Assignment 3: Of objects and features

ETH Zurich

Hand-out: 2 October 2009
Due: 13 October 2009

DAD, WHAT CAUSES WIND?
TREES SNEEZING.
REALLY?!
NO, BUT THE TRUTH IS MORE COMPLICATED.
THE TREES ARE REALLY SNEEZING TODAY.

Calvin and Hobbes© Bill Watterson

Goals

- Understand the difference between a *class* and an *object*.
- Distinguish between queries and commands.
- Learn to read feature call instructions.
- Write more feature call instructions.

1 Classes vs. objects

To do

1.1 Try to describe the difference between a class and an object (1-2 sentences).

1.2 Find an analogy that captures the relationship between objects and classes in real life.

To hand in

Write down your answers (1.1 and 1.2) and hand them in.

2 Categorizing features

There are two main categories of features: queries and commands. In last week's assignment you learned how to categorize features. In this week's lecture you have a better look at their declaration in the class interface. The general patterns for queries and commands in a class interface are:

	no arguments	**with arguments**
command	$\overbrace{command\_name}^{feature\ signature}$ **Examples:** *spotlight*	$\overbrace{command\_name\ \underbrace{(arg_1 : TYPE_1; \ldots; arg_n : TYPE_n)}_{argument\ declaration}}^{feature\ signature}$ **Examples:** *set_center (a_center: TRAFFIC_POINT)* *set_size (a_width, a_height, a_depth: REAL_64)*
query	$\overbrace{query\_name\ \underbrace{: TYPE}_{return\ type}}^{feature\ signature}$ **Examples:** *center: TRAFFIC_POINT* *corner_1: TRAFFIC_POINT*	$\overbrace{query\_name\ \underbrace{(arg_1 : TYPE_1; \ldots; arg_n : TYPE_n)}_{argument\ declaration}\ \underbrace{: TYPE}_{return\ type}}^{feature\ signature}$ **Examples:** *contains_point (a_x: REAL_64; a_y: REAL_64): BOOLEAN*

TYPE, TYPE$_1$, TYPE$_n$ are class names. In the case of an argument declaration, they will tell you the expected type of the arguments. In the case of a query, TYPE denotes the type of the object you get as an answer when calling the query. Note, once again, that the only way to distinguish between a query and a command is to look whether a feature returns an object (i.e. look for the return type in its declaration).

The examples given above are from Listing 1 that shows a shortened interface of class *TRAFFIC_BUILDING*. The argument declaration of *set_size* uses a short form for the declaration of its arguments. Instead of stating for each argument that it is of type *REAL_64*, it separates the identifiers by comma (instead of semicolon) and gives the type at the end. The short form can be used whenever there are two or more arguments of the same type appearing one after the other in the declaration. So the declaration *set_size* (*a_width*, *a_height*, *a_depth*: *REAL_64*) is equivalent to *set_size* (*a_width*: *REAL_64*; *a_height*: *REAL_64*; *a_depth*: *REAL_64*) and *contains_point* (*a_x*: *REAL_64*; *a_y*: *REAL_64*): *BOOLEAN* could also be written as *contains_point* (*a_x*, *a_y*: *REAL_64*): *BOOLEAN*.

Listing 1: Class *TRAFFIC_BUILDING*

```
deferred class interface TRAFFIC_BUILDING

feature

  center: TRAFFIC_POINT
      -- Center of the building

  corner_1: TRAFFIC_POINT
      -- Lower left corner of the building
    ensure
      result_exists : Result /= Void

  contains_point (a_x: REAL_64; a_y: REAL_64): BOOLEAN
      -- Is point ('a_x', 'a_y') inside building?

  spotlight
      -- Highlight.
    ensure -- from TRAFFIC_CITY_ITEM
      highlighted : is_spotlighted

  set_center (a_center: TRAFFIC_POINT)
```

```
      -- Set center to ‘a_center’.
    require
      a_center_valid: a_center /= Void
    ensure
      center_set: center = a_center

  set_size (a_width, a_height, a_depth: REAL_64)
      -- Set width to ‘a_width’, height to ‘a_height’, and depth to ‘a_depth’.
    require
      size_valid: a_width > 0.0 and a_height > 0.0 and a_depth > 0.0
    ensure
      size_set: width = a_width and height = a_height and depth = a_depth

end
```

Todo

In Listing 2 you find the class interface of *TRAFFIC_TIME* that is responsible for simulating time in the city, used for example for letting passengers move at a certain speed. Make two lists of features for this class interface: one for queries, the other for commands. Use the way described above to distinguish between queries and commands.

Listing 2: Class *TRAFFIC_TIME*

```
deferred class interface TRAFFIC_TIME

feature -- All features

  pause
      -- Pause the time count.
    require
      is_time_running
    ensure
      not is_time_running

  actual_time: TIME
      -- Simulated time

  reset
      -- Reset the time to (0:0:0).
    ensure
      is_time_running = False
      actual_time.hour = 0
      actual_time.minute = 0
      actual_time.second = 0

  duration (a_start_time, a_end_time: TIME): TIME_DURATION
      -- Duration from ‘a_start_time’ until ‘a_time2’.
      -- Takes into account midnight.
    require
      both_exist: a_start_time /= Void and a_end_time /= Void
    ensure
      result_exists : Result /= Void
```

```
            result_positive : Result.is_positive

    speedup: INTEGER_32
            -- Speedup to let the time run faster than the real time

    set_speedup (a_speedup: INTEGER_32)
            -- Set speedup to ‘a_speedup’.
        require
            a_speedup_valid: a_speedup >= 1
        ensure
            speedup_set: speedup = a_speedup

    start
            -- Start to count the time at (0:0:0).
        require
            not is_time_running
        ensure
            is_time_running

    is_time_running: BOOLEAN
            -- Is the time running?

    resume
            -- Resume the paused time.
        require
            not is_time_running
        ensure
            is_time_running

    set (a_hour, a_minute, a_second: INTEGER_32)
            -- Sets the time to (‘a_hour’:‘a_minute’:‘a_second’).
        require
            valid_time: a_hour >= 0 and a_minute >= 0 and a_second >= 0

invariant
    actual_time.hour >= 0
    actual_time.minute >= 0
end
```

3 Feature reading

In Task 2 you saw that feature declarations of queries **always** include the declaration of a return type. The return type is the type of the object that is returned as an answer when calling the query. This knowledge, in combination with the fundamental mechanism of program execution (applying a “feature” to an “object”), allows to build complex targets and arguments to feature call instructions. To make it clearer:

- Queries return a value (an object), e.g. *Station_balard.location* yields an object of type *TRAFFIC_POINT*, the position of Balard. Since the result is an object, it is possible to apply features to it, e.g. *Station_balard.location.up_by (5.0)*. What features can be applied is defined in the class *TRAFFIC_POINT*. As a side note: Station_balard is also a query returning an object of type *TRAFFIC_STATION* and is declared in class *TOUCH_PARIS_OBJECTS*. Class *PREVIEW* offers the features of *TOUCH_PARIS_OBJECTS* because *PREVIEW* "inherits" from *TOUCH_PARIS_OBJECTS* (see the clause at the beginning of the class *PREVIEW* definition). More about this in a future assignment.

- Similarly, it is possible to use results of queries as arguments, e.g. *Console.show (Line8.south_end)*
- The result of an arithmetic expression (say x * *3* + *72*) is also an implicit object on which you can call features, e.g. *(x * 3 + 72).out*

Expressions built using the "." notation are evaluated from left to right, e.g. *x.y.z.f* is evaluated as *((x.y).z).f*. This knowledge helps us dissecting feature call instructions.

Example 1

$$\overbrace{\underbrace{\underbrace{Line2}_{TRAFFIC\_LINE}\ .color}_{TRAFFIC\_COLOR}}^{target}\ .\ \overbrace{set\_red}^{command}\ (\overbrace{\underbrace{\underbrace{\underbrace{Line8}_{TRAFFIC\_LINE}\ .color}_{TRAFFIC\_COLOR}\ .red)}_{INTEGER}}^{arguments}$$

Explanation:

- *Line2* is a query defined in class *TOUCH_PARIS_OBJECTS* and returns an object of type *TRAFFIC_LINE*.
- In class *TRAFFIC_LINE* there is a query *color* defined that returns an object of type *TRAFFIC_COLOR*.
- In class *TRAFFIC_COLOR* there is a command *set_red* defined. It takes an argument of type *INTEGER*.
- *Line8* is a query defined in class *TOUCH_PARIS_OBJECTS* and returns an object of type *TRAFFIC_LINE*.
- In class *TRAFFIC_LINE* there is a query *color* defined that returns an object of type *TRAFFIC_COLOR*.
- In class *TRAFFIC_COLOR* there is a query *red* defined that returns an object of type *INTEGER*.
- The argument is thus an *INTEGER* that conforms to the type requested by *set_red*.

Example 2

$$\overbrace{\underbrace{\underbrace{\underbrace{\underbrace{\underbrace{\underbrace{Route1}_{TRAFFIC\_ROUTE}\ .first}_{TRAFFIC\_LEG}\ .destination}_{TRAFFIC\_STATION}\ .stop(\ \underbrace{Line8}_{TRAFFIC\_LINE}\ )}_{TRAFFIC\_STOP}\ .line}_{TRAFFIC\_LINE}\ .south\_end}_{TRAFFIC\_STATION}}^{target}\ .\ \overbrace{highlight}^{command}$$

Explanation:

- *Route1* is a query defined in class *TOUCH_PARIS_OBJECTS* and returns an object of type *TRAFFIC_ROUTE*.
- In class *TRAFFIC_ROUTE* there is a query *first* defined that returns an object of type *TRAFFIC_LEG*.
- In class *TRAFFIC_LEG* there is a query *destination* defined that returns an object of type *TRAFFIC_STATION*.
- In class *TRAFFIC_STATION* there is a query *stop* defined that returns an object of type *TRAFFIC_STOP* and takes an object of type *TRAFFIC_LINE* as argument.
- *Line8* is a *TRAFFIC_LINE* and thus can be used as such an argument.
- In class *TRAFFIC_STOP* there is a query *line* that returns a *TRAFFIC_LINE*.
- In class *TRAFFIC_LINE* there is a query *south_end* that returns a *TRAFFIC_STATION*.
- And in class *TRAFFIC_STATION* the command *highlight* is defined and thus can be called on the target.

A remark on methodology

Generally, long chains of feature calls (with a lot of dots) are considered bad practice, because they tend to be difficult to read and to debug. We include this task to show you how to read these feature calls properly.

To do

For each of the instructions below, determine the type of the target following the scheme from the examples. You will need to read class declarations, so start EiffelStudio and open the project located under `traffic/example/02_objects`.

Note that for certain classes there exist aliases. As an example, *DOUBLE* might appear named as *REAL_64* and *STRING* as *STRING_8* depending on the view you are using to look at the classes in EiffelStudio.

1. *Route2.first.line.extend (Line7_a.i_th (1))* where *Route2* is of type *TRAFFIC_ROUTE* and *Line7_a* of type *TRAFFIC_LINE*.
2. *Route1.first.next.origin.location.left_by (20.0)* where *Route1* is of type *TRAFFIC_ROUTE*.
3. *Line2.i_th (Line2.count).stop (Route3.first.line).station.highlight* where *Route3* is of type *TRAFFIC_ROUTE* and *Line2* of type *TRAFFIC_LINE*.

Hint

To navigate between classes and features in EiffelStudio, you can use the 'pick-and-drop' technique. Just 'pick' a class (or a feature) by holding down the [SHIFT] key and right-clicking on the class (feature) name. The cursor will change shape to an oval (or a thick cross in case you picked a feature). You can then 'drop' it in another tools pane within EiffelStudio by right-clicking again. When this is not possible, a thin black cross appears on the cursor.

To hand in

Your answers to questions 1-3.

4 Writing more feature calls

To do

1. Download http://se.inf.ethz.ch/teaching/2009-H/eprog-0001/exercises/assignment_3.zip and extract it in `traffic/example`. You should now have a new directory `traffic/example/assignment_3` with assignment_3.ecf directly in it. It is important that the location corresponds to the description here!

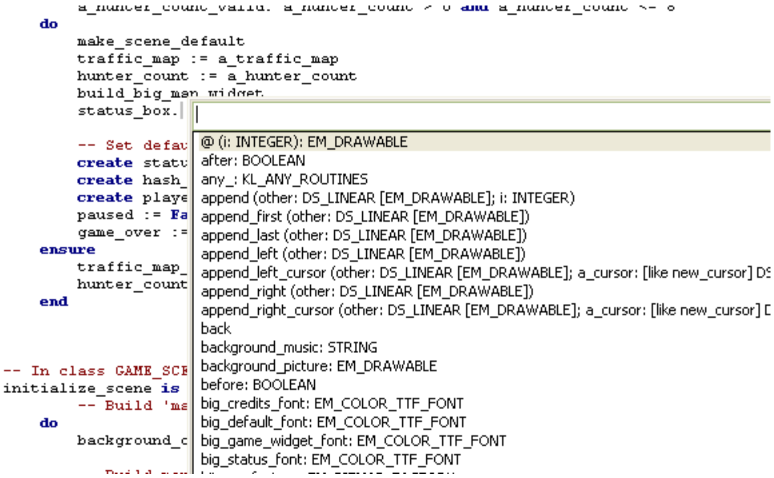
2. Open and compile this new project.

3. Open the class text of *PLANNER* which you will change in this task. Assume that you are planning to change the original metro system of Paris (see Figure 1(a)) in the following way: Line1, Line3, Line8, and Line7_a all only consist of one connection going from the original starting terminal (*terminal_1*) to Concorde (*Station_Concorde*). Note that *remove_all_segments* removes all stations except the terminal 1. Line2 is a cyclic line containing its original terminal 1 and the starting terminal stations of Line3, Line7_a, Line1, and Line8 connected as shown in Figure 1(b).

Hint

To complete the task you need features from the class *TRAFFIC_LINE* such as *remove_all_segments* and *extend*.

In the text editor, when you type the name of an entity followed by a dot, EiffelStudio will automatically display a list of all the features that can be called at the current position (see Figure below). To get the list of almost all features applicable to the Current object, press [CTRL] + [SPACE]. But if you really want to see all the features applicable to the Current object you have to change an option: from the menu Tools/Preferences... choose the directory Editor/Eiffel. Set the 'Show ANY features' option to True, and when pressing [CTRL] + [SPACE] you should be able to see, in addition to the others, the most general features, those that can be applied to all objects. Pressing [SHIFT] at the same time will do the same for class names, for example when declaring an attribute or a return type.

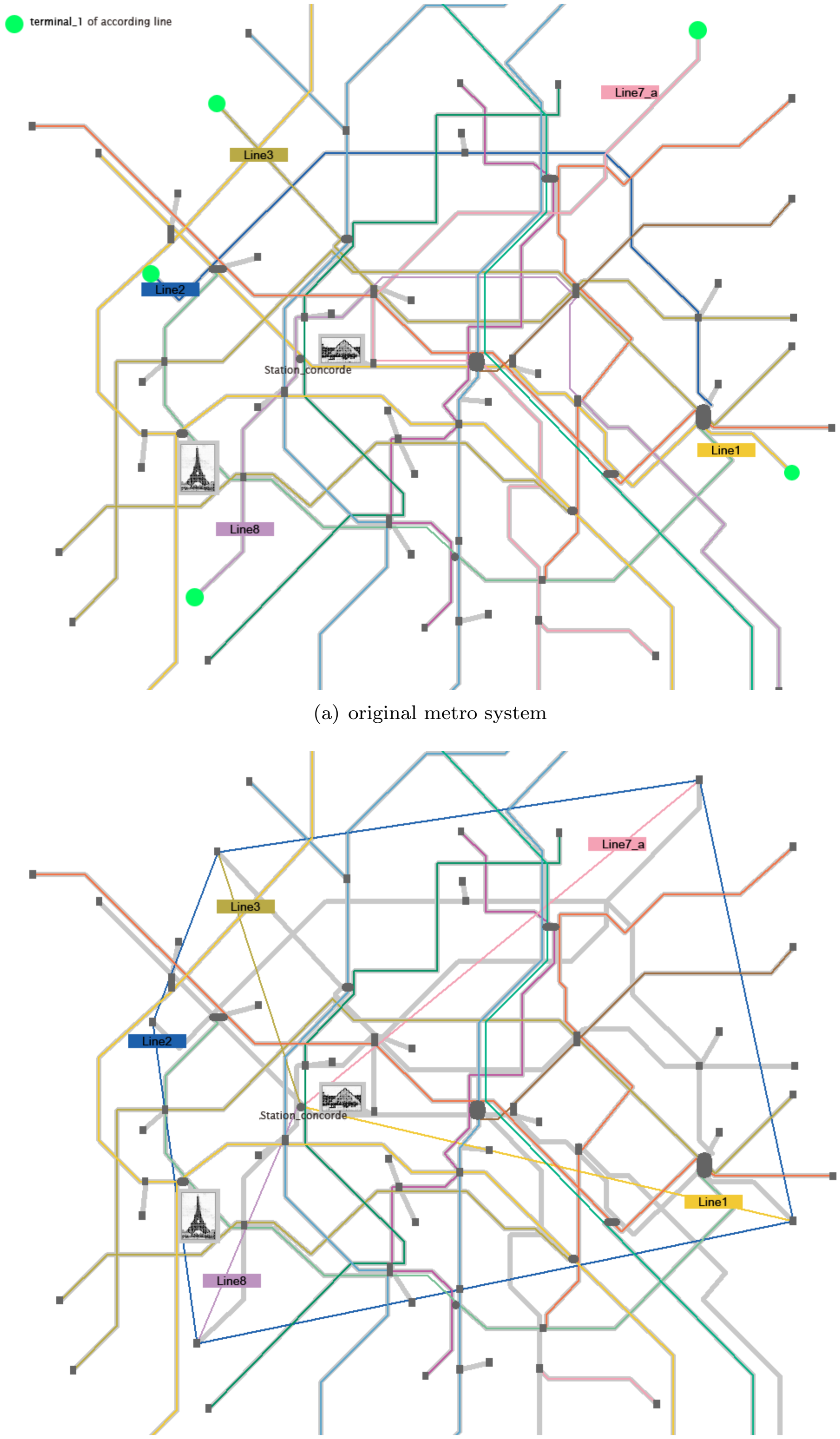


```
        a_hunter_count_valid: a_hunter_count > 0 and a_hunter_count <= 8
    do
        make_scene_default
        traffic_map := a_traffic_map
        hunter_count := a_hunter_count
        build_big_map_widget
        status_box.

        -- Set defau
        create statu
        create hash_
        create playe
        paused := Fa
        game_over :=
    ensure
        traffic_map_
        hunter_count
    end


-- In class GAME_SCE
initialize_scene is
        -- Build 'ma
    do
        background_c
```

```
@ (i: INTEGER): EM_DRAWABLE
after: BOOLEAN
any_: KL_ANY_ROUTINES
append (other: DS_LINEAR [EM_DRAWABLE]; i: INTEGER)
append_first (other: DS_LINEAR [EM_DRAWABLE])
append_last (other: DS_LINEAR [EM_DRAWABLE])
append_left (other: DS_LINEAR [EM_DRAWABLE])
append_left_cursor (other: DS_LINEAR [EM_DRAWABLE]; a_cursor: [like new_cursor] DS
append_right (other: DS_LINEAR [EM_DRAWABLE])
append_right_cursor (other: DS_LINEAR [EM_DRAWABLE]; a_cursor: [like new_cursor] D
back
background_music: STRING
background_picture: EM_DRAWABLE
before: BOOLEAN
big_credits_font: EM_COLOR_TTF_FONT
big_default_font: EM_COLOR_TTF_FONT
big_game_widget_font: EM_COLOR_TTF_FONT
big_status_font: EM_COLOR_TTF_FONT
```

To hand in

Submit class *PLANNER* to your assistant.



(a) original metro system

(b) new metro system

Figure 1: Changing the metro system