652064 7.6830647

7 8.582590 6.786815 6.8137984 6.28660880 6.2596746 7.750357 7.4069159 7.839247 6.8539280

8 6.976409 4.414612 5.3079047 6.22016022 8.5151691 7.160901 8.1095739 7.534835 6.8883111

9 9.089492 4.630601 7.5311652 4.65686016 6.6396216 4.077978 7.9917964 6.185292 8.0044141

10 7.008354 1.320113 -0.6399949 0.03612261 0.6556479 0.284883 0.7208782 -1.099781 0.8217731

X10

1 8.4631842

2 6.5948939

3 7.7214164

4 8.4621783

5 5.9602789

6 6.2102752

7 5.9393291

8 5.6118538

9 7.1510504

10 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9

1 8.442026 8.375937 6.7644292 7.52651794 7.2770664 7.392993 6.7038332 6.027949 8.5837748

2 6.506370 9.357713 5.2897594 7.77590515 6.7100105 6.287229 7.2562984 6.980881 7.3289892

3 7.434196 5.682207 6.8991505 8.10617133 7.8292310 8.646795 7.6528915 7.694586 7.1595080

4 7.703930 6.792279 8.2857425 6.46214144 6.3443630 7.713967 8.4708046 6.117544 6.9501713

5 7.475336 6.937746 8.9662613 7.57602294 5.7027868 7.160828 6.3437758 6.528239 5.8767389

6 6.964943 7.707018 6.6405987 5.35405913 7.5038858 7.347619 8.3736104 7.652064 7.6830647

7 8.582590 6.786815 6.8137984 6.28660880 6.2596746 7.750357 7.4069159 7.839247 6.8539280

8 6.976409 4.414612 5.3079047 6.22016022 8.5151691 7.160901 8.1095739 7.534835 6.8883111

9 9.089492 4.630601 7.5311652 4.65686016 6.6396216 4.077978 7.9917964 6.185292 8.0044141

10 7.008354 8.391181 -0.6399949 0.03612261 0.6556479 0.284883 0.7208782 -1.099781 0.8217731

X10

1 8.4631842

2 6.5948939

3 7.7214164

4 8.4621783

5 5.9602789

6 6.2102752

7 5.9393291

8 5.6118538

9 7.1510504

10 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9

1 8.442026 8.375937 6.764429 7.52651794 7.2770664 7.392993 6.7038332 6.027949 8.5837748

2 6.506370 9.357713 5.289759 7.77590515 6.7100105 6.287229 7.2562984 6.980881 7.3289892

3 7.434196 5.682207 6.899150 8.10617133 7.8292310 8.646795 7.6528915 7.694586 7.1595080

4 7.703930 6.792279 8.285743 6.46214144 6.3443630 7.713967 8.4708046 6.117544 6.9501713

5 7.475336 6.937746 8.966261 7.57602294 5.7027868 7.160828 6.3437758 6.528239 5.8767389

6 6.964943 7.707018 6.640599 5.35405913 7.5038858 7.347619 8.3736104 7.652064 7.6830647

7 8.582590 6.786815 6.813798 6.28660880 6.2596746 7.750357 7.4069159 7.839247 6.8539280

8 6.976409 4.414612 5.307905 6.22016022 8.5151691 7.160901 8.1095739 7.534835 6.8883111

9 9.089492 4.630601 7.531165 4.65686016 6.6396216 4.077978 7.9917964 6.185292 8.0044141

10 7.008354 8.391181 6.431073 0.03612261 0.6556479 0.284883 0.7208782 -1.099781 0.8217731

X10

1 8.4631842

2 6.5948939

3 7.7214164

4 8.4621783

5 5.9602789

6 6.2102752

7 5.9393291

8 5.6118538

9 7.1510504

10 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.2770664 7.392993 6.7038332 6.027949 8.5837748 8.4631842

2 6.506370 9.357713 5.289759 7.775905 6.7100105 6.287229 7.2562984 6.980881 7.3289892 6.5948939

3 7.434196 5.682207 6.899150 8.106171 7.8292310 8.646795 7.6528915 7.694586 7.1595080 7.7214164

4 7.703930 6.792279 8.285743 6.462141 6.3443630 7.713967 8.4708046 6.117544 6.9501713 8.4621783

5 7.475336 6.937746 8.966261 7.576023 5.7027868 7.160828 6.3437758 6.528239 5.8767389 5.9602789

6 6.964943 7.707018 6.640599 5.354059 7.5038858 7.347619 8.3736104 7.652064 7.6830647 6.2102752

7 8.582590 6.786815 6.813798 6.286609 6.2596746 7.750357 7.4069159 7.839247 6.8539280 5.9393291

8 6.976409 4.414612 5.307905 6.220160 8.5151691 7.160901 8.1095739 7.534835 6.8883111 5.6118538

9 9.089492 4.630601 7.531165 4.656860 6.6396216 4.077978 7.9917964 6.185292 8.0044141 7.1510504

10 7.008354 8.391181 6.431073 7.107190 0.6556479 0.284883 0.7208782 -1.099781 0.8217731 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.7038332 6.027949 8.5837748 8.4631842

2 6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.2562984 6.980881 7.3289892 6.5948939

3 7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.6528915 7.694586 7.1595080 7.7214164

4 7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.4708046 6.117544 6.9501713 8.4621783

5 7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.3437758 6.528239 5.8767389 5.9602789

6 6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.3736104 7.652064 7.6830647 6.2102752

7 8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.4069159 7.839247 6.8539280 5.9393291

8 6.976409 4.414612 5.307905 6.220160 8.515169 7.160901 8.1095739 7.534835 6.8883111 5.6118538

9 9.089492 4.630601 7.531165 4.656860 6.639622 4.077978 7.9917964 6.185292 8.0044141 7.1510504

10 7.008354 8.391181 6.431073 7.107190 7.726716 0.284883 0.7208782 -1.099781 0.8217731 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.7038332 6.027949 8.5837748 8.4631842

2 6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.2562984 6.980881 7.3289892 6.5948939

3 7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.6528915 7.694586 7.1595080 7.7214164

4 7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.4708046 6.117544 6.9501713 8.4621783

5 7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.3437758 6.528239 5.8767389 5.9602789

6 6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.3736104 7.652064 7.6830647 6.2102752

7 8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.4069159 7.839247 6.8539280 5.9393291

8 6.976409 4.414612 5.307905 6.220160 8.515169 7.160901 8.1095739 7.534835 6.8883111 5.6118538

9 9.089492 4.630601 7.531165 4.656860 6.639622 4.077978 7.9917964 6.185292 8.0044141 7.1510504

10 7.008354 8.391181 6.431073 7.107190 7.726716 7.355951 0.7208782 -1.099781 0.8217731 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.703833 6.027949 8.5837748 8.4631842

2 6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.256298 6.980881 7.3289892 6.5948939

3 7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.652892 7.694586 7.1595080 7.7214164

4 7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.470805 6.117544 6.9501713 8.4621783

5 7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.343776 6.528239 5.8767389 5.9602789

6 6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.373610 7.652064 7.6830647 6.2102752

7 8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.406916 7.839247 6.8539280 5.9393291

8 6.976409 4.414612 5.307905 6.220160 8.515169 7.160901 8.109574 7.534835 6.8883111 5.6118538

9 9.089492 4.630601 7.531165 4.656860 6.639622 4.077978 7.991796 6.185292 8.0044141 7.1510504

10 7.008354 8.391181 6.431073 7.107190 7.726716 7.355951 7.791946 -1.099781 0.8217731 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.703833 6.027949 8.5837748 8.4631842

2 6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.256298 6.980881 7.3289892 6.5948939

3 7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.652892 7.694586 7.1595080 7.7214164

4 7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.470805 6.117544 6.9501713 8.4621783

5 7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.343776 6.528239 5.8767389 5.9602789

6 6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.373610 7.652064 7.6830647 6.2102752

7 8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.406916 7.839247 6.8539280 5.9393291

8 6.976409 4.414612 5.307905 6.220160 8.515169 7.160901 8.109574 7.534835 6.8883111 5.6118538

9 9.089492 4.630601 7.531165 4.656860 6.639622 4.077978 7.991796 6.185292 8.0044141 7.1510504

10 7.008354 8.391181 6.431073 7.107190 7.726716 7.355951 7.791946 5.971287 0.8217731 0.6532043

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.703833 6.027949 8.583775 8.4631842

2 6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.256298 6.980881 7.328989 6.5948939

3 7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.652892 7.694586 7.159508 7.7214164

4 7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.470805 6.117544 6.950171 8.4621783

5 7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.343776 6.528239 5.876739 5.9602789

6 6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.373610 7.652064 7.683065 6.2102752

7 8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.406916 7.839247 6.853928 5.9393291

8 6.976409 4.414612 5.307905 6.220160 8.515169 7.160901 8.109574 7.534835 6.888311 5.6118538

9 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

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.703833 6.027949 8.583775 8.463184

2 6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.256298 6.980881 7.328989 6.594894

3 7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.652892 7.694586 7.159508 7.721416

4 7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.470805 6.117544 6.950171 8.462178

5 7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.343776 6.528239 5.876739 5.960279

6 6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.373610 7.652064 7.683065 6.210275

7 8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.406916 7.839247 6.853928 5.939329

8 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

# a vectorized solution looks like:

> set.seed(42)

> m=10

> n=10

> mymat <- replicate(m, rnorm(n))

> mydframe <- data.frame(mymat)

> mydframe <- mydframe + 10\*sin(0.75\*pi)

> mydframe

X1 X2 X3 X4 X5 X6 X7 X8 X9 X10

1 8.442026 8.375937 6.764429 7.526518 7.277066 7.392993 6.703833 6.027949 8.583775 8.463184

2 6.506370 9.357713 5.289759 7.775905 6.710011 6.287229 7.256298 6.980881 7.328989 6.594894

3 7.434196 5.682207 6.899150 8.106171 7.829231 8.646795 7.652892 7.694586 7.159508 7.721416

4 7.703930 6.792279 8.285743 6.462141 6.344363 7.713967 8.470805 6.117544 6.950171 8.462178

5 7.475336 6.937746 8.966261 7.576023 5.702787 7.160828 6.343776 6.528239 5.876739 5.960279

6 6.964943 7.707018 6.640599 5.354059 7.503886 7.347619 8.373610 7.652064 7.683065 6.210275

7 8.582590 6.786815 6.813798 6.286609 6.259675 7.750357 7.406916 7.839247 6.853928 5.939329

8 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

the last line takes the place of the nested for loop. **Note** the use of the set.seed() to ensure that the two implementations give exactly the same result.

quantify the execution time for the two solutions.

Call system.time() to the whole code

> # Insert `system.time()` to measure loop execution

> system.time(

for (i in 1:m) {

for (j in 1:n) {

mydframe[i,j] <- mydframe[i,j] + 10\*sin(0.75\*pi)

}

}

)

user system elapsed

0.27 0.01 0.32

>

> # Add `system.time()` to measure vectorized execution

> system.time( mydframe <- mydframe + 10\*sin(0.75\*pi))

user system elapsed

0.004 0.000 0.002

In the code chunk above, the job of choosing m and n, the matrix creation and its transformation into a data frame only once at the start, and then evaluate the for chunk against the “one-liner” of the vectorized version with the two separate call to system.time().

You see that already with a minimal setting of m=n=10 the vectorized version is 16 time faster, although for such low values, it is barely important for the user.

Differences become noticeable (at the human scale) if you put m=n=100, whereas increasing to 1000 causes the for loop look like hanging for several tens of seconds, whereas the vectorized form still performs in a blink of an eye.

For m=n=10000 the for loop hangs for more than a minute while the vectorized requires 2.54 sec. Of course, these measures should be taken lightly and will depend on the hardware and software configuration, possibly avoiding overloading your laptop with a few dozens of open tabs in your internet browser, and several applications running in the background.

In fairness, the increase of m and n severely affects also the matrix generation as you can easily see by placing another system.time() call around the replication function.

When we play around with m and n to see how the execution time changes, by plotting the execution time as a function of the product m x n. This is the relevant indicator, because it expresses the dimension of the matrices created. It thus also quantifies the number of iterations necessary to complete the task via the nset-ed for loop.