Welcome to Lab Memory!
Course Website: https://courses.engr.illinois.edu/cs225/sp2021

Overview
In this week’s lab, you will learn about memory management: how to allocate and de-allocate memory correctly in your program. You will discover ways of memory management, and practice spotting memory bugs in the code.

Destructors
Destructors (dtors) are special member functions of classes. They are the opposite of constructors: their job is to release (de-allocate) memory when an object of the class is no longer needed. Destructors are automatically called when an object runs out of its scope; we never explicitly call a destructor, instead it is implicitly called when we use the keyword “delete” or when the lifetime of the object ends.

Exercise 1.1: Write the destructor for the Orchard class.
Exercise 1.2: On which line(s) will the destructors be called in main.cpp (see next page)? ~Orchard:__12__ ~Tree:__12, 13, 14__

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**orchard.h**

```cpp
#pragma once

class Tree {
public:
    string fruitName;
    double yield;
};

class Orchard {
public:
    static const int MAX_TREES = 500;
    Orchard();
    bool addTree(Tree& t);
    Orchard(const Orchard& other);
    Orchard& operator = (Orchard const & other);
    // YOUR CODE HERE
private:
    int size_;  
    Tree* trees_;
};
```

**orchard.cpp**

```cpp
#include "orchard.h"

Orchard::Orchard() {
    size_ = 0;
    trees_ = new Tree[MAX_TREES];
}

bool Orchard::addTree(Tree& t) {
    if (size_ < MAX_TREES) {
        trees_[size_] = t;
        size_++;
        return true;
    } else {
        return false;
    }
}

Orchard::Orchard(const Orchard& other) {
    trees_ = new Tree[MAX_TREES];
    for (int i=0; i<other.size_; i++) {
        trees_[i] = other.trees_[i];
    }
    size_ = other.size_;
}

Orchard& Orchard::operator = (Orchard const & other) {
    if(this != &other){
        for (int i=0; i<other.size_; i++) {
            this->trees_[i] = other.trees_[i];
        }
        this->size_ = other.size_;
    }
    return *this;
}

Orchard::~Orchard() {
    delete[] trees_;  
    trees_ = null;
}
```
main.cpp

```cpp
int main() {
    Tree *t1 = new Tree;
    t1->fruitName = "peach";
    t1->yield = 25;
    Tree *t2 = new Tree;
    t2->fruitName = "apple";
    t2->yield = 40;
    Orchard * myorchard = new Orchard();
    myorchard->addTree(*t1);
    myorchard->addTree(*t2);
    delete myorchard;
    delete t1;
    delete t2;
}
```

Memory Errors
Memory errors occur when memory access is mismanaged; some ways it can occur are through: 1) invalid memory access in heap or stack, 2) mismatched allocation/deallocation, or 3) missing allocation or uninitialized variable access (eg. dereferencing NULLs). Memory errors often result in “segfaults” when the program is run.

Exercise 2.1: What will line 7 in main.cpp print out? ___012345678910___(possibly)segmentation fault____

Exercise 2.2: A memory error will occur somewhere between lines 10 and 16. Find and correct this error.

```cpp
void func(int idx){
    HSLAPixel array[10];
    array[idx] = HSLAPixel(0,0,0);
}
```

In the programming part of this lab, you will:
- Learn about one memory debugging tool: Valgrind
- Complete the given code for lab_memory
- Debug the given code by correcting memory errors and memory leaks

As your TA and CAs, we’re here to help with your programming for the rest of this lab section! 😊