

## Exercise I2 Introduction to Programming Concepts

### Objectives

This exercise will give you an introduction to some important concepts -- reading a program and tracing its execution, understanding how it works, and looking for errors. These are skills you will use constantly as you study programming.

### Group Instructions

The flowcharts for this exercise describe a program intended to solve the following problem:

There is a rectangular room that is composed of solid walls with one window. The room may be of any size. Karel starts somewhere within this room, facing in a random direction. Karel must find the window and stop beside it.

The illustration shows a typical starting situation for this task.

1. Start by executing this program, starting with the situation illustrated. Each group member should take one of the following roles. (See the detailed instructions for each role on the following pages.)
  - a. Flowchart Reader for main program and Go To Wall
  - b. Flowchart Reader for Find Window
  - c. Karel Simulator
  - d. Facilitator

The following steps call for group discussions. Near the end of the time allotted for this exercise, we will have a general class discussion on these same questions. Each person in the group should be prepared to report on the results of your group discussions.

2. As a group, describe in words how this program works. (Imagine that you are telling another person how to go to the window, using the same method as in the program.) Give separate descriptions for the main program and for each separate flowchart. Be sure that everyone in the group agrees with these descriptions and can explain them.
3. Each group member should work alone on this problem for two minutes; then have the Facilitator call the group together to talk about the solutions.

In step 1, you should have successfully completed the program. (That is, Karel should have found the window and stopped beside it.) However, there can be many different starting situations — that is different positions for the window and different starting locations for Karel. There is at least one starting situation for which the program does not work correctly. Can you find it? Is there more than one such problem situation? (You may want to try different locations for the window and different starting positions for Karel, using the blank illustration sheets to experiment or diagram your answers.)

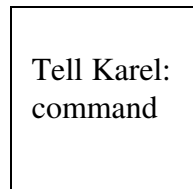
4. After you have found the problem situation(s) in step 3, think about how you did it. If you had to tell someone else how to look for problems like this, what would you say? Have each member of the group try to explain in his or her own words.
5. Suppose you want to change the program so it works correctly in all situations, including the problem situation(s) you just discovered. How might you do this? There may be more than one possible answer — as a group, brainstorm as many ways as you can think of.
6. Besides the problem you found in Step 3, there is at least one other starting situation in which the program does not work the way we might expect. In that situation, Karel does eventually find the window and stop; however, it makes an extra trip around the room before doing so. Can you find this problem situation? How could you fix the program to make it more efficient in this case?

## Flowchart Reader Instructions

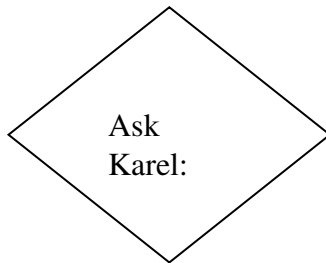
If you are reading the main program flowchart, you will start at the top when you begin executing the program. If you are reading one of the other flowcharts, you will start at the top when someone else calls you. In either case, you follow the same set of rules:



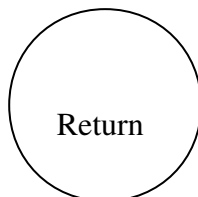
Call the person who is reading the flowchart for this operation. Continue with the next step in your flowchart after that person returns control to you.



Tell the person who is simulating Karel to execute the specified command



Ask the person who is simulating Karel the specified question. Follow the path marked "Yes" or "No" according to the answer you receive.



Return control to the person who called you.



### Karel Simulator Instructions

Simulate the operation of Karel by moving your token on the illustration that represents the robot world. As a robot, Karel can only execute the following simple commands:

Move	Move forward to the next intersection (in whatever direction Karel is currently facing). Karel "crashes" if it runs into a wall (or falls off the edge of the robot world).
Turn left	Turn left 90 degrees, remaining at the same intersection.
Turn right	Turn right 90 degrees, remaining at the same intersection.
Stop	Stop receiving and executing commands.

Karel can also answer the following simple questions, replying to each with either "Yes" or "No":

Is front clear?	Could Karel move forward to the next intersection without running into a wall or a window?
Is front blocked?	Is there a wall or a window directly ahead of Karel?
Is wall on right?	Is there a solid wall (not a window) immediately to Karel's right?

## **Facilitator Instructions**

As Facilitator, your job is to perform several very important functions for your group. First, observe and monitor the progress of your group as it works through the group instructions. Help the group members stay "on task" and follow the instructions for this exercise. Be aware of the time remaining, and try to ensure that your group is ready when it is time to resume with general class discussion.

In this exercise, each of the other group members has a specific task to perform. For example, the Flowchart Readers should go through their assigned flowcharts one step at a time, calling other readers or giving instructions to Karel. The Karel Simulator should move the robot only when instructed by a Flowchart Reader. Start the group process by giving each person a few minutes to look over the instructions for his or her role.

It is very important for each person to stay in the assigned role, following the appropriate set of instructions. If you notice that one of the other group members is having trouble with his or her role, try to help that person see what to do. (Don't perform the role yourself, but help out with hints and suggestions as appropriate.) If you aren't sure how to do this, call one of the instructors over to help out.