Assignment 1: Karel the Robot

Part I—Get an electronic mail account

A few years ago, some students would start off in CS 106A without having an e-mail account, but students today are so much more familiar with the electronic world that not having an e-mail address has become exceedingly rare. If, by some chance, you are one of those holdouts who do not use e-mail, make sure that you get someone from the course staff to help you set up your account.

Part II—Send mail to your section leader

Send an introductory e-mail message to your section leader (as soon as you know who it is) and to Jerry Cain (**`jerry@cs`**). Here's the information to include in your e-mail:

1. Your name
2. Your year (frosh, sophomore, junior, senior, graduate, other)
3. Your major or area of interest ("unknown" is a perfectly acceptable answer)
4. Why you decided to take CS 106A
5. What you are most looking forward to about the class
6. What you are least looking forward to about the class
7. Any suggestions that you think might help you learn and master the course material

And if you feel like giving us a little more to remember you by, you could also include the following:

8. What do you do for fun?
9. Tell us a quick anecdote about something that makes you unique—a talent, an unusual experience, or anything of that sort.

Due: Wednesday, April 7th at 5:00 p.m.

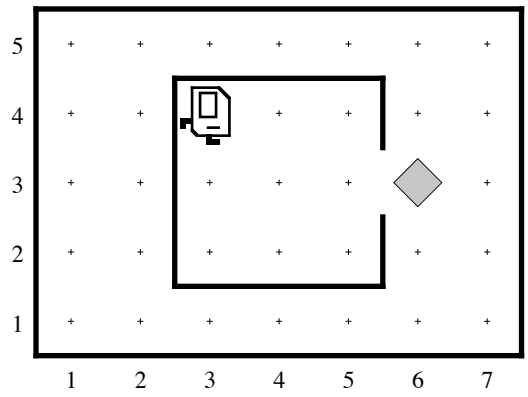
Part III—Solve some Karel problems

The real problem-solving part of this assignment consists of four Karel programs. There are starter projects for each of these problems on the CS 106 web site in the area for Assignment 1. When you want to work on one of these programs, you need to download that starter folder as described in Handout 04 (Using Karel in Eclipse). From there, you need to edit the program files so that the assignment actually does what it's supposed to do, which will involve a cycle of coding, testing, and debugging until everything works. The final step is to submit your assignment using the **Submit Project** entry under the **Stanford** menu. Remember that you can submit your programs individually as you finish them and that you can submit more than one version. If you discover an error after you've submitted one of these problems, just fix your program and submit a new copy.

Also, please remember that your Karel programs must limit themselves to the features of the **`Karel`** and **`SuperKarel`** classes as described in *Karel the Robot Learns Java*. You may not use other features of Java, even though the Eclipse-based version of Karel accepts them.

Problem 1

Your first task is to solve a simple story-problem in Karel's world. Suppose that Karel has settled into its house, which is the square area in the center of the following diagram:



Karel starts off in the northwest corner of its house as shown in the diagram. The problem you need to get Karel to solve is to collect the newspaper—represented (as all objects in Karel's world are) by a beeper—from outside the doorway and then to return to its initial position.

This exercise is extremely simple and exists just to get you started. You can assume that every part of the world looks just as it does in the diagram. The house is exactly this size, the door is always in the position shown, and the beeper is just outside the door. Thus, all you have to do is write the sequence of commands necessary to have Karel

1. Move to the newspaper,
2. Pick it up, and
3. Return to its starting point.

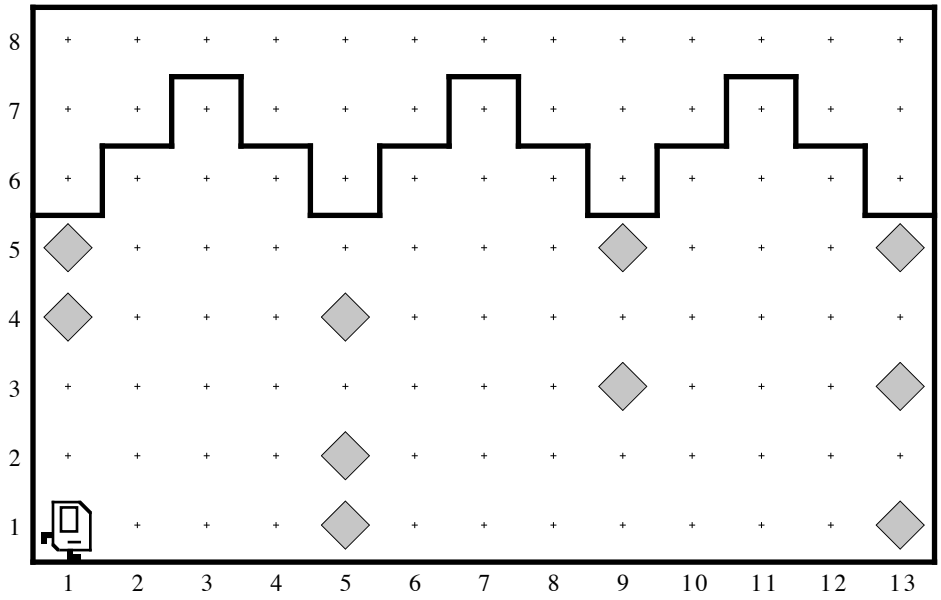
Even though the program is only a few lines, it is still worth getting at least a little practice in decomposition. In your solution, include a private method for each of the steps shown in the outline.

A Word of Advice

Before you go on to the harder problems on this assignment, why don't you try submitting your project as soon as you are done with this first problem? Every year, a handful of students run into some kind of problem with the electronic submission option provided in the Stanford version of Eclipse. If you wait until 4:45 P.M. on Wednesday before you submit any of your work, you may discover that there is some aspect of the submission process that you didn't quite understand only after it's too late to get any help. So right now, as soon as you've got this first program working, go ahead and hit the submit button to make sure that you can ship things off. Once you've done so, you'll know that you've got the submission process under control. Remember, we only look at the last submission you make before the due date, so it doesn't hurt to submit new versions of your solution as you finish them.

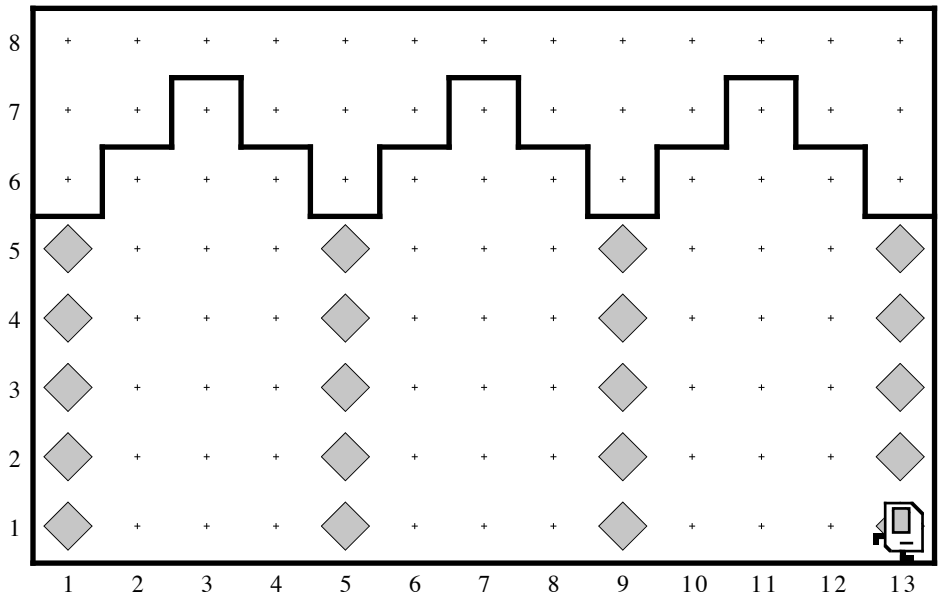
Problem 2

Karel has been hired to repair the damage done to the Quad in the 1989 earthquake. In particular, Karel is to repair a set of arches where some of the stones (represented by beepers, of course) are missing from the columns supporting the arches, as follows:



Your program should work on the world shown above, but it should be general enough to handle any world that meets certain basic conditions as outlined at the end of this problem. There are several example worlds in the starter folder, and your program should work correctly with all of them.

When Karel is done, the missing beepers in the columns should be replaced, so that the final picture resulting from the world shown above would look like this:

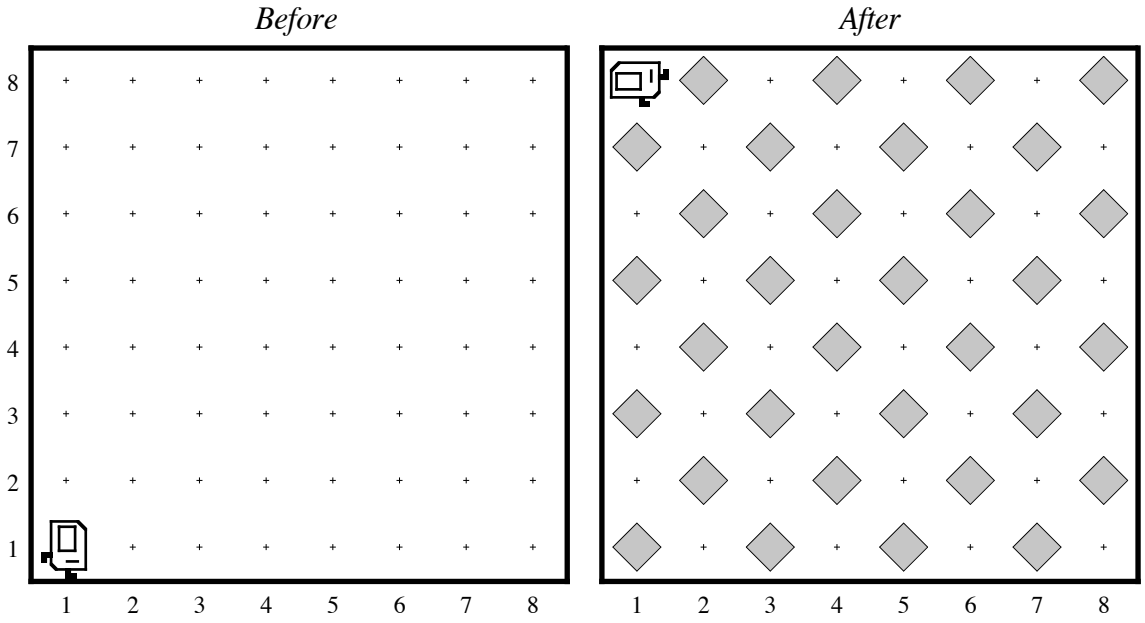


Karel may count on the following facts about the world:

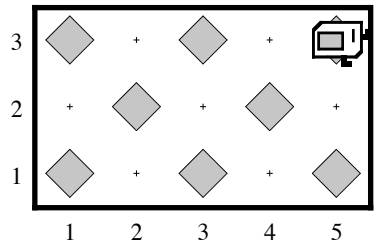
- Karel starts at 1st Avenue and 1st Street, facing east, with an infinite number of beepers.
- The columns are exactly four units apart, on 1st, 5th, 9th Avenue, and so forth.
- The end of the columns is marked by a wall immediately after the final column. This wall section appears after 13th Avenue in the example, but your program should work for any number of columns.
- The top of the column is marked by a wall, but Karel cannot assume that columns are always five units high, or even that all columns are the same height.
- Some of the corners in the column may already contain beepers representing stones that are still in place. Your program should not put a second beeper on these corners.

Problem 3

In this exercise, your job is to get Karel to create a checkerboard pattern of beepers inside an empty rectangular world, as illustrated in the following before-and-after diagram:



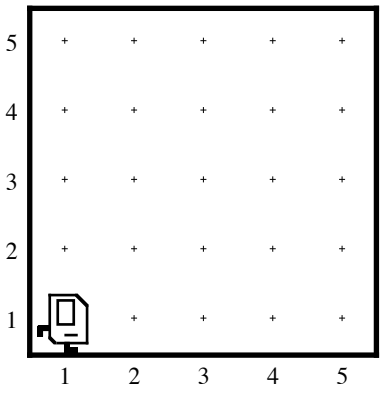
This problem has a nice decomposition structure along with some interesting algorithmic issues. As you think about how you will solve the problem, you should make sure that your solution works with checkerboards that are different in size from the standard 8x8 checkerboard shown in the example. Odd-sized checkerboards are tricky, and you should make sure that your program generates the following pattern in a 5x3 world:



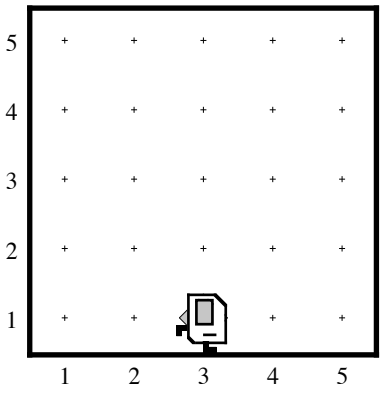
Another special case you need to consider is that of a world which is only one column wide or one row high. The starter folder contains several sample worlds that test these special cases, and you should make sure that your program works for each of them.

Problem 4

As an exercise in solving algorithmic problems, program Karel to place a single beeper at the center of 1st Street. For example, if Karel starts in the world



it should end with Karel standing on a beeper in the following position:



Note that the final configuration of the world should have only a single beeper at the midpoint of 1st Street. Along the way, Karel is allowed to place additional beepers wherever it wants to, but must pick them all up again before it finishes.

In solving this problem, you may count on the following facts about the world:

- Karel starts at 1st Avenue and 1st Street, facing east, with an infinite number of beepers in its bag.
- The initial state of the world includes no interior walls or beepers.
- The world need not be square, but you may assume that it is at least as tall as it is wide.
- Your program, moreover, can assume the following simplifications:
- If the width of the world is odd, Karel must put the beeper in the center square. If the width is even, Karel may drop the beeper on either of the two center squares.
- It does not matter which direction Karel is facing at the end of the run.

There are many different algorithms you can use to solve this problem. The interesting part of this particular problem is to come up with a strategy that works.