ETH Zürich

Chair of Software Engineering

# Einführung in die Programmierung
# Introduction to Programming

Prof. Dr. Bertrand Meyer

## Exercise Session 3

## Today

- We will revisit classes, features and objects.
- We will see how program execution starts.
- We will play a role game.

## Static view

- A program consists of a set of classes.

- Features are declared in classes. They define operations on objects created from classes.
  - Queries answer questions. The answer is provided in a variable called Result.
  - Commands execute actions. They do not return any result, so there is no variable called Result that we can use.

- Another name for a class is type.
- Class and Type are not exactly the same, but they are close enough for now, and we will learn the difference later on.

## Declaring the type of an object

- The type of any object you use in your program must be declared somewhere.
- Where can such declarations appear in a program?
  - in feature declarations
    - formal argument types
    - return type for queries
      - functions
      - attributes
  - in the local clauses of routines

Here is where you declare objects that only the routine needs and knows about.

# Declaring the type of an object

```
class DEMO
feature
    procedure_name (a1: T1; a2, a3: T2)
                -- Comment
            local
                l1: T3
            do
                ...
            end

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

    attribute_name: T3
                -- Comment
end
```

formal argument type

local variable type

return type

return type

## Exercise: Find the classes / objects

Hands-On

```
class
    game

feature
    map_name: string
        -- Name of the map to be loaded for the game

    last_player: player
        -- Last player that moved

    players: player_list
        -- List of players in this game.

...
```

## Exercise: Find the classes / objects

Hands-On

```
feature
	is_occupied (a_location: traffic_place): boolean
			-- Check if `a_location' is occupied.
		require
			a_location_exists: a_location /= Void
		local
			old_cursor: cursor
		do
			Result := False

			-- Remember old cursor position.
			old_cursor := players.cursor


		   ...
```

## Exercise: Find the classes / objects

Hands-On

```
    -- Loop over all players to check if one occupies `a_location'.
    from
        players.start
        -- do not consider estate agent, hence skip the first
        -- entry in `players'.
        players.forth
    until
        players.after or Result
    loop
        if players.item.location = a_location then
            Result := True
        end
        players.forth
    end

    -- Restore old cursor position.
    players.go_to(old_cursor)
end
```

## Dynamic view

- At runtime (ie., during the program execution), we have a set of objects (instances) created from the classes (types).

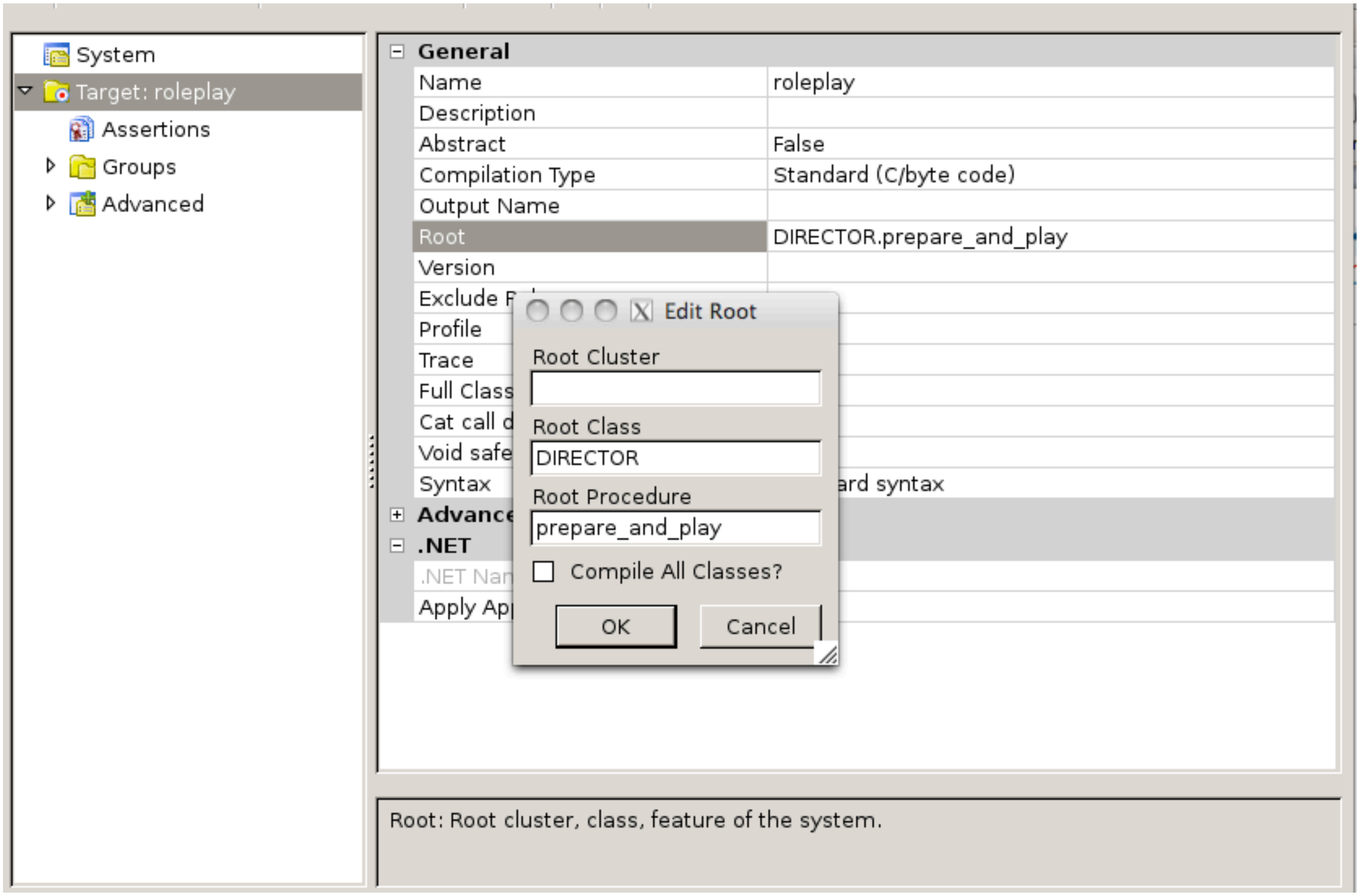
- The creation of an object implies that a piece of memory is allocated in the computer to represent the object itself.

- Objects interact with each other by calling features on each other.

## Who are Adam and Eve?

- Who creates the first object?
    - The runtime creates a so-called **root object**.
    - The root object creates other objects, which in turn create other objects, etc.
    - You define the type of the root object in the project settings.
- How is the root object created?
    - The runtime calls a creation procedure of the root object.
    - You define this creation procedure in the project settings.
    - The application exits at the end of this creation procedure.

# Changing the root class



System
Target: roleplay
Assertions
Groups
Advanced

General

| | |
|---|---|
| Name | roleplay |
| Description | |
| Abstract | False |
| Compilation Type | Standard (C/byte code) |
| Output Name | |
| Root | DIRECTOR.prepare_and_play |
| Version | |
| Exclude R | |
| Profile | |
| Trace | |
| Full Class | |
| Cat call d | |
| Void safe | |
| Syntax | ard syntax |

Advance
.NET
.NET Nar
Apply Ap

Edit Root

Root Cluster: 
Root Class: DIRECTOR
Root Procedure: prepare_and_play
☐ Compile All Classes?

OK Cancel

Root: Root cluster, class, feature of the system.

## Static view vs. dynamic view

- Queries (attributes and functions) have a result type. When **executing** the query, you get an object of that type.
- Routines have **formal arguments** of certain types. During the **execution** you pass objects of the same (or compatible) type as **actual arguments** to a routine call.
- Local variables are declared in their own section, associating names with types. During the **execution**, local variables may hold different values of their respective types at different points in time.

## Acrobat game

Hands-On

- We will play a little game now.
- Some of you will act as objects.
  - When you get created, please stand up and stay standing during the game
- There will be different roles
  - Acrobat
  - Acrobat with Buddy
  - Author
  - Curmudgeon
  - Director

## You are an acrobat

- When you are asked to **Clap**, you will be given a number. Clap your hands that many times.
- When you are asked to **Twirl**, you will be given a number. Turn completely around that many times.
- When you are asked for **Count**, announce how many actions you have performed. This is the sum of the numbers you have been given to date.

## You are an *ACROBAT*

```
class
    ACROBAT

feature
    clap (n: INTEGER)
        do
            -- Clap `n' times and adjust `count'.
        end

    twirl (n: INTEGER)
        do
            -- Twirl `n' times and adjust `count'.
        end

    count: INTEGER
end
```

## You are an acrobat with a buddy

- You will get someone else as your Buddy.
- When you are asked to **Clap**, you will be given a number. Clap your hands that many times. Pass the same instruction to your Buddy.
- When you are asked to **Twirl**, you will be given a number. Turn completely around that many times. Pass the same instruction to your Buddy.
- If you are asked for **Count**, ask your Buddy and answer with the number he tells you.

## You are an *ACROBAT_WITH_BUDDY*

```
class
    ACROBAT_WITH_BUDDY

inherit
    ACROBAT
        redefine
            twirl, clap, count
        end

create
    make

feature
    make (p: ACROBAT)
        do
            -- Remember `p' being
            -- the buddy, i.e. store
            -- value of `p' in `buddy'
        end

    clap (n: INTEGER)
        do
            -- Clap `n' times and
            -- forward to buddy.
        end

    twirl (n: INTEGER)
        do
            -- Twirl `n' times and
            -- forward to buddy.
        end

    count: INTEGER
        do
            -- Ask buddy and return
        end

    buddy: ACROBAT
end
```

## You are an author

- When you are asked to **Clap**, you will be given a number. Clap your hands that many times. Say "Thank You." Then take a bow (as dramatically as you like).
- When you are asked to **Twirl**, you will be given a number. Turn completely around that many times. Say "Thank You." Then take a bow (as dramatically as you like).
- When you are asked for **Count**, announce how many actions you have performed. This is the sum of the numbers you have been given to date.

## You are an *AUTHOR*

```
class
    AUTHOR

inherit
    ACROBAT
        redefine clap, twirl end

feature
    clap (n: INTEGER)
        do
            -- Clap `n' times say thanks and bow.
        end

    twirl (n: INTEGER)
        do
            -- Twirl `n' times say thanks and bow.
        end
end
```

## You are a curmudgeon

- When given any instruction (**Twirl** or **Clap**), ignore it, stand up and say (as dramatically as you can) "I REFUSE".
- If you are asked for **Count**, always answer with 0.

## You are a *CURMUDGEON*

```
class
    CURMUDGEON

inherit
    ACROBAT
        redefine clap, twirl end

feature
    clap (n: INTEGER)
        do
            -- Say "I refuse".
        end

    twirl (n: INTEGER)
        do
            -- Say "I refuse".
        end
end
```

## I am the root object

- I got created by the runtime
    - by executing my creation feature.

## I am a *DIRECTOR*

- I got created by the runtime
    - by executing my creation feature.

```
class
    DIRECTOR

create
        prepare_and_play

feature
        prepare_and_play
            do
                -- See following slides.
            end
```

## Let’s play

## I am the root object

```
prepare_and_play
        local
            acrobat1, acrobat2, acrobat3 : ACROBAT
            partner1, partner2: ACROBAT_WITH_BUDDY
            author1: AUTHOR
            curmudgeon1: CURMUDGEON
        do
            create acrobat1
            create acrobat2
            create acrobat3
            create partner1.make (acrobat1)
            create partner2.make (partner1)
            create author1
            create curmudgeon1
            author1.clap (4)
            partner1.twirl (2)
            curmudgeon1.clap (7)
            acrobat2.clap (curmudgeon1.count)
            acrobat3.twirl (partner2.count)
            partner1.buddy.clap (partner1.count)
            partner2.clap (2)
        end
```

## Concepts seen

| Eiffel | Game |
|---|---|
| Classes with features | Telling person to behave according to a specification |
| Inheritance | All people were some kind of ACROBAT |
| Interface | Queries and commands that are applicable |
| Objects | People |
| Creation | People stand up |
| Entities | Names for the people |
| Polymorphism | A name can refer to different kind of ACROBATs |
| Dynamic binding | Telling people by name to do the same has different outcome |

## Concepts seen

| Eiffel | Game |
|---|---|
| Command call | Telling people to do something |
| Query call | Asking a question to a person |
| Arguments | E.g.<br>how many times to clap |
| Return value | E.g.<br>count in ACROBAT_WITH_BUDDY |
| Chains of feature calls | E.g.<br>partner1.buddy.clap (2) |