

Multi-Dimensional Arrays In Pascal

In this section of notes you will learn about how and when to use multi-dimensional arrays.

James Tam

When To Use Arrays Of Different Dimensions

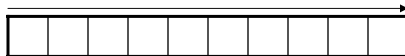
- Determined by the data – the number of categories of information determines the number of dimensions to use.

Examples:

- (1D array)

- Tracking grades for a class
- Each cell contains the grade for a student i.e., `grades[i]`
- There is one dimension that specifies the student

One dimension (which student)



- (2D array)

- Personal finances program
- One dimension of information specifies the financial category (cash in or cash out).
- The other dimension is used to specify the time

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When To Use Arrays Of Different Dimensions (2)

- (2D array continued)

Time

Financial category

| | January | February | March | ... |
|------------|---------|----------|-------|-----|
| Income | | | | |
| -Rent | | | | |
| -Food | | | | |
| -Fun | | | | |
| -Car | | | | |
| -Misc | | | | |
| Net income | | | | |

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When To Use Arrays Of Different Dimensions (3)

- (2D array continued)
- Notice that each row is merely a 1D array
- (A 2D array is an array containing rows of 1D arrays)

Columns

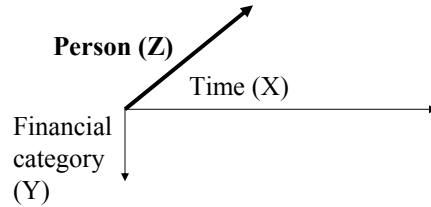
| | [1] | [2] | [3] | [4] |
|----------------|-----|-----|-----|-----|
| [1] Income | | | | |
| [2] -Rent | | | | |
| [3] -Food | | | | |
| [4] -Fun | | | | |
| [5] -Car | | | | |
| [6] -Misc | | | | |
| [7] Net income | | | | |

Rows

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When To Use Arrays Of Different Dimensions (4)

- (3D array – take the 2D array but allow for multiple people)
- The third dimension specifies whose finances are being tracked.



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When To Use Arrays Of Different Dimensions (5)

A 3D array diagram showing a table of financial data for three people (Bob, Mary, John) across four months (January, February, March, ...). The rows represent financial categories: Income, -Rent, -Food, -Fun, -Car, -Misc, and Net income.

| | January | February | March | ... |
|------------|---------|----------|-------|-----|
| Income | | | | |
| -Rent | | | | |
| -Food | | | | |
| -Fun | | | | |
| -Car | | | | |
| -Misc | | | | |
| Net income | | | | |

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Declaring Multi-Dimensional Arrays

Format:

(Two dimensional arrays)

Name : array [*min..max*, *min..max*] of *type*;

(Three dimensional arrays)

Name : array [*min..max*, *min..max*, *min..max*] of *type*;

Rows Columns

Example:

var johnFinances : array [1..7, 1..7] of real;

var cube : array[1..3, 1..4, 1..6] of char;

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Declaring Multi-Dimensional Arrays As A Type

Format:

Type declaration

Type name = array [*min..max*, *min..max*] of *element type*;

Type name = array [*min..max*, *min..max*, *min..max*] of *element type*;

Variable declaration

Array name : *Type name*;

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Declaring Multi-Dimensional Arrays As A Type (2)

Example

Type declaration

```
Finances = array [1..7, 1..7] of real;
```

```
Cube = array[1..3, 1..4, 1..6] of char;
```

Variable declaration

```
var johnFinances : Finances;
```

```
var aCube : Cube;
```

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Accessing / Assigning Values To Elements

Format:

```
name [row][column] := name [row][column];
```

Example:

```
finances [1][1] := 4500;
```

```
writeln (finances[1][1]);
```

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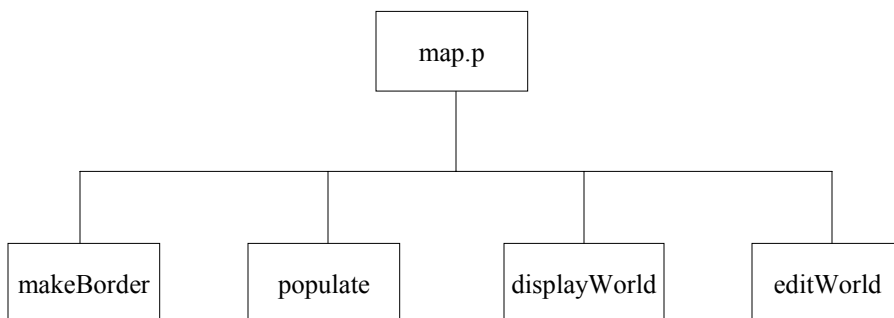
Example Program: Map Generator And Editor

You can find the full program in Unix under:
/home/231/examples/array/map.p

```
|-----|
|  T^C  T^ |
| C^~   C ^ |
|      ~ C   |
|  C      ~  |
|  ^ T^  ^   |
|      ~  ^   |
|    C  T    |
| T T ^C    |
|-----|
```

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Example Program: Map Generator And Editor: Breaking The Problem Down



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Example Program: Map Generator And Editor

```
program map (input, output);
const
  MAXROWS = 10;
  MAXCOLUMNS = 10;

type
  Level = array[1..MAXROWS, 1..MAXCOLUMNS] of char;
```

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Example Program: Map Generator And Editor (2)

```
procedure makeBorder (var world: Level);
var
  r, c : integer;
begin

  for c := 1 to MAXCOLUMNS do
    world[1][c] := '-';

  for c := 1 to MAXCOLUMNS do
    world[MAXROWS][c] := '-';

  for r := 1 to MAXROWS do
    world[r][1] := '|';

  for r := 1 to MAXROWS do
    world[r][MAXCOLUMNS] := '|';
end;
```

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Example Program: Map Generator And Editor (3)

```
procedure populate (var world: Level);
var
  r, c      : integer;
  randomValue : real;
begin
  for r := 2 to (MAXROWS-1) do
  begin
    for c:= 2 to (MAXCOLUMNS-1) do
    begin
      randomValue := random;
```

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Example Program: Map Generator And Editor (4)

```
  if (randomValue <= 0.05) then
    world [r][c] := '~'
  else if (randomValue <= 0.25) then
    world [r][c] := '^'
  else if (randomValue <= 0.30) then
    world [r][c] := 'C'
  else if (randomValue <= 0.40) then
    world [r][c] := 'T'
  else
    world [r][c] := ' ';
  end; (* inner for *)
end; (* outer for *)
end; (* procedure populate *)
```

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Example Program: Map Generator And Editor (5)

```
procedure displayWorld (world: Level);
var
  r, c : integer;
begin
  (* Display world *)
  for r := 1 to MAXROWS do
  begin
    for c := 1 to MAXCOLUMNS do
    begin
      write(world[r][c]);
    end;
    writeln;
  end; (* for loop - displays world *)
end; (* Procedure displayWorld *)
```

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Example Program: Map Generator And Editor (6)

```
procedure editWorld (var world : Level);
var
  editChoice, charToChange : char;
  rowToEdit, ColumnToEdit : integer;
begin
  writeln;
  write('Enter "Y" or "y" if you wish to edit the world or the return ');
  write('key otherwise: ');
  readln(editChoice);
```

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Example Program: Map Generator And Editor (7)

```
if (editChoice = 'Y') OR (editChoice = 'y') then
begin
  writeln;
  write('Enter row (2 - 9) to edit: ');
  readln(rowToEdit);
  write('Enter column (2 - 9) to edit: ');
  readln(columnToEdit);
```

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Example Program: Map Generator And Editor (8)

```
if (rowToEdit < 2) OR (rowToEdit > (MAXROWS-1)) OR
(columnToEdit < 2) OR
(columnToEdit > (MAXCOLUMNS-1)) then
  writeln('Value for row must be in the range of 2 - 9')
else
begin
  writeln('What do wish to change this square to? Choices include:');
  writeln("'~" for water');
  writeln("'^" for trees');
  writeln("'C" for a city');
  writeln("'T" for a town');
  writeln("' " (A space) for an open field');
  write('Enter choice and hit return: ');
  readln(charToChange);
  world[rowToEdit][columnToEdit] := charToChange;
end; (* else *)
end; (* if edit mode chosen. *)
end; (* Procedure editWorld *)
```

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Example Program: Map Generator And Editor (9)

```
begin (* Start of main program *)
  var world      : Level;
  var quitChoice : char;

  makeBorder(world);
  populate(world);

  (* A loop that displays the world and allows the user to edit it. *)
  repeat
  begin
    displayWorld(world);
    editWorld(world);
    write("Type 'Q' or 'q' to quit, or return to continue: ");
    readln(quitChoice);
  end; (* repeat loop *)
  until (quitChoice = 'Q') OR (quitChoice = 'q');

end. (* End of main program *)
```

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You Should Now Know

- The number of dimensions that should be set for an array
- How to declare arrays of multiple dimensions
- How to access and assign values to different parts (elements, rows etc.) of multi-dimensional arrays
- How to scan selected parts of the array using loops

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