ETH Zürich
Chair of Software Engineering

Einführung in die Programmierung
Introduction to Programming

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Exercise Session 2

Organizational

- Assignments
  - One assignment per week
  - Will be put online on Monday, due on Tuesday the next week
- Testat
  - You have to hand in n - 1 out of n assignments
    - Must include the last one
    - Show serious effort
  - You have to hand in two mock exams
  - Military service or illness -> contact assistant
- Group mailing list
  - Is everybody subscribed?

Today

- Give you the intuition behind object-oriented (OO) programming
- Teach you about formatting your code
- Distinguishing between
  - commands and queries
  - feature declaration and feature call
- Understanding feature call chains
- Getting to know the basics of EiffelStudio

Classes and objects

- Classes are pieces of software code.
- Several classes make up a program.
- Objects are instances of classes.
- Classes define operations applicable to their instances.
  - Example: A class *STUDENT* can define operations applicable to all its instances, such as subscribing to a course, registering for an exam, etc. This means that all class *STUDENT*'s instances (such as the students Bob, Mike, Steve, etc.) will be able to subscribe themselves to a course, to register for an exam, etc.
- Only operations defined in a class can be applied to its instances.

Features

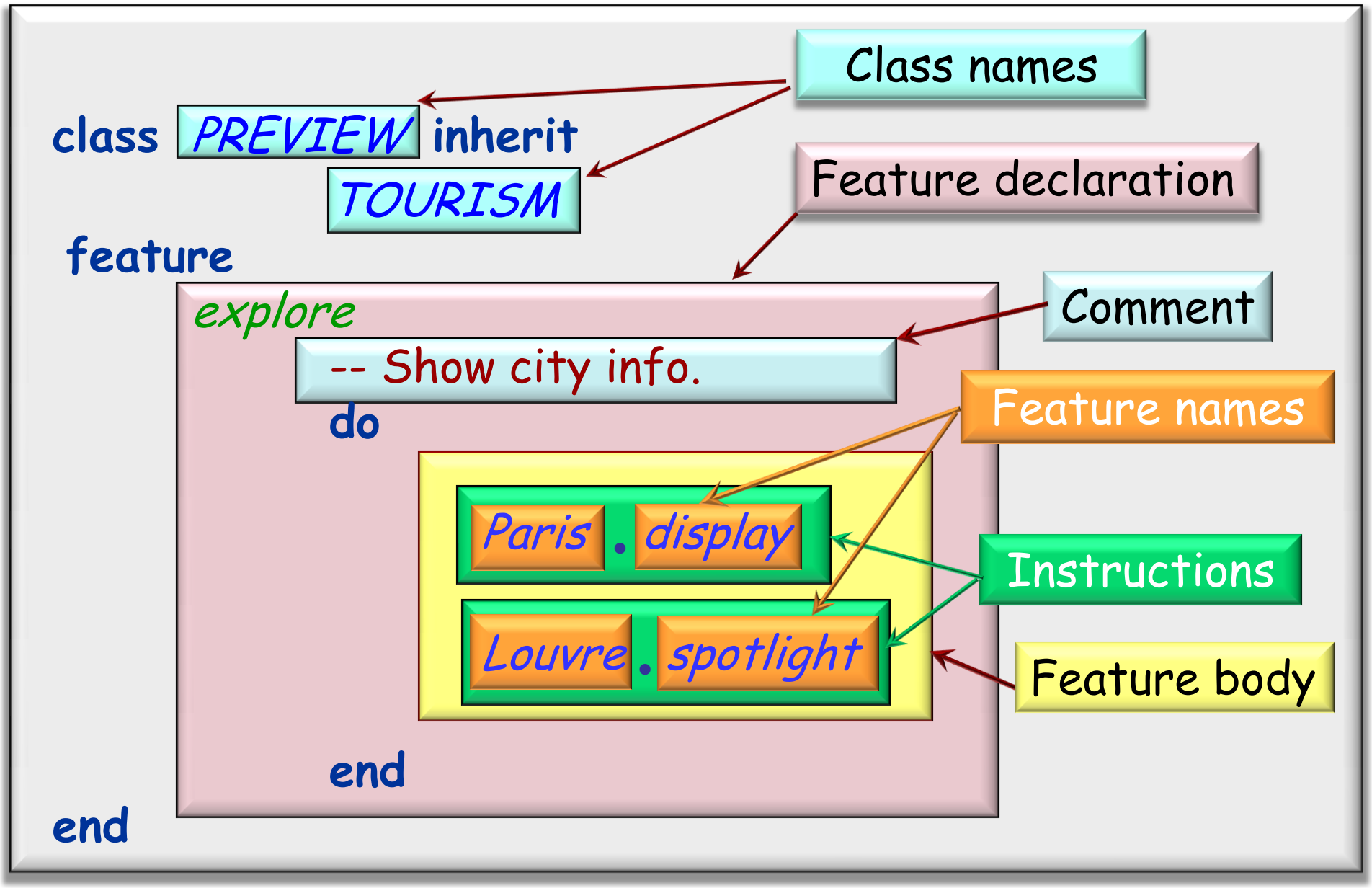
- A feature is an operation that programs may apply to certain classes of objects. A feature can be called on an object. This object is called the target of the feature call.
- Examples
  - *next_message.send*
  - *computer.shut_down*
  - *telephone.ring*
- A feature call can have arguments.
- Examples
  - *next_message.send_to (recipient)*
  - *computer.shut_down_after (3)*
  - *telephone.ring_several (10, Loud)*

Features: Exercise

Hands-On

- Class *BANK_ACCOUNT* defines and implements the following operations:
  - *deposit (i: INTEGER)*
  - *withdraw (i: INTEGER)*
  - *close*
- If *b: BANK_ACCOUNT* (*b* is an instance of class *BANK_ACCOUNT*) which of the following feature calls are possible:
  - *b.deposit (10)* ✓
  - *b.deposit* ✗
  - *b.close* ✓
  - *b.close ("Now")* ✗
  - *b.open* ✗
  - *b.withdraw (100.50)* ✗
  - *b.withdraw (0)* ✓

Class text


Class names
class PREVIEW inherit
TOURISM
Feature declaration
feature
explore
-- Show city info.
do
Comment
Feature names
Paris . display
Louvre . spotlight
Instructions
Feature body
end
end

Style rule

For indentation, use tabs, not spaces

Use this property to highlight the **structure** of the program, particularly through **indentation**


```
class
        PREVIEW

inherit
        TOURISM

feature
    explore
                -- Show city info
                -- and route.
        do
            Paris.display
            Louvre.spotlight
            Line8.highlight
            Route1.animate
        end
end
```

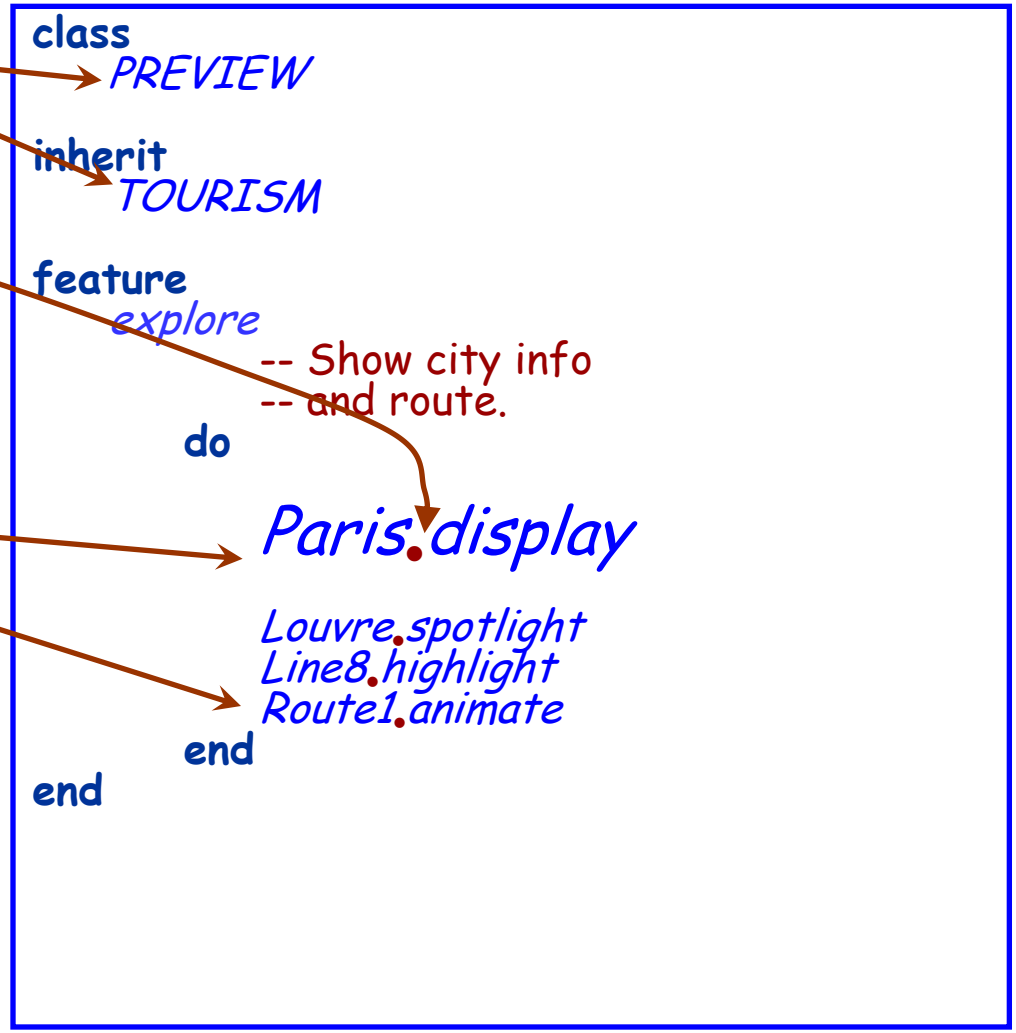
More style rules

Class name: all upper-case

Period in feature call: no space before or after

Names of predefined objects: start with upper-case letters

New names (for objects you define) start with lower-case letters



Even more style rules

For features, use full names, not abbreviations

Always choose identifiers that clearly identify the intended role

Use words from natural language (preferably English) for the names you define

For multi-word identifiers, use underscores

```
class
    PREVIEW

inherit
    TOURISM

feature
    explore
            -- Show city info
            -- and route.
        do
            Paris.display
            Louvre.spotlight
            Line8.highlight
            Line8.remove_all_sections
            Route1.animate
        end
end
```

Exercise: style rules

Hands-On

- Format this class:

```
class bank_account
feature deposit (sum: INTEGER)
-- Add `sum' to the account.
do balance := balance + sum end
balance: INTEGER end
```

Exercise: solution

```
class
    BANK_ACCOUNT

feature
    deposit (sum: INTEGER)
            -- Add `sum' to the account.
        do
            balance := balance + sum
        end

    balance: INTEGER
end
```

Commands and queries

- A feature can be a:
  - Command: a feature that may modify an object
  - Query: a feature that accesses an object

Queries

- Goal: obtain properties of objects
- Always return a value.
- Should not modify any objects.
- Examples
  - What is the name of a person?
  - What is the age of a person?
  - What is the id of a student?
  - Is a student registered for a particular course?
  - Are there any places left in a certain course?
  - … other examples?

Commands

- Goal: produce a change on an object, or several
- Does not return a value.
- May modify objects.
- Examples
  - Register a student to a course
  - Assign an id to a student
  - Record the grade a student got in an exam
  - … other examples?

Exercise: query or command?

Hands-On

- What is the balance of a bank account?
- Withdraw some money from a bank account
- Who is the owner of a bank account?
- Who are the clients of a bank whose deposits are over 100,000 CHF?
- Change the account type of a client
- How much money can a client withdraw at a time?
- Set a minimum limit for the balance of accounts
- Is Steve Jobs a client of Credit Suisse?

Command-query separation principle

"**Asking** a question **shouldn't change** the answer"

i.e. a query

Query or command?

```
class DEMO

feature
    procedure_name (a1: T1; a2, a3: T2)
            -- Comment
        do
            ...
        end

    function_name (a1: T1; a2, a3: T2): T3
            -- Comment
        do
            Result := ...
        end

    attribute_name: T3
            -- Comment
end
```

command

- no result
- body

query

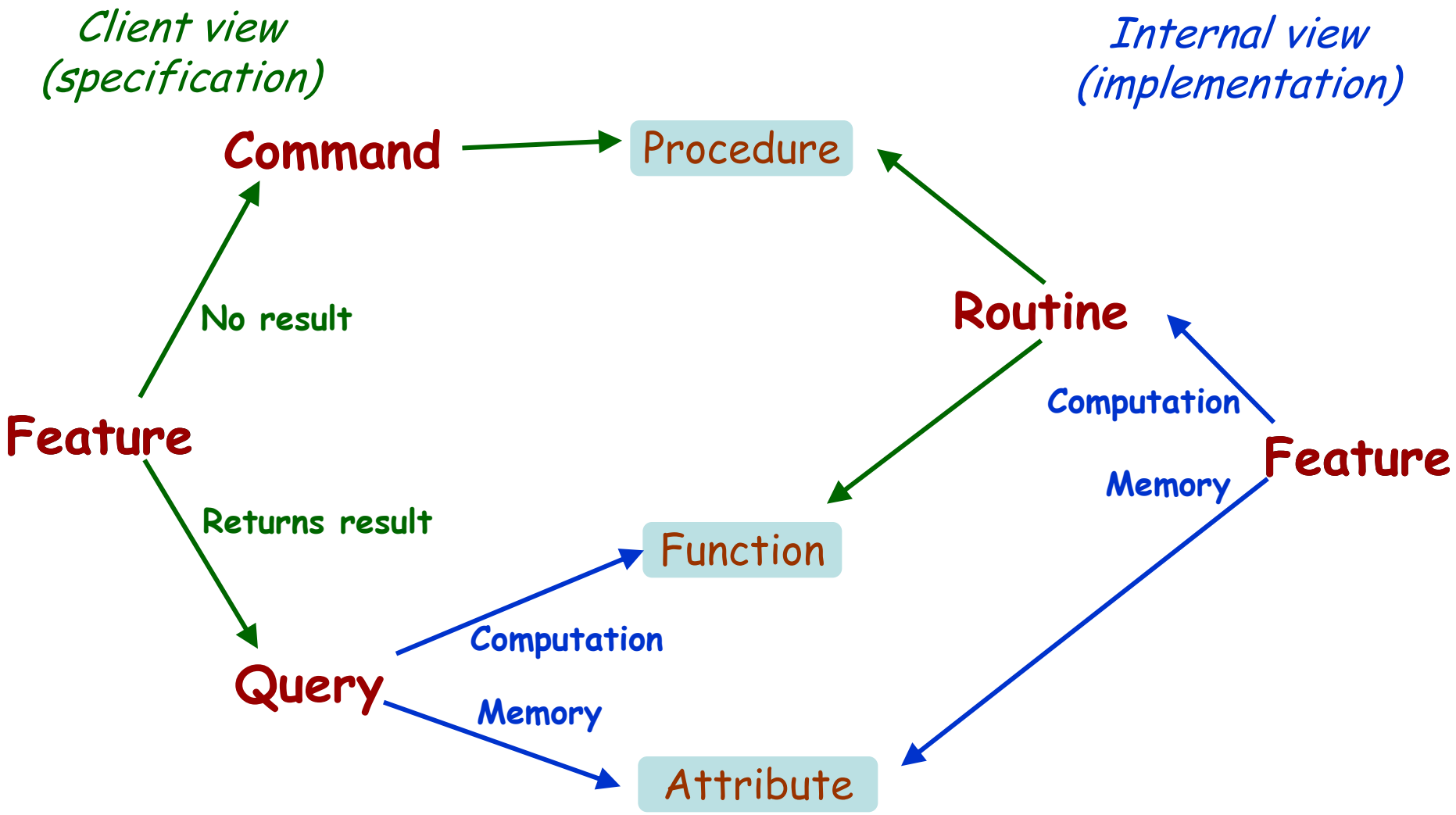
- result
- body

predefined local variable denoting the result

query

- result
- no body

Features: the full story



Feature declaration vs. feature call

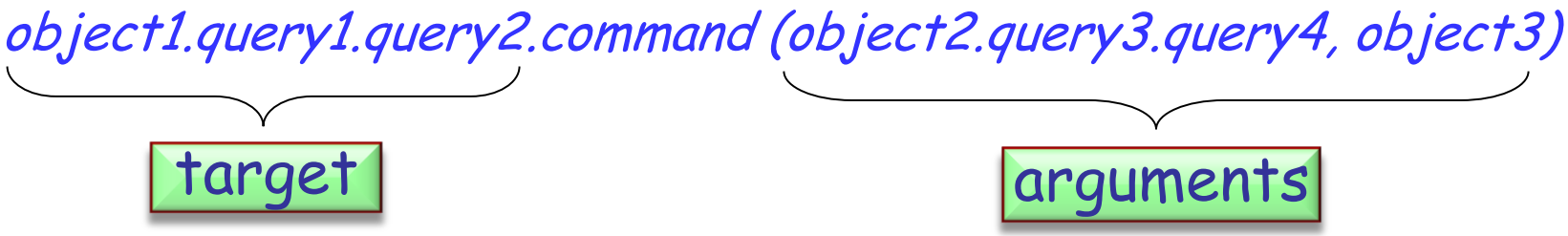
- You declare a feature when you write it into a class.

```
set_name (a_name: STRING)
        -- Set 'name' to 'a_name'.
    do
        name := a_name
    end
```

- You call a feature when you apply it to an object.

```
a_person.set_name ("Peter")
```

General form of feature call instructions



- Targets and arguments can contain feature calls themselves.

Hands-On

- Where are *query1*, *query2*, *query3* and *query4* defined?
- Where is *command* defined?

Unqualified vs. qualified feature calls

- It is possible to leave out the target in a feature call. Such a call is called **unqualified**. The implicit target will be the current object. A **qualified** feature call has a target.
- The **current object** in a feature is always the instance of the surrounding class.

```
assign_same_name (a_name: STRING; a_other_person: PERSON)
        -- Set 'a_name' to this person and 'a_other_person'.
    do
        a_other_person.set_name(a_name)
        set_name(a_name)
    end
```

qualified call

unqualified call: **Current**.*set_name(a_name)*

```
person1.assign_same_name("Hans", person2)
```

In this call the current object will be person1.

EiffelStudio

- EiffelStudio is a software tool (IDE) to develop Eiffel programs.

Integrated Development Environment

- Help & Resources
  - Online tour in the help of EiffelStudio
  - http://www.eiffel.com/
  - http://docs.eiffel.com/
  - http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-367.pdf

Components

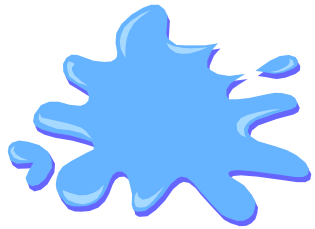
- editor
- context tool
- clusters pane
- features pane
- compiler
- project settings
- ...

Editor

- Syntax highlighting
- Syntax completion
- Class name completion (SHIFT+CTRL+Space)
- Smart indenting
- Block indenting or unindenting (TAB and SHIFT+TAB)
- Block commenting or uncommenting (CTRL+K and SHIFT+CTRL+K)
- Infinite level of Undo/Redo (reset after a save)
- Quick search features (first CTRL+F to enter words then F3 and SHIFT+F3)

Compiler

- Uses incremental compilation
  - freezing: Generates C code from the whole system and then compiles it to machine code. This code is used during development. Initially the system is frozen.
  - melting: Generates bytecode for the changed parts of the system. This is much faster than freezing. This code is used during development.
  - finalizing: Creates an executable production version. Finalization performs extensive time and space optimizations.



Debugger: setup

- The system must be melted/frozen (finalized systems cannot be debugged).
- Set / delete breakpoints
  - An efficient way of adding breakpoints consists in dropping a feature in the context tool.
  - Click in the margin to enable/disable single breakpoints.
- Use the toolbar debug buttons to enable or disable all breakpoints globally.

Debugger: run

- Run the program by clicking on the Run button.
- Pause by clicking on the Pause button or wait for a triggered breakpoint.
- Analyze the program:
  - Use the call stack pane to browse through the call stack.
  - Use the object tool to inspect the current object, the locals and arguments.
- Run the program or step over / into the next statement.
- Stop the running program by clicking on the Stop button.

Advanced Material

The following slides contain advanced material and are optional.

Outline

- Syntax comparison: Eiffel vs Java
- Naming in Eiffel
- Feature comments: Less is better (sometimes...)

Eiffel vs Java: Class declaration

```
class
        ACCOUNT
end
```

```
class Account {


}
```

Eiffel vs Java: Inheritance

```
class
        ACCOUNT
inherit
        ANY
end
```

```
public class Account
                extends Object {

}
```

Eiffel vs Java: Feature redefinition

```
class
        ACCOUNT
inherit
        ANY
          redefine out end
feature
    out: STRING
        do
          Result := "abc"
        end
end
```

```
public class Account
            extends Object {

  String toString() {
    return "abc";
  }

}
```

Eiffel vs Java: Precursor call

```
class
        ACCOUNT
inherit
        ANY
          redefine out end
feature
    out: STRING
        do
          Result :=
            Precursor {ANY}
        end
end
```

```
public class Account
        extends Object {

  String toString() {
    return super();
  }

}
```

Eiffel vs Java: Deferred

```
deferred class
        ACCOUNT
feature
        deposit (a: INT)
          deferred
          end
end
```

```
abstract class Account {
    abstract void
        deposit(int a);
}
```

Eiffel vs Java: Frozen

```
frozen class
        ACCOUNT
inherit
        ANY
end
```

```
final class Account
        extends Object {

}
```

Eiffel vs Java: Expanded

```
expanded class
        ACCOUNT
end
```

int, float, double, char

Eiffel vs Java: Constructors

```
class
      ACCOUNT
create
      make
feature
      make  do end
end
```

```
public class Account {
  public Account() {}
}
```

Eiffel vs Java: Constructor overloading

```
class
   ACCOUNT
create
   make, make_amount
feature
   make  do end
   make_amount (a: INT)
        do end

end
```

```
public class Account {
  public Account() {}
  public Account(int a) {}
}
```

Eiffel vs Java: Overloading

```
class
   PRINTER
feature
   print_int (a: INTEGER)
      do end
   print_real (a: REAL)
      do end
   print_string (s: STRING)
      do end
end
```

```
public class Printer {
  public print(int i) {}
  public print(float f) {}
  public print(String s)
    {}
}
```

Eiffel vs Java: Exception Handling

```
class
   PRINTER
feature
   print_int (a: INTEGER)
      do
(create EXCEPTION).raise
      rescue
         retry
      end
end
```

```
public class Printer {
  public print(int i) {
    try {
     throw new Exception()
    }
    catch(Exception e) {
    }
  }
}
```

Eiffel vs Java: Conditional

```
class
   PRINTER
feature
   print
      do
         if True then

         else

         end
      end
end
```

```
public class Printer {
  public print() {
    if (true) {
    }
    else {
    }
  }
}
```

Eiffel vs Java: Loop 1

```
print
    local
        i: INTEGER
    do
        from
            i := 1
        until
            i >= 10
        loop
            i := i + 1
        end
    end
```

```
public class Printer {
  public print() {
    for(int i=1;i<10;i++) {
    }
  }
}
```

Eiffel vs Java: Loop 2

```
print
    local
        i: INTEGER
    do
        from
            i := 1
        until
            i >= 10
        loop
            i := i + 1
        end
    end
```

```
public class Printer {
  public print() {
    int i=1;
    while(i<10) {
        i++;
    }
  }
}
```

Eiffel vs Java: Loop 3

```
print
   do
      from
         list.start
      until
         list.after
      loop
         list.item.print
         list.forth
      end
   end
```

```
public class Printer {
  public print() {
    for(Element e: list) {
      e.print();
    }
  }
}
```

ECMA commitee is discussing about foreach for Eiffel

Eiffel Naming: Classes

- Full words, no abbreviations (with some exceptions)
- Classes have global namespace
  - Name clashes arise
- Usually, classes are prefixed with a library prefix
  - Traffic: TRAFFIC_
  - EiffelVision2: EV_
  - Base is not prefixed

Eiffel Naming: Features

- Full words, no abbreviations (with some exceptions)
- Features have namespace per class hierarchy
  - Introducing features in parent classes, can clash with features from descendants

Eiffel Naming: Locals / Arguments

- Locals and arguments share namespace with features
  - Name clashes arise when a feature is introduced, which has the same name as a local (even in parent)
- To prevent name clashes:
  - Locals are prefixed with **l_**
  - Some exceptions like „i" exist
  - Arguments are prefixed with **a_**

Feature comments: Version 1

```
tangent_ from (p: POINT): LINE
        -- Return the tangent line to the current circle
        -- going through the point p, if the point
        -- is outside of the current circle.
    require
        outside_circle: not has (p)
```

Example is from http://dev.eiffel.com/Style_Guidelines

Feature comments: Version 2

```
tangent_ from (p: POINT): LINE
        -- The tangent line to the current circle
        -- going through the point p, if the point
        -- is outside of the current circle.
    require
        outside_circle: not has (p)
```

Feature comments: Version 3

```
tangent_ from (p: POINT): LINE
        -- Tangent line to current circle from point p
        -- if the point is outside of the current circle.
    require
        outside_circle: not has (p)
```

Feature comments: Version 4

```
tangent_ from (p: POINT): LINE
        -- Tangent line to current circle from point p.
    require
        outside_circle: not has (p)
```

Feature comments: Final version

```
tangent_ from (p: POINT): LINE
        -- Tangent from p.
    require
        outside_circle: not has (p)
```

Feature comments: More information

```
tangent_ from (p: POINT): LINE
        -- Tangent from p.
        --
        -- `p': The point from ...
        -- `Result': The tangent line ...
        --
        -- The tangent is calculated using the
        -- following algorithm:
        --  ...
    require
        outside_circle: not has (p)
```

Feature comments: Inherited comments

```
tangent_ from (p: POINT): LINE
        -- <Precursor>
    require
        outside_circle: not has (p)
```

Ideas for future sessions

- Inheritance concepts: Single/Multiple/Non-conforming
- CAT Calls (Covariance and generics)
- Once/Multiple inheritance vs. Static
- Exception handling
- Design by contract in depth
- Void-safety
- Modeling concepts
- Best practices in Eiffel
- A look at ECMA specification of Eiffel