Arrays and Structures

Multidimensional Arrays

Joseph Chuang-Chieh Lin (林莊傑)

Department of Computer Science & Engineering,
National Taiwan Ocean University

Fall 2024

Outline

Representation of Multidimensional Arrays

- Implemented by a one-dimensional array.
- Two common ways of representation.
  - Row major or column major.
- Consider array `A[3][2]` as an example.

Representation of Multidimensional Arrays

- Implemented by a one-dimensional array.
- Two common ways of representation.
  - Row major or column major.
- Consider array `A[3][2]` as an example.

Representation of Multidimensional Arrays

- Implemented by a one-dimensional array.
- Two common ways of representation.
  - Row major or column major.
- Consider array `A[3][2]` as an example.

α	$\alpha+1$	$\alpha+2$	$\alpha+3$	$\alpha+4$	$\alpha+5$
$A[0][0]$	$A[0][1]$	$A[1][0]$	$A[1][1]$	$A[2][0]$	$A[2][1]$

Outline

Two-Dimensional Arrays

- $A[u_0][u_1]$ is interpreted as u_0 rows: $\text{row}_0, \text{row}_1, \ldots, \text{row}_{u_0-1}$.
  - Each row contains u_1 elements.
- The address of $A[i][j]$ is $\alpha + i \cdot u_1 + j$, where α is the address of $A[0][0]$.

Two-Dimensional Arrays

- $A[u_0][u_1]$ is interpreted as u_0 rows: $\text{row}_0, \text{row}_1, \ldots, \text{row}_{u_0-1}$.
  - Each row contains u_1 elements.
- The address of $A[i][j]$ is $\alpha + i \cdot u_1 + j$, where α is the address of $A[0][0]$.

	col_0	col_1	$\cdots$	col_{u_1-1}
row_0	$A[0][0]$	$A[0][1]$	$\cdots$	$A[0][u_1-1]$
row_1	$A[1][0]$	$A[1][1]$	$\cdots$	$A[1][u_1-1]$
$\vdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
row_{u_0-1}	$A[u_0-1][0]$	$A[u_0-1][1]$	$\cdots$	$A[u_0-1][u_1-1]$

Outline

Three-Dimensional Arrays

- $A[u_0][u_1][u_2]$ is interpreted as u_0 two-dimensional arrays of dimension $u_1 \times u_2$.
- The address of $A[i][0][0]$ is $\alpha + i \cdot u_1 \cdot u_2 + j$, where α is the address of $A[0][0][0]$.

Three-Dimensional Arrays

- $A[u_0][u_1][u_2]$ is interpreted as u_0 two-dimensional arrays of dimension $u_1 \times u_2$.
- The address of $A[i][0][0]$ is $\alpha + i \cdot u_1 \cdot u_2 + j$, where α is the address of $A[0][0][0]$.
- The address of $A[i][j][k]$ is $\alpha + i \cdot u_1 \cdot u_2 + j \cdot u_2 + k$.

Multidimensional Arrays

- The address of $A[i_0][i_1][i_2]\ldots[i_{n-1}]$ is:

$$\begin{aligned} \alpha &+ i_0 u_1 u_2 \ldots u_{n-1} \\ &+ i_1 u_2 \ldots u_{n-1} \\ &+ i_2 u_3 \ldots u_{n-1} \\ &\vdots \\ &+ i_{n-2} u_{n-1} \\ &+ i_{n-1} \\ = \alpha &+ \sum_{j=0}^{n-1} i_j a_j, \end{aligned}$$

where $a_j = \prod_{k=j+1}^{n-1} u_k$ for $0 \le j \le n-1$ and $a_{n-1} = 1$.

Discussions