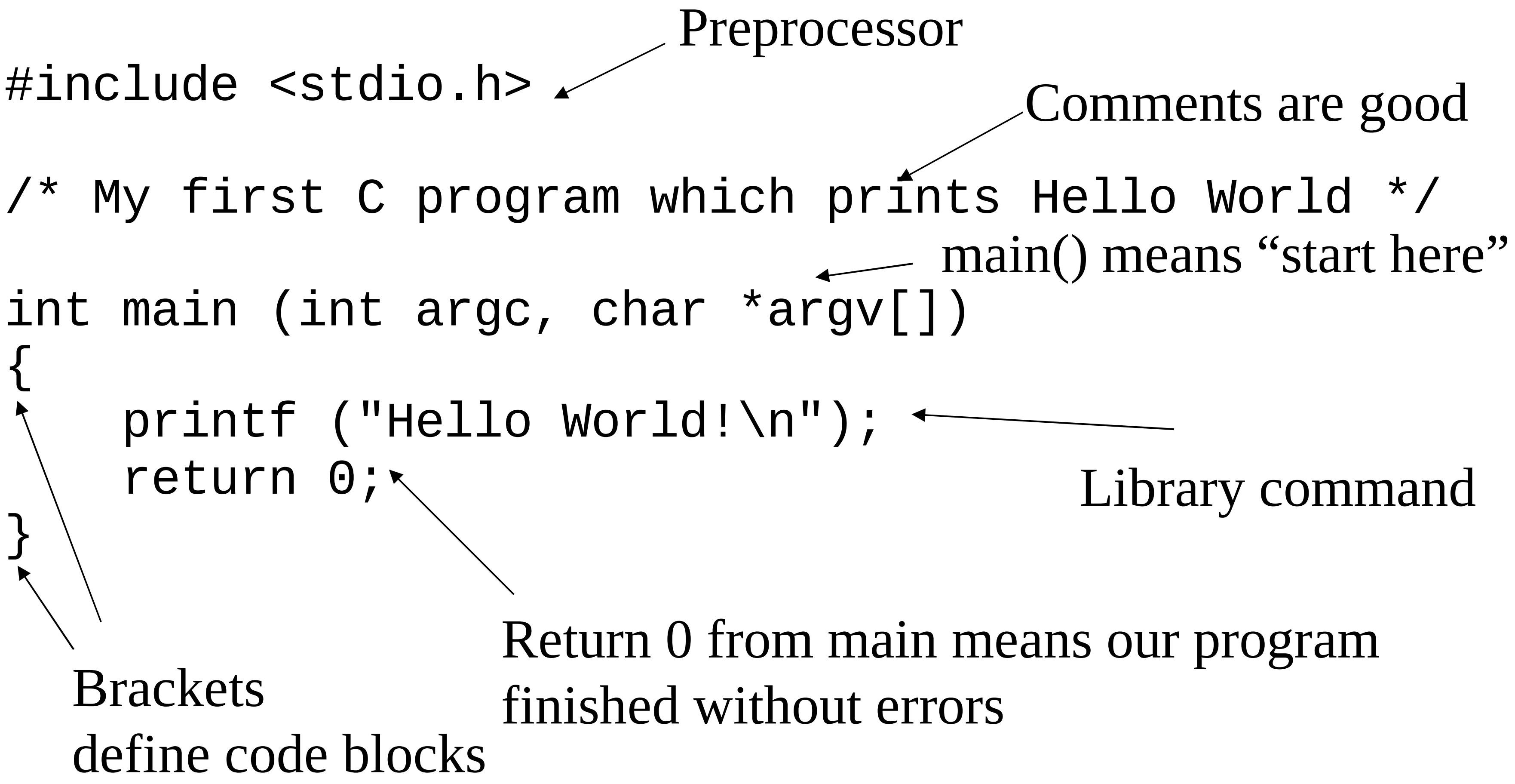
Why teach C?

- C is *small* (only 32 keywords).
- C is *common* (lots of C code about).
- C is *stable* (the language doesn’t change much).
- C is *quick running*.
- C is the *basis for many other languages* (Java, C++, awk, Perl).
- It may not feel like it but C is one of the easiest languages to learn.

Some programmer jargon

- Some words that will be used a lot:
  - Source code: The stuff you type into the computer. The program you are writing.
  - Compile (build): Taking source code and making a program that the computer can understand.
  - Executable: The compiled program that the computer can run.
  - Language: (Special sense) The core part of C central to writing C code.
  - Library: Added functions for C programming which are bolted on to do certain tasks.
  - Header file: Files ending in .h which are included at the start of source code.

More about Hello World



```
#include <stdio.h>

/* My first C program which prints Hello World */

int main (int argc, char *argv[])
{
    printf ("Hello World!\n");
    return 0;
}
```

Preprocessor

Comments are good

main() means “start here”

Library command

Brackets
define code blocks

Return 0 from main means our program
finished without errors

Keywords of C

- Flow control (6) – `if, else, return, switch, case, default`
- Loops (5) – `for, do, while, break, continue`
- Common *types* (5) – `int, float, double, char, void`
- *structures* (3) – `struct, typedef, union`
- Counting and sizing things (2) – `enum, sizeof`
- Rare but still useful *types* (7) – `extern, signed, unsigned, long, short, static, const`
- Evil keywords which we avoid (1) – `goto`
- Wierdies (3) – `auto, register, volatile`

Types of variable

- We must *declare* the *type* of every variable we use in C.
- Every variable has a *type* (e.g. `int`) and a *name*.
- We already saw `int, double` and `float.`
- This prevents some bugs caused by spelling errors (misspelling variable names).
- Declarations of types should always be together at the top of main or a function (see later).
- Other types are `char`, `signed`, `unsigned`, `long`, `short` and `const.`

Naming variables

- Variables in C can be given any name made from numbers, letters and underlines which is not a keyword and does not begin with a number.
- A good name for your variables is important

```
int a,b;
double d;
/* This is
a bit cryptic */
```

```
int start_time;
int no_students;
double course_mark;
/* This is a bit better */
```

- Ideally, a comment with each variable name helps people know what they do.
- In coursework I like to see well chosen variable names and comments on variables (I don’t always do this in notes because there is little space).

The `char` type

- `char` stores a character variable
- We can print `char` with `%c`
- A `char` has a *single quote* not a double quote.
- We can use it like so:

```
int main()
{
   char a, b;
   a= 'x';  /* Set a to the character x */
   printf ("a is %c\n",a);
   b= '\n'; /* This really is one character*/
   printf ("b is %c\n",b);
   return 0;
}
```

More types: Signed/unsigned, long, short, const

- `unsigned` means that an `int` or `char` value can only be positive. `signed` means that it can be positive or negative.
- `long` means that `int`, `float` or `double` have more precision (and are larger) `short` means they have less
- `const` means a variable which doesn't vary – useful for physical constants or things like pi or e

```
short int small_no;
unsigned char uchar;
long double precise_number;
short float not_so_precise;
const short float pi= 3.14;
const long double e= 2.718281828;
```

A short note about ++

- ++i means increment i then use it
- i++ means use i then increment it

```
int i= 6;
printf ("%d\n",i++);  /* Prints 6 sets i to 7 */
```

Note this important difference

```
int i= 6;
printf ("%d\n",++i);  /* prints 7 and sets i to 7 */
```

It is easy to confuse yourself and others with the difference between `++i` and `i++` - it is best to use them only in simple ways.

All of the above also applies to `--`.

Some simple operations for variables

- In addition to `+`, `-`, `*` and `/` we can also use +=, `-=`, `*=`, `/=`, `--` and `%` (modulo)
- `--` (subtract one) e.g. `countdown--;`
- `+=` (add to a variable) e.g. `a+= 5;`
- `-=` (subtract from variable) e.g. `num_living-= num_dead;`
- `*=` (multiply a variable) e.g. `no_bunnies*=2;`
- `/=` (divide a variable) e.g. `fraction/= divisor;`
- `(x % y)` gives the remainder when `x` is divided by `y`
- `remainder= x%y`; (ints only)

Casting between variables

- Recall the trouble we had dividing ints
- A cast is a way of telling one variable type to temporarily look like another.

```
int a= 3;
int b= 4;
double c;
c= (double)a/(double)b;
```

Cast ints a and b to be doubles

By using (*type*) in front of a variable we tell the variable to act like another type of variable. We can cast between any type. Usually, however, the only reason to cast is to stop ints being rounded by division.

What is a function?

- The *function* is one of the most basic things to understand in C programming.
- A *function* is a sub-unit of a program which performs a specific task.
- We have already (without knowing it) seen one function from the C library – `printf.`
- We need to learn to write our own functions.
- Functions take *arguments* (variables) and may return an *argument.*
- Think of a function as extending the C language to a new task.
- Or perhaps variables are NOUNS functions are VERBS.

An example function

```
#include <stdio.h>
int maximum (int, int);  /* Prototype – see later in lecture */

int main(int argc, char*argv[])
{
    int i= 4;
    int j= 5;
    int k;
    k= maximum (i,j);  /* Call maximum function */
    printf ("%d is the largest from %d and %d\n",k,i,j);
    printf ("%d is the largest from %d and %d\n",maximum(3,5), 3, 5);
    return 0;
}

int maximum (int a, int b)
/* Return the largest integer */
{
    if (a > b)
         return a;  /* Return means "I am the result of the function"*/
    return b;       /* exit the function with this result */
}
```

Prototype the function

Call the function

function header

The function itself

Functions can access other functions

- Once you have written a function, it can be accessed from other functions. We can therefore build more complex functions from simpler functions

```
int max_of_three (int, int, int); /* Prototype*/
.
.  /* Main and rest of code is in here */
.
int max_of_three (int i1, int i2, int i3)
/* returns the maximum of three integers */
{
    return (maximum (maximum(i1, i2), i3));
}
```

`void` functions

- A function doesn't have to take or return arguments. We prototype such a function using `void`.

Prototype (at top of file remember)

```
void print_hello (void);

void print_hello (void)
/* this function prints hello */
{
    printf ("Hello\n");
}
```

Function takes and returns void (no arguments)

Another prototype

```
void odd_or_even (int);
void odd_or_even (int num)
/* this function prints odd or even appropriately */
{
    if ((num % 2) == 0) {
        printf ("Even\n");
        return;
    }
    printf ("Odd\n");
}
```

Function which takes one int arguments and returns none

Notes about functions

- A function can take any number of arguments mixed in any way.
- A function can return at most one argument.
- When we return from a function, the values of the argument HAVE NOT CHANGED.
- We can declare variables within a function just like we can within `main()` - these variables will be deleted when we return from the function

Where do functions go in the program

- Generally speaking it doesn't matter too much.
- main() is a function just like any other (you could even call it from other functions if you wanted.
- It is common to make main() the first function in your code.
- Functions must be entirely separate from each other.
- Prototypes must come before functions are used.
- A usual order is: Prototypes THEN main THEN other functions.

What are these prototype things?

- A prototype tells your C program what to expect from a function - what arguments it takes (if any) and what it returns (if any)
- Prototypes should go before `main()`
- `#include` finds the prototypes for library functions (e.g. printf)
- A function MUST return the variable type we say that it does in the prototype.

ANSI library

A list of the most common libraries and a brief description of the most useful functions they contain follows:

stdio.h: I/O functions:

  - getchar() returns the next character typed on the keyboard.
  - putchar() outputs a single character to the screen.
  - printf() as previously described
  - scanf() as previously described

- string.h: String functions
  - strcat() concatenates a copy of str2 to str1
  - strcmp() compares two strings
  - strcpy() copys contents of str2 to str1
- ctype.h: Character functions
  - isdigit() returns non-0 if arg is digit 0 to 9
  - isalpha() returns non-0 if arg is a letter of the alphabet
  - isalnum() returns non-0 if arg is a letter or digit
  - islower() returns non-0 if arg is lowercase letter
  - isupper() returns non-0 if arg is uppercase letter
- math.h: Mathematics functions

ANSI library-contd.

  - acos() returns arc cosine of arg
  - asin() returns arc sine of arg
  - atan() returns arc tangent of arg
  - cos() returns cosine of arg
  - exp() returns natural logarithim e
  - fabs() returns absolute value of num
  - sqrt() returns square root of num
- time.h: Time and Date functions
  - time() returns current calender time of system
  - difftime() returns difference in secs between two times
  - clock() returns number of system clock cycles since program execution
- stdlib.h:Miscellaneous functions
  - malloc() provides dynamic memory allocation, covered in future sections
  - rand() as already described previously
  - srand() used to set the starting point for rand()

For more complete information, please read the header files in /usr/include/. The following two websites have quite complete information about ANSI C library.

http://www.infosys.utas.edu.au/info/documentation/C/CStdLib.html

http://www.phim.unibe.ch/comp doc/c manual/C/FUNCTIONS/funcref.htm

What is scope?

- The *scope* of a variable is where it can be used in a program
- Normally variables are *local* in *scope* - this means they can only be used in the function where they are declared (main is a function)
- We can also declare *global* variables.
- If we declare a variable outside a function it can be used in any function *beneath* where it is declared
- Global variables are A BAD THING

The print stars example

This program prints five rows of five stars

```
*****
*****
*****
*****
*****
```

```
#include <stdio.h>
void print_stars(int);

int main()
{
    int i;
    for (i= 0; i < 5; i++)
        print_stars(5);
    return 0;
}

void print_stars (int n)
{
    int i;
    for (i= 0; i < n; i++)
        printf ("*");
    printf ("\n");
}
```

Loop around 5 times to print the stars

Variables here are LOCAL variables

This prints 'n' stars and then a new line character

Why global is bad

Variable here is global variable

```
#include <stdio.h>
void print_stars(int);
int i;   /* Declare global i */

int main()
{
    for (i= 0; i < 5; i++)
        print_stars(5);
    return 0;
}

void print_stars (int n)
{
    for (i= 0; i < n; i++)
        printf ("*");
    printf ("\n");
}
```

This program only
prints ONE row
of five stars