Using Objects

Object-Oriented Programming with C++

Safe way to read a string in?

std::string

The string class

- You must add this at the head of you code
  - `#include <string>`
- Define variable of string like other types
  - `string str;`
- Initialize it w/ string contant
  - `string str = "Hello";`
- Read and write string w/ cin/cout
  - `cin >> str;`
  - `cout << str;`

Assignment for string

```
char char1[20];
char char2[20] = "jaguar";

string str1;
string str2 = "panther";

char1 = char2; // illegal
str1 = str2;   // legal
```

Concatenation for string

- `string str3;`
- `str3 = str1 + str2;`
- `str1 += str2;`
- `str1 += "lalala";`

Ctors

- string (const char *cp, int len);
- string (const string& s2, int pos);
- string (const string& s2, int pos, int len);

Sub-string

- substr (int pos, int len);

Alter string

- assign (…);
- insert (…);
- insert (int pos, const string& s);
- erase (…);
- append (…);
- replace (int pos, int len, const string& s);

Search string

- find (const string& s);

File I/O

- #include <ifstream>   // read from file
- #include <ofstream>   // write to file

```
ofstream File1("C:\\test.txt");
File1 << "Hello world" << std::endl;

ifstream File2("C:\\test.txt");
std::string str;
File2 >> str;
```

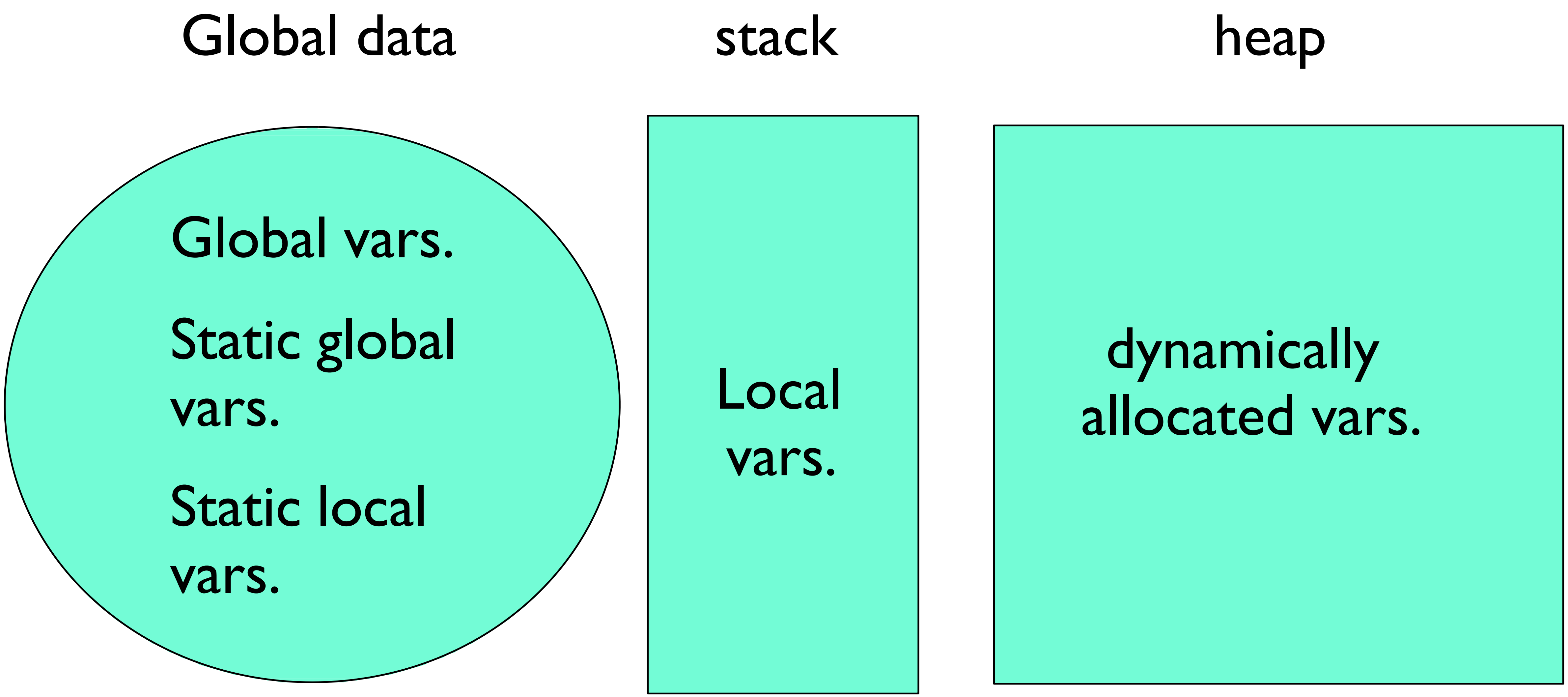
- Assignment 001 on PTA
    - due in 2 weeks

Memory Model

What are they?

```
int i;                  // global vars.

static int j;           // static global vars.

void f() {

  int k;                // local vars.

  static int l;         // static local vars.

  int *p = malloc(sizeof(int)); // allocated vars.

}
```

Where are they?



Global vars

- vars defined outside any functions
- can be shared btw .cpp files
- extern

Extern

- extern is a declaration says there will be such a variable somewhere in the whole program
- “such a” means the type and the name of the variable
- global variable is a definition, the place for that variable

Static

- static global variable inhibits access from outside the .cpp file
- so as the static function

Static local var

- static local variable keeps value btw visit to the function
- is initialized at its first access

Static

- for global stuff: access restriction
- for local stuff: persistence

Pointers to Objects

Pointers to Objects

- string s = “hello”;
- string* ps = &s;

Operators with Pointers

- &: get address
  - ps = &s;
- *: get the object
  - (*ps).length()
- ->: call the function
  - ps->length()

Two Ways to Access

- string s;
  - s is the object itself
- string *ps;
  - ps is a pointer to an object

- string s;
  - At this line, object s is created and initialized
- string *ps;
  - At this line, the object ps points to is not known yet.

Assignment

- string s1, s2;
  - s1 = s2;
- string *ps1, *ps2;
  - ps1 = ps2;

Dynamically Allocated Memory

Dynamic memory allocation

- **new**
  - new int;
  - new Stash;
  - new int[10]
- **delete**
  - delete p;
  - delete[] p;

new and delete

- **new** is the way to allocate memory as a program runs. Pointers become the only access to that memory.
- **delete** enables you to return memory to the memory pool when you are finished with it.

Dynamic arrays

```
int *psome = new int[10];
```

- The new operator returns the address of the first element of the block.

```
delete[] psome;
```

- The presence of the brackets tells the program that it should free the whole array, not just the element

The new-delete mech.

```
int *p=new int;

int *a=new int[10];
```

```
Student *q=new Student();

Student *r=new Student[10];
```

The new-delete mech.

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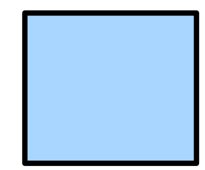

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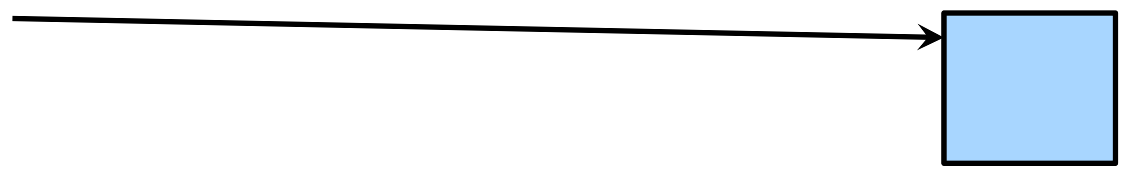

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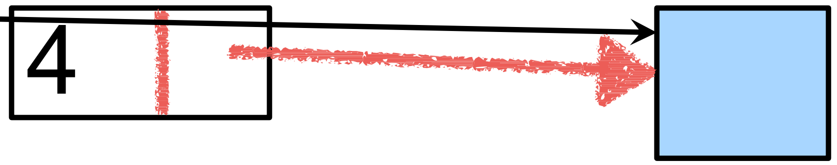


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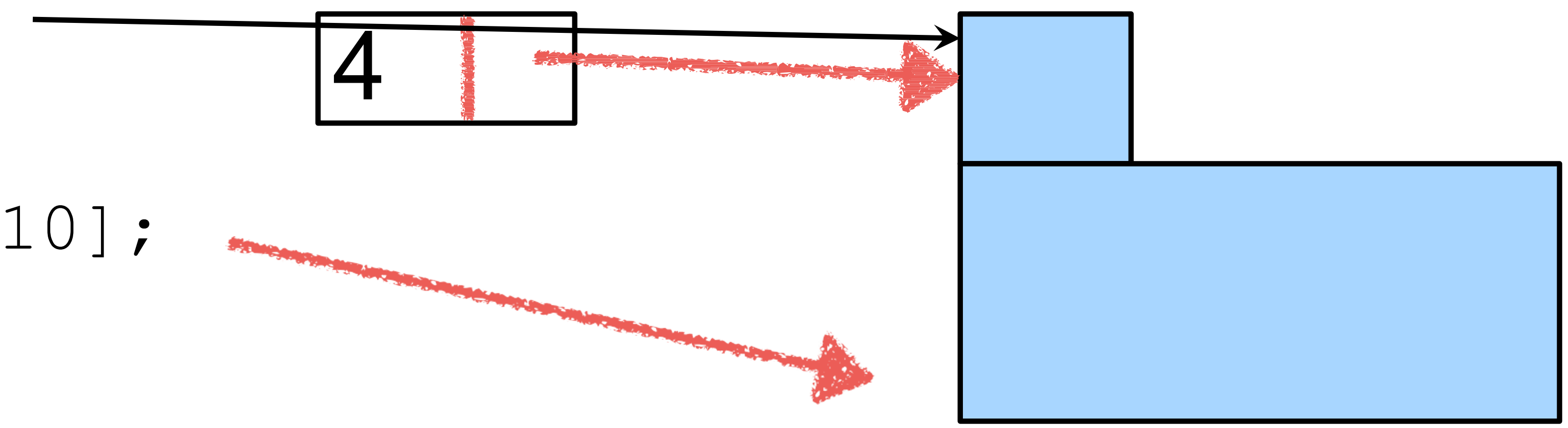


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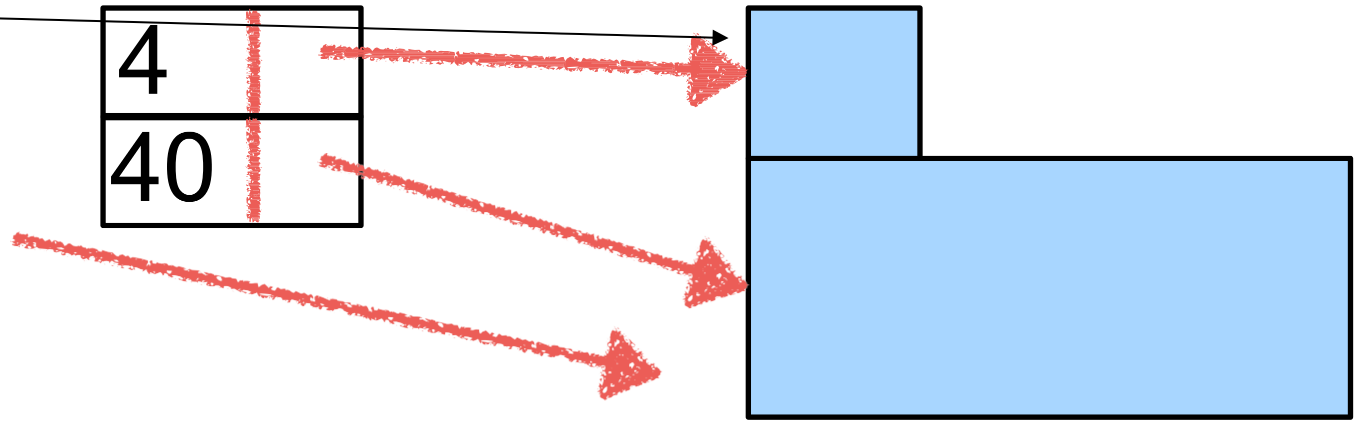


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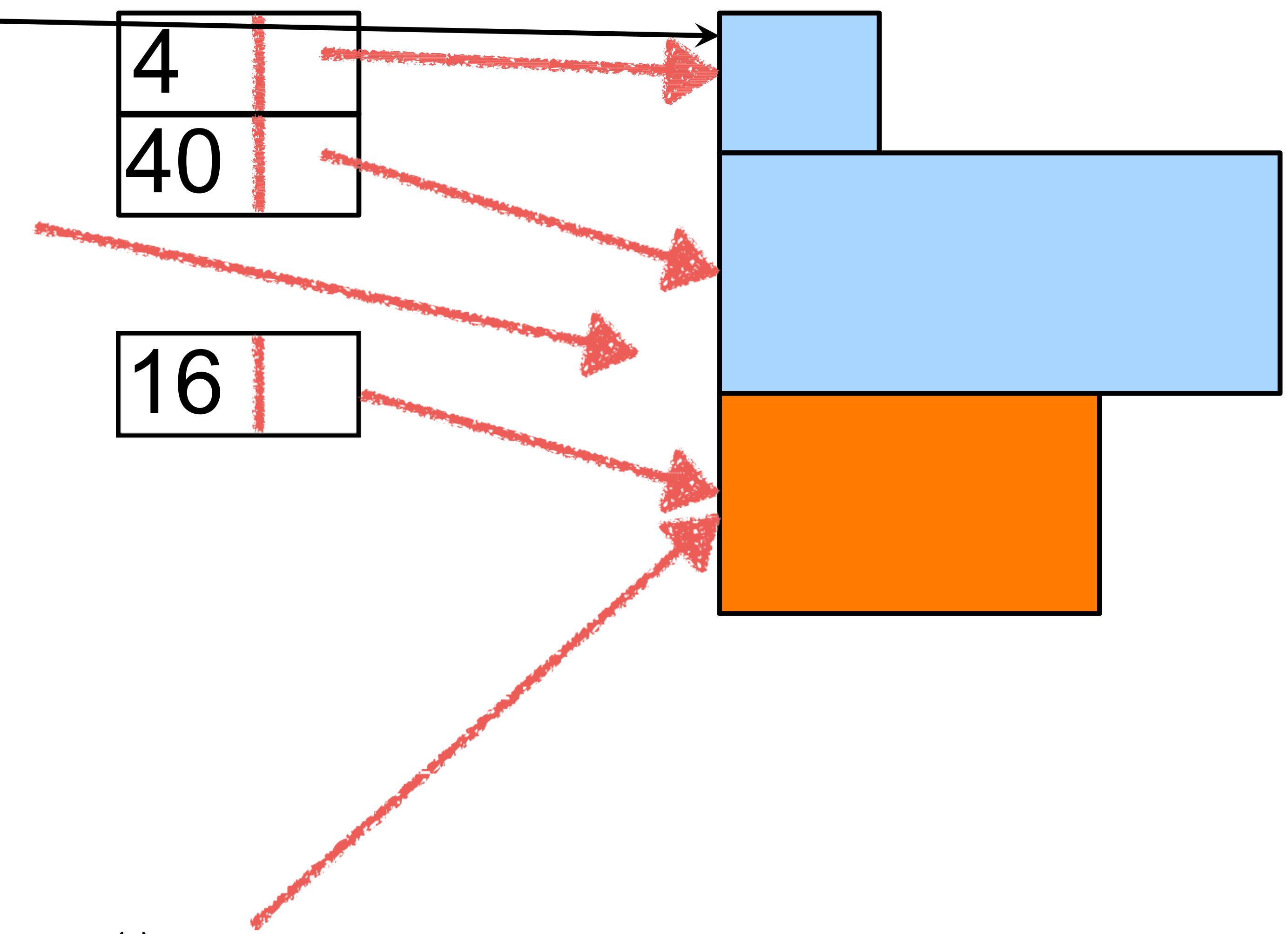


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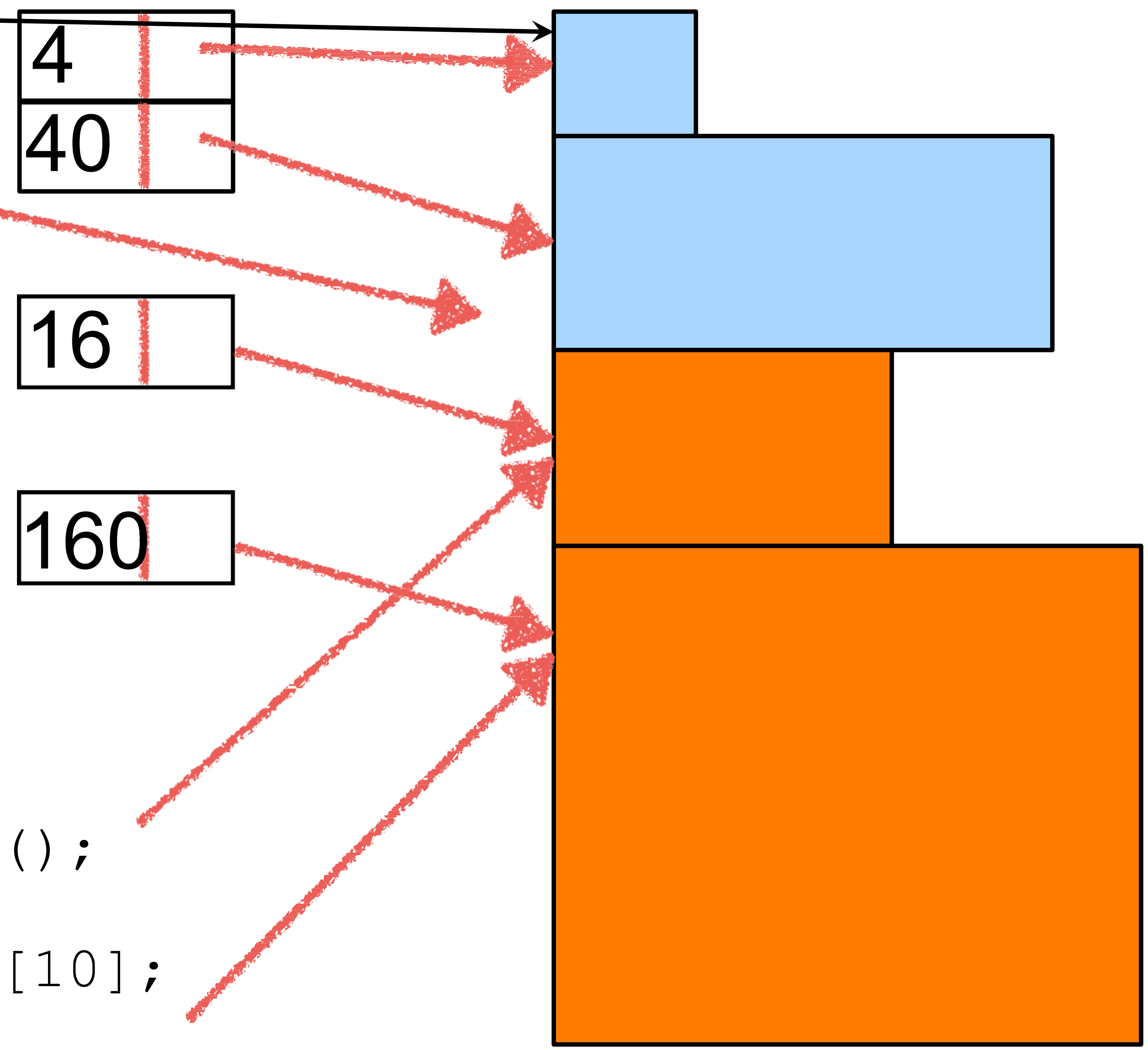


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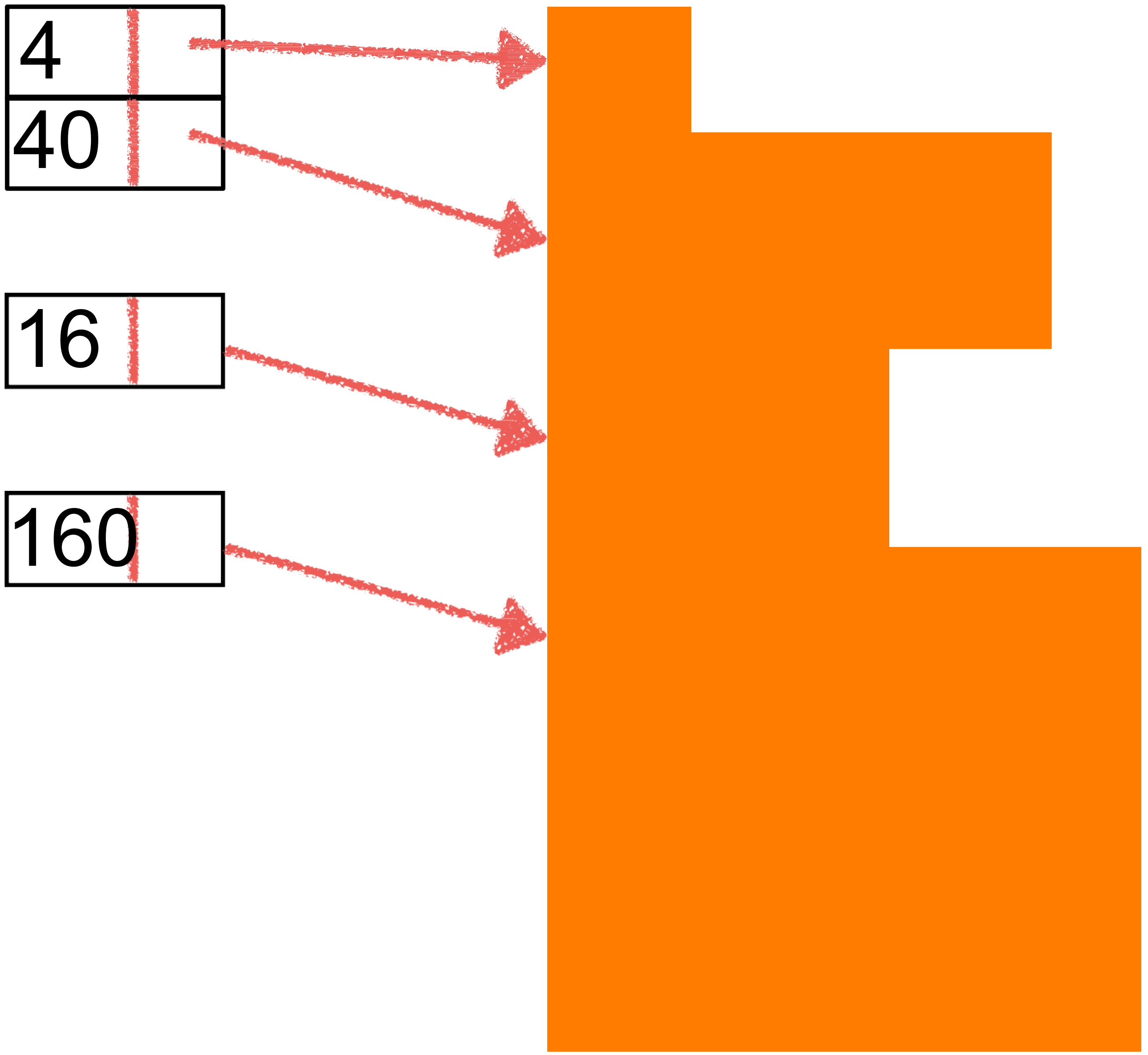

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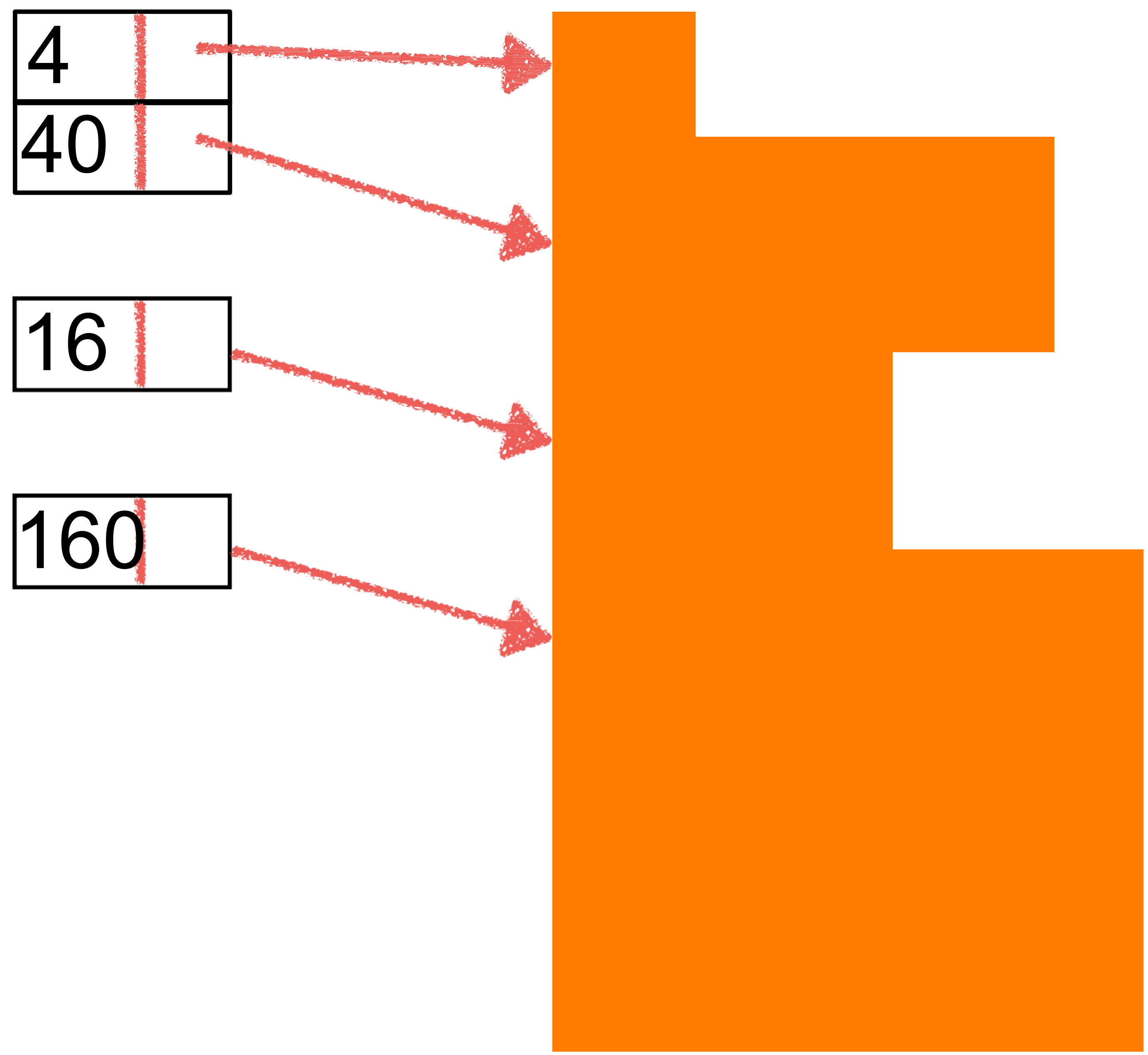

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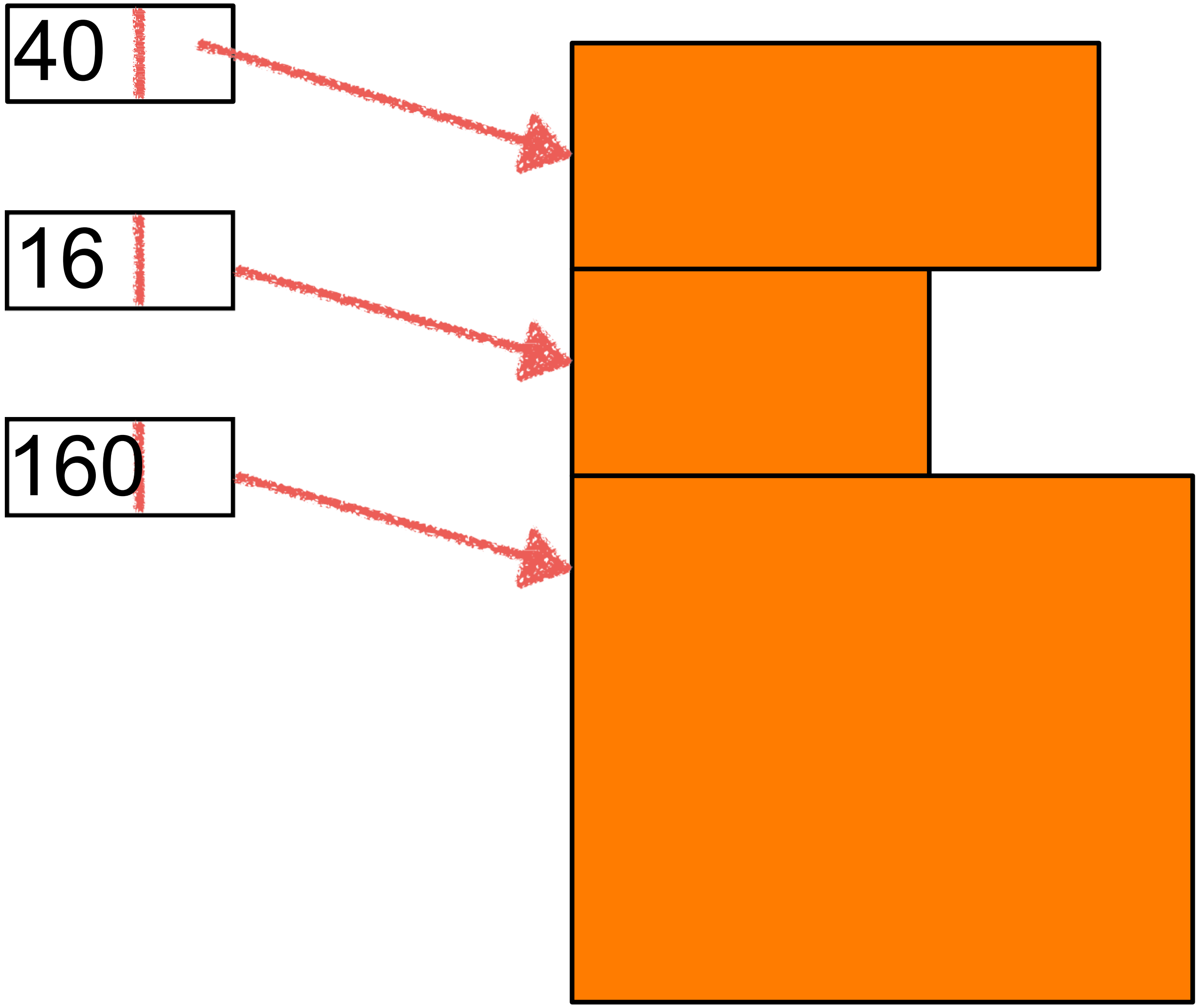

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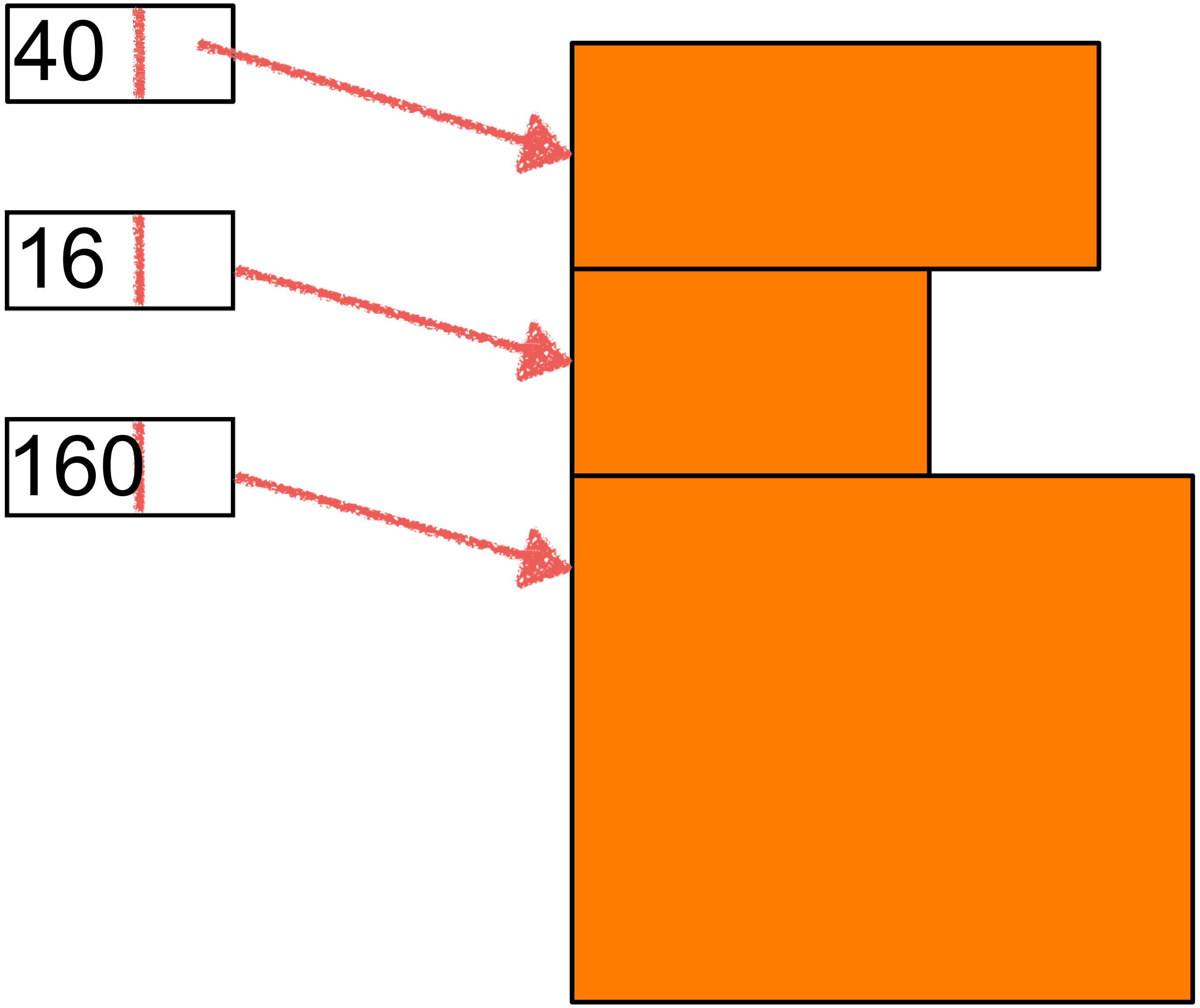

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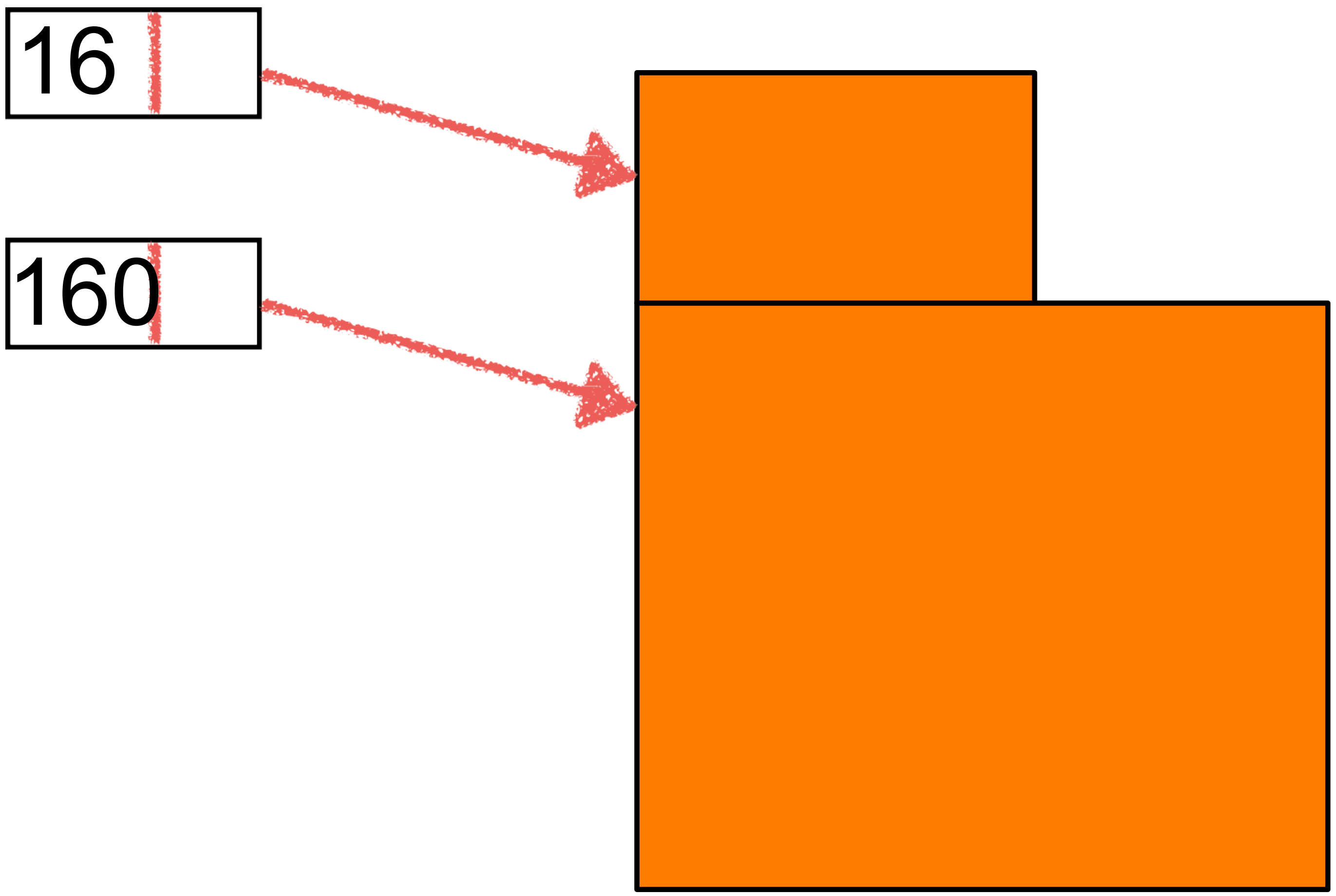

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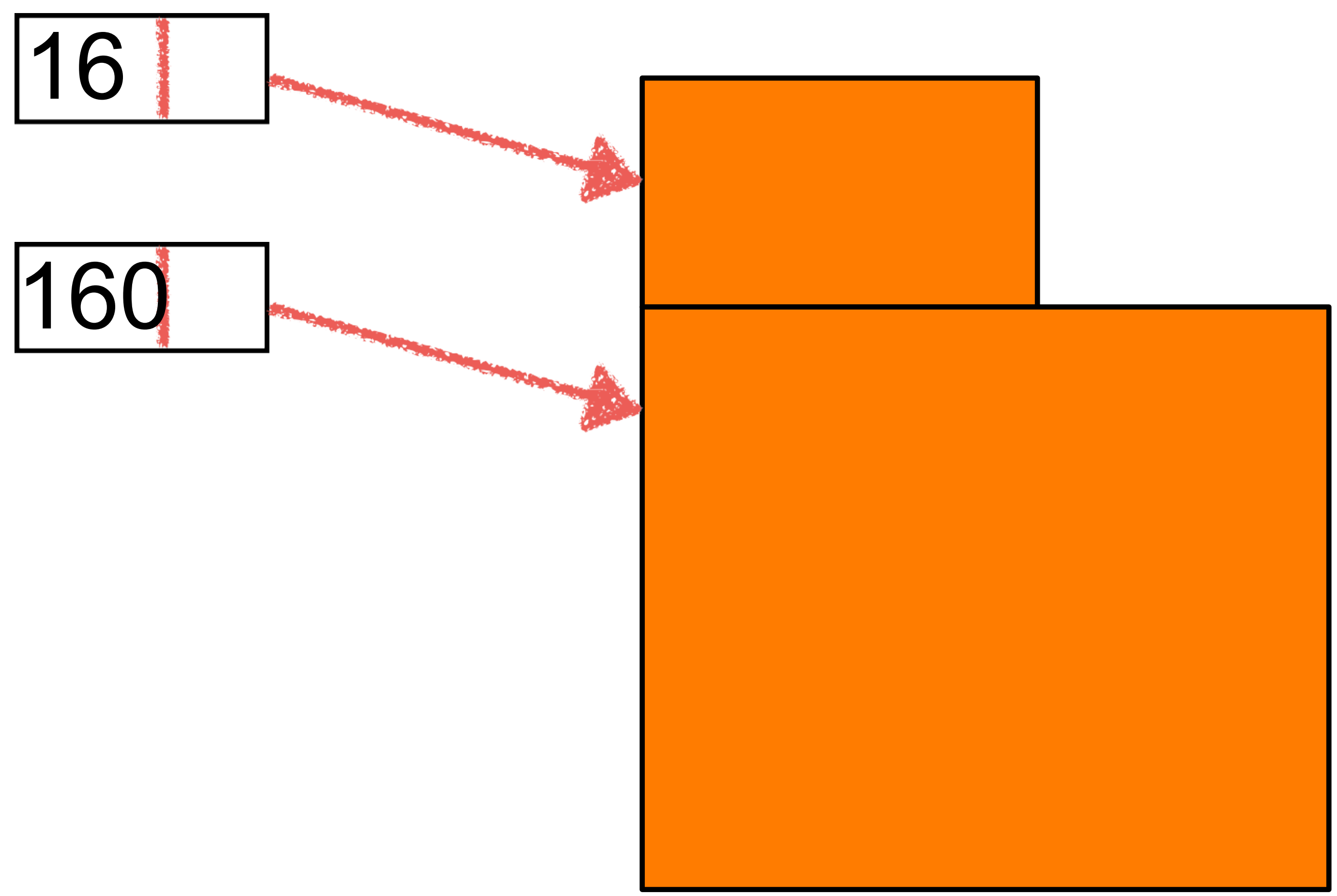

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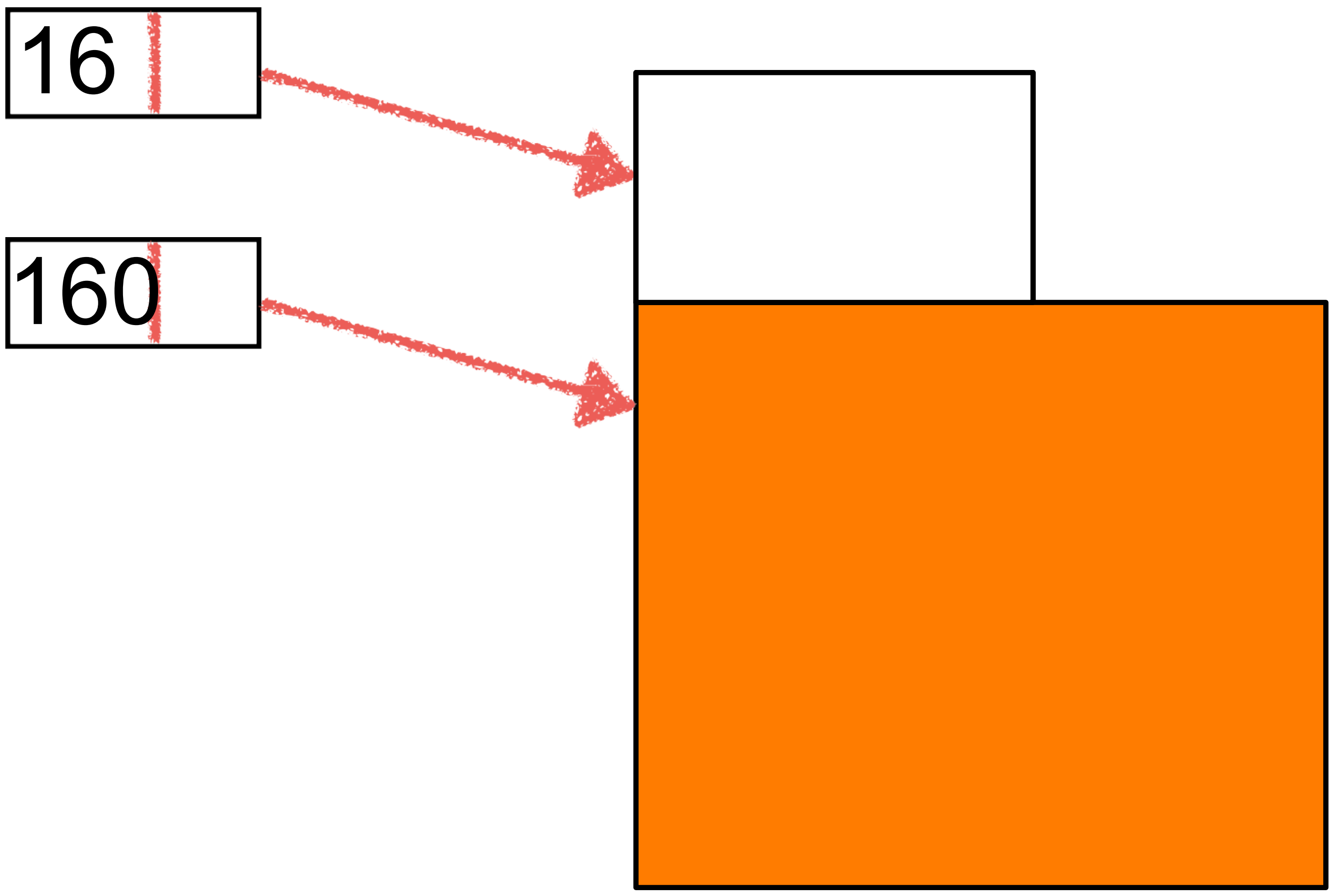

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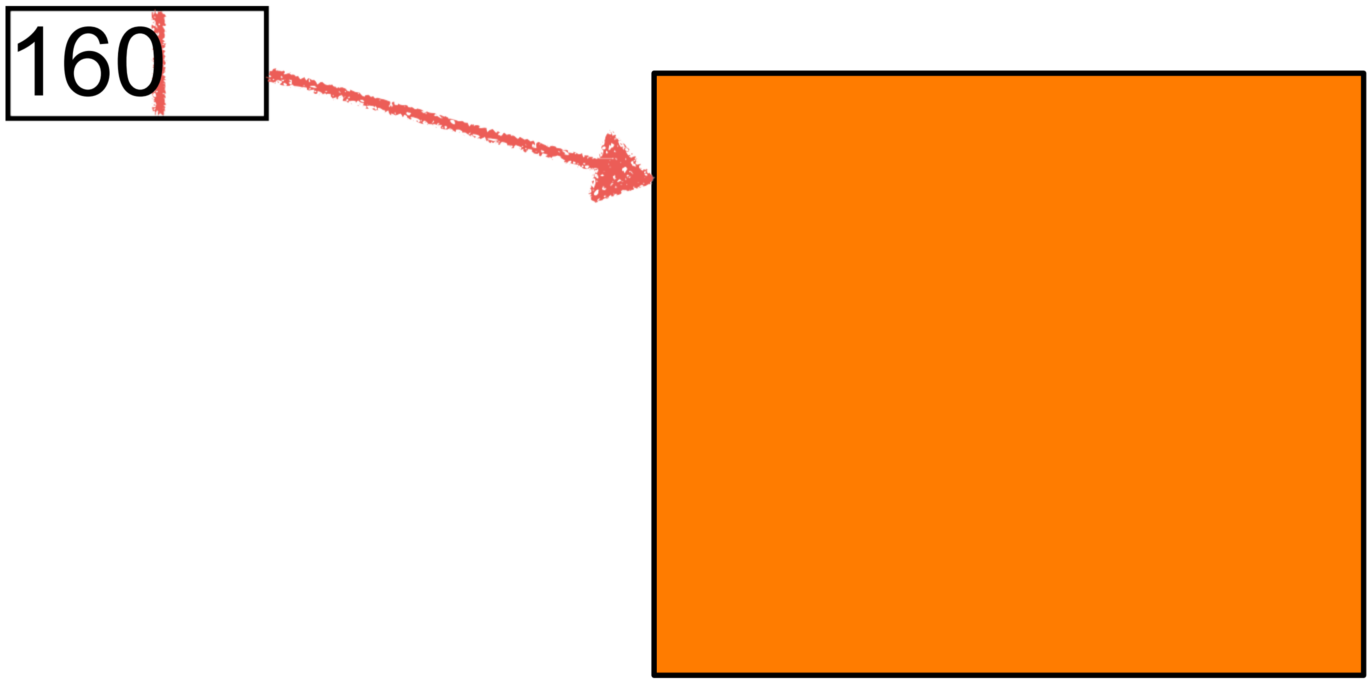

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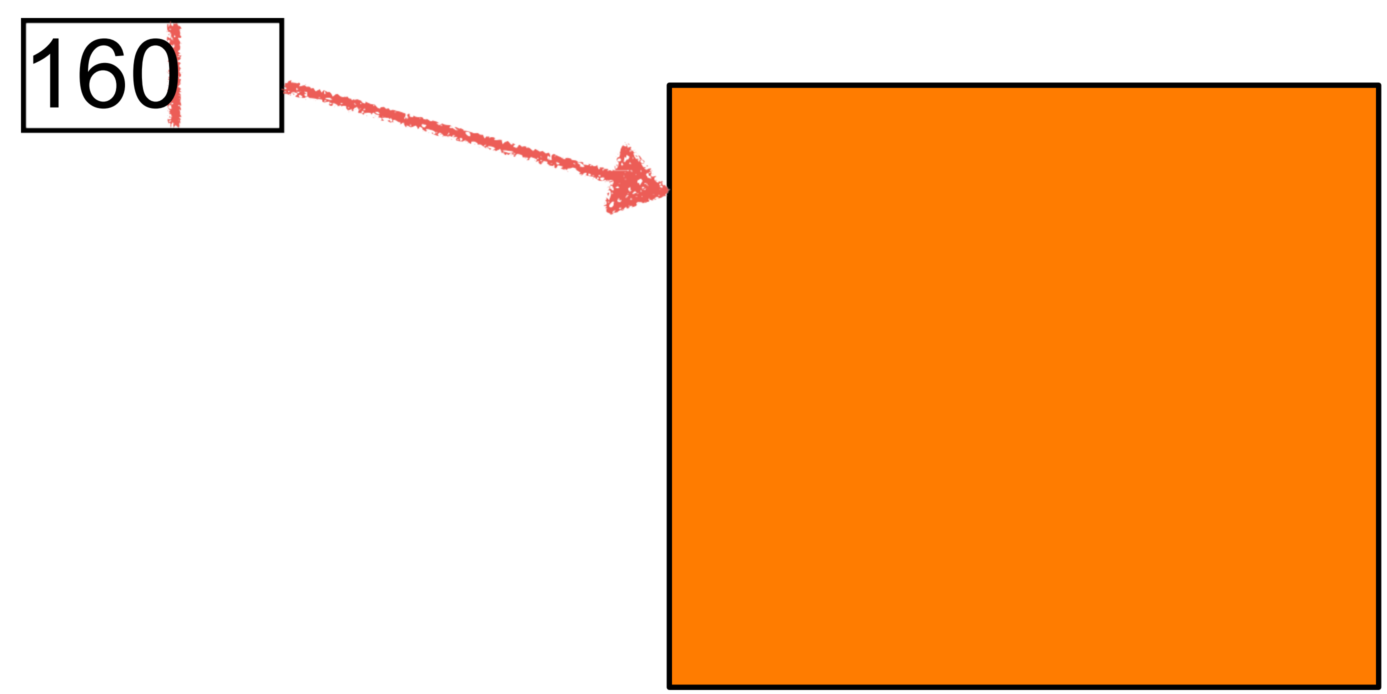

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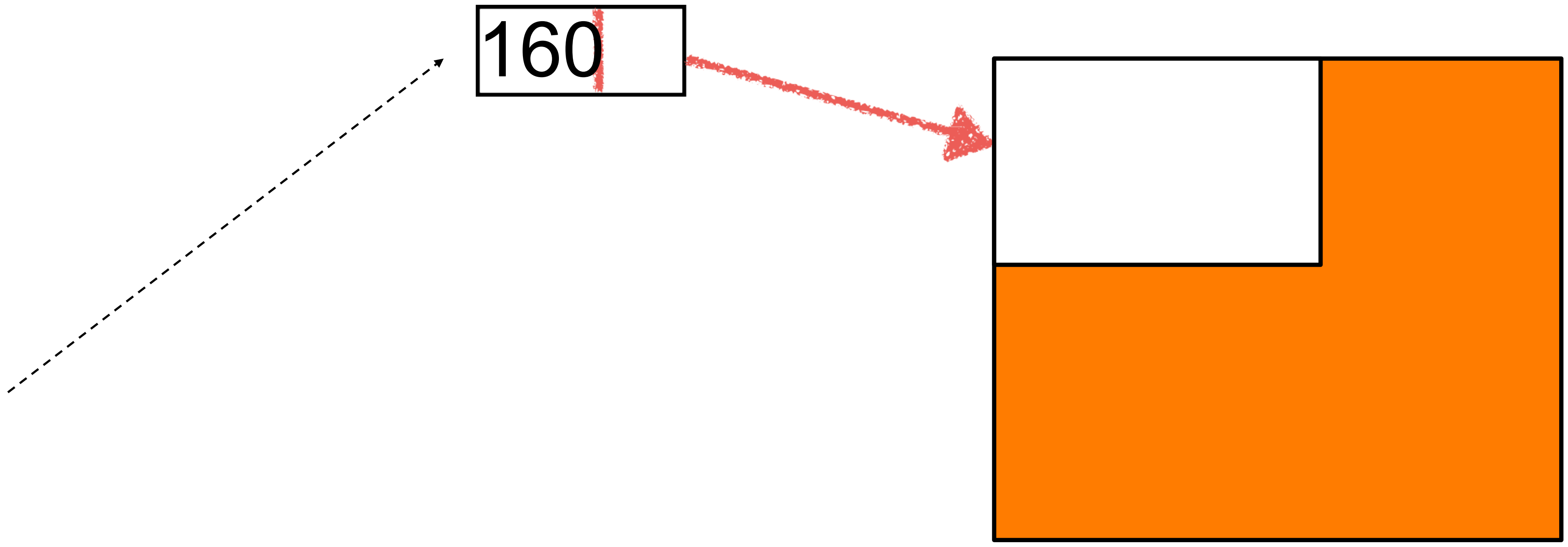

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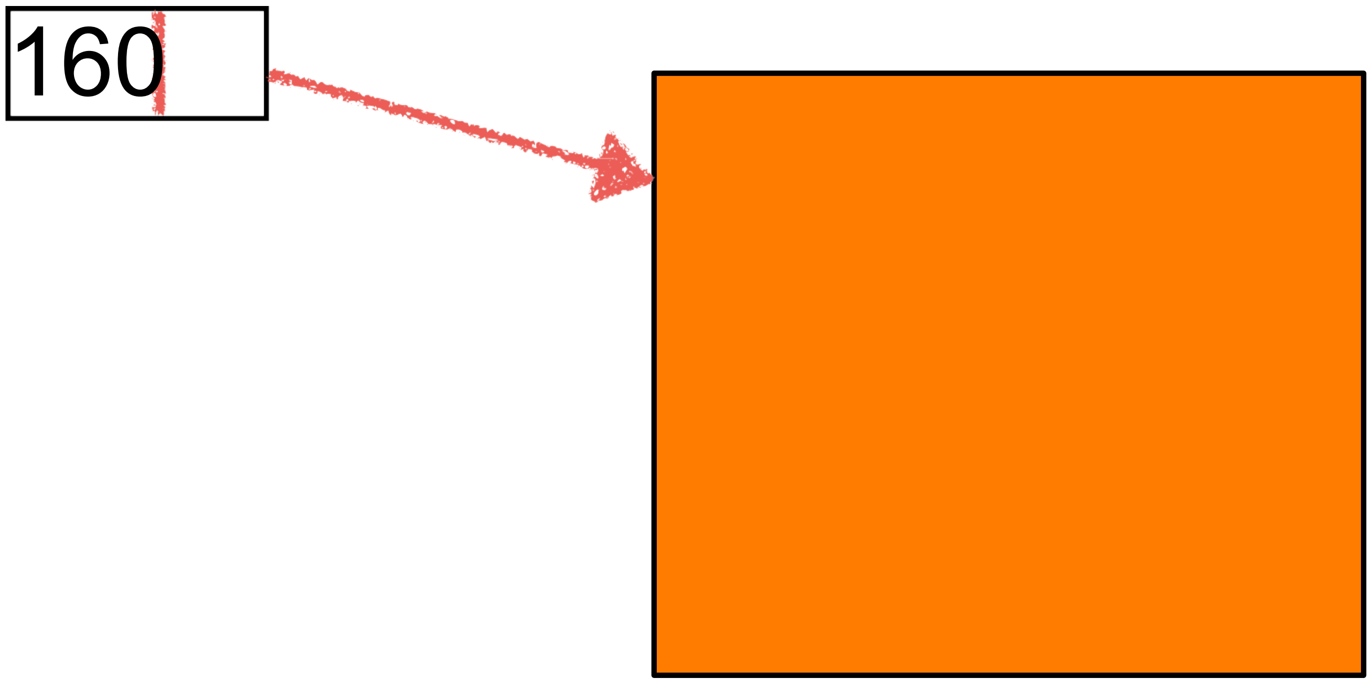

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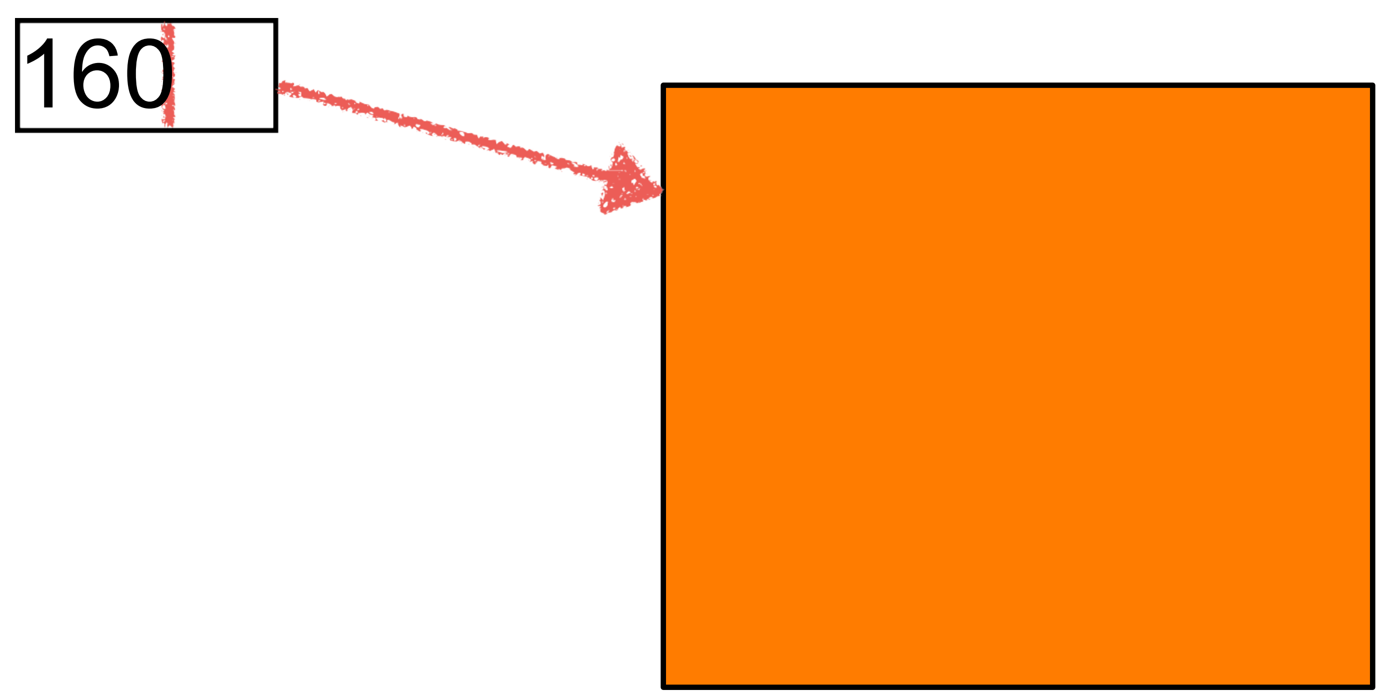

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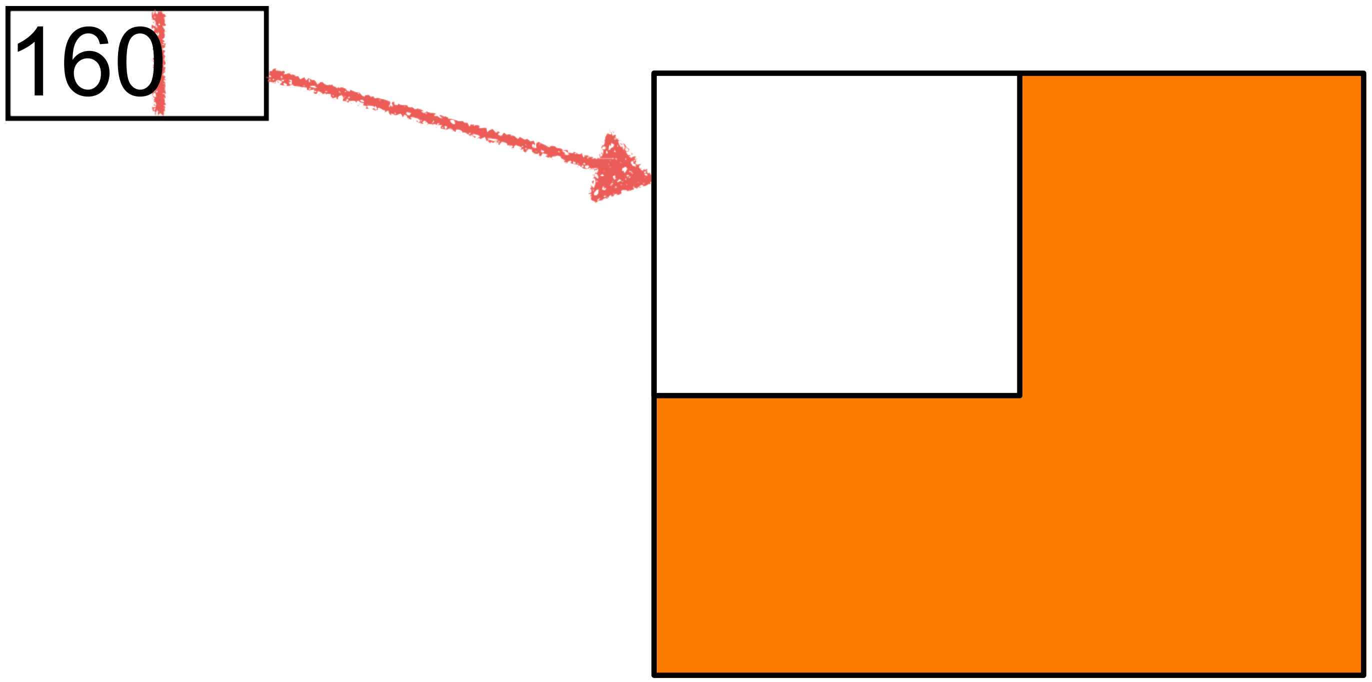

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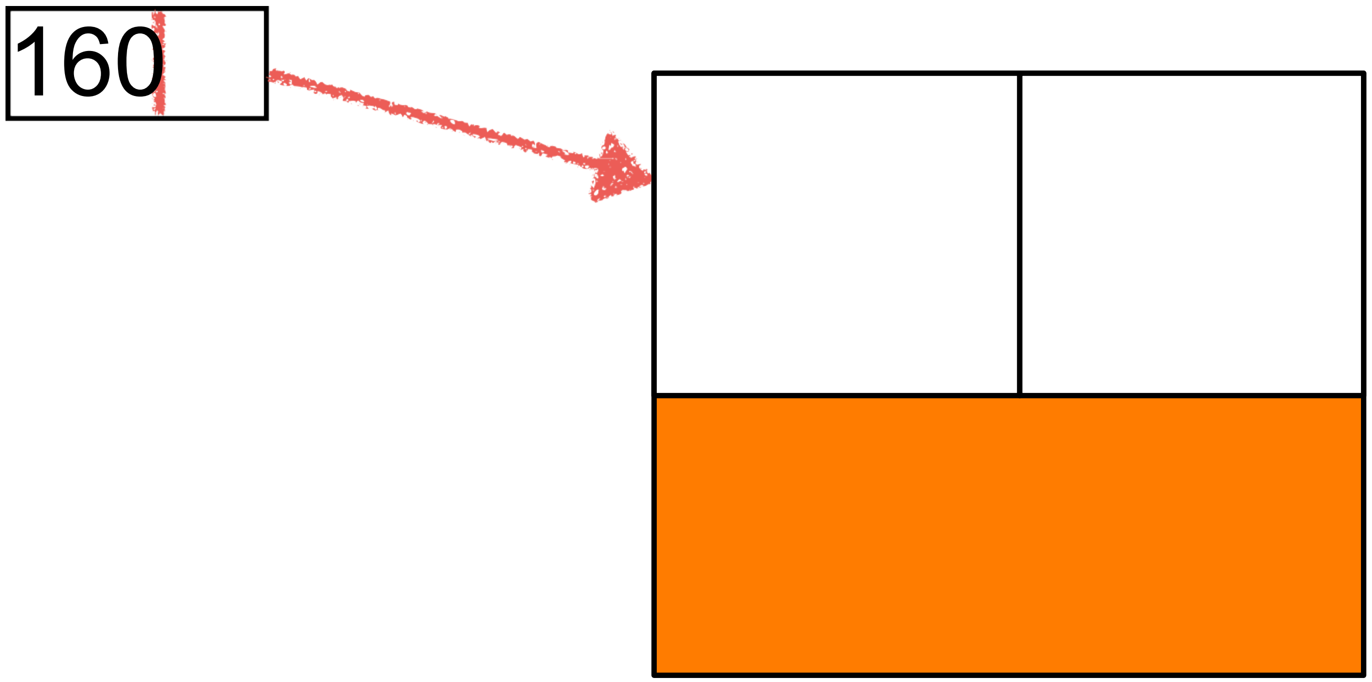

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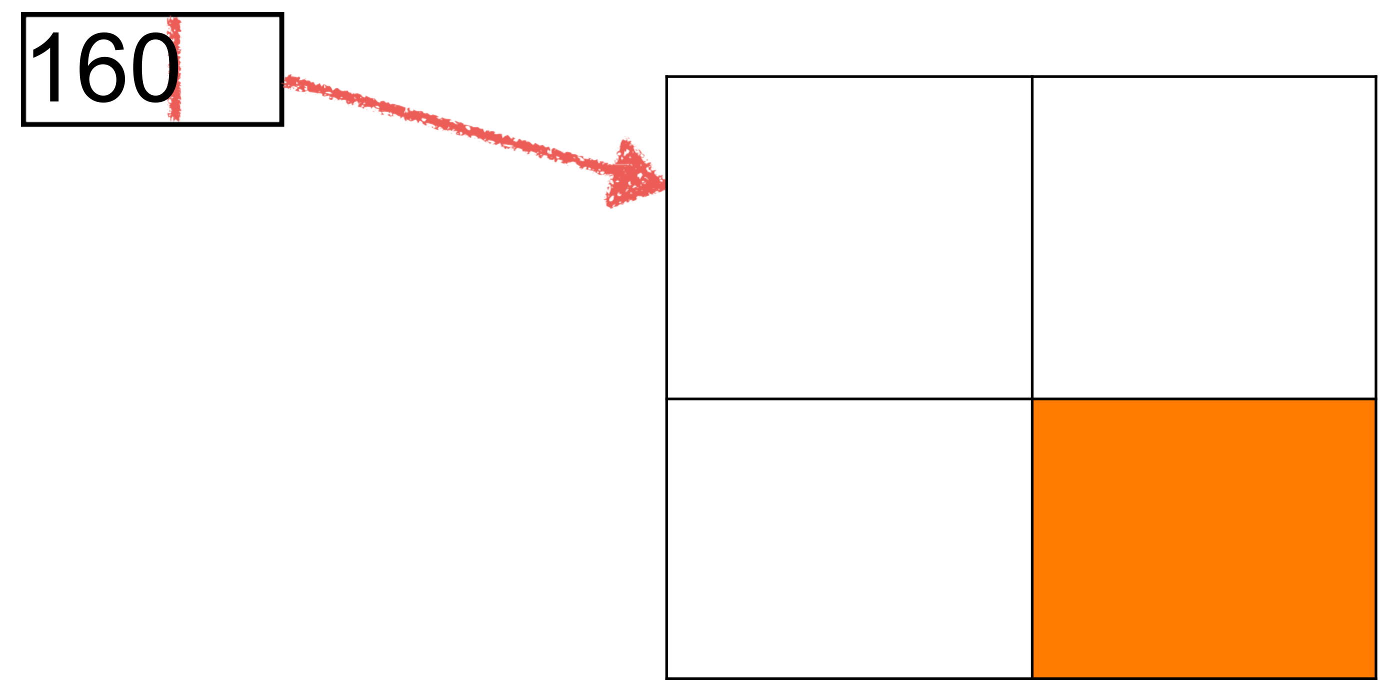

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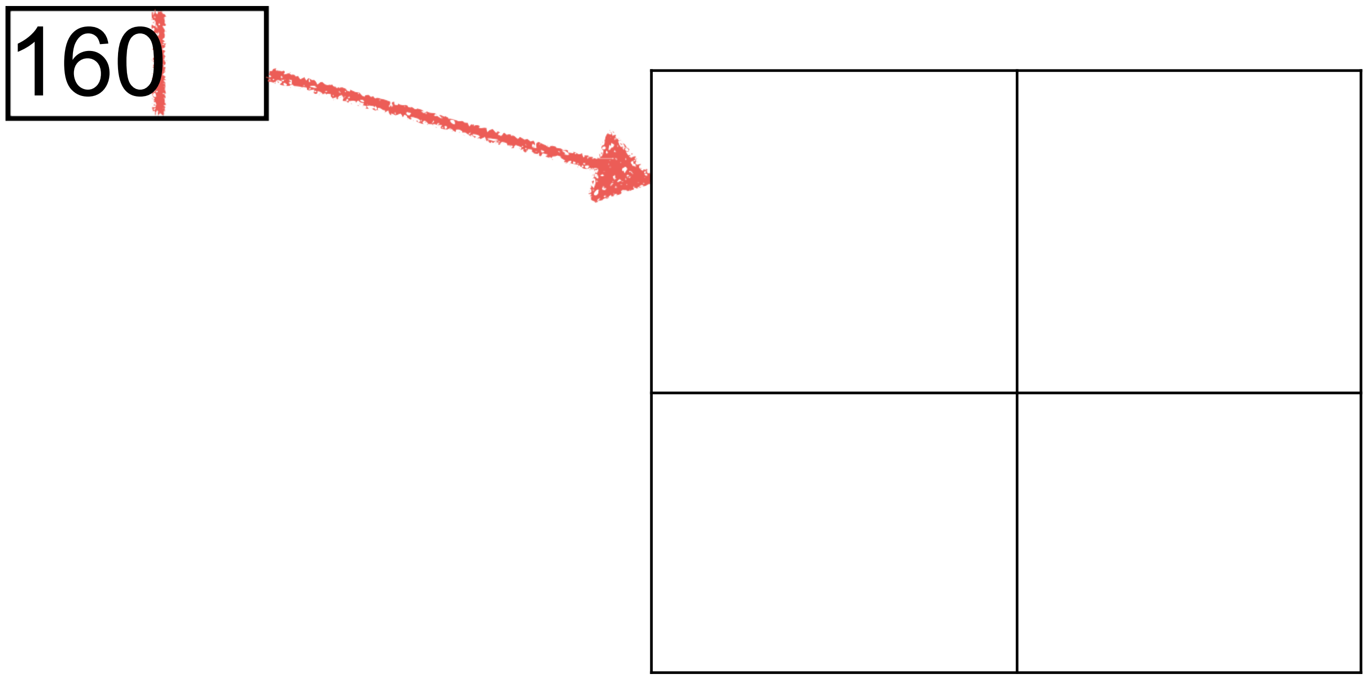

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Tips for new and delete

- Don't use delete to free memory that new didn't allocate.
- Don't use delete to free the same block of memory twice in succession.
- Use delete [] if you used new [] to allocate an array.
- Use delete (no brackets) if you used new to allocate a single entity.
- It's safe to apply delete to the null pointer (nothing happens).

Reference

Declaring references

Declaring references

- References are a new data type in C++
  - `char c;         // a character`
  - `char* p = &c; // a pointer to a character`
  - `char& r = c;  // a reference to a character`
- Local or global variables
  - *type*& *refname* = name;
  - For ordinary variables, the initial value is required
- In parameter lists and member variables
  - *type*& *refname*
  - Binding defined by caller or constructor

References

- Declares a new *name* for an *existing* object

```
int  X = 47;
int& Y = X; // Y is a reference to X


// X and Y now refer to the same variable
cout << "Y = " << Y;  // prints Y = 47
Y = 18;
cout << "X = " << X;  // prints X = 18
```

Rules of references

- References must be initialized when defined
- Initialization establishes a binding
  - In declaration

```
int x = 3;
int& y = x;
const int& z = x;
```

  - As a function argument

```
void f ( int& x );

f(y); // initialized when function is called
```

Rules of references

Rules of references

- Bindings don’t change at run time, unlike pointers

Rules of references

- Bindings don't change at run time, unlike pointers
- Assignment changes the object referred-to

```
int& y = x;

y = 12; // Changes value of x
```

- The target of a reference must have a location!

```
void func(int &);

func (i * 3);   // Warning or error!
```

Pointers vs. References

- References
  - can't be null
  - can't change to a new "address" location
  - are dependent on an existing variable, they are an alias for an variable
- Pointers
  - can be set to null
  - can change to point to a different address
  - pointer is independent of existing objects

Restrictions

Restrictions

- No references to references

Restrictions

- No references to references
- No pointers to references

```
int&* p;          // illegal
```

  - Reference to pointer is ok

```
void f(int*& p);
```

- No arrays of references

const

const

- declares a *variable* to have a constant value

```
const int x = 123;
x = 27; // illegal!
x++; // illegal!

int y = x; // Ok, copy const to non-const

y = x;      // Ok, same thing

const int z = y; // ok, const is safer
```

Constants

Constants

- Constants are like variables
  - Observe scoping rules
  - Declared with “const” type modifier

Constants

- Constants are like variables
  - Observe scoping rules
  - Declared with "const" type modifier
- A const in C++ defaults to internal linkage
  - the compiler tries to avoid creating storage for a const -- holds the value in its symbol table.
  - extern forces storage to be allocated.

Compile time constants

```
const int bufsize = 1024;
```

- Value must be initialized
- Unless you make an explicit extern declaration:

```
extern const int bufsize = 1024;
```

- Compiler won't let you change it

- Compile time constants are entries in compiler symbol table, not really variables.

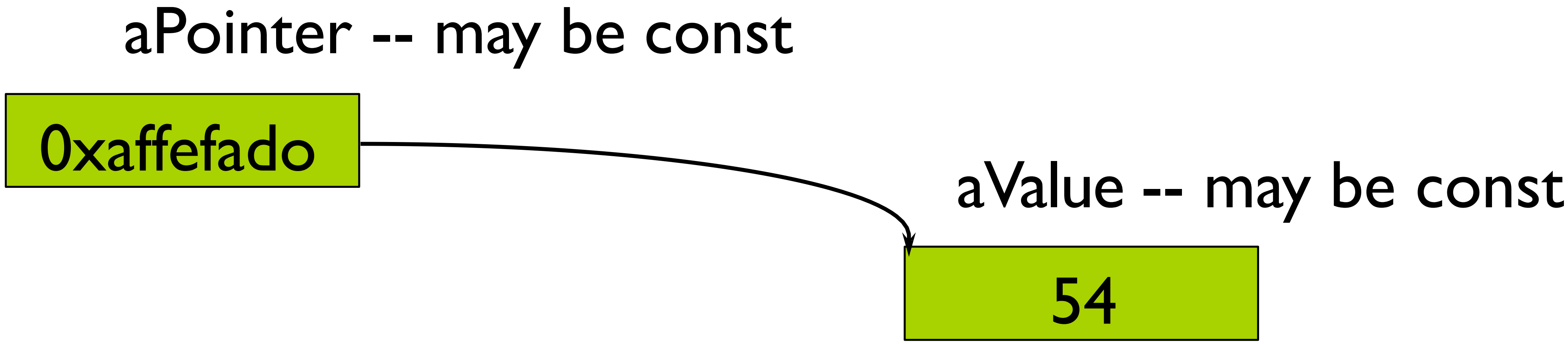
Run-time constants

- const value can be exploited

```
const int class_size = 12;
int finalGrade[class_size]; // ok

int x;
cin >> x;
const int size = x;
double classAverage[size]; // error!
```

Pointers and const



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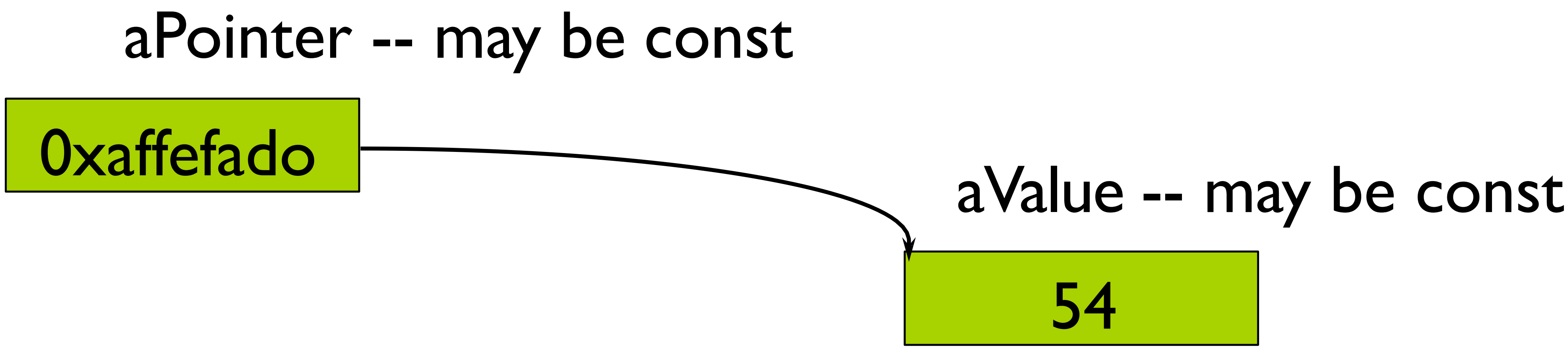

- `char * const q = "abc"; // q is const`
  ```
  *q = 'c'; // OK
  q++;      // ERROR
  ```
- `const char *p = "ABCD";`
  ```
  // (*p) is a const char
  *p = 'b'; // ERROR! (*p) is the const
  ```

Quiz: What are these?

```
string s( "Fred" );
const string* p = &s;
string const* p = &s;
string *const p = &s;
```

Pointers and constants

	`int i;`	`const int ci = 3;`
`int * ip;`	`ip = &i;`	`ip = &ci; //Error`
`const int *cip`	`cip = &i;`	`cip = &ci;`

Remember:

```
*ip  = 54;  // always legal since ip points to int
*cip = 54;  // never legal since cip points to const int
```

String Literals

```
char* s = "Hello, world!";
```

- `s` is a pointer initialized to point to a string constant

- This is actually a `const char* s` but compiler accepts it without the const

- Don't try and change the character values (it is an undefined behavior)

- If you want to change the string, put it in an array:

```
char s[] = "Hello, world!";
```

Conversions

Conversions

- Can always treat a non-const value as const

```
void f(const int* x);

int a = 15;

f(&a); // ok

const int b = a;


f(&b); // ok

b = a + 1; // Error!
```

*You cannot treat a constant object as non-constant without an explicit cast (**const_cast**)*

Passing by const value?

```
void f1(const int i) {
  i++; // Illegal -- compile-time error
}
```

Returning by const value?

```
int f3() { return 1; }

const int f4() { return 1; }

int main() {

  const int j = f3(); // Works fine

  int k = f4(); // But this works fine too!

}
```

Passing addresses

- Passing a whole object may cost you a lot. It is better to pass by a pointer. But it's possible for the programmer to take it and modify the original value.

- In fact, whenever you're passing an address into a function, you should make it a **const** if at all possible.