Functions

The Basis of C

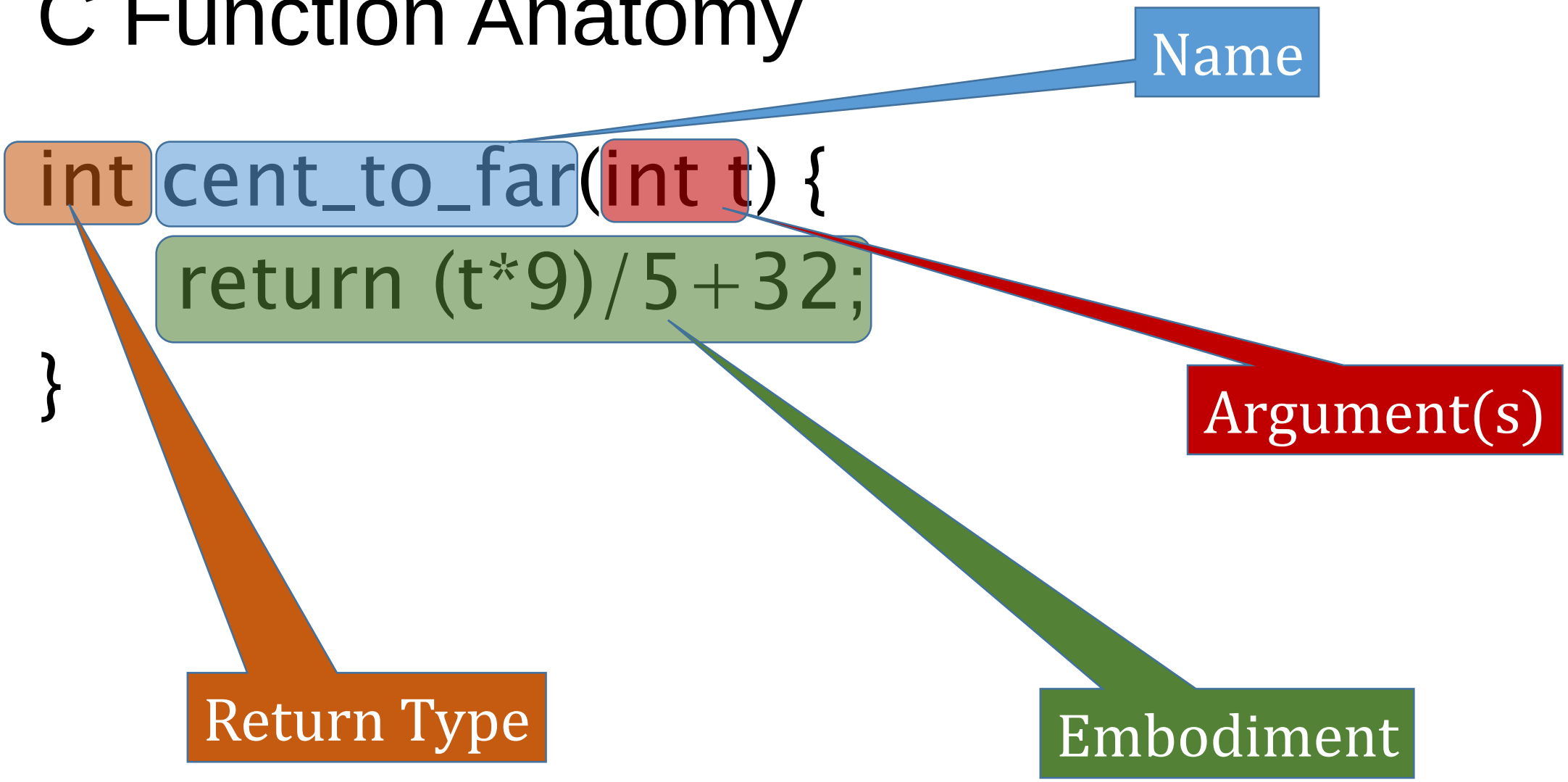
What is a function?

- Lab 01 Question 5: What can a computer help with?
  - "conversion of five temperatures in Celsius to Fahrenheit; the computer would calculate it by just writing the formula in the program and compiling it."
- Demo: http://www.pronk.com/samples/projects/021$Function_Machine/Function_Machine.HTML

Function in C

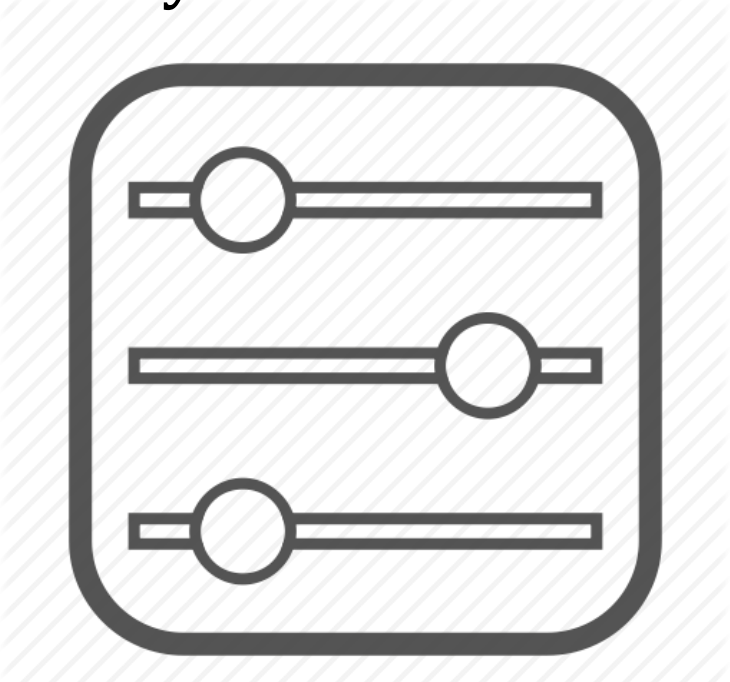
```
int cent_to_far(int t) {
        return (t*9)/5+32;
}
```

C Function Anatomy



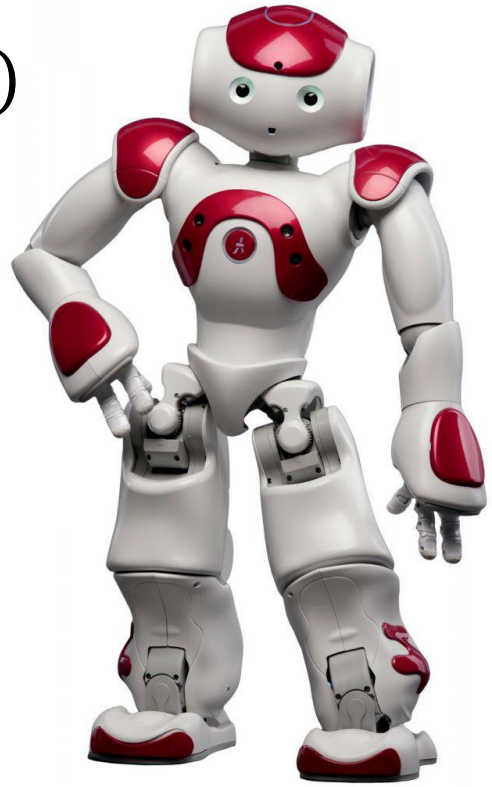
Function Arguments or Parameters

- Comma separated list of data passed in to the function
- Each entry in the list specifies the “type” and “name” of one argument or parameter
- The value of the parameter can be referenced by its name in the function embodiment



Function Embodiment

- List of C statements that define how the function works
- Typically works on arguments to produce result
- May have "side effects" (other than producing a result)
  - Write messages to the console
  - Read information from a file
  - Change a global variable value
- Result is specified by a "return" statement



Function Return Value

- Type specified in function definition
- Value specified in embodiment by “return” statement

Function Invocation

cent_to_far(22)

cent_to_far(73.2)

cent_to_far("very cold")

cent_to_far(cent_value("very cold"))

cent_to_far(-278)

cent_to_far(ctemp*1.10)

Functions for Abstraction

- Function Prototype: `int cent_to_far(int t)`
- Function Behavior: Convert Centigrade to Farenheit
- Function Embodiment: WHO CARES?
  - As long as it works, we can ignore the embodiment!
  - Code it once, test it, and then use it lots of times!

Generalization 1: Change types

```
float cent_to_far_xact(float t) {
    return (t*1.8)+32.0;
}
```

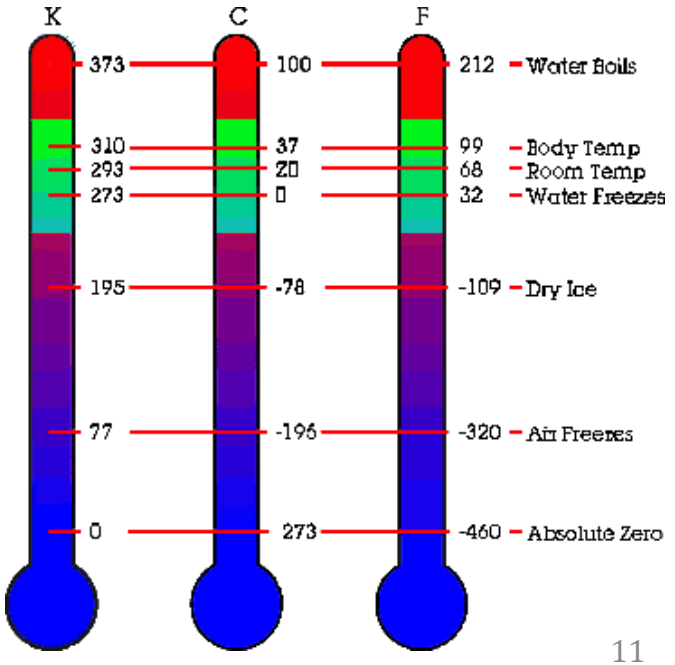
Generalization 2: Multiple Arguments

```
float temp_conv(float t, float f_frz, float f_boil, float t_frz, float t_boil)
{
        return t *(t_boil-t_frz) / (f_boil-f_frz) + (t_frz – f_frz);
}
```

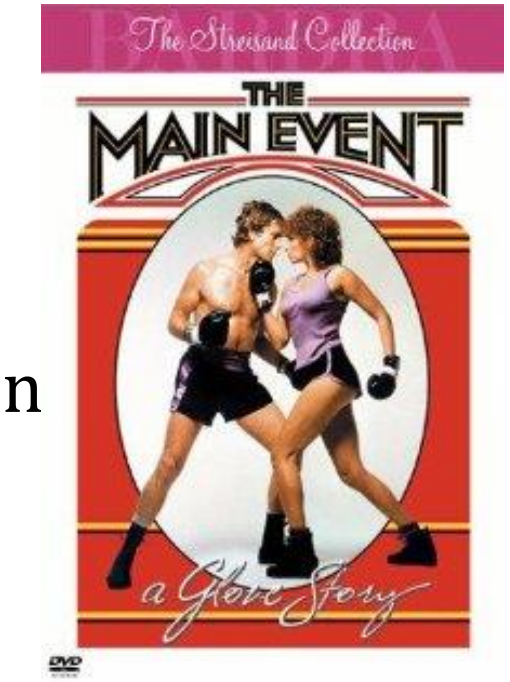
temp_conv(22,0,100,32,212)

temp_conv(22,0,100,273,373)

temp_conv(71.6,32,212,0,100)



The "main" function



- Every C program must have a "main" function
- When C program is run, the OS invokes the main function
- When the main function returns, program ends
- Return value "int"
  - Return value 0 indicates program worked OK
  - Return value other than 0 indicates program failed
- main function arguments – stay tuned
- main function may invoke lower level functions
- For now: `int main() { … ; return 0; }`

C Declare before Use Rule

- In C, you cannot invoke a function which has not been “declared”
- One way to declare a function is to fully specify the function
- This causes “upside down” code
  - Lowest Level functions are first in the file
  - Highest Level function (main) is last in the file

Example of Upside Down Code

```
int square(int x) { return x*x; }
int poly(int x,int c1, int c2, int c3) {
        return c1*square(x) + c2*x + c3;
}
int main() {
        int x=7;
        if (poly(x)>14) return 1;
        return 0;
}
```

Function Prototype Declare

- Function Prototype: `int cent_to_far(int t);`
- We can "Declare" a function by specifying the prototype;
  - Still need full function definition lower in the file
- Enables "Right Side Up" coding
  - Function Prototypes at the top of the file
  - Function definition for top level function (main) next
  - Then function definitions for lower level functions

Example of RightSide Up Code

```
int poly(int x,int c1, int c2, int c3);
int square(int x);

int main() {
        int x=7;
        if (poly(x)>14) return 1;
        return 0;
}
int poly(int x,int c1, int c2, int c3) {
        return c1*square(x) + c2*x + c3;
}
int square(int x) { return x*x; }
```

C Standard Library Functions

- Library of functions that comes with C
- Package (abstract) complexity in functions
  - Keep C simple
- See Programming in C, Appendix B
- Need "#include <_____.h>"

Resources

- Programming in C, Chapter 7 up to "Functions Calling Functions Calling …" (p. 130)
- YouTube: Meat-a-Morphis – Introduction to Functions (https://www.youtube.com/watch?v=VUTXsPFx-qQ)
- WikiPedia: Subroutine (https://en.wikipedia.org/wiki/Subroutine)
- WikiPedia: C Standard Library: (https://en.wikipedia.org/wiki/C_standard_library)
- ACM C Library Reference Guide (https://www-s.acm.illinois.edu/webmonkeys/book/c_guide/)