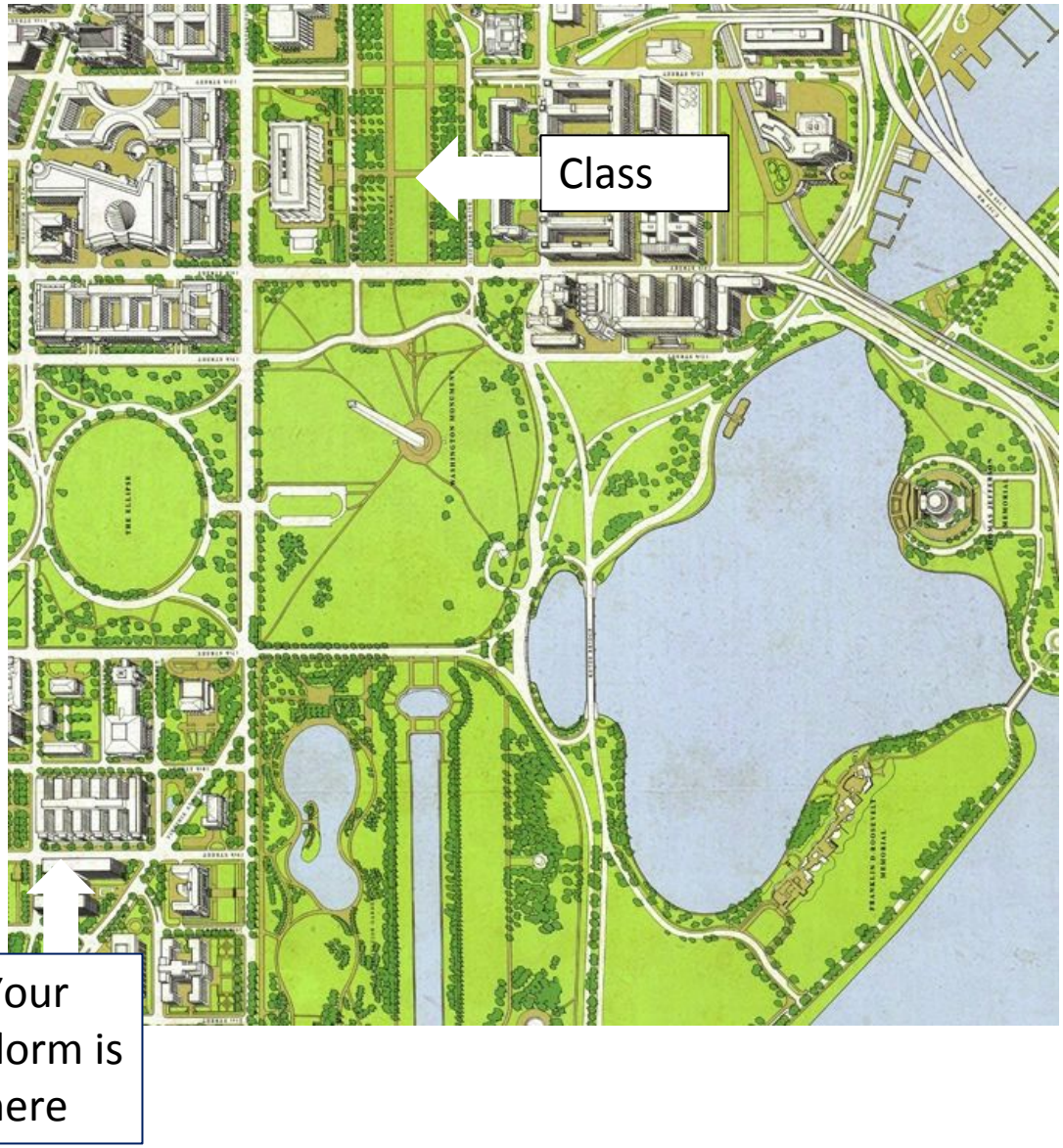
Object Oriented Programming

By Emma Rosensaft

EXERCISE

Write instructions for getting from your dorm to class



1st Step: Plan

What do the instructions have to include?

-leave the dorm building

-turn right

-walk forward

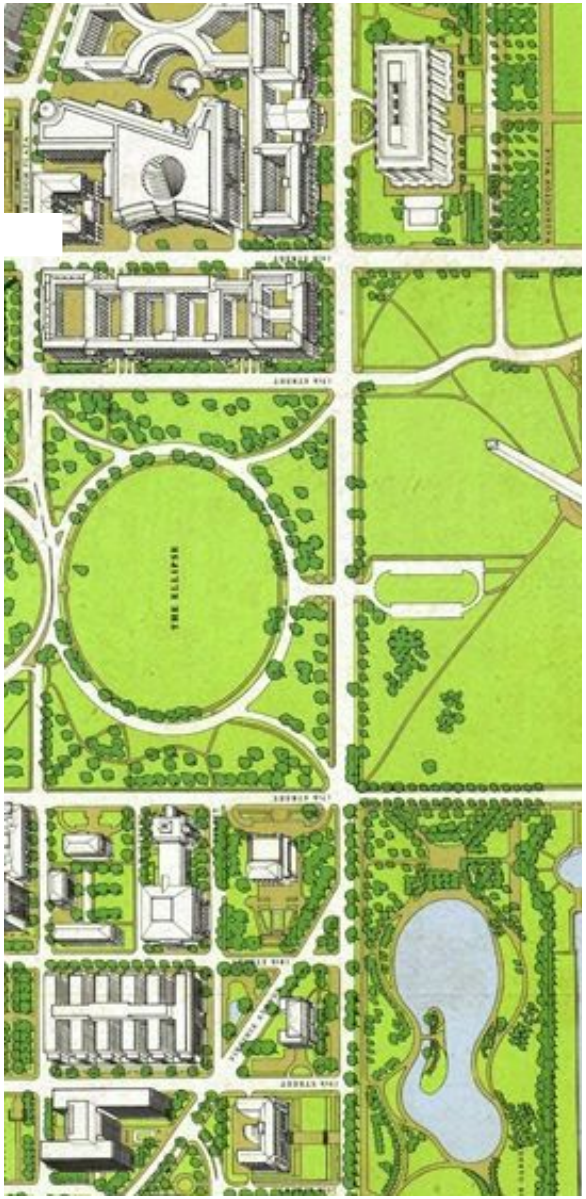
-turn right

-walk forward

-turn left

-walk forward

-enter school building



If you were assigned this task, the outline for the instructions would include almost all of the information needed.

If you gave the outline to someone, he/she could probably figure out how to get to class

But what if the instructions were intended for a human-like robot? Would the outline still be sufficient?

Probably not: A key difference between humans and robots (in most cases) is that robots can't really "figure" things out if they are unclear/ambiguous.

a) Robots are pretty dumb. They don't have "common sense"

Humans

**minus some of the details (e.g. distances), this includes all of the basic info someone would need

-leave the dorm building

-turn right

-walk forward

-turn right

-walk forward

-turn left

-walk forward

-enter school building

Robots

****A robot would not understand what these commands mean**

1) **What does is mean to "leave" a building ? Is leaving "the dorm" building a special circumstance –where a different set of tasks would be needed? How "much" to leave?**
2) **What does it mean to turn? How much to turn?**
3) **What does it mean to walk?**

etc……

b) Robots are really dumb. They don't automatically "figure things out" even when they have all of the necessary information

In other words: for the purposes of coding for the robot, the computer/control unit will not use deductive reasoning

For Example

I like ice cream. I have 3 flavors at home: vanilla, chocolate and strawberry. I don't like 1 of those flavors, which we will call x.

If:

-I like vanilla ice cream

-I like strawberry ice cream more than I like vanilla ice cream

It would be obvious to us that I don't like chocolate ice cream, therefore chocolate must be flavor x.

This conclusion would not be obvious for a computer because a computer would view this as an algebra problem.

Since a calculation wasn't performed to isolate the "value of x," **the computer will not automatically assign chocolate to x**.

In the context of getting to class:

-the robot wouldn't be able to "figure" out when to turn based on when the road/sidewalk has a path that allows you to turn

-similarly the robot wouldn't know that the turn would have to be 90 degrees

This is important because either:

a) the computer will prevent your code from being processed if it is missing important info

or

b) an error will occur while the program is running

This means that you cannot rely on “forcing” the robot to do things using constraints that it doesn’t know about.

-so you can’t have the robot pressing up against the side of the road until the road turns

-you also can’t expect the robot to “handle” something specific just because, in practice, that would be the only possible thing to “handle”

Main Point to take away from this: Your robot instructions must be really really really detailed and precise

The following 3 slides are examples of possible approaches for writing instructions for a robot

Questions to consider:

-which is the simplest?

-which requires the most repetition?

-which looks the least time consuming to write?

-which is the most intuitive?

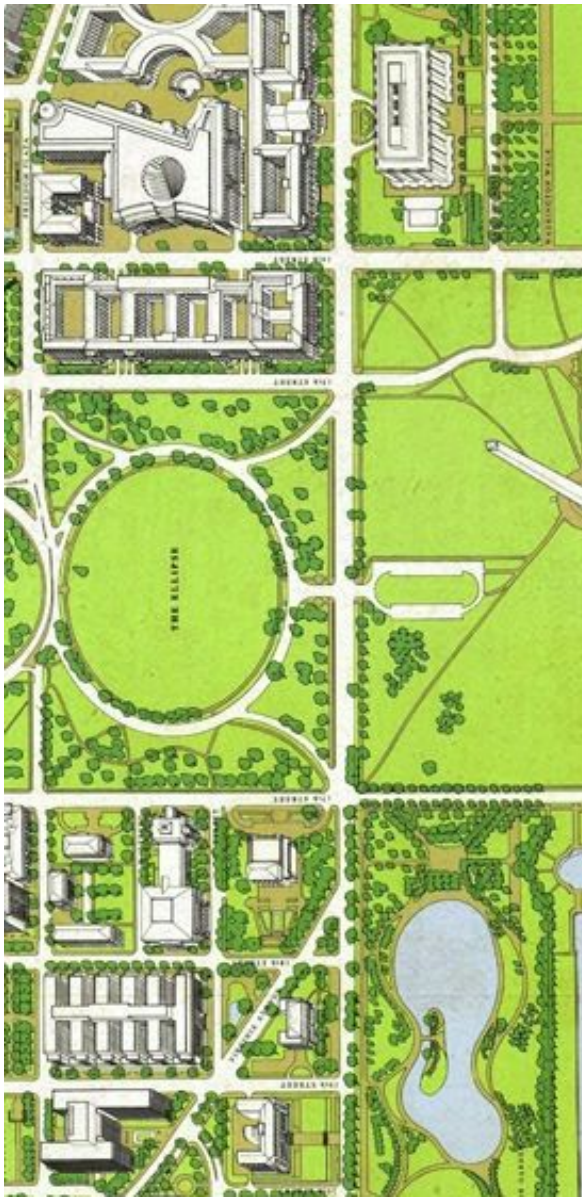
-which seems to model the real world the most accurately?

(walking out of dorm building)
Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot....

(pushing on door to exit)
Extend both arms, lift right foot.....

(walking down front steps)
Lower both arms. Lift right foot, place it one the nearest step below, lift left root.....

(turning right)
Lift right foot, place it rotated 30 degrees, 6 inches horizontally away from the left foot. Lift left foot, rotate it 30 degrees , place it 4 inches away from the right foot. Lift right foot....



Solution 1

-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Descend stair right = lift right foot, place it on the nearest step below.

Step left = lift left foot, place it <stride length> in front of right foot.

Descend stair left = lift left foot, place it on the nearest step below

Turn right 90 degrees = Do this 3 times:: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

_____

(walking out of dorm building)

Step right. Step left. Step right.....

.....

(pushing on door to exist)

Extend both arms. Step right. Step left.....

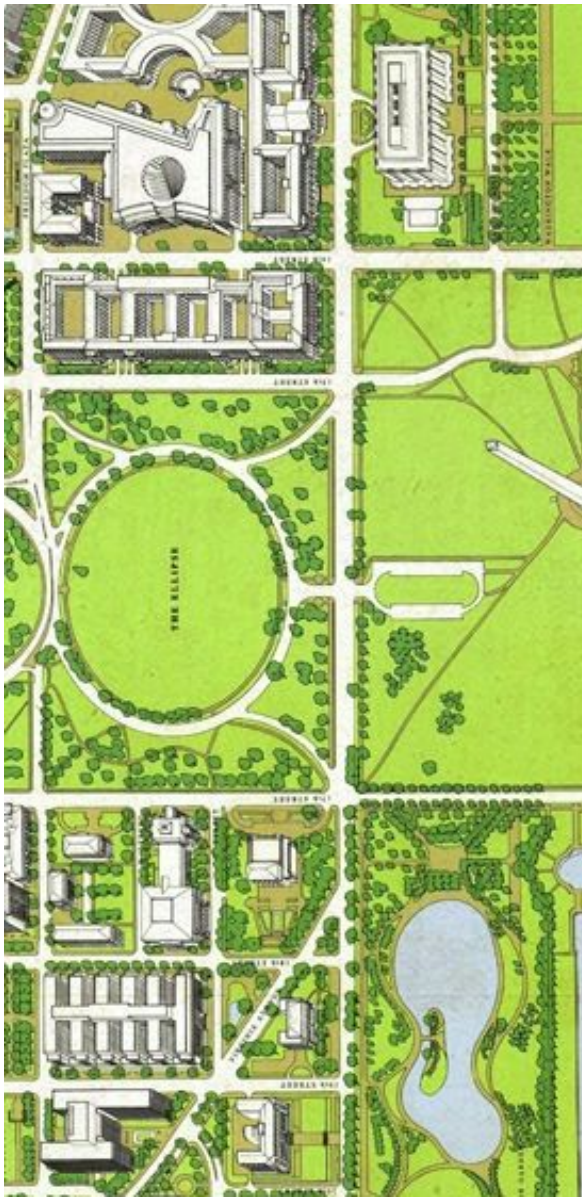
(going down front steps)

Descend stair right . Descend stair left. Descend stair right....

(turning right)

Turn right 90 degrees.

Step right. Step left.....



Solution 2

Taking a closer look....

-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Descend stair right = lift right foot, place it on the nearest step below.

Step left = lift left foot, place it <stride length> in front of right foot.

Descend stair left = lift left foot, place it on the nearest step below

Turn right 90 degrees = Do this 3 times:: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

Taking a closer look....

_____

(walking out of dorm building)

Step right. Step left. Step right.....

.....

(pushing on door to exist)

Extend both arms. Step right. Step left.....

(going down front steps)

Descend stair right . Descend stair left. Descend stair right....

(turning right)

Turn right 90 degrees.

Step right. Step left.....

MOVEMENT
-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Step left = lift left foot, place it <stride length> in front of right foot.

Walk one mile = Do this 1760 times:: Step right. Step left.

Descend stair right = lift right foot, place it on the nearest step below lowest foot.

Descend stair left = lift left foot, place it on the nearest step below lowest foot.

Descend 1 flight of stairs = *where 1 flight = 20 steps* Do this 10 times: Descend stair right. Descend stair left.

INSTRUCTIONS
-MOVEMENT

Turn right 90 degrees = Do this 3 times: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

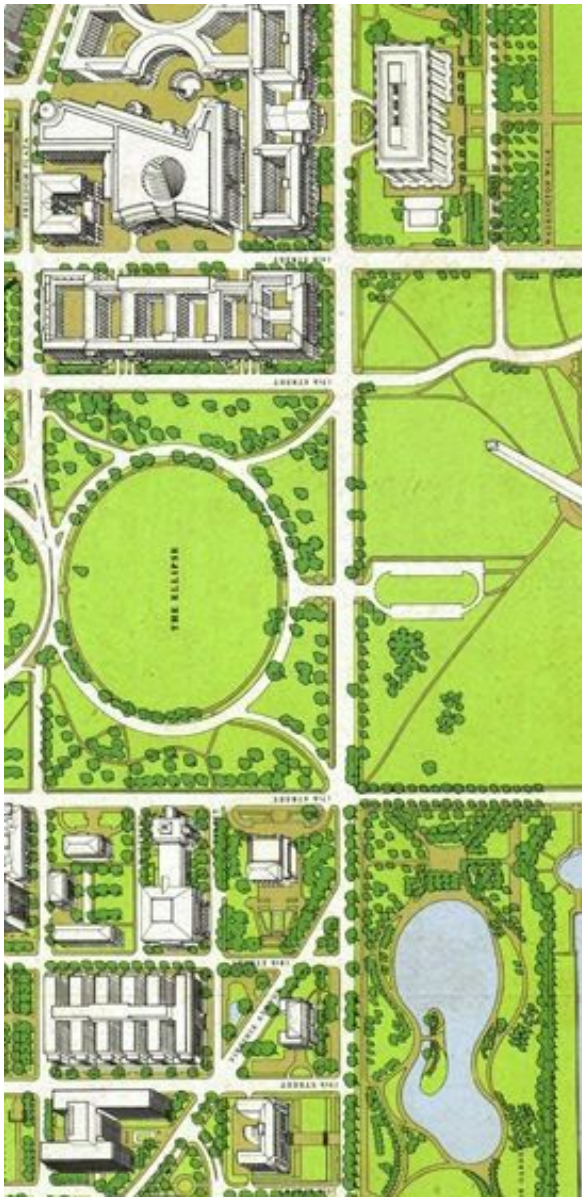
Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

(walking out of dorm building)
(0.1 X Walk one mile).

(pushing on door to exit)
Extend both arms. (0.002 X Walk one mile).

(going down front steps)
Descend one flight of stairs. Descend stair left. Descend stair right.

(turning right)
Turn right 90 degrees.
(0.25 X Walk one mile).



Solution 3

Taking a closer look....

MOVEMENT

-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Step left = lift left foot, place it <stride length> in front of right foot.

Walk one mile = Do this 1760 times: Step right. Step left.

Descend stair right = lift right foot, place it on the nearest step below lowest foot.

Descend stair left = lift left foot, place it on the nearest step below lowest foot.

Descend 1 flight of stairs = *where 1 flight = 20 steps* Do this 10 times: Descend stair right. Descend stair left.

INSTRUCTIONS

-MOVEMENT

Turn right 90 degrees = Do this 3 times: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

Taking a closer look....

(walking out of dorm building)
(0.1 X Walk one mile).

(pushing on door to exit)
Extend both arms. (0.002 X Walk one mile).

(going down front steps)
Descend one flight of stairs. Descend stair left. Descend stair right.

(turning right)
Turn right 90 degrees.
(0.25 X Walk one mile).

Comparison

(pushing on door to exit)

Solution 1

Extend both arms. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot.....

Solution 2

Extend both arms. Step right. Step left. Step right.....

.....

Solution 3

Extend both arms. (0.02 X Walk one mile).

Approach

Sequential programming:

→based on describing how different actions function with respect to time—moment-by-moment

"Method-oriented" programming:

→focused on organizing small tasks into larger actions

→otherwise the same as sequential

Object-oriented programming:

→focus on describing "things" and the actions that are performed on or with these "things."

→focused on **how objects change** over the course of the program **rather than the sum total of things that occurs** over a period of time--the way sequential does

Observations

- The solutions progressively get shorter
- The solutions progressively become more similar to “human” instructions

Comparison

(Pushing on door to exit)

Solution 1

Extend both arms. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot.. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift right foot, place it 1.5 feet in front of the left foot.

Solution 2

Extend both arms. Step right. Step left. Step right. Step left. Step right. Step left. Step right. Step left. Step right.

Solution 3

Extend both arms. (0.002 X Walk one mile).

Based on your responses to:
-Questions to Consider
-your own observations
-the points in the last slide

Which approach do you think is the best?

Hopefully your answer is
“object- oriented”

because

this.java is how we do it.....

Benefits of Object-Oriented Programming

1. It is more intuitive
    a. It makes it easier to design programs
    b. It makes it easier to debug code
    c. It enables code to be organized more effectively (in modules)
2. It is more conducive for code reusability

Instructions Example

1) **Intuitive**

- MOVEMENT is a broad category of actions

2) some of the actions encompassed in MOVEMENT were described

3) certain simple actions were combined to form processes

2) Reusable

4) the instructions require movement

5) the category of movement was referenced

→this enabled INSTRUCTIONS to access the actions defined in movement, eliminating the need to redefine them

MOVEMENT

-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Step left = lift left foot, place it <stride length> in front of right foot.

Walk one mile = Do this 1760 times:: Step right. Step left.

Descend stair right = lift right foot, place it on the nearest step below lowest foot.

Descend stair left = lift left foot, place it on the nearest step below lowest foot.

Descend 1 flight of stairs = *where 1 flight = 20 steps* Do this 10 times: Descend stair right. Descend stair left.

INSTRUCTIONS

-MOVEMENT

Turn right 90 degrees = Do this 3 times: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

(walking out of dorm building)
(0.1 X Walk one mile).

(pushing on door to exit)
Extend both arms. (0.002 X Walk one mile).

(going down front steps)
Descend one flight of stairs. Descend stair left. Descend stair right.

(turning right)
Turn right 90 degrees.
(0.25 X Walk one mile).

Key components of object-oriented programming

- Classes
- Objects
- Methods

Quick Review

Primitive data types:

-Include:

- Bytes (byte)
- Shorts (short)
- Longs (long)
- Integers (int)
- Floating-point numbers (float)
- Double-precision floating-point numbers (double)
- Characters (char)
- Booleans (boolean)

→referencing a variable of any one of these types is the same as referring to that variable's data (or value)

Non-primitive data types:

-are objects (we'll get to this later), which include:

- Arrays
- Strings

-any variable of a non-primitive type has 2 features:

- A reference to a specific memory location
- A value (or set of values) that is stored in that specific memory location

→referencing a variable of a non-primitive type is not the same as referring to that variable's data (or value(s))

Methods

- Method = process
  - A method's name (by convention) is always a verb
- Methods do at least 1 of 2 possible things:
  - result in a specific value/set of values
  - carry out a set of executed tasks
- Methods can use other methods (with certain exceptions)

Methods Continued

Every executable program has a *main* method

MOVEMENT

-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Step left = lift left foot, place it <stride length> in front of right foot.

Walk one mile = Do this 1760 times:: Step right. Step left.

Descend stair right = lift right foot, place it on the nearest step below lowest foot.

Descend stair left = lift left foot, place it on the nearest step below lowest foot.

Descend 1 flight of stairs = *where 1 flight = 20 steps* Do this 10 times: Descend stair right. Descend stair left.

INSTRUCTIONS

-MOVEMENT

Turn right 90 degrees = Do this 3 times: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

(walking out of dorm building)
(0.1 X Walk one mile).

(pushing on door to exit)
Extend both arms. (0.002 X Walk one mile).

(going down front steps)
Descend one flight of stairs. Descend stair left. Descend stair right.

(turning right)
Turn right 90 degrees.
(0.25 X Walk one mile).

MOVEMENT only has a set of definitions

This is a set definitions, not part of the main method

INSTRUCTIONS provides the commands that are directly executed by the robot

This is the is analogous to the start of the **main** method

Classes

- Classes = categories of things
- Classes serve as the blueprint for objects and methods
- Each class has its own file
- Classes are part of a hierarchy
  - Some classes completely encompass other classes
  - Some classes describe general characteristics that other classes inherit
    - but do not encompass the classes that inherit from it

Objects

- Objects = instances of classes
- An object is like a package of variables, which operate under a common set of rules
- All objects of the same *type* (created from the same class) have the same variables and follow the same rules
- Each object is distinct
  - has it's own data

Instructions Example

Classes:

In this example there are 2 classes:
-MOVEMENT
-INSTRUCTIONS

Methods:

MOVEMENT has the following methods:
-Step right
-Step left
-Walk one mile
-Descend stair right
-Descend stair left
-Descend 1 flight of stairs

INSTRUCTIONS has the following methods:
-Turn right 90 degrees
-Turn left 90 degrees
***and a sort of a main method (below the bar)

Objects:

MOVEMENT

MOVEMENT

-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Step left = lift left foot, place it <stride length> in front of right foot.

Walk one mile = Do this 1760 times:: Step right. Step left.

Descend stair right = lift right foot, place it on the nearest step below lowest foot.

Descend stair left = lift left foot, place it on the nearest step below lowest foot.

Descend 1 flight of stairs = *where 1 flight = 20 steps* Do this 10 times: Descend stair right. Descend stair left.

INSTRUCTIONS

-MOVEMENT

Turn right 90 degrees = Do this 3 times: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

(walking out of dorm building)
(0.1 X Walk one mile).

(pushing on door to exit)
Extend both arms. (0.002 X Walk one mile).

(going down front steps)
Descend one flight of stairs. Descend stair left. Descend stair right.

(turning right)
Turn right 90 degrees.
(0.25 X Walk one mile).

Beginning of junk slides
(leave until final version→useful for formatting)

Taking a closer look....

_____

(walking out of dorm building)

Step right. Step left. Step right.....

.....

(pushing on door to exist)

Extend both arms. Step right. Step left.....

(going down front steps)

Descend stair right . Descend stair left. Descend stair right....

(turning right)

Turn right 90 degrees.

Step right. Step left.....

MOVEMENT

-stride length = 1.5 feet

Step right = lift right foot, place it <stride length> in front of left foot.

Step left = lift left foot, place it <stride length> in front of right foot.

Walk one mile = Do this 1760 times:: Step right. Step left.

Descend stair right = lift right foot, place it on the nearest step below lowest foot.

Descend stair left = lift left foot, place it on the nearest step below lowest foot.

Descend 1 flight of stairs = *where 1 flight = 20 steps* Do this 10 times: Descend stair right. Descend stair left.

INSTRUCTIONS

-MOVEMENT

Turn right 90 degrees = Do this 3 times: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.

Turn left 90 degrees = Do this 3 times: lift left foot, rotate it -30 degrees, place it 6 inches horizontally away from right foot. Lift right foot, rotate it -30 degrees, place it 4 inches horizontally away from left foot.

(walking out of dorm building)
(0.1 X Walk one mile).

(pushing on door to exit)
Extend both arms. (0.002 X Walk one mile).

(going down front steps)
Descend one flight of stairs. Descend stair left. Descend stair right.

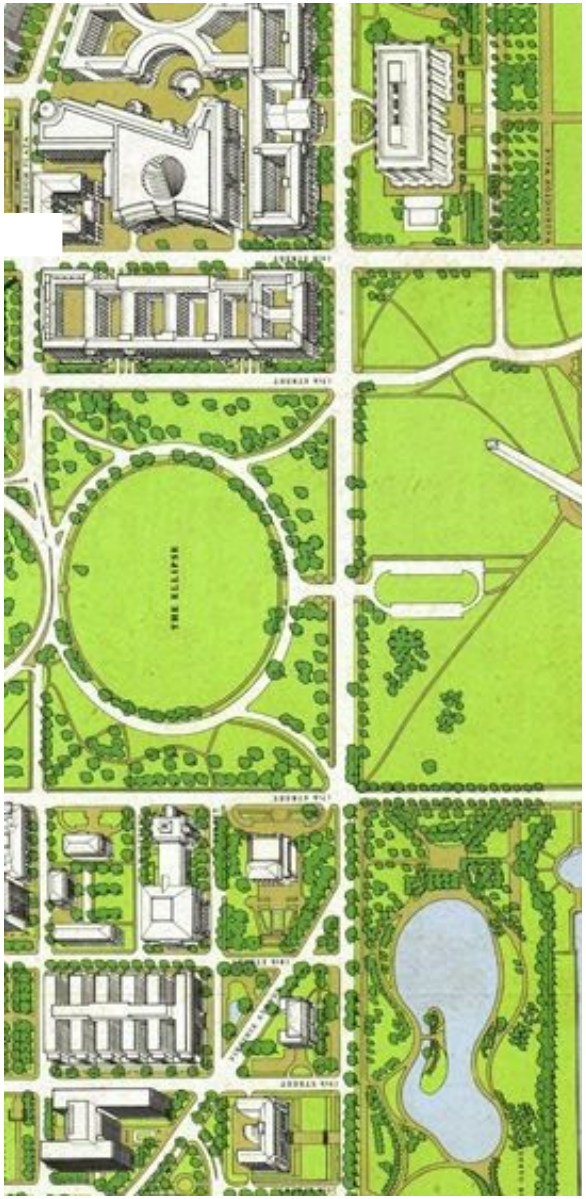
(turning right)
Turn right 90 degrees.
(0.25 X Walk one mile).

Solution 2

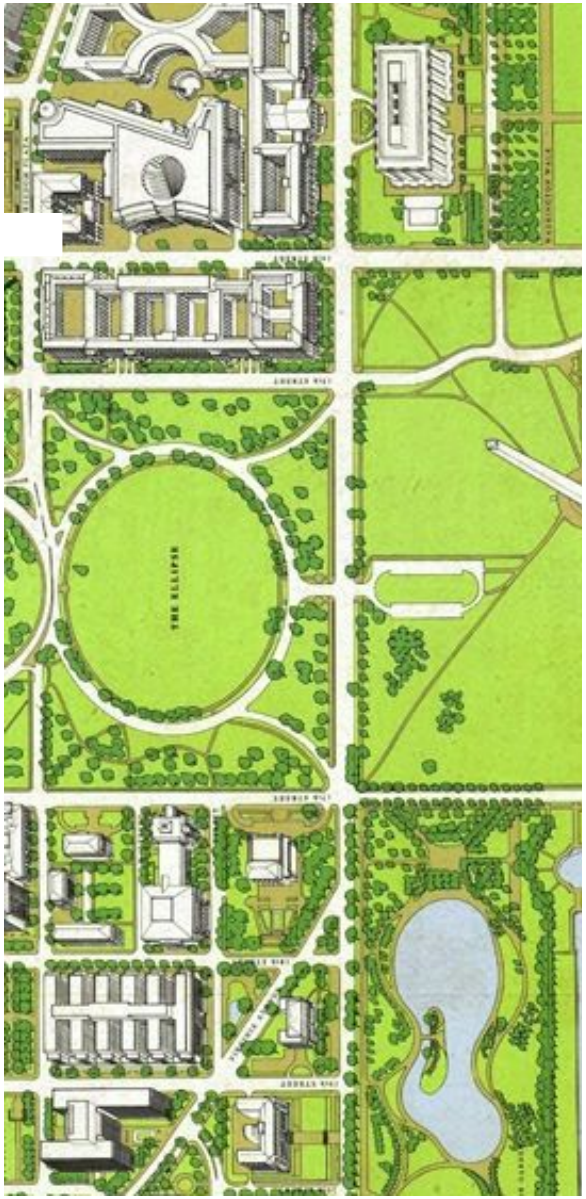
Step right = lift right foot, place it 1.5 feet in front of left foot.

Step left = lift left foot, place it 1.5 feet in front of right foot.

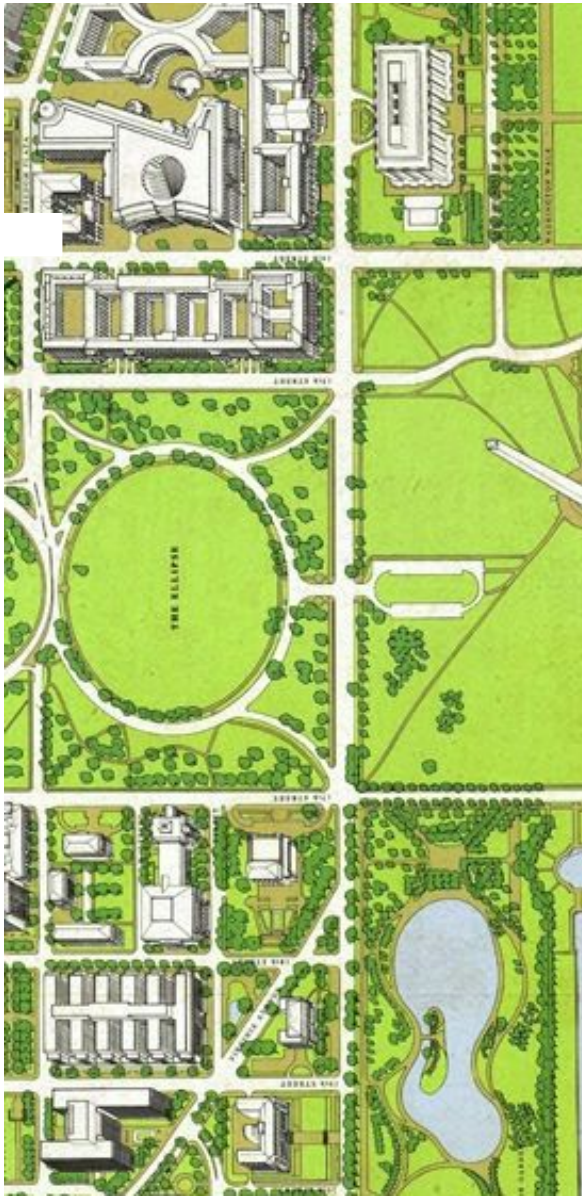
Turn right 90 degrees = Do this 3 times: lift right foot, rotate it 30 degrees, place it 6 inches horizontally away from left foot. Lift left foot, rotate it 30 degrees, place it 4 inches horizontally away from right foot.



Solution 1



Write instructions for getting to class



1st Step: Plan

**minus some of the details (e.g. distances), this includes all of the basic info someone would need

-leave the dorm building

-turn right

-walk forward

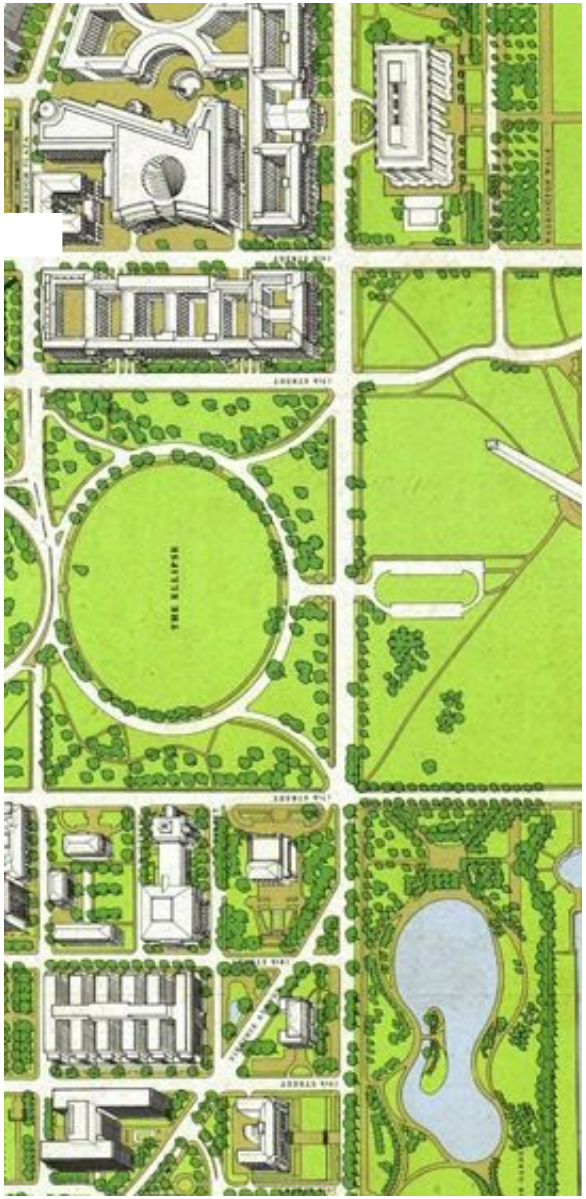
-turn right

-walk forward

-turn left

-walk forward

-enter school building



Some Observations

-The solutions progressively get shorter

-The solutions progressively become more similar to "human" instructions

Comparison

(Pushing on door to exit)

Solution 1

Extend both arms. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot.. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift right foot, place it 1.5 feet in front of the left foot.

Solution 2

Extend both arms. Step right. Step left. Step right. Step left. Step right. Step left. Step right. Step left. Step right.

Solution 3

Extend both arms. (0.002 X Walk one mile).

Comparison

(Pushing on door to exit)

Solution 1

Extend both arms. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot.. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift right foot, place it 1.5 feet in front of the left foot.

Solution 2

Extend both arms. Step right. Step left. Step right. Step left. Step right. Step left. Step right. Step left. Step right.

Solution 3

Extend both arms. (0.002 X Walk one mile).

Some Observations

-The solutions progressively get shorter

-The solutions progressively become more similar to "human" instructions

Comparison

(Pushing on door to exit)

Solution 1

Extend both arms. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot.. Lift right foot, place it 1.5 feet in front of the left foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift left foot, place it 1.5 feet in front of the right foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift right foot, place it 1.5 feet in front of the left foot. Lift right foot, place it 1.5 feet in front of the left foot.

Solution 2

Extend both arms. Step right. Step left. Step right. Step left. Step right. Step left. Step right. Step left. Step right.

Solution 3

Extend both arms. (0.002 X Walk one mile).

Based on your answers to the Questions to Consider, you can probably see that object-oriented programming has a lot of benefits
-it is a lot more intuitive. Explaining things in terms of their qualities and behaviors/uses in the real world is a lot easier.
→this is