Some slides contain lots of animation; you must be in class to fully understand them.

Writing a Java Program (2/2)

covering

** using our new programming skills to write a real program (and learning some new ones on the way!)
** **`ArrayList`**
** Java API

Chapter 6 (*) – "Head First Java" book

(*) *Example from the chapter*

Using arrays and problems with arrays

- Fixed size:
  - Arrays cannot grow and shrink in size.
- Not easy to change the order of elements:
  - Difficult to insert or remove elements.

```
Rabbit[] racers = new Rabbit[2];
Rabbit r1 = new Rabbit();
//r1 set up
racers[0] = r1;

Rabbit r2 = new Rabbit();
//r2 set up
racers[1] = r2;
```

1. Change the size to **3**

How to add one more **`Rabbit r3`** to the index 1?

2. Add **`r2`** to index 2: **`racers[2] = r2;`**
3. Add **`r3`** in index 1: **`racers[1] = r3;`**

How to swap **`r2`** and **`r3`**?
We need a temp place …

The operations are difficult and every time we need to modify the code!

import java.util.ArrayList;

http://download.oracle.com/javase/8/docs/api/

Modifier and Type	Method and Description
boolean	add(E e) Appends the specified element to the end of this list.
E	get(int index) Returns the element at the specified position in this list.
int	indexOf(Object o) Returns the index of the first occurrence of the specified element in this list, or -1 if this list does not contain the element.
boolean	isEmpty() Returns true if this list contains no elements.
boolean	contains(Object o) Returns true if this list contains the specified element.
E	remove(int index) Removes the element at the specified position in this list.
boolean	remove(Object o) Removes the first occurrence of the specified element from this list, if it is present.
int	size() Returns the number of elements in this list.

These are only some of the methods available for **ArrayLists**; method **add()** is a bit stranger than listed here!

ArrayLists (1/3)

Assume we already have a **`Flower`** class:

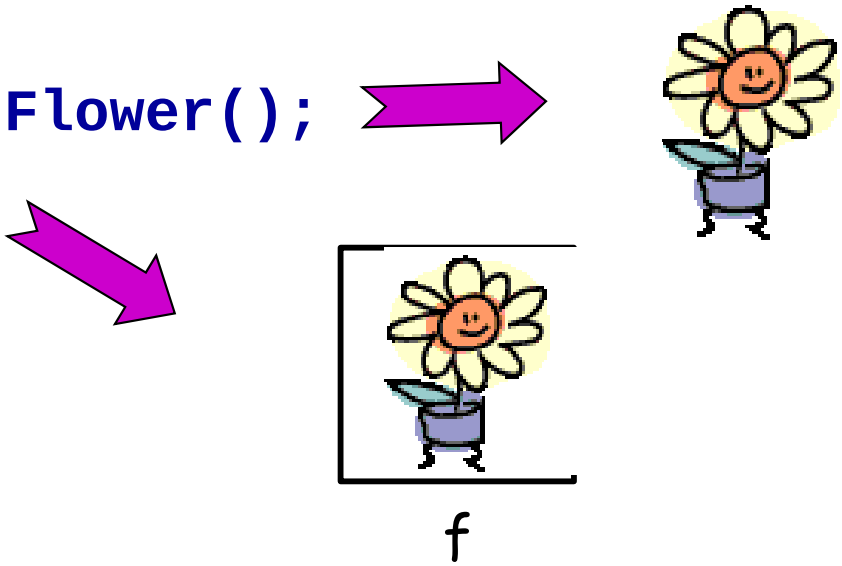
1. Make a list of **`Flower`**s:

```
ArrayList<Flower> myList = new ArrayList<Flower>();
```

A new **`ArrayList`** object on the heap.
It is little because it is empty.

2. Put something in it:

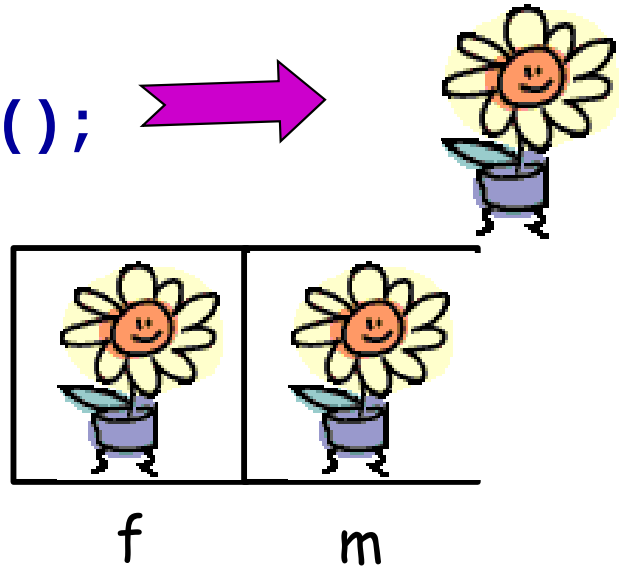
```
Flower f = new Flower();
myList.add(f);
```



ArrayLists (2/3)

3. Put something else in it:

```
Flower m = new Flower();
myList.add(m);
```



4. Find out how many things are in it:

```
int size = myList.size();
```

2

5. Find out if it contains something:

```
boolean inIt = myList.contains(f);
```

true

ArrayLists (3/3)

6. Find out where in the list something is:

```
int index = myList.indexOf(f);
```

0

`ArrayList`s are still zero-based (just like arrays)!

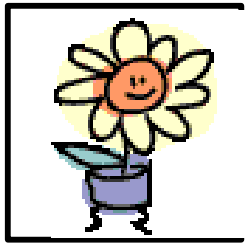
7. Find out if the list is empty:

```
boolean empty = myList.isEmpty();
```

false

8. Remove something from the list:

```
myList.remove(f);
```



m

array *versus* ArrayList (1/2)

1. An array needs to know its size at time of creation, whereas an **ArrayList** does not:

   a. `new String[6];`

   b. `new ArrayList<E>();`

2. To assign an object in a regular array, you must assign it to a specific index.

   a. `myList[4] = b;`

   b. `myArrayList.add(b);`

array *versus* ArrayList (2/2)

3. Arrays use array syntax (`[ ]`) that is not used anywhere else in Java. `ArrayList`s use standard dot notation:

   a. `myList[4];`

   b. `myArrayList.get(4);`

4. `ArrayList`s are parameterised.

   b. Parametrised types were introduced in Java 5.0.

   `ArrayList<String>`

   The `< >` indicate the type of `ArrayList`. This list is a list of `String`s, as opposed to `ArrayList<Rabbit>` which would be a list of `Rabbit`s (and only `Rabbit`s!).

… and things for you to try out!

Sink a Dot Com [Revision]

- Let us come back to the game …

CMD

```
>java SimpleDotComGame
Enter a number
0
miss
Enter a number
1
miss
Enter a number
2
miss
Enter a number
3
hit
Enter a number
4
hit
Enter a number
5
kill
You took 6 guesses

>
```

The first test ... Passed!
All seems to work fine, but ...

CMD

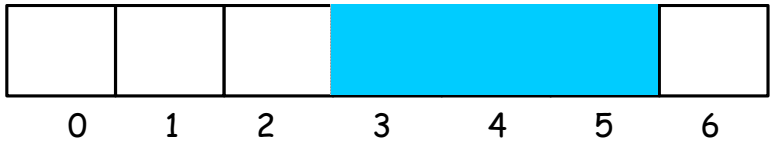
```
>java SimpleDotComGame
Enter a number
4
hit
Enter a number
4
hit
Enter a number
4
kill
You took 3 guesses

>_
```

The second test … Failed!
The "Dot Com" is killed if the same cell is used 3 times …

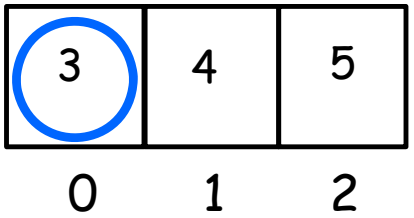
How do we fix the problem? (1/2)

- Our virtual row with the 3-cell **`SimpleDotCom`** object:



- Remember: our program actually finds out where the "Dot Com" is, by asking it. The "Dot Com" knows where it is, by using its **`cellLocation`** array:

```
int numberOfHits = 0
int[] cellLocation =
```



instance variables

player makes a guess ...

`guess = 4?` ⇒ check the entire array …

check at position 0 …

`cellLocation[0] = 3` ⇒ no match!

How do we fix the problem? (2/2)

instance variables

```
int numberOfHits = 1
```

int[] cellLocation =

3	4	5
0	1	2

---

guess = 4?

check at position 1 … **cellLocation[1] = 4** ⇒ match!

If the user guessed **4** again, the interaction would be repeated. The **numberOfHits** gets incremented, even if the player has hit there before...
To find the bug, lets look at variable **numberOfHits**.

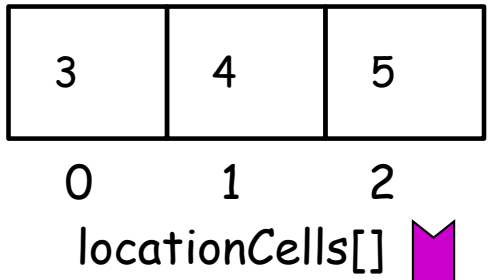
So what happened?

```
public String checkYourself(String stringGuess) {
  int guess = Integer.parseInt(stringGuess);
  String result = "miss";
  for (int cell : this.locationCells) {
    if (guess == cell) {
      result = "hit";
      this.numberOfHits++;
      break;
    }
  }
  if (this.numberOfHits == this.locationCells.length) {
    result = "kill";
  }
  System.out.println(result);
  return result;
}
```

We did not check to see if it is a different cell that was hit …

Option 1

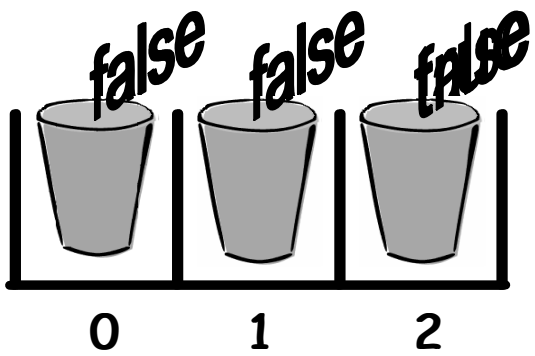
- Make a second **`boolean`** array called **`hitsArray`**.
  - Initialise all locations to **`false`**.
  - Each time a user makes a hit, change the respective location to **`true`**.



Check if location is in array.

Check if it has been hit before

If it hasn't been hit: update and return hit/kill.

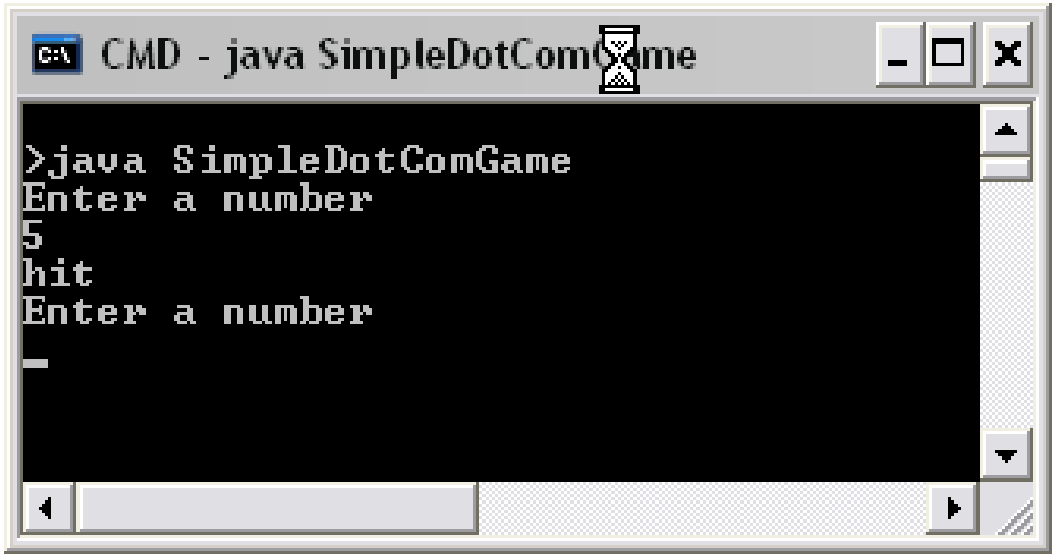


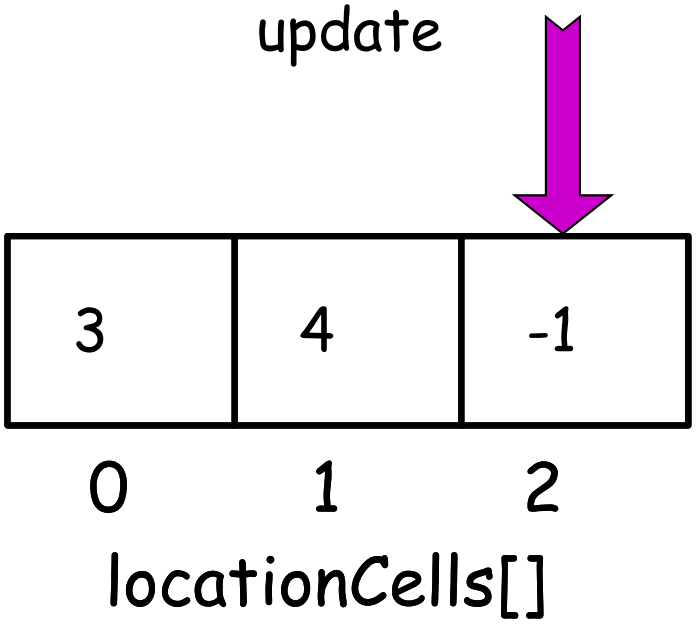
boolean[] hitsArray = new boolean[2]

Option 1 … too 'clunky'! Option 2?

- Option 1 is quite a bit of work!
- Have to check this, check that, update this, etc, etc …

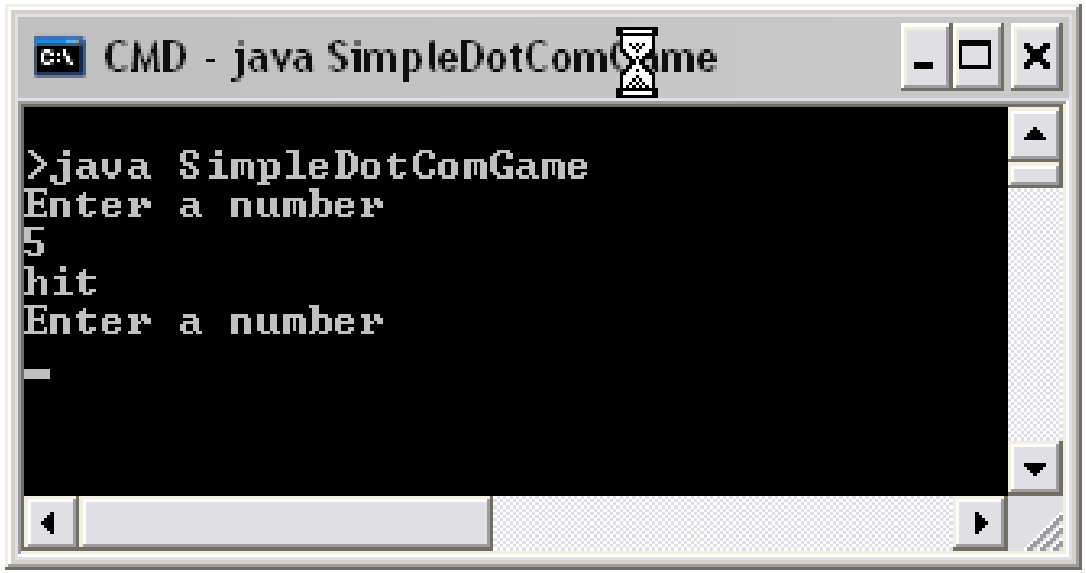
- Option 2:
  - Keep the array as it is, but change the value stored there, if it gets hit!

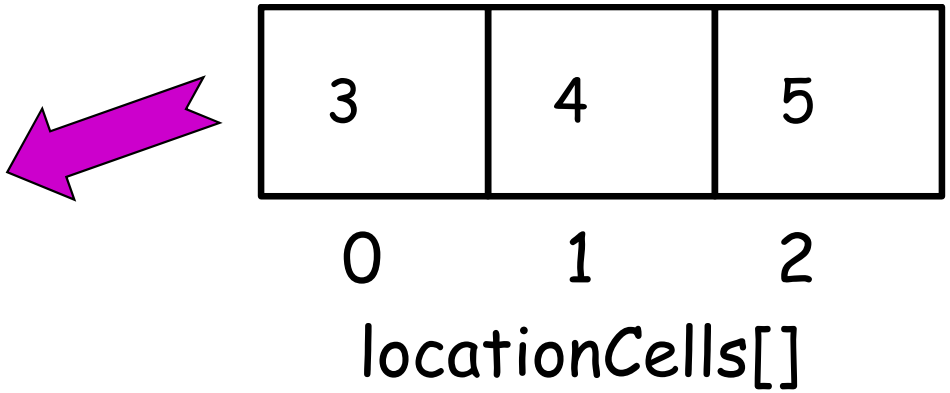


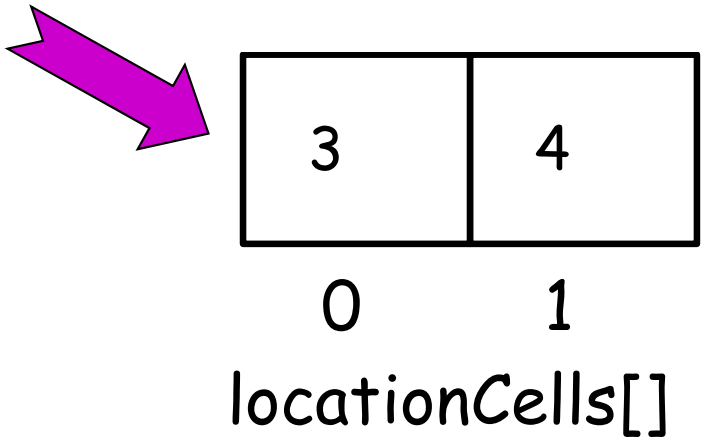


Option 2 … still a bit ‘clunky’! Option 3?

- Option 3:
  - Delete each cell location as it gets hit, and modify the array to be smaller.







Option 3 (cont.)

- Standard arrays cannot grow and shrink in size.

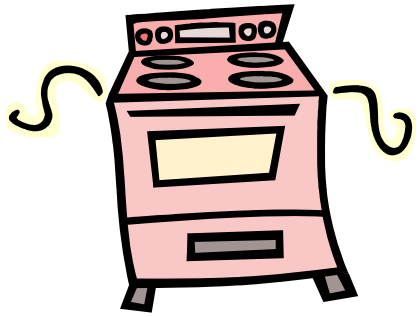
- Therefore to do this, we must create a new smaller array when the "Dot Com" is hit and reassign it to the instance variable **`locationCells[]`**.

- This option would be much more appealing if arrays could grow and shrink …

But they cannot … can they?!

Welcome to the world of the core Java library (or API)

- There is indeed such a thing and it is called an **`ArrayList`**.
  - Just like our "ready-baked" code from our first "Dot Com" game, the API comes with hundreds of pre-built classes.
  - Unlike our "ready-baked" code, these classes are already compiled – just waiting for you to use them!



```
import java.util.ArrayList;

public class DotCom {
  private ArrayList<String> locationCells;
  // private int numberOfHits = 0;  =>  Don't need this!
  public void setLocationCells(ArrayList<String> loc) {
    locationCells = loc;
    // rest of code
}
```

New and improved checkYourself()

```
public String checkYourself(String stringGuess) {
  String result = "miss";
  int index = this.locationCells.indexOf(stringGuess);
  if (index >= 0) {
    this.locationCells.remove(stringGuess);
    // or this.locationCells.remove(index);
    if (locationCells.isEmpty()) {
      result = "kill";
    }
    else {
      result = "hit";
    }
  }
  System.out.println(result);
  return result;
}
```

Changes to main()

```
ArrayList<String> locations = new ArrayList<String>();
locations.add(""+randomNum);
locations.add(""+(randomNum + 1));
locations.add(""+(randomNum + 2));
```

if randomNum = 3, then
locations = [3,4,5]

- Do we need the brackets? What if we do …

```
ArrayList<String> locations = new ArrayList<String>();
locations.add(""+randomNum);
locations.add(""+randomNum + 1);
locations.add(""+randomNum + 2);
```

if randomNum = 3, then
locations = [3,31,32]

Retesting the improved game version …

CMD

```
>java DotComGame
Enter a number
3
hit
Enter a number
4
miss
Enter a number
2
hit
Enter a number
1
kill
You took 4 guesses

>
```

Don't forget the first test (as we changed the code) ... Passed!

CMD - java DotComGame

```
>java DotComGame
Enter a number
3
hit
Enter a number
3
miss
Enter a number
```

The second test … Passes!

… and things for you to try out!

Building the real "Sink a Dot Com“ (Recap only)

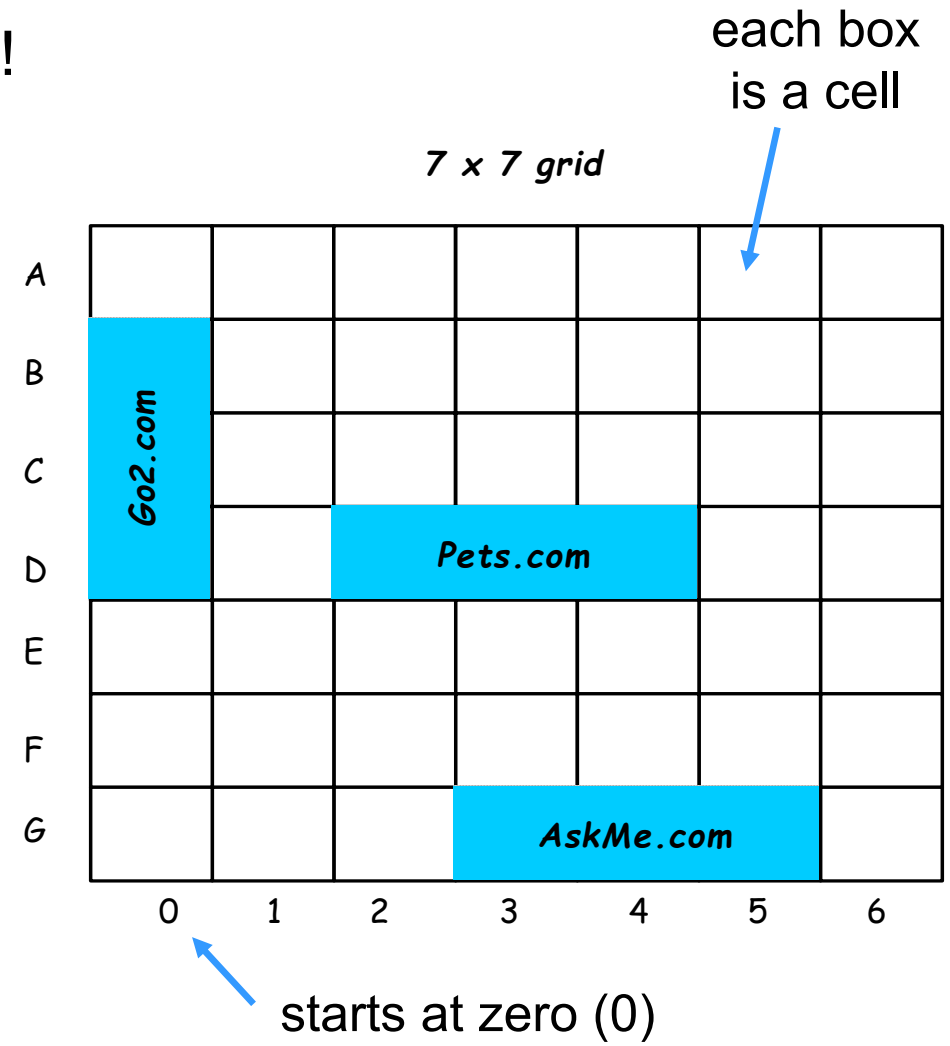
- We have been writing the simple version of the “Dot Com” game.
- Now we have to build the whole thing!

GOAL

- Sink all the computer's “Dot Coms” in the fewest number of guesses.
- You are given a rating, based on how well you perform.

SETUP

- A virtual 7x7 board with 3 randomly placed “Dot Coms”.
- After that, the player should be prompted to enter their first guess.



What needs to change? (1/2)

1. DotCom class

   a. Needs a *name* variable!
   Remember that the dot com needs to be able to print its name after being killed!
   (*Ouch! You sunk Pets.com* ☹)

2. DotComBust class (the game)

   a. Need *three* DotComs instead of one!

   b. Give each of the DotComs a name when created!
   Need to use a *setter* to do it!

What needs to change? (2/2)

2 DotComBust class (the game) - cont

C Put the DotComs on a grid rather than a single row.
This is kind of complicated so:

to the rescue!
put this in the mysterious GameHelper class.

D Check the user's guess with ALL THREE of the DotComs!

e Keep playing until ALL THREE DotComs are killed!

F Get out of main.

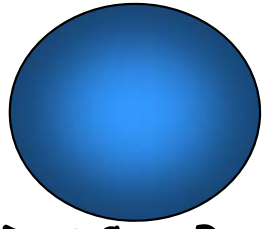
The classes

DotCom	DotComBust	GameHelper
The actual DotCom objects. DotComs know their *name*, *location* and how to check a user guess for a match.	**The game class.** Makes DotComs and gets user input, plays until all DotComs are dead	**The helper class.** *Ready bake...* Can accept user command-line input and make DotCom locations

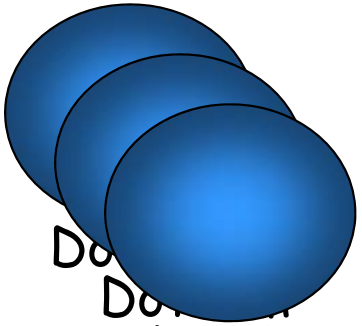
creates and plays with

used for player input and `DotCom` locations

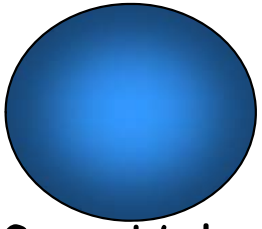
The objects



DotComBust

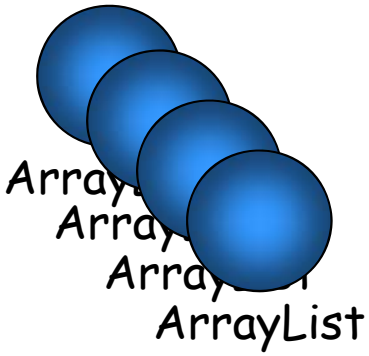


DotCom



GameHelper

plus 4 ready-baked objects. Instances of ArrayLists are objects too!

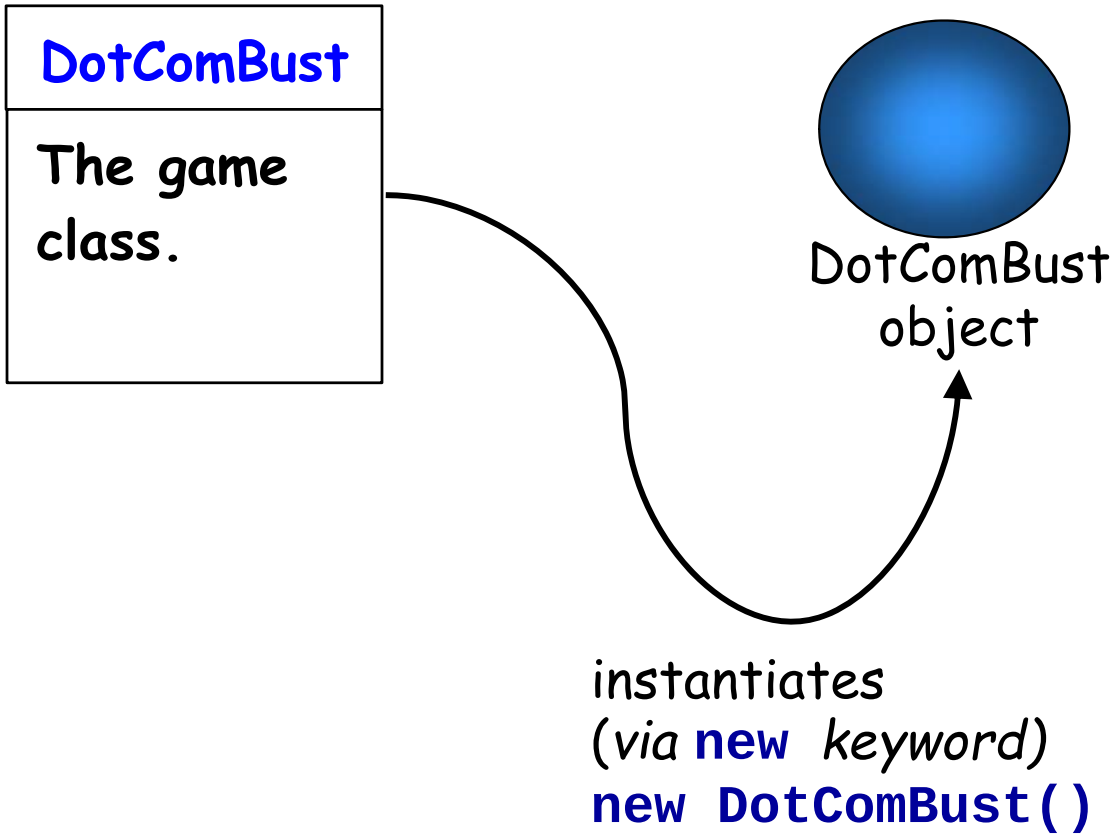


ArrayList

One for DotComBust

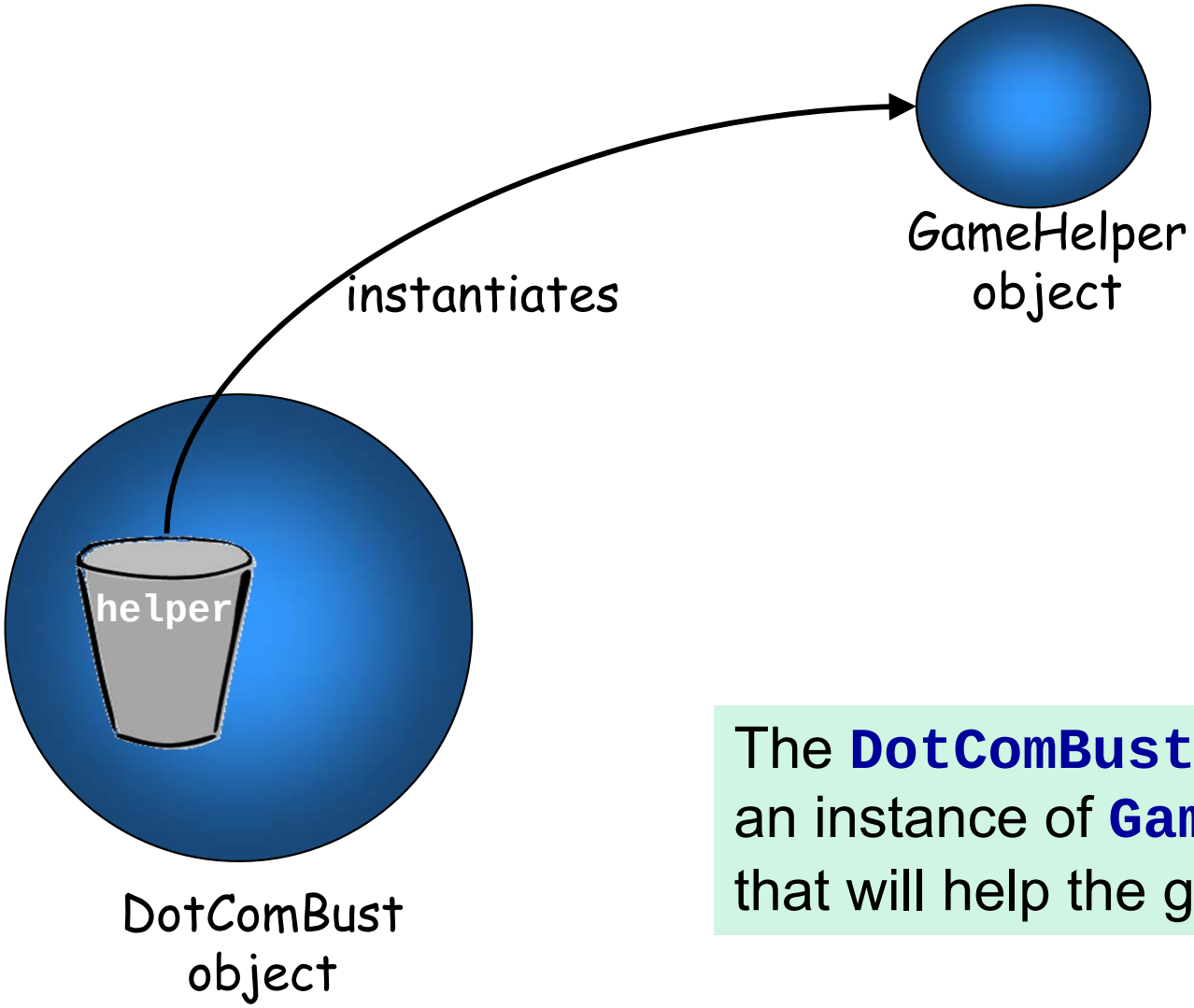
One for each instance of DotCom (*three*)

Who, what, when, where, why?!



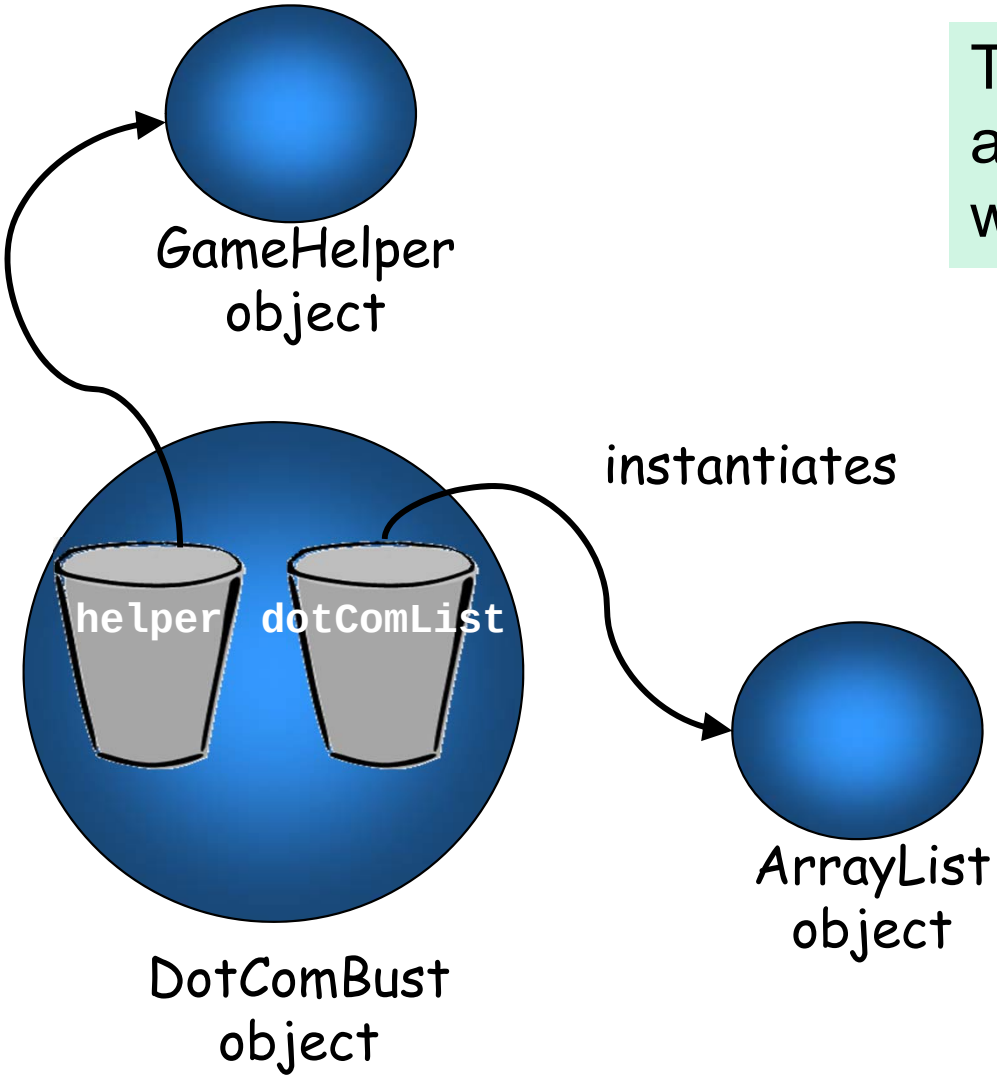
The **`main()`** method in the **`DotComBust`** class instantiates the **`DotComBust`** object that does all the game stuff.

Who, what, when, where, why?! *(cont.)*



The **`DotComBust`** object instantiates an instance of **`GameHelper`**, the object that will help the game do its work.

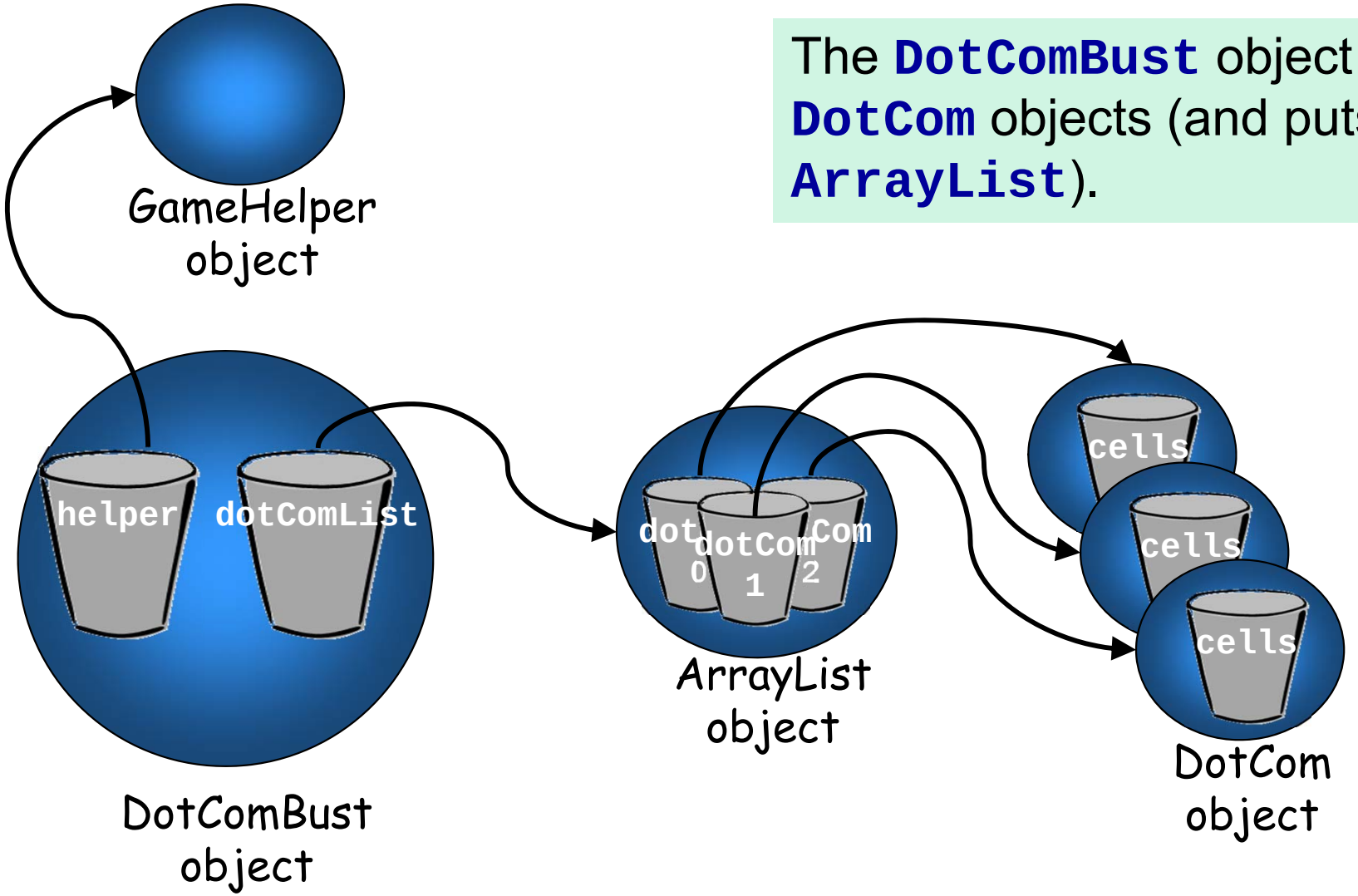
Who, what, when, where, why?! *(cont.)*



The **`DotComBust`** object instantiates an instance of an **`ArrayList`** that will hold the 3 **`DotCom`** objects.

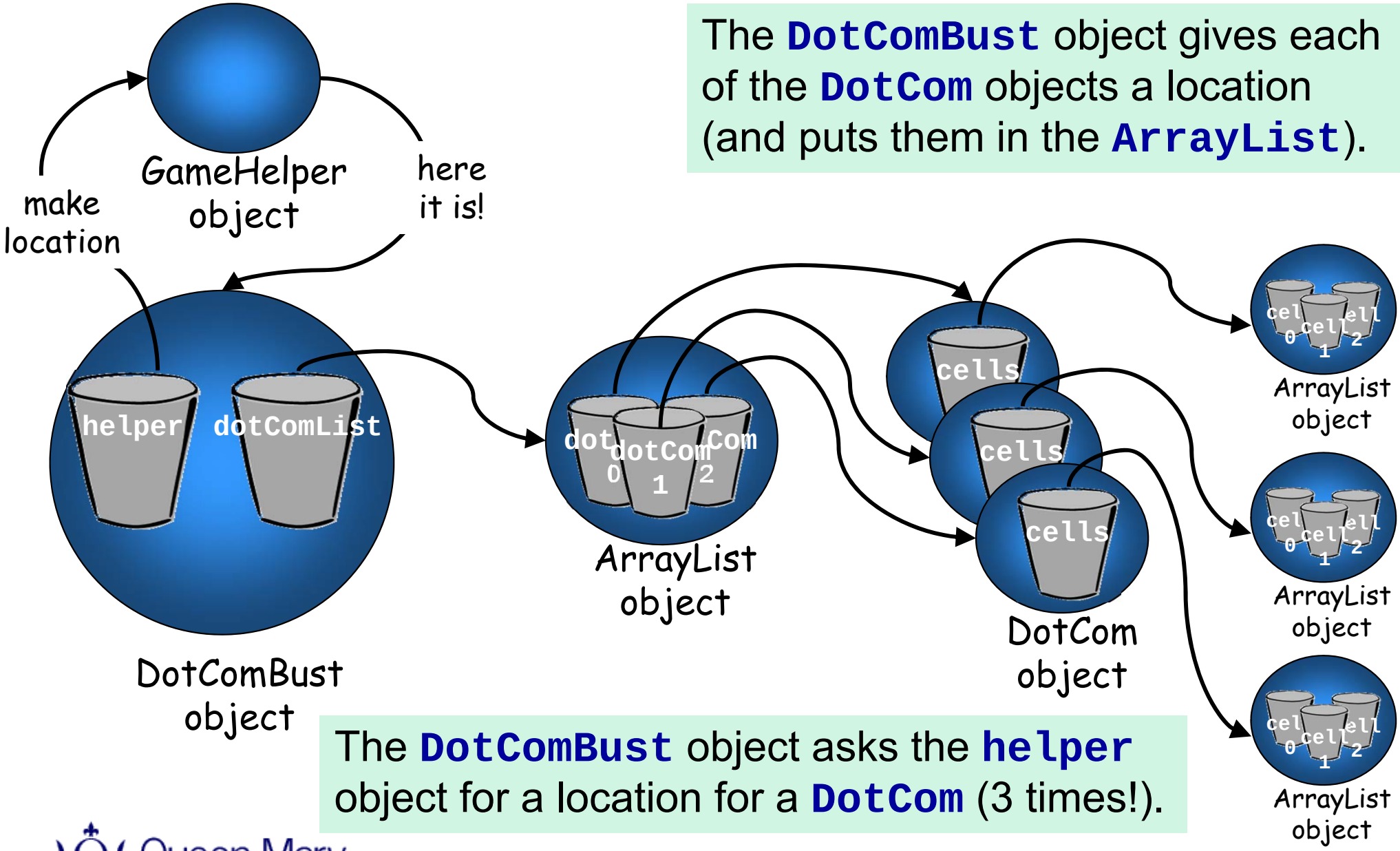
Who, what, when, where, why?! *(cont.)*

The **`DotComBust`** object creates 3 **`DotCom`** objects (and puts them in the **`ArrayList`**).



Who, what, when, where, why?! *(cont.)*

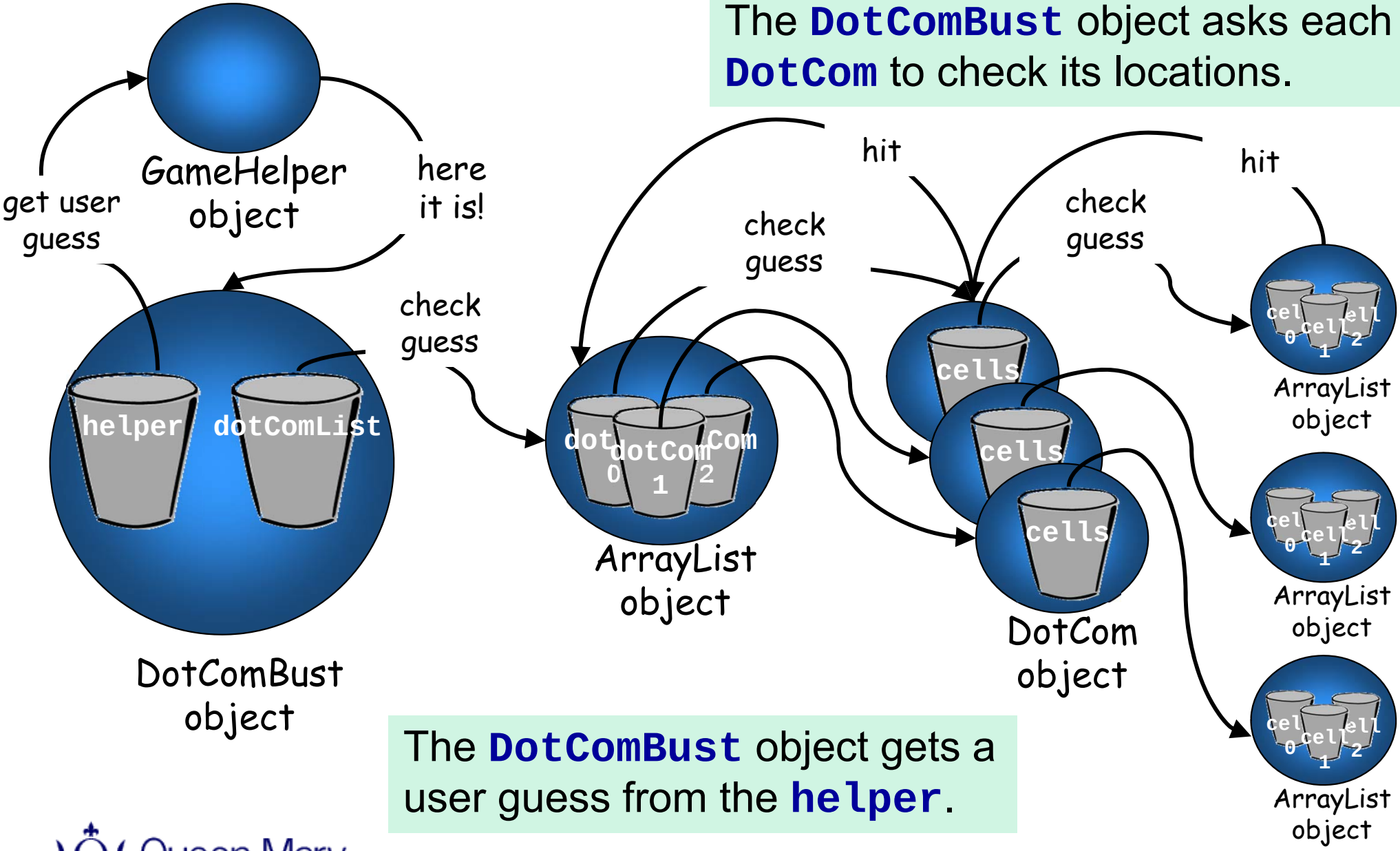
The **DotComBust** object gives each of the **DotCom** objects a location (and puts them in the **ArrayList**).



The **DotComBust** object asks the **helper** object for a location for a **DotCom** (3 times!).

Who, what, when, where, why?! *(cont.)*

The **DotComBust** object asks each **DotCom** to check its locations.



The **DotComBust** object gets a user guess from the **helper**.

The improved code (1/3)

```
import java.util.*;
public class DotComBust {
   private GameHelper helper = new GameHelper();
   private ArrayList<DotCom> dotComList = new ArrayList<DotCom>();
   private int numOfGuesses = 0;

   private void setUpGame() {
     // first make some dot coms and give them locations
     DotCom one = new DotCom();
     one.setName("Pets.com");
     DotCom two = new DotCom();
     two.setName("eToys.com");
     DotCom three = new DotCom();
     three.setName("Go2.com");
     dotComList.add(one);
     dotComList.add(two);
     dotComList.add(three);

     System.out.println("Your goal is to sink three dot coms.");
     System.out.println("Pets.com, eToys.com, Go2.com");
     System.out.println("Try to sink them all in the fewest number
                                 of guesses");
     for (DotCom dc : dotComList) {
       ArrayList<String> newLocation = helper.placeDotCom(3);
       dc.setLocationCells(newLocation);
     }
   }
```

```
for(int i=0; i<dotComList.size(); i++) {
  ArrayList<String> newLocation =
                 helper.placeDotCom(3);
  dotComList.get(i).
      setLocationCells(newLocation);
}
```

The improved code (2/3)

```
private void startPlaying() {
  while(!dotComList.isEmpty()) {
    String userGuess = helper.getUserInput("Enter a guess");
    checkUserGuess(userGuess);
  }
  finishGame();
}

private void checkUserGuess(String userGuess) {
  numOfGuesses++;
  String result = "miss";
  for (DotCom dc : dotComList) {
    result = dc.checkYourself(userGuess);
    if (result.equals("hit")) { break; }
    if (result.equals("kill")) {
      dotComList.remove(dc);
      break;
    }
  }
  System.out.println(result);
}
```

```
for (int i=0; i<dotComList.size(); i++) {
  result = dotComList.get(i).
              checkYourself(userGuess);
}
```

```
  private void finishGame() {
    System.out.println("All Dot Coms are dead!
                        Your stock is now worthless.");
    if (numOfGuesses <= 18) {
      System.out.println("It only took you "
                          + numOfGuesses + " guesses.");
      System.out.println("You got out before your options sank.");
    }
    else {
      System.out.println("Took you long enough. "
                          + numOfGuesses + " guesses");
      System.out.println(" Fish are dancing with your options.");
    }
  }
  public static void main(String[] args) {
    DotComBust game = new DotComBust();
    game.setUpGame();
    game.startPlaying();
  }
}
```

… and things for you to try out!

Using the Java Library (API) – 1/2

- Using the class **`ArrayList`** helped us get through creating the **`DotCom`** class.
  - But **`ArrayList`** does not solve all your programming problems!

Java™ 2 Platform Standard Edition 8 API Specification

- To use a class in the API, you need to know what package the class is in.
  - For example, to use an **`ArrayList`**, you need to know that **`ArrayList`**s belong to the **`java.util`** package.
  - The **`java.util`** package contains other utility classes as well!
  - Using a class from an API is just like using our "ready-baked" code – only we don't even have to compile it!

Using the Java Library (API) – 2/2

- We have already been using the API without realising it!
- The `java.lang` package is automatically included in every class; other examples:
  - `Math.random();`
  - `System.out.println();`

- However, to use other packages you need to know the full name of the class you want to use in your code:
  - `java.util.ArrayList`

package name class name

Using `ArrayList` (or other classes)

Two approaches:

A IMPORT ← More common

Put an **`import`** statement at the top of your source code file.

```
import java.util.ArrayList;
```

B TYPE

Type the full name everywhere in your code. Each time you use it. *Anywhere* you use it.

```
java.util.ArrayList<Rabbit> list =
                    new java.util.ArrayList<Rabbit>();
```

JDK Class Library

- ↑ Package familiarity == ↑ Your programming skills

- Half the battle is knowing what class to use, and when …

- Main packages:

  `java.lang` -- Provides classes that are fundamental to the design of the Java programming language.

  `java.io` -- Provides for system input and output through data streams, serialization and the file system.

  `java.awt` -- Contains all of the classes for creating user interfaces and for painting graphics and images.

How to learn about the API

- Use a reference book
- Use the HTML API docs: a) download a local copy OR b) use them online

Overview (Java Pla

Secure | https://docs.oracle.com/javase/8/docs/api/

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Java™ Platform Standard Ed. 8

All Classes All Profiles

Packages

java.applet
java.awt
java.awt.color
java.awt.datatransfer
java.awt.dnd

All Classes

AbstractAction
AbstractAnnotationValueVisitor6
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AbstractButton
AbstractCellEditor
AbstractChronology
AbstractCollection
AbstractColorChooserPanel
AbstractDocument
AbstractDocument.AttributeContext
AbstractDocument.Content
AbstractDocument.ElementEdit
AbstractElementVisitor6
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Java™ Platform, Standard Edition 8 API Specification

This document is the API specification for the Java™ Platform, Standard Edition.

See: Description

Profiles

- compact1
- compact2
- compact3

Packages

Package	Description
java.applet	Provides the classes necessary to create an applet and the classes an applet uses to communicate with its applet context.
java.awt	Contains all of the classes for creating user interfaces and for painting graphics and images.
java.awt.color	Provides classes for color spaces.
java.awt.datatransfer	Provides interfaces and classes for transferring data between and within applications.
java.awt.dnd	Drag and Drop is a direct manipulation gesture found in many Graphical User Interface systems that provides a mechanism to transfer information between two entities logically associated with presentation elements in the GUI.
java.awt.event	Provides interfaces and classes for dealing with different types of events fired by AWT