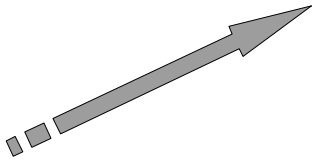
Lecture 5



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Standard Input and Output

- Many programs have the form:

Input Data
Process It
Output Data ⇩

- Where data can be read from the keyboard or a file and be printed to the screen or a file

Standard Input and Output

- In C, the *standard input* (stdin) is generally connected to the keyboard and the *standard output* (stdout) to the screen.
- However, in UNIX we can redirect the either or both at run time from the command line
- If we have a simple program a.out which takes some text from the keyboard and prints the results to the screen, then

```
a.out > outfile.txt                - sends output to file
a.out < infile.txt                 - reads input from file
a.out < infile.txt > outfile.txt   - does both
prog1 | prog2                      - sends output of prog1 to input of prog2
```

Standard Input and Output

- Luckily some nice person has written a whole library of C calls which allow use to easily perform stdio i.e. <stdio.h>
- In order to use these routines we need to include the appropriate header file

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

- We will study some of these more common routines, namely
  - OUTPUT: `puts, printsf and putchar`
  - INPUT: `scanf, getchar`

hello.c

```
/* Hello world program */

#include <stdio.h>

void main()
{
   printf("Hello world");
}
```

stdout

- The first program we will look at uses `puts` to *put a string* to standard out
  - a newline is automatically added to the end of the string
  - see `puts.c` (available on web)

```
/* Example: outputting strings using puts */
#include <stdio.h>
void main()
{
  puts("To be or not to be: that is the question:");
  puts("Whether 'tis nobler in the mind to suffer");
  puts("The slings and arrows of outrageous fortune,");
  puts("Or to take arms against a sea of troubles,");
  puts("And by opposing end them? To die: to sleep;");
  puts("No more; and by a sleep to say we end");
  puts("The heart-ache and the thousand natural shocks");
  puts("That flesh is heir to, 'tis a consummation");
  puts("Devoutly to be wished. To die, to sleep;");
  puts("To sleep: perchance to dream: ay, there's the rub.");
  puts("For in that sleep of death what dreams may come");
  puts("When we have shuffled off this mortal coil,");
  puts("Must give us pause.");
  /* Hamlet */
}
```

stdout

- Often we need to print data that the program has calculated and we need to control the formatting of this data.
  - e.g. the value 30 could be printed as 30 or 30.00 or +3E+01
  - this can all be done with `printf` which prints formatted output to standard out
  - note: `printf` does not automatically add a new line for us
- Basic printing
  - for an int j: printf("%i",j);
  - for a float x: printf("%f",x);
- The %-string is a format conversion string

printf1.c

```
/* Example: outputting numeric data using printf */
#include <stdio.h>
void main()
{
  int j = 5;
  float x = 123.4567890123456789;
  double z = 123.4567890123456789;
  char c = 'A';

  printf("The value of j is %i\n\n", j);

  printf("The value of x is %f\n", x);
  printf("...or %E\n", x);
  printf("...or %30.27f\n\n", x);

  printf("The value of z is %f\n", z);
  printf("...or %30.27f\n\n", z);

  printf("\nThe value of c is %c or %i\n", c, c);
  c++;
  printf("The new value of c is %c or %i\n\n", c, c);

  printf("0.05 is equivalent to %i%%\n\n", j);

  printf("Hello ");
  printf("world!\n");
}
```

```
The value of j is 5

The value of x is 123.456787
...or 1.23456E+002
...or 123.456787109375000000000000000

The value of z is 123.456789
...or 123.456789012345680000000000000


The value of c is A or 65
The new value of c is B or 66

0.05 is equivalent to 5%

Hello world!
```

printf2.c

```
/* Example: formatting integer data using printf */
#include <stdio.h>

main()
{
  int j = 1234;
  int k = -5678;

  puts("j = 1234");
  puts("k = -5678");

  puts("\n|...| is used to show the field width.\n");

  printf("Using %i,    j = |%i|\n", j);
  printf("             k = |%i|\n\n", k);

  printf("Using %i+i,  j = |%+i|\n", j);
  printf("             k = |%+i|\n\n", k);

  printf("Using %% i,  j = |% i|\n", j);
  printf("             k = |% i|\n\n", k);

  printf("Using %8i,   j = |%8i|\n", j);
  printf("             k = |%8i|\n\n", k);

  printf("Using %X-8i, j = |%-8i|\n", j);
  printf("             k = |%-8i|\n\n", k);

  printf("Using %X- 8i, j = |%- 8i|\n", j);
  printf("             k = |%- 8i|\n\n", k);

  printf("Using %X08i, j = |%08i|\n", j);
  printf("             k = |%08i|\n\n", k);

  printf("Using %X8.6i, j = |%8.6i|\n", j);
  printf("             k = |%8.6i|\n\n", k);
}
```

```
j = 1234
k = -5678

|...| is used to show the field width.

Using %i,    j = |1234|
             k = |-5678|

Using %+i,   j = |+1234|
             k = |-5678|

Using % i,   j = | 1234|
             k = |-5678|

Using %8i,   j = |   1234|
             k = |  -5678|

Using %-8i,  j = |1234    |
             k = |-5678    |

Using %- 8i, j = | 1234    |
             k = |-5678    |

Using %08i,  j = |00001234|
             k = |-0005678|

Using %8.6i, j = |  001234|
             k = | -005678|
```

printf3.c

```
/* Example: formatting float/double data using printf */

#include <stdio.h>

main()
{
  double a = 123.4;  /* These could all be floats */
  double b = -567.8;
  double c = 987654321;
  double d = -0.00008765;

  puts("a = 123.4");
  puts("b = -567.8");
  puts("c = 987654321");
  puts("d = -0.00008765");

  puts("\n|...| is used to show the field width.\n");

  printf("Using %f,     a = |%f|\n", a);
  printf("              b = |%f|\n", b);
  printf("              c = |%f|\n", c);
  printf("              d = |%f|\n\n", d);

  printf("Using %8.3f,  a = |%8.3f|\n", a);
  printf("              b = |%8.3f|\n", b);
  printf("              c = |%8.3f|\n", c);
  printf("              d = |%8.3f|\n\n", d);

  printf("Using %E,     a = |%E|\n", a);
  printf("              b = |%E|\n", b);
  printf("              c = |%E|\n", c);
  printf("              d = |%E|\n\n", d);

  printf("Using %12.3E, a = |%12.3E|\n", a);
  printf("              b = |%12.3E|\n", b);
  printf("              c = |%12.3E|\n", c);
  printf("              d = |%12.3E|\n\n", d);

  printf("Using %G,     a = |%G|\n", a);
  printf("              b = |%G|\n", b);
  printf("              c = |%G|\n", c);
  printf("              d = |%G|\n\n", d);
}
```

```
a = 123.4
b = -567.8
c = 987654321
d = -0.00008765

|...| is used to show the field width.

Using %f,     a = |123.400000|
              b = |-567.800000|
              c = |987654321.000000|
              d = |-0.000088|

Using %8.3f,  a = | 123.400|
              b = |-567.800|
              c = |987654321.000|
              d = |  -0.000|

Using %E,     a = |1.234000E+002|
              b = |-5.678000E+002|
              c = |9.876543E+008|
              d = |-8.765000E-005|

Using %12.3E, a = |  1.234E+002|
              b = | -5.678E+002|
              c = |  9.877E+008|
              d = | -8.765E-005|

Using %G,     a = |123.4|
              b = |-567.8|
              c = |9.87654E+008|
              d = |-8.765E-005|
```

printf.bug

```
/* BUG ZONE!!!
Example: outputting numeric data using printf */

#include <stdio.h>

main()
{
  int j = 5;
  float x = 123.4567890123456789;
  double z = 123.4567890123456789;
  char c = 'A';

  printf("The value of j is %f\n\n", j); /* BUG */

  printf("The value of x is %i\n", x); /* BUG */

  printf("The value of z is %c\n", z); /* BUG */

  printf("\nThe value of c is %f or %s\n", c, c); /* 2 BUGS */

  printf("0.05 is equivalent to 5%"); /* BUG */
}
```

```
The value of j is 0.000000

The value of x is 0
The value of z is Ó

The value of c is 0.000000 or
0.05 is equivalent to
```

puchar

- `putchar` : put a character (to stdout)
  - Remember a char can be treated as a character or as a number so `putchar('A');` and `putchar(65);` are equivalent

```
/* Example: outputting characters using putchar */

#include <stdio.h>

main()
{
  putchar('H');
  putchar('e');
  putchar(108);
  putchar(108);
  putchar('o');
  putchar('!');
  putchar('\t');
  putchar('*');
  putchar('\n');
}
```

```
Hello!   *
```

Can you spot the bugs in this program ?

```
/*  BUG ZONE!!!
Example: standard output */

#include (studio.h)                /* 2 BUGS! */

Main()                            /* BUG! */
{
  puts(Multiplication);           /* BUG! */

  printf("9 times 7 = %c", 9 * 7);  /* BUG! */

  putchar("\n");                  /* BUG */

  print("9 times 8 = %i", 9 * 8);   /* BUG */

  printf("/n");                   /* BUG */
}
```

stdin

- `scanf` : scan formatted (from stdin)
- Basic use
  - for an int j : `scanf("%i",&j);`
  - for a float x : `scanf("%f",&x);`
- the & is very important and must not be omitted (an easy mistake to make)!
  - &x means "the address of x", well see why later
- Again the %-string is a format conversion string.

scanf.c

```
/* Example: inputting numeric data using scanf */

#include <stdio.h>
#include <limits.h> /* defines INT_MIN, INT_MAX, LONG_MIN, LONG_MAX */

main()
{
  int j;
  long int k;
  float x;
  double z;

  printf("Enter an integer (between %i and %i): ", INT_MIN, INT_MAX);
  scanf("%i", &j);
  printf("You entered %i\n\n", j);

  printf("Enter a long integer (between %li and %li): ", LONG_MIN, LONG_MAX);
  scanf("%li", &k);
  printf("You entered %li\n\n", k);

  printf("Enter a floating point number: ");
  scanf("%f", &x);
  printf("You entered %20.10E\n\n", x);

  printf("Enter a double precision floating point number: ");
  scanf("%lf", &z);
  printf("You entered %20.10E\n\n", z);

  puts("\n\nTry again: enter invalid data and see what happens!");
}
```

```
Enter an integer (between -2147483648 and 2147483647): 10
You entered 10

Enter a long integer (between -2147483648 and 2147483647): 10
You entered 10

Enter a floating point number: 1.1
You entered    1.1000000238E+000

Enter a double precision floating point number: 1.1
You entered    1.1000000000E+000


Try again: enter invalid data and see what happens!
```

scanf.bug

```
/* BUG ZONE!!!
Example: inputting numeric data using scanf */

#include <stdio.h>
#include <limits.h> /* defines INT_MIN, INT_MAX */

main()
{
  int j;
  double z;

  printf("Enter an integer (between %i and %i): ", INT_MIN, INT_MAX);
  scanf("%i", j); /* BUG */
  printf("You entered %i\n\n", j);

  printf("Enter a double precision floating point number: ");
  scanf("%i", &z); /* BUG */
  printf("You entered %20.10E\n\n", z);
}
```

getchar

- `getchar` : get a character (from stdin)
- The input is buffered - this means you have to press ENTER after the character.
- It can also cause problems because this ENTER (='\n') will be read next time getchar is called.
- The solution is to "flush the buffer" before reading it using `fflush(stdin);`

getchar.c

```
/*  Example: getting a single character from the keyboard, using getchar */

#include <stdio.h>

main()
{
   char key;

  printf("Press a key (then ENTER): ");
  key = getchar();
  printf("You pressed %c\n", key);
  puts("-------------");

  printf("Press another key: ");
  key = getchar();
  printf("You pressed %c\n", key);
  puts("-------------");

  puts("Oops! What went wrong?");
  puts("Let's try again...\n\n");

  printf("Press a key (then ENTER): ");
  fflush(stdin); /* flush the keyboard buffer */
  key = getchar();
  printf("You pressed %c\n", key);
  puts("-------------");

  printf("Press another key: ");
  fflush(stdin); /* flush the keyboard buffer */
  key = getchar();
  printf("You pressed %c\n", key);
  puts("-------------");

  puts("Ah, that's more like it!");
  /* getchar is both echoed and buffered */
}
```

```
Press a key (then ENTER): p
You pressed p
-------------
Press another key: You pressed

-------------
Oops! What went wrong?
Let's try again...


Press a key (then ENTER): p
You pressed p
-------------
Press another key: r
You pressed r
-------------
Ah, that's more like it!
```