Operation	Vector	Matrix	Array
No of cells (not dimension)	vector.size()	matrix.size()	array.size()
Dimension		matrix.rows() matrix.cols()	array.dim array.rows() array.cols()
Extraction	vector(int) vector.head(int) vector.tail(int) .head & .tail take first & last int cells where int can be either integer or integer variable vector.segment(int1,int2) where int1 is starting cell & int2 is number of cells	matrix(int,int) matrix.row(int) matrix.col(int) .row & .col take int row or column where int can be either integer or integer variable	array(int,int) .row & .col do not apply to arrays where int can be either integer or integer variable
		int ii = matrix(int,int) does not extract integer from matrix or array Extraction of integers from matrices or arrays requires CppAD ii = CppAD::Integer(matrix(int,int)	
Assignment & Extraction		matrix.row(int) = vector matrix.col(int) = vector extracts row int or col int from matrix matrix.block(ref_row,ref_col,n_rows,n_cols) where ref_row & ref_col are start row & col and n_rows and n_cols are number of rows & cols	array.row(int) = vector array.col(int) = vector extracts row int or col int from array block extraction not available for arrays
Operations on total vector, matrix or array	vector.sum() or sum(vector) .mean() .prod() .minCoeff() .maxCoeff()	matrix.sum() .mean() .prod() .minCoeff() .maxCoeff() .transpose()	array.sum() .mean() .prod() .minCoeff() .maxCoeff() .transpose()

	.minCoeff & .maxCoeff extract min and max value in vector	.diagonal() .trace() .transpose() flips matrix .diagonal() gives diagonal starting at 0,0 .trace() sums diagonal() starting at 0,0 Need to be careful using min & max operations on parameter –dependent objects (see Wiki Things-you-should-NOT-do-in-TMB)	.rotate(int) rotate(int) rotates array int dimensions .trace() & .diagonal do not work on arrays .
Operations on part of matrix or array		matrix.rowwise().sum() matrix.colwise().sum() .sum(), .mean(), .prod(), .minCoeff() & ,maxCoeff() available	array.matrix().rowwise().sum() array.matrix().colwise().sum() need to convert array to matrix for rowwise & colwise operations
		Can chain operations e.g. matrix.colwise().sum().maxCoeff() When multiple operations summed, parentheses needed around object summed e.g (array2.row(int) * array2.row(int)).sum()	
Math operations	exp(vector) log(vector)	exp(matrix.array()) log(matrix.array())	exp(array.dim) log(array.dim)
Element by element operations	vector + vector +, -, *, / available	matrix + matrix matrix – matrix matrix.array() * matrix.array() matrix.array() / matrix.array() matrix + array.matrix()	array + array array - array array * array array / array array.matrix() + matrix
Matrix Algebra	(vector*vector).sum() is inner product of two vectors	matrix * matrix matrix * vector vector.matrix() creates nx1 matrix vector.matrix().transpose() creates 1xn matrix vector.matrix()*vector.matrix() .transpose() is outer product	(array.matrix()*array.matrix()).array()