C programming language

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origins

Dennis Ritchie in 2011 / CC BY 2.0

Brian Kernighan in 2012 / CC BY 2.0

comparison

Java	C
object-oriented	procedural
interpreted	compiled
`String`	`char` array
condition (`boolean`)	condition (`int`)
garbage-collected	no memory management
references	pointers
exceptions	error codes

hello, world

```c
#include <stdio.h>

int main() {
  printf("hello, world\n");
  return 0;
}
```

```
$ gcc -o helloworld helloworld.c
$ ./helloworld
hello, world
```

conditions

- under what conditions will each of the following be execute?

```
if (x) {
  /* ??? */
}
if (x-y) {
  /* ??? */
}
if (x=y) {
  /* ??? */
}
```

add evens

- create program called `add_even.c` that adds all the even numbers between 1 and 100 and prints the sum

cli

```c
#include <stdio.h>

int main(int argc, char * argv[]) {
  printf("(%d) %s:%s\n", argc, argv[0],
    argv[1]);
  return 0;
}
```

- modify `add_even.c` to get maximum value from the command-line instead of hard-coded as 100

printf / scanf

- `printf()` interprets variables and prints character representations to standard out (usually the terminal)
- `scanf()` scans characters from standard in (usually the terminal) and interprets them for storage in variables

```c
#include <stdio.h>

int main() {
  int i;
  scanf("%d", &i);
  return 0;
}
```

echo

- modify `helloworld.c` to ask user for an input and then print it back
- change its name to `echo.c`

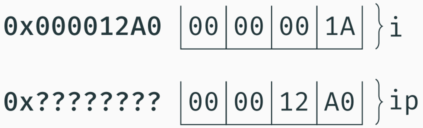
```
$ ./echo
Enter a string to echo: hello, world
hello,
```

pointers

- a pointer is a variable whose value is a memory address

```c
int    i   = 0x1A;
int  * ip  = &i;
```

- `&i` evaluates to the address where the variable `i` is stored in memory
- `i` is an `int`, so `ip` is a *pointer* to an `int`



pointers cont.

```c
printf("0x%X\n", i);    /* 0x1A */
printf("0x%#X\n", &i);  /* 0x12A0 */
printf("0x%#X\n", ip);  /* 0x12A0 */
printf("0x%#X\n", &ip); /* 0x???????? */
```

pointer dereference

- `*ptr` will
  1. treat the value of `ptr` as a memory address
  2. get the bytes of data located at that memory address
  3. interpret those bytes according to the type of pointer that `ptr` is

```c
printf("0x%X\n", *ip);   /* 0x1A */
```

- `ip[X] = *(ip + X)`

```c
printf("0x%X\n", ip[0]); /* 0x1A */
```

pointers cont.

```c
printf("0x%X\n", i);         /* 0x1A */
printf("0x%X\n", *ip);       /* 0x1A */
printf("0x%X\n", ip[0]);     /* 0x1A */
printf("0x%X\n", *(ip+0));   /* 0x1A */
printf("0x%#X\n", &i);       /* 0x12A0 */
printf("0x%#X\n", ip);       /* 0x12A0 */
printf("0x%#X\n", &ip);      /* 0x???????? */
```

pointers cont.

```c
char * cp = "hello, world";
```

- `cp` is a *pointer* to a `char`

0x00004C80	h	e	l	l	o	,		w	o	r	l	d	\0

0x????????	00	00	4C	80

```c
printf("%c\n", *cp);       /* h */
printf("%c\n", cp[0]);     /* h */
printf("%c\n", cp[4]);     /* o */
printf("%c\n", *(cp+4));   /* o */
printf("%s\n", cp);        /* hello, world */
printf("%s\n", cp+7);      /* world */
printf("0x%#X\n", cp);     /* 0x4C80 */
printf("0x%#X\n", &cp);    /* 0x???????? */
```

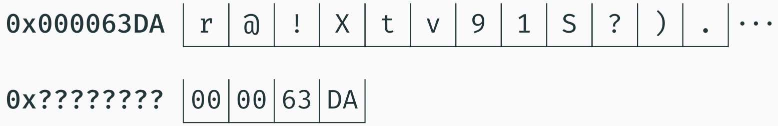
practice

```c
#include <stdio.h>

void swap(int n1, int n2) {
  int tmp = n1;
  n1 = n2;
  n2 = tmp;
}

int main() {
  int v1 = 11, v2 = 77;
  printf("BEFORE  v1=%d, v2=%d\n", v1, v2);
  swap(v1, v2);
  printf("AFTER  v1=%d, v2=%d\n", v1, v2);
  return 0;
}
```

heap memory

- designate a block of memory to store value(s) of a particular data type

```c
int * ip = malloc(100*sizeof(int));
```

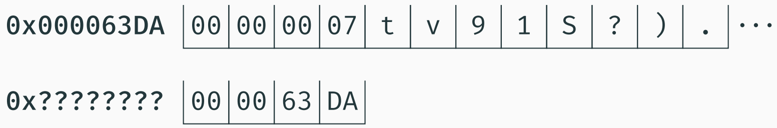


- release a block of memory back to system to be used elsewhere

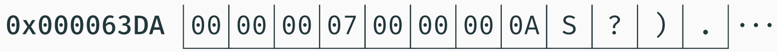
```c
free(ip);
```

heap memory cont.

```c
ip[0] = 0x7; /* *ip = 0x7; */
```



```c
ip[1] = 0xA; /* *(ip + 1) = 0xA; */
```



file i/o

```c
#include <stdio.h>

int main() {
  int m, n;
  FILE * fp;

  if (!(fp = fopen("example.txt", "r")))
    return EXIT_FAILURE;
  if (2 != fscanf(fp, "%d %d", &m, &n))
    return EXIT_FAILURE;
  if (!fclose(fp))
    return EXIT_FAILURE;

  return 0;
}
```

final thoughts

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