Homework 7

The first two problems are due Monday, April 16. The other problems are due Friday, April 20 (in class).

The programming problems are intended to be solved with Little Smalltalk. Those wishing to use Smalltalk-80 may need to adapt them slightly or may have to do more work. For programming problems, hand in a print-out and mail a version that can be read with `fileIn` to `coleman` on snowhite (make a note if you did not use little Smalltalk).

1. (10 points) Add a method `diff:` to the class `Set`, which removes all the elements of the receiver that are in the argument.

2. (10 points) Implement a class `SortedList` in Smalltalk, where the elements of a `SortedList` are assumed to respond to the messages `<=` and keep the elements of a `SortedList` in increasing order. Make `SortedList` a subclass of the class `List`. You should redefine the `addFirst:` and `addLast:` messages in the class `SortedList` to give an error if invoked. You should redefine the `add:` method to insert the argument in the correct position to maintain the list in sorted order. You should also redefine the `includes` method to use a binary search. You should also redefine any other methods that are inherited from `List` but are not appropriate for sorted lists.

3. (50 points) Object-oriented programming techniques are touted as being good for simulation. In this problem you will investigate an iterated prisoner's dilemma, using simulation techniques and Smalltalk.

   The prisoner's dilemma is a general model of social interactions. The idea is that people are often faced with situations where they may either "cooperate" or "defect". As the standard example, consider two criminals, Bonnie and Clyde, who have been arrested on a minor charge but are suspected of committing a major crime. The police make the following offer to each: "if you confess and implicate your partner, then you will go free and your partner will get 5 years in jail, but if you do not confess, you will have to serve one year in jail on the minor charge. Oh by the way, if you both confess, you will each serve 3 years in jail." In this case cooperation (among the prisoners) means keeping silent, defection means implicating the partner. The police offer can be represented by the following payoff matrix:

Bonnie\Clyde	cooperate	defect
cooperate	(-1,-1)	(-5,0)
defect	(0,-5)	(-3,-3)

   where the entry (0,-5) means that if Bonnie defects and Clyde cooperates, then Bonnie gets a jail term of 0 years, while Clyde gets 5 years in jail (-5). Each prisoner wants to maximize his or her payoff (i.e., each wants to get the fewest years in jail).

   The iterated prisoner's dilemma is like the prisoner's dilemma, only repeated over many encounters. Imagine Bonnie and Clyde both cooperate, and after a year in jail, they get together again, rob more banks, and then wind up in the same situation. More to the point, imagine a world of agents who are continually interacting. For example, consider graduate students and their use of disk space. One may cooperate by deleting unused files, but this takes some time and effort. Hence there is a cost to cooperation. If others use disk space without deleting unneeded files (the defectors), you are just subsidizing their lethargy with your time! However, if everyone cooperates, then there will usually be plenty of disk space for all. Similar examples can be found in many social interactions, from driving a car to trade relations among nations.

Your task is write a simulation of the iterated prisoner's dilemma in Smalltalk, and test at least three (3) different strategies for the behavior of prisoners to see which is best. A strategy is an algorithm for deciding whether to cooperate or defect, based on internal state such as a history of how the other agent has cooperated or defected in previous rounds or a random number generator. You should submit an English explaination of your program and the strategy you found to be the best, along with your experimental results.

Generally useful classes will be found in files that can be filed in to little Smalltalk in the directory

`~leavens/cs541public/prisoners-dilemma`

on snowhite.

These files and some more help on exactly what should be done for this problem will appear later.