Arrays

Lecture 21, Mon Mar 8 2010

borrowing from slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/111-10
Reading

This week:
- Chap 7: 7.1, 7.5-7.7. Topics 7.3 and 7.4 (3rd ed)
- Chap 8: 8.1, 8.5-8.7. Topics 6.3 and 6.4 (2nd ed)
News

- Midterms returned before break
  - get yours after class if you didn't already

- Departmental announcements
Department of Computer Science
Undergraduate Events

Events this week

Drop-In Resume and Cover Letter Editing (20 min. appointments)
Date: Thurs., March 11
Time: 11:30 am – 2:30 pm
Location: Rm 255, ICICS/CS

Townhall Meeting for Combined Majors /Honours, Cogs, BA, B.Comm in CS
Date: Thurs., March 11
Time: 12:30 – 2 pm
Location: DMP 310
Lunchn will be provided!

CS Distinguished Lecture Series Featuring David Parkes
Title: Incentive Mechanism Engineering in the Internet Age
Date: Thurs., Mar 11
Time: 3:30 – 4:50 pm
Location: DMP 110

CSSS Movie Night: “Zombieland” & “Iron Man”
Date: Thurs., Mar 11
Time: 6 – 10 pm
Location: DMP 310
Free pop & popcorn for every attendee!

Events next week

Interview Skills Practice Session
Mon., March 15, 12 – 2 pm, Rm 202, ICICS/CS

Transport Canada Info Session
Tues., March 16, 4 – 6 pm, HENN 201

Financial Literacy 101
Wed., March 17, 12 – 1 pm, Angus 426

Townhall Meeting for CS Major/Honours Students
Thurs., March 18, 12:30 – 2 pm, DMP 310

CS Distinguished Lecture Series Featuring Jeff Hawkins
Thurs., March 18, 3:30 – 4:50 pm, DMP 110
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
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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?
Cans of pop sold this month:

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

**Answer: Arrays**

- 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

- 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

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

- 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

- 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:

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

- Prints value 209
Array Declaration and Types

- Just like ordinary variable, must
  - declare array before we use it
  - give array a type
- Since `cansSold` contains integers, make integer array:
  ```java
  int[] cansSold = new int[10]
  ```
- Looks like variable declaration, except:

<table>
<thead>
<tr>
<th>cansSold</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
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  - empty brackets on the left tell Java that `cansSold` is an array...
Array Declaration and Types

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  - 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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  - 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
  - **DO NOT** put size of array in brackets on the left

```
cansSold
0   185
1   92
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Array Declaration and Types

- Just like ordinary variable, must
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  - 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
  - DO NOT put size of array in brackets on the left
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[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

```java
public class ArrayTest2 {
    public static void main(String[] args) {
        int[] cansSold = {185, 92, 370, 485, 209, 128, 84, 151, 32, 563};
        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

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```java
public class ArrayTest3 {
    public static void main(String[] args) {
        //
    }
}
```
Using Arrays and Loops

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```java
public class ArrayTest3 {
    public static void main(String[] args) {
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    }
}
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        for (int i = 0;
        }
    }
}
```
Using Arrays and Loops

■ Write program to
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        for (int i = 0; i < cansSold.length; i++)
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}

totalCans 0
Tracing Arrays and Loops

cansSold.length = 10

cansSold
  0  185
  1  92
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totalCans = 0
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}
```

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

---

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: 0

totalCans: 0
Tracing Arrays and Loops

cansSold.length = 10

cansSold

<table>
<thead>
<tr>
<th>i</th>
<th>totalCans</th>
</tr>
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<tr>
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        }
        System.out.println("We've sold " + totalCans + " cans of pop");
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}
```

- Is i < 10?
  - yes, 1 < 10
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}
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- Is i < 10?
  - yes, 2 < 10
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```java
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");
    }
}
```

- `cansSold.length` = 10
- `cansSold[0]` = 185
- `cansSold[1]` = 92
- `cansSold[2]` = 370
- `cansSold[5]` = 128
- `cansSold[6]` = 84
- `cansSold[7]` = 151
- `cansSold[8]` = 32
- `cansSold[9]` = 563

- `totalCans` = 647
- `i` = 3
Tracing Arrays and Loops

```java
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
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");
    }
}
public class ArrayTest3 {
    public static void main(String[] args) {
        int totalCans = 0;
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        for (int i = 0; i < cansSold.length; i++) {
            totalCans = totalCans + cansSold[i];
        }
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    }
}
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```java
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
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");
    }
}
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

```java
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

```
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");
    }
}
```

---

<table>
<thead>
<tr>
<th>i</th>
<th>totalCans</th>
<th>cansSold</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1704</td>
<td>185</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>92</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>370</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>485</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>209</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>128</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>84</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>151</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>563</td>
</tr>
</tbody>
</table>

And so on...
Tracing Arrays and Loops

```java
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

```java
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 += cansSold[i];
        }

        System.out.println("We've sold "+totalCans+" cans of pop");
    }
}
```

And so on...
Tracing Arrays and Loops

```java
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");
    }
}
```

```
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
```
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;
        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");
    }
}

i 10

Is i < 10?
no, 10 not < 10
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

```java
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++) { // What would happen if we made this little change?
            totalCans = totalCans + cansSold[i];
        }

        System.out.println("We've sold " + totalCans + " cans of pop");
    }
}
```
Tracing Arrays and Loops

```java
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

<table>
<thead>
<tr>
<th>cansSold</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>185</td>
</tr>
<tr>
<td>1</td>
<td>92</td>
</tr>
<tr>
<td>2</td>
<td>370</td>
</tr>
<tr>
<td>3</td>
<td>485</td>
</tr>
<tr>
<td>4</td>
<td>209</td>
</tr>
<tr>
<td>5</td>
<td>128</td>
</tr>
<tr>
<td>6</td>
<td>84</td>
</tr>
<tr>
<td>7</td>
<td>151</td>
</tr>
<tr>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td>563</td>
</tr>
</tbody>
</table>

- 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
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

- 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

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

<table>
<thead>
<tr>
<th>numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
</tbody>
</table>
Histogram Loop Example

- 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

<table>
<thead>
<tr>
<th>numbers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>
### Storing Different Data Types

<table>
<thead>
<tr>
<th>cansSold</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
</tr>
<tr>
<td>1 92</td>
</tr>
<tr>
<td>2 370</td>
</tr>
<tr>
<td>3 485</td>
</tr>
<tr>
<td>4 209</td>
</tr>
<tr>
<td>5 128</td>
</tr>
<tr>
<td>6 84</td>
</tr>
<tr>
<td>7 151</td>
</tr>
<tr>
<td>8 32</td>
</tr>
<tr>
<td>9 563</td>
</tr>
</tbody>
</table>
Storing Different Data Types

<table>
<thead>
<tr>
<th>cansSold</th>
<th>cashIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
<td>0 201.25</td>
</tr>
<tr>
<td>1 92</td>
<td>1 100.50</td>
</tr>
<tr>
<td>2 370</td>
<td>2 412.75</td>
</tr>
<tr>
<td>3 485</td>
<td>3 555.25</td>
</tr>
<tr>
<td>4 209</td>
<td>4 195.00</td>
</tr>
<tr>
<td>5 128</td>
<td>5 160.00</td>
</tr>
<tr>
<td>6 84</td>
<td>6 105.00</td>
</tr>
<tr>
<td>7 151</td>
<td>7 188.75</td>
</tr>
<tr>
<td>8 32</td>
<td>8 40.00</td>
</tr>
<tr>
<td>9 563</td>
<td>9 703.75</td>
</tr>
</tbody>
</table>

Could use two arrays of same size but with different types
Storing Different Data Types

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

<table>
<thead>
<tr>
<th>cansSold</th>
<th>cashIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
<td>0 201.25</td>
</tr>
<tr>
<td>1 92</td>
<td>1 100.50</td>
</tr>
<tr>
<td>2 370</td>
<td>2 412.75</td>
</tr>
<tr>
<td>3 485</td>
<td>3 555.25</td>
</tr>
<tr>
<td>4 209</td>
<td>4 195.00</td>
</tr>
<tr>
<td>5 128</td>
<td>5 160.00</td>
</tr>
<tr>
<td>6 84</td>
<td>6 105.00</td>
</tr>
<tr>
<td>7 151</td>
<td>7 188.75</td>
</tr>
<tr>
<td>8 32</td>
<td>8 40.00</td>
</tr>
<tr>
<td>9 563</td>
<td>9 703.75</td>
</tr>
</tbody>
</table>

Could use two arrays of same size but with different types
Storing Different Data Types

- 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
### Storing Different Data 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]));
        }
    }
}
```

<table>
<thead>
<tr>
<th>cansSold</th>
<th>cashIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
<td>0 201.25</td>
</tr>
<tr>
<td>1 92</td>
<td>1 100.50</td>
</tr>
<tr>
<td>2 370</td>
<td>2 412.75</td>
</tr>
<tr>
<td>3 485</td>
<td>3 555.25</td>
</tr>
<tr>
<td>4 209</td>
<td>4 195.00</td>
</tr>
<tr>
<td>5 128</td>
<td>5 160.00</td>
</tr>
<tr>
<td>6 84</td>
<td>6 105.00</td>
</tr>
<tr>
<td>7 151</td>
<td>7 188.75</td>
</tr>
<tr>
<td>8 32</td>
<td>8 40.00</td>
</tr>
<tr>
<td>9 563</td>
<td>9 703.75</td>
</tr>
</tbody>
</table>

Could use two arrays of same size but with different types

What happens when we run the program?
## Storing Different Data Types

<table>
<thead>
<tr>
<th>cansSold</th>
<th>cashIn</th>
<th>Machine</th>
<th>Off by</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
<td>0 201.25</td>
<td>0</td>
<td>$30.0</td>
</tr>
<tr>
<td>1 92</td>
<td>1 100.50</td>
<td>1</td>
<td>$14.5</td>
</tr>
<tr>
<td>2 370</td>
<td>2 412.75</td>
<td>2</td>
<td>$49.75</td>
</tr>
<tr>
<td>3 485</td>
<td>3 555.25</td>
<td>3</td>
<td>$51.0</td>
</tr>
<tr>
<td>4 209</td>
<td>4 195.00</td>
<td>4</td>
<td>$66.25</td>
</tr>
<tr>
<td>5 128</td>
<td>5 160.00</td>
<td>5</td>
<td>$0.0</td>
</tr>
<tr>
<td>6 84</td>
<td>6 105.00</td>
<td>6</td>
<td>$0.0</td>
</tr>
<tr>
<td>7 151</td>
<td>7 188.75</td>
<td>7</td>
<td>$0.0</td>
</tr>
<tr>
<td>8 32</td>
<td>8 40.00</td>
<td>8</td>
<td>$0.0</td>
</tr>
<tr>
<td>9 563</td>
<td>9 703.75</td>
<td>9</td>
<td>$0.0</td>
</tr>
</tbody>
</table>

Somebody has been stealing from the machines after all! We need an anti-theft plan...
Arrays With Non-Primitive Types

<table>
<thead>
<tr>
<th>cansSold</th>
<th>cashIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
<td>0 201.25</td>
</tr>
<tr>
<td>1 92</td>
<td>1 100.50</td>
</tr>
<tr>
<td>2 370</td>
<td>2 412.75</td>
</tr>
<tr>
<td>3 485</td>
<td>3 555.25</td>
</tr>
<tr>
<td>4 209</td>
<td>4 195.00</td>
</tr>
<tr>
<td>5 128</td>
<td>5 160.00</td>
</tr>
<tr>
<td>6 84</td>
<td>6 105.00</td>
</tr>
<tr>
<td>7 151</td>
<td>7 188.75</td>
</tr>
<tr>
<td>8 32</td>
<td>8 40.00</td>
</tr>
<tr>
<td>9 563</td>
<td>9 703.75</td>
</tr>
</tbody>
</table>

- 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

- 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

<table>
<thead>
<tr>
<th>cansSold</th>
<th>cashIn</th>
<th>location</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
<td>0 201.25</td>
<td>0 Chan Centre</td>
</tr>
<tr>
<td>1 92</td>
<td>1 100.50</td>
<td></td>
</tr>
<tr>
<td>2 370</td>
<td>2 412.75</td>
<td></td>
</tr>
<tr>
<td>3 485</td>
<td>3 555.25</td>
<td></td>
</tr>
<tr>
<td>4 209</td>
<td>4 195.00</td>
<td></td>
</tr>
<tr>
<td>5 128</td>
<td>5 160.00</td>
<td></td>
</tr>
<tr>
<td>6 84</td>
<td>6 105.00</td>
<td></td>
</tr>
<tr>
<td>7 151</td>
<td>7 188.75</td>
<td></td>
</tr>
<tr>
<td>8 32</td>
<td>8 40.00</td>
<td></td>
</tr>
<tr>
<td>9 563</td>
<td>9 703.75</td>
<td></td>
</tr>
</tbody>
</table>

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

location[0] = "Chan Centre";
## Arrays of Objects

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

```java
location[0] = "Chan Centre";
location[1] = "Law School";
```
Arrays of Objects

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

```java
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.

```java
location[0] = "Chan Centre";
location[1] = "Law School";
location[2] = "Main Library";
...and so on...
```
### Arrays of Objects

<table>
<thead>
<tr>
<th>cansSold</th>
<th>cashIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 185</td>
<td>0 201.25</td>
</tr>
<tr>
<td>1 92</td>
<td>1 100.50</td>
</tr>
<tr>
<td>2 370</td>
<td>2 412.75</td>
</tr>
<tr>
<td>3 485</td>
<td>3 555.25</td>
</tr>
<tr>
<td>4 209</td>
<td>4 195.00</td>
</tr>
<tr>
<td>5 128</td>
<td>5 160.00</td>
</tr>
<tr>
<td>6 84</td>
<td>6 105.00</td>
</tr>
<tr>
<td>7 151</td>
<td>7 188.75</td>
</tr>
<tr>
<td>8 32</td>
<td>8 40.00</td>
</tr>
<tr>
<td>9 563</td>
<td>9 703.75</td>
</tr>
</tbody>
</table>

- Or we could have done this:

```java
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?

```java
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?

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

- 12
Arrays of Objects

- location
- cashIn
- cansSold

<table>
<thead>
<tr>
<th>location</th>
<th>cashIn</th>
<th>cansSold</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>185</td>
<td>201.25</td>
</tr>
<tr>
<td>1</td>
<td>92</td>
<td>100.50</td>
</tr>
<tr>
<td>2</td>
<td>370</td>
<td>412.75</td>
</tr>
<tr>
<td>3</td>
<td>485</td>
<td>555.25</td>
</tr>
<tr>
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<td>209</td>
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<td>32</td>
<td>40.00</td>
</tr>
<tr>
<td>9</td>
<td>563</td>
<td>703.75</td>
</tr>
</tbody>
</table>

- Think about a cleaner way to do all this…