CSE 333 – Spring 2013
Section #2 – 4/10/13
Not a quiz! Will not count towards your grade! For learning purposes only!

Suppose we have the following `struct` definition:

```
typedef struct _Foo {
    int baz;
    int qux;
} Foo;
```

Write C statement(s) that would:

- Statically allocate a Foo

```
Foo foo;
```

- Dynamically allocate a Foo

```
Foo *foop = (Foo*)malloc(sizeof(Foo));
```

- Statically allocate an array of Foos

```
Foo fooarr[4];
```

- Dynamically allocate an array of Foos

```
Foo* foodarr = (Foo*)malloc(4 * sizeof(Foo));
```

What does the following statement do? Describe and draw a diagram.

```
Foo **bar = malloc(16 * sizeof(Foo*));
```

The statement allocates space for an array of 16 Foo pointers. The pointers are uninitialized.

What is the type of `**bar`? What about `bar[4]`? What do each represent?

`**bar` is of type `Foo`. `bar[4]` is of type `Foo*`. `**bar` is the actual `Foo` structure referenced by the first pointer in the `bar` array, but is meaningless and will likely cause a segmentation fault right now since all the pointers are uninitialized. `bar[4]` is the fifth pointer in the `bar` array, but is uninitialized and thus currently meaningless.

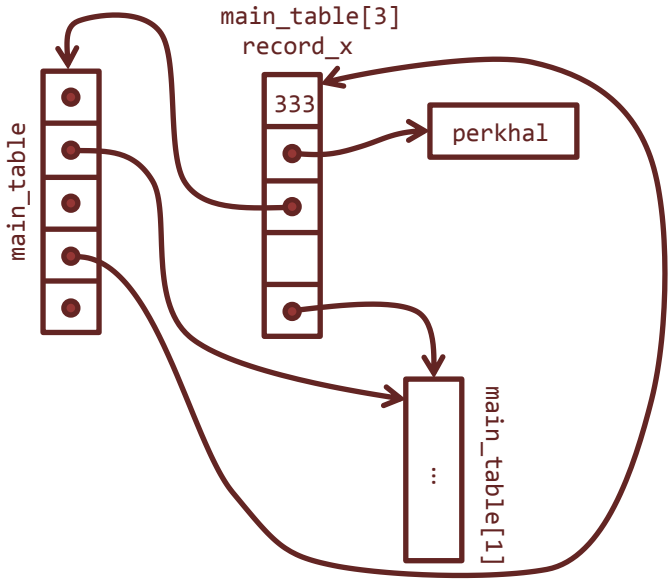
Write a function `makefoo` that creates an array of Foo pointers (not just Foos!). Each pointer should point to a valid Foo structure, and each Foo must be initialized with `baz` being the index of that Foo structure (or its pointer) in the array, and `qux` being set to the value 333.
The function must take as parameters an integer representing the size of the array and a pointer with the correct amount of indirection (number of stars) so that the array can be passed back through this parameter. The function must also return whether it was successful or not.
The function declaration should thus look similar to the following, with the question marks replaced with the appropriate type:

```
bool makefoo(int n, ???? array_out);
```

```
bool makefoo(int n, Foo*** array_out) {
    Foo** array = (Foo**)malloc(n * sizeof(Foo*));
    if (array == NULL)
        return false;
    for (int i = 0; i < n; i++) {
        array[i] = (Foo*)malloc(sizeof(Foo));
        if (array[i] == NULL) {
            for (int j = 0; j < i; j++)
                free(array[j]);
            free(array);
            return false;
        }
        array[i]->baz = i;
        array[i]->qux = 333;
    }
    *array_out = array;
    return true;
}
/* Note the cleanup in case one of the internal malloc()s fail
 * This prevents memory leaks on failure (though you probably have worse problems if
 *   malloc() is failing) */
```

Given the following definitions, draw a diagram including at least `main_table` and `record_x`. Make up any additional values if you feel compelled.

```
typedef struct _XRef {
    int rec_id;
    char* label;
    struct _XRef ** parent_table; // array of XRef pointers
    int table_index;
    struct _XRef * cross_ref;
} XRef;
...
XRef ** main_table = malloc(5 * sizeof(XRef*));
... (Allocate space for each XRef)
... (Initializing values)
XRef * record_x = main_table[3];
record_x->rec_id = 333;
strncpy(record_x->label, "perkhal", LABEL_LEN);
record_x->parent_table = main_table;
record_x->table_index = 3;
record_x->cross_ref = main_table[1];
... (Initialize remaining values)
```



Assuming `LABEL_LEN` is already properly defined, give an example snippet of code that would allocate space for each `XRef` in the code above.

```
for (int i = 0; i < 5; i++) {
    main_table[i] = (XRef*)malloc(sizeof(XRef));
    main_table[i]->label = (char*)malloc(LABEL_LEN + 1);
}
/* Remember that the label field needs to be allocated as well!
 * Also make sure to allocate LABEL_LEN + 1, since we need space for that possible
 *   null byte. */
```

Look at the following struct and function definitions. Describe what the struct is and what the function does as well as you can.

```
typedef struct _Myst {
    uint64_t thing0;
    struct _Myst * thing1;
    struct _Myst * thing2;
} Myst;

void function(Myst *m, uint64_t u) {
    Myst *p = NULL;
    while (m) {
        p = m;
        if (u > m->thing0)
            m = m->thing2;
        else
            m = m->thing1;
    }
    m = malloc(sizeof(Myst));
    if (u > p->thing0)
        p->thing2 = m;
    else
        p->thing1 = m;
}
```

Yup, it's a binary tree! It stores an unsigned 64-bit integer as its data in increasing order (by preorder traversal). The mystery function inserts the specified value into the given tree, with ties going into the left subtree. Note that the function is using a parameter (`m`) in place of a temporary variable. Since arguments are passed by value, this does not change anything from the client's point of view. Also note that the while-loop test does not explicitly compare `m` to `NULL`; however, `NULL` (or `0`) values are implicitly `false` and all other values are `true`.

WARNING: These tricks may not always lead to clear code!