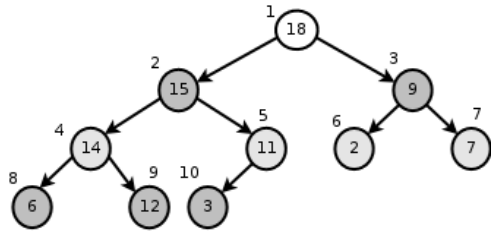
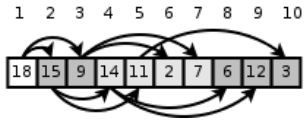
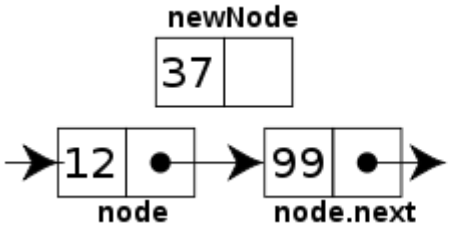
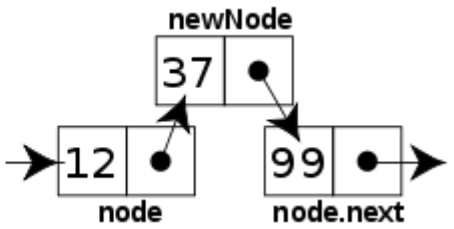




INSERTION-SORT(A)	*cost*	*times*
1 **for** $j = 2$ **to** $A.length$	c_1	n
2 $key = A[j]$	c_2	$n-1$
3 // Insert $A[j]$ into the sorted sequence $A[1..j-1]$.	0	$n-1$
4 $i = j-1$	c_4	$n-1$
5 **while** $i > 0$ and $A[i] > key$	c_5	$\sum_{j=2}^{n} t_j$
6 $A[i+1] = A[i]$	c_6	$\sum_{j=2}^{n}(t_j-1)$
7 $i = i-1$	c_7	$\sum_{j=2}^{n}(t_j-1)$
8 $A[i+1] = key$	c_8	$n-1$





WELCOME TO CS 24!

Problem Solving with Computers-II

About me

- Lawton Nichols (lawtonnichols@cs.ucsb.edu)
  - From Riverside County
  - Went to Fresno State for undergrad
  - Proud plant dad of two large moss balls
  - I'm a grad student; pity me

- Office hours (starting next week 09/30):
  - M: 2pm–4pm
  - Location: Trailer 936 (Google Maps link with exact GPS coordinates on course website!)

- Try to contact me via Piazza

Getting help

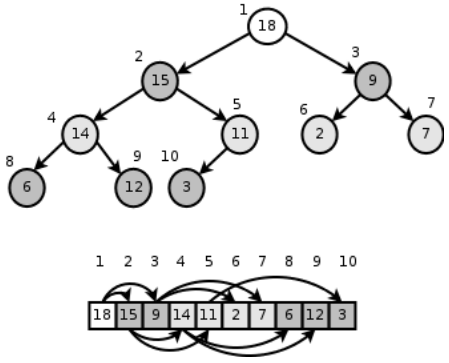
- Come to office/open lab hours and introduce yourself to staff on duty
  - Open lab hours are still TBD—I'll send out an announcement when they're finalized
- It's a good habit to regularly come to office hours—we get lonely and we're here to help!
- Communicate with the staff in person and remotely on:

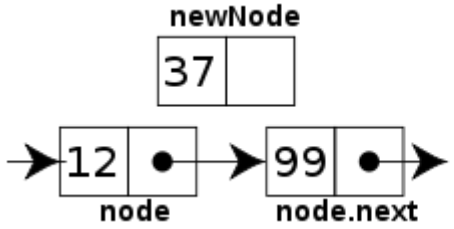
PIAZZA!

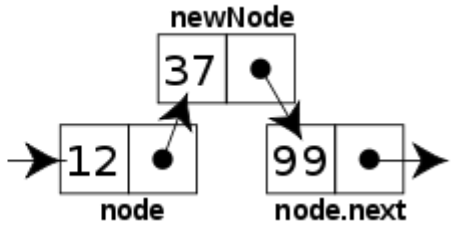
About this course

You will learn to:

- Design and implement **larger programs** that **run fast**
- Organize **data** in programs using **data structures**
- **Analyze** the **complexity** of your programs







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5 **while** $i > 0$ and $A[i] > key$	c_5	$\sum_{j=2}^{n} t_j$
6 $A[i+1] = A[i]$	c_6	$\sum_{j=2}^{n} (t_j - 1)$
7 $i = i-1$	c_7	$\sum_{j=2}^{n} (t_j - 1)$
8 $A[i+1] = key$	c_8	$n-1$

Data Structures and C++ **Complexity Analysis**

Course Logistics

- Course website: https://ucsb-cs24.github.io/f19/
- Grading
  - Homeworks (Quizzes!): 10%
  - Lab assignments: 15%
  - Programming assignments: 18%
  - Midterm Exams: 30%
  - Final Examination: 25%
  - Participation: 2%

- NO MAKEUPS ON EXAMS!

- 15% penalty for each day a lab/programming assignment is late.

- Instead of turning in homeworks, you'll take a short quiz on Gauchospace. Homeworks can't be late, but I'll drop the lowest two.

- To complete the labs you need a college of engineering account. If you don't have one yet, send an email to help@engineering.ucsb.edu

iClickers: You must bring them

- Buy an iClicker at the Bookstore
- Bring your iclicker to class

Required textbook

- Michael Main and Walter Savitch. *Data Structures and Other Objects Using C++ (4th edition)*, Addison-Wesley, 2011.

Recommended textbook

- Problem Solving with C++, Walter Savitch, Edition 9

Clickers out – frequency AB

About you…

What is your familiarity/confidence with programming in C++?

A. Know nothing or almost nothing about it.
B. Used it a little, beginner level.
C. Some expertise, lots of gaps though.
D. Lots of expertise, a few gaps.
E. Know too much; I have no life.

About you…

What is your familiarity/confidence with using version control – git or subversion?

A. Know nothing or almost nothing about it.
B. Used it a little, beginner level.
C. Some expertise, lots of gaps though.
D. Lots of expertise, a few gaps.
E. Know too much; I have no life.

About you…

What is your familiarity/confidence with C++ memory-management? (i.e., `new`/`delete`, pointers, references)

A. Know nothing or almost nothing about it.
B. Used it a little, beginner level.
C. Some expertise, lots of gaps though.
D. Lots of expertise, a few gaps.
E. Know too much; I have no life.

Procedural Programming

- Break down a problem into sub tasks (functions)
- Algorithm to bake a cake
    - Preheat the oven to 350F
    - Get the ingredients: 2 eggs, 1 cup flour, 1 cup milk
    - Mix ingredients in a bowl
    - Pour the mixture in a pan
    - Place in the oven for 30 minutes

Object Oriented Programming: A cake baking example

- Solution to a problem is a system of interacting **objects**
- An object has attributes and behavior
- What are the objects in this example?

1. Preheat the oven to 350F
2. Get the ingredients: 2 eggs, 1cup flour, 1 cup milk
3. Mix ingredients in a bowl
4. Pour the mixture in a pan
5. Place in the oven for 30 minutes

Objects have attributes and behavior: A cake baking example

Object	Attributes	Behaviors
Oven	Size Temperature Number of racks	Turn on Turn off Set temperature
Bowl	Capacity Current amount	Pour into Pout out
Egg	Size	Crack Separate(white from yolk)

A class: pattern for describing similar objects

A generic pattern that is used to describe objects that have similar attributes and behaviors

e.g. a bowl and a pan may be described by the same class

```
class Dish{
      void pourIn( double amount);
      void pourOut(double amount);
      double capacity;
      double currentAmount;
};
```

Objects vs classes

```
class Dish{
     void pourIn(double amount);
     void pourOut(double amount);
     double capacity;
     double currentAmount;
};
 //Creating objects of this class
```

Concept: Classes describe objects

- Every object belongs to (is an instance of) a class
- An object may have fields, or variables
  - The class describes those fields
- An object may have methods
  - The class describes those methods
- A class is like a template, or cookie cutter

Concept: Classes are like Abstract Data Types

- An Abstract Data Type (ADT) bundles together:
  - some data, representing an object or "thing"
  - the operations on that data
- The operations defined by the ADT are the *only* operations permitted on its data
- ADT = classes + information hiding

```
class Dish{
public:
      void pourIn( double amount);
      void pourOut(double amount);
private:
      double capacity;
      double currentAmount;
};
```

Approximate Terminology

- instance = object
- field = instance variable
- method = function
- sending a message to an object = calling a function

Some advice on designing classes

- Always, *always* strive for a narrow interface
- Follow the principle of information hiding:
  - the caller should know as little as possible about how the method does its job
  - the method should know little or nothing about where or why it is being called
- Make as much as possible private
- Your class is responsible for it's own data; don't allow other classes to easily modify it!

Summary So Far

- Class = Data + Member Functions.
- Abstract Data Type = Class + information hiding
- You activate member functions on specific objects.
  - An object of type DayOfYear is an instance of class DayOfYear.

Clickers, Peer Instruction, and PI Groups

- Find 1-2 students sitting near you. If you don't have any move.
- Introduce yourself.
- This is your initial PI group (at least for today)
- Discuss what you hope to get out of this class.