



PROGRAMMING METHODOLOGY (PHƯƠNG PHÁP LẬP TRÌNH)

UNIT 11: Random Numbers

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Recording of modifications

- Currently, there are no modification on these contents.

Unit 11: Random Numbers

Objective:

- Learn the use of random numbers

Unit 11: Random Numbers

1. Introduction
2. `rand()`
3. `srand()`
4. “Randomising” the Seed
5. The HiLo Game

1. Introduction

- In simulation and games, we need **random number generation**.
- Computer cannot generate true random numbers. At most, they could generate **pseudo-random numbers**, close enough to being random and good enough for most practical purposes.
- We will learn two functions here:
 - `rand()`
 - `srand()`

2. rand() (1/2)

- Run the following program `Unit11_Random1.c`

```
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    int i;

    for (i = 1; i <= 10; i++)
        printf("%d\n", rand());

    return 0;
}
```

`<stdlib.h>` needed to
use `rand()` function

Unit11_Random1.c

16838
5758
10113
17515
31051
5627
23010
7419
16212
4086

The **same**
set of
numbers are
generated
every time
the program
is run!

2. rand() (2/2)

- In sunfire, `rand()` generates an integer in the range `[0, 32676]`. (Note: `[a, b]` indicates a closed range, i.e. the range is inclusive of both `a` and `b`.)
- The same set of numbers are printed every time the program is run because the numbers are picked from a **pre-determined sequence** based on some **seed**.
- Question: How to generate an integer in the range `[101, 500]`?

```
for (i = 1; i <= 10; i++)  
    printf("%d\n", rand() % 400 + 101);
```

Unit11_Random2.c

In general, to generate an integer in the range `[a, b]`, we write:

`rand() % (b-a+1) + a`

(This is not the best way, but a simple technique for our purpose.)

3. srand() (1/2)

- As mentioned, these “random numbers” generated are the same from run to run, due to the same default **seed** being used.
- To get a different set of random numbers each time the program is run, the trick is to change the seed, by calling the **srand()** function.
- A particular seed (which is an integer) indicates which pre-determined sequence of pseudo-numbers to use, and a subsequent call to **rand()** will pick up the next number from this sequence.
- Hence, you need only call **srand()** function **once**, before you call the **rand()** function.

3. srand() (2/2)

- Test out the program `Unit11_Random3.c`

Unit11_Random3.c

```
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    int seed, i;

    printf("Enter seed: ");
    scanf("%d", &seed);
    srand(seed); // feed srand() with a new seed

    for (i = 1; i <= 10; i++)
        printf("%d\n", rand()%400 + 101);

    return 0;
}
```

```
Enter seed: 3
248
408
466
413
323
297
274
444
493
308
```

```
Enter seed: 27
351
199
284
249
242
449
402
425
351
445
```

4. “Randomising” the Seed (1/2)

- In the preceding example, the user is asked to enter a value for the seed.
- However, in many applications such as games or simulations, we want to “automate” this step since we do not want user’s invention.
- How do we ensure that everytime the program is run, a different seed is used?
- One simple solution is to use the `time(NULL)` function, which returns an integer that is the number of seconds since 1st of January 1970. This value can then be used as the seed for the `srand()` function.

4. “Randomising” the Seed (2/2)

Unit11_Random4.c

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

int main(void) {
    int i;

    srand(time(NULL));

    for (i = 1; i <= 10; i++)
        printf("%d\n", rand()%400 + 101);

    return 0;
}
```

<time.h> needed to
use time() function

408
368
136
360
429
474
378
359
120
229

117
117
388
357
367
242
341
483
300
382

5. The HiLo Game (1/3)

- We will illustrate with the [HiLo game](#), where user is asked to guess a secret number between 1 and 100 inclusive, given up to 5 attempts.

```
*** Welcome to the HiLo game! ***

Guess a number between 1 and 100 inclusive.
Enter your guess [1]: 50
Your guess is too low!
Enter your guess [2]: 70
Your guess is too low!
Enter your guess [3]: 90
Your guess is too high!
Enter your guess [4]: 83
Your guess is too high!
Enter your guess [5]: 76
Too bad. The number is 72. Better luck next time!

Do you want to play again (y/n)?
```

5. The HiLo Game (2/3)

Unit11_HiLo.c

```
#include <stdio.h>
#include <time.h>
#include <stdlib.h>

void play_a_game(int);

int main(void) {
    int secret;
    char response;

    srand(time(NULL));

    printf("*** Welcome to the HiLo game! ***\n");
    do {
        secret = rand()%100 + 1;
        play_a_game(secret);
        printf("Do you want to play again (y/n)? ");
        scanf(" %c", &response);
    } while (response == 'y');

    printf("\n*** Thanks for playing. Bye! ***\n");

    return 0;
}
```

5. The HiLo Game (3/3)

Unit11_HiLo.c

```
// Play one HiLo game
void play_a_game(int secret) {
    int guess, tries = 0;
    printf("\nGuess a number between 1 and 100 inclusive.\n");
    do {
        tries++;
        printf("Enter your guess [%d]: ", tries);
        scanf("%d", &guess);

        if (guess < secret)
            printf("Your guess is too low!\n");
        else if (guess > secret)
            printf("Your guess is too high!\n");
    } while ( (tries < 5) && (guess != secret) );

    if (guess == secret) {
        printf("Congratulations! You did it in %d step", tries);
        if (tries == 1) printf(".\n");
        else             printf("s.\n");
    }
    else
        printf("Too bad. The number is %d. Better luck next time!\n",
               secret);
}
```


Summary

- In this unit, you have learned about
 - Generating pseudo-random numbers using `rand()`
 - Seeding a pseudo-random sequence using `srand()`
 - Providing a “random” seed by using `time(NULL)` in the `srand()` function

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