Structures

Structures

- Structures
- Typedef
- Declarations
- Using Structures with Functions
- Structure Example

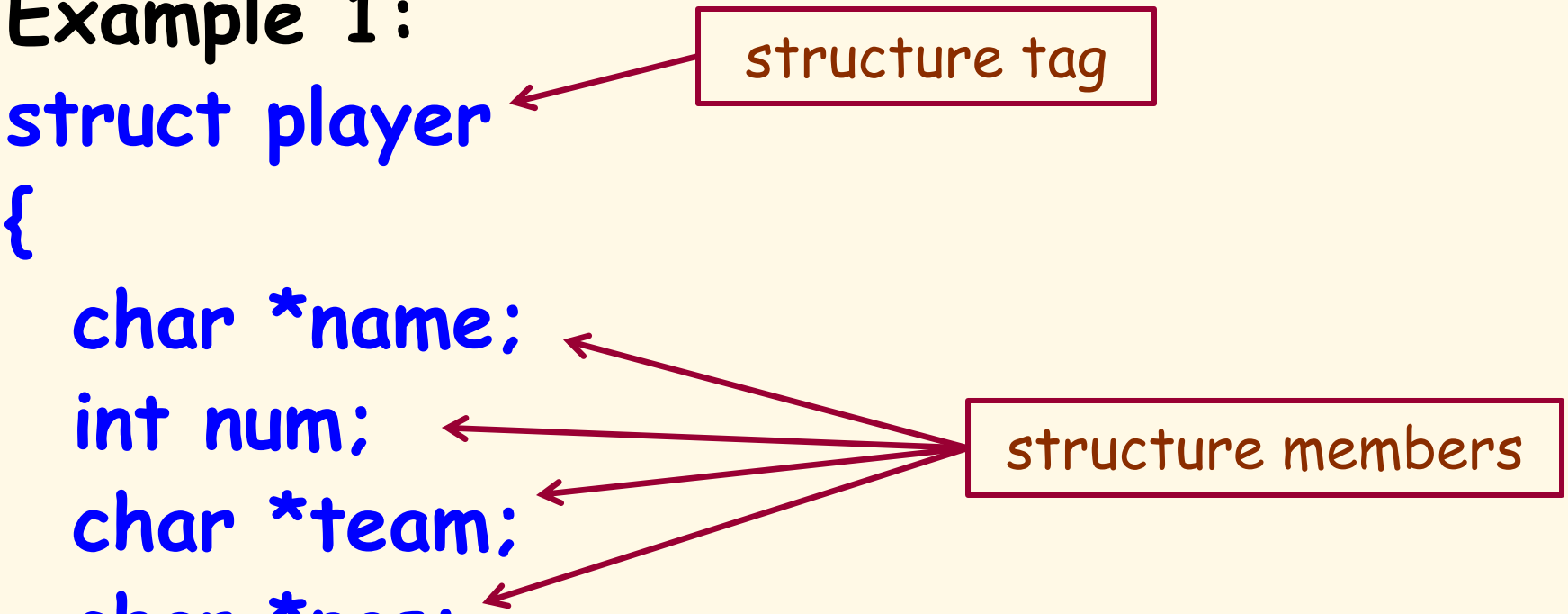
10.1 Introduction

- Structures
  - A collection of related variables (aggregated) under one name.
    - Can contain variables of different data types.
  - Commonly used to define records to be stored in files.

*When combined with pointers, structures can create linked lists, stacks, queues, and trees.

Structures

Example 1:

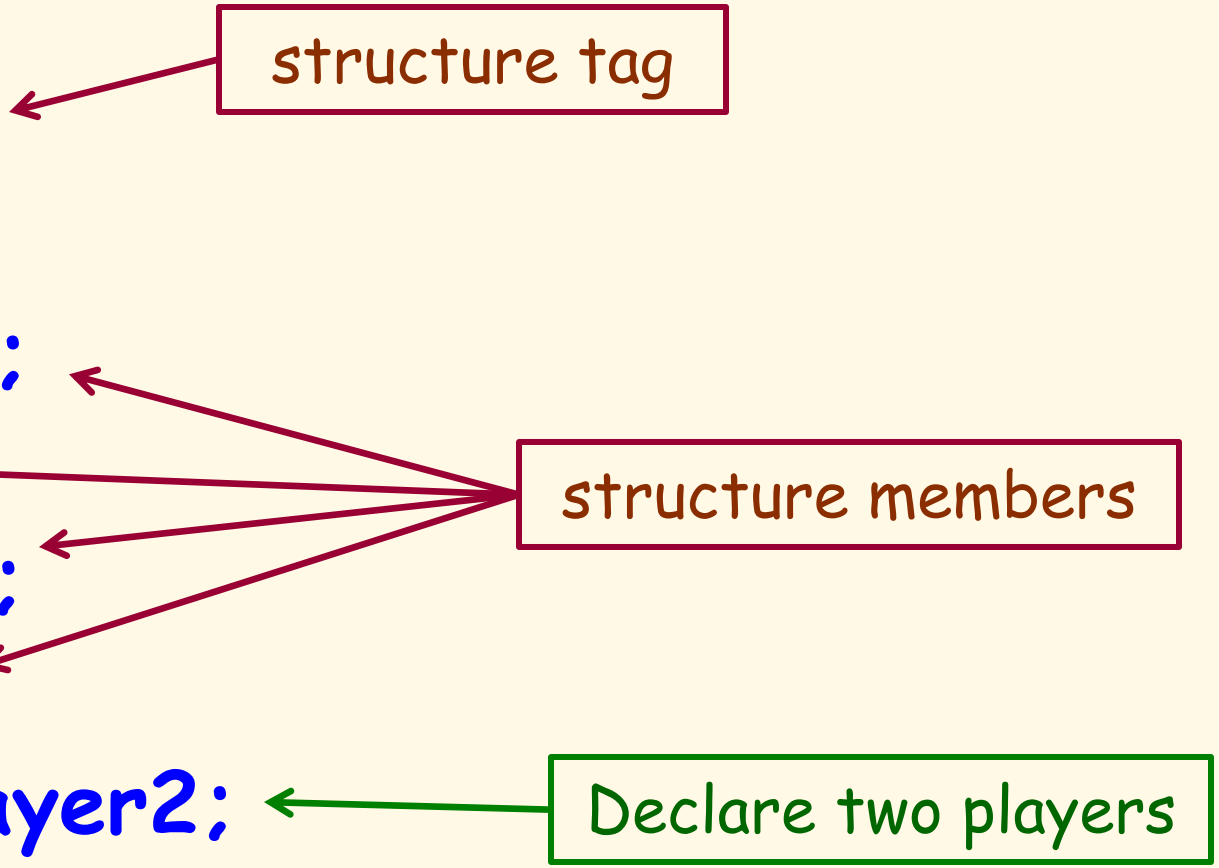



```
struct player
{
  char *name;
  int num;
  char *team;
  char *pos;
} ;
/* Don't forget the semicolon! */
```

Structures

Example 1:

```
struct player
{
   char *name;
   int num;
   char *team;
   char *pos;
} player1, player2;
```



Typedef Example

Example 2:

```
struct card
{
   const char *face;
   const char *suit;
} ;
typedef struct card Card;
```

The new type Card is an alias for type struct card.

struct introduces the definition for structure card.

- card is the structure name and is used to declare variables of the structure type.
- card contains two members of type char *
  - These members are face and suit.

typedef

Another way to declare this!!

```
typedef struct
{
   const char *face;
   const char *suit;
} Card;

...
Card deck[52];
```

10.6 typedef

Example:

```
typedef struct Card *CardPtr;
```

or

```
Card *Cardptr;
```

- Defines a new type name `CardPtr` as an alias for type `struct Card *`.
- `typedef` does not create a new data type.
  - It only creates an alias.

- Capitalize the first letter of `typedef` names to emphasize that they are synonyms for other type names.

10.2 Structure Definitions

- struct information
  - A struct cannot contain an instance of itself.
  - It can contain a member that is a pointer to the same structure type (a self-referential structure) .
  - A structure definition does not reserve space in memory. Rather a struct creates a new data type used to define structure variables.
- Definitions
  - Defined like other variables:

```
card oneCard, deck[ 52 ], *cPtr;
```

  - Can use a comma separated list:

```
struct card {
   char *face;
   char *suit;
} oneCard, deck[ 52 ], *cPtr;
```

10.2 Structure Definitions

- Valid Operations
  - Assigning a structure to a structure of the same type.
  - Taking the address (&) of a structure
  - Accessing the members of a structure.
  - Using the sizeof operator to determine the size of a structure.

10.3 Initializing Structures

- Initializer lists
  - Example:

```
struct card oneCard = { "Three", "Hearts" };
```

- Assignment statements
  - Example:

```
struct card threeHearts = oneCard;
```

  - Could also define and initialize `threeHearts` as follows:

```
struct card threeHearts;
threeHearts.face = "Three";
threeHearts.suit = "Hearts";
```

10.4 Accessing Members of Structures

- Accessing structure members
  - The dot operator (.) {the structure member operator} is used to access a structure member via the structure variable name.

```
card myCard;
printf( "%s", myCard.suit );
```

  - The arrow operator (->) {the structure pointer operator} accesses a structure member via a pointer to the structure.

```
card *myCardPtr = &myCard;
printf( "%s", myCardPtr->suit );
```

  - myCardPtr->suit is equivalent to

```
( *myCardPtr ).suit
```

Structure member and pointer operators

```
1  /* Fig. 10.2: fig10_02.c
2     Using the structure member and
3     structure pointer operators */
4  #include <stdio.h>
5
6  /* card structure definition */
7  struct card {
8     char *face; /* define pointer face */
9     char *suit; /* define pointer suit */
10 }; /* end structure card */
11
12 int main( void )
13 {
14    struct card aCard; /* define one struct card variable */
15    struct card *cardPtr; /* define a pointer to a struct card */
16
17    /* place strings into aCard */
18    aCard.face = "Ace";
19    aCard.suit = "Spades";
```

Structure definition

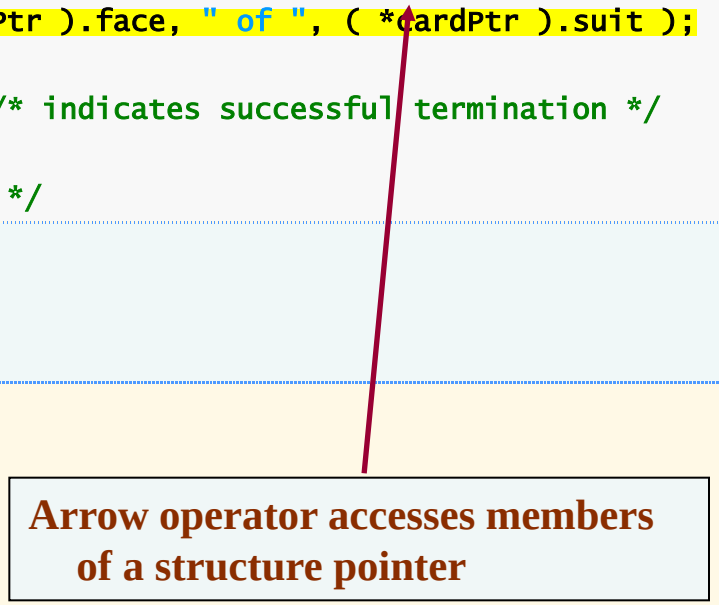
Structure definition must end with semicolon

Dot operator accesses members of a structure

Structure member and pointer operators

```
20
21    cardPtr = &aCard; /* assign address of aCard to cardPtr */
22
23    printf( "%s%s%s\n%s%s%s\n%s%s%s\n",
24       cardPtr->face, " of ", cardPtr->suit,
25       ( *cardPtr ).face, " of ", ( *cardPtr ).suit );
26
27    return 0; /* indicates successful termination */
28
29 } /* end main */
```

```
Ace of Spades
Ace of Spades
Ace of Spades
```



Arrow operator accesses members of a structure pointer

10.5 Using Structures with Functions

- Passing structures to functions
  - The entire structure can be passed.
  - Individual members of the structure can be passed.
  - For both cases, they are passed by value.
- To pass a structure by-reference
  - Pass the address of the structure variable.
- To pass arrays by-value
  - Create a structure with the array as a member and then pass the structure.

A Structure Example

```
1  /* Fig. 10.3: fig10_03.c
2     The card shuffling and dealing program using structures */
3  #include <stdio.h>
4  #include <stdlib.h>
5  #include <time.h>
6
7  /* card structure definition */
8  struct card {
9     const char *face; /* define pointer face */
10    const char *suit; /* define pointer suit */
11 }; /* end structure card */
12
13 typedef struct card Card; /* new type name for struct card */
14
15 /* prototypes */
16 void fillDeck( Card * const wDeck, const char * wFace[],
17    const char * wSuit[] );
18 void shuffle( Card * const wDeck );
19 void deal( const Card * const wDeck );
20
21 int main( void )
22 {
23    Card deck[ 52 ]; /* define array of Cards */
24
25    /* initialize array of pointers */
26    const char *face[] = { "Ace", "Deuce", "Three", "Four", "Five",
27       "Six", "Seven", "Eight", "Nine", "Ten",
28       "Jack", "Queen", "King"};
29
```

Each `card` has a face and a suit

`Card` is now an alias for `struct card`

A Structure Example

```
30    /* initialize array of pointers */
31    const char *suit[] = { "Hearts", "Diamonds", "Clubs", "Spades"};
32
33    srand( time( NULL ) ); /* randomize */
34
35    fillDeck( deck, face, suit ); /* load the deck with Cards */
36    shuffle( deck ); /* put Cards in random order */
37    deal( deck ); /* deal all 52 Cards */
38
39    return 0; /* indicates successful termination */
40
41 } /* end main */
42
43 /* place strings into Card structures */
44 void fillDeck( Card * const wDeck, const char * wFace[],
45    const char * wSuit[] )
46 {
47    int i; /* counter */
48
49    /* loop through wDeck */
50    for ( i = 0; i <= 51; i++ ) {
51       wDeck[ i ].face = wFace[ i % 13 ];
52       wDeck[ i ].suit = wSuit[ i / 13 ];
53    } /* end for */
54
55 } /* end function fillDeck */
56
```

Constant pointer to modifiable array of `Cards`

Fills the deck by giving each `Card` a face and suit

A Structure Example

```
57 /* shuffle cards */
58 void shuffle( Card * const wDeck )
59 {
60    int i;     /* counter */
61    int j;     /* variable to hold random value between 0 - 51 */
62    Card temp; /* define temporary structure for swapping Cards */
63
64    /* loop through wDeck randomly swapping Cards */
65    for ( i = 0; i <= 51; i++ ) {
66       j = rand() % 52;
67       temp = wDeck[ i ];
68       wDeck[ i ] = wDeck[ j ];
69       wDeck[ j ] = temp;
70    } /* end for */
71
72 } /* end function shuffle */
73
74 /* deal cards */
75 void deal( const Card * const wDeck )
76 {
77    int i; /* counter */
78
79    /* loop through wDeck */
80    for ( i = 0; i <= 51; i++ ) {
81       printf( "%5s of %-8s%c", wDeck[ i ].face, wDeck[ i ].suit,
82          ( i + 1 ) % 2 ? '\t' : '\n' );
83    } /* end for */
84
85 } /* end function deal */
```

Each card is swapped with another, random card, shuffling the deck

? is part of conditional operator (only ternary operator in C) see page 76!!

A Structure Example

```
Four of Clubs          Three of Hearts
Three of Diamonds       Three of Spades
 Four of Diamonds         Ace of Diamonds
 Nine of Hearts           Ten of Clubs
Three of Clubs           Four of Hearts
Eight of Clubs           Nine of Diamonds
Deuce of Clubs          Queen of Clubs
Seven of Clubs           Jack of Spades
  Ace of Clubs           Five of Diamonds
  Ace of Spades          Five of Clubs
Seven of Diamonds         Six of Spades
Eight of Spades         Queen of Hearts
 Five of Spades         Deuce of Diamonds
Queen of Spades           Six of Hearts
Queen of Diamonds       Seven of Hearts
 Jack of Diamonds         Nine of Spades
Eight of Hearts          Five of Hearts
 King of Spades           Six of Clubs
Eight of Diamonds         Ten of Spades
  Ace of Hearts          King of Hearts
 Four of Spades          Jack of Hearts
Deuce of Hearts          Jack of Clubs
Deuce of Spades           Ten of Diamonds
Seven of Spades          Nine of Clubs
 King of Clubs            Six of Diamonds
  Ten of Hearts          King of Diamonds
```

Review of Structure

- Definition of structures in C
- Syntax details for declaring structs
- Initializing structs
- Typedef
- Structure member (.) and pointer -> operators
- Passing structures to functions
- A Structure Example