Welcome!

We'll get started shortly. Please take the Zoom poll in the meanwhile!

CS 49 Week 2

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Agenda

- Goal for Week 2 section: To understand how to use control flow in designing and implementing coding solutions
- Review of lecture concepts
  - Conditionals: **`if`**, **`if-else`**
  - Loops: **`for`**, **`while`**
  - Functions
- Worked example: Spring Flowers
- Section problem: Hospital Karel

How to get hold of me / get help from other resources

- Surajit's office hours
  - Fridays 12 noon–1p, directly after section
  - By appointment on Zoom
- Post on the section forum, usually get a response within 2 hours
- Email bosesurajit@fhda.edu or Canvas inbox, 24 hr turnaround
- The github repo has section materials, starter code, and solutions

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- Canvas inbox for Lane
- The main forum for the course on the Code in Place site
- Lane's office hours
- Online or in-person tutoring (Room 3600)
- One-on-one code reviews with Sarah or Lia

Control Flow: Conditionals, Loops

Control Flow

- The order in which instructions are executed is not always linear
- We discussed how in Archway, calling **`move_three_spaces()`** or **`turn_right()`** causes program execution to jump out of **`main()`** to the called function, then back to main once the called function's work is completed
- A function call therefore affects the program's flow of control
- Conditionals and loops are other mechanisms used for control flow
- Conditionals include **`if`** and **`if-else`**
- Loops include **`for`** and **`while`**
- Let's look at each of these in turn

Python Conditionals

`if` Statement

- An `if` statement performs the block of code indented inside it only when the associated condition is `True`, and only once
- An example `if` statement that you might see and use with Karel:

```
if front_is_clear():
    move()
```

- Note that `move()` is indented below the `if` clause. As with functions, indentation is meaningful and necessary in all Python conditionals and loops. It demarcates the **block** of commands that will be performed as part of that conditional or loop
- There can be several commands under a single `if`, all part of the same block

`if-else` Statement

- An `if-else` statement performs a block of code when the associated condition is `True`, or a different block of code when the condition is `False`
- The appropriate indented block is performed only once
- An example `if-else` statement that you might see and use with Karel:

```
if no_beepers_present():
    move()
else:
    pick_beeper()
```

- There can be several commands within each block

Python Loops

`while` Loop

- A `while` loop repeatedly performs a block of code until its associated condition evaluates to `False`
- The condition is evaluated before each pass through the loop
- If the condition is `True`, the indented block is executed
- This process repeats until the condition becomes `False`
- An example `while` loop that you might see and use with Karel:

```
while front_is_clear():
    move()
```

- This loop is also called an *indefinite loop* because we don't know in advance how many times it will run

`for` Loop

- A `for` loop performs its block of code a specified number of times
- An example `for` loop that you might see and use with Karel:

```
for i in range(3):
    turn_left()
```

- **`i`** is a conventional name for the counter, from integer. The underscore _ is also a very common counter. But you can call the counter anything, even **`jane`** or **`bob`**
- The counter is incremented after each pass through the loop
- This loop is also called a *definite loop*, because we know when it ends: when the counter reaches the specified number

Functions

Functions

- The process of breaking down a problem into smaller, self-contained building blocks is **decomposition**
- These smaller building blocks are **functions**
- A function is a sequence of steps that achieves a specific outcome
- Any set of steps that needs to be repeated could be made a function
- So could any logically self-contained portion of the program
- A sample function you might see and use with Karel:

```
def turn_right():
    for _ in range(3):
        turn_left()
```

Advantages of using functions

- **Readability** : a single statement **`turn_right()`** is easier to understand than three consecutive **`turn_left()`** statements
- **Repeatability** : If Karel needs to turn right several times in a program (e.g., as in Archway), using this function can help us avoid writing the same code over and over again
- **Reliability** : Using functions makes the code modular and easier to debug, as we can test each function out after writing it to make sure it works rather than testing the whole program at once

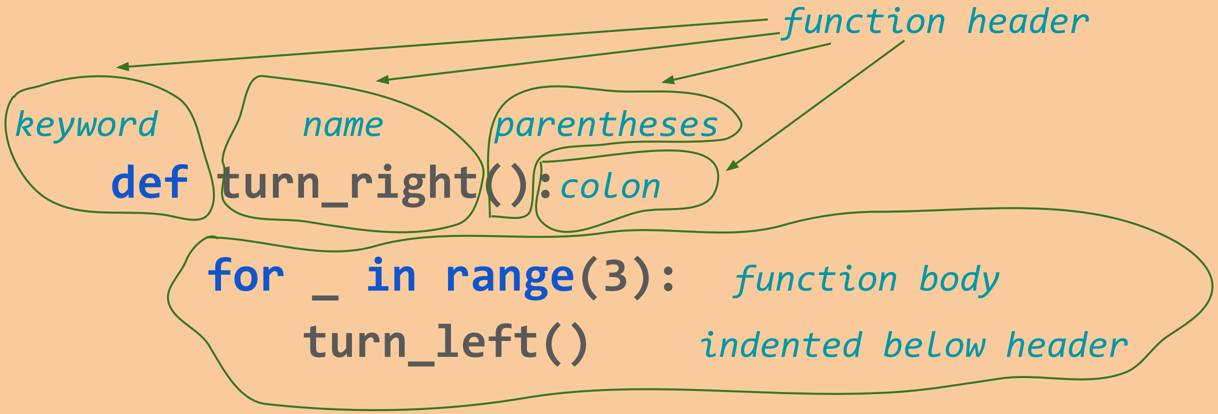
Function Structure (Slide 1 of 2)

- The function header is at the top of the function definition:

```
def function_name():
```

- The header starts with the keyword **`def`** followed by the function name
- The function name should briefly but clearly state what the function does
- The function name is followed by a pair of parentheses **`()`**
- The function header ends with a colon **`:`**
- The function body is an indented block below the header. It includes all the commands necessary for the function to do its work

Function Structure (Slide 2 of 2)

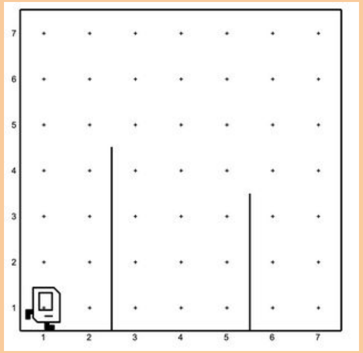


```
def turn_right():
    for _ in range(3):
        turn_left()
```

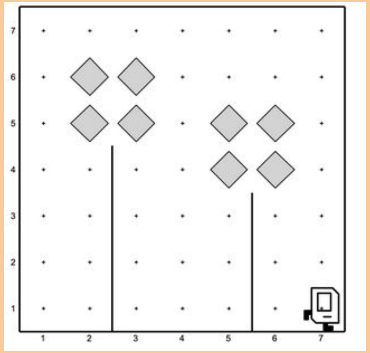
Worked Example: Spring Flowers

Understanding the Problem: Pre- and Postconditions

- Preconditions
  - Karel starts facing east in the bottom left corner of the world
  - The world has an arbitrary number of columns
  - There are exactly two flower stem walls somewhere in the row
  - Flower stems are of arbitrary height
  - There are at least two rows above the top of each stem



- Postconditions:
  - Karel is at the end of the row facing east
  - Flower stems have "bloomed" with petals consisting of 2 x 2 squares of beepers



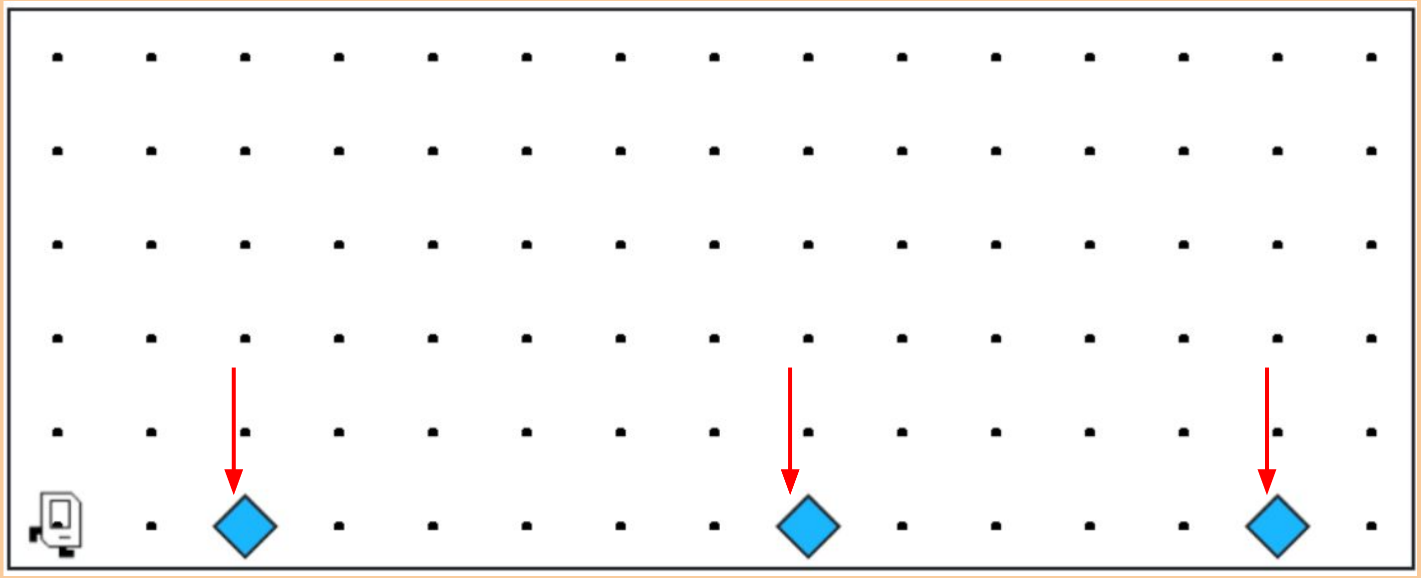
Designing, Implementing, and Testing the Solution

- Design considerations
  - What are the overall steps to get from preconditions to postconditions?
    - Not "how" but "what"; do not worry about implementation yet
  - What self-contained, repeating units can be turned into functions?
  - What control flow mechanisms are needed? Do steps need to be repeated?
    - A certain number of times (**`for`** loop)
    - As long as a condition is true (**`while`** loop)
- Implement and test the solution
  - Write out each function header
  - Write out each function and test it by putting a function call in **`main()`**
  - Debug each function as needed
  - When all functions are written and assembled in **`main()`**, test the entire solution
  - Are there any fencepost conditions?

Section Problem: Hospital Karel

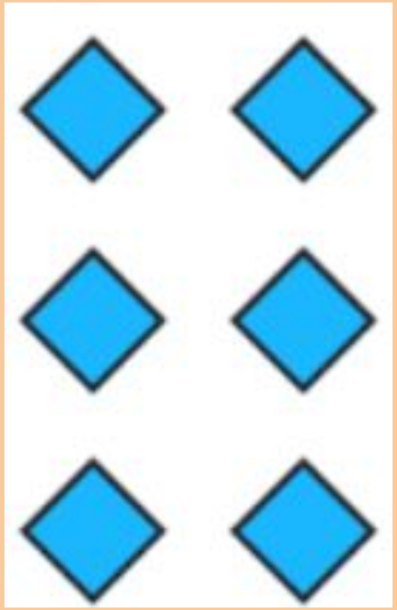
Hospital Karel Preconditions (Slide 1 of 3)

Karel starts facing east at [1, 1] with an infinite supply of beepers in its bag. Each beeper in the bottom row represents a location where Karel should build a hospital:



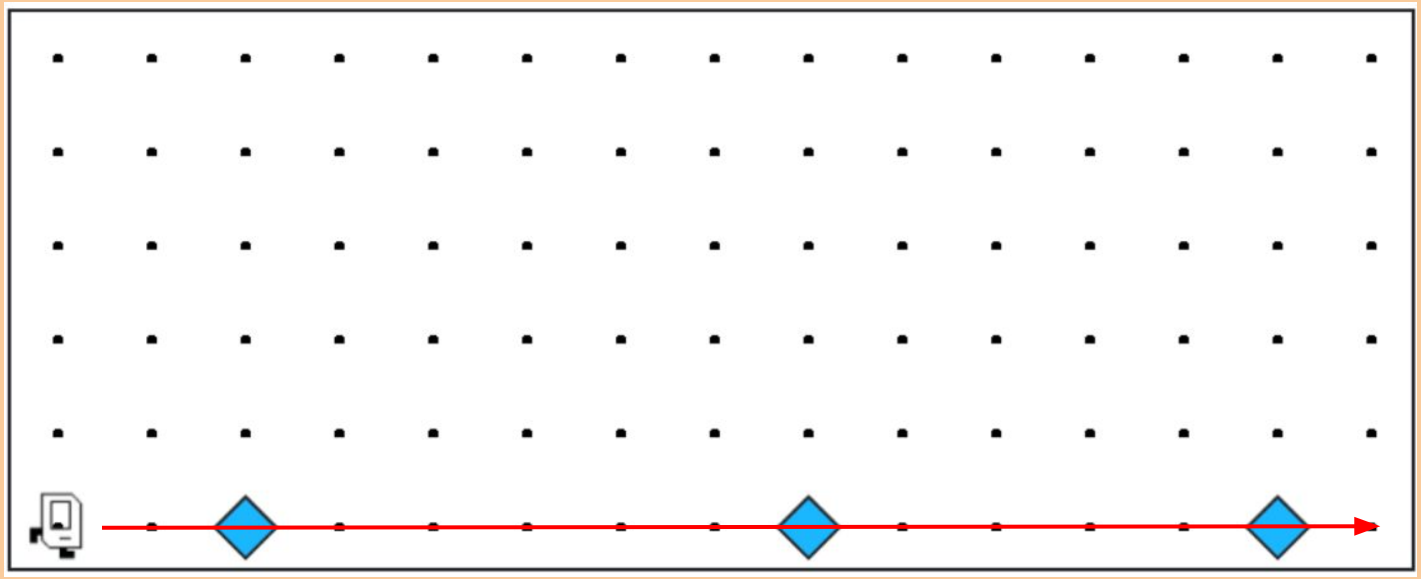
Hospital Karel Preconditions (Slide 2 of 3)

The hospitals Karel should build are a 3 x 2 rectangle of beepers:



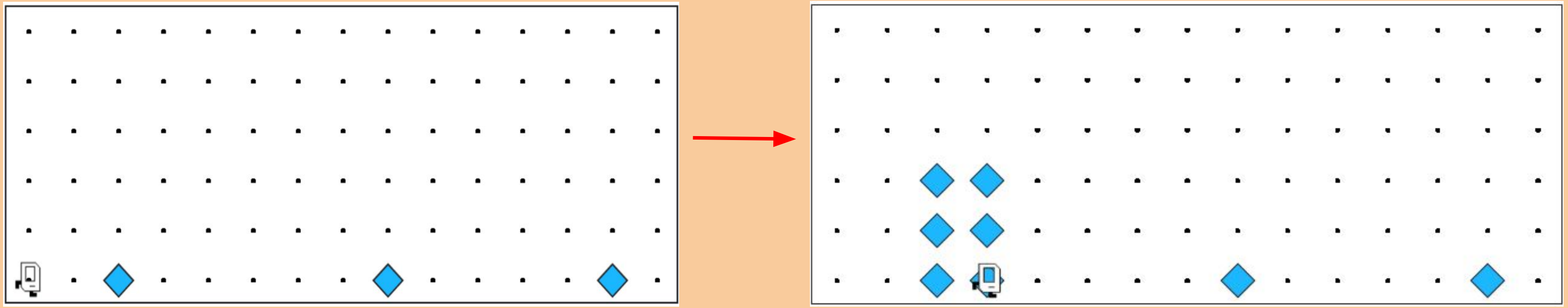
Hospital Karel Preconditions (Slide 3 of 3)

Karel must walk the row and build a hospital at each location. The beepers indicating the locations will be spaced such that there will be no overlapping or hitting walls:



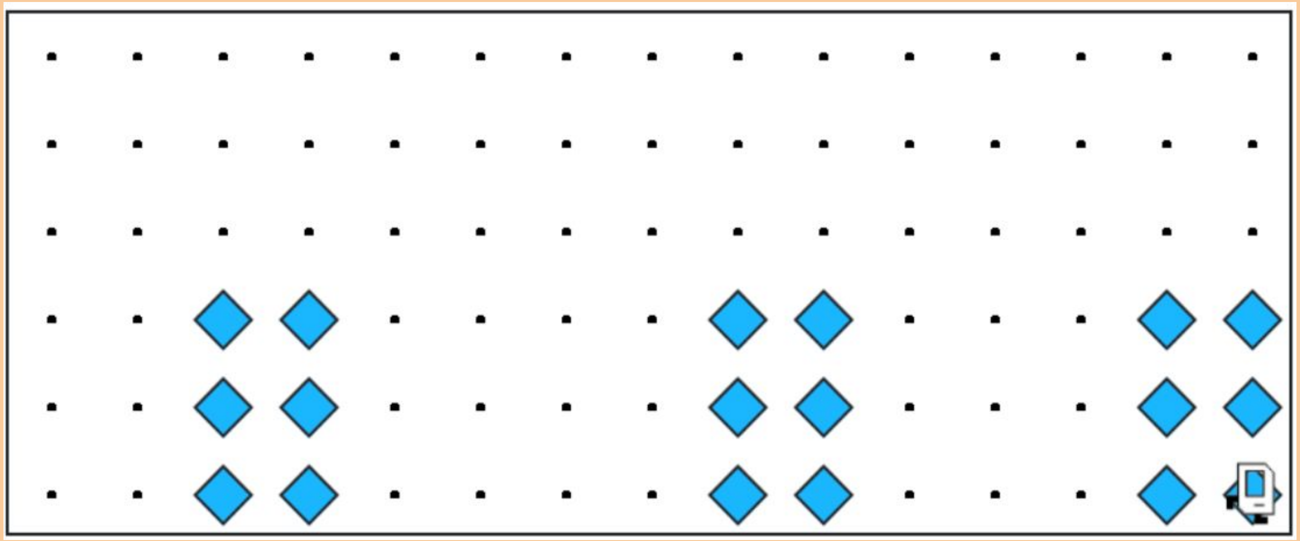
Hospital Karel Postconditions (Slide 1 of 2)

Here is the state after Karel has built the first hospital:



Hospital Karel Postconditions (Slide 2 of 2)

For the initial set of conditions shown, the result should look like this. Karel should not run into the wall after building the hospital that extends to the final corner:



Hospital Karel Hints

- Decompose the solution thoroughly
- You might want to consider whether building a hospital can be further broken down into twice building a column of three beepers. If you do this, make sure you don't end up with two beepers at the starting point for each hospital
- Be prepared to iterate over the solution. Tackle fencepost problems (such as the possibility of a hospital's being located on the leftmost corner) *after* you have tackled the general case
- Your program should work for any world that meets the preconditions; do not engineer it specifically for one world, e.g., by counting the number of hospitals and/or corners

That's all, folks!

Next up: Problem Solving