

## BASIC MATRIX ALGEBRA

(Appendix to ch 18 Stock and Watson, appendix A Verbeek)

### Notation:

matrices are represented by capital letters in bold, e.g.  $\mathbf{A}$ , vectors in lowercase bold, e.g.  $\mathbf{a}$ , and entries of vectors and matrices are italic (since they are numbers from a field), e.g.  $A$  and  $a$ . Index notation is often the clearest way to express definitions, and is used as standard in the literature. The  $i, j$  entry of matrix  $\mathbf{A}$  is indicated by  $(\mathbf{A})_{ij}$ ,  $A_{ij}$  or  $a_{ij}$ , whereas a numerical label (not matrix entries) on a collection of matrices is subscripted only, e.g.  $\mathbf{A}_1, \mathbf{A}_2$ , etc.

### Definitions of Vectors and Matrices

A **vector** is a collection of  $n$  numbers or elements, collected either in a column (a **column vector**) or in a row (a **row vector**). The  $n$ -dimensional column vector  $\mathbf{b}$  and the  $n$ -dimensional row vector  $\mathbf{c}$  are

$$\mathbf{b} = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix} \text{ and } \mathbf{c} = [c_1 \quad c_2 \quad \cdots \quad c_n],$$

where  $b_1$  is the first element of  $\mathbf{b}$  and in general  $b_i$  is the  $i^{\text{th}}$  element of  $\mathbf{b}$ .

Throughout, a boldface symbol denotes a vector or matrix.

A **matrix** is a collection, or an array, of numbers or elements in which the elements are laid out in columns and rows. The dimension of a matrix is  $n \times m$ , where  $n$  is the number of rows and  $m$  is the number of columns. The  $n \times m$  matrix  $\mathbf{A}$  is

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix},$$

where  $a_{ij}$  is the  $(i, j)$  element of  $\mathbf{A}$ , that is,  $a_{ij}$  is the element that appears in the  $i^{\text{th}}$  row and  $j^{\text{th}}$  column. An  $n \times m$  matrix consists of  $n$  row vectors or, alternatively, of  $m$  column vectors.

To distinguish one-dimensional numbers from vectors and matrices, a one-dimensional number is called a **scalar**.

# Matrix Algebra Assets

**L Darling-Hammond**



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