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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| **Answer** |
|  |  |
|  |  |
|  | #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) |
|  |  |
|  | for(i in 1:10){ |
|  | for(j in 1:10){ |
|  | df\_1[i,j]<- df\_1[i,j] + 10\*sin(0.75\*pi) |
|  | print(df\_1) |
|  | } |
|  | } |
|  |  |
|  | #time difference |
|  |  |
|  | system.time( |
|  | df\_1[i,j]<- df\_1[i,j] + 10\*sin(0.75\*pi) |
|  | ) |
|  |  |
|  | system.time( |
|  | for(i in 1:10){ |
|  | for(j in 1:10){ |
|  | df\_1[i,j]<- df\_1[i,j] + 10\*sin(0.75\*pi) |
|  | } |
|  | } |
|  | ) |