

Arrays and Structures

Multidimensional Arrays

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Outline

- 1 Two-Dimensional Arrays
- 2 Three and More Dimensional Arrays



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.



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



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Two-Dimensional Arrays

- $A[u_0][u_1]$ is interpreted as u_0 rows: $\text{row}_0, \text{row}_1, \dots, \text{row}_{u_0-1}$.
 - 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 $A[0][0]$.



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



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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 $A[0][0][0]$.



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- $A[u_0][u_1][u_2]$ 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 $A[i_0][i_1][i_2] \dots [i_{n-1}]$ is:

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

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



Discussions

