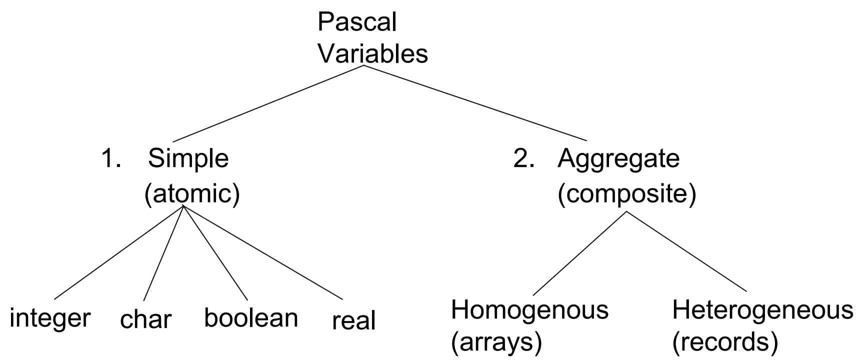
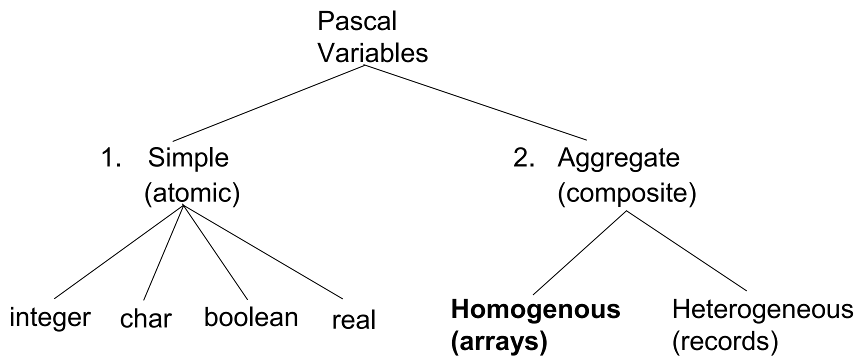
Arrays

In this section of notes you will be introduced to a homogeneous composite type, one-dimensional arrays

Types Of Variables



Types Of Variables



Why Bother With Composite Types?

For a compilable example look in Unix under: /home/231/examples/arrays/classList1.p

```
const
   CLASS_SIZE =  5;
begin
   var stu1      : real;
   var stu2      : real;
   var stu3      : real;
   var stu4      : real;
   var stu5      : real;
   var total      : real;
   var average : real;
   write('Enter grade for student number 1: ');
   readln(stu1);
```

Why Bother With Composite Types? (2)

```
  write('Enter grade for student number 2: ');
  readln(stu2);
  write('Enter grade for student number 3: ');
  readln(stu3);
  write('Enter grade for student number 4: ');
  readln(stu4);
  write('Enter grade for student number 5: ');
  readln(stu5);
  total := stu1 + stu2 + stu3 + stu4 + stu5;
  average := total / CLASS_SIZE;
  writeln('The average grade is ', average:6:2, '%');
```

With Bother With Composite Types? (3)

```
  (* Printing the grades for the class. *)
   writeln('Student1: ', stu1:6:2);
   writeln('Student2: ', stu2:6:2);
   writeln('Student3: ', stu3:6:2);
   writeln('Student4: ', stu4:6:2);
   writeln('Student5: ', stu5:6:2);
end.
```

With Bother With Composite Types? (3)

```
(* Printing the grades for the class. *)
   writeln('Student1: ', stu1:6:2);
   writeln('Student2: ', stu2:6:2);
   writeln('Student3: ', stu3:6:2);
   writeln('Student4: ', stu4:6:2);
   writeln('Student5: ', stu5:6:2);
end.
```

NO!

What's Needed

- A composite variable that is a collection of another type.
- The composite variable can be manipulated and passed throughout the program as a single entity.
- At the same time each element can be accessed individually.
- What's needed…an array!

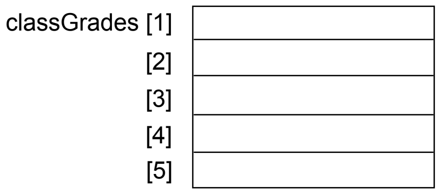
Declaring Arrays

Format:

name: array [*low index..high index*] of *element type*;

Example:

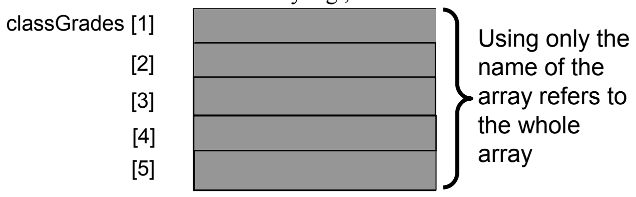
classGrades : array [1..CLASS_SIZE] of real;



Accessing Data In The Array

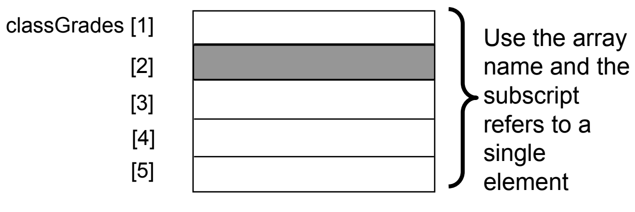
First you need to indicate which array is being accessed

- Done via the name of the array e.g., "classGrades"



If you are accessing a single element, you need to indicate which element that you wish to access.

- Done via the array index e.g., "classGrades[2]"


classGrades [1]
[2]
[3]
[4]
[5]
Use the array name and the subscript refers to a single element

Assigning Data To The Array

Format:

(Whole array) (One element)

name of array name of array [index]

Examples (assignment via the assignment operator):

(Whole array) (One element)

```
firstArray := secondArray;          classGrades [1] := 100;
```

Assigning Data To The Array (2)

Examples (assigning values via read or readln):

(Single element)

```
readln(classGrades[1]);
```

(Whole array – all elements)

```
for i: = 1 to CLASS_SIZE do
begin
    write('Input grade for student No. ', i, ': ');
    readln(classGrades[i]);
end;
```

Assigning Data To The Array (3)

(Whole array – all elements: Character arrays only)

```
var charArray : array [1..5] of char;
readln(charArray);
```

Accessing Data In The Array

Examples (displaying information):

(Single element)

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

(Whole array – all elements)

```
for i := 1 to CLASS_SIZE do
    writeln('Grade for student No. ', i:2, ' ', classGrades[i]:6:2);
```

Accessing Data In The Array (2)

(Whole array – all elements: Character arrays only)

```
var charArray : array [1..5] of char;
write(charArray);
```

Revised Version Using An Array

For a compilable example look in Unix under:
/home/231/examples/arrays/classList2.p

```
const
   CLASS_SIZE =  5;
begin
   var classGrades : array [1..CLASS_SIZE] of real;
   var i                 :  integer;
   var total             : real;
   var average           : real;
   total := 0;
```

Class Example Using An Array (2)

```
for i := 1 to CLASS_SIZE do
begin
    write('Enter grade for student no. ', i, ': ');
    readln (classGrades[i]);
    total := total + classGrades[i];
end;
average := total / CLASS_SIZE;
writeln;
writeln('The average grade is ', average:6:2, '%');

for i := 1 to CLASS_SIZE do
    writeln('Grade for student no. ', i, ' is ', classGrades[i]:6:2, '%');
```

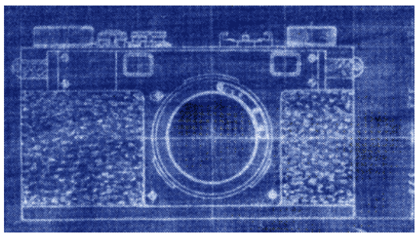
Passing Arrays As Parameters

1. Declare a type for the array.

   e.g.

   ```
   type
       Grades = array [1..CLASS_SIZE] of real;
   ```

   - Declaring A type does not create an instance
     - A type only describes the attributes of a new kind of variable that can be created and used.
     - No memory is allocated.



Passing Arrays As Parameters (2)

2. Declare an instance of this type.

   e.g., var lecture01 : Grades;
   - Memory is allocated!

3. Pass the instance to functions/procedures as you would any other parameter.

```
(Function/procedure call)
 displayGrades (lecture01, average);

(Function/procedure definition)
procedure displayGrades (lecture01 : Grades;
                         average   : real);
```

Passing Arrays As Parameters: An Example

The full example can be found in Unix under /home/231/examples/classList3.p)

```
program classList (input, output);

const

  CLASS_SIZE =  5;

type

  Grades = array [1..CLASS_SIZE] of real;


procedure tabulateGrades (var lecture01 : Grades;
                          var average   : real);

var
  i     : integer;
  total : real;
```

Passing Arrays As Parameters: An Example (2)

```
begin       (* tabulateGrades *)
  total := 0;
  for i := 1 to CLASS_SIZE do
  begin
    write('Enter grade for student no. ', i, ': ');
    readln(lecture01[i]);
    total := total + lecture01[i];
  end;
  average := total / CLASS_SIZE;
  writeln;
end;        (* tabulateGrades *)
```

Passing Arrays As Parameters: An Example (3)

```
procedure displayGrades (lecture01: Grades;
                           average  : real);
var
  i : integer;
begin
  writeln('Grades for the class...');
  for i := 1 to CLASS_SIZE do
    writeln('Grade for student no. ', i, ' is ', lecture01[i]:6:2, '%');
  writeln('The average grade is ', average:6:2, '%');
  writeln;
end;
```

Passing Arrays As Parameters: An Example (4)

```
begin
   var lecture01 : Grades;
   var average   : real;
   tabulateGrades (lecture01, average);
   displayGrades (lecture01, average);
end.
```

Returning Arrays From Functions

1. Declare a type for the array.

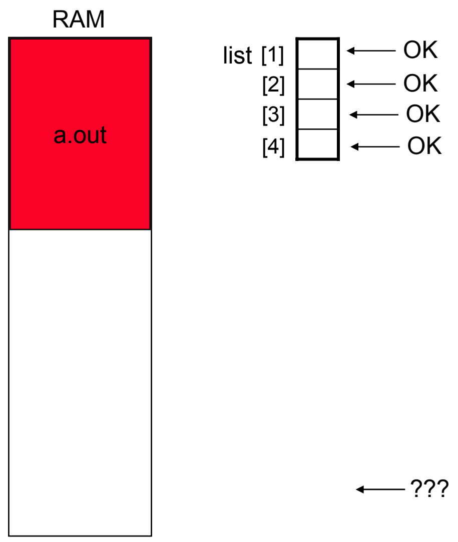
   e.g.
   ```
   type
       Grades = array [1..CLASS_SIZE] of real;
   ```
2. Declare an instance of this type.

   e.g.,
   ```
   var lecture01 : Grades;
   ```
3. Return the instance of the array as you would any other return value.

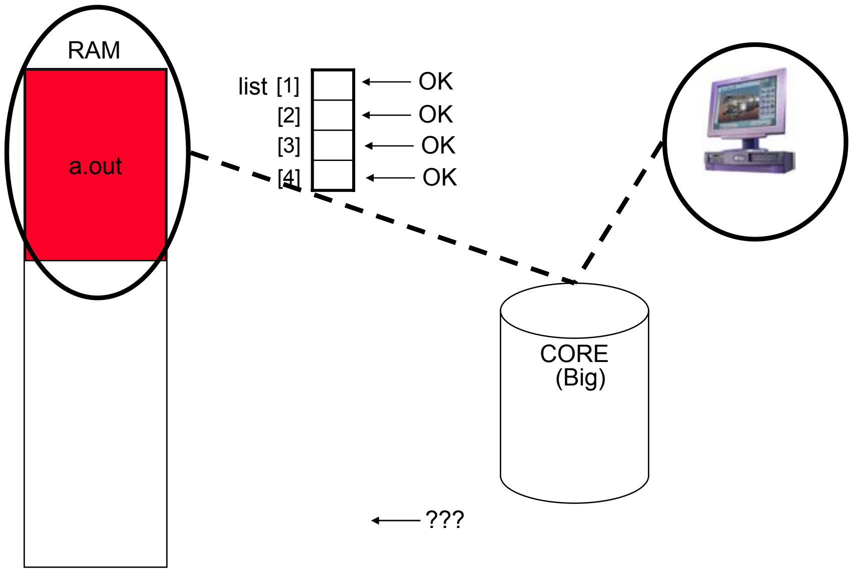
   (Function/procedure call)
   ```
   lecture01 := fun (L01);
   ```

   (Function/procedure definition)
   ```
   function fun (lecture01 : Grades ): Grades;
   ```

Segmentation Faults And Arrays



Segmentation Faults And Arrays



Wav file from “The SImpsons”

The String Type

It is a special type of character array.

Format for declaration:

```
var name : string [SIZE];
```

Example declaration:

```
var list2 : string[MAX];
```

Benefits Of The String Type

1. The end of array is marked.
2. There are a number of built in functions.

Marking The End Of The Array

The full example can be found in Unix under the path:
/home/231/examples/arrays/stringExample.p

```
program stringExample (output);
const
   MAX = 8;
begin
   var list1 : array [1..MAX] of char;
   var list2 : string[MAX];
   list1 := 'abcdefg';
   list2 := 'abcdefg';
   writeln('-', list1, '-');
   writeln('-', list2, '-');
end;
```

The Contents Of A String

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
‘a’	‘b’	‘c’	‘d’	‘e’	‘f’	‘g’	NULL

Strings Are A Built-In Type[1]

This means that they can be passed as parameter in the same fashion as other built in types:

Format:

procedure *procedureName* (*stringName* : string);

OR

procedure *procedureName* (var *stringName* : string);

Examples:

```
procedure proc1 (list : string);
                        OR
procedure proc2 (var list :  string);
```

1 For many programming languages and some versions of Pascal

You Should Now Know

- What is the difference between simple types (atomic) and composite types (aggregate)
- What is the benefit of using homogeneous composite types (arrays)
- How to declare arrays
- How to access or assign values to array elements
- How to work with an entire array
- How to pass instances of arrays into methods and how to return an array from a function.
- What is a segmentation fault and core dump file.
- How to declare and to use instances of a string type.