5 Vectors

5.1 Vectors, Row Vectors and Column Vectors

MATLAB was built around vectors and matrices. As in linear algebra, one can create both a row vector and a column vector; the row vector corresponds to an array in other programming languages. A (row) vector is entered by enclosing values in square brackets, separated by spaces and optionally commas. For example \( \mathbf{A} = [1, 6, 3] \). The expression \( \mathbf{A}(2) \) gives the second element in array \( \mathbf{A} \): in the above example it is 6. A column vector is similar, except that values are separated by semi-colons or newlines. The quote mark converts between row and column vector.

There are several inbuilt vector functions e.g. \texttt{median} or \texttt{max}. Finding the maximum of an array is a standard programming example; here is the idea without exploiting the features of MATLAB:

\[
\begin{align*}
\text{max} &= \mathbf{A}(1); \\
\text{for } i &= 2: \text{length}(\mathbf{A}) \\
\text{if } \mathbf{A}(i) &> \text{max} \\
\text{max} &= \mathbf{A}(i);
\end{align*}
\]

One can readily build vectors. For example, expression \( 1:5 \) is the vector \([1 2 3 4 5]\) and expression \( 1:2:9 \) is the vector \([1 3 5 7 9]\). One can extract a sub-vector: for example \( \mathbf{A}(2:4) \) returns a vector formed with the 2nd through 4th entry of \( \mathbf{A} \).

5.2 Vector Arithmetic

One can apply a function \texttt{entry-wise} on an array. This uses a dot before the operator: e.g. the expression \( \mathbf{A}.*2 \) yields the array with each entry squared. The expression \( \mathbf{A}\mathbf{B}' \) (note the quote) yields the dot-product of row-vectors \( \mathbf{A} \) and \( \mathbf{B} \). (The operation \( \mathbf{A}^2 \) attempts to square \( \mathbf{A} \), which fails unless \( \mathbf{A} \) is a square matrix.) Note that a scalar function applied to a vector automatically operates entry-wise; e.g. \( \sin(0:0.1:2*\pi) \) gives an array of values of \( \sin x \) for \( x \) running from 0 to \( 2\pi \) in increments of 0.1.
We can use this to approximate $\pi$ again. The idea this time is that the area under the semicircle $y = \sqrt{1 - x^2}$ in the first quadrant is $\pi/4$. The area is equal to the base times the average height (and the base has length 1). So $\pi$ is approximated by 4 times an approximation to the average of $y$ over the interval $0 \leq x \leq 1$. We find the approximation by taking 1000 equally spaced values of $x$.

\[
x = \text{linspace}(0, 1, 1000);
y = \text{sqrt}(1 - x.^2);
\text{PIE} = 4*\text{mean}(y)
\]

5.3 Logical Vectors

If one compares two vectors for equality with an if statement such as if $A==B$, it works. But if one enters $A==B$ as a statement, one gets a vector: it is 1 where $A$ and $B$ agree, and 0 where $A$ and $B$ disagree (and we get an error if $A$ and $B$ don’t have the same dimensions). It is suggested that you use $\text{isequal}(A,B)$ in the if statement.

But we can make use of logical vectors. For a logical vector $X$, the function all tests if all the entries true (or nonzero), while any tests if there is at least one that is true (or nonzero). For example, $\text{sum}(A==B)$ gives the number of places the vectors $A$ and $B$ agree, and $\text{any}(C>10)$ is true if and only if some entry in $C$ is more than 10.

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**Sample code**

*Here is code to check whether all the entries in vector $X$ are different or not.*

```
isDistinct=true;
for i=1:length(X)
    for j=i+1:length(X)
        if X(i)==X(j)
            isDistinct=false;
        end
    end
end
display( isDistinct );
```