Reference variables

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Why references?

```
// Wrong version
void swap(int a, int b) {
   int temp = a;
   a = b;
   b = temp;
int main() {
   int x=3, y=7;
   swap(x, y);
   // still x == 3, y == 7 !
}
   // C++ version
```

```
// C version
void swap (int *a, int *b) {
   int t = *a;
   *a = *b;
   *b = t;
}; // swap(&x,&y)
```

```
// C++ version
void swap (int &a, int &b) {
   int t = a;
   a = b;
   b = t;
}; // swap(x,y)
```

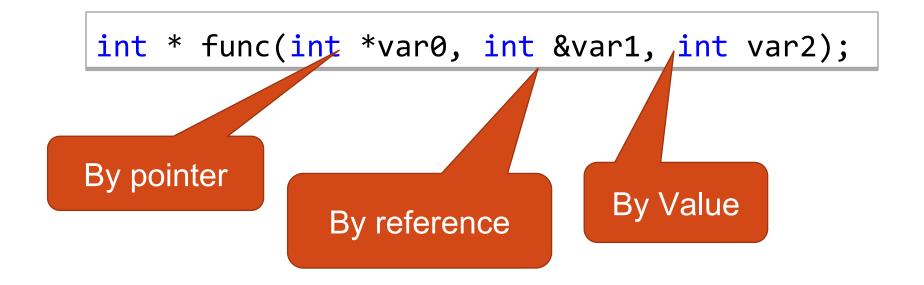
References – two definitions

- (a) A pointer that is used like an object.
- (b) Alias alternative name to existing object.

Pointer vs. Reference (folder 1)

	Pointer	Reference
Initialization	Optional	Mandatory
Dynamic	Yes	No
Arithmetic	Yes	No
Always defined	No	Yes
Notation	(*p), p->x	r, r.x
Containers	Yes	No

Three ways to pass arguments



Lvalue & Rvalue

```
Lvalue = Left Value – can appear at left side of =.
      = Located Value - has a fixed memory location.
        Examples: variables, references ...
Rvalue = not Left Value. Numbers, temporaries ...
int a=1;
a=5; // Lvalue = Rvalue, Ok
a=a; // Lvalue = Lvalue, Ok
5=a; // Rvalue = Lvalue Comp. error
5=5; // Rvalue = Rvalue Comp. error
a+5=7; // Temporary = Rvalue - Comp. error
f(5)=7; // RIDDLE: Is this legal?
```

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a+5=7; // Temporary = Rvalue - Comp. error
f(5)=7; // .. it depends: we will see soon.
```

R/L value and references

non-const Reference – only to a non const Lvalue.

const reference – to both Lvalue and Rvalue

int lv-1:

```
int lv=1;
const int clv=2;
int& lvr1=lv;
int& lvr2=1+l; //error!
int& lvr3=clv; //error! prevents lvr3++;
const int& cr1=clv;
const int& cr2=5+5; // This is useful for
                    // Functions arguments
```

Passing arguments by const reference

```
// Pass by value
                         // pass by ref
void foo (int a)
                         void foo (int &a)
// Pass by pointer
void foo (int *pa)
                         // pass by const ref
                         void foo (const int &a)
```

Avoid copying objects
 without allowing changes in their value.

Parameter passing

By value	By reference	By const reference
void f (Point x) {}	void f (Point& x) {}	void f (const Point& x) {}
x is copied	x is not copied	x is not copied
Compiler lets f modify x, but changes have no effect outside	f can modify x	compiler does not let f modify x

```
void add(Point& a, Point b)
  // a is reference, b is a copy
  a._x += b._x;
  a._y += b._y;
int main()
  Point p1(2,3), p2(4,5);
   add(p1,p2); // note: we don't send pointers!
          // p1 is now (6,8)
```

```
void add(Point& a, const Point& b)
   // a is reference,

    b is Reference => is not copied

   // b is a const ref
                                 b is Const => we can't
   a._x+=b._x;
                                 change it
   a. y+= b. y;

    Important for large objects!

int main()
   Point p1(2,3), p2(4,5);
   add(p1,p2); // note: we dont send pointers!
         // p1 is now (6,8)
```

Return a reference to variable (folder 2)

```
class Buffer
   size t length;
   int * buf;
public:
   Buffer (size_t 1) :
   length (1),
   buf (new int [1])
   int& get(size_t i)
      return _buf[i];
```

```
int main ()
{
    Buffer buf(5);
    buf.get(0)= 3;
    int& x = buf.get(0);
    x++;
}
```

Return a ref. to a legal variable (e.g. not on the function stack).

Return a reference from a function (folder 2)

- Don't return a reference to a local variable.
- You can return a reference to a variable that will survive the function call, e.g:
 - A heap variable (allocated with new).
 - A variable from a lower part of the stack.
 - Globals.
 - Class members.
 - *this (Useful for call-chaining).

Call chaining

```
Point& add(Point& a, const Point& b) {
   a. x+=b. x;
  a. y+=b.y;
   return a;
int main() {
  Point p1(2,3), p2(4,5), p3(1,1);
                      // now p1 is (7,9)
  add(add(p1,p2),p3);
   cout << add(p1,p2).getX(); // note the syntax</pre>
```

```
Call chaining (2)
class Point {
   int x, y;
   Point& add (const Point& b) {
      a. x+=b. x; a. y+=b. y;
      return *this;
int main() {
   Point p1(2,3), p2(4,5), p3(1,1);
   p1.add(p2).add(p3); // now p1 is (7,9)
   cout << p1.add(p2).getX();</pre>
```