Robot? What’s a Robot?

Introducing
Karel-the-Robot
Robot

• “A robot is a virtual or mechanical artificial agent.”
• “Usually an electro-mechanical system which, by it’s appearance or movements,” gives the sense that it is operating on its own.
• “The word robot can refer to both physical robots and virtual software agents…” If these virtual robots run over the Internet they are often called bots.


• Robotics – “the science and technology of robots, and their design, manufacture and application. Robotics has connections to electronics, mechanics and software.”

Robots

• Roomba (Robot Vacuum) Commercial
  http://www.youtube.com/watch?v=oSiTZToJBy4&feature=related
  http://www.youtube.com/watch?v=GTxW3GWZ5hI&feature=related

• Climbing Robot
  http://www.youtube.com/watch?v=JzfP0Ig7eVQ&feature=related

• Robot play the violin
  http://www.youtube.com/watch?v=EzjkBwZtxp4

• Robot History
  http://www.youtube.com/watch?v=MCtds4nGhQo&feature=related
Robots and Karel

• Karel is not a robot like the ones in the videos.
• Karel is not a fictional robot like C3P0 from Star Wars
• Rather Karel is a software “entity” that you program in a version of a high level language called PASCAL.
• You, the human controller (programmer), tell Karel exactly what to do.
• Karel is very good at following instructions.
• You however, have to learn to Speak Karel’s very limited language.
Karel the Robot

Karel’s World

– Plain made of streets & avenues
– Corners or intersection
– Location
  • determined by avenue & street numbers
  • Positive integers
– Origin/Start is 1st avenue & 1st street
Karel the Robot

Walls

• Made of neutronium
• Obstacles
  – Karel cannot pass through a wall
• Located
  – Between streets
  – Between avenues
• From origin, Karel’s World has a huge immovable wall on his west side & south side
Karel the Robot

Beepers

• Pinging beeper
  – Found at intersections
• Karel can do things with the beepers
  – pick up one at a time
  – carry
  – put down
Karel the Robot

Karel is a Robot

Karel cannot think

– Karel is remarkable at his ability to follow instructions
– As long as these instructions are VERY detailed
Karel the Robot

Karel’s Capabilities

– Move forward (move)
  • turn in place (turnleft)

– Knows which direction it is facing – compass
  • is equipped with three cameras
  • forward
  • right
  • left

– These cameras have a $\frac{1}{2}$ block range
Karel the Robot

Karel’s Capabilities

– Karel can hear
  • Can detect a beeper on the same corner Karel is standing

– Karel’s has a Beeper Bag
  • Stores beepers
  • Soundproof
  • Karel cannot hear beepers in the bag

– Karel can put beepers in the bag and remove beepers from the bag
Karel the Robot

Karel’s Abilities

• Not isn’t very smart
• But, Karel is very good at following instructions
• The algorithm or step-by-step set of instructions Karel follows is called a program
• Karel understands a very simple programming language
• By computer standards, it is a high-level language
• The computer inside Karel doesn’t actually “speak” the language of our programs
• Our programs will have to be translated into the machine code (0,1) that the computer understands. To do this we will compile our programs.
Karel the Robot

How does Karel know what to do?

– Karel only does what we tell it to do.
– We write a program that gives Karel its instructions.
Karel the Robot

Karel’s Programming Language

– vocabulary
– punctuation marks
– rules of grammar
– Simple, yet powerful
Karel the Robot

Tasks & Situations

• What is a task?
  – Something we want Karel to do

• What is a situation?
  – Description of Karel’s world
  – Includes
    • Size & location of wall(s)
    • Location & number of beepers
    – Karel’s location & direction Karel is facing

• Initial Situation (Initialize)
  – Situation when Karel is assigned a task

• Final Situation
  – After task is completed

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Karel the Robot

Primitive Instructions

- move
- turnleft
- pickbeeper
- putbeeper
- turnoff

- They allow Karel to move through world & handle beepers
- Provide for avoiding obstacles & transporting beepers
Karel the Robot

Program & Instruction Execution

• An instruction is **Executed** (Run) when Karel performs the task it is told to perform.

• A program is **Executed** when the instructions in a program are carried out.
Karel the Robot

Primitive Instruction Details

- Changing Position
  - move
    - Karel moves forward one block
    - Karel remains facing in the same direction
    - If a wall is in Karel’s way & a move instruction is executed, Karel shuts off

When Karel turns off due to an error this is called an **Error shutoff**

- turnleft
  - Karel pivots 90 degrees to left
  - Location does not change
  - Cannot cause error shutoff

  **Why not?**
Karel the Robot

Handling Beepers

• **pickbeeper**
  – Karel picks up a beeper from the corner on which it is standing and deposits beeper in the beeper bag
  – The pickbeeper command work on one beeper at a time
  – There may be more than one beeper on a corner

What if Karel tries to pick up a beeper when no beeper is at the corner?

**Error shutoff**

• **putbeeper**
  – Karel takes a beeper out of beeper bag and places beeper on corner

What if there are not any beepers in the bag?

**Error shutoff**
Karel the Robot

Completing a Task –

When a task is complete, Karel must be told to that the program is finished.

– turnoff

• Karel must be shut down after task is completed
• Last instruction in every program
Karel the Robot

What does a Karel the Robot Program look like?

BEGINNING-OF-PROGRAM

BEGINNING-OF-EXECUTION

Instructions, ending with a semicolon (;)

END-OF-EXECUTION

END-OF-PROGRAM

• The instructions are made up of the **Primitive** commands Karel understands.

• Karel’s Language has **Reserved Words** that structure the program.

BEGINNING-OF-PROGRAM

BEGINNING-OF-EXECUTION

instructions

END-OF-EXECUTION

END-OF-PROGRAM
Karel the Robot

Errors, Bugs, Debugging

Four kinds of errors can occur in Karel’s Language

1. Lexical Errors
   - When Karel tries to read a word it doesn’t understand
   - Spelling

2. Syntax Errors
   - Errors in Grammar and Punctuation, Ex.
   - Reserved words in the wrong order
   - Missing semicolon (;)
Karel the Robot

Errors, Bugs, Debugging

Four kinds of errors can occur in Karel’s Language

3. Execution Errors
   – When Karel is asked to do something it cannot do
   – Pick up a bepper where none exists
   – Walk into a wall

5. Logic Errors
   – Hardest to find and recognize
   – Where program has no obvious errors but it doesn’t solve the problem
   – Or Karel executes part way and turns off
Running/Executing a Program

- Instructions between BEGINNING-OF-EXECUTION and END-OF-EXECUTION are acted on in order (from top to bottom) until a turnoff instruction or error shutoff is encountered.

- How do we know what to ask Karel to do?
  - Simulate – we model our solution on paper before we ever write a line in Karel’s language
  - We trace the program to make sure we have given Karel all the instructions needed
    
    Graph paper might be a good idea
  
    - Verification

What-If we run Karel’s program, and our goal is not achieved?
  - We again trace the program seeing if we can find where we gave Karel incorrect information.
  - Verification
Karel the Robot

– Using Karel the Robot in Lab
– Different “Windows”
  • World View (Window)
  • Program View (Window)
  • Execution Window
Karel the Robot

Create a World
• Beeper inside a box
• Retrieve and Return

Write a Program
Karel the Robot

**Problem statement:** Karel is to go to the open side of the box, go inside and retrieve the beeper, then go home.

Remember our Algorithm Planner

- Define the output
- Define the input
- Define the initial algorithm
- Refine the algorithm
- Define the program
Define the output: Karel ends up at the origin having retrieved a beeper from the box

Define the input: Karel starts at the origin with no beepers in the beeper-bag

Define the initial algorithm
- Karel is at the origin
- Karel is to go to the open side of the box
- Karel goes inside and retrieve the beeper
- Karel goes home
Karel the Robot

Refine the algorithm

• Karel is initialized at the origin with an empty beeper-bag
• Karel is to go to the open side of the box
  – Go up to 5th street
  – Turnright
  – Go another 4 blocks
  – Make another right
• Karel goes inside and retrieve the beeper
  – Go one more block
  – Pickup the beeper (and put it in the beeper-bag)
• Karel goes home
• Travel the reverse of the directions given before
Karel the Robot

Refine Again

– Karel is initialized at the origin with an empty beeper-bag
– Go up to 5th street
– Turnright
– Go another 4 blocks
– Make another right
– Go one more block
– Pickup the beeper (and put it in the beeper-bag)
– Turn around
– Go one block
– Make a left
– Go 4 blocks
– Turnleft again
– Go 4 blocks
– Turnaround

End