1 Preliminaries

First, we make sure Maple preferences are set appropriately. Launch Maple. If you receive a Java Error, please reboot your machine. Once Maple has started, go to Maple 13 → Preferences. From the Display tab be sure that the Input Display is set to 2-D Math Notation. Next, from the Interface tab be sure that Default format for new worksheets is set to Document.

Be sure to select Apply Globally, then quit and restart Maple.

Begin by clicking on the text button in the context bar near the top of the window. This allows you to use Maple as a simple word processor. Enter your names, Math 306 and Lab 1 at the top of the Document, and format these as headers/title/or other appropriate form. enter a few blank lines, and click on the math button in the context bar. This will put you in the mode to enter mathematics that can be executed.

2 Matrices in Maple

We begin by loading the Linear Algebra package. This can be done in two ways. You can select Tools → Load Package → Linear Algebra or you can enter the command with(LinearAlgebra);
2.1 Entering a matrix

In keeping with our standard, please label matrices with capital letters.

Type \(A := \). Do NOT press return yet. You can use the Matrix palette on the left side of the Maple Window to give you a template for the matrix. You specify the number of rows and columns and click on insert matrix. Note that there are also specific templates that can be entered as well. Maple inserts placeholders for each entry of the matrix. The (1,1) entry is highlighted. Once you type this entry, hit the TAB key to move to the next entry. When all entries are specified, press Return. This palette also allows you to specify certain types of random matrices (diagonal, upper triangular, etc.).

Alternatively, matrices can be entered in command line format, using several constructs.

One way to enter a matrix is to specify each column separated by vertical bars:

\[
A := <<1,2,3>|<4,5,6>|<7,8,9>>. \text{This produces}\begin{bmatrix}
1 & 4 & 7 \\
2 & 5 & 8 \\
3 & 6 & 9
\end{bmatrix}
\]

We can also use the Matrix command to enter the matrix. Below, we specify each row of the matrix \(A\).

\[
A := \text{Matrix}([[1,2,3],[4,5,6],[7,8,9]]);. \text{This produces}\begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9
\end{bmatrix}
\]

To access a specific entry in the matrix, we can use \(A[i,j]\). So, for example, \(A[2,3]\) gives 6.

2.2 Matrix Arithmetic and Algebra

To multiply a matrix by a scalar, use ordinary scalar multiplication notation such as \(2A\). To add matrices of the same size, use ordinary scalar addition notation such as \(A+B\).

To multiply two matrices, we use a period between the two names: \(A.B\).

Other useful commands are

- Transpose
- MatrixInverse
- GaussianElimination
- ReducedRowEchelonForm

2.3 Large matrices

We can work in several ways with large matrices in Maple. For now, we will explore the Browse interface. To specify an ordinary \(100 \times 100\) matrix, we enter \(A := \text{Matrix}(100,100);\). We
could have used any reasonable dimension. To browse the matrix, Control-click the matrix, and a contextual menu appears. Select Browse. Here we can enter values in the cells, or we can visualize the entries of the matrix.

3 Exercises

1. Enter the matrix $A := \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$

   (a) Determine the transpose of $A$.

   (b) Find the inverse of $A$. Verify that your matrix is the inverse of $A$ by computing $AA^{-1}$ and $A^{-1}A$.

   (c) Create a new matrix $B = [A|\vec{b}]$, the matrix $A$ augmented with the column vector $\vec{b} = \begin{bmatrix} 3 \\ -1 \\ 4 \end{bmatrix}$. Find the reduced row echelon form of $B$. Use this to solve the equation $A\vec{x} = \vec{b}$.

2. Let $B = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$. Experiment to determine what happens when we multiply a matrix on the left by $B$. Also, determine what happens when we multiply a matrix on the right by $B$.

3. Determine a matrix $C$ such that for any $3 \times 3$ matrix $A$, $CA$ is the matrix $A$ with the first and third rows interchanged. What happens when you consider $AC$?

4. Determine a matrix $E$ such that multiplying a $3 \times 3$ matrix $A$ on the left by $E$ has the effect of adding twice the first row to the second row. What happens if you consider $AE$?

5. Another way to build a matrix is to specify a function of the indices that will produce entries in the matrix. Load the Combinatorics package either through the Tools $\rightarrow$ Load Packages menu or by entering

\begin{verbatim}
with(combinat):
\end{verbatim}

Define a function of $(i,j)$:

\begin{verbatim}
f := (i,j) -> mod(fibonacci(i*j), 30)
\end{verbatim}

Now, define the $100 \times 100$ matrix $A$ by

\begin{verbatim}
A := Matrix(100,100,f)
\end{verbatim}

Explore this matrix with the browser to see visual patterns in the data. Try values in the mod function besides 30. You can also try larger matrices, but I would be careful about going above $200 \times 200$. 