

# Functions (in C++)

Similar to functions you've seen in math class: like a transformation / mapping between sets.

Example:  $f: \mathbb{R} \rightarrow \mathbb{R}, \quad f(x) = x^2 + 1.$

Now in C++:

```
double f(double); // "prototype"
```

```
double f(double x) {  
    double y;  
    y = x*x + 1;  
    return y; // says y = f(x).  
}
```

Similarities / differences w/ math functions

\* Math functions have no external "state". They are "self-contained".

However, C++ functions use external variables all the time (stdin, stdout, cout, cin).

Maybe think of C++ functions like this:

$$f: \text{World} \times \mathbb{R} \longrightarrow \text{World} \times \mathbb{R}$$

Put another way: in C++, functions can have side-effects.

\* Corollary: computing  $f(x)$  <sup>(in C++)</sup> over & over

may produce different results !!

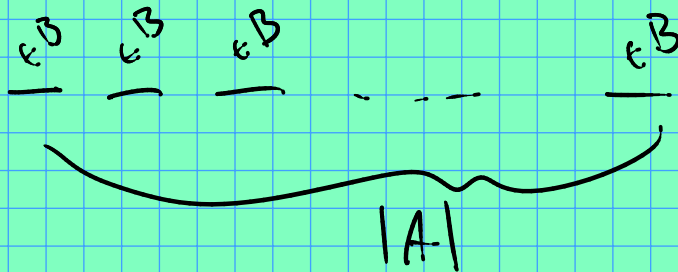
many functions you use in calc  
(but not all) (or "rules")  
have short descriptions that let you  
effectively capture them. E.g.  $f(x) = x^2 + 1$ .

Note: not all functions can have short descriptions.

Say  $A, B$  are sets w/  $|A| < \infty$ ,  $|B| < \infty$ .  
How many functions are there from  $A \rightarrow B$ ?

$$|\{f: A \rightarrow B\}| = |B|^{|A|}$$

if ( $x == 0$ ) return —  
if ( $x == 1$ ) return —  
:  
:



Even for  $f: \{0,1\}^{128} \rightarrow \{0,1\}$ ,

we have many choices: # f's =  $2^{128}$

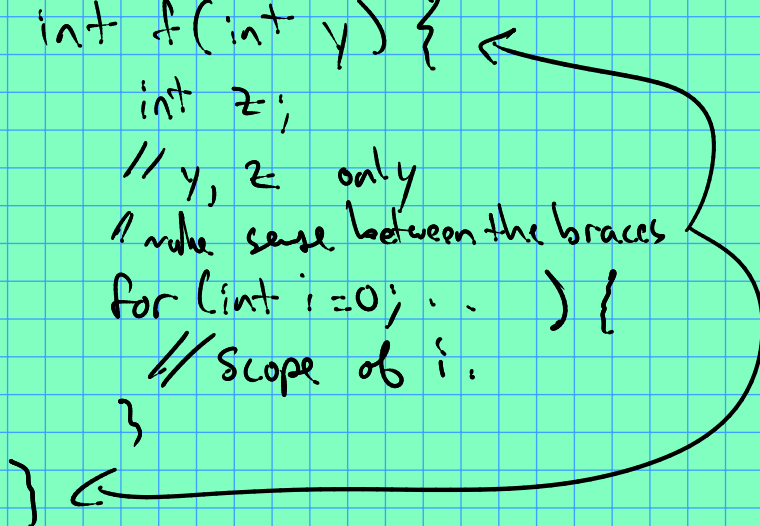
Exercise: prove that  $\exists$  functions  $f: A \rightarrow \{0,1\}$   
that require size  $|A|$  to write down.

Scope : where do variable names make sense?

Global: e.g. `cout`, can be used anywhere.

Local: variables declared in a function (or even a for loop) are only visible in that function.

```
int x; // global  
int f(int y) {  
    int z;  
    // y, z only  
    // make sense between the braces  
    for (int i=0; ... ) {  
        // scope of i.  
    }  
}
```



Reference vs Value parameters

Next time...

See Prof. Li's notes.