University of British Columbia
CPSC 111, Intro to Computation
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Arrays

Lecture 14, Tue Feb 28 2006

based on slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/cpsc111-06-spr

News

- Assignment 2
  - corrections to ASCIIArtiste.java posted
  - definitely read WebCT bboards!

Reading

- This week: 8.1, 8.5-8.7, topics 6.3 and 6.4

Recap: While Loop Example

```
public class WhileDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    while (counter <= limit)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    }
    System.out.println("End of demonstration");
  }
}
```

- **while** version

Recap: For Loop Example

```
public class ForDemo
{
  public static void main (String[] args)
  {
    for (int counter = 1; counter <= 3; counter = counter + 1)
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
    }
    System.out.println("End of demonstration");
  }
}
```

- **for** version

Recap: Do Loop Example

```
public class DoDemo
{
  public static void main (String[] args)
  {
    int limit = 3;
    int counter = 1;

    do
    {
      System.out.println("The square of " + counter +
                         " is " + (counter * counter));
      counter = counter + 1;
    } while (counter <= limit);

    System.out.println("End of demonstration");
  }
}
```

- **do** version

Recap: `For` Statement

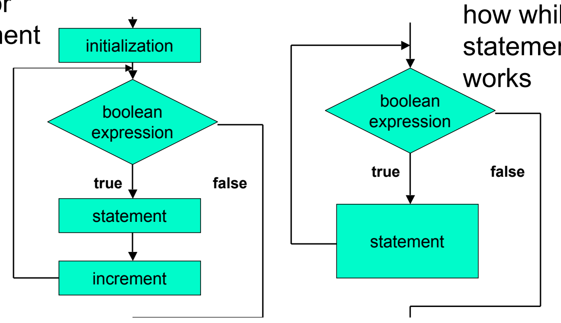
`for` (initialization; boolean expression; increment)
  body

- Body of loop can be
  - single statement
  - whole block of many statements in curly braces
- Control flow
  - first time through: initialization
  - boolean expression evaluated
  - if expression true, body executed; if false, end
  - increment processed
  - boolean expression evaluated
  - if true, body executed; if false, end
  - ….

Recap: `For` Versus `While` Statement

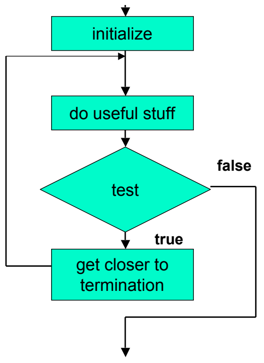
how for statement works

how while statement works



- flowcharts can be somewhat deceptive
  - need initialization and incrementing/modifying in while loop too
  - although syntax does not require it in specific spot

Recap: `Do` Statement



- Body always executed at least once

order of four things can change, but need them all

Objectives

- More practice with loops
- Understand when and how to use arrays
  - and loops over arrays

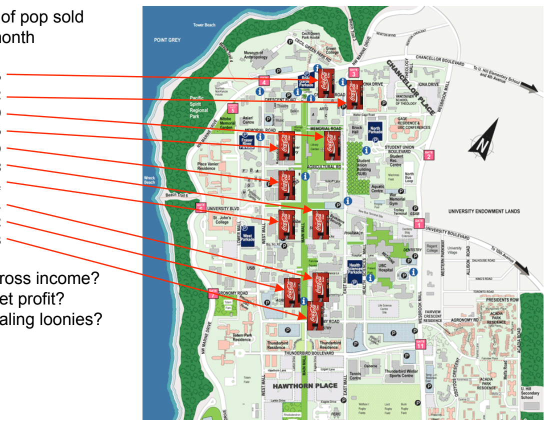
Flipping Coins

- Did **`while`** version last time
- Let's try **`for`** version now

Keeping Track of Things

Cans of pop sold this month

```
185
 92
370
485
209
128
 84
151
 32
563
```

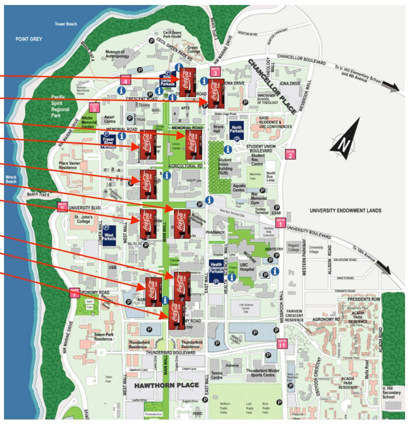


What's the gross income?
What's the net profit?
Is Bubba stealing loonies?

Keeping Track of Things

Cans of pop sold this month

```
185
 92
370
485
209
128
 84
151
 32
563
```



In other words, how can I organize the data above in my computer so that I can access it easily and do the computations I need to do?

Answer: Arrays

Cans of pop sold this month

```
185
 92
370
485
209
128
 84
151
 32
563
```

- use arrays: common programming language construct
  - grouping related data items together
  - meaningful organization such that each individual data item can be easily retrieved or updated

Answer: Arrays

cansSold

185
92
370
485
209
128
84
151
32
563

- use arrays: common programming language construct
  - grouping related data items together
  - meaningful organization such that each individual data item can be easily retrieved or updated
- collection of variables
  - all of same type
  - share common name
- each variable holds single value

Using Arrays

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

- Collection of variables has single name
  - how do we access individual values?

Using Arrays

cansSold

0	185
1	92
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- Collection of variables has single name
  - how do we access individual values?
- Each value stored at unique numbered position
  - number called index of array element
    - aka subscript
- cansSold name of this array
  - holds 10 values

Using Arrays

cansSold

0	185
1	92
2	370
3	485
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9	563

- To access individual value in array
  - use array name followed by pair of square brackets
  - inside brackets, place index of array element we want to access
- Reference to array element allowed anywhere that variables can be used
- Example:

```
System.out.println(cansSold[4]);
```

  - Prints value 209

Array Declaration and Types

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

- Just like ordinary variable, must
  - declare array before we use it
  - give array a type
- Since **`cansSold`** contains integers, make integer array:

```
int[] cansSold = new int[10]
```

- Looks like variable declaration, except:

Array Declaration and Types

cansSold

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```
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- Looks like variable declaration, except:
  - empty brackets on the left tell Java that **`cansSold`** is an array...

Array Declaration and Types

cansSold

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  - give array a type
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```
int[] cansSold = new int[10]
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- Looks like variable declaration, except:
  - empty brackets on the left tell Java that cansSold is an array...
  - the number in the brackets on the right tell Java that array should have room for 10 elements when it's created

Array Declaration and Types

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int[10] cansSold = new int[10]
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  - empty brackets on the left tell Java that cansSold is an array...
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  - DO NOT put size of array in brackets on the left

Array Declaration and Types

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```
int[10] cansSold = new int[10]
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  - empty brackets on the left tell Java that cansSold is an array...
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  - DO NOT put size of array in brackets on the left

Array Declaration and Types

cansSold

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1	92
2	370
3	485
4	209
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7	151
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```
public class ArrayTest1
{
  public static void main(String[] args)
  {
    final int ARRAYSIZE = 10;
    int[] cansSold = new int[ARRAYSIZE];

    cansSold[0] = 185;
    cansSold[1] = 92;
    cansSold[2] = 370;
    cansSold[3] = 485;
    cansSold[4] = 209;
    cansSold[5] = 128;
    cansSold[6] = 84;
    cansSold[7] = 151;
    cansSold[8] = 32;
    cansSold[9] = 563;

    // do useful stuff here
    System.out.println("Element 4 is " +
                       cansSold[4]);
  }
}
```

Array Declaration and Types

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

```
public class ArrayTest2
{
  public static void main(String[] args)
  {

    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    // do useful stuff here
    System.out.println("Element 4 is " +
                       cansSold[4]);
  }
}
```

- Can also use initializer list
- Right side of declaration does not include type or size
  - Java figures out size by itself
- Types of values on right must match type declared on left
- Initializer list may only be used when array is first declared

Using Arrays and Loops

- Write program to
  - create array
  - find total number of cans sold
  - print result

cansSold

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Using Arrays and Loops

- Write program to
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  - print result

cansSold

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1	92
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6	84
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```
public class ArrayTest3
{









}
```

Using Arrays and Loops

- Write program to
  - create array
  - find total number of cans sold
  - print result

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

```
public class ArrayTest3
{
  public static void main(String[] args)
  {







  }
}
```

Using Arrays and Loops

- Write program to
  - create array
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cansSold

0	185
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8	32
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```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;






  }
}
```

Using Arrays and Loops

- Write program to
  - create array
  - find total number of cans sold
  - print result

cansSold

0	185
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public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};




  }
}
```

Using Arrays and Loops

- Write program to
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  - find total number of cans sold
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cansSold

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```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0;





  }
}
```

Using Arrays and Loops

- Write program to
  - create array
  - find total number of cans sold
  - print result

cansSold

0	185
1	92
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3	485
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```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length;





  }
}
```

Using Arrays and Loops

- Write program to
  - create array
  - find total number of cans sold
  - print result

cansSold

0	185
1	92
2	370
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```
public class ArrayTest3
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  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)





  }
}
```

Using Arrays and Loops

- Write program to
  - create array
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  - print result

cansSold

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  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }


  }
}
```

Using Arrays and Loops

- Write program to
  - create array
  - find total number of cans sold
  - print result

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
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```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");

  }
}
```

Tracing Arrays and Loops

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
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Tracing Arrays and Loops

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                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");

  }
}
```

```
totalCans   0
```

Tracing Arrays and Loops

```
cansSold.length  10
    cansSold
    0 185
    1  92
    2 370
    3 485
    4 209
    5 128
    6  84
    7 151
    8  32
    9 563
```

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
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                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");

  }
}
```

```
totalCans   0
```

Tracing Arrays and Loops

```
cansSold.length  10
    cansSold
  → 0 185
    1  92
    2 370
    3 485
    4 209
    5 128
    6  84
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    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");

  }
}
```

```
        i   0
totalCans   0
```

Tracing Arrays and Loops

```
cansSold.length  10
    cansSold
  → 0 185
    1  92
    2 370
    3 485
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    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");

  }
}
```

```
        i   0
totalCans   0
```

- Is i < 10?
  - yes, 0 < 10

Tracing Arrays and Loops

```
cansSold.length  10
    cansSold
  → 0 185
    1  92
    2 370
    3 485
    4 209
    5 128
    6  84
    7 151
    8  32
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```

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public class ArrayTest3
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      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");

  }
}
```

```
        i   0
totalCans 185
```

Tracing Arrays and Loops

```
cansSold.length  10
    cansSold
    0 185
  → 1  92
    2 370
    3 485
    4 209
    5 128
    6  84
    7 151
    8  32
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public class ArrayTest3
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    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");

  }
}
```

```
        i   1
totalCans 185
```

Tracing Arrays and Loops

cansSold.length 10

cansSold

	0	185
→	1	92
	2	370
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    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

i 1

totalCans 185

- Is i < 10?
  - yes, 1 < 10

Tracing Arrays and Loops

cansSold.length 10

cansSold

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    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

i 1

totalCans 277

Tracing Arrays and Loops

cansSold.length 10

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  }
}
```

i 2

totalCans 277

Tracing Arrays and Loops

cansSold.length 10

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    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

i 2

totalCans 277

- Is i < 10?
  - yes, 2 < 10

Tracing Arrays and Loops

cansSold.length 10

cansSold

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→	2	370
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                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

i 2

totalCans 647

Tracing Arrays and Loops

cansSold.length 10

cansSold

	0	185
	1	92
	2	370
→	3	485
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    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

i 3

totalCans 647

Tracing Arrays and Loops

```
cansSold.length  10
     cansSold
     0 185
     1  92
     2 370
  →  3 485
     4 209
     5 128
     6  84
     7 151
     8  32
     9 563

        i     3
totalCans   647
```

```
public class ArrayTest3
{
   public static void main(String[] args)
   {
      int totalCans = 0;
      int[] cansSold = {185, 92, 370, 485, 209,
                        128, 84, 151, 32, 563};

      for (int i = 0; i < cansSold.length; i++)
      {
         totalCans = totalCans + cansSold[i];
      }
      System.out.println("We've sold " + totalCans
                         + " cans of pop");
   }
}
```

- Is i < 10?
  - yes, 3 < 10

Tracing Arrays and Loops

```
cansSold.length  10
     cansSold
     0 185
     1  92
     2 370
  →  3 485
     4 209
     5 128
     6  84
     7 151
     8  32
     9 563

        i     3
totalCans  1132
```

```
public class ArrayTest3
{
   public static void main(String[] args)
   {
      int totalCans = 0;
      int[] cansSold = {185, 92, 370, 485, 209,
                        128, 84, 151, 32, 563};

      for (int i = 0; i < cansSold.length; i++)
      {
         totalCans = totalCans + cansSold[i];
      }
      System.out.println("We've sold " + totalCans
                         + " cans of pop");
   }
}
```

Tracing Arrays and Loops

```
cansSold.length  10
     cansSold
     0 185
     1  92
     2 370
     3 485
  →  4 209
     5 128
     6  84
     7 151
     8  32
     9 563

        i     4
totalCans  1132
```

```
public class ArrayTest3
{
   public static void main(String[] args)
   {
      int totalCans = 0;
      int[] cansSold = {185, 92, 370, 485, 209,
                        128, 84, 151, 32, 563};

      for (int i = 0; i < cansSold.length; i++)
      {
         totalCans = totalCans + cansSold[i];
      }
      System.out.println("We've sold " + totalCans
                         + " cans of pop");
   }
}
```

Tracing Arrays and Loops

```
cansSold.length  10
     cansSold
     0 185
     1  92
     2 370
     3 485
  →  4 209
     5 128
     6  84
     7 151
     8  32
     9 563

        i     4
totalCans  1132
```

```
public class ArrayTest3
{
   public static void main(String[] args)
   {
      int totalCans = 0;
      int[] cansSold = {185, 92, 370, 485, 209,
                        128, 84, 151, 32, 563};

      for (int i = 0; i < cansSold.length; i++)
      {
         totalCans = totalCans + cansSold[i];
      }
      System.out.println("We've sold " + totalCans
                         + " cans of pop");
   }
}
```

- Is i < 10?
  - yes, 4 < 10

Tracing Arrays and Loops

```
cansSold.length  10
     cansSold
     0 185
     1  92
     2 370
     3 485
  →  4 209
     5 128
     6  84
     7 151
     8  32
     9 563

        i     4
totalCans  1341
```

```
public class ArrayTest3
{
   public static void main(String[] args)
   {
      int totalCans = 0;
      int[] cansSold = {185, 92, 370, 485, 209,
                        128, 84, 151, 32, 563};

      for (int i = 0; i < cansSold.length; i++)
      {
         totalCans = totalCans + cansSold[i];
      }
      System.out.println("We've sold " + totalCans
                         + " cans of pop");
   }
}
```

- And so on…

Tracing Arrays and Loops

```
cansSold.length  10
     cansSold
     0 185
     1  92
     2 370
     3 485
     4 209
  →  5 128
     6  84
     7 151
     8  32
     9 563

        i     5
totalCans  1469
```

```
public class ArrayTest3
{
   public static void main(String[] args)
   {
      int totalCans = 0;
      int[] cansSold = {185, 92, 370, 485, 209,
                        128, 84, 151, 32, 563};

      for (int i = 0; i < cansSold.length; i++)
      {
         totalCans = totalCans + cansSold[i];
      }
      System.out.println("We've sold " + totalCans
                         + " cans of pop");
   }
}
```

- And so on…

Tracing Arrays and Loops

```
cansSold.length  10
      cansSold
      0 185
      1  92
      2 370
      3 485
      4 209
      5 128
  →   6  84
      7 151
      8  32
      9 563

          i       6
  totalCans    1553
```

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- And so on…

Tracing Arrays and Loops

```
cansSold.length  10
      cansSold
      0 185
      1  92
      2 370
      3 485
      4 209
      5 128
      6  84
  →   7 151
      8  32
      9 563

          i       7
  totalCans    1704
```

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- And so on…

Tracing Arrays and Loops

```
cansSold.length  10
      cansSold
      0 185
      1  92
      2 370
      3 485
      4 209
      5 128
      6  84
      7 151
  →   8  32
      9 563

          i       8
  totalCans    1736
```

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- And so on…

Tracing Arrays and Loops

```
cansSold.length  10
      cansSold
      0 185
      1  92
      2 370
      3 485
      4 209
      5 128
      6  84
      7 151
      8  32
  →   9 563

          i       9
  totalCans    2299
```

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- And so on…

Tracing Arrays and Loops

```
cansSold.length  10
      cansSold
      0 185
      1  92
      2 370
      3 485
      4 209
      5 128
      6  84
      7 151
      8  32
      9 563
  →

          i      10
  totalCans    2299
```

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

Tracing Arrays and Loops

```
cansSold.length  10
      cansSold
      0 185
      1  92
      2 370
      3 485
      4 209
      5 128
      6  84
      7 151
      8  32
      9 563
  →

          i      10
  totalCans    2299
```

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- Is i < 10?
  - no, 10 not < 10

Tracing Arrays and Loops

cansSold.length 10

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

i 10

totalCans 2299

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i < cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- "We've sold 2299 cans of pop" printed out

Tracing Arrays and Loops

cansSold.length 10

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

i 10

totalCans 2299

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i <= cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- What would happen if we made this little change?

Tracing Arrays and Loops

cansSold.length 10

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

i 10

totalCans 2299

```
public class ArrayTest3
{
  public static void main(String[] args)
  {
    int totalCans = 0;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};

    for (int i = 0; i <= cansSold.length; i++)
    {
      totalCans = totalCans + cansSold[i];
    }
    System.out.println("We've sold " + totalCans
                       + " cans of pop");
  }
}
```

- What would happen if we made this little change?

```
java.lang.ArrayIndexOutOfBoundsException: 10
```

Something To Remember

cansSold.length 10

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

- Array `cansSold` created with 10 elements
  - Indices (plural of index) are 0 through 9
- In general, array of size n will have indices ranging from 0 through n-1
- When you number things, you're used to beginning with 1
- Computer folks begin with 0
  - leads to "off by one" errors, even among computer veterans

Initializing Array With Keyboard Input

cansSold

0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

```
import java.util.Scanner;
public class ArrayTest3b
{
  public static void main(String[] args)
  {
    final int ARRAYSIZE = 10;
    int[] cansSold = new int[ARRAYSIZE];
    Scanner scan = new Scanner(System.in);

    for (int i = 0; i < cansSold.length; i++)
    {
      System.out.print("Enter machine " +
   (i+1));
      cansSold[i] = scan.nextInt();
    }

    // do useful stuff here
    System.out.println("Element 4 is " +
                       cansSold[4]);
  }
}
```

Averaging Loop Example

numbers

0	6
1	8
2	11
3	18
4	20
5	17
6	14
7	10
8	5
9	2

- Let's say we want to write a program that prints average of values in some arbitrarily large array
  - like the one to the left called numbers
- Will require loop
- Simple task for looping in the context of an array
  - how will we make this happen?

PrintMax Loop Example

	numbers
0	6
1	8
2	11
3	18
4	20
5	17
6	14
7	10
8	5
9	2

- Now instead of average, we want to find and print maximum value from some arbitrarily large array
  - Similar loop, but with some extra tweaks.

Histogram Loop Example

	numbers	
0	6	******
1	8	********
2	11	***********
3	18	******************
4	20	********************
5	17	*****************
6	14	**************
7	10	**********
8	5	*****
9	2	**

- Now use same data as basis for histogram
  - Write one loop to look at value associated with each row of array
    - for each value print a line with that many asterisks
    - For example, if program reads value 6 from the array, should print line of 6 asterisks
      - Program then reads the value 8, prints a line of 8 asterisks, and so on.
- Need outer loop to read individual values in the array
- Need inner loop to print asterisks for each value

Storing Different Data Types

	cansSold
0	185
1	92
2	370
3	485
4	209
5	128
6	84
7	151
8	32
9	563

Storing Different Data Types

	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75

Could use two arrays of same size but with different types

Storing Different Data Types

	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75

- Write program to compare what's been collected from each machine vs. how much should have been collected?

Could use two arrays of same size but with different types

Storing Different Data Types

	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75

Could use two arrays of same size but with different types

- Write program to compare what's been collected from each machine vs. how much should have been collected?

```java
public class ArrayTest4
{
  public static void main(String[] args)
  {
    double expected;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};
    double[] cashIn = {201.25, 100.50, 412.75,
                       555.25, 195.00, 160.00,
                       105.00, 188.75, 40.00,
                       703.75};
    for (int i = 0; i < cansSold.length; i++)
    {
      expected = cansSold[i] * 1.25;
      System.out.println("Machine " + (i + 1) +
                         " off by $" +
                         (expected - cashIn[i]));
    }
  }
}
```

Storing Different Data Types

	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75

- Write program to compare what's been collected from each machine vs. how much should have been collected?

```
public class ArrayTest4
{
  public static void main(String[] args)
  {
    double expected;
    int[] cansSold = {185, 92, 370, 485, 209,
                      128, 84, 151, 32, 563};
    double[] cashIn = {201.25, 100.50, 412.75,
                       555.25, 195.00, 160.00,
                       105.00, 188.75, 40.00,
                       703.75};
    for (int i = 0; i < cansSold.length; i++)
    {
      expected = cansSold[i] * 1.25;
      System.out.println("Machine " + (i + 1) +
                         " off by $" +
                         (expected - cashIn[i]));
    }
  }
}
```

Could use two arrays of same size but with different types

What happens when we run the program?

Storing Different Data Types

	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75

```
Machine 0 off by $30.0
Machine 1 off by $14.5
Machine 2 off by $49.75
Machine 3 off by $51.0
Machine 4 off by $66.25
Machine 5 off by $0.0
Machine 6 off by $0.0
Machine 7 off by $0.0
Machine 8 off by $0.0
Machine 9 off by $0.0
```

Somebody has been stealing from the machines after all! We need an anti-theft plan…

Arrays With Non-Primitive Types

	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75

- Great if you're always storing primitives like integers or floating point numbers
  - What if we want to store String types too?
  - remember that String is an object, not a primitive data type

Arrays With Non-Primitive Types

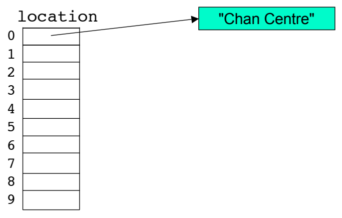
	cansSold		cashIn		location
0	185	0	201.25	0	
1	92	1	100.50	1	
2	370	2	412.75	2	
3	485	3	555.25	3	
4	209	4	195.00	4	
5	128	5	160.00	5	
6	84	6	105.00	6	
7	151	7	188.75	7	
8	32	8	40.00	8	
9	563	9	703.75	9	

- Then we create array of objects
  - In this case objects will be Strings
- Array won't hold actual object
  - holds references: pointers to objects

```
String[] location = new String[10];
```

Arrays of Objects

	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75

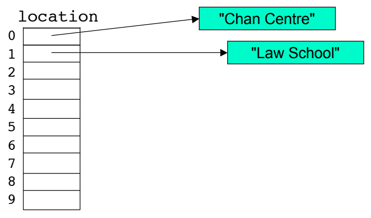


- Now we can put references to Strings in our String array.

```
location[0] = "Chan Centre";
```

Arrays of Objects

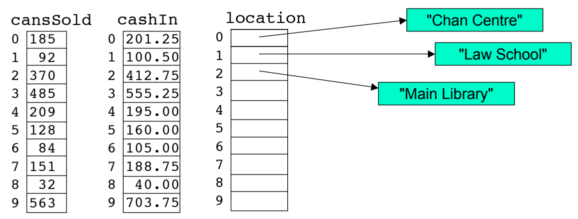
	cansSold		cashIn
0	185	0	201.25
1	92	1	100.50
2	370	2	412.75
3	485	3	555.25
4	209	4	195.00
5	128	5	160.00
6	84	6	105.00
7	151	7	188.75
8	32	8	40.00
9	563	9	703.75



- Now we can put references to Strings in our String array.

```
location[0] = "Chan Centre";
location[1] = "Law School";
```

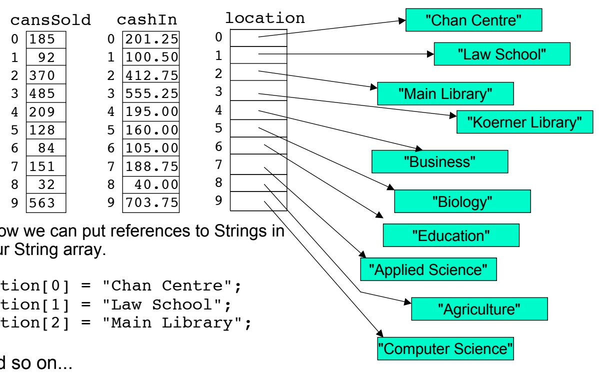
Arrays of Objects



- Now we can put references to Strings in our String array.

```
location[0] = "Chan Centre";
location[1] = "Law School";
location[2] = "Main Library";
```

Arrays of Objects

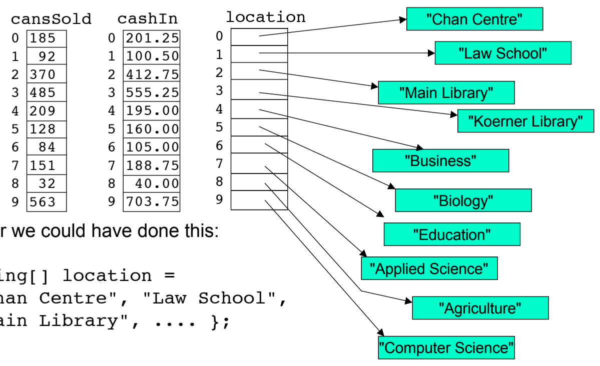


- Now we can put references to Strings in our String array.

```
location[0] = "Chan Centre";
location[1] = "Law School";
location[2] = "Main Library";
```

...and so on...

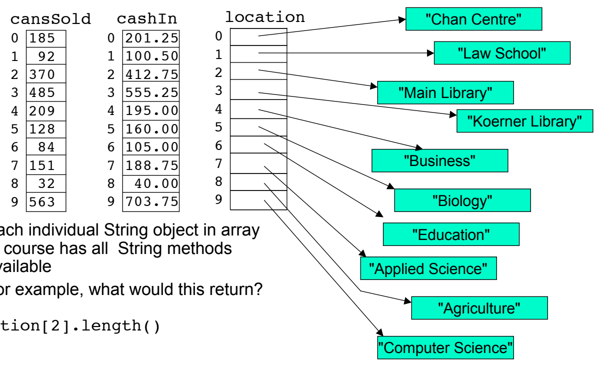
Arrays of Objects



- Or we could have done this:

```
String[] location =
{"Chan Centre", "Law School",
 "Main Library", .... };
```

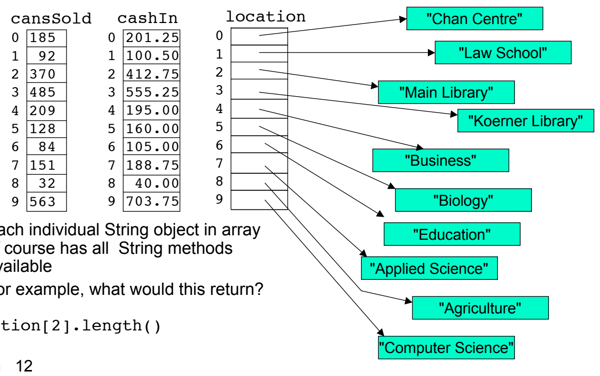
Arrays of Objects



- Each individual String object in array of course has all String methods available
- For example, what would this return?

```
location[2].length()
```

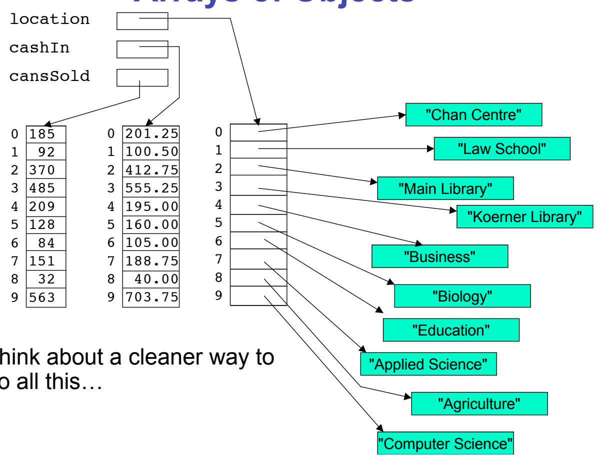
Arrays of Objects



- Each individual String object in array of course has all String methods available
- For example, what would this return?

```
location[2].length()
```

Arrays of Objects



- Think about a cleaner way to do all this…