CS100J Fall 2006 Assignment A2
Due (submitted on the CMS) on Thursday, 19 September
Monitoring Elephants

Endangered species **Click on any image to see an enlarged version**

As you can find out on website http://www.worldwildlife.org/elephants, elephants, the largest living land animals, are threatened by shrinking living space and poaching (for their tusks). That site says that elephants are key players in the forest. The water wells they dig are used by other animals. They create habitat for grazing animals. The roadways they make act as fire breaks and drainage conduits. The pygmy elephant in Borneo is also endangered. Much smaller than African elephants, they don't get over 6.5 feet tall. The website http://www.panda.org/news_facts/newsroom/features/index.cfm?uNewsID=24317 talks about tagging pygmy elephants in order to study their habits. The two elephants to the right are pygmy elephants.

Elephants are not the only endangered species. Web page http://www.redlist.org/ says that the number of endangered vertebrates (mammals, birds, reptiles, amphibians, and fishes) grew from 3,314 in 1996/98 to 5,188 in 2004. Of the 22,733 evaluated species, 23% were endangered. See http://www.worldwildlife.org/endangered for more info on endangered species.

When an animal population is small, the animals can be monitored. Sometimes they will be captured and tagged. Some tags emit a signal, so that the animal can be tracked. Even in populated places, animals are tagged. Here in Ithaca, one can see deer with tags on their ears wandering in the fields. Gries sees them often in his back yard near Community Corners.

This assignment: monitoring elephants

This assignment illustrates how Java's classes and objects can be used to maintain data about a collection of things —like individual elephants. Read the WHOLE handout before you begin to do the assignment. You may do this assignment with one other person. If you are going to work together, then, as soon as possible, get on the CMS for the course and do what is required to form a group. When working as a group, take turns being the driver (the person at the keyboard) and the navigator (the person who keeps track of what is to be done and helps the driver).

Requirements

For this assignment, you are required to design and implement two classes. Class `Elephant` is used by to keep track of elephants. It has lots of fields and methods, but each method is simple. Do one thing at a time, and start early, you should have little trouble with this assignment. Class `ElephantTester`, a JUnit class, is used to test class `Elephant`. Do not think too much about this class when first reading this handout. Wait until we tell you how to write such classes before starting.

HELP

If you don't know where to start, if you don't understand testing, if you are lost, **SEE SOMEONE IMMEDIATELY**. Gries, a TA, a consultant. Do not wait. Over 50 of you have never programmed before, and it is reasonable to expect that you may not fully grasp everything. But a little one-on-one help can do wonders.

Class Elephant

An instance of class `Elephant` represents a single elephant. It has several fields that one might use to describe an elephant, as well as methods that operate on these fields. Here are the fields, all of which should be **private** (you can choose the names of these fields).

- name (a `String`), which can be any sequence of characters

- gender (a `String`: "F" for female and "M" for male)
- month of birth (an `int`)
- year of birth (an `int`)
- tag (an `int`)
- father (an `Elephant` object)
- mother (an `Elephant` object)
- number of children (an `int`)
- Elephant population (a static `int`)

Here are some details about these fields:

- The name is used to identify the elephant. It can be any string of letters and digits. All elephant will have different names. Your program should NOT check that elephant names are legal.
- The month of birth is in the range 1..12, representing a month from January to December. The year of birth is something like 1857 or 2005. Do not worry about invalid dates; do **not** write code that checks whether dates are valid: assume they are valid.
- The tag is the number on the elephant's tag. This is an integer ≥ 0. If the elephant is not tagged yet, this field contains –1.
- The father and mother fields are the names of the `Elephant` objects that correspond to this elephant's parents. They are `null` if not known.
- The elephant population is the number of elephant for whom objects (manila folders) have been created. **Whenever an elephant object is created, this field should be increased by 1**.

Accompanying the declarations of these fields should be comments that describe what each field means —what it contains. For example, on the declaration of field `tag`, write that the field is –1 if the elephant is untagged and is the tag number itself (≥ 0) if the elephant is tagged. *The collection of these fields is called the "class invariant"*.

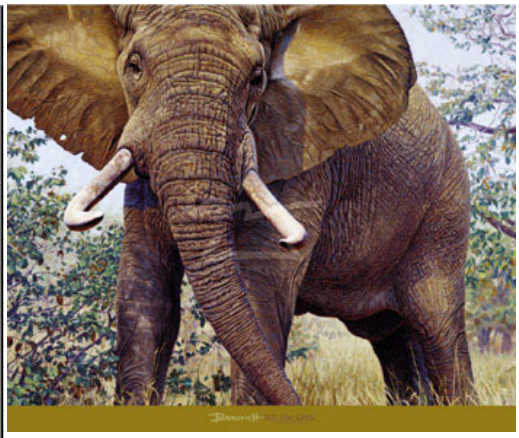
Whenever you write a method (see below), look through the class invariant and convince yourself that the class invariant is correct when the method ends, for **all** objects of class `Elephant`. For example, if the method does something to the mother field of the object, are all the mother-object fields correct?

Elephant Methods

Class `Elephant` has the following methods. Pay close attention to the parameters and return values of each method. The descriptions, while informal, are complete.

Constructor	Description
Elephant(String name, String female, int month, int year)	Constructor: a new `Elephant`. Parameters are, in order, the name of the elephant, its gender, and the month and year of birth. The new elephant is not tagged, and its parents are not known.
Elephant(String name, String gender, Elephant father, Elephant mother, int month, int year)	Constructor: a new `Elephant`. Parameters are, in order, the name of the elephant, its gender, its father and mother, and the month and year of birth. The new elephant is not tagged. Precondition: , father and mother are not null.

Method	Description
getName()	= the name of this elephant (a `String`)
getGender()	= the gender of this elephant (a `String`).
getMOB()	= the month in which this elephant was born, in the range 1..12 (an `int`).
getYOB()	= the year in which this elephant was born (an `int`).
getFather()	= (the name of the object representing) the father of this elephant (a `Elephant`).
getMother()	= (the name of the object representing) the mother of this elephant (a `Elephant`).
getNumberChildren()	= the number of children of this elephant (an `int`).
getTag()	= this elephant tag (–1 if none) (an `int`)
getPopulation()	Static method. = the number of `Elephant` objects created thus far (an `int`).
toString()	= a `String` representation of this elephant. It has to be in a precise format discussed below.



Method	Description
setName(String n)	Set the name of this elephant to `n`.
setGender(String g)	Set the gender of the elephant to `g`. Precondition: g is "F" or "M"
setMOB(int i)	Set the month of birth for this elephant to `i`.
setYOB(int i)	Set the year of birth for this elephant to `i`.
setTag(int t)	Set whether this elephant's tag to t. Precondition: t ≥ 0 and the tag is currently –1.
setFather(Elephant r)	Set this elephant's father to `r` (and increment r's number of children). Precondition: This elephant's father is `null`, `r` is not `null`, and `r` is male.
setMother(Elephant r)	Set this elephant's mother to `r` (and increment r's number of children). Precondition: This elephant's mother is `null`, `r` is not `null`, and `r` is female.
isOlder(Elephant r)	= "this elephant is older than r " (a `boolean`). Precondition: `r` is not null.
areSameAge(Elephant r1, Elephant r2)	Static function. = "`r1` and `r2` are not null and are the same age —i.e. have the same birth date " (a `boolean`).
isBrother(Elephant r)	= "`r` is this elephant's brother" (a `boolean`). Note: elephant A is called the brother of elephant B if the two are different, if A is male, and if they have at least one parent in common. Precondition: `r` is not `null`.
isSister(Elephant r)	= "`r` is this elephant's sister " (a `boolean`). Note: elephant A is called the sister of elephant B if the two are different, if A is female, and if they have at least one parent in common. Precondition: `r` is not `null`.
areSiblings(Elephant r1, Elephant r2)	Static method. = "`r1` and `r2` are not null and `r1` and `r2` are siblings (brothers or sisters)" (a `boolean`).
isMotherOf(Elephant r)	= "this elephant is `r`'s mother" (a `boolean`). Precondition: `r` is not `null`.
isFatherOf(Elephant r)	= "this elephant is `r`'s father" (a `boolean`). Precondition: `r` is not `null`.
isParentOf(Elephant r)	= "this elephant is `r`'s parent" (a `boolean`). Precondition: `r` is not `null`.
areTwins(Elephant r1, Elephant r2)	Static method. = "`r1` and `r2` are not null and `r1` and `r2` are siblings and have the same birth date" (a `boolean`).

Make sure that the names of your methods match those listed above **exactly**, including capitalization. The number of parameters and their order must also match. The best way to ensure this is to copy and paste. Our testing will expect those method name and parameters, so any mismatch will fail during our testing. Parameter names will not be tested —you can change the parameter names if you want.

Each method **must** be preceded by an appropriate specification, as a Javadoc comment. The best way to ensure this is to copy and paste. After you have pasted, be sure to do any necessary editing. For example, the spec does not have to say that a function is static, because that is known from the header of the method. And the spec of a function does not have to say that the function yields a boolean or int or anything else, because that is known from the header of the method.

A precondition should **not** be tested by the method; it is the responsibility of the caller to ensure that the precondition is met. As an example, in method `isMotherOf`, the method body should not test whether `fm` is `null`. However, in function `areSiblings`, the tests for `fm1` and `fm2` not `null` MUST be made.

The number of children of a newly created elephant is 0. Whenever an elephant R is made the mother or father of another elephant, R's number of children should increase by 1.

It is possible for elephant R1 to be R2's mother, and visa versa, at the same time. We do not check for such strange occurrences.

Function toString
Here is an example of output from function toString:

> "Male elephant Fatso. Tag 34. Born 6/2005. Has 2 children. Father Weighty. Mother unknown."

The output from your function toString must be like the above. Here are some points about this output.

1. Exactly one blank separates each piece of information, and the periods are necessary.
2. "Male" or "Female" has to be capitalized.
3. If the mother field or father field is `null`, use "unknown" for its name; otherwise, use the name that appears in the mother or father.
4. In your method body, you may not use an if statement, but you should use a conditional expression —look it up in the index of the CD *ProgramLive.*

Your method bodies should have no if statements. Your method bodies should contain only assignments and return statements. Points will be deducted if **if** statements are used. Further, conditional expressions may be used only in function toString.

Class ElephantTester

How do you know whether class `Elephant` that you are designing is correct? The only way to be sure is to test it, to see if it does what it is supposed to do. It is not enough simply to try out your class `Elephant` in the interactions pane. Every time you write a method for your class `Elephant`, you should also write a couple of tests for it. Further, you should run your collection of tests frequently to make sure that everything works correctly.

Class `ElephantTester` will contain your JUnit test suite; it will perform these testing tasks for you. Make sure that your test suite adheres to the following principles:

- For each method in your class `Elephant`, your test suite should have **at least** one test case that tests that method.
- The more interesting or complex a method is, the more test cases you should have for it. What makes a method 'interesting' or complex can be the number of interesting combinations of inputs that method can have, the number of different results that the method can have when run several times, the different results that can arise when other methods are called before and after this method, and so on.
- Here is one important point. If an argument of a method can be `null`, there should be a test case that has that

argument as `null`.
- Test very basic methods early in your test suite; then move on to more complex ones.
- Don't try to test too many things in a single test case. Each test case should test only a couple of conditions.

If a test changes static variables, they will retain their values in later tests. Also, the tests are not necessarily run in the order in which you list them in your test suite. So when testing static variables, record their initial value at the beginning of the test and test that the *change* in the value is what you expect.

How to do this assignment

We suggest that you proceed as follows.

- First, start a new folder on your hard drive that will contain the files for this project. Sart every new project in its own folder.
- Second, write a class `Elephant` using DrJava. In it, declare the fields in class `Elephant`, compiling often as you proceed. Write comments that specify what these fields mean.
- Third,
  - (1) Write the first constructor and all the getter methods of class `Elephant`.
  - (2) Put a method in class `ElephantTester` that tests whether the first constructor and all the getter methods work.
  - (3) Check that the first constructor and all the getter methods work as required. Don't go on to the next step until this is done.
- Fourth, for the second constructor, write it and test it as done for the first constructor.
- Fifth, write function toString and write a method in `ElephantTester` to test it thoroughly.
- Sixth, write each of the setter methods, add a method in `Elephant` to test them, and test them. We suggest writing and testing one method at a time —write a method, put tests for it in class `ElephantTester`, and test it thoroughly; then move on to the next.
- Seventh, add a method to `ElephantTester` to test the comparison methods. Then work on one of the comparison methods at a time: put in its header and specification (as a comment), write the method body, add test cases to the method in `Elephant`Tester, and test and debug until the method works properly.

At each step, make sure all methods are correct before proceeding to the next step. When adding a new method, cut and paste the comment and the header from the assignment handout and then edit the comment.

Other hints and directions

- **Do not** use `if` statements when completing this assignment. For boolean expressions, the operators `&&` (AND), `||` (OR), and ! (NOT) are sufficient to implement all the methods shown above. You will lose points for using `if` statements.
- Some of the `Elephant` methods can be implemented easily by using other `Elephant` methods that you have already created. Look for these cases. Take advantage of them as much as possible.
- Methods `substring`, `toUpperCase`, and `toLowerCase` in class `String` may be useful.
- Remember that a `String` literal is enclosed in double quotation marks and a `char` literal is enclosed in single quotation marks.
- Use method `.equals` to compare objects (including String objects) for equality and `==` to compare primitive values for equality.
- Only object variables can have the value `null`. So comparisons between primitive types and `null` are not legal.
- To create a JUnit test suite, select menu item `File ->?New JUnit Test Case`, and then replace the `testX` method with many methods that test your `Elephant` functionality.

Your grade depends on:

1. Having precise and complete specifications of methods. You can get these by copying from this handout, pasting, and editing.
2. Having suitable Javadoc comments. Before submitting the assignment, in DrJava, click the "javadoc" button and

check *all* your javadoc comments.
3. Correctness —methods should work for all allowed parameters. For example, if a parameter can be null, have a test case that has null for that parameter.
4. Having a suitable class `ElephantTester`. Make sure there are enough test cases for each method, so that you *know* the method works.
5. Following directions in this handout –read it carefully. For example, don't use an if-statement, and use if-expressions only where allowed.

Submitting the assignment

Check these points before you submit your assignment

- Did you use an if statement? Get rid of it.
- Did you make sure that each method is tested enough? For example, if an argument can be null, is there at least one test case that has a call on the method with that argument being null?
- Did you check your javadoc? Click the javadoc button in the DrJava navigation bar. This will cause the specification of the classes and methods of the classes to be extracted from your program and html pages to be created that contain the specs. You should look at those specs carefully and make sure that the specs are suitable. Can you understand precisely what a method does based on the extracted spec? If not, fix the spec, generate the javadoc, and look at it again.

Submit only files that end with `".java"`. Be careful about this, because in the same place as your `.java` files you may also have files that end with `.class` or `.java~`. but otherwise have the same name.