C No Evil

A practitioner's guide

Topics

- Program arguments
- Pointer arithmetic
- Output
- Stack memory

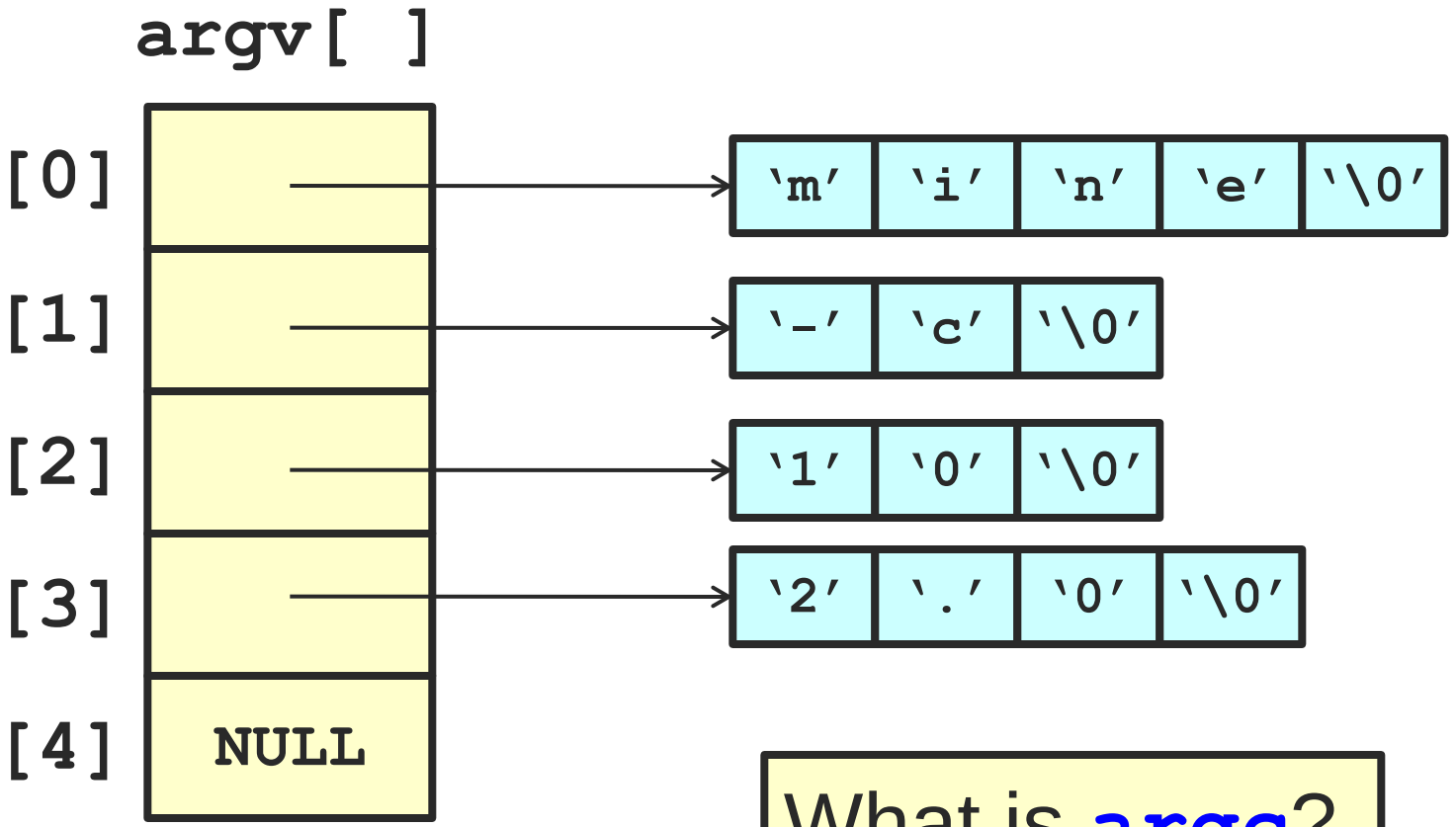
main()

```
int main(int argc, char** argv)
int main(int argc, char* argv[])
```


main()

```
$ mine -c 10 2.0
```


ARGCount ARGValues



What is **argc**?

Type questions

- **`char **argv;`**
  What type is **`argv`**?
  What type is **`*argv`**?
  What type is **`**argv`**?

Review

- `main(int argc, char**argv) {`
  what is `*argv`?
  what is `argv[argc]`?

ARGCount ARGValues

```
int main(argc, char** argv)
int main(argc, char* argv[])
```

- **`argc`**
  - Argument count
  - The number of arguments that are passed to **`main`** in the argument vector **`argv`**.
  - the value of **`argc`** is always one greater than the number of command-line arguments that the user enters.

ARGCount ARGValues

```
int main(argc, char** argv)
int main(argc, char* argv[])
```

- **`argv`**
  - argument vector
  - An array of string pointers passed to a C program's **`main`** function
  - **`argv[0]`** is always the name of the command
  - **`argv[argc]`** is a null pointer

Adding integers to pointers

- Compiler uses the type information
  - `long *p;`
  - `p` ▸ `[long][long][long][...]`
    `array of long types`

- What address is `p + 2`?
  - … `p + sizeof(long) * 2`

Output

```
char *s1 = "Hello";
char *s2 = "World";

fprintf(stdout, "%s %s", s1, s2);
 printf("%s %s", s1, s2);
```


`printf` Format Identifiers

`%d` or `%i`	Decimal signed integer
`%o`	Octal integer
`%x` or `%X`	Hex integer
`%u`	Unsigned integer
`%c`	Character
`%s`	String
`%f` or `%g`	Double
`%p`	Pointer

All of the parameters should be the value to be inserted EXCEPT %s, this expects a pointer to be passed

printf Formatting

```
        %[flags][width][.precision][length]specifier
%02ld = %   0      2                    l        d

              0 := Zero-fill empty space
                    2 := Write at least two digits
                   Data type is long =: l
                        Data type is integer =: d
```


printf Basic Data Types

```
#include <stdio.h> // for printf
int main(int argc, char *argv[]) {

    // print "the date is: 01/25/2010",
    // i.e. 2- or 4-digit with leading zeros
    // using 32-bit 'long' datatype
    long day = 25;
    long month = 1;
    long year = 2010;
    printf("the date is: %02ld/%02ld/%04ld\n", month, day, year);

    // - print 8-digit hex value
    // - print a pointer value
    unsigned long ulID = 0x12345678;
    unsigned long *pID = &ulID;
    printf("hex value: 0x%02lX at address: %p\n", ulID, pID);
```


printf Basic Data Types

```
    // - print 4 bytes of a 32-bit ulong value
    // as separate hex values
    unsigned char uc1 = (unsigned char)(ulID >> 24);
    unsigned char uc2 = (unsigned char)(ulID >> 16);
    unsigned char uc3 = (unsigned char)(ulID >> 8);
    unsigned char uc4 = (unsigned char)(ulID >> 0);
    printf("hex bytes: %02X %02X %02X %02X\n",uc1,uc2,uc3,uc4);

    // - print double value like "70.35000"
    double dTemp = 70.35;
    printf("temperature: %5.5f\n", dTemp);
}
```


`printf` Escape Sequences

`\a`	<bell>
`\b`	<backspace>
`\e`	<escape>
`\f`	<form-feed>
`\n`	<new-line>
`\r`	<carriage return>
`\t`	<tab>
`\v`	<vertical tab>
`\0`	<null>

`\"`	<double quote>
`\\`	<backslash>
`\`*`num`*	an 8-bit character with ASCII value of the 1-, 2-, or 3-digit octal number *num*.
`%%`	<percent>

Typecasting

- C allows programmers to perform typecasting by
  - Place the type name in parentheses and place this in front of the value

```
main() {
    float a;
    a = (float)5 / 3;
}
```

- Result is a = 1.666666
  - Integer 5 is converted to floating point value before division and the operation between float and integer results in float
- What would `a` be without the `(float)`?

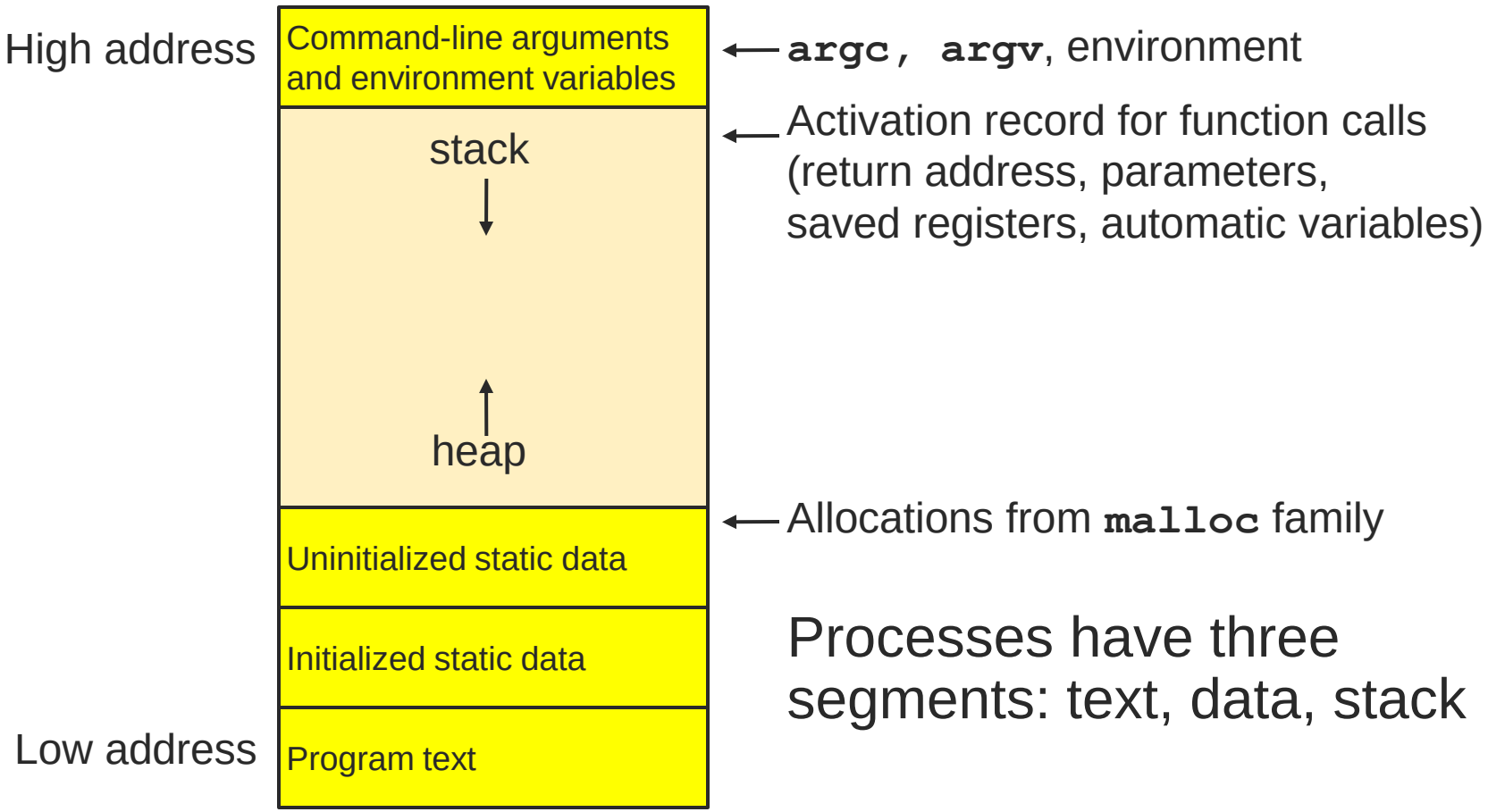
Typecasting

- Take care about using typecast
- If used incorrectly, may result in loss of data
  - e.g., truncating a **`float`** when casting to an **`int`**

Common Pitfall

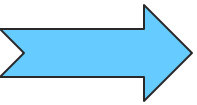
- Returning a variable in stack memory from a function
  - What is stack memory?

Sample layout for program image in main memory



Example

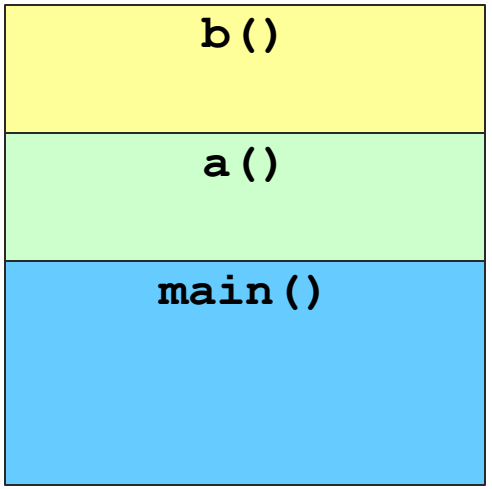
```
int b() {
    /* … */
}

int a() {
    /* … */
    b();
}

int main(int argc,
    char **argv) {
     /* … */
     a();
}
```



Example

```
int b() {
    /* … */
}

int a() {
    /* … */
    b();
}

int main(int argc,
    char **argv) {
    /* … */
    a();
}
```

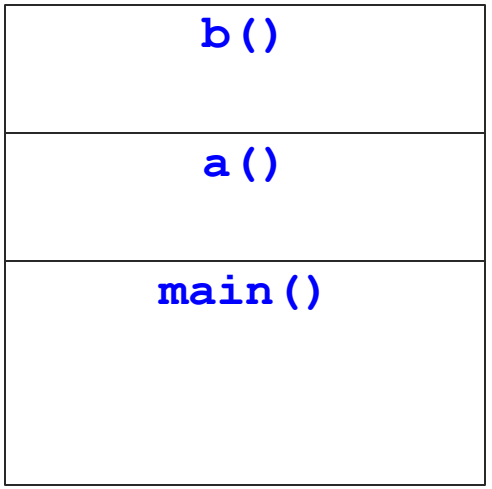
Stack Memory:



Example

```
int b() {
    /* … */
}

int a() {
    /* … */
    b();
}

int main(int argc,
    char **argv) {
     /* … */
     a();
}
```

Stack Memory:



Better Example

```
my_queue * b() {
    my_queue q;
    return &q;
}

int a(int yourVal) {
    int myVal;
    my_queue *myQueue;
    myVal = yourVal + 3;
    myQueue = b();
    return
      remove_int(myQueue);
}
```

```
int main(int argc,
     char **argv) {
     int myVal = 3;
     a(myVal);
}
```

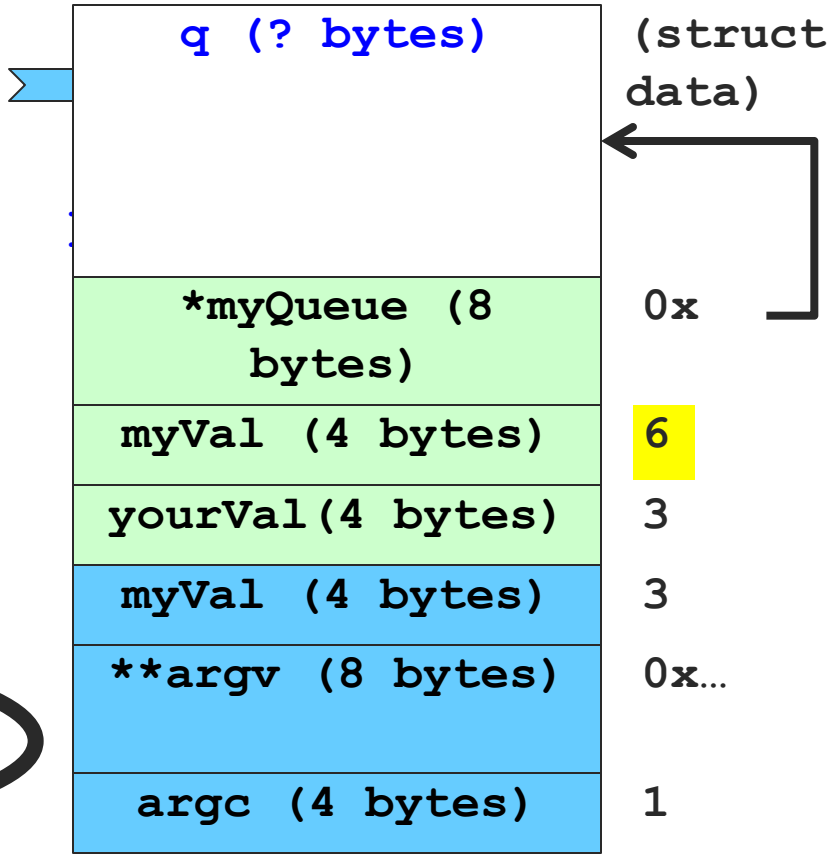
`main()` still calls **`a()`**
`a()` still calls **`b()`**
`b()` returns a pointer to **`a()`**
`a()` returns an **`int`** to **`main()`**
`my_queue` is a custom **`struct`**

```
my_queue * b() {
   my_queue q;
   return &q;
}

int a(int yourVal) {
   int myVal;
   my_queue *myQueue;
   myVal = yourVal + 3;
   myQueue = b();
   return remove_int(myQueue);
}

void main() {
    int myVal = 3;
    a(myVal);
}
```

Better Example

```
my_queue * b() {
    my_queue q;
    return &q;
}

int a(int yourVal) {
    int myVal;
    my_queue *myQueue;
    myVal = yourVal + 3;
    myQueue = b();
    return
        remove_int(myQueue);
}
```

```
int main(int argc,
```



Use your stack wisely

- Returning a pointer to a stack variable results in unpredictable behavior
- Three ‘common’ fixes
  - Good: Pass in a pointer to the variable you want to use
  - Good: Use a heap variable
  - Very Bad (usually): Use a global variable