Intro to C

```
#include <stdio.h>

int main() {
   int i;
   extern int gcd(int x, int y);
   for (i = 0; i < 20; i++)
        printf("gcd of 12 and %d is %d\n", i, gcd(12,i));
   return (0);
}

int gcd(int x, int y) {
   int t;
   while (y) {
        t = x; x = y; y = t % y;
   }
   return (x);
}
```

About C

- Similar to Java - Java took best of C
- `#include` - use declarations of functions
- `main()` returns int, the exit status
- Functions must be
  - declared - tells compiler how to use function
  - defined - creates the item
- Declarations must appear before code

Basic Control Structures

- Functions - can omit `extern` declaration
- `for` loop - like Java
  - body is one statement
  - braces `{ }` enclose blocks
  - blocks introduce scope level
  - can't mix declarations and non-declarations
    - `for (int i ...` illegal in ANSI C

More about C

- Uninitialized variables have no default value!
- No run-time checking!
- No polymorphism (`printf` format strings)
- No objects (C predates object-oriented)

Compile: `gcc -Wall -g -o gcd gcd.c`

C data types

- basic types and literals (King: Ch 7)

```
int i = 38;          long el = 38L;
int hex = 0x2a;      int oct = 033;
printf("i = %d, el = %ld, hex = %d, oct = %d\n",
       i, el, hex, oct);
```

```
i = 38, el = 38, hex = 42, oct = 27
```

```
double d1 = 0.3;   double d2 = 3.0;
double d3 = 6.02e23;
printf("d1 = %f, d2 = %f, d3 = %e\n", d1, d2, d3)
```

```
d1 = 0.300000, d2 = 3.000000, d3 = 6.020000e+23
```

Data Type Conversion

- The expression on the right side is converted to the type of the variable on the left.

```
char c;
int i = c;    /* c is converted to int */
double d = i; /* i is converted to double */
```

- This is no problem as long as the variable's type is at least as “wide” as the expression.

```
char c = 500; /* compiler warning */
int k = d1;
printf("c = %c, k = %d\n", c, k);
```

```
c =  , k = 0
```

Data Type Capacity

- What happens when the following code is executed?

```
char c = 127;
int d;

printf("c = %d\n", c);
c++;

d = 512 / c;
printf("c = %d, d = %d\n", c, d);
```

Mixed Mode Arithmetic

```
double m = 5/6; /* int / int = int */
printf("Result of 5/6 is %f\n", m);
```

```
Result of 5/6 is 0.000000
```

```
double n = (double)5/6; /* double / int = double */
printf("Result of (double)5/6 is %f\n", n);
```

```
Result of (double)5/6 is 0.833333
```

```
double o = 5.0/6; /* double / int = double */
printf("Result of 5.0/6 is %f\n", o);
```

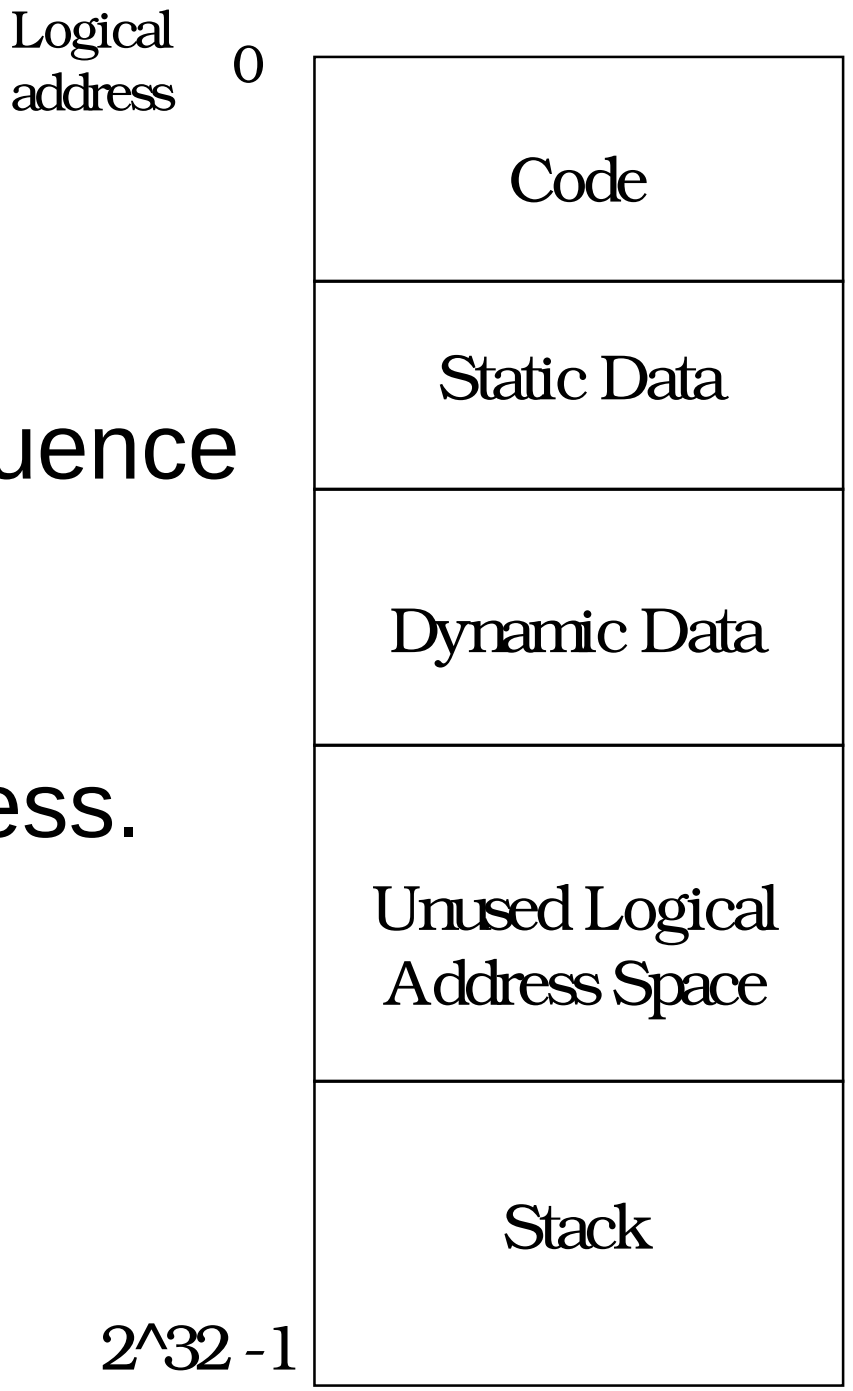
```
Result of 5.0/6 is 0.833333
```

```
int p = 5.0/6; /* double / int = double but then
                  converted to int */
printf("Result of 5.0/6 is %d\n", p);
```

```
Result of 5.0/6 is 0
```

Memory model

- Memory is just a sequence of bytes
- A memory location is identified by an address.



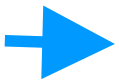
Example

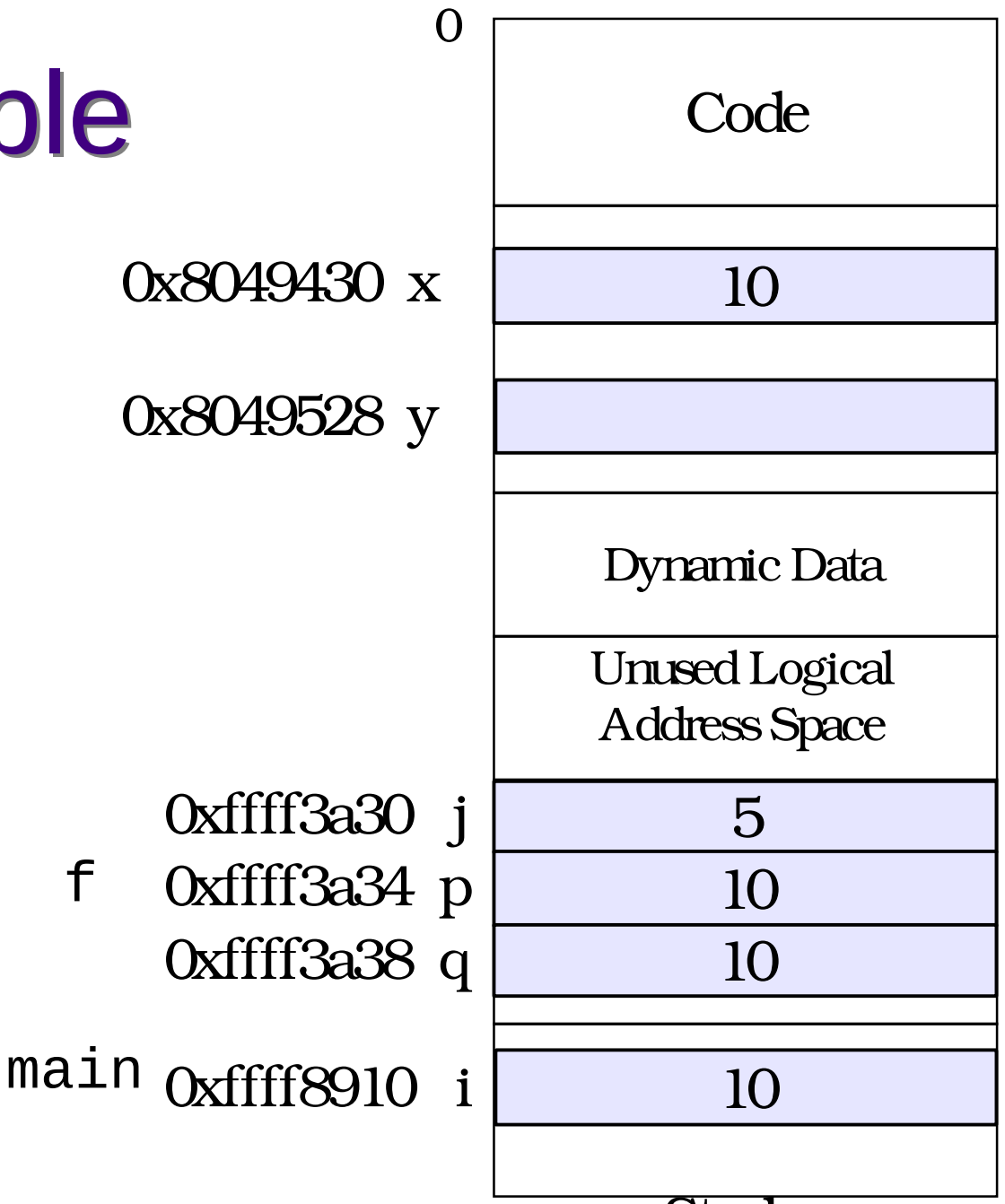
```
int x = 10;
int y;

int f(int p, int q) {
    int j = 5;
    return p * q + j;
}

int main() {

    int i = x;
    y = f(i, i);
    return 0;
}
```



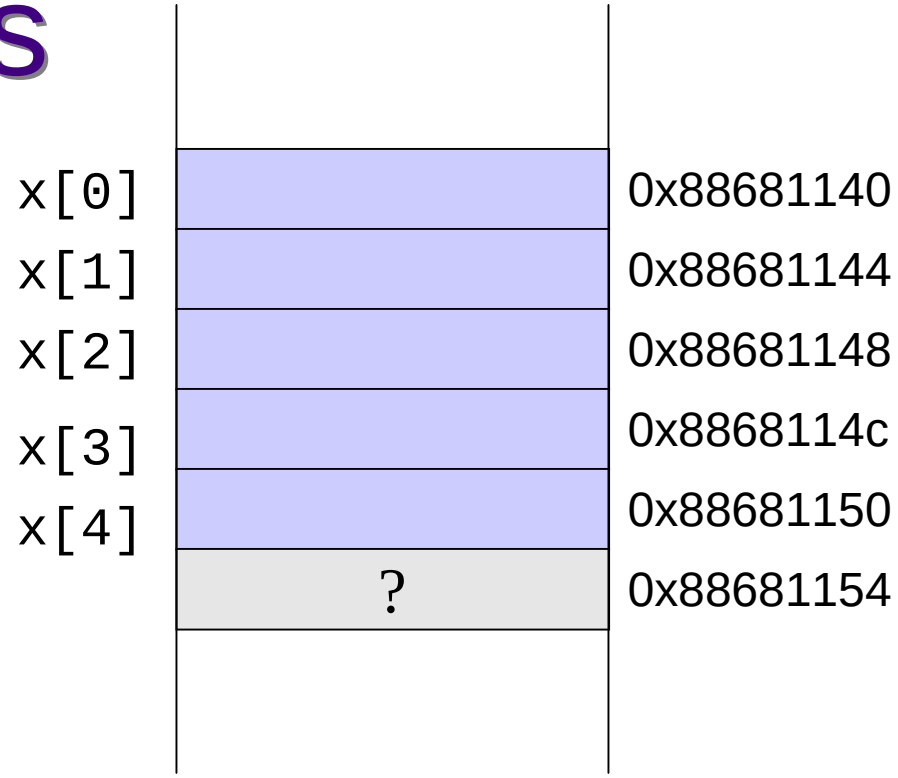


Arrays

- Arrays in C are a contiguous chunk of memory that contain a list of items of the same type.
- If an array of ints contains 10 ints, then the array is 40 bytes. There is nothing extra.
- In particular, the size of the array is not stored with the array. There is no runtime checking.

Arrays

```
int x[5];
for (i = 0; i <= 5; i++) {
    x[i] = i*i;
}
```



- No runtime checking of array bounds
- Behaviour of exceeding array bounds is “undefined”
  - → program might appear to work
  - → program might crash
  - → program might do something apparently random

Initializing arrays

Declaration/Definition

```
int a[10]; /*declare 'a' as an
                array of 10 ints*/
sizeof(a) == 10 * sizeof(int) == 40;
```

Static initialization:

```
char letters[4] = {'a', 'q', 'e', 'r'};
```

Initialization loop:

```
for(i = 0; i < N; i++) {
   a[i] = 0;
}
```

Arrays

- Warning: It is the programmer's responsibility to keep track of the size of an array.
- Often define a maximum size.
- Pre-processor directives used for constants:
  - E. g., `#define MAXSIZE 30`

Pointers

- A pointer is a higher level version of an address.
- A pointer has type information.

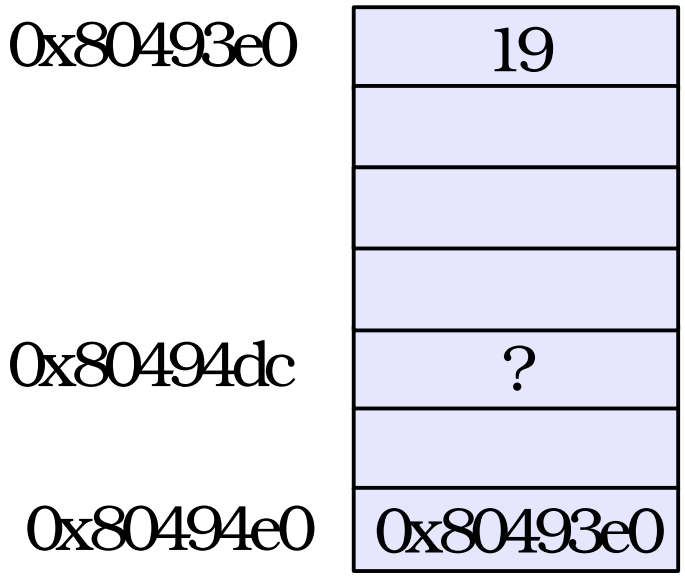
```
int i;
int *p;  /* declare p to point to type int */
*p = i;  /* dereference p – set what p point to*/
p = &i   /* Give p the value of the address of i*/
char *c = p; /* Warning: initialization from
                incompatible pointer type */
```

Important!

- `int *p;`
- Memory is allocated to store the **pointer**
- No memory is allocated to store what the pointer points to!
- Also, p is **not** initialized to a valid address or null.
- I.e., `*p = 10;` is wrong unless memory has been allocated and p set to point to it.

A picture

```
int i = 19;
int *p;
int *q;
*p = i; /*error*/
q = &i
```



Symbol Table

i	0x80493e0
p	0x80494dc
q	0x80494e0

A picture

```
int i = 19;
int *p;
int *q;

q = &i
p = (int *)malloc(sizeof(int));
*p = i;
```

Symbol Table

i	0x80493e0
p	0x80494dc
q	0x80494e0