Introduzione al linguaggio C

Laboratorio di
Linguaggi di Programmazione
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Sommario (II parte)

- Struttura di un programma C
- Funzioni
- La libreria standard
- I/O base
- Tipi derivati
  - puntatori
  - vettori
  - strutture

La struttura di programma

Pascal

program *nome-prog*
dich-tipi
dich-variabili
def-procedure-e-funzioni
begin
istruzioni
end

C

main() {
istruzioni
}
funzione-1
funzione-2
...
funzione-n

La struttura di programma (II)

Pascal

- struttura nidificata
- dichiarazioni raccolte in apposita sezione
  - visibilità all'interno della procedura/funzione
  - leggibilità, controllo

C

- struttura appiattita
- dichiarazioni sparse
  - visibilità all'interno del blocco
  - efficienza in spazio

Le funzioni: prototipo

return-value-type *function-name*(*parameter-list*)

- *function-name*: qualsiasi identificatore valido
- *return-value-type*: tipo del valore di ritorno
  - **`int`** (tipo di default)
  - **`void`** (nessun valore di ritorno)
- *parameter-list*: lista di parametri separati da virgola
  - **`int`** (tipo di default)

- Esempio

```
int maximum( int, int, int );
```

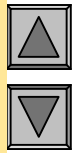
Le funzioni: definizione

return-value-type function-name`(` *parameter-list* `){`
declarations-and-statements
`}`

- *declarations-and-statements* : corpo di funzione (blocco)
  - Dichiarazione di variabili
  - Impossibilità di annidare definizioni di funzione
- Restituzione del controllo
  - Se non viene restituito alcun valore
    - `return;`
    - o, fino al raggiungimento di `}`
  - Se viene restituito un valore
    - `return` *expression*`;`

```c
/* Fig. 5.4: fig05_04.c
   Finding the maximum of three integers */
#include <stdio.h>

int maximum( int, int, int );   /* function prototype */

int main()
{
   int a, b, c;

   printf( "Enter three integers: " );
   scanf( "%d%d%d", &a, &b, &c );
   printf( "Maximum is: %d\n", maximum( a, b, c ) );

   return 0;
}

/* Function maximum definition */
int maximum( int x, int y, int z )
{
   int max = x;

   if ( y > max )
      max = y;

   if ( z > max )
      max = z;

   return max;
}
```

```
Enter three integers: 22 85 17
Maximum is: 85
```



Outline

1. Function prototype (3 parameters)

2. Input values

2.1 Call function

- Function definition

Program Output

I file di intestazione

- Contengono prototipi di funzione
- Funzioni della libreria standard
  - Individua il file di libreria che contiene le funzioni di tuo interesse (Es. **`<stdio.h>`** , **`<math.h>`** , etc)
  - Caricale nei tuoi programmi con

```
#include <filename>
```

- Funzioni riusabili definite dall'utente
  - Crea funzioni
  - Salvale in un file **`filename.h`**
  - Caricale nei tuoi programmi con

```
#include "filename.h"
```

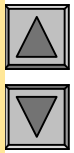
La libreria standard

- **<stdio.h>** (I/O)
- **<ctype.h>** (controllo sulla classe dei caratteri)
- **<string.h>** (manipolazione di stringhe)
- **<math.h>** (funzioni matematiche)
- **<stdlib.h>** (funzioni di utilità)
- **<assert.h>** (funzioni di diagnostica)
- **<stdarg.h>** (funzioni di scansione liste variabli di argomenti)
- **<setjmp.h>** (funzioni di gestione salti non locali)
- **<time.h>** (funzioni di manipolazione data e ora)
- **<limits.h>** (definizioni limiti implementativi)

Esempio: Un gioco d'azzardo

- Simulatore di lancio dei dadi
- Regole
  - Tira due dadi
    - il giocatore vince se ottiene 7 o 11 al primo lancio,
    - il giocatore perde se ottiene 2, 3, o 12 al primo lancio
    - Uno dei valori 4, 5, 6, 8, 9, 10 diventa il punteggio del giocatore
  - Il giocatore deve lanciare un numero pari al proprio punteggio prima di tirare 7 per vincere

```c
/* Fig. 5.10: fig05_10.c
   Craps */
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int rollDice( void );

int main()
{
   int gameStatus, sum, myPoint;

   srand( time( NULL ) );
   sum = rollDice();            /* first roll of the dice */

   switch ( sum ) {
      case 7: case 11:          /* win on first roll */
         gameStatus = 1;
         break;
      case 2: case 3: case 12:  /* lose on first roll */
         gameStatus = 2;
         break;
      default:                  /* remember point */
         gameStatus = 0;
         myPoint = sum;
         printf( "Point is %d\n", myPoint );
         break;
   }

   while ( gameStatus == 0 ) {    /* keep rolling */
      sum = rollDice();

```



Outline

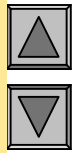
1. `rollDice` prototype

1.1 Initialize variables

1.2 Seed `srand`

2. Define `switch` statement for win/loss/continue

2.1 Loop



Outline

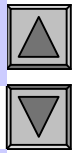
2.2 Print win/loss

```
33       if ( sum == myPoint )       /* win by making point */
34          gameStatus = 1;
35       else
36          if ( sum == 7 )          /* lose by rolling 7 */
37             gameStatus = 2;
38    }
39
40    if ( gameStatus == 1 )
41       printf( "Player wins\n" );
42    else
43       printf( "Player loses\n" );
44
45    return 0;
46 }
47
48 int rollDice( void )
49 {
50    int die1, die2, workSum;
51
52    die1 = 1 + ( rand() % 6 );
53    die2 = 1 + ( rand() % 6 );
54    workSum = die1 + die2;
55    printf( "Player rolled %d + %d = %d\n", die1, die2, workSum );
56    return workSum;
57 }
```

Program Output

```
Player rolled 6 + 5 = 11
Player wins
```

```
Player rolled 6 + 6 = 12
Player loses
```



Outline

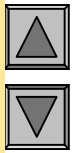
```
Player rolled 4 + 6 = 10
Point is 10
Player rolled 2 + 4 = 6
Player rolled 6 + 5 = 11
Player rolled 3 + 3 = 6
Player rolled 6 + 4 = 10
Player wins
```

Program Output

```
Player rolled 1 + 3 = 4
Point is 4
Player rolled 1 + 4 = 5
Player rolled 5 + 4 = 9
Player rolled 4 + 6 = 10
Player rolled 6 + 3 = 9
Player rolled 1 + 2 = 3
Player rolled 5 + 2 = 7
Player loses
```

```c
/* Fig. 5.15: fig05_15.c
   Recursive fibonacci function */
#include <stdio.h>

long fibonacci( long );

int main()
{
   long result, number;

   printf( "Enter an integer: " );
   scanf( "%ld", &number );
   result = fibonacci( number );
   printf( "Fibonacci( %ld ) = %ld\n", number, result );
   return 0;
}

/* Recursive definition of function fibonacci */
long fibonacci( long n )
{
   if ( n == 0 || n == 1 )
      return n;
   else
      return fibonacci( n - 1 ) + fibonacci( n - 2 );
}
```

```
Enter an integer: 0
Fibonacci(0) = 0

Enter an integer: 1
Fibonacci(1) = 1
```



Outline

1. Function prototype

1.1 Initialize variables

2. Input an integer

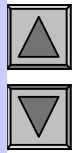
2.1 Call function `fibonacci`

2.2 Output results.

3. Define `fibonacci` recursively

Program Output

```
Enter an integer: 2
Fibonacci(2) = 1

Enter an integer: 3
Fibonacci(3) = 2

Enter an integer: 4
Fibonacci(4) = 3

Enter an integer: 5
Fibonacci(5) = 5

Enter an integer: 6
Fibonacci(6) = 8

Enter an integer: 10
Fibonacci(10) = 55

Enter an integer: 20
Fibonacci(20) = 6765

Enter an integer: 30
Fibonacci(30) = 832040

Enter an integer: 35
Fibonacci(35) = 9227465
```



Outline

Program Output

Streams di I/O

- Sequenze di caratteri organizzati in righe
  - Terminazione con ritorno a capo
  - ANSI C deve supportare righe di almeno 254 caratteri
- Forniscono tutto ciò che occorre per I/O
- Possono essere ridirezionati
  - Standard input - tastiera
  - Standard output - schermo
  - Standard error - schermo

Formattare con `printf`

`printf(`*format-control-string*`, `*other-arguments*`);`**

- *format-control-string*: stringa che descrive il formato di output
  - ogni specifica comincia con un segno % e termina con lo specificatore di conversione (flags, field widths, precisions, etc.)
  - Può effettuare arrotondamenti, allineamento di colonne, giustificazione sinistra/destra, inserzione di caratteri literal, formato esponenziale, formato esadecimale, e ampiezza e precisione fisse
- *other-arguments*: un argomento per ciascuna specifica di conversione nella stringa *format-control-string*

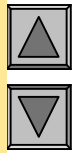
Formattare con scanf

`scanf(`*format-control-string*`,` *other-arguments*`);`**

- *format-control-string*: stringa che descrive il formato di input
    - Acquisisce tutti i tipi di dati
    - Acquisisce specifici caratteri
    - Salta specifici caratteri
- *other-arguments*: puntatori a variabili dove i valori di input verranno memorizzati
- può includere ampiezze di campo per leggere un numero specifico di caratteri dal flusso di input

```c
/* Fig 9.24: fig09_24.c */
/* Reading and discarding characters from the input stream */
#include <stdio.h>

int main()
{
   int month1, day1, year1, month2, day2, year2;

   printf( "Enter a date in the form mm-dd-yyyy: " );
   scanf( "%d%*c%d%*c%d", &month1, &day1, &year1 );
   printf( "month = %d  day = %d  year = %d\n\n",
      month1, day1, year1 );
   printf( "Enter a date in the form mm/dd/yyyy: " );
   scanf( "%d%*c%d%*c%d", &month2, &day2, &year2 );
   printf( "month = %d  day = %d  year = %d\n",
      month2, day2, year2 );

   return 0;
}
```

```
Enter a date in the form mm-dd-yyyy: 11-18-2000
month = 11  day = 18  year = 2000

Enter a date in the form mm/dd/yyyy: 11/18/2000
month = 11  day = 18  year = 2000
```



Outline

1. Initialize variables

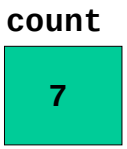
2. Input

3. Print

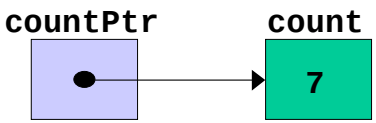
Program Output

I puntatori

- Le variabili “normali” contengono un valore (riferimento diretto)



- Le variabili “puntatore” contengono l’indirizzo di un’altra variabile (riferimento indiretto)

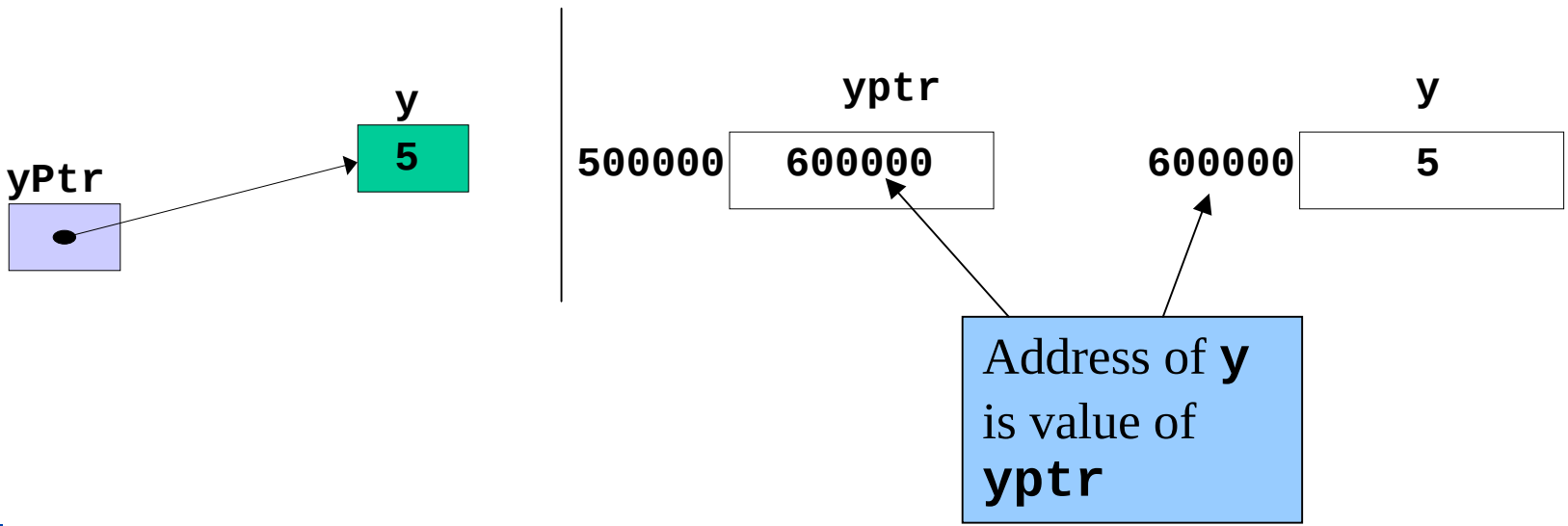


tipo ***** *var*

I puntatori (II)

- **&** (operatore di indirizzamento)
  - Restituisce l'indirizzo di un operando

```
int y = 5;
int *yPtr;  //yPtr points to y
yPtr = &y;  //yPtr gets address of y
```

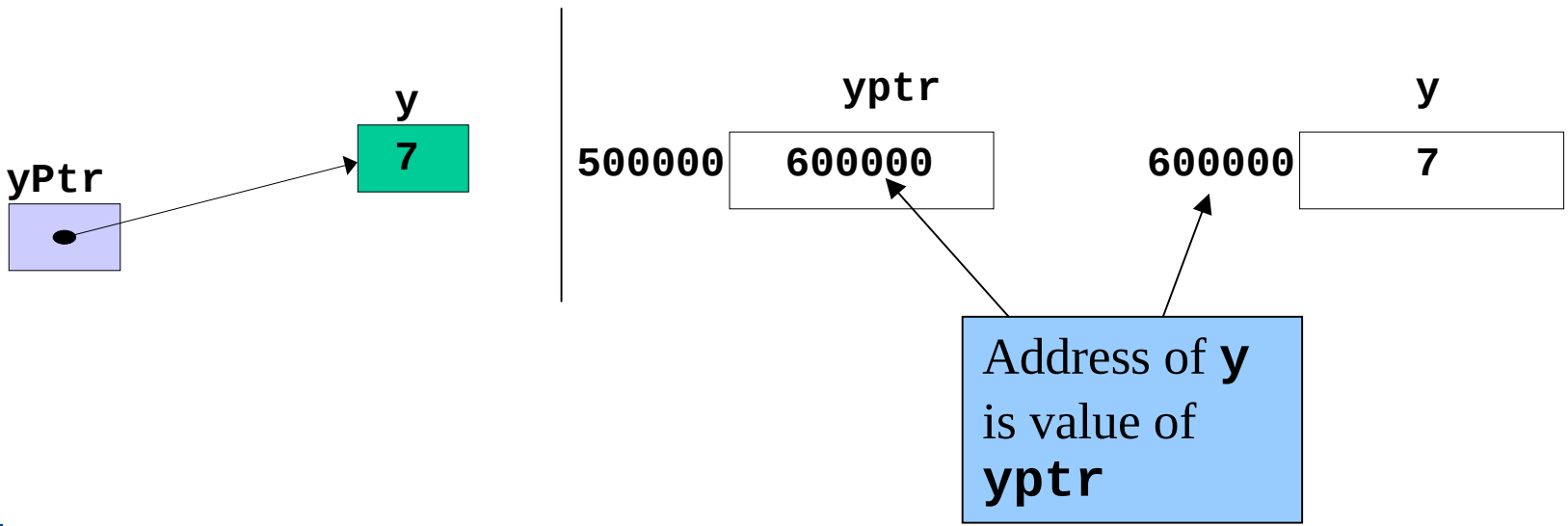


I puntatori (III)

- ***** (operatore di dereferenziamento)
  - Restituisce un alias della variabile “puntata”

    ***yptr** restituisce **y** (perché **yptr** punta a **y**)
  - Dereferenziamento può essere usato per l’assegnamento di nuovi valori alla variabile “puntata”

```
*yptr = 7; // changes y to 7
```



```c
/* Fig. 7.7: fig07_07.c
   Cube a variable using call-by-reference
   with a pointer argument */

#include <stdio.h>

void cubeByReference( int * );   /*

int main()
{
   int number = 5;

   printf( "The original value of number is %d", number );
   cubeByReference( &number );
   printf( "\nThe new value of number is %d\n", number );

   return 0;
}

void cubeByReference( int *nPtr )
{
   *nPtr = *nPtr * *nPtr * *nPtr;  /* cube number in main */
}
```

Notice how the address of **number** is given - **cubeByReference** expects a pointer (an address of a variable).

Inside **cubeByReference**, ***nPtr** is used (***nPtr** is **number**).

```
The original value of number is 5
The new value of number is 125
```

Outline

1. Function prototype - takes a pointer to an `int`.

1.1 Initialize variables

2. Call function

3. Define function

Program Output

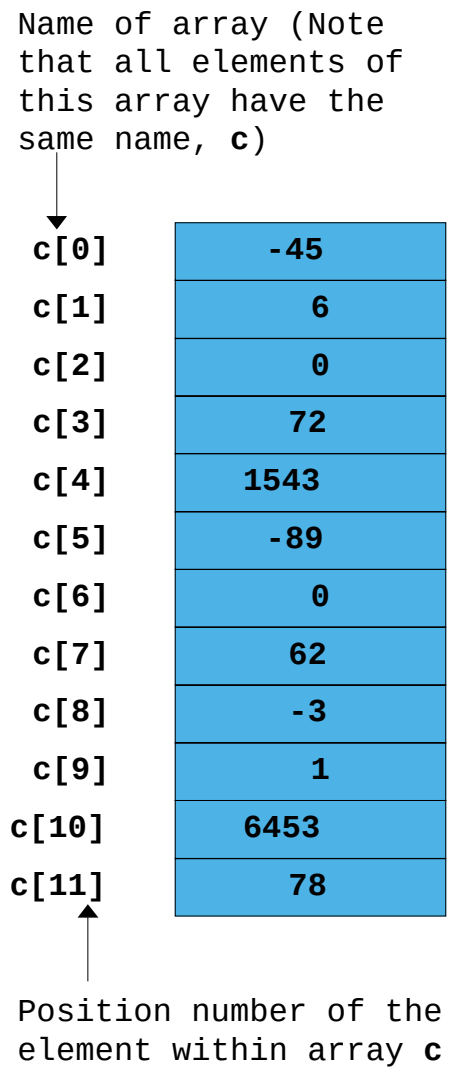
I vettori

Pascal

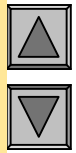
var`:array [`*tipo-indice-1*`, .., `*tipo-indice-n*`] of` *tipo-elemento*

C

tipo-elemento *var*`[`*dim-1*`], .., [`*dim-1*`]`



```c
/* Fig. 6.8: fig06_08.c
   Histogram printing program */
#include <stdio.h>
#define SIZE 10

int main()
{
   int n[ SIZE ] = { 19, 3, 15, 7, 11, 9, 13, 5, 17, 1 };
   int i, j;

   printf( "%s%13s%17s\n", "Element", "Value", "Histogram" );

   for ( i = 0; i <= SIZE - 1; i++ ) {
      printf( "%7d%13d        ", i, n[ i ]) ;

      for ( j = 1; j <= n[ i ]; j++ )   /* print one bar */
         printf( "%c", '*' );

      printf( "\n" );
   }

   return 0;
}
```

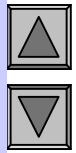


Outline

1. Initialize array

2. Loop

3. Print

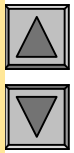


Outline

Program Output

```
Element         Value         Histogram
      0            19         ********************
      1             3         ***
      2            15         ***************
      3             7         *******
      4            11         ***********
      5             9         *********
      6            13         *************
      7             5         *****
      8            17         *****************
      9             1         *
```

```c
/* Fig. 6.10: fig06_10.c
   Treating character arrays as strings */
#include <stdio.h>

int main()
{
   char string1[ 20 ], string2[] = "string literal";
   int i;

   printf(" Enter a string: ");
   scanf( "%s", string1 );
   printf( "string1 is: %s\nstring2: is %s\n"
           "string1 with spaces between characters is:\n",
           string1, string2 );

   for ( i = 0; string1[ i ] != '\0'; i++ )
      printf( "%c ", string1[ i ] );

   printf( "\n" );
   return 0;
}
```



Outline

1. Initialize strings

2. Print strings

2.1 Define loop

2.2 Print characters individually

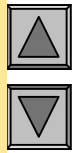
2.3 Input string

3. Print string

Program Output

```
Enter a string: Hello there
string1 is: Hello
string2 is: string literal
string1 with spaces between characters is:
H e l l o
```

```c
/* Fig. 6.13: fig06_13.c
   Passing arrays and individual array elements to functions */
#include <stdio.h>
#define SIZE 5

void modifyArray( int [], int );  /* appears strange */
void modifyElement( int );

int main()
{
   int a[ SIZE ] = { 0, 1, 2, 3, 4 }, i;

   printf( "Effects of passing entire array call "
           "by reference:\n\nThe values of the "
           "original array are:\n" );

   for ( i = 0; i <= SIZE - 1; i++ )
      printf( "%3d", a[ i ] );

   printf( "\n" );
   modifyArray( a, SIZE );  /* passed call by reference */
   printf( "The values of the modified array are:\n" );

   for ( i = 0; i <= SIZE - 1; i++ )
      printf( "%3d", a[ i ] );

   printf( "\n\n\nEffects of passing array element call "
           "by value:\n\nThe value of a[3] is %d\n", a[ 3 ] );
   modifyElement( a[ 3 ] );
   printf( "The value of a[ 3 ] is %d\n", a[ 3 ] );
   return 0;
}
```



Outline

1. Function definitions

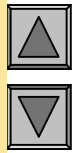
2. Pass array to a function

2.1 Pass array element to a function

Entire arrays passed call-by-reference, and can be modified

Array elements passed call-by-value, and cannot be modified

```
33
34 void modifyArray( int b[], int size )
35 {
36    int j;
37
38    for ( j = 0; j <= size - 1; j++ )
39       b[ j ] *= 2;
40 }
41
42 void modifyElement( int e )
43 {
44    printf( "Value in modifyElement is %d\n", e *= 2 );
45 }
```



Outline

3.1 Function definitions

Program Output

```
Effects of passing entire array call by reference:

The values of the original array are:
  0  1  2  3  4
The values of the modified array are:
  0  2  4  6  8

Effects of passing array element call by value:


The value of a[3] is 6
Value in modifyElement is 12
The value of a[3] is 6
```

Le strutture

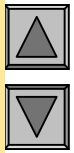
Pascal

tipo-record=
record
    campo-1;
    ..;
    campo-n
end
tipo-record var;

C

struct *nome-struttura*
{*campo-1;*
..;
*campo-n;***}** *var***;**

```
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  struct card {
8     const char *face;
9     const char *suit;
10 };
11
12 typedef struct card Card;
13
14 void fillDeck( Card * const, const char *[],
15                const char *[] );
16 void shuffle( Card * const );
17 void deal( const Card * const );
18
19 int main()
20 {
21    Card deck[ 52 ];
22    const char *face[] = { "Ace", "Deuce", "Three",
23                           "Four", "Five",
24                           "Six", "Seven", "Eight",
25                           "Nine", "Ten",
26                           "Jack", "Queen", "King"};
27    const char *suit[] = { "Hearts", "Diamonds",
28                           "Clubs", "Spades"};
29
30    srand( time( NULL ) );
```



Outline

1. Load headers

1.1 Define `struct`

1.2 Function prototypes

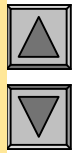
1.3 Initialize `deck[]` and `face[]`

1.4 Initialize `suit[]`

```
31
32    fillDeck( deck, face, suit );
33    shuffle( deck );
34    deal( deck );
35    return 0;
36 }
37
38 void fillDeck( Card * const wDeck, const char * wFace[],
39                const char * wSuit[] )
40 {
41    int i;
42
43    for ( i = 0; i <= 51; i++ ) {
44       wDeck[ i ].face = wFace[ i % 13 ];
45       wDeck[ i ].suit = wSuit[ i / 13 ];
46    }
47 }
48
49 void shuffle( Card * const wDeck )
50 {
51    int i, j;
52    Card temp;
53
54    for ( i = 0; i <= 51; i++ ) {
55       j = rand() % 52;
56       temp = wDeck[ i ];
57       wDeck[ i ] = wDeck[ j ];
58       wDeck[ j ] = temp;
59    }
60 }
```

Put all 52 cards in the deck. **face** and **suit** determined by remainder (modulus).

Select random number between **0** and **51**. Swap element **i** with that element.



Outline

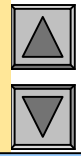
2. Randomize

2. fillDeck

2.2 deal

3. Function definitions

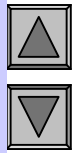
```
61
62 void deal( const Card * const wDeck )
63 {
64    int i;
65
66    for ( i = 0; i <= 51; i++ )
67       printf( "%5s of %-8s%c", wDeck[ i ].face,
68               wDeck[ i ].suit,
69               ( i + 1 ) % 2 ? '\t' : '\n' );
70 }
```



Outline

Cycle through array and print out data.

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



Outline

Program Output