Review

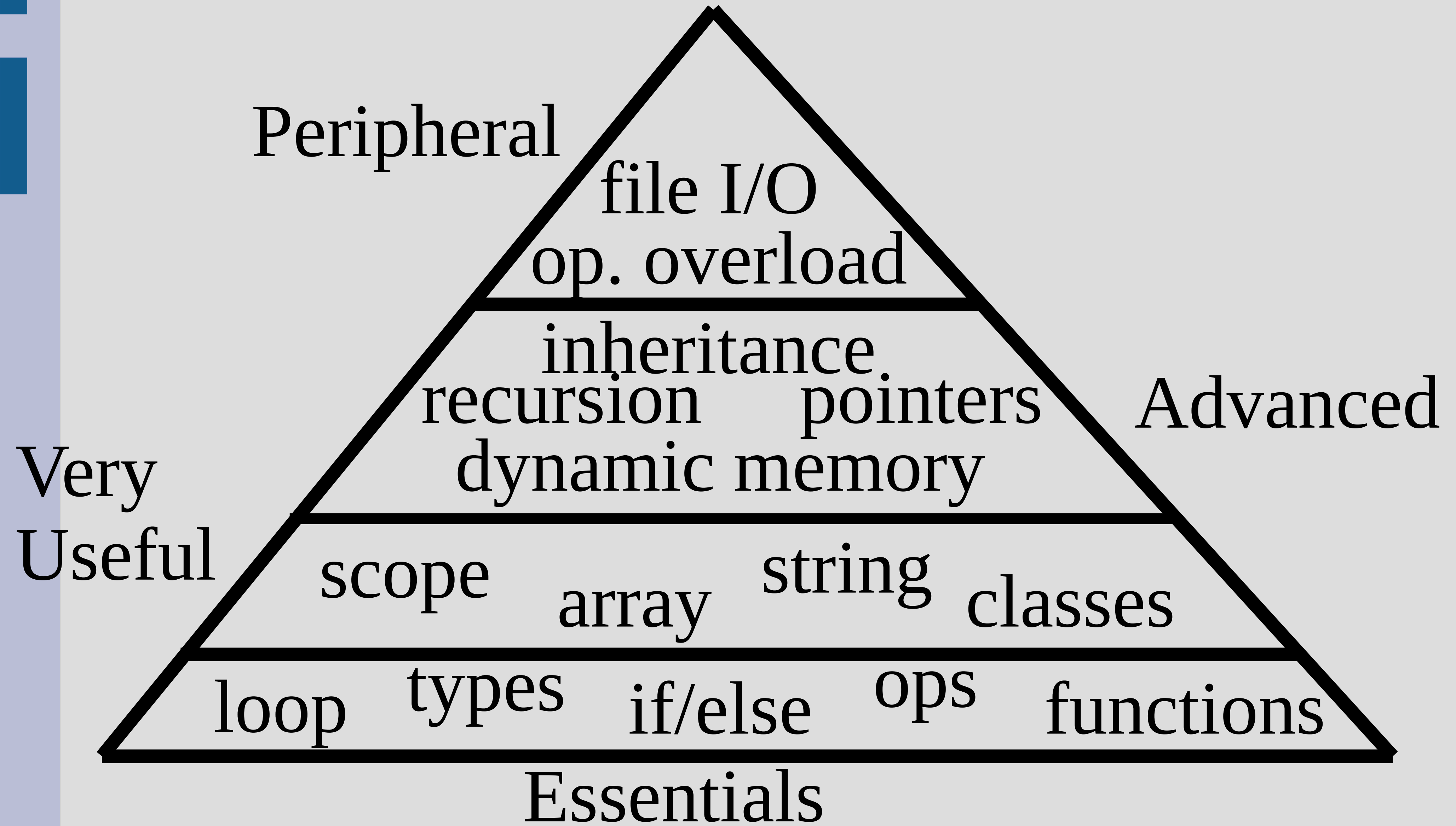
Final exam

Final exam will be 12 problems, drop any 2

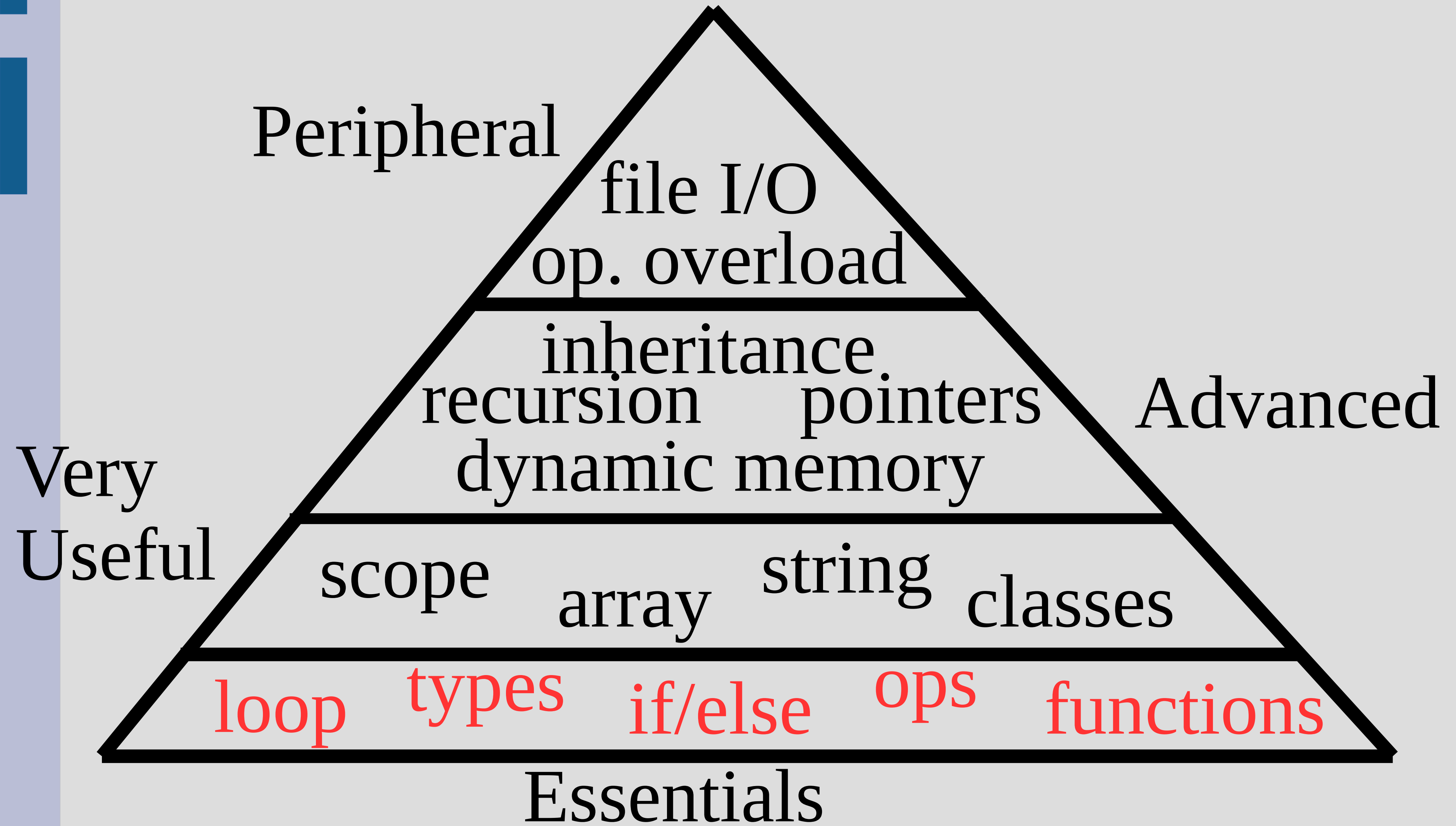
Cumulative up to and including week 14
(emphasis on weeks 9-14: classes & pointers)

2 hours exam time, so 12 min per problem
(midterm 2 had 8-ish)

Review: Overview



Review: Overview



Fundamental Types

bool - true or false
char - (character) A letter or number
int - (integer) Whole numbers
double - Larger decimal numbers

long - (long integers) Larger whole numbers
float - Decimal numbers

Functions

Functions allow you to reuse pieces of code (either your own or someone else's)

Every function has a return type, specifically the type of object returned

sqrt(2) returns a double, as the number will probably have a fractional part

The “2” is an argument to the sqrt function

Functions

return type

function header

```
int add(int x, int y)
{
        return x+y;
}
```

parameters (order matters!)

return statement

body

The return statement value must be the same as the return type (or convertible)

```
int x = add(3,5);
```

3 to x, 5 to y... value 8 returned and stored in x

Functions

Function call stack (after returning, start from where the previous function called it)

Overloading - same function name, different arguments (typically similar)

Call-by-reference (not copy)

```
void changeMe(int &x)
{
    x=2;
}
```

addresses share

Functions should be minimal

Order of operations

Order of precedence (higher operations first):

:: (scope resolution)
functions, . (dot), -> (sorta binary operators)
&, *, -, +, ++, -- and ! (unary operators)
*, / and % (binary operators)
+ and - (binary operators)
==, >=, <= and != (binary operators)
&& and || (binary operators)
=, +=, -=, *=, /=, %= (binary operators)

if/else

-an else statement needs an associated if
-else/if construct ensures only one block is run
-short circuit evaluation

```
if(x != NULL && *x < 10)
{
    cout << "Smaller than 10\n";
}
else
{
    cout << "Bigger than 9\n";
}
```

Loops

3 parts to any (good) loop:

-Test variable initialized `i=0;`

-bool expression `while (i < 10)`

-Test variable updated inside loop `i++;`

3 types of loops:

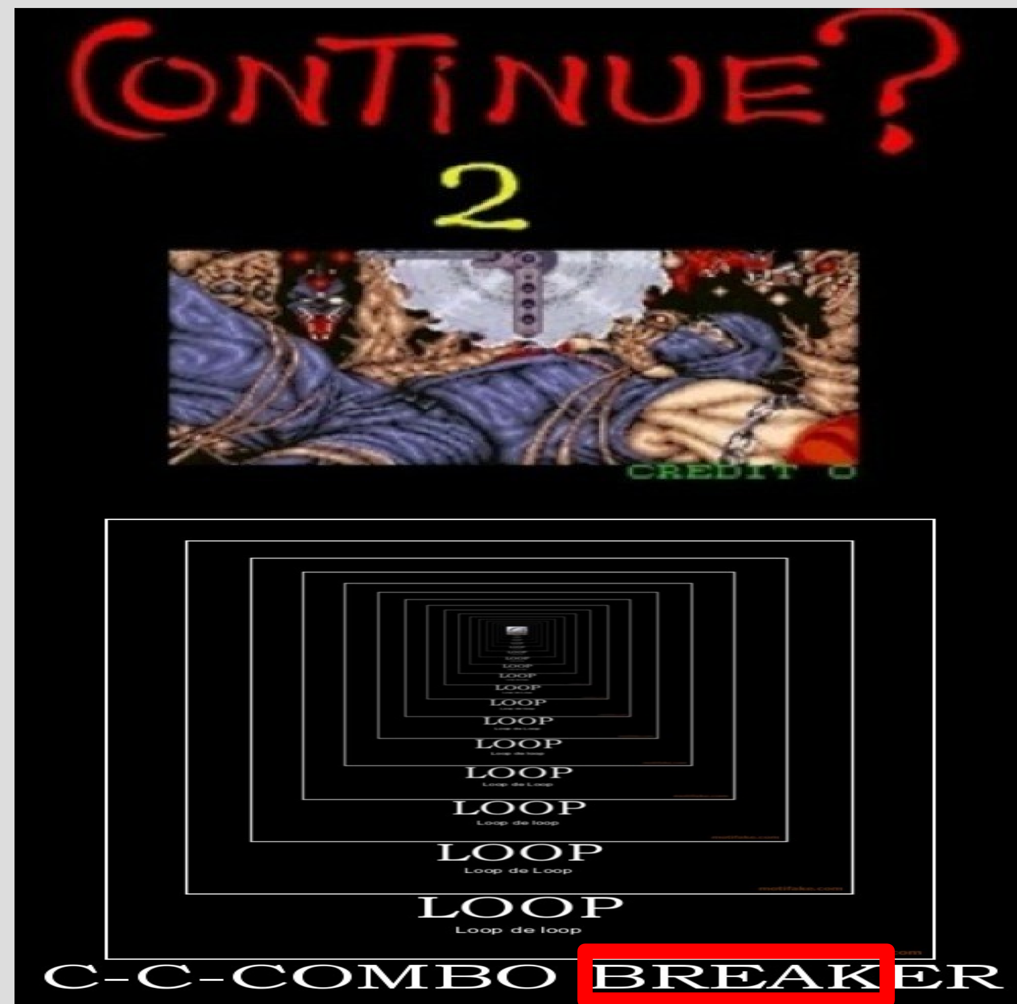
while - general purpose

for - known number of iterations (arrays)

do-while - always run at least once (user input)

continue/break

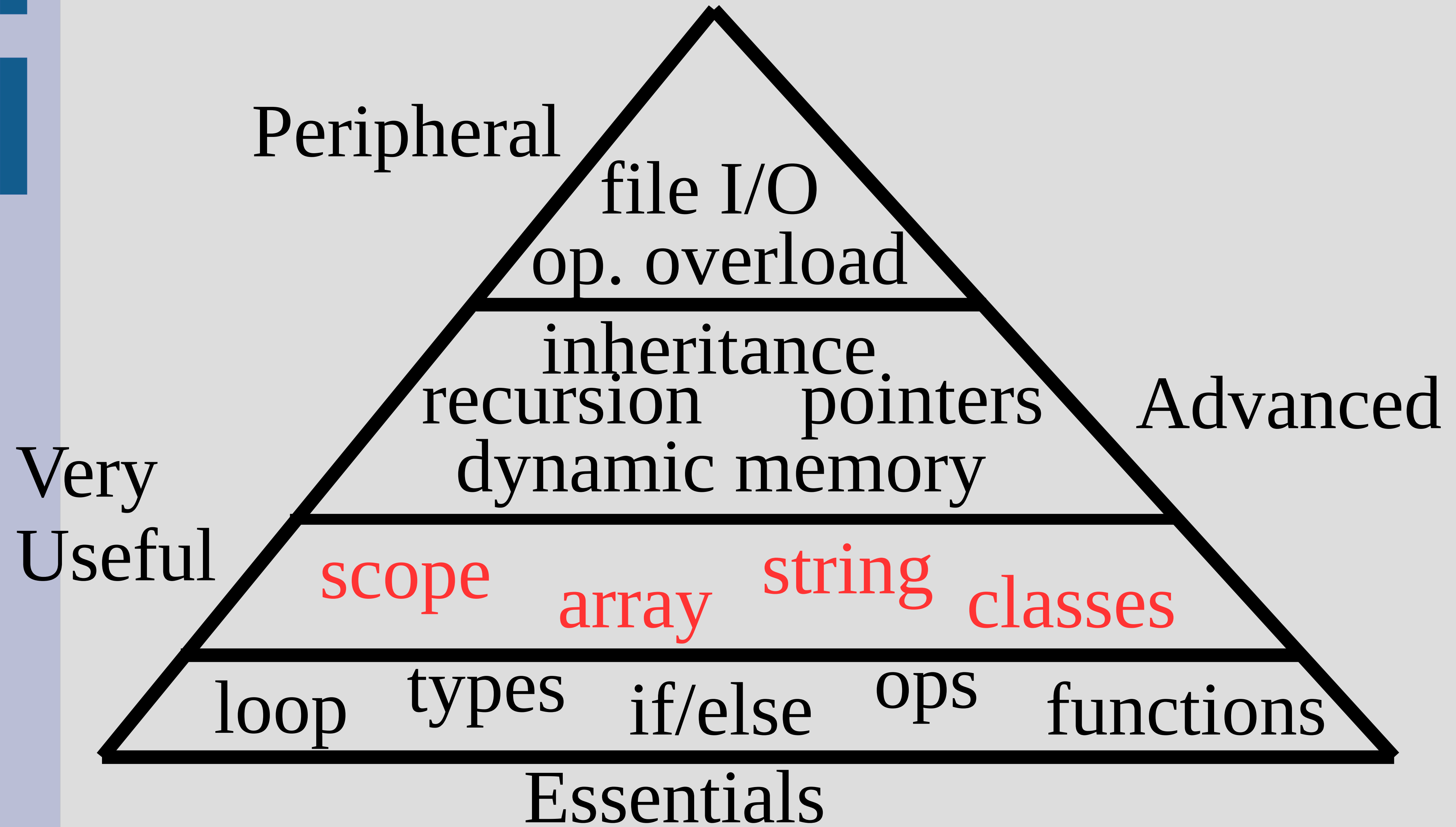
There are two commands that help control loops:



continue tells the loop to start over again (next iteration)

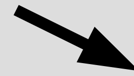
break stops the loop

Review: Overview



C-Strings and strings

c-string uses <u>null character</u> to tell when to end



```
char word [] = {'h', 'i', '\0'};
string sameWord = word;
```

(c++) string is a class (which is a type) and is newer and has many functions:
- find(), substr(), at() or [ ], etc.

Essential for dealing with more than one char at a time

Scope

Variables exist in the braces where it is declared (in { })

```
int x = 3;
int main()
{
    int y = 2;
    if(y < 10)
    {
        int z=3;
    }
}
```

x anywhere here

knows about x and y

knows x, y and z

Scope

```
int add(int x, int y);

int main()
{
    int x = add(2, 4);
}

int add(int x, int y)
{
    int z = x+y;
    return z;
}
```

main()'s x lives here

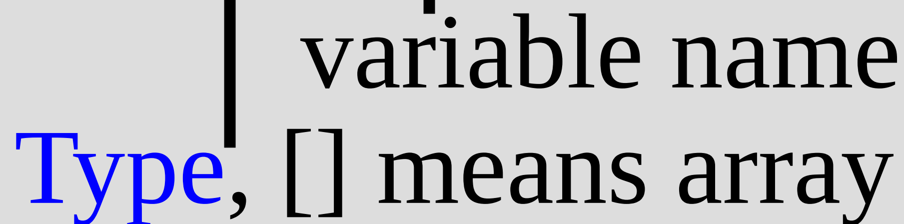
add() has a different x, which along with y and z exist in here

Scope

Arrays

Arrays store multiple things of the same type

```
int x[5]; // 5 ints
```



After declaration **any use of [ ]** is interpreted as element indexing

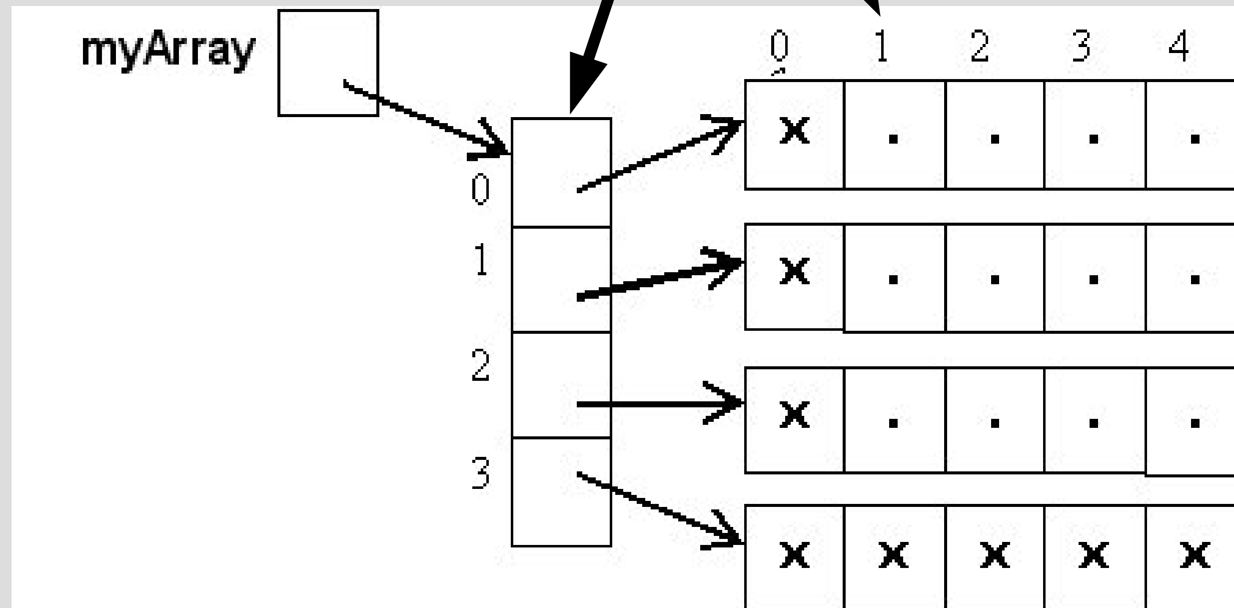
Arrays are memory addresses, shares with functions (cannot call-by-reference)

Multidimensional Arrays

```
string myArray[4][5];
```

four rows

five columns



Must specify (some parts of) size when using as argument in function

Classes

A class is a way to bundle functions and variables (different types) into one logical unit

```
class date
{
private:
    int day;
    int month;
    int year;
public:
    date(int day, int month, int year);
    // ^^ constructor has same name as class
    void print();
};
```

Only "date" variables can read or modify

Anyone can edit/use

Classes are custom made types (like int), that you make and define

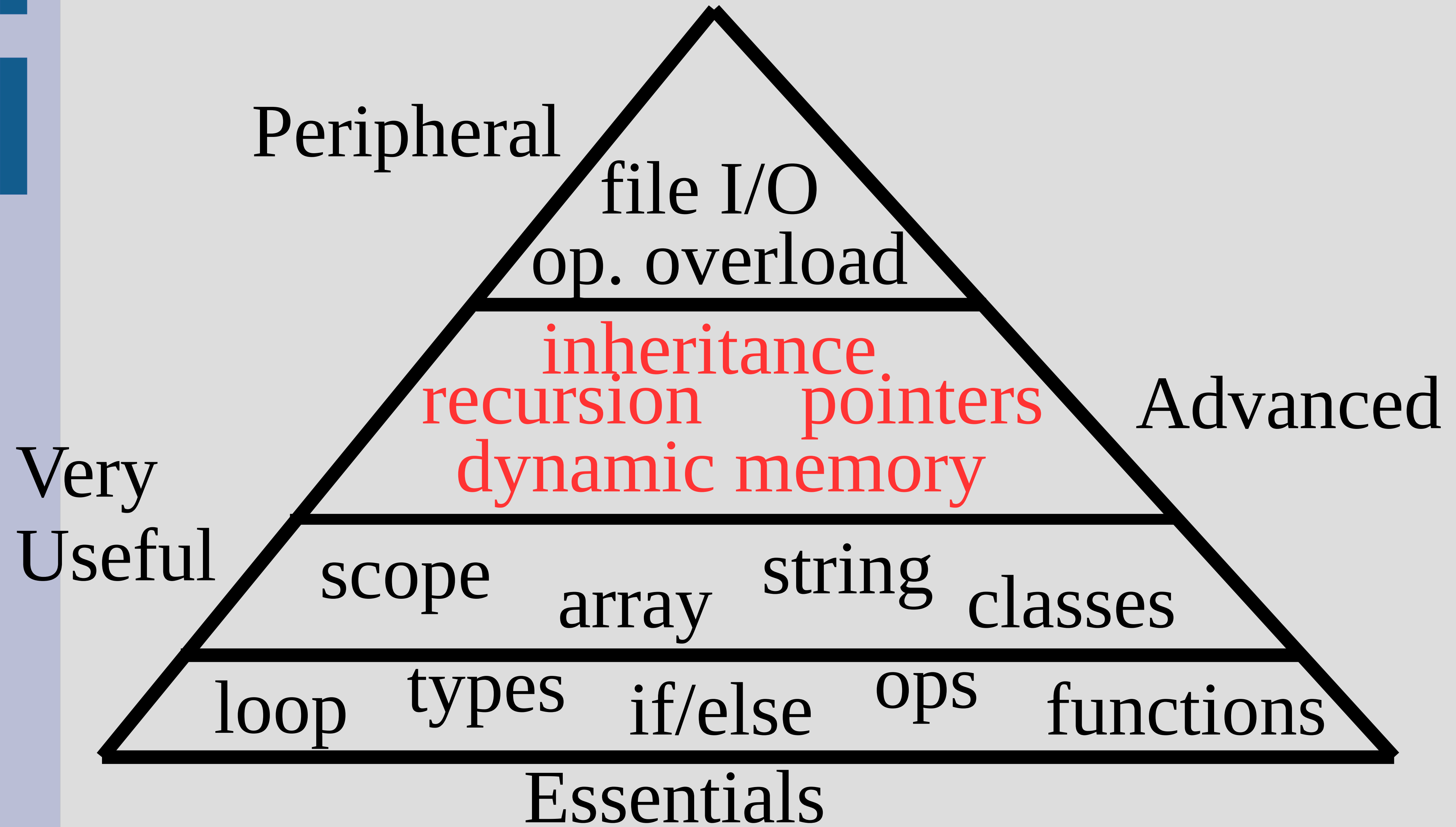
Classes

Every time you actually create an object of the class type, you must run a constructor

```
date today1; // default construcor
date today2 = date(); // same as above
date today3(12, 15, 2015); // non-default constructor
date today4 = date(12, 15, 2015); // same as above
```

Constructors should initialize (probably) all variables inside the class

Review: Overview



Recursion

There are two important parts of recursion:

- -A stopping case that ends the recursion
- -A reduction case that reduces the problem

Identify the problem sub-structure, then move inputs towards the base case

$$F_n = F_{n-1} + F_{n-2},$$

$$0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, \ldots$$

You can assume your function works as you want it to (and it will if you do it properly!)

Pointers

A pointer is used to store a memory address and denoted by a * (star!)

```
int x = 6;
int* xp;
xp = &x;
cout << *xp;
```

declare type of xp as int*

point xp to address of x

dereference pointer

As arrays, the * on the declaration is special (declares a type only)

Every other use of * will try to go where the variables is pointing to

Pointers - nullptr

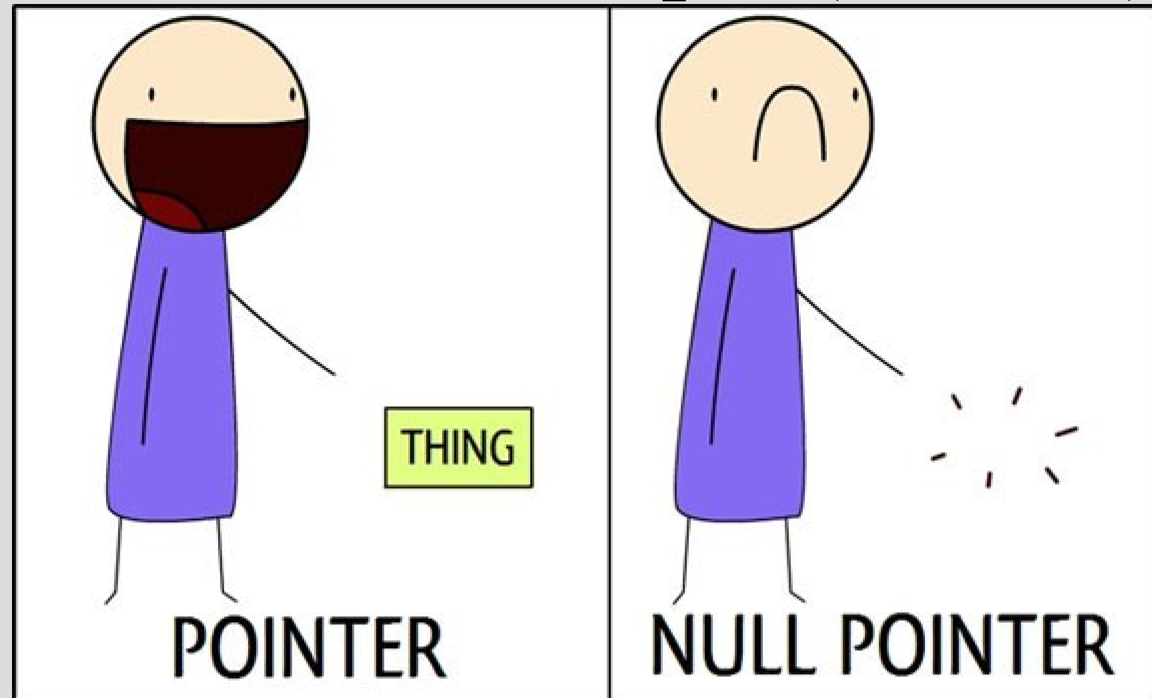
If you try to go to a place outside your memory, you will seg fault

```
Segmentation fault (core dumped)
```

This is especially true with the nullptr (NULL)

```
int* ptr = nullptr;
*ptr = 2;
```

(Typically the values when uninitialized)



Dynamic memory

Dynamic memory makes variables without names (much as array elements do not have individual names)

Pointers can hold both a single variable or an array of variables:

```
char* ptr = new char;
*ptr = 'x';
cout << *ptr;
delete ptr;
```

```
char* ptr = new char[3];
ptr[0] = 'x';
ptr[2] = '\0';
cout << ptr;
delete [] ptr;
```

Dynamic memory in classes

If a variable inside a class uses dynamic memory, we should build a deconstructor (which does the “delete”ing)

```
Dynamic();
~Dynamic();
Dynamic(const Dynamic &other);
Dynamic operator=(const Dynamic &d);
```

deconstructor

copy constructor

operator =

If we need one of these, then we need them all:

-deconstructor

-copy-constructor

-overload “=” operator

Inheritance

To create create a child class from a parent class, use a : in the (child) class declaration

This shares functions and variables from the parent class to the child

child class

parent class

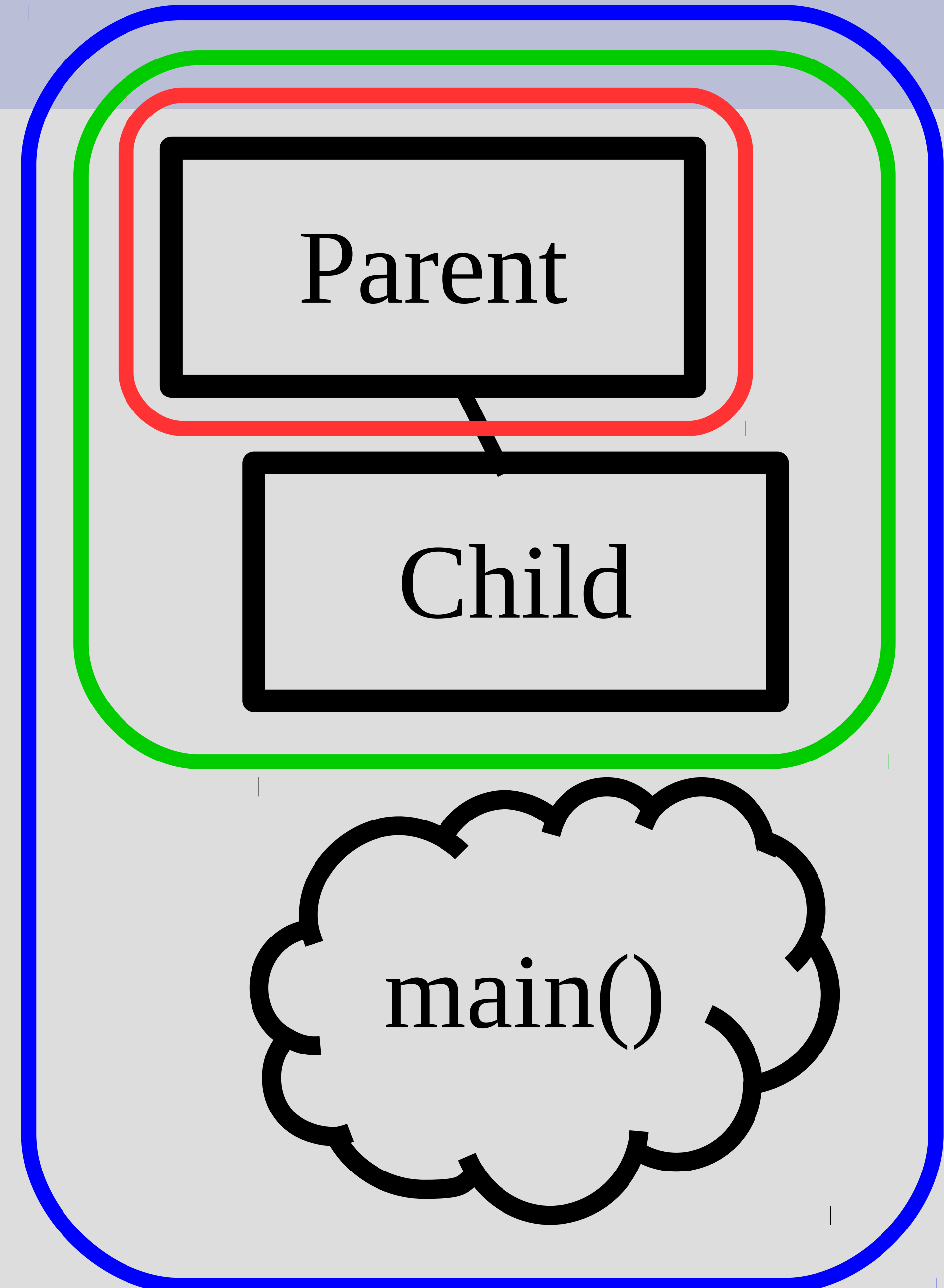
```
class Child : public Parent {
    // more stuff
};
```

```
class Parent {
protected:
    int data;
public:
    void doSomething();
};
```

protected

Picture:
Red = private
Green = protected
Blue = public

Variables should be either private or protected



Dynamic binding

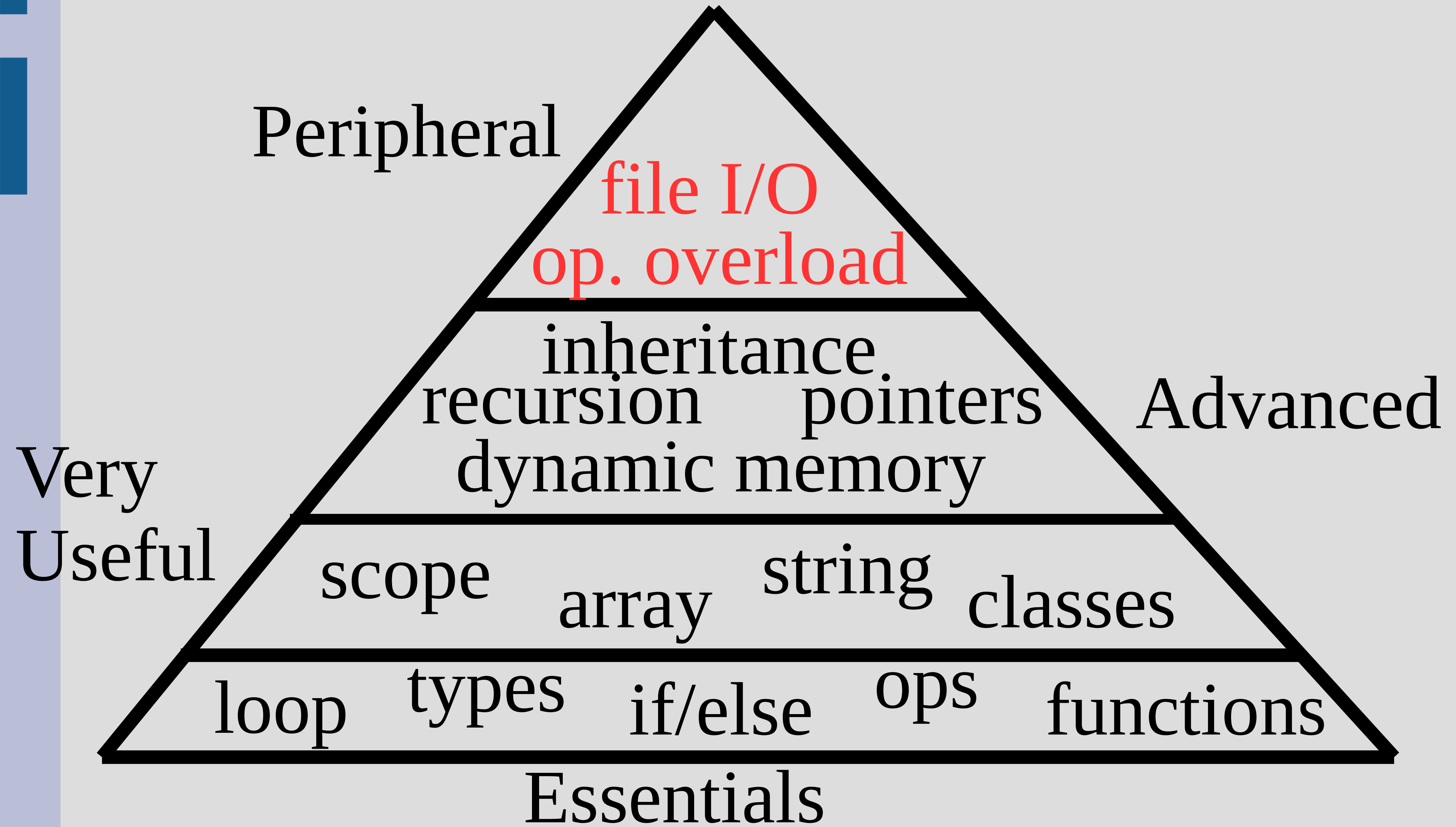
Store child as parent, can keep all of child if you use pointers

```
Person* p = new Person();
Boxer* b = new Boxer();
p = b;
p->swing();
```

Add virtual to use more appropriate function in pointed object:

```
class Person{
public:
    virtual void swing()
};
```

Review: Overview



File I/O

4 steps to file I/O:
Declare, open, use (loop), close

```
string x;
ifstream in;
in.open("input.txt");
if(!in.fail())
{
    in >> x;
}
in.close();
```

input should check to see if file opened

output overrides file by default

After this point use the variable ("in" above) in place of cin/cout for read/write (respective)

End of file (EOF)

3 ways of looping over whole file (reading)

```
while(getline(in,x))
while(in >> x)
while(!in.eof())
```

reads from file

does not read from file (just tells if at end)

eof() will not be true **until** a read fails, so must check for eof() immediately after reading

Operator overloading

Will convert: `Point c = a+b;`

function in class:

```
Point c = a.operator+(b);
```

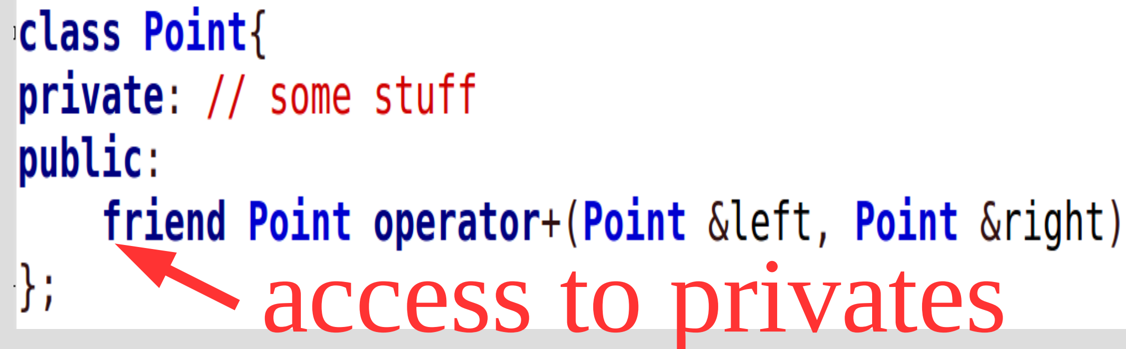
... defined as...

```
class Point{
private: // some stuff
public:
    Point operator+(Point &other)
};
```

friend function:

```
Point c = operator+(a,b);
```

... defined as...



```
class Point{
private: // some stuff
public:
    friend Point operator+(Point &left, Point &right)
};
```


Use friend over in-class version if order matters (i.e. “cout << c” not “c << cout”)

Problems

Suppose you want a length 10 array, but all the odd indexes are represented by the same number

This is also true for the even numbers:

3	7	3	7	3	7	3	7	3	7
arr [0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]

(picture not quite accurate)

change x[0] to 5:

5	7	5	7	5	7	5	7	5	7
arr [0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]

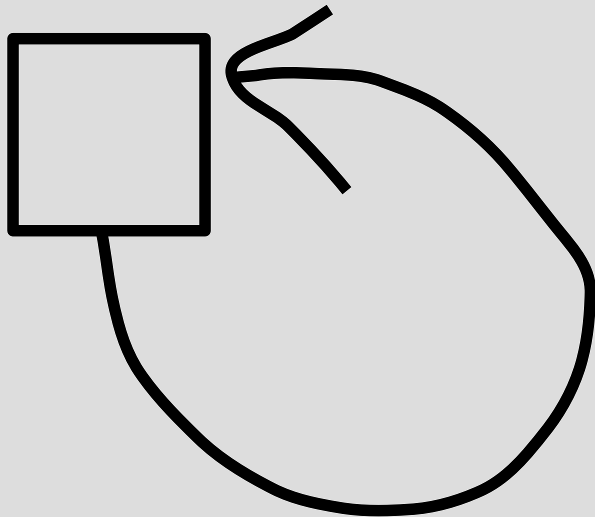
Problems

Write some code to make the lines below syntactically correct and cout different things:

```
a* x = new a();
a* y = new b();
x -> foo();
y -> foo();
```

Problems

Can you make a pointer point to itself? Why or why not?



Problems

Suppose there exists a “seat” class

Write the “classroom” class with a constructor that takes in an integer and makes a dynamic array of that many seats

What else does the classroom class need to have?

The End

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