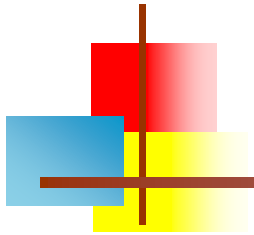
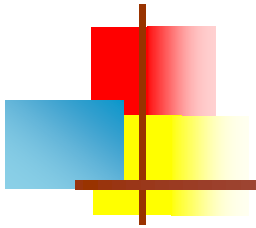


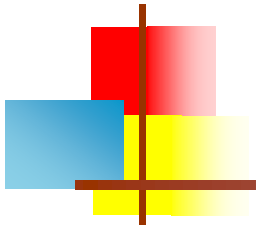
Managing Complexity

Programming is more than just syntax



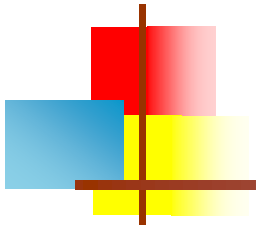
Learning things that matter

- Things change rapidly in computer science
  - Languages go in and out of popularity, operating systems change, even programming styles changes
  - Half of what you learn in my class will be outdated in five years
- CIT591 is primarily an introductory ***programming*** course
  - It uses this year's popular programming language
  - Unfortunately, that language is so complex that learning the syntax takes time away from learning to program
- In this slide set I'm talking about things that will ***not*** be outdated in five years
  - But my examples will be from Java



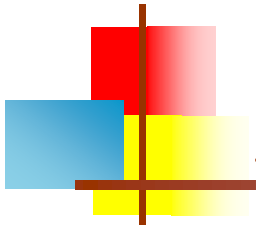
Programs should work

- Programs should work correctly
  - Many programs must be ***highly*** reliable
    - Medical programs, space vehicle control programs, sales programs, income tax programs
    - Household robots, self-driving automobiles
  - The need for correctness isn't going to change any time soon
- Programs should continue to work correctly after they are modified, or updated, or had new features added
  - Thus, it is important to be able to modify programs **safely**
- This means:
  - Clear, concise, readable programs
  - Good tests, especially regression tests



Readability

- Can we *read* a program, or do we have to *decipher* it?
  - Here's a method I would consider readable:
  - ```
    public boolean isLeapYear(int year) {
        if (year % 400 == 0) return true;
        if (year % 100 == 0) return false;
        return year % 4 == 0;
    }
    ```
- At this point, you may feel that *all* programs have to be deciphered
  - I feel the same way when I try to read German
  - With practice, deciphering changes to reading—mostly ☺
    ```



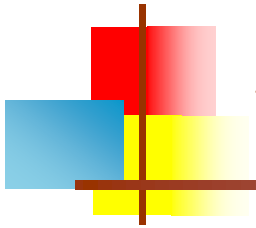
Another readable method

```
void playGame() {
    boolean playAgain = true;

    while (playAgain) {
        int computersScore = 0;
        int usersScore = 0;
        boolean nobodyHasWonYet = true;
        while (nobodyHasWonYet) {
            computersScore = computersScore + resultOfComputersTurn();
            usersScore = usersScore + resultOfUsersTurn();
            printCurrentScores(computersScore, usersScore);
            nobodyHasWonYet = computersScore < WINNING_SCORE &&
                              usersScore < WINNING_SCORE;
        }
        printFinalScores(computersScore, usersScore);
        playAgain = askUser("Do you want to play again?");
    }
}
```

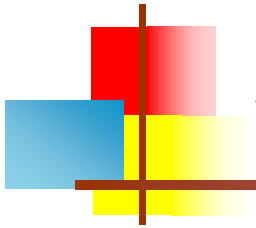
A less readable method

```
private static int giveRandomNumber(int minValue, int maxValue) {
    if (minValue>maxValue){
        int temp=maxValue;
        maxValue=minValue;
        minValue=temp;
    }
    Random random=new Random();
    int temp;
    if(maxValue<0&&minValue<0){
            temp=0-random.nextInt(minValue)-1;
            while(maxValue<temp){
                temp=0-random.nextInt(minValue)-1;
            }//w
        }else{
            temp=random.nextInt(maxValue+1);
            while (minValue>temp){
                temp=random.nextInt(maxValue+1);
            }//w
        }//e
        return temp;
        }
```



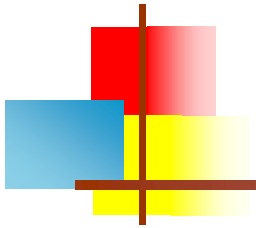
What makes a method "readable"?

- Short enough to see the entire method at once, without scrolling
- Does a single thing
- Has a meaningful, descriptive name
- Is properly formatted, and follows established conventions
- Has comments that further clarify what the method does
- Calls methods with meaningful, descriptive names
- Uses established idioms
  - Very idiomatic: `for (int i = 0; i < array.length; i++)`
  - Less idiomatic: `for (row = 0; row <= array.length - 1; ++row)`
- Has a short, memorable parameter list, with well-chosen parameter names
- Doesn't do "weird" things
  - Doesn't change parameter objects unnecessarily
  - If available outside the class, works for any valid object
    - That is, it doesn't depend on some other method being called first



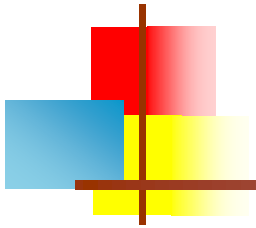
What makes a program "modifiable"?

- Good tests are essential
  - More bugs are introduced when "correcting" a program than at any other time
    - If you have a complete set of tests, you can do this much more safely
  - Frequently, in order to introduce new features, you have to refactor (reorganize) a program
    - If you have a complete set of tests, you can do this much more safely
- You can add features, but you cannot change features that other people (that is, other parts of the project) depend upon
  - At least, not without an ***extremely*** convincing reason
  - You can't change *what* methods do, but you can change *how* they do it
  - You can *only* change how methods work *if nothing else depends on it*
    - This is why you must ***hide*** as much as possible of your implementation



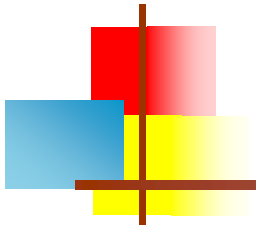
Example

- A modifiable program:
  - public class Lexicon {
    private String[] words;
    private int[] counts;
    private int numberOfWords = 0;
    // etc.
    }
- An ***un***modifiable program:
  - public class Lexicon {
    String[] words;
    int[] counts;
    int numberOfWords = 0;
    // etc.
    }



Information hiding

- When you provide a class to a project,
  - You should provide everything that is needed by the project
  - You should ***not*** provide anything that isn't needed
    - If you do, someone, somewhere, will take advantage of it
    - If you then change it, *you* will get the blame
- There is a lot more to be said on the topic of information hiding, but I don't have the time right now to say it all
- I will add this much:
  - Information hiding *also* applies to your JUnit tests
  - If you don't want your tests to break when you make *correct* changes to your program, don't depend on features that should be hidden



The End