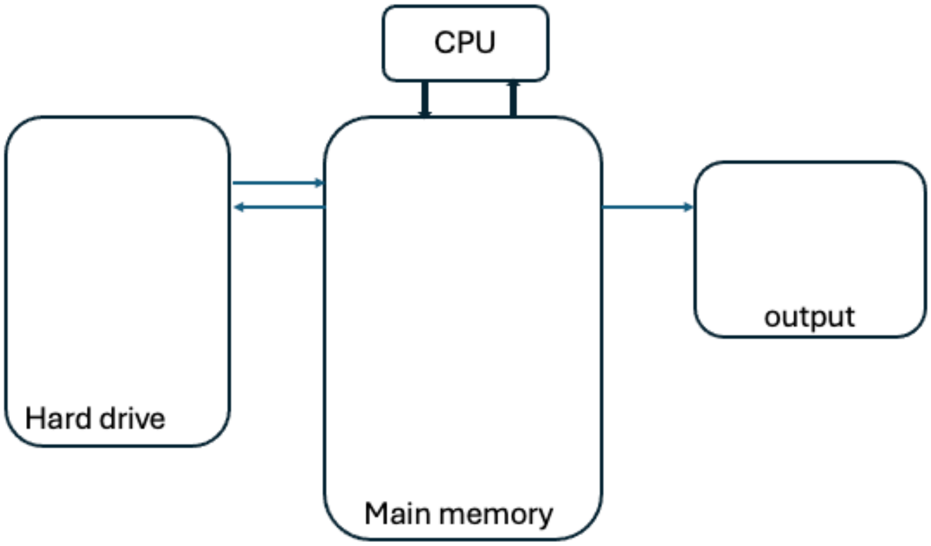
CSCI 3110 Introduction

Data Structures: To organize, manage, and store data in a format in a computer that is efficient in accessing data for the application.

Main memory vs. secondary memory

- Program and data reside in secondary memory, i.e., hard disk drive, when not in use. Program and Data are stored permanently on secondary memory.
- Main memory, aka primary memory, stores data temporarily. Data stored in main memory can be directly accessed by the CPU
- When we run a program, the program and the data will be fetched into the main memory, CPU will execute the commands, performs task.



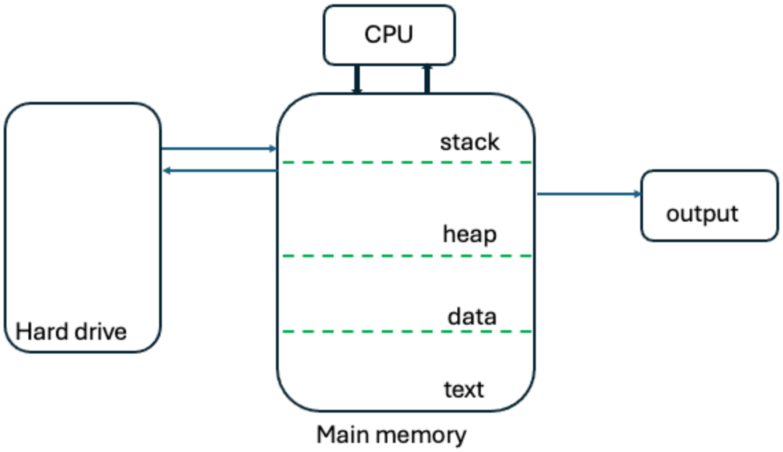
Example program demo

- What data is used?
- How are the data stored during program execution?
- Are there other ways this data can be stored?
- What are the tasks of this application?
- Is this a good data structure that supports the tasks of this application?
    - How do we objectively evaluate "goodness"?

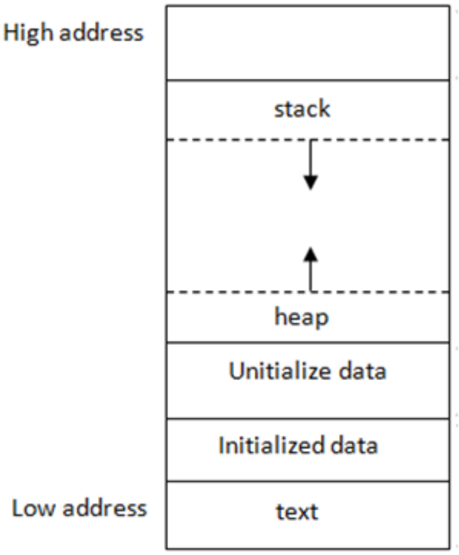
Stack and Heap

Each running program has its own memory layout, separated from other programs. The layout consists of a lot of segments, including:

- `stack`: stores local variables
- `heap`: dynamic memory for programmer to allocate
- `data`: stores global variables, separated into initialized and uninitialized
- `text`: stores the code being executed



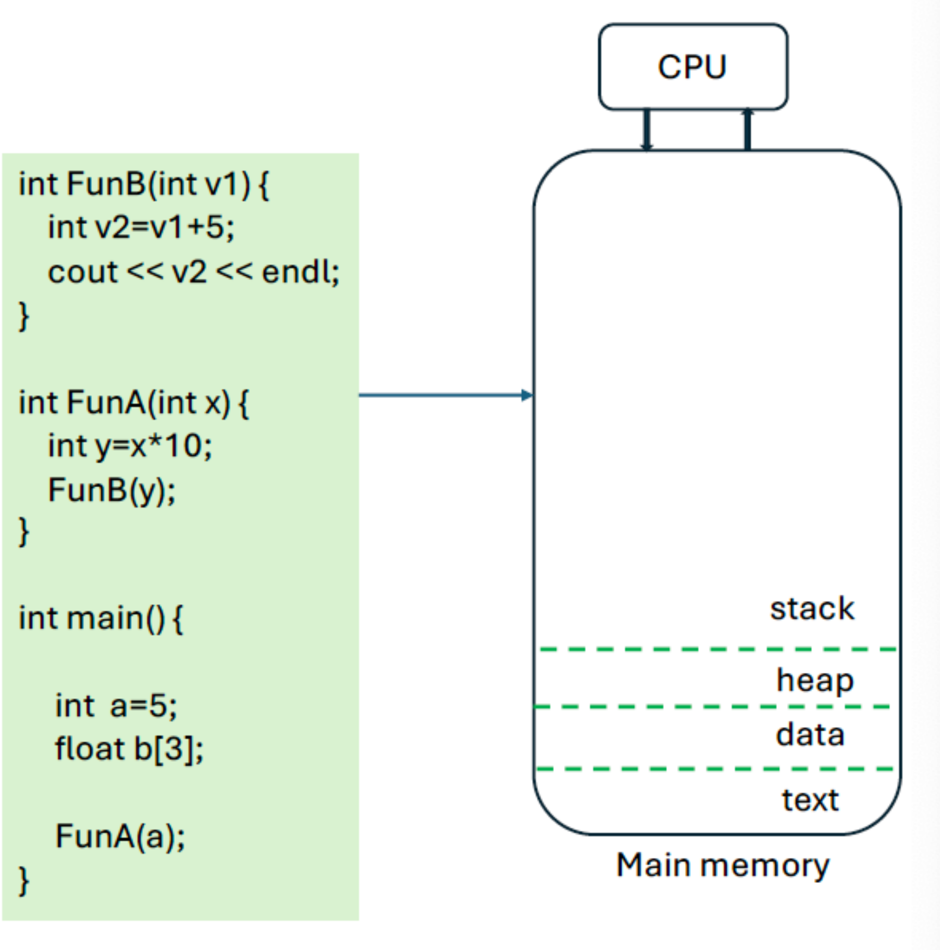
The addresses go from 0 all the way to the largest possible address, depending on the machine. As the figure below, the `text`, `data`, and `heap` segments have low address numbers, while the `stack` memory has higher addresses.



Memory layout of a c++ program

Stack

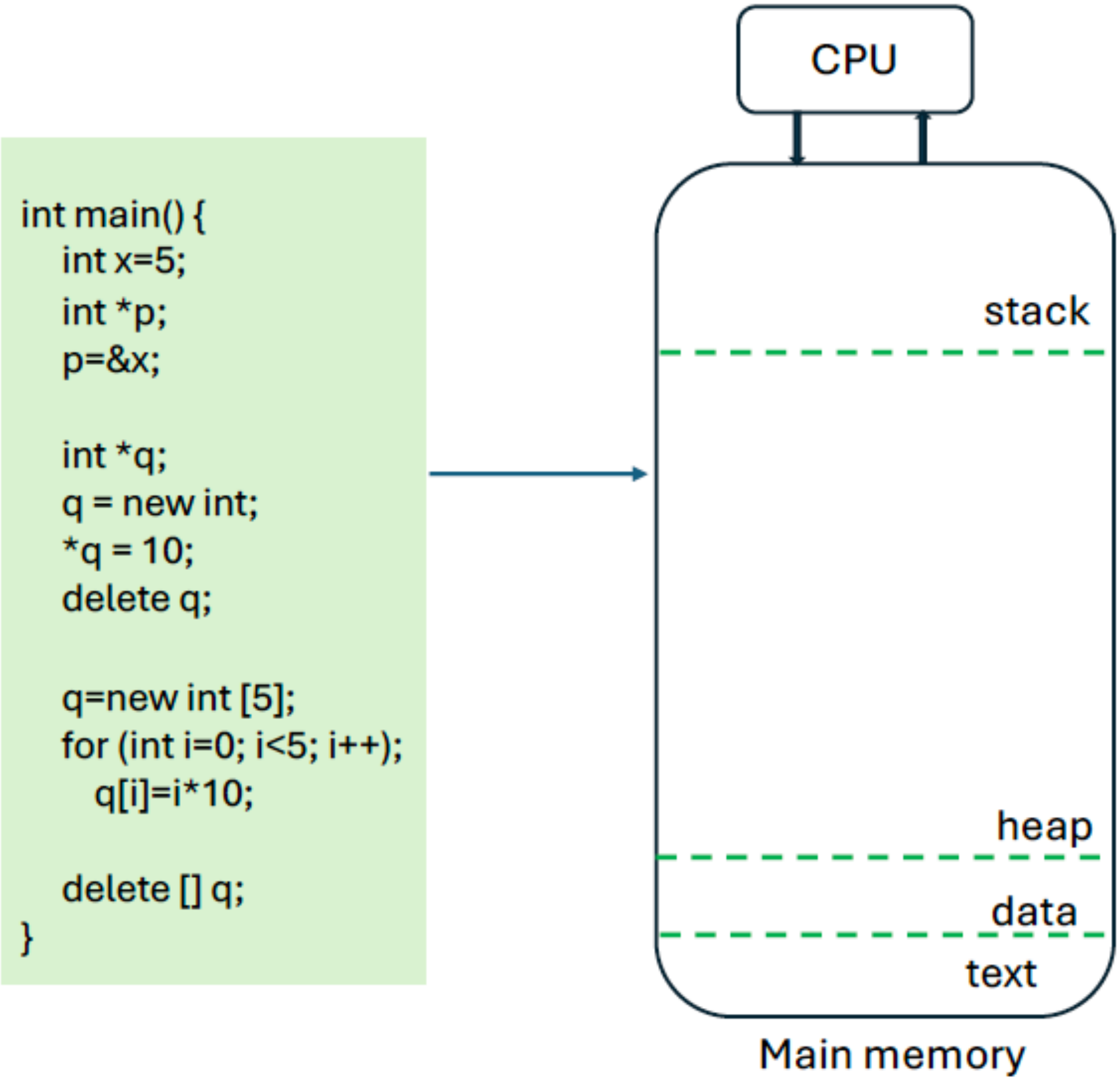
The stack segment is near the top of memory with high address. Every time a function is called, the machine allocates some stack memory for it. When a new local variables is declared, more stack memory is allocated for that function to store the variable. Such allocations make the stack grow downwards. After the function returns, the stack memory of this function is deallocated, which means all local variables become invalid. **The allocation and deallocation for stack memory is automatically done**. The variables allocated on the stack are called *stack variables*, or *automatic variables*.



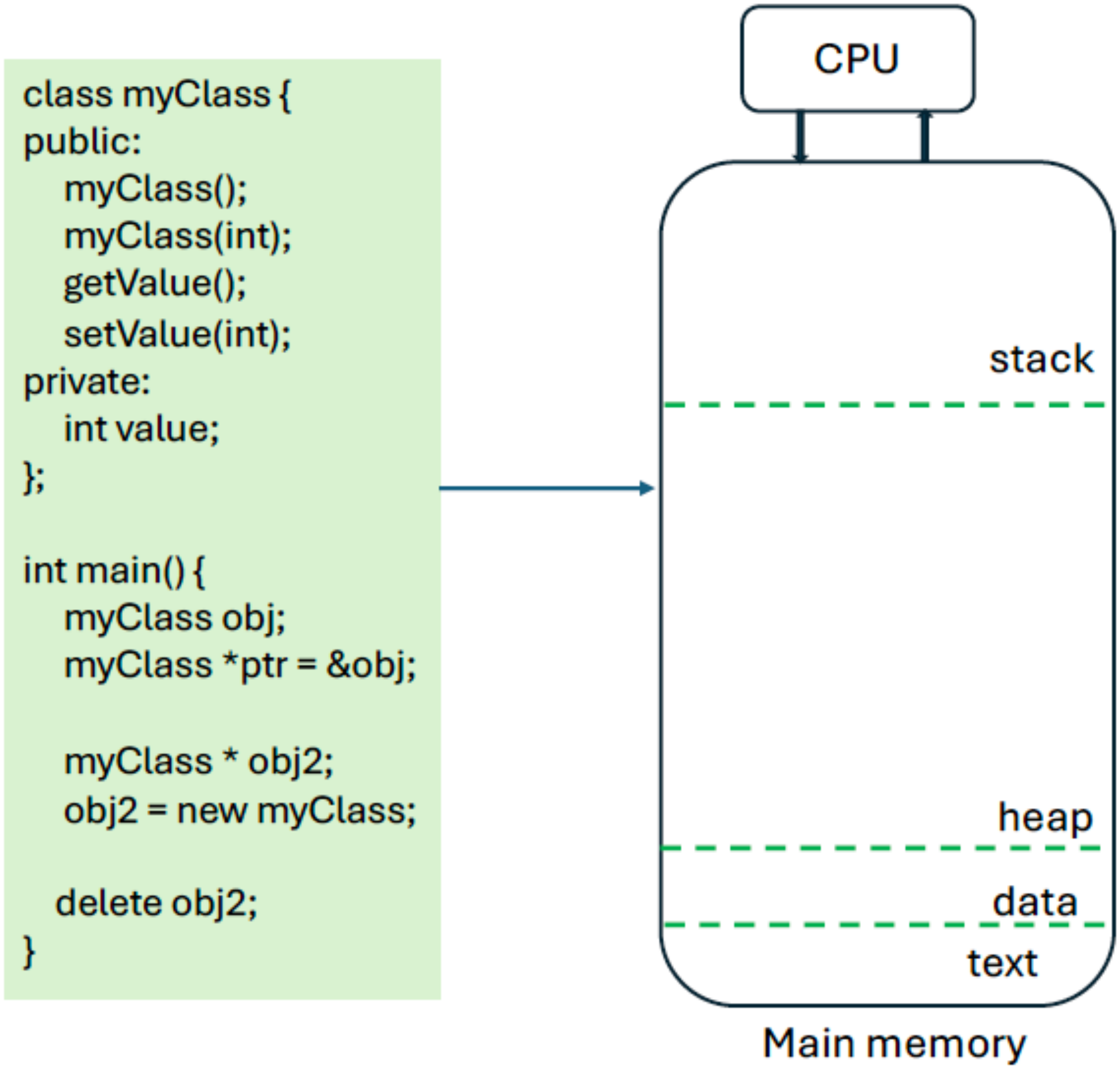
```
int FunB(int v1) {
   int v2=v1+5;
   cout << v2 << endl;
}

int FunA(int x) {
   int y=x*10;
   FunB(y);
}

int main() {

    int  a=5;
    float b[3];

    FunA(a);
}
```

Heap

Unlike stack memory, heap memory is allocated explicitly by programmers and it won't be deallocated until it is explicitly freed.



```
int main() {
    int x=5;
    int *p;
    p=&x;

    int *q;
    q = new int;
    *q = 10;
    delete q;

    q=new int [5];
    for (int i=0; i<5; i++);
       q[i]=i*10;

    delete [] q;
}
```



```
class myClass {
public:
    myClass();
    myClass(int);
    getValue();
    setValue(int);
private:
    int value;
};

int main() {
    myClass obj;
    myClass *ptr = &obj;

    myClass * obj2;
    obj2 = new myClass;

   delete obj2;
}
```