CS 535 Object-Oriented Programming & Design
Fall Semester, 2013
Doc 14 Some Building Blocks
Oct 22 2013

References

Domain Specific Languages, http://en.wikipedia.org/wiki/Domain-specific_programming_language

Example - Turtle Graphics

Turtle Graphics - used help teach programming

Program Turtle to

- Move across screen
- Draw patterns

Operations

- move
- turn
- penUp
- penDown

Sample Program

```
penDown
move 5
turn 90 left
move 10
turn 90 left
move 5
turn 90 left
move 10
```

Assume We Have Turtle class

Displays small turtle on screen

Responds to basic command

- Move
- Turn
- penUp
- penDown

Draws line when pen is down and Turtle moves

How to parse Turtle Program

As String

```
turtleProgram := 'penDown
move 5
turn 90 left
move 10
turn 90 left
move 5
turn 90 left
move 10'.
```

```
lines := turtleProgram tokensBasedOn: Character cr.
lines do: [:aLine | | command amount direction |
    parts := aLine tokensBasedOn: Character space.
    command :=  parts first.
    command = 'move' | 'turn'
        ifTrue: [
            amount := (parts at: 2) asNumber.
            command = 'turn' ifTrue: [
                direction := parts last.]].
    command = 'turn' ifTrue: [turtle turn: amount direction: direction].
    command = 'move' ifTrue: [turtle move: amount].
    command = 'penDown' ifTrue: [turtle penDown].
    command = 'penUp' ifTrue: [turtle penUp].
```

New Commands

color

One argument - a color

circle

One argument - radius

Building Block - TurtleStream

Possible Operations

nextToken
nextCommand
nextArgument

Executing Turtle Program/Command

TurtleInterpreter class
- Responsibilities
  - Analyze and execute turtle programs
- Collaborations
  - Turtle
  - TurtleStream

Turtle class
- Responsibilities
  - Draw on screen
  - Perform operations

TurtleInterpreter

Instance variables

turtle - instance of Turtle

source - instance of TurtleStream

```
TurtleInterpreter>>on: aProgramString
    Initializes turtle and source

        turtle := Turtle new.
        source := TurtleStream on: aProgramString
```

```
TurtleInterpreter>>evaluate
    [source atEnd]
        whileFalse: [self evaluateCommand]
```

Simple Solution

```
TurtleInterpreter>>evaluateCommand
    | command |
    command := source nextCommand.
    command asLowercase = 'penUp'
        ifTrue: [^self penUp].
    command asLowercase = 'move'
        ifTrue: [^self move].
    command asLowercase = 'turn'
        ifTrue: [^self turn].
    etc.
```

```
TurtleInterpreter>>penUp
    turtle penUp
```

```
TurtleInterpreter>>move
    | distance |
    distance := source nextArgument.
    turtle move: distance
```

```
TurtleInterpreter>>turn
    | amount direction |
    amount := source nextArgument.
    direction := source nextArgument.
    turtle
        turn: amount
        direction: direction
```

What Have We Gained?

Bigger Building Blocks - TurtleCommands

Read line of program

Give line of program to TurtleCommand class

TurtleCommand parses line

Some methods

- isMove
- isTurn
- amount
- direction

Command Solution

```
TurtleInterpreter>>evaluateCommand
    | command  |
    line := source nextLine.
    command := TurtleCommand on: line
    command isPenUp
        ifTrue: [^self penUp].
    command isMove
        ifTrue: [^self move: command].
    command isTurn
        ifTrue: [^self turn: command].
    etc.
```

```
TurtleInterpreter>>move: command
    turtle move: command amount.
```

```
TurtleInterpreter>>turn: command
    turtle
        turn:  command amount
        direction: command direction
```

```
TurtleInterpreter>>penUp
    turtle penUp
```

What Have We Gained?

Who knows the syntax for command?

Who has to change if syntax changes

Command Solution - Improved

```
TurtleInterpreter>>evaluateCommand
    | command  |
    command := TurtleCommand fromStream: source
    command isPenUp
        ifTrue: [^self penUp].
    command isMove
        ifTrue: [^self move: command].
    command isTurn
        ifTrue: [^self turn: command].
    etc.
```

Only TurtleCommand knows program syntax

A class should hide a design decission

Turtle Command now hides all of the syntax of program

Syntax change change - rest of program does not have to know

Smarter Commands

Let the commands tell the turtle what to do

TurtleInterpreter

```
TurtleInterpreter class>>on: aProgramString
        ^super new on: aProgramString
```

```
TurtleInterpreter>>on: aProgramString
        turtle := Turtle new.
        source := ReadStream on: aProgramString
```

```
TurtleInterpreter>>evaluate
    [source atEnd]
        whileFalse: [self evaluateCommand]
```

```
TurtleInterpreter>>evaluateCommand
    | command  |
    command := TurtleCommand fromStream: source on: turtle.
    command execute.
```

TurtleCommand

```
TurtleCommand>>execute
    self isPenUp
        ifTrue: [^ turtle penUp].
    self isMove
        ifTrue: [^ turtle move: amount].
    self isTurn
        ifTrue: [^ turtle
                        turn:  amount
                        direction: direction].
    etc.
```

```
TuttleCommand instance variables
    turtle
    command
    amount
    direction
    programSource
```

What Have We Gained?

Undo

Since command know what it did

It knows enough to undo it

- Need eraser to undo drawing

Can save commands in stack for multiple undo

Macros

Can group commands into compound command to make new commands

```
Square
    move 100
    turn 90 left
    move 100
    turn 90
    move 100
    turn 90
    move 100
```

Changing Program Syntax

Some environments provide GUI elements to create Turtle program

GUI element for move can produce Move commend

GUI creates list of command object to run

Command Objects

Create a Command Class for each command in language

Command knows how to

- Execute the command
- Undo the command

Allows stepping through the program and undoing operations

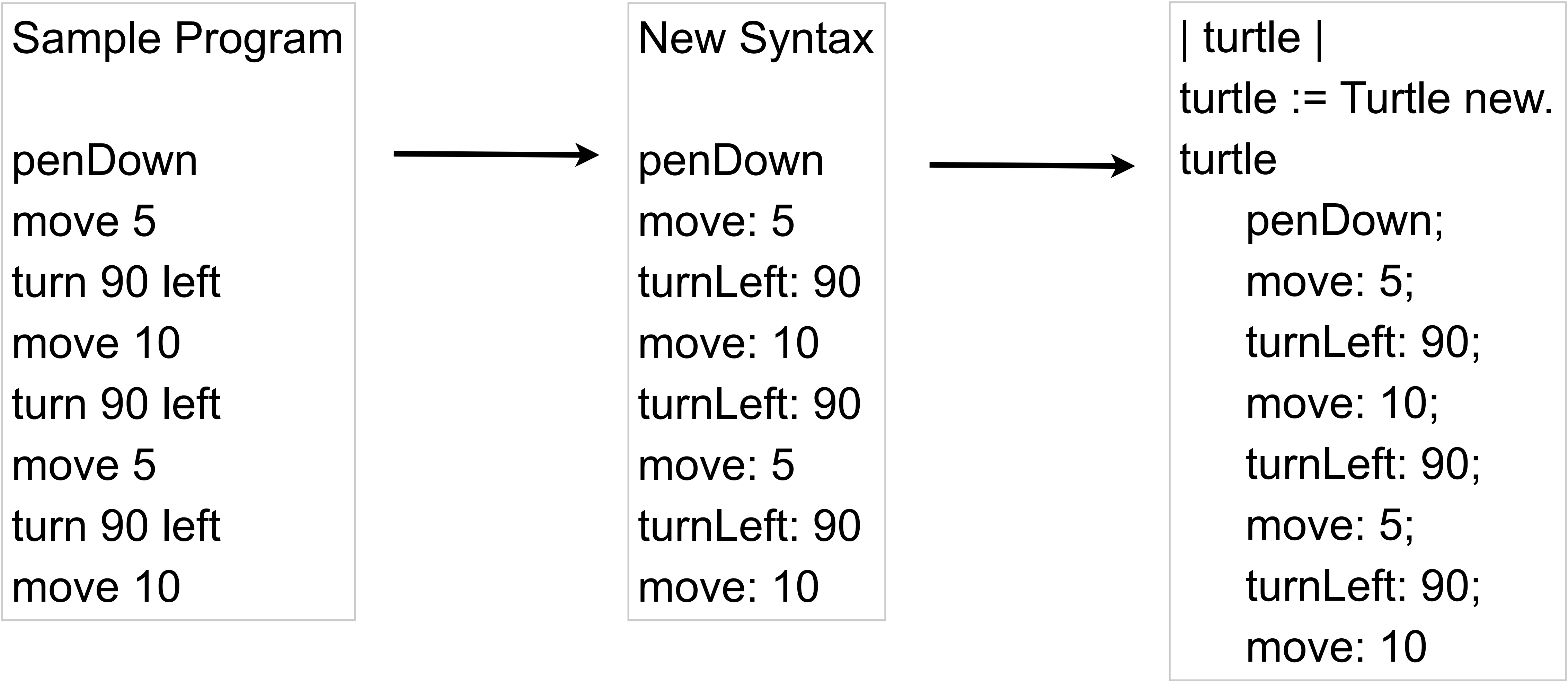
MoveCommand

```
Smalltalk defineClass: #MoveCommand
    superclass: #{Core.TurtleCommand}
    instanceVariableNames: 'turtle amount '


MoveCommand>>execute
    turtle move: amount

MoveCommand>>undo
    turtle
        left: 180;
        move: amount;
        left: 180
```

Back to Turtle



```
Sample Program

penDown
move 5
turn 90 left
move 10
turn 90 left
move 5
turn 90 left
move 10
```

```
New Syntax

penDown
move: 5
turnLeft: 90
move: 10
turnLeft: 90
move: 5
turnLeft: 90
move: 10
```

```
| turtle |
turtle := Turtle new.
turtle
     penDown;
     move: 5;
     turnLeft: 90;
     move: 10;
     turnLeft: 90;
     move: 5;
     turnLeft: 90;
     move: 10
```

If we have control over syntax create so we can use compiler evaluate (Do it)

Read the program, transform the string into complete Smalltalk code and use compiler evaluate: (do it)

Of course we could just require the user to enter the text on the right, which would make our job easier.

Domain-Specific language (DSL)

Language dedicated to a particular problem domain

Examples

- UNIX shell scripts
- ColdFusion Markup Language
- FilterMeister
    - For writing Photoshop plugins

Some Advantages

Program written in words from the domain

Domain experts can understand, validate, modify, and write programs

Self-documenting code

Enhance quality, productivity, reliability, maintainability, portability and reusability

Domain-specific languages allow validation at the domain level