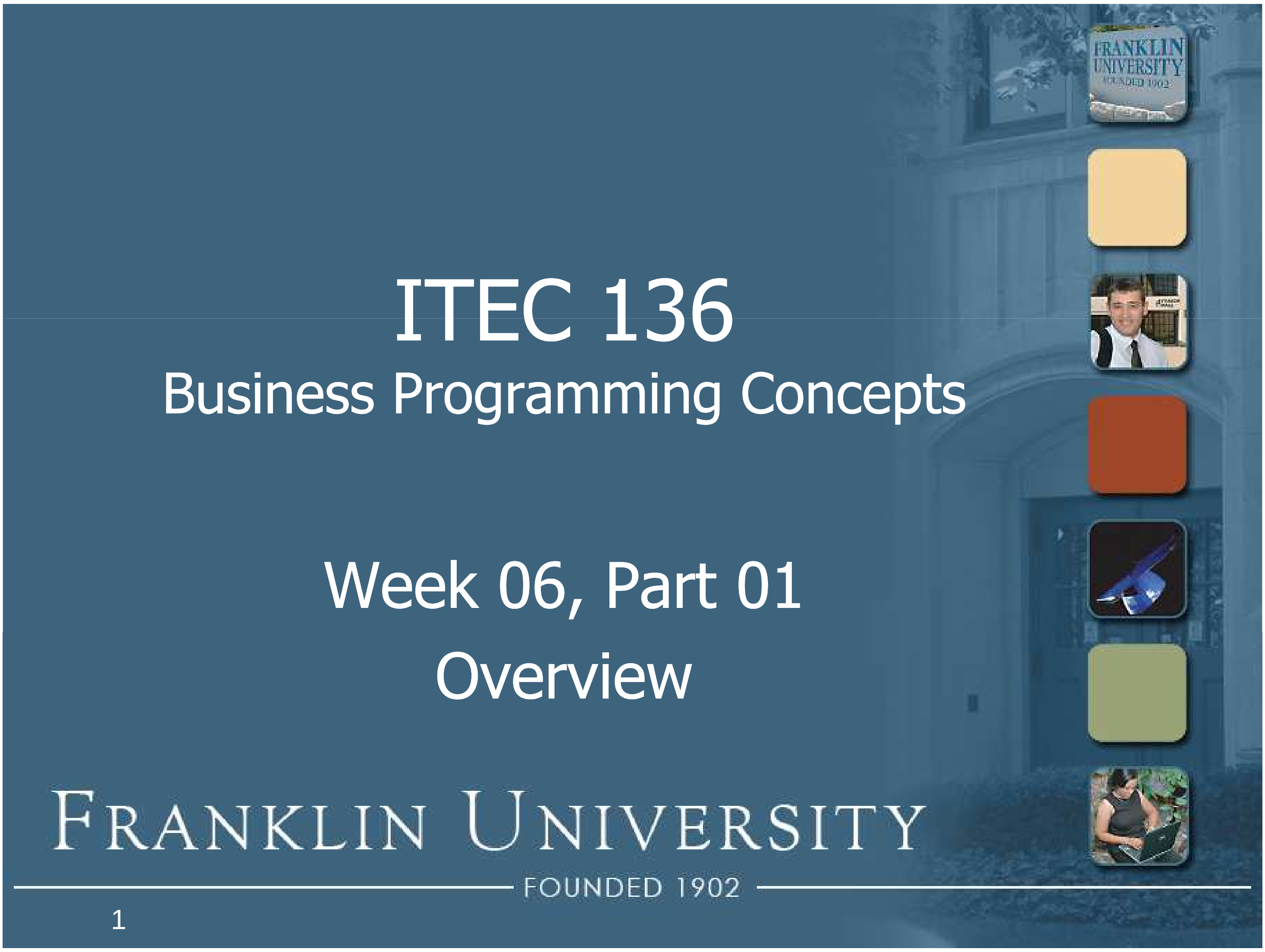

ITEC 136
Business Programming Concepts

Week 06, Part 01

Overview

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Week 6 Overview

- Week 5 review
  - Exam 1 (no new material)

Week 6 Overview

- Outcomes
  - Sketch the solution to a problem requiring iteration.
  - Write correct iterative code to solve a given problem.
  - Identify and correct common loop errors such as off-by-one errors, infinite loops, and non-executing loops.

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Business Programming Concepts

Week 06, Part 02

Repetition

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Repetition

- Repetition (aka Iteration)
  - Not many problems are solvable using only straight line and conditional execution with `if/else` and `case` statements.
  - Need an additional control structure that lets us execute the same code while some condition is true.

Repetition

- Example:
  - Input a number representing the length of a line and then “draw” the line using asterisks:
  - Input: 6, output: ******

Repetition

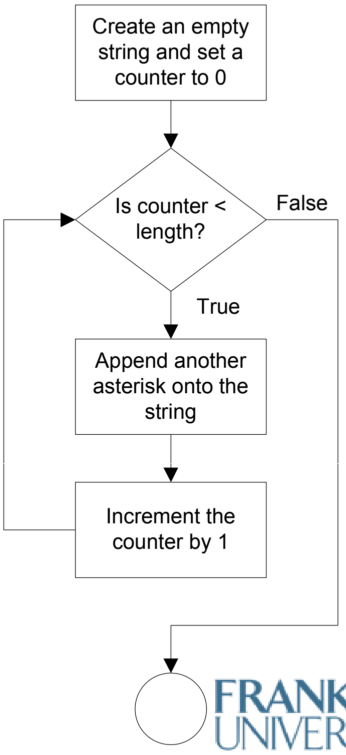
- An effort without repetition:

```
function makeLine(length, ch){
    var str = "";
    if (length >= 1)
        str += ch;
    if (length >= 2)
        str += ch;
    if (length >= 3)
        str += ch;
    //... and so on
    return str;
}
```

Since the length is variable based on the user’s input, there is no way to write enough code to handle all possible inputs!

Repetiton

- A better solution:



Create an empty string and set a counter to 0

Is counter < length?

False

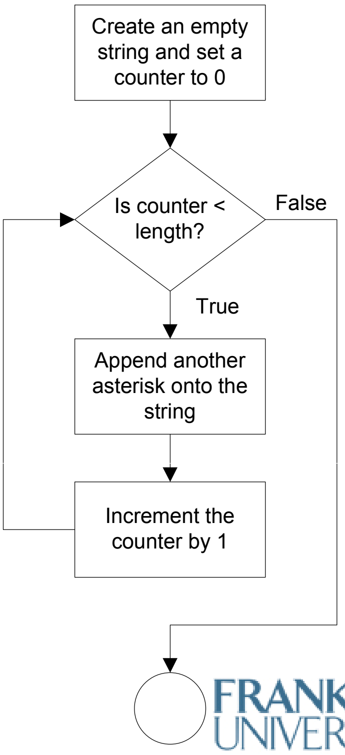
True

Append another asterisk onto the string

Increment the counter by 1

Repetiton

- A better solution:



Create an empty string and set a counter to 0

Is counter < length?

True

False

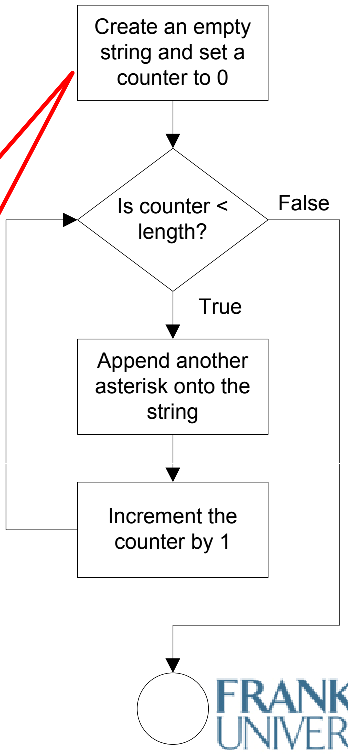
Append another asterisk onto the string

Increment the counter by 1

This line allows us to jump backwards and do something over again! Called a "loop."

Repetiton

- A better solution:
- Four parts to loops
  - Initialization



Create an empty string and set a counter to 0

Is counter < length?

True

False

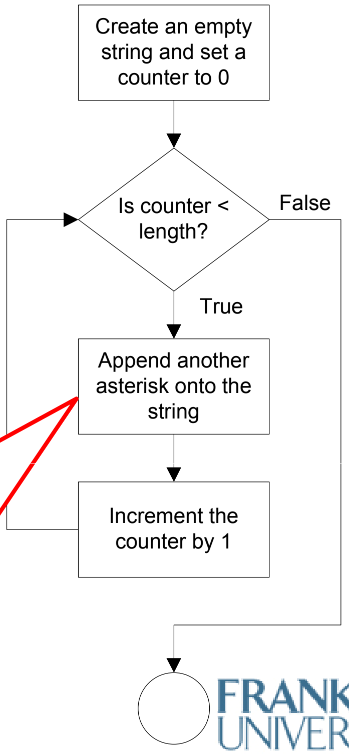
Append another asterisk onto the string

Increment the counter by 1

Sets up the loop so that it can be executed the first time (especially the condition variables). Ex: `counter=0;`

Repetiton

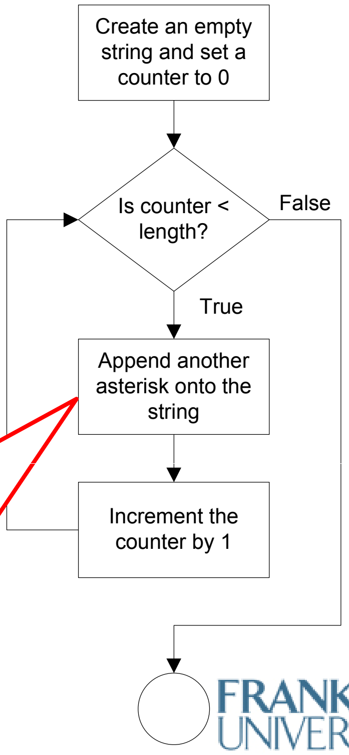
- A better solution:
- Four parts to loops
  - Initialization
  - Condition


Create an empty string and set a counter to 0
Is counter < length?
False
True
Append another asterisk onto the string
Increment the counter by 1

A Boolean expression that controls whether or not the loop executes again.
Ex: `counter < length`

Repetiton

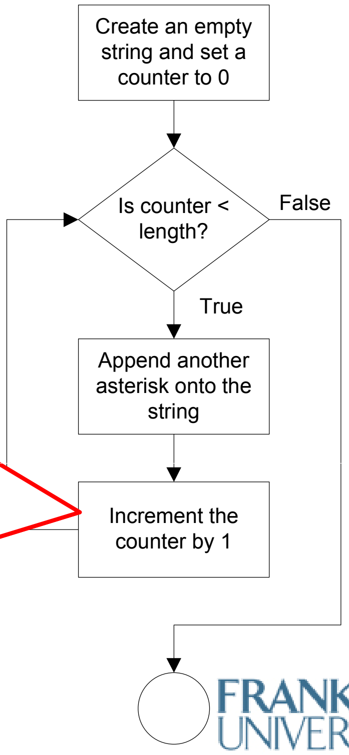
- A better solution:
- Four parts to loops
  - Initialization
  - Condition
  - Body


Create an empty string and set a counter to 0
Is counter < length?
False
True
Append another asterisk onto the string
Increment the counter by 1

The statement(s) that need to be repeatedly executed in order to solve the given problem.
Ex: `str += "*";`

Repetiton

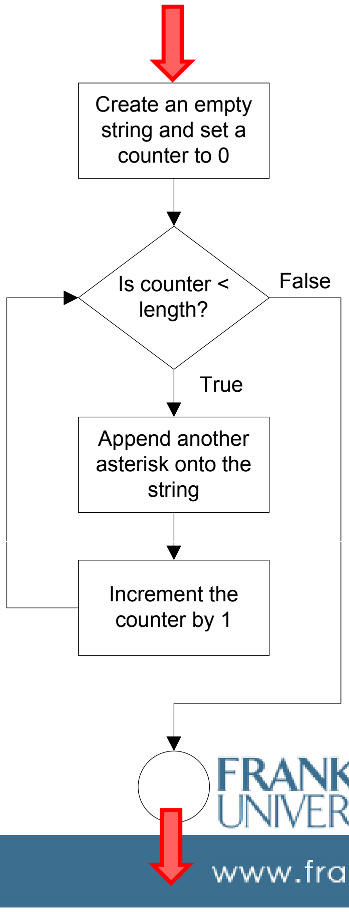
- A better solution:
- Four parts to loops
  - Initialization
  - Condition
  - Body
  - Update


Create an empty string and set a counter to 0
Is counter < length?
False
True
Append another asterisk onto the string
Increment the counter by 1

A change to one of the condition variables that makes progress toward the condition becoming false.
Ex: `++counter;`

Repetiton

- A better solution:
- Four parts to loops
  - Initialization
  - Condition
  - Body
  - Update


Create an empty string and set a counter to 0
Is counter < length?
False
True
Append another asterisk onto the string
Increment the counter by 1

Just like with if/else and case statements, there is one path in and one path out of the control structure.

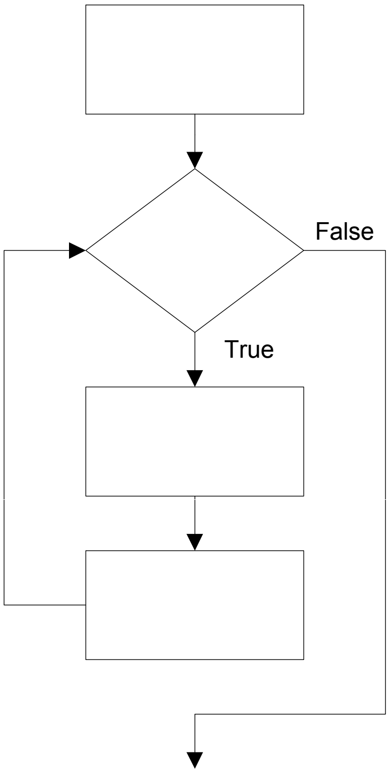
Repetition

- Try it yourself
  - Suppose `makeLine(length, ch)` exists, and produces a string of the given length using the given character.
  - Use `makeLine` to create a loop that produces a right triangle of a given height:

```
*
**
***
****
*****
```

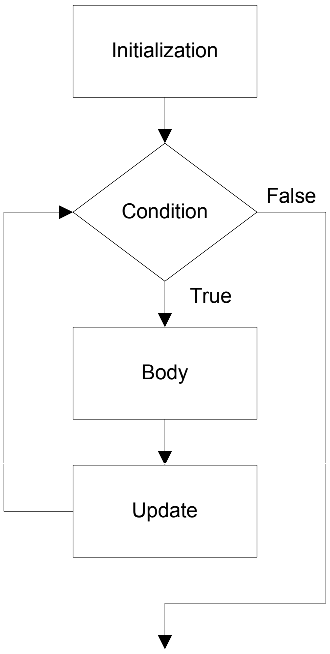
Here, the height is 5.

Repetition



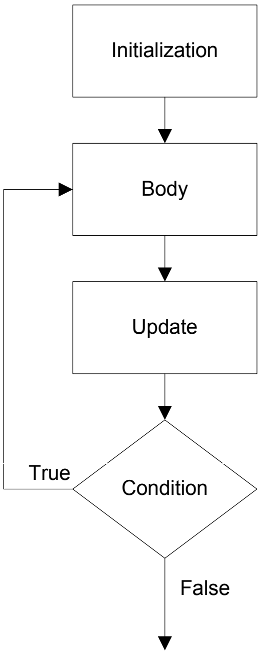
Repetition

- Pre-test loops
  - Condition is evaluated before the body of the loop is executed.
  - Key idea: body may not ever execute.



Repetition

- Post-test loops
  - Condition is evaluated after the body of the loop is executed.
  - Key idea: body always executes at least once



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Business Programming Concepts

Week 06, Part 03

Loop structure syntax

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while loops

- While loops:
  - Pre-test loop syntax

```
while (condition) {
    body_statements;
}
```

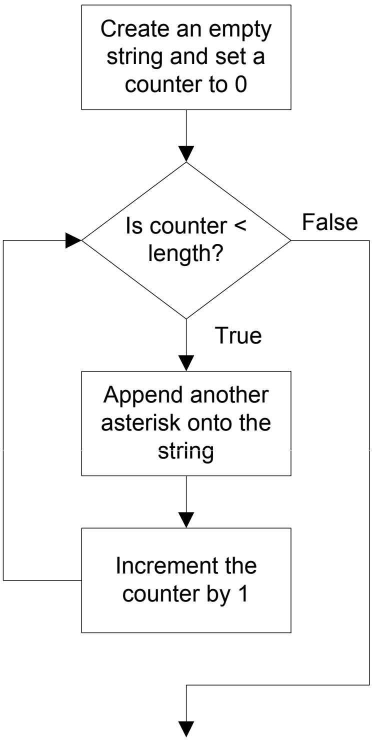
All that is really required. But, which of the four parts are missing?

while loops

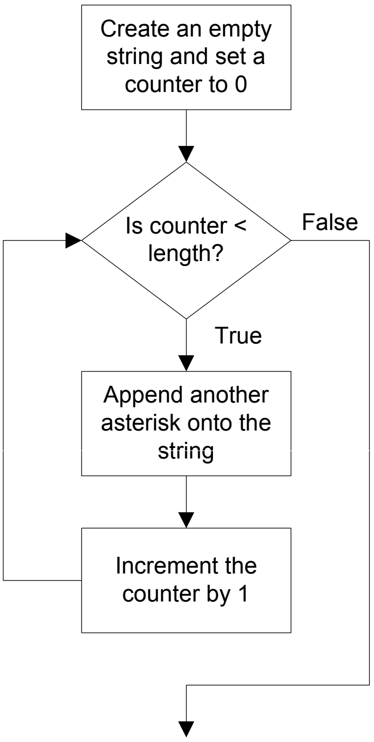
- While loops:
  - Pre-test loop syntax

```
initialization;
while (condition) {
    body_statements;
    update_statement;
}
```

while loops

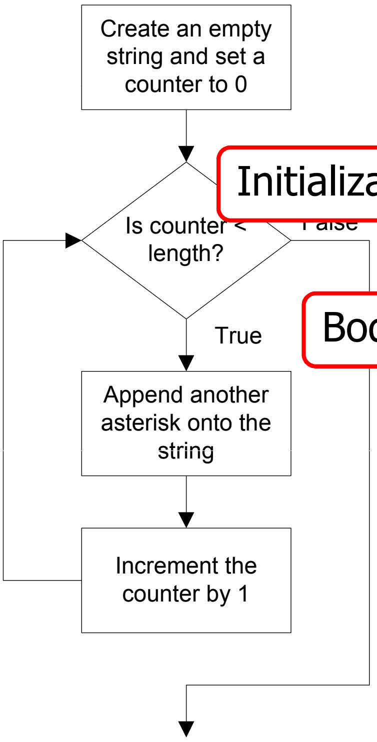

Create an empty string and set a counter to 0
Is counter < length?
False
True
Append another asterisk onto the string
Increment the counter by 1

while loops


Create an empty string and set a counter to 0
Is counter < length?
False
True
Append another asterisk onto the string
Increment the counter by 1

```
function makeLine(length, ch) {
    var str = "";
    var count = 0;

    while (count < length) {
        str += ch;
        ++count;
    }

    return str;
}
```

while loops


Create an empty string and set a counter to 0
Is counter < length?
False
True
Append another asterisk onto the string
Increment the counter by 1

```
function makeLine(length, ch) {
    var str = "";
    var count = 0;

    while (count < length) {
        str += ch;
        ++count;
    }

    return str;
}
```

Initialization

Body

Condition

Update

while loops

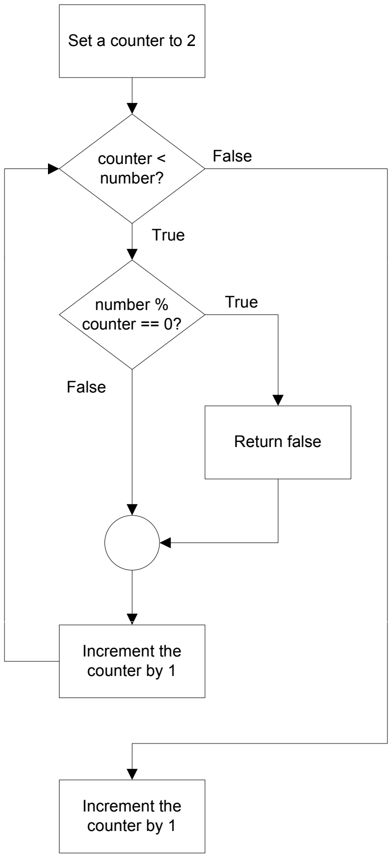
- Try it yourself:
  - Write the function `makeTriangle(height, ch)` that will produce the string containing a right-triangle.

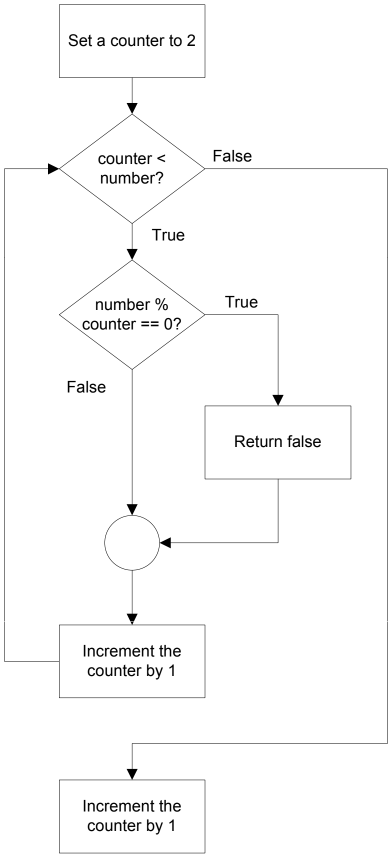
while loops

```
function makeTriangle(height, ch) {








}
```

`while` loops

- A little harder problem:
  - Write a function `isPrime(number)` that determines if the given number parameter is prime (i.e. is only divisible evenly by 1 and itself).
    - Hint 1: loop through all the numbers [2…(number-1)]
    - Hint 2: if the remainder when dividing is zero (modulus), then it is not prime.





Set a counter to 2

counter < number?

False

True

number % counter == 0?

True

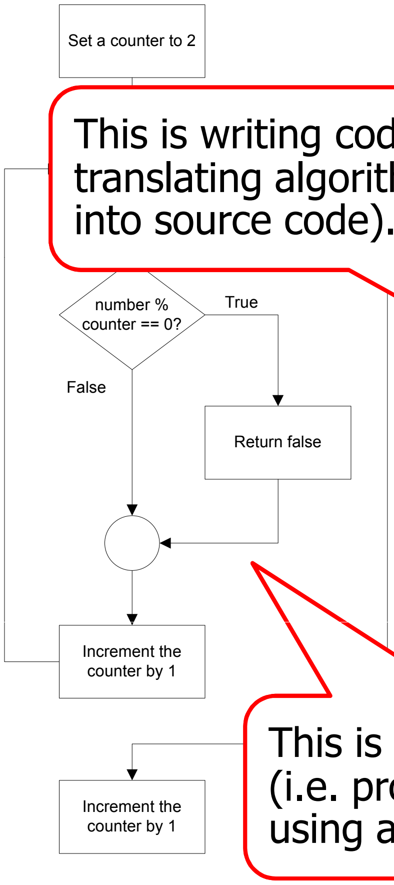
False

Return false

Increment the counter by 1

Increment the counter by 1

```
function isPrime(number){
  var counter = 2;
  while (counter < number) {
    if (number % counter == 0) {
      return false;
    }
    ++counter;
  }
  return true;
}
```



Set a counter to 2

number % counter == 0?

True

False

Return false

Increment the counter by 1

Increment the counter by 1

This is writing code (i.e. translating algorithms into source code).

```
   ction isPrime(number){
   ar counter = 2;
  while (counter < number) {
    if (number % counter == 0) {
      return false;
    }
    ++counter
  }
  return true
}
```

Which is harder?

This is program design (i.e. problem solving using algorithms).

for loops

- For loops:
  - Pre-test loop syntax

```
for (initialization; condition; update) {
        body_statements;
}
```

for loops

- For loops:
  - Pre-test loop syntax

```
for (initialization; condition; update) {
        body_statements;
}
```

This is precisely equivalent to:

```
initialization;
while (condition) {
    body_statements;
    update;
}
```

for loops

- Rewriting `isPrime` using a for-loop

```
function isPrime(number) {
  for (var counter = 0; counter < number; ++counter) {
    if (number % counter == 0) {
      return false
    }
  }
  return true;
}
```

for vs. while loops

- When to use `for` vs. `while`
  - Equivalent at runtime
  - `while` loops are a little more flexible (i.e. the update step can be conditional or in the middle of the body)
  - `for` loops are generally used for counting (i.e. the bounds are known)

do…while loops

- do…while loops:
  - Post-test loop syntax

```
do {
    body_statements;
} while (condition);
```

```
initialization;
do {
    body_statements;
    update;
} while (condition);
```

do…while loops

- do…while loops:
  - Post-test loop syntax

```
do {
    body_statements;
} while (condition);
```

```
initialization;
do {
    body_statements;
    update;
} while (condition);
```

Required elements.

All 4 elements.

do…while loops

- Post-test loops
  - Body always guaranteed to execute at least once.
  - But, we could still copy-and-paste the body above a pre-test loop and achieve the same results.

do…while loops

- Example: read input using prompt() ensuring that the user enters a positive number

```
var number;
do {
  number = parseInt(prompt(
    "Enter a positive number"));
} while (isNaN(number) || number < 0);

alert("Read number: " + number);
```

Key idea: initialization and update use the same code, so a natural fit for do…while

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Business Programming Concepts

Week 06, Part 04

Case study: Investment Calculator

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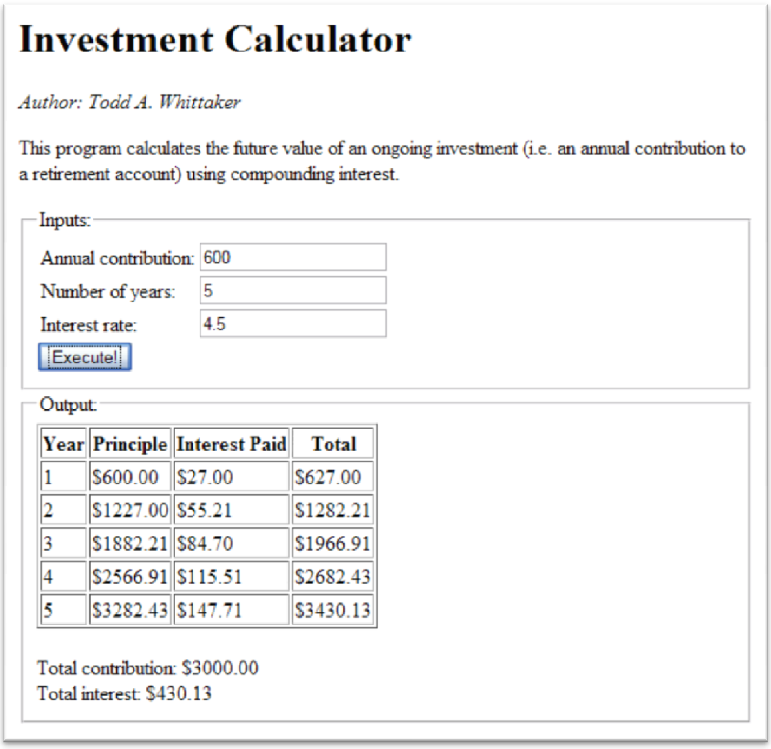
Case study



Investment Calculator

Author: Todd A. Whittaker

This program calculates the future value of an ongoing investment (i.e. an annual contribution to a retirement account) using compounding interest.

Inputs:

Annual contribution: 600

Number of years: 5

Interest rate: 4.5

Output:

Year	Principle	Interest Paid	Total
1	$600.00	$27.00	$627.00
2	$1227.00	$55.21	$1282.21
3	$1882.21	$84.70	$1966.91
4	$2566.91	$115.51	$2682.43
5	$3282.43	$147.71	$3430.13

Total contribution: $3000.00
Total interest: $430.13

Case Study

- Set up the HTML page

Investments.html

```
<html>
  <head>
    <title>Investment Calculator</title>
    <script type="text/javascript"
       src="div.js"></script>
    <script type="text/javascript"
       src="get.js"></script>
    <script type="text/javascript"
       src="Investments.js"></script>
  </head>
  <body>
    <h1>Investment Calculator</h1>
    <p><em>Author: Todd A. Whittaker</em></p>
```

Case Study

- Set up the HTML page

Investments.html

```
<fieldset><legend>Inputs:</legend>
  <table><tr>
    <td><label for="contrib">Annual contribution:</label></td>
    <td><input type="text" id="contrib" value="500" /></td>
  </tr><tr>
    <td><label for="years">Number of years:</label></td>
    <td><input type="text" id="years" value="20" /></td>
  </tr><tr>
    <td><label for="interest">Interest rate:</label></td>
    <td><input type="text" id="interest" value="4.5" /></td>
  </tr></table>
  <input type="button" value="Execute!"
    onclick="main('contrib', 'years', 'interest', 'output')" />
</fieldset>
```

Case Study

- Set up the HTML page

Investments.html

```
    <fieldset>
      <legend>Output:</legend>
      <div id="output"></div>
    </fieldset>
  </body>
</html>
```

Case Study

- Input validation

Investments.js

```
function main(contribID, yearsID, interestID, outputID) {
    var contrib = getFloat(contribID);
    var years = getInt(yearsID);
    var interest = getFloat(interestID);

    var errors = "";
    if (isNaN(contrib) || contrib < 0) {
        errors += "Contribution has a bad value.\n"
    }
```

Case Study

- Input validation

Investments.js

```
    if (isNaN(years) || years < 0) {
        errors += "Years has a bad value.\n"
    }
    if (isNaN(interest) || interest < 0) {
        errors += "Interest rate has a bad value.\n"
    }
    if (errors != "") {
        alert(errors);
        return;
    }
    var tableHtml = calculate(contrib, years, interest);
    setDiv(outputID, tableHtml);
}
```

Case Study

- Calculations

Investments.js

```
function calculate(contrib, years, interestRate) {
  var sumPrinciple = 0;
  var sumInterest = 0;
  var result = "";

  result += "<table border='1'><tr><th>Year</th>" +
    "<th>Principle</th><th>Interest Paid</th>" +
    "<th>Total</th></tr>";
```

Case Study

- Calculations

Investments.js

```
for (var year = 1; year <= years; ++year) {
  sumPrinciple += contrib;
  var interest = sumPrinciple * (interestRate / 100);
  result += "<tr>";
  result += td(year);
  result += td("$" + sumPrinciple.toFixed(2));
  result += td("$" + interest.toFixed(2));
  result += td("$" + (sumPrinciple + interest).toFixed(2));
  result += "</tr>";
  sumPrinciple += interest;
}
```

Case Study

- Calculations

Investments.js

```
for (var year = 1; year <= years; ++year) {
  sumPrinciple
  var interest
  result += "<t
  result += td(y
  result += td("$" +         nciple.toFixed(2));
  result += td("$" + interest.toFixed(2));
  result += td("$" + (sumPrinciple + interest).toFixed(2));
  result += "</tr>";
  sumPrinciple += interest;
}
```

```
function td(val) {
  return "<td>" + val + "</td>";
}
```

Case Study

- Calculations

Investments.js

```
  result += "</table><br />";
  result += "Total contribution: $" +
     (contrib * years).toFixed(2) + "<br />";
  result += "Total interest: $" +
     (sumPrinciple - contrib * years).toFixed(2) + "<br />";

  return result;
}
```

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Business Programming Concepts

Week 06, Part 05

Common Loop Errors

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Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Initialization or Condition
    - Could cause the loop to never execute

```
var i = 10;
while (i < 10) {
  document.writeln("i is " + i + "<br />");
  ++i;
}
```

Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Initialization or Condition
    - Could cause the loop to never execute

```
var i = 10;
while (i < 10) {
  document.writeln("i is " + i + "<br />");
  ++i;
}
```

i starts at 10, and 10 is not less than 10, so the loop body never executes.

Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Initialization or Condition
    - Could execute one too *many* times

```
var i = 0;
while (i <= 10) {
  document.writeln("i is " + i + "<br />");
  ++i;
}
```

Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Initialization or Condition
    - Could execute one too *many* times

```
var i = 0;
while (i <= 10) {
  document.writeln("i is " + i + "<br />");
  ++i;
}
```

Loop body actually executes 11 times, not 10 times.

Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Initialization or Condition
    - Could execute one too *few* times

```
var i = 1;
while (i < 10) {
  document.writeln("i is " + i + "<br />");
  ++i;
}
```

Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Initialization or Condition
    - Could execute one too *few* times

```
var i = 1;
while (i < 10) {
  document.writeln("i is " + i + "<br />");
  ++i;
}
```

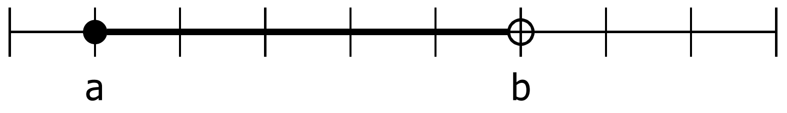
Loop body actually executes 9 times, not 10 times.

Co

- Loop er
  with ea
  - Initiali
    - Could exe ne too *few* times

Tip: programmers start counting with `0` and use `<` as their condition. To execute `10` times, initialize "i" to `0` and set the condition to "`i<10`". This is typical of left-bound-included and right-bound-excluded.

Remember 2nd grade number lines: [a, b)



```
var i = 1;
while (i < 10) {
  document.writeln("i is " + i + "<br />");
  ++i;
}
```

Loop body actually executes 9 times, not 10 times.

Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Condition or update
    - Could execute *forever*

```
var i = 0;
while (i < 10) {
  document.writeln("i is " + i + "<br />");

}
```

Common Loop Errors

- Loop errors are due to problems with each of the four components.
  - Condition or update
    - Could execute *forever*

```
var i = 0;
while (i < 10) {
  document.writeln("i is " + i + "<br />");

}
```

Note that the update step is *missing*. No progress is made toward the condition being `false`. An *incorrect* update (i.e. “`--i`”) would also do this.

Questions?

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Business Programming Concepts

Week 06, Part 06

Self Quiz

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Self Quiz

- Name and describe the four basic parts of every loop.
- Compare and contrast pre-test vs. post-test loops. What Javascript constructs correspond to each?
- Name 3 common loop errors and where to look for bugs.

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Self Quiz

- What is the output of the following code segment?

```
function whatAmI(number){
    var x = 0, y = 1;
    for (var i = 0; i < number; ++i) {
        var next = x + y;
        x = y;
        y = next;
    }
    return y;
}
document.writeln(whatAmI(5));
```

Self Quiz

- Rewrite the function `whatAmI` using a `while`-loop instead of a `for`-loop.
- Write a function that prints out all the numbers in the range [a, b) that are evenly divisible by 7 but not divisible by 5.

Self Quiz

- Write a function that receives a parameter X, and then reads in X numbers. It should then print out the average, minimum, and maximum or the numbers read.

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Business Programming Concepts

Week 06, Part 07

Upcoming deadlines

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Upcoming Deadlines

- Homework 5 – Due February 16
- Pre-class 7 – Due February 16
- Lab 2 – Due February 23