Worksheet – Introduction to Matrix Computation in R – US City Temps

Mean Temperature (F)				
A	1970s	1980s	1990s	2000s
LA	**62.95**	**63.41**	**63.63**	**62.97**
Miami	**76.01**	**76.22**	**77.35**	**77.18**
Orlando	**72.44**	**72.50**	**73.11**	**72.74**

All instructions assume matrices are conformable to the operations (R will let you know if not!)

1. To create a matrix in R, enter the elements (default is by columns) separated by commas in concatenated form, followed by the numbers or rows and columns (there are many shorthand ways to do this).
   A <- matrix(c(a11,a21,a31,a12,a22,a32,a31,a32,a33,a41,a42,a43), 3, 4)
2. To create an nxn Identity matrix, use **diag(n)**
3. To obtain the transpose of the matrix A, use **t(A)**
4. To multiply the matrix A by the scalar k, use **k*A**
5. To add two matrices, use **A + B**
6. To subtract one matrix from another, use **A – B**
7. To multiply 2 matrices (columns(A) = rows(B)): **A %*% B**
8. To create an mxn J matrix, **J <- matrix(rep(1,m*n), m, n)**
9. To obtain a submatrix of A, containing rows $i_1,\ldots,i_r$ and columns $j_1,\ldots,j_c$ use
   As <- A[c($i_1,\ldots,i_r$) , c($j_1,\ldots,j_c$)] if consecutive rows and columns: **As <- A[i_1:i_r , j_1:j_c]**
10. To obtain a submatrix containing a subset of rows: **Ar <- A[c($i_1,\ldots,i_r$) ,]**
11. To obtain a submatrix containing a subset of rows: **Ac <- A[, c($j_1,\ldots,j_c$)]**

Using these commands:

A. Create the matrix **A**
B. Create a 3x1 vector of 1's (**j3**), a 4x1 vector of 1's (**j4**), a 3x3 identity matrix (**I3**), a 3x3 matrix of 1's (**J33**), a 4x4 identity matrix (**I4**), a 4x4 matrix of 1's (**J44**)

Using only the matrices and vectors above:

C. Obtain the 3x1 column vector of city means
D. Obtain the 1x4 column vector of decade means
E. Create the matrix of mean temperatures in Celsius C = (5/9)(F-32)
F. Obtain the variance-covariance matrix of the decade temperatures **S_col** = (1/(3-1)) **A'(I3-J33)A**
G. Obtain the variance-covariance matrix of the city temperatures **S_row** = (1/(4-1)) **A(I4-J44)A'**
H. Obtain the submatrix containing only the Florida cities and only the decades 1970s and 2000s.
I. Generate the matrix A using equation (4.3) on page 21 of Harville using the following algorithm.

- Create an mxn matrix of 0's where m=3, n=4 **Anew <- matrix(rep(0, m*n), m, n)**
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for (i1 in 1:m) {
   for (i2 in 1:n) {
      e_i1 <-  matrix(I33[ , i1],ncol=1);   u_i2 <-  matrix(I44[ i2 ,],ncol=4)
     Anew <- Anew + A[i1,i2] * e_i1 %*% u_i2
   }
 }
```
- Show that **I33[2 ,] %*% A %*% I44[, 3]** gives the temperature for the correct city/decade.