Automated Unit Testing

EECS 168 Programming 1

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Perfection is Impossible

- No one writes perfect code the first time, every time
- How do we find out if code is correct?
  - Testing
- Forms of testing
  - **Compiling** tests for valid syntax
  - **Acceptance testing** involves running the program as a user testing for correct operation
  - **Unit testing** involves testing individual units (functions)
- Once we know there are defects, we must fix them through code review and debugging

Exhaustive Testing is Impossible

- Even a simple one-parameter function can have an infinite number of inputs

```
float square(float number)
{
   return number * number;
}
```

- So we test with a representative set of input/output combinations

  -14.8, -1, 0, 0.0001, 5.987, 22, 1025.9

Manual Unit Testing

- Individual units can be tested by writing drivers

```
// This function sums the integers from min to max inclusive.
// Pre: min < max
// Post: return-value = min + (min+1) + ...  + (max-1) + max
int sum(int min, int max);


int main()
{
  int first, second;
  cout << "Enter two integers, the first smaller" << endl;
  cin >> first >> second;
  cout << "sum(" << first << "," << second << ") is "
       << sum(first,second) << endl;
  return 0;
}
```

Automatic Unit Testing

- Individual units can be tested by writing automated tests with assert()
- assert() takes one boolean parameter

```
#include <cassert>
int sum(int min, int max);


int main()
{
  assert(sum(0,2) == 3);
  assert(sum(-2,2) == 0);
  assert(sum(3,7) == 25);
  return 0;
}
```

assert()

- If assert's parameter is false, then program execution is halted and a message is given

```
#include <cassert>
int sum(int min, int max);

int main()
{
  assert(sum(3,7) == 15);
  return 0;
}
```

```
$./a.out
assertion "sum(3,7) == 15" failed: file "sumtest.cpp", line 36
```

Assert() alternative

- The following[1] gives extra information

```
#include <cassert>
#define Assert(b,s) { if (!(b)) s; assert(b); }
int sum(int min, int max);

int main()
{
   Assert(sum(3,7) == 15,
          cout << "sum(3,7) = " << sum(3,7) << endl);
   return 0;
}
```

```
$./a.out
sum(3,7) = 25
assertion "sum(3,7) == 15" failed: file "sumtest.cpp", line 40
```

1. Contributed by Dr. John Gauch

Organizing Tests

```
#include <cassert>
void run_tests();
int sum(int min, int max);

int main()
{
  run_tests();
  //what the program actually does
  return 0;
}
void run_tests()
{
  assert(sum(0,2) == 3);
  assert(sum(-2,2) == 0);
  assert(sum(3,7) == 25);
}
```

```
int sum(int min, int max)
{
  int sum=0;
  for(int i=min;i<=max;i++)
  {
    sum += i;
  }
  return sum;
}

int sumrec(int min, int max)
{
  if(min == max)
  {
    return min;
  }
  if(min < max)
  {
    return min + sumrec(min+1,max);
  }
}
```

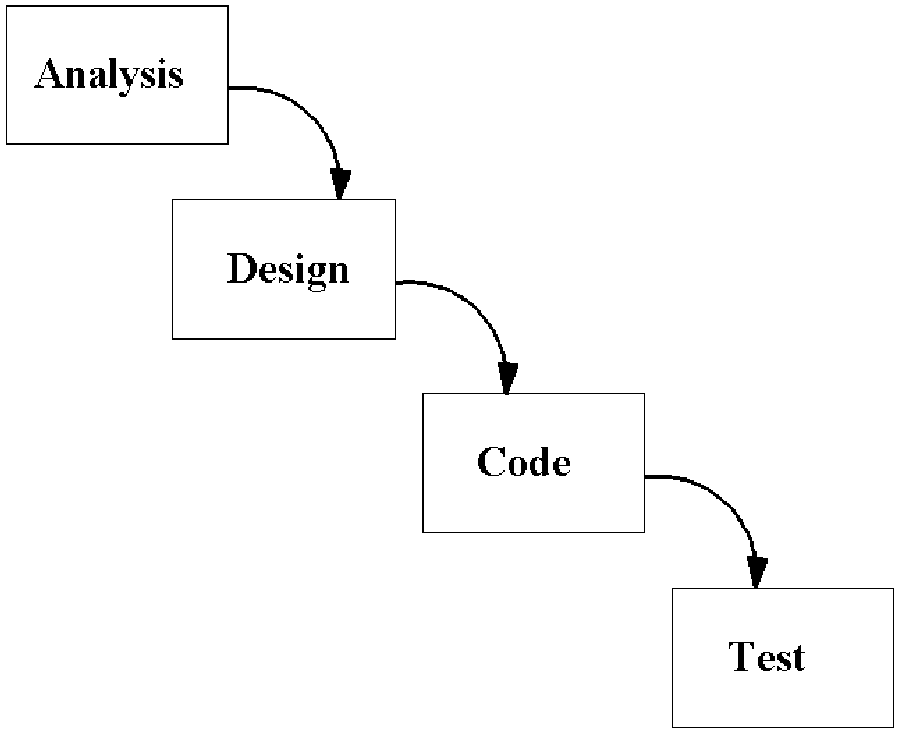
```
void run_tests()
{
  assert(sum(3,7) == 25);
  assert(sumrec(3,7) == 25);

  assert(sum(-2,3) == 3);
  assert(sumrec(-2,3) == 3);

  assert(sum(-5,5) == 0);
  assert(sumrec(-5,5) == 0);
}
```

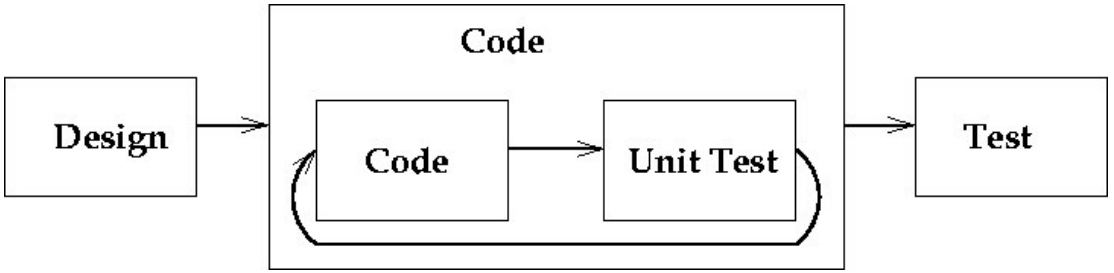
When do we test?

- Traditional linear/waterfall model
- “Big design up-front”



Test-First vs. Test-Last

- Test-Last process
  1. Design software
  2. Write code
  3. Write unit tests
  4. Repeat to 2



- Test-First process
  1. Write a unit test
  2. Write code to make test pass
  3. Refactor code and test
  4. Repeat to 1