Data Structures with C++ : CS189

Lecture 6-1: Recursion

Recap

- A recursive function is one that calls itself
  - Usually starts with a "driver"
  - Ends with a "base case"
- Driver: Usually public; does the one-time setup before recursion starts
- Base case: The condition that prevents the function from calling itself anymore

Tail Recursion (Loop) 5.12 #2

Q: Write a function that returns length of list

A: Return 1 + the number of nodes after me

```
int Driver() return Recurse(head->next);

int Recurse(ListNode *what)
    if( what == tail ) return 0;
    return 1 + Recurse( what->next );
```

Recursion: 5.12 #6

Print 1234
1
1,
1,234

1234567?
Print(1234)
1,234
1,234,
1,234,567

Q: Write a recursive method that takes a positive integer and prints it with commas

A: Print everything but the last 3 numbers, then a comma, then the last three numbers

Does that sound right? Test it in English before you make life hard for yourself.

Comma Code

```
string PutCommas( int x)
    return Recurse(x/1000, x%1000);

string Recurse(int left, int right)
    if( left == 0 )
        return to_string(right);
    else
        return Recurse( left/1000, left%1000)
            + "," + to_string(right);
```

Recursion that Forks

5.12 #9

I have no idea what a binomial coefficient is.

```
int BC( int n, int k )
    if( k == 0 || n == 0 )
        return 1;
    return BC(n - 1,k - 1) + BC(n-1, k)
```

99% of the time, when an algo "forks" (calls itself multiple times in different ways) then you need recursion and loop won't work.

Recursion and Dead Ends

- Each path of BC there traveled from root to base case (leaf) and used every step
- But a recursive function could have wrong answers, or "dead ends" in the tree
  - Draw this out! Driver up top and leaves at bottom
  - "Print my family tree except for anyone with a female descendant"
  - Finding a woman needs to "retroactively" mark people as invalid
  - Draw a tree with these female nodes and you'll see you "backtrack"

Recursion and Stacks

- If we were printing out each person's name as we went this wouldn't work
  - Bob Charlie Alice… shoot I need to erase Bob
- So commonly found alongside recursive functions that can change their mind is a stack holding temporary results
- The homework is writing a program that can solve a maze
  - The most literal classic example of backtracking

End

Like all recursion, the code for the maze solver ends up comically short