Computer Programming 143 – Lecture 23
C Structures I

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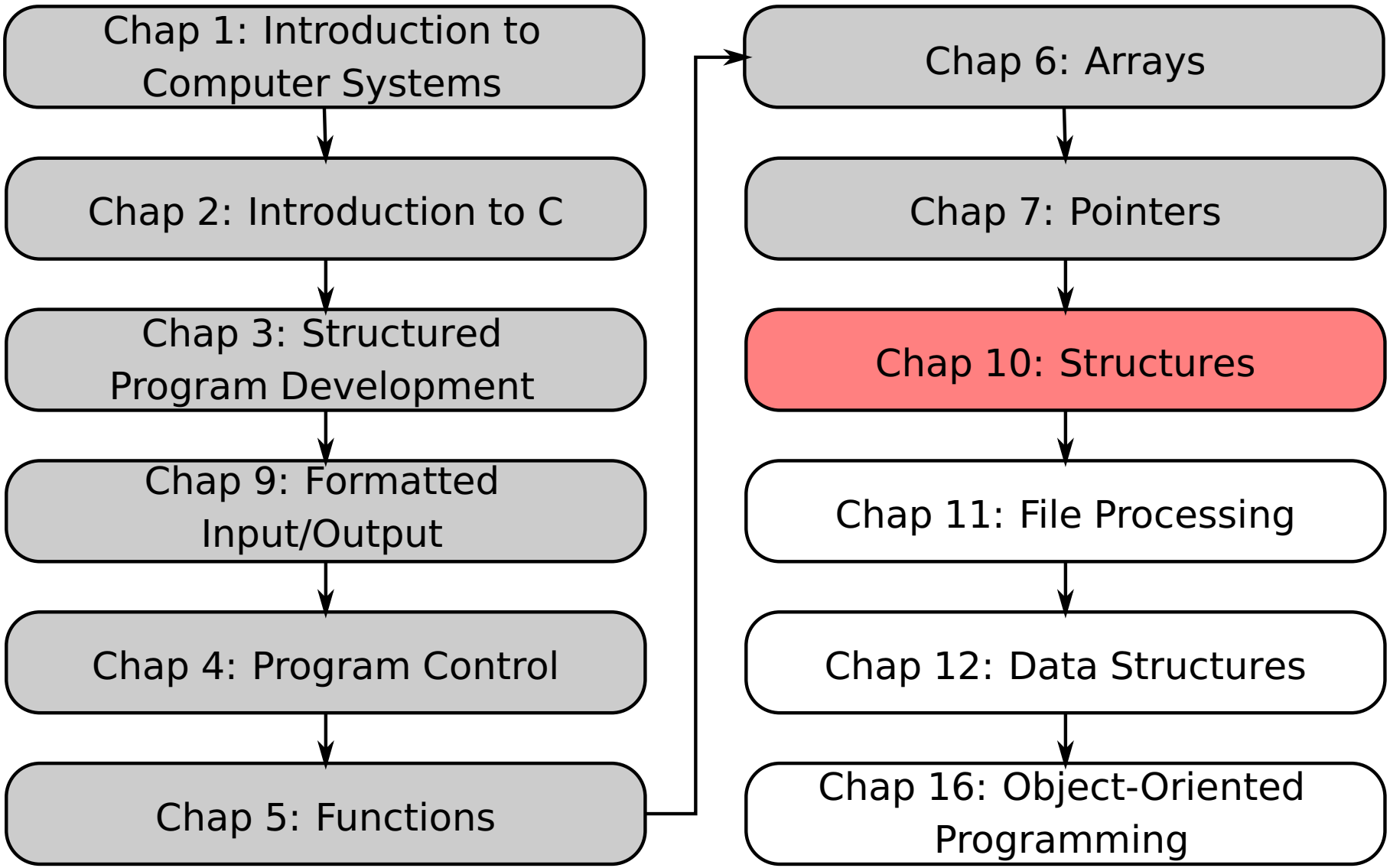
Module Overview



Lecture Overview

1. Structures (10.1)
2. Structure Definitions (10.2)
3. Initialising Structures (10.3)
4. Accessing Members of Structures (10.4)
5. Using Structures with Functions (10.5)
6. `typedef` (10.6)

10.1 Structures

Structures

- Definition: collections of related variables (aggregates) under one name

```
struct coord {
   double x;
   double y;
};
```

- Variables in a structure are called *members* of the structure
  - Can contain members of different data types
- Commonly used to define records to be stored in files (Chap. 11)
- Combined with pointers, can create linked lists, stacks, queues, and trees (Chap. 12)

10.2 Structure Definitions I

Example I

```
struct coord {
   double x;
   double y;
};          /*<--- NB ; !! */
```

- **struct** introduces the definition for structure **coord**
- coord is the structure name and is used to declare variables of the structure type
- coord contains two members of type **double**
  - These members are x and y

10.2 Structure Definitions II

Example II

```
struct student {
   char Name[ 30 ];
   char gender;
   long number;
};
```

Example III

```
struct node {
   struct node *leftPtr;
   struct node *rightPtr;
};
```

`struct` information

- A `struct` cannot contain a member that is an instance of itself
- Can contain a member that is a pointer to the same structure type (link lists, etc. – Chap. 12)
- A structure definition does not reserve space in memory
  - Instead creates a new data type used to define structure variables

10.2 Structure Definitions III

Valid Operations

```
struct coord {
    double x;
    double y;
};
struct coord lCorner, origin = {0.0, 0.0};
struct coord *cPtr;
```

1. Assigning a structure variable to a structure variable of the same type

```
lCorner = origin;
```

2. Taking the address (&) of a structure variable

```
cPtr = &lCorner;
```

3. Accessing the members of a structure variable (next sections)
4. Using the `sizeof` operator to determine the size of a structure variable

10.3 Initialising Structures

Example

```
struct coord origin = {0.0, 0.0};
```

Example

```
struct person {
   char firstName[ 20 ];
   char lastName[ 20 ];
   int age;
   char gender;
};

struct person DEls = {"Danie", "Els", 22, 'M'};
```

10.4 Accessing Members of Structures

- Dot operator (`.`) used to access members by means of the *structure name*
- Arrow operator (`->`) used to access members by means of a *pointer to the structure* (no spaces - >)

```
struct coord {
    double x;
    double y;
};

struct coord c, *cPtr;

cPtr = &c;

/* The following assignments are all equivalent */
        c.x = 10.5;                    c.y = 12.3;
  (*cPtr).x = 10.5;              (*cPtr).y = 12.3;
    cPtr->x = 10.5;                cPtr->y = 12.3;
```

Operator precedence

Operators								Associativity	Type
[]	()	.	->					left to right	highest
-	+	++	--	!	*	&	(type)	right to left	unary
*	/	%						left to right	multiplicative
+	-							left to right	additive
<	<=	>	>=					left to right	relational
==	!=							left to right	equality
&&								left to right	logical and
||								left to right	logical or
?:								right to left	conditional
=	+=	-=	*=	/=	%=			right to left	assignment
,								left to right	comma

Note: `++c.x` is `c.x += 1` is `c.x = c.x + 1`

10.5 Using Structures with Functions

```c
#include <stdio.h>

struct coord {
    double x;
    double y;
};

struct coord addCoordVal( struct coord a, struct coord b );
void addCoordRef( const struct coord *aPtr,
                  const struct coord *bPtr, struct coord *rPtr );
int main ()
{
    struct coord pr;
    struct coord pa = { 10.0, 11.0 };
    struct coord pb = { 1.0, 2.0 };

    printf ( "pa:    x = %4.1f, y = %4.1f\n", pa.x, pa.y );
    printf ( "pb:    x = %4.1f, y = %4.1f\n", pb.x, pb.y );
```

```
    pr = addCoordVal( pa, pb );
    printf( "pa+pb: x = %4.1f, y = %4.1f\n", pr.x, pr.y );

    addCoordRef( &pa, &pb, &pr );
    printf( "pa+pb: x = %4.1f, y = %4.1f\n", pr.x, pr.y );

    return 0;
}

/* Call by value and return via return value */
struct coord addCoordVal( struct coord a, struct coord b )
{
    struct coord res;

    res.x = a.x + b.x;
    res.y = a.y + b.y;

    return res;
}
```

```c
/* Call by reference and return via argument list */
void addCoordRef( const struct coord *aPtr,
                  const struct coord *bPtr, struct coord *rPtr )
{
    rPtr->x = aPtr->x + bPtr->x;
    rPtr->y = aPtr->y + bPtr->y;
}
```

Output:

```
pa:    x = 10.0, y = 11.0
pb:    x =  1.0, y =  2.0
pa+pb: x = 11.0, y = 13.0
pa+pb: x = 11.0, y = 13.0
```

10.6 typedef

typedef

- Creates synonyms (aliases) for previously defined data types
- Use `typedef` to create shorter type names
- Example:

```
/*Option 1*/
    struct coord {
        double x;
        double y;
    };

    typedef struct coord Point;

    Point pa, pb;
```

```
/*Option 2*/
    typedef struct {
        double x;
        double y;
    } Point;

    Point pa, pb;
```

- Defines a new type name `Point` as a synonym for type `struct coord`
- `typedef` does not create a new data type, only an alias

```c
/* typedefExample.c
 * Example using typedef */
#include <stdio.h>

typedef int *IntPtrType;

void printInteger( IntPtrType myPtr );

int main( void )
{
   int a = 5;
   IntPtrType intPtr = &a; // declares intPtr as type IntPtr
   printInteger( intPtr );

   return 0; // indicates successful termination
} // end main

void printInteger( IntPtrType myPtr )
{
   printf( "The value is: %d\n", *myPtr );
} // end function printInteger
```

Perspective

Today

C Structures

- Introduction to structures
- Structure definitions
- Inisialising structures
- Accessing structure members
- Using structures with functions
- `typedef`

Next lecture

- Arrays of Structures
- `malloc()` and Structures
- Example: shuffling and dealing of cards

Homework

1. Study Sections 10.1-10.6 in Deitel & Deitel
2. Do Self Review Exercises 10.2(a),(c)-(g), 10.3, 10.4(a),(b),(d)-(f) in Deitel & Deitel
3. Do Exercise 10.6 in Deitel & Deitel