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C++ Basics and Applications in technical Systems

Lecture 5 - Object oriented Programming

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University of Bremen

23th November 2012 / Bremen

WiSe 2012/2013

VAK 01-036

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Overview

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Lecture schedule

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Time schedule

HK	**26. Oct.** - Introduction / Simple Program / Datatypes ...
HK	**02. Nov.** - Flow control / User-Defined Data types ...
CF	**09. Nov.** - Simple IO / Functions/ Modular Design ...
CF	**16. Nov.** - C++ Pointer
CF	**23. Nov.** - Object oriented Programming / Constructors
AL	**30. Nov.** - UML / Inheritance / Design principles
AL	**07. Dec.** - Namespace / Operators
AL	**14. Dec.** - Polymorphism / Template Classes / Exceptions
HK	**11. Jan.** - Design pattern examples

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Important dates

Submission of exercises

1-3 **16. Nov.** - Deadline for submission of Exercise I, 13:00

4-6 **07. Dec.** - Deadline for submission of Exercise II, 13:00

For admission to final exam you need at least 50% of every exercise sheet.

Final project

1-9 **15. Feb.** - Deadline for submission of final project, 13:00

Final exam

1-9 **06. Feb.** - Final exam, 10:00-12:00, H3

Pointer in C++

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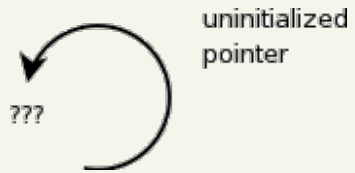
Definition

The value of a pointer variable is an address of a specific memory cell.

Declaration

```
int * pPointerToInteger;
char * pPointerToChar;
float * pPointerToFloat;
```

Attention: The pointer value is not initialized after declaration!



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Constant pointers on constant values

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Pointer on constant character

```
const char * pChar;          // character fixed
```

Constant pointer on character

```
char const * pChar;          // pointer fixed
```

Constant pointer on constant character

```
const char const * pChar;    // both fixed
```

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Structures for chained lists / trees

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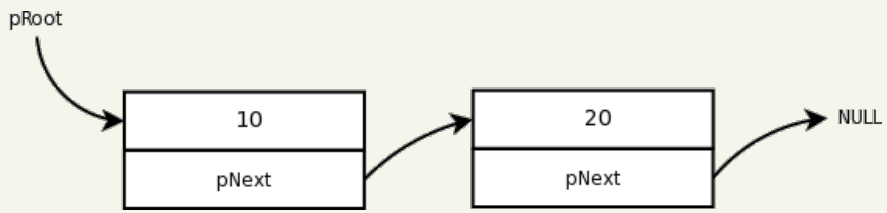
```
struct Node_T
{
  int m_iValue;
  Node_T * m_pNext;
};
```




```
// 1. Create root "object"
Node_T * pRoot = new Node_T;

// 2. Initialize elements
pRoot->m_iValue = 10;
pRoot->m_pNext = NULL;
```

```
// 3. Create second "object"
Node_T * pTemp = new Node_T;
pRoot->m_pNext = pTemp;

// 4. Initialize elements
pTemp->m_iValue = 20;
pTemp->m_pNext = NULL;
```

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Deallocation of memory

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Memory for allocated objects has to be deallocated after usage:

```
1  int * pValue1 = new int;                          // Pointer to int
2  ...                                                    // usage ...
3  delete pValue1;                                  // Deallocate memory
4  pValue1 = NULL;                          // Reinitialize dangling pointer
```

```
1  int iNumber;
2  std::cin >> iNumber;
3  int * pValue2 = new int[iNumber];      // Create array on run-time
4  ...                                                    // usage ...
5  delete [] pValue2;       // Deletes the array (deallocates memory)
6  pValue2 = NULL;                          // Reinitialize dangling pointer
```

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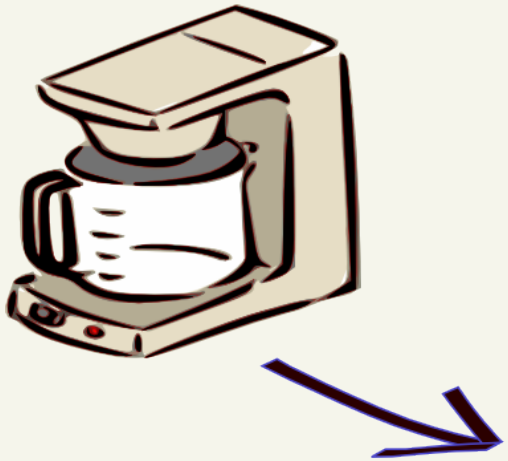
Mission of Object-Oriented-Programming (OOP)



Mapping of

- real world objects
- artificial objects
- elements of a technical application (e.g a GUI)
- concepts (e.g. Petri-Nets)

to software.

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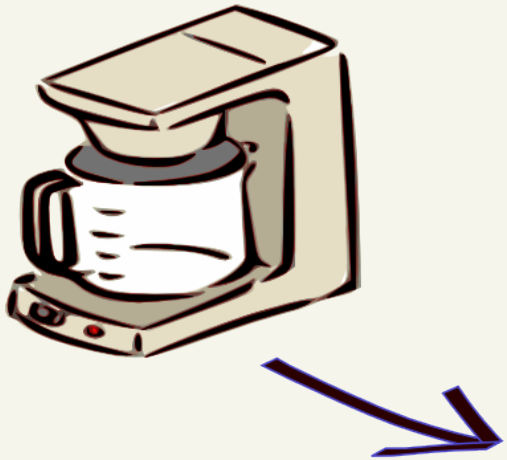
Mission of Object-Oriented-Programming (OOP)



Like real world objects, objects in SW have

- attributes (e.g. states like IsFilled)
- behavior (e.g. moves on the screen)
- relationships (e.g. aggregations like: a Petri-Net has arcs and transitions)

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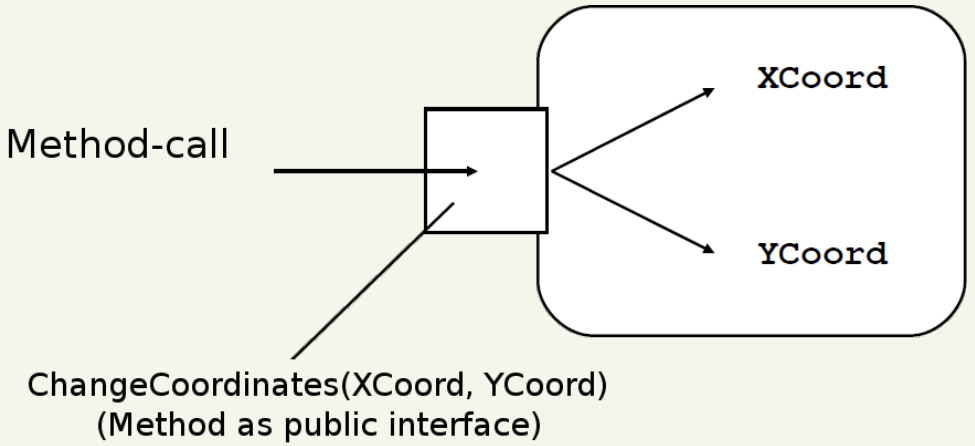
Encapsulation principle

Access to the data (attributes) exclusive via member functions of a class (methods) prevents un-authorized access and enables the programmer to influence the way of changing the attributes.



OOP - You already used it ...

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You already got in contact with convenient to use elements based on classes: Classes from the STL (Standard Template Library):

STL - Standard template library

- `std::string`
- `std::complex<typename>` (template-class)
- `std::vector<typename>` (container-template-class)

⇒ Now you will learn how to construct your own classes, e.g. construct your own abstract datatypes.

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Classes and objects

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Keep the difference between class and object in mind!

class

- Is an abstract data-type
- Is the description for objects
  - A class defines the structure of all by its sample produced objects (members + methods)
  - Serves the compiler a description of later defined objects

Example

```
std::string sMyString;
```

`std::string` is a class

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Classes and objects

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object

Concrete instantiation of the data-type defined by the class:

- Occupies in contrast to the class memory space
- Has an internal state (represented by the value of the member variables)
- This state can be changed by object activities i.e. operations that are performed with the member variables
- Has a unique identity i.e. address in memory space, that makes it distinguishable from other objects (even with same data content)

Example

```
std::string sMyString;
```

`sMyString` is an object (also called instance of class `std::string`)

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Classes and objects

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Declaration and instanciation

1. You define a class (abstract data type, declaration)
2. You instantiate objects of that class (similar to the process of declaring a variable)
3. Each object (or instance):
   - allocates memory from the OS
   - has a unique identity
   - has an internal state (contents of attributes) that can be changed with the class' methods

Components of a class: Attributes

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Definition

Data members (attributes) have the syntax of variable definitions.

Example

Declaration:

```
int m_iAttribute;
```

Access (if granted):

```
myObject.m_iAttribute = iNewValue;
```

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Components of a class: Methods

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Definition

Methods have the syntax of function prototypes and specify the class operations.

Example

Declaration:

```
void MyMethod(void);
```

Implementation:

```
void MyClass::MyMethod(void) { ... }
```

Access (if granted):

```
myObject.MyMethod();
```

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Components of a class: `const` Methods

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Definition

`const` methods are not allowed to change the attributes of a class. They are the only permitted operations on const objects.

Example

Declaration:

```
void MyMethod(void) const;
```

Implementation:

```
void MyClass::MyMethod(void) const { ... }
```

Access (if granted):

```
myObject.MyMethod();
```

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Declaration of classes

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```
1  // To declare a class, use the class keyword followed by an
2  // opening brace and then list the members of that class.
3  // End the declaration with a closing brace and a semicolon.
4  class Classname
5  {
```

```
1  // Keyword public: specifies those members that are
2  // accessible from outside the class
3  public:
4      ReturnType Method1(ArgType Arg1);
5      ReturnType Method2(void);
```

```
1  // Keyword private: specifies those members that are
2  // not accessible from outside the class directly.
3  private:
4      ReturnType Method3(void);
5      Type m_Attribute1;
6      Type m_Attribute2;
```

```
1  };
```

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Example class header file (*.h)

```
1  #ifndef POINT_H
2  #define POINT_H
3  class Point
4  {
```

```
1  public:
2      int GetXCoord(void) const; // Keyword const ensures that the
3      int GetYCoord(void) const; // methods can't change the object.
4      // The data can be changed only by this method
5      void ChangeCoordinates(int iXCoord, int iYCoord);
```

```
1  private:
2      int m_iXCoord;
3      int m_iYCoord;
```

```
1  };
2  #endif // POINT_H
```

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Example class implementation file (*.cpp)

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```
1  #include "Point.h"
```

```
1  int Point::GetXCoord(void) const
2  {
3      return m_iXCoord;
4  }
```

```
1  int Point::GetYCoord(void) const
2  {
3      return m_iYCoord;
4  }
```

```
1  void Point::ChangeCoordinates(int iXCoord, int iYCoord)
2  {
3      m_iXCoord = iXCoord;
4      m_iYCoord = iYCoord;
5  }
```

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Example main programm

```
1  #include "Point.h"
2  #include <iostream>
3  using std::cout;
4  using std::endl;
```

```
1  int main()
2  {
```

```
1      // create object
2      Point newPoint;
3      newPoint.ChangeCoordinates(2, 5); // change coordinates
4      cout << "The Point has the coordinates:" << endl
5           << "x = " << newPoint.GetXCoord() << endl
6           << "y = " << newPoint.GetYCoord() << endl;
```

```
1      return 0;
2  }
```

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Access restrictions on members

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Attributes and methods fall under one of three different access permissions:

- **Public** members are accessible by all class users.
- **Private** members are only accessible by the class members.
- **Protected** members are only accessible by the class members and the members of a derived class.

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Default access restrictions

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If no keyword is given, the following access permissions are used:

- **struct:** public
- **class:** private

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Accessor and Mutator

Due to the data encapsulation principle, attributes should be declared as `private` (or `protected`) and classes have to provide the following methods:

- an accessor method to get the data of a class.
- a mutator to change the data of class.

Besides the prevention of unauthorized data access, there is a significant design advantage:

Advantage

The type of attribute can be changed without having to alert all programmers using the class. Just a modification of accessor and mutator is necessary (keeping the signature).

Constructors

Purpose:

- Initialization during definition
- Supply of memory space

Syntax:

- Method name is equal to class name
- No return-value (nor void)

Constructor types:

- Standard constructor
- General constructor
- Copy constructor
- Type conversion constructor (not discussed)

Standard constructor

The standard constructor has no arguments! Implementation is done by:

- the compiler (automatically, not view/changeable, all values of attributes are uninitialized!)
- the programmer (see example)

Example

```
MyClass::MyClass()
{
   ...
}
```

Standard constructor example

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Header

```
// "Position.h"
class Position
{
public:
    Position();
    int GetXCoord() const;
    int GetYCoord() const;
    void ChangeCoords(
                int iXCoord,
                int iYCoord);

private:
    int m_iXCoord;
    int m_iYCoord;
};
```

This implementation assures initialized attributes.

Implementation

```
// "Position.cpp"

Position::Position()
{
    m_iXCoord = 0;
    m_iYCoord = 0;
}
```

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Destructor

Clearing up work inside an object before destruction (Most important purpose is the de-allocation of memory space before the object leaves the range of validity). Implementation is done by:

- the compiler (automatically, not view/changeable)
- the programmer (see example on next slide)

Rules for manual implementation:

- no parameters
- no return value
- tilde (~) used as prefix for declaration

Destructor example

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The destructor has to be declared as public method of the class.

Example

```
// Position.h
class Position
{
public:
    ~Position();
};
```

```
// Position.cpp
Position::~Position()
{
    // Clearing up work
    ...
}
```

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Exercise

Create a class `Cuboid` that offers the following functionalities (first implement empty methods):

- Set and get the required parameters height, width and depth, e.g. `SetDimensions()`, `GetDimensions()`, ...
- Calculation of surface area and volume, e.g. `CalculateVolume()`, ...
- Returning of the calculated values, e.g. `GetVolume()`, ...
- Implement all these methods.
- Add a standard constructor and a destructor.
- Verify the class with the help of a test program.

General constructor

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Characteristics:

- Contrary to a standard constructor, a general constructor has parameters
- They can be overloaded (like functions), i.e., there may be several general constructors with different parameters

Attention:

- The introduction of a general constructor prevents the automatic creation of the standard constructor

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General constructor example

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Header

```
// "Vehicle.h"
class Vehicle
{
public:
    Vehicle();
    Vehicle(
            double dHeight,
            double dWidth);
    double GetHeight() const;
    double GetWidth() const;

private:
    double m_dHeight;
    double m_dWidth;
};
```

This implementation assures attributes with individual initialization.

Implementation

```
// "Vehicle.cpp"

Vehicle::Vehicle(
            double dHeight,
            double dWidth)
{
    m_dHeight = dHeight;
    m_dWidth = dWidth;
}
```

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General constructor execution

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Implementation

```
// "Vehicle.cpp"

Vehicle::Vehicle(
            double dHeight,
            double dWidth)
{
    m_dHeight = dHeight;
    m_dWidth = dWidth;
}
```

- Before entering the block `{...}`, memory for the data elements `m_dHeight` and `m_dWidth` is allocated (header-file).
- The program code inside the block is executed and the parameters `dHeight` and `dWidth` are assigned to the member variables

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Initialization with lists

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Header

```
class Vehicle
{
public:
    Vehicle();
    Vehicle(double dHeight, double dWidth);
private:
    double m_dHeight;
    double m_dWidth;
};
```

Implementation

```
Vehicle::Vehicle(double dHeight, double dWidth)
: m_dHeight(dHeight), m_dWidth(dWidth)
{ ... }
```

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Initialization with lists

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Characteristics:

- Memory allocation and parameter assignment are summarized
- Run time advantages in case of large or many objects

Processing:

- The initialization order depends on the order of declaration within the class and **NOT** on the order within the list
- Attention when an initialization depends on the result of a preceding initialization!
- The block $\{...\}$ is executed

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General constructor usage

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Parameter initialization with object declaration.

Header

```
// "Vehicle.h"
class Vehicle
{
public:
    Vehicle();
    Vehicle(
            double dHeight,
            double dWidth);
    double GetHeight() const;
    double GetWidth() const;

private:
    double m_dHeight;
    double m_dWidth;
};
```

Application

```
// "main.cpp"
#include "Vehicle.h"

int main()
{
    double dHeight = 5.0;
    double dWidth = 3.2;

    Vehicle myVehicle(dHeight,
                      dWidth);

    return 0;
}
```

Copy constructor

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Definition

Initialization of an object with an already existing object

Characteristics:

- The first parameter is a const reference to an *object of the same class*

Attention:

- If no copy constructor is available, one is created by the compiler automatically (bit by bit!!)
- Problem when elements with manually allocated memory are used

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Copy constructor example

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Header

```
class Vehicle
{
public:
    Vehicle(const Vehicle& vehicleObj);
private:
    double m_dHeight;
    double m_dWidth;
};
```

Implementation

```
Vehicle::Vehicle(const Vehicle& vehicleObj)
 : m_dHeight(vehicleObj.m_dHeight),
   m_dWidth(vehicleObj.m_dWidth)
{ ... }
```

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Copy constructor usage

Creation of an object `SecondVehicle`, which is initialized with the values of the already existing object `FirstVehicle`

Example

```
Vehicle firstVehicle(5.0, 3.5);          // General constructor
Vehicle secondVehicle = firstVehicle;    // Copy constructor
```

Although the equal-sign is used, an **initialization** and **not** an **assignment** takes place.

Example

```
Vehicle thirdVehicle;
thirdVehicle = firstVehicle;             // Assignment
```

Important

Remember

A copy constructor is **only** necessary during the **creation** of a new object, not for the assignment with an object, i.e., for changes of already existing objects!

Small Exercise

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Extend the class `Cuboid` that offers the following functionalities:

- A general constructor to set these height, width and depth with the creation of an object.
- A copy constructor to initialize an object with another object of the same class.
- Instantiate an object of that class with the help of a test program. Use the general constructor.
- Instantiate another object of that class by using the copy constructor.
- Get the parameters of the second object and print them on the screen.

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Introduction to MDD (Model Driven Development)

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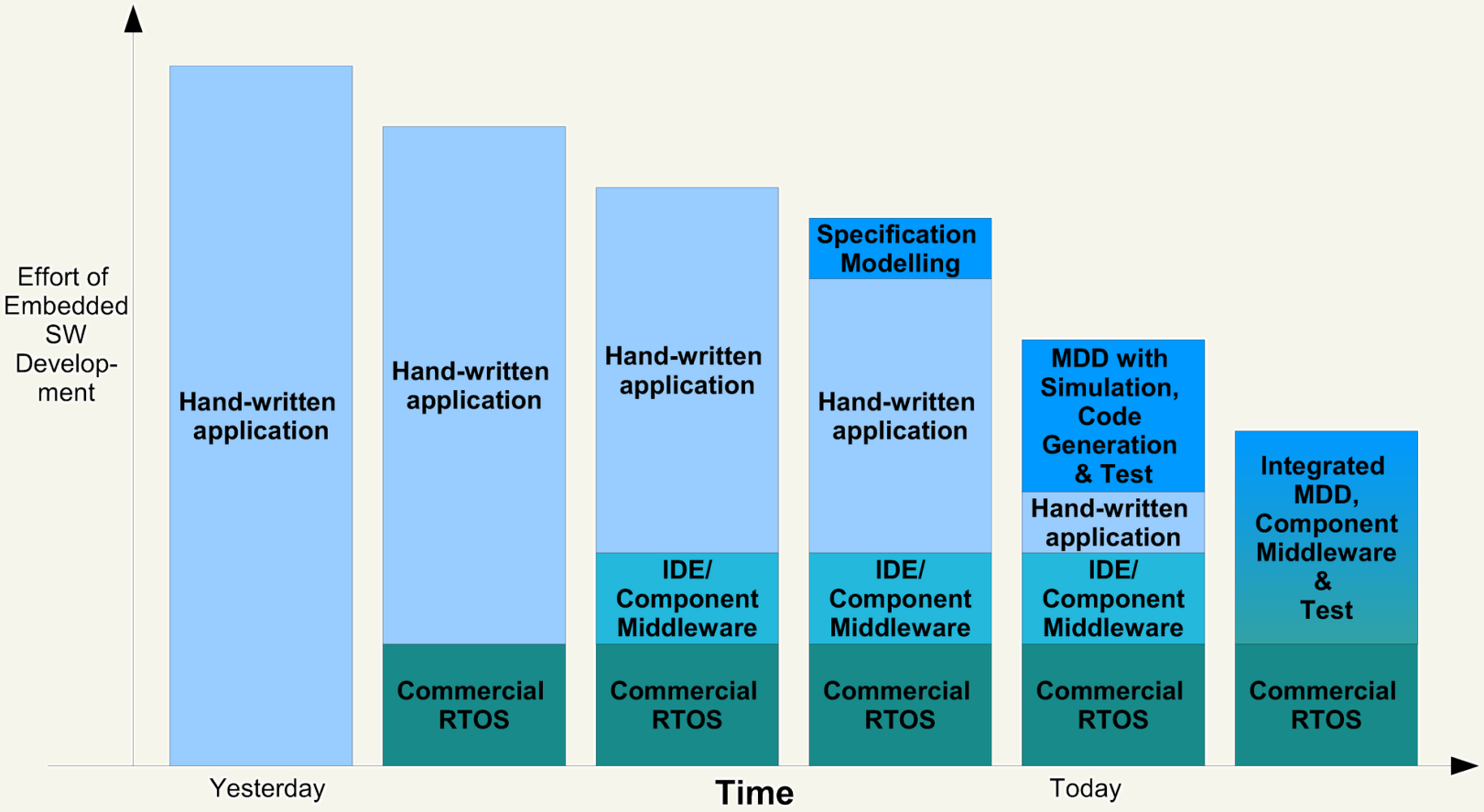
MDD: Emerging future technology



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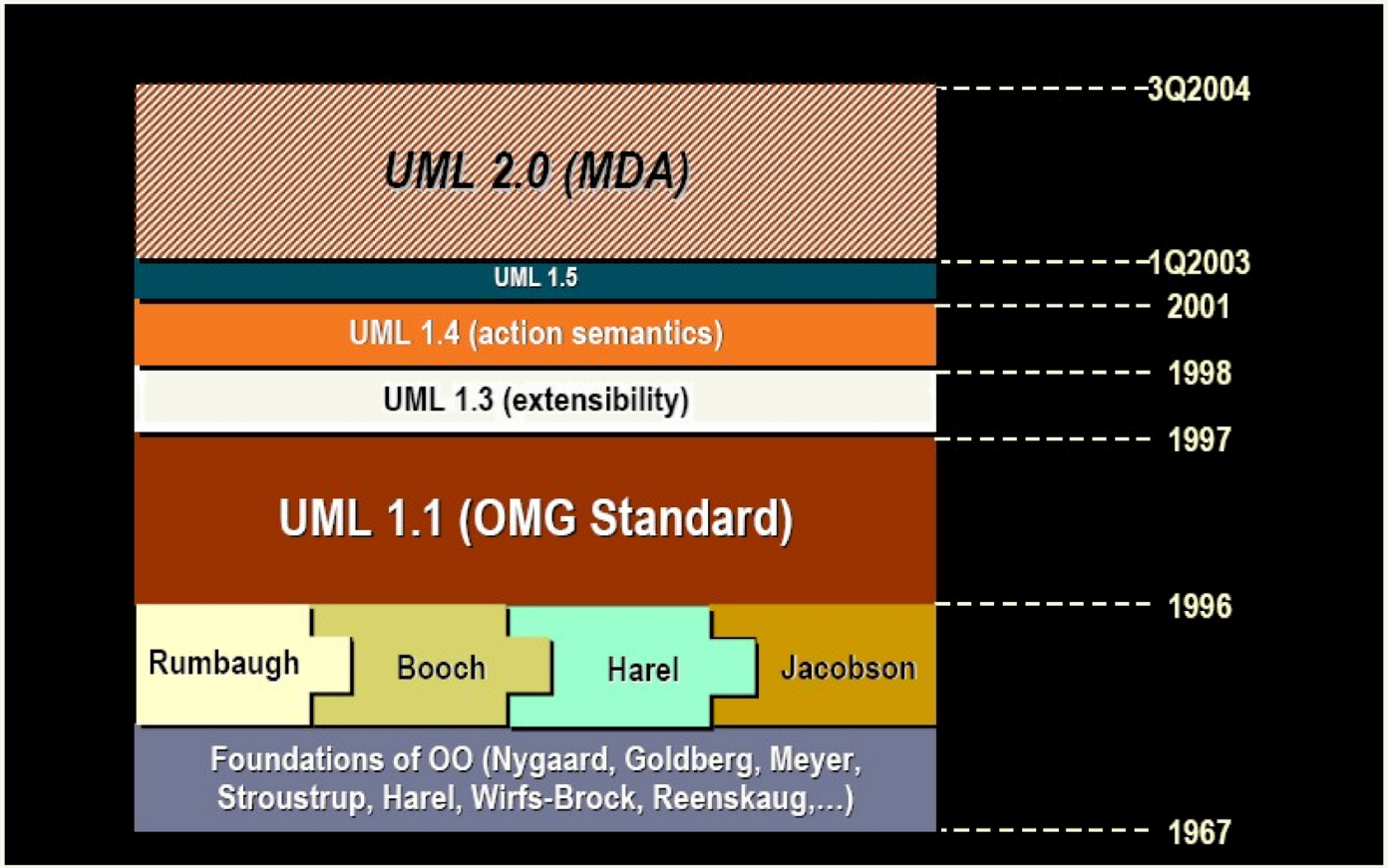
UML (Unified Modeling Language) – the history



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UML – The mission

- UML is a **standardized modeling language** consisting of an integrated set of diagrams
- Developed to help system and software developers accomplish the following tasks
  - Specification
  - Visualization
  - Architecture design
  - Construction
  - Simulation and Testing
- Allows the developer to concentrate "**on the big picture**"
- Properly constructed diagrams and models are **efficient communication techniques**

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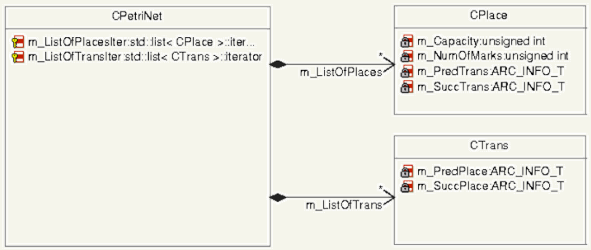
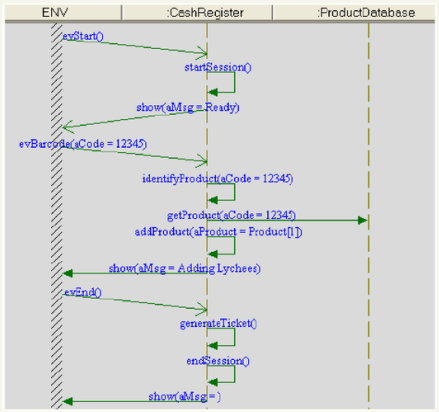
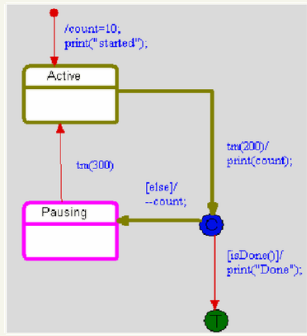
UML – 13 diagram types

- Activity Diagram
- **Class Diagram**
- Communication Diagram
- Component Diagram
- Composite Structure Diagram
- Deployment Diagram
- Interaction Overview Diagram
- **Object Diagram**
- **Package Diagram**
- **Sequence Diagram**
- **State Machine Diagram**
- Timing Diagram
- **Use Case Diagram**







Good online summary on UML:
http://bdn.borland.com/article/31863

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Rhapsody – Technical issues

- Easiest and preferred access:
  - Usage on notebook
  - Need connection to IAT license server via OpenVPN
  - Apply for certificate by writing email to
    kampe@iat.uni-bremen.de
  - Follow instructions provided at
    www2.iat.uni-bremen.de/~friend2/sw/rhapsody
    - user: guest
    - password: iatguest2006

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Rhapsody – Sources of information

- RhapsodyInstallDir/Doc
  - user guide, properties manual, tutorials
- iatWiki extracts are provided in the elearning system

- For OOP-experienced users:
  - Rhapsody Hands-On-Workshop, provided on www2.iat.uni-bremen.de/~friend2/sw/rhapsody

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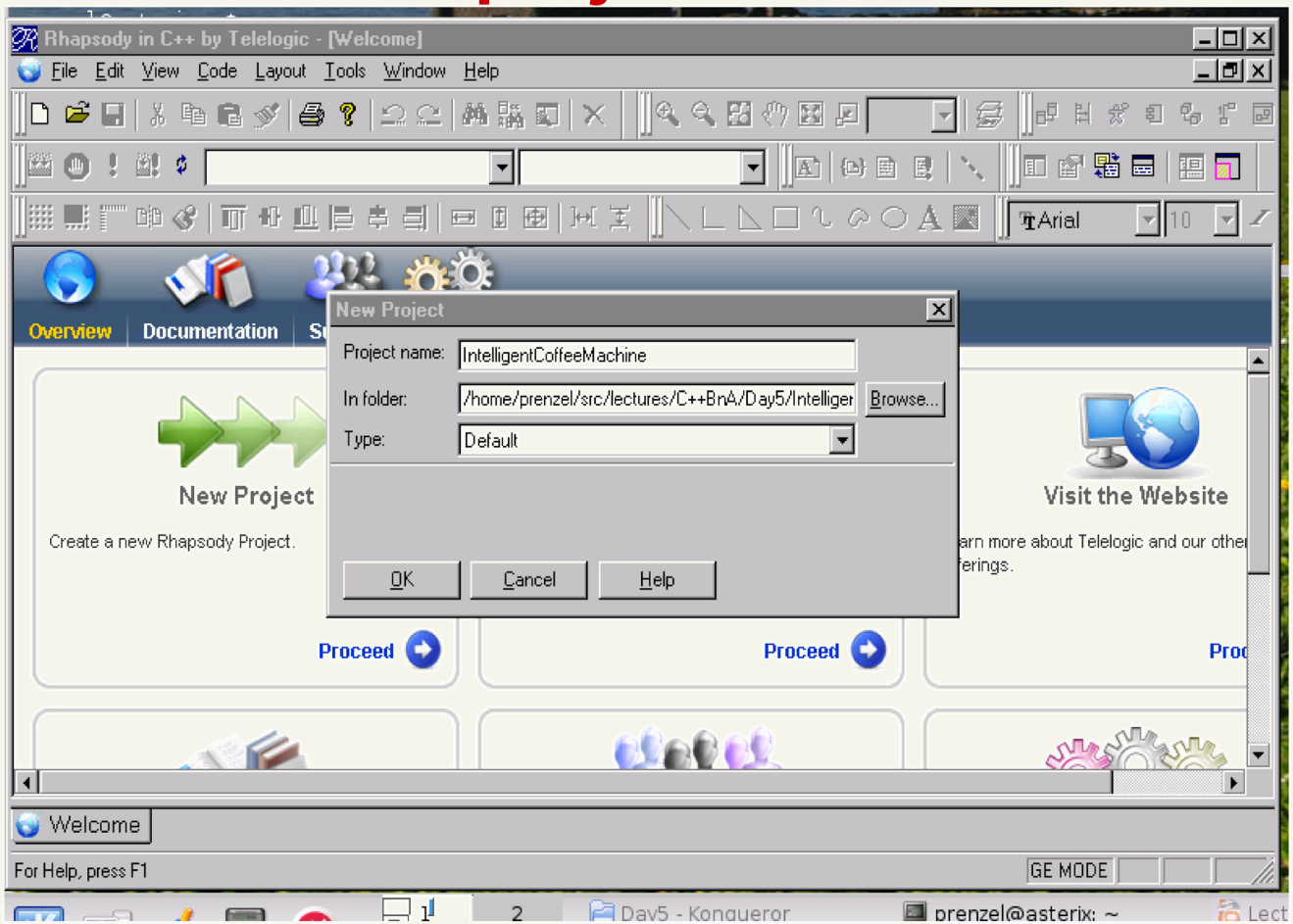
Rhapsody – first steps
#1: Create a new project



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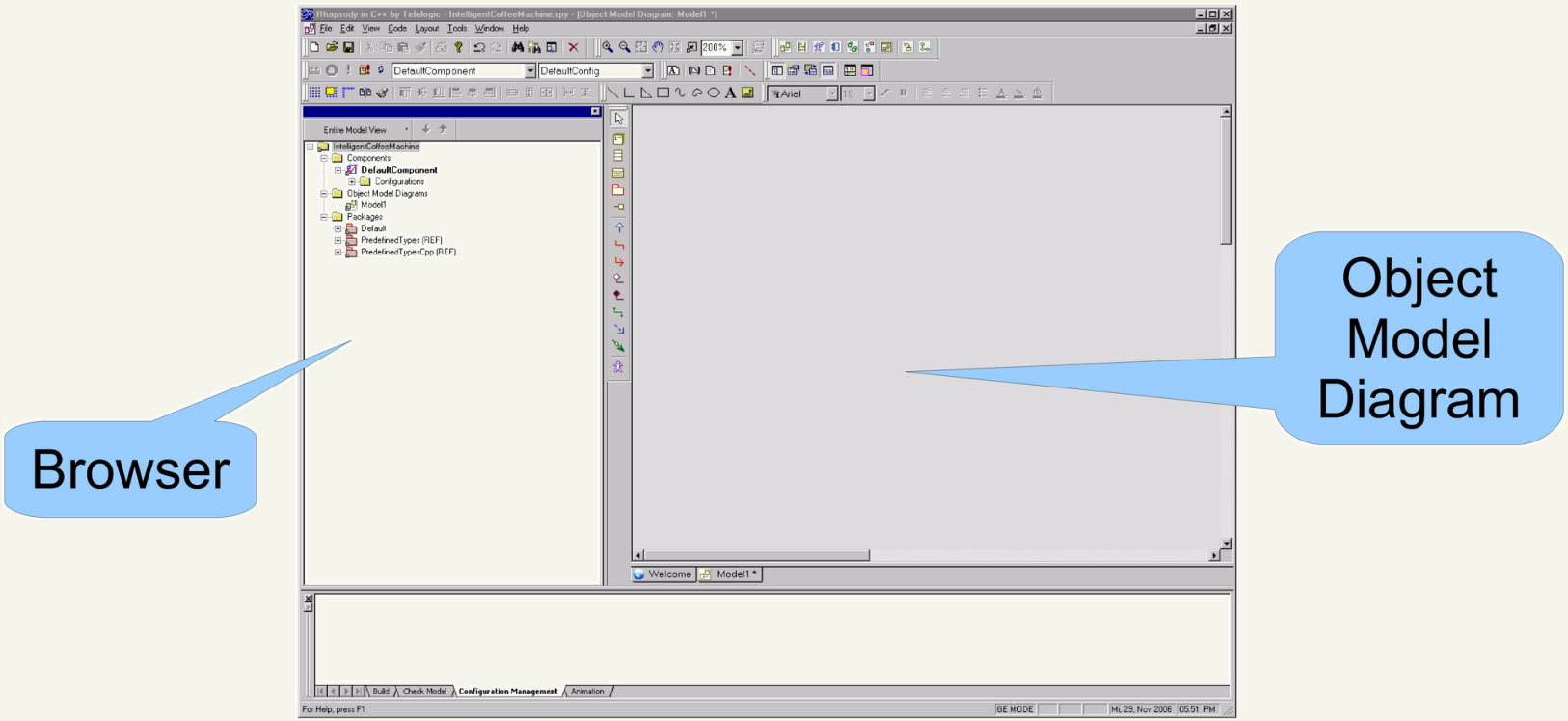
Rhapsody – first steps
The browser



The browser shows everything that is in the model

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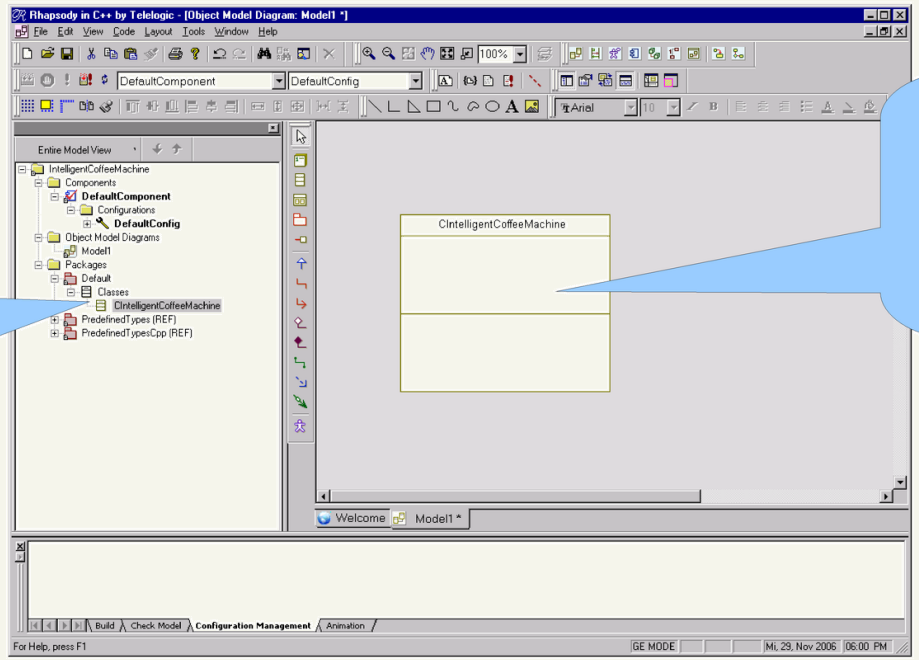
Rhapsody – first steps
#2: Create a new class

- In the Object Model Diagram (OMD), use the class icon  to draw a new class
- Name it *CIntelligentCoffeeMachine*



Expand the browser to see the new class ...

... or right-click on the class and select *Locate* *(short: Ctrl + L)*

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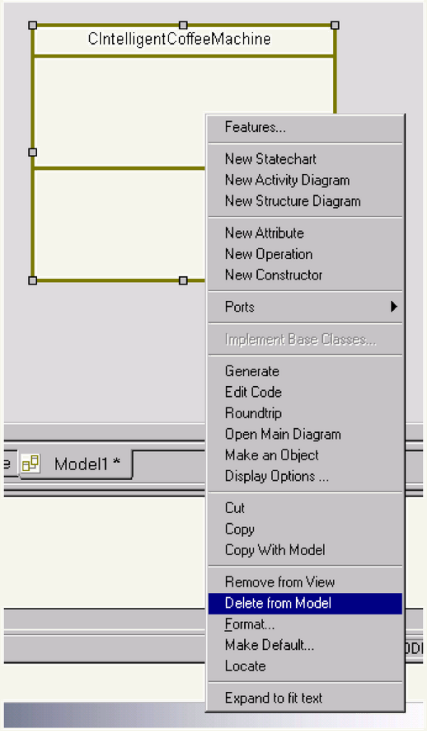
Rhapsody – first steps
Remove from View/Model

- There are two ways of deleting a class:
  - either remove the class from the view (same effect as with “delete” key)
  - delete the class from the model



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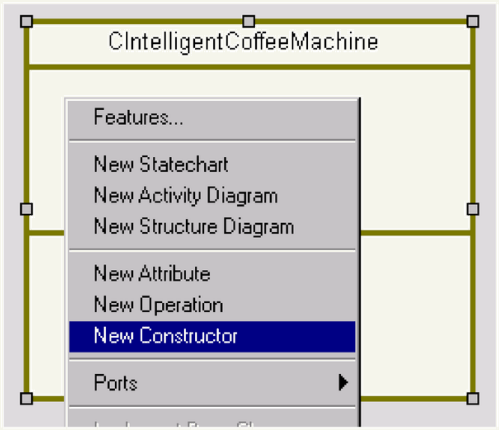
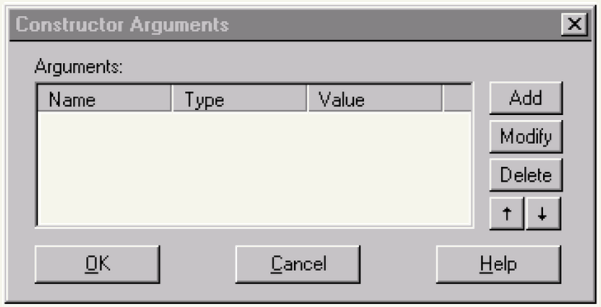
Rhapsody – first steps #3: Create a constructor

- A constructor initializes a class (more details later)



- Right-click on the class and choose *New Constructor*
- We need no constructor arguments, so click “OK” in the subsequent dialog



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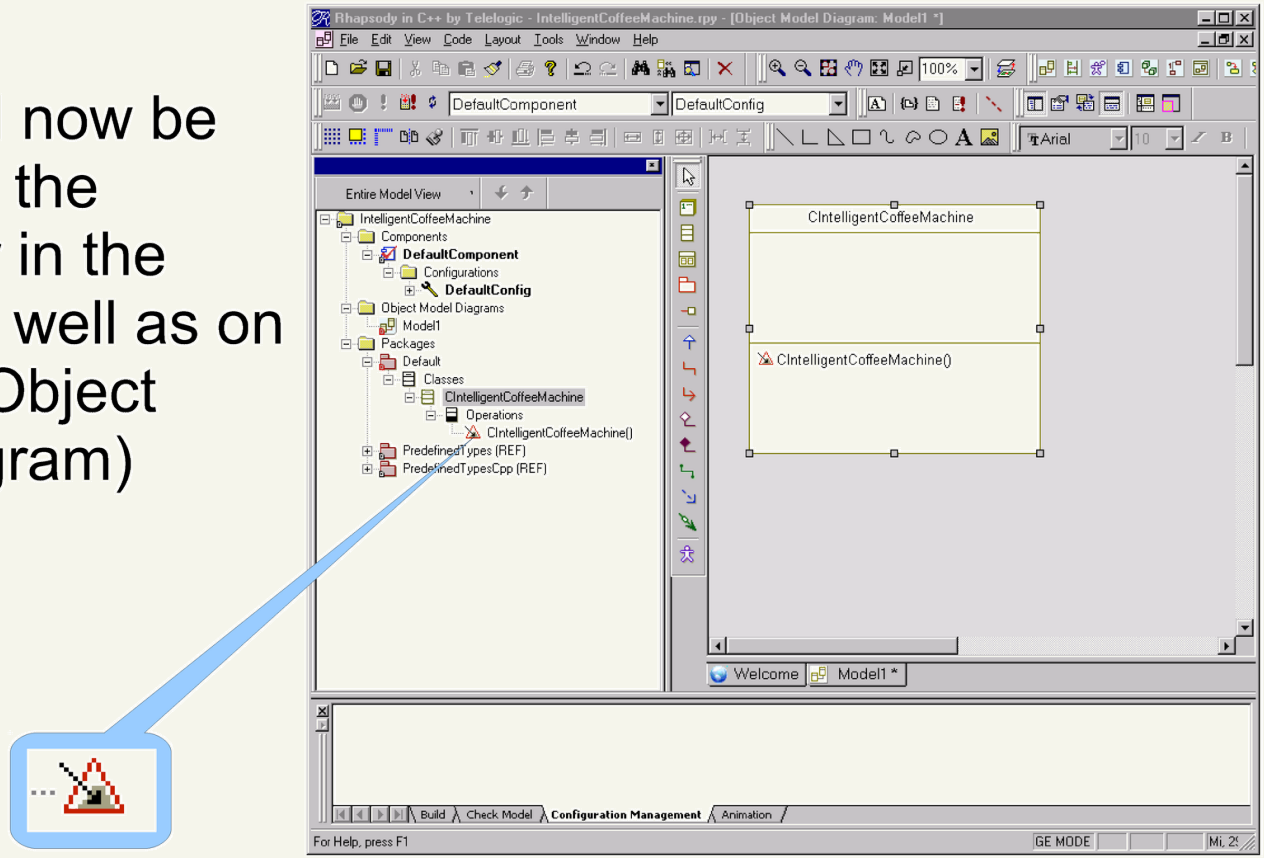
Rhapsody – first steps
Display constructor

- You should now be able to see the constructor in the browser as well as on the OMD (Object Model Diagram)



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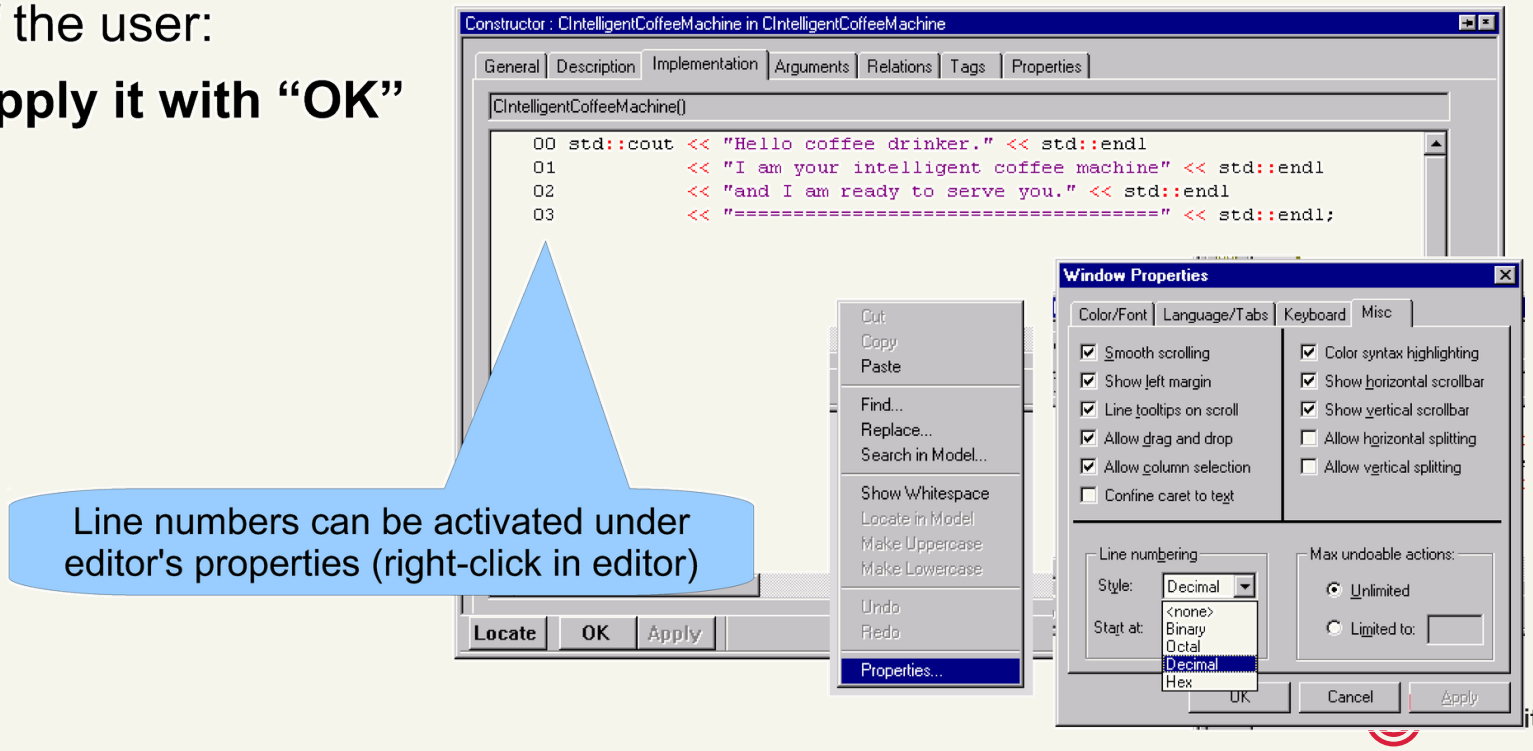
Rhapsody – first steps
#4: Adding implementation

- Select the *CIntelligentCoffeeMachine* constructor in the browser and double-click to open the *Features* dialog.
- Select the implementation tab and enter an implementation for the initialization of the intelligent coffee machine, e.g. a greeting of the user:
- **Apply it with "OK"**



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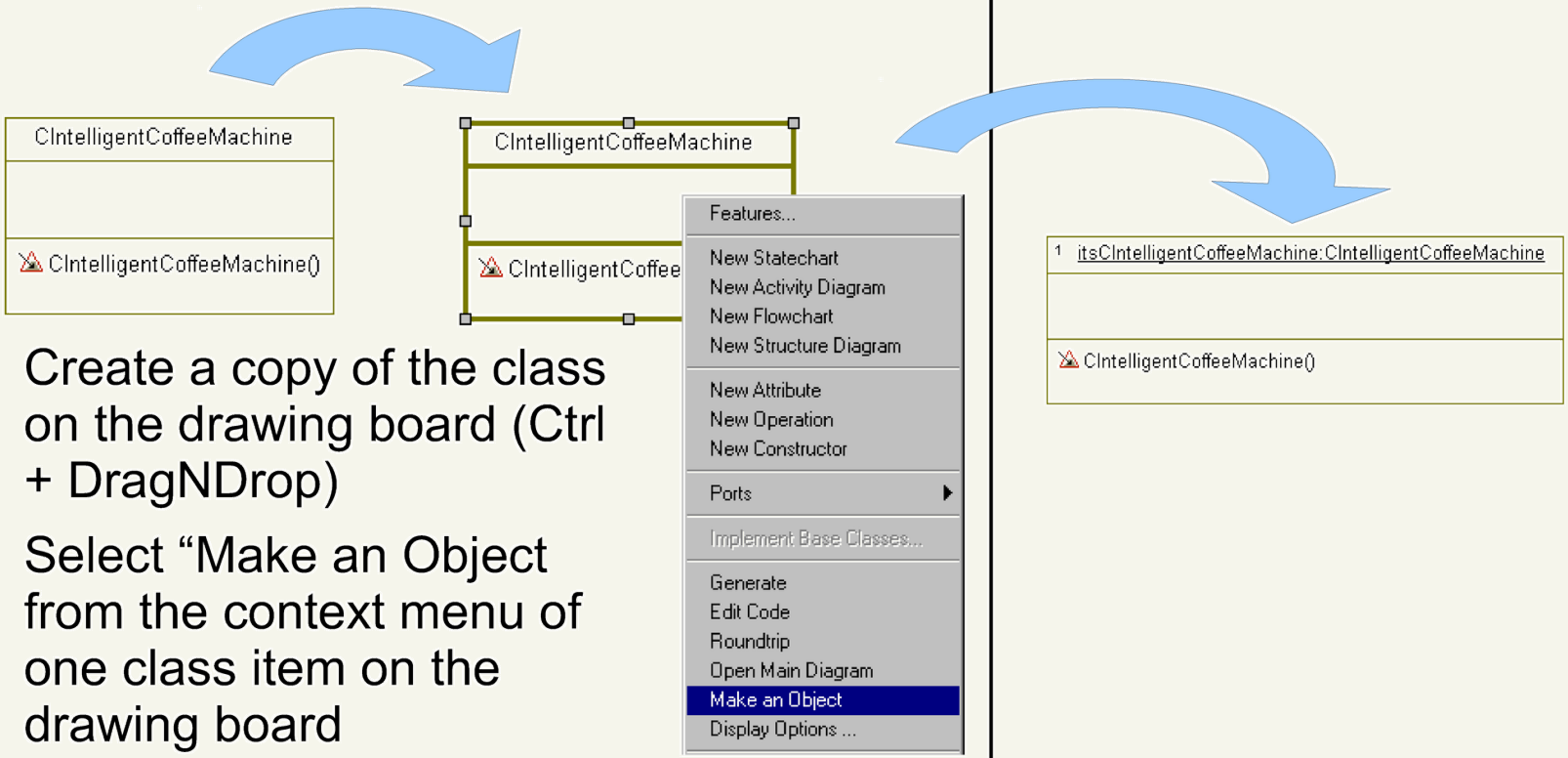
Class ➡ Object: #5: Make an Object



- Create a copy of the class on the drawing board (Ctrl + DragNDrop)
- Select “Make an Object from the context menu of one class item on the drawing board

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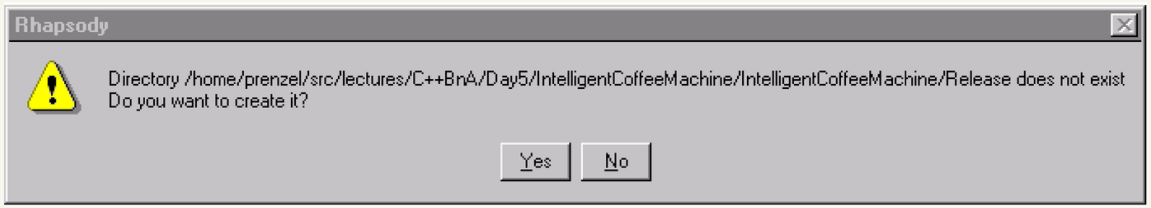
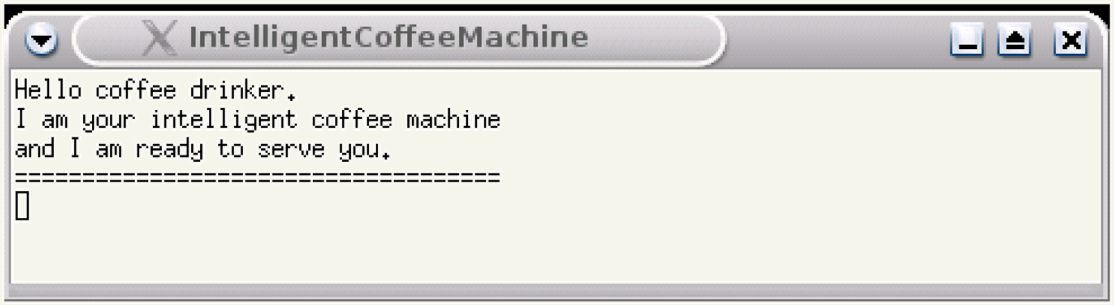
Rhapsody – first steps
#6: Generate code, build, run ...

- Now, code can be generated
- Save the model 
- Select *Generate/Make/Run* 
- Answer *Yes*





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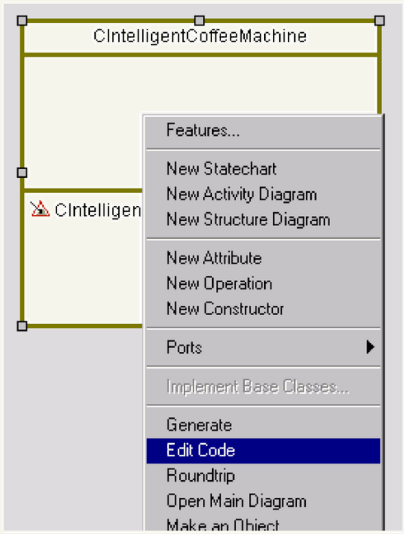
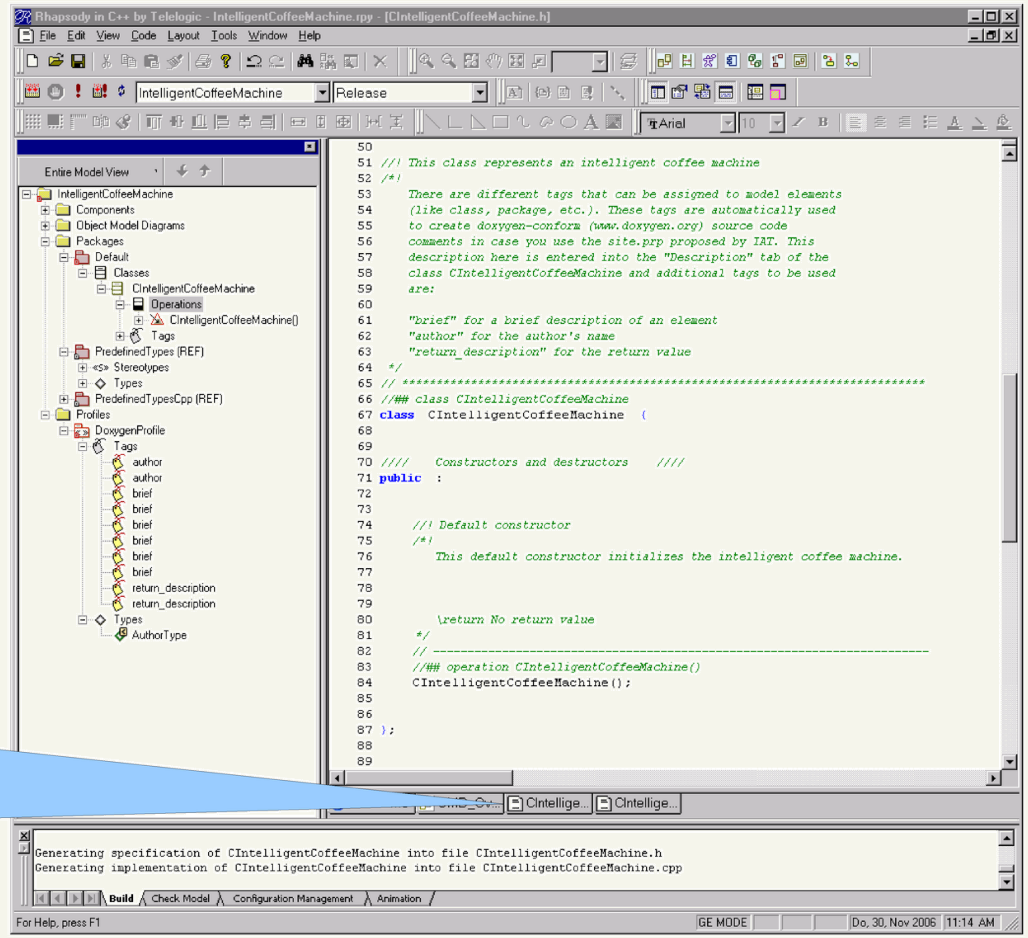
Rhapsody – first steps
Having a look at the code



Select Edit Code from the class context menu and the header as well as implementation of your class will be displayed (two new tabs at bottom).



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Rhapsody – first steps
Having a look at the code

CIntelligentCoffeeMachine.h

```
//! This class represents an intelligent coffee machine
// ****************************************************
//## class CIntelligentCoffeeMachine
class CIntelligentCoffeeMachine  {


////    Constructors and destructors    ////
public :
    //! Default constructor
    /*!
        This default constructor initializes the intelligent
        coffee machine.


        \return No return value
     */
    // ----------------------------------------------------
    //## operation CIntelligentCoffeeMachine()
    CIntelligentCoffeeMachine();
};
```

Public keyword for defining public interfaces (methods) to the class. Constructors normally have to be public.

A constructor is similar to a function but
- **has no return value**
- has the **class name as function name**

A default constructor has no arguments. More about constructors in the next lecture ... .

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Rhapsody – first steps
Having a look at the code

CIntelligentCoffeeMachine.cpp

In the implementation file the **class name + "::" + method name** (in this case again the class name, due to defining the constructors body) have to be specified.

Implementation

```
//---------------------------------------------------------
// CIntelligentCoffeeMachine.cpp
//---------------------------------------------------------
//## package Default
//## class CIntelligentCoffeeMachine
CIntelligentCoffeeMachine::CIntelligentCoffeeMachine() {
    //#[ operation CIntelligentCoffeeMachine()
    std::cout << "Hello coffee drinker." << std::endl
              << "I am your intelligent coffee machine" << std::endl
              << "and I am ready to serve you." << std::endl
              << "====================================" << std::endl;
    //#]
}
// ---------------------------------------------------------------
// End of CIntelligentCoffeeMachine.cpp
// ---------------------------------------------------------------
```

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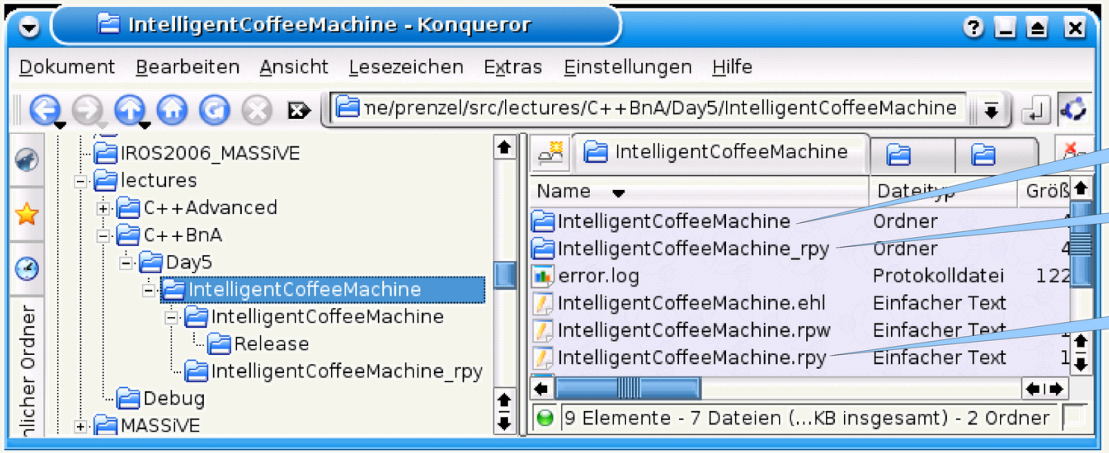
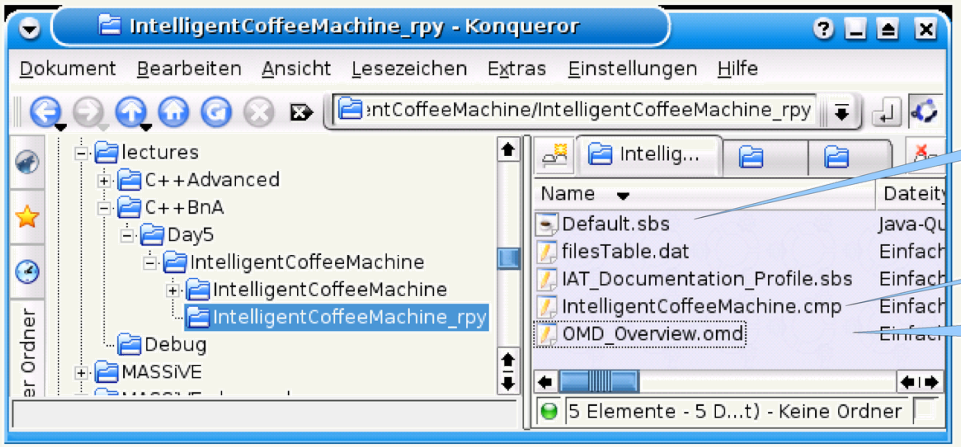
Rhapsody – first steps
The model files and generated files





Component directory (generated files)

Model directory

Project file

Package file

Component file

OMD file (Object modeldiagram)

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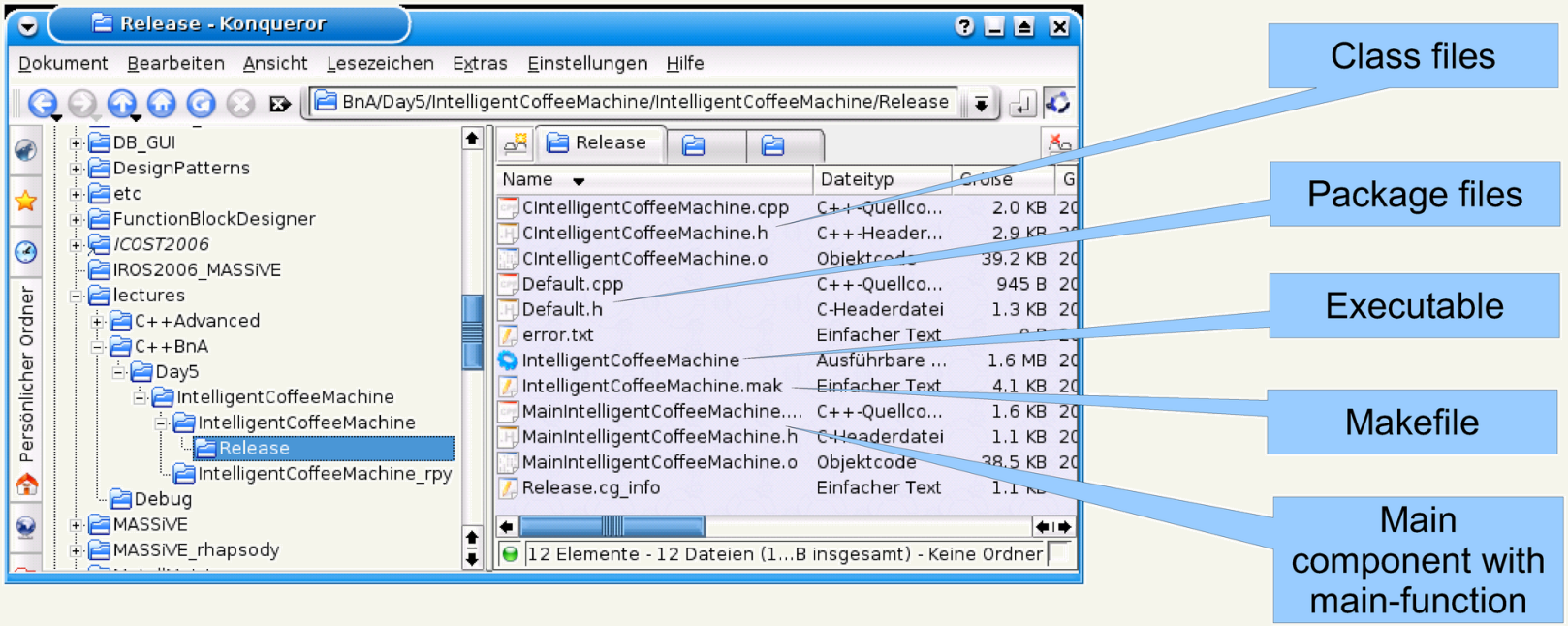
Rhapsody – first steps
The model files and generated files



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Rhapsody – first steps
Bi-directional model-code associativity

- The code in the generated files can be modified:
  - Change the constructor's implementation in CIntelligentCoffeeMachine.cpp
  - Change the window focus to some other window and the changes will be roundtripped into the model

- Even though the roundtripping works very well in general be aware that not everything can be roundtripped!

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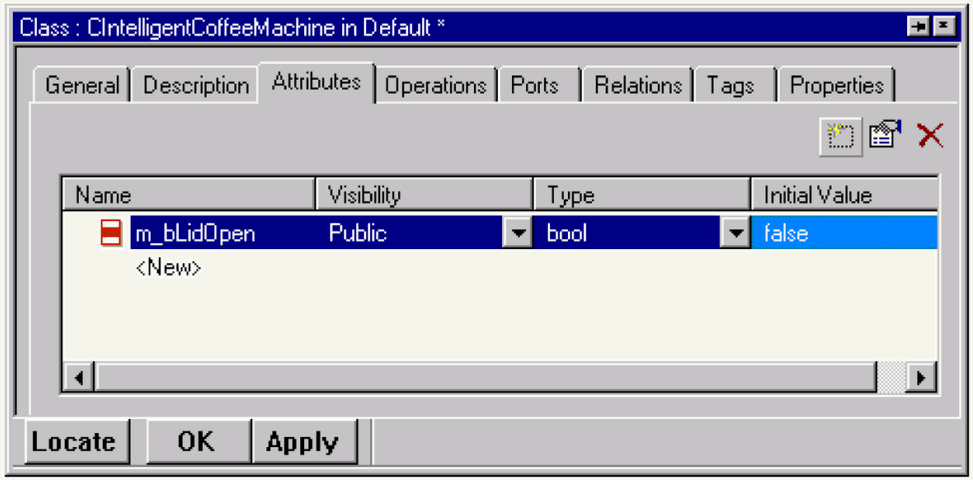
Rhapsody – next steps
Adding attributes

- We now want to add an attribute to the intelligent coffee machine that indicates the opening state of the water reservoir's lid:
  - bool m_bLidOpen, with the default value “false”
- Double click on the class in the model to bring up the features dialog and select the *Attributes* tab



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Rhapsody – next steps
Generated code for attribute

Select Edit Code or switch to the still open code view

Header file

```
////    Additional operations    ////
public :

    //## auto_generated
    bool getM_bLidOpen() const;

    //## auto_generated
    void setM_bLidOpen(bool p_m_bLidOpen);


////    Attributes    ////
protected :

    //! Describes the opening state of the water reservoir's lid
    bool m_bLidOpen;                    //## attribute m_bLidOp
```

Per default attributes are ***protected*** (cannot be accessed directly from outside) = **encapsulation principle**

Setting initial value in initialization list

Accessor

Mutator

```
CIntelligentCoffeeMachine::CIntelligentCoffeeMachine() : m_bLidOpen(false) {
    //#[ operation CIntelligentCoffeeMachine()
    std::cout << "Hello coffee drinker." << std::endl
                      << "I am your intelligent coffee machine" << std::endl
                      << "and I am ready to serve you." << std::endl
                      << "==================================" << std::endl;
    //#]
}

bool CIntelligentCoffeeMachine::getM_bLidOpen() const {
    return m_bLidOpen;
}

void CIntelligentCoffeeMachine::setM_bLidOpen(bool p_m_bLidOpen) {
    m_bLidOpen = p_m_bLidOpen;
}
```

Implementation file

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Rhapsody – next steps
Attribute visibility

- Changing the *Visibility* in the *Attribute Features* dialog changes the accessor and mutator visibility, not the data member visibility!

Note that an accessor's signature includes the ***const***-keyword. This means **this method does not change the class members**. Every method with this characteristic shall be set to ***const*** to prevent later implementation mistakes!!

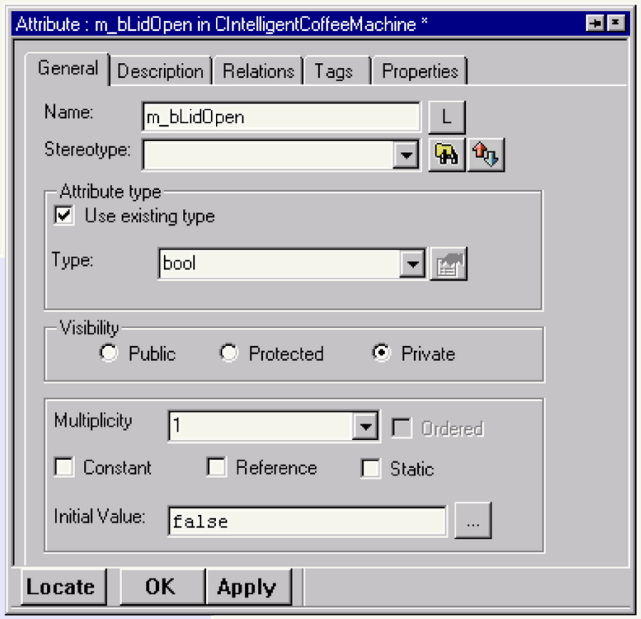
```
////    Additional operations
private :

    //## auto_generated
    bool getM_bLidOpen() const;

    //## auto_generated
    void setM_bLidOpen(bool p_m_bLidOpen);


////    Attributes    ////
protected :

    //! Describes the opening state of the water reservoir's lid
    bool m_bLidOpen;                    //## attribute m_bLidOp
```



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Rhapsody – next steps
Adding a method

- Now try on your own to add the method
  bool InsertCoffee(unsigned int NumberOfSpoons)
  (use "New Operation")

  where
  - *NumberOfSpoons* is a "In"-Parameter
    (remember the concept call-by-value/call-by-reference/pointer and see next slide ...)
  - An internal state variable for the content of the coffee reservoir is set according to the number of spoons
  - The return value is set according to the success of the operation, i.e.
    - has the lid been opened before?
    - is the maximum number of spoons (introduce this constant) respected?

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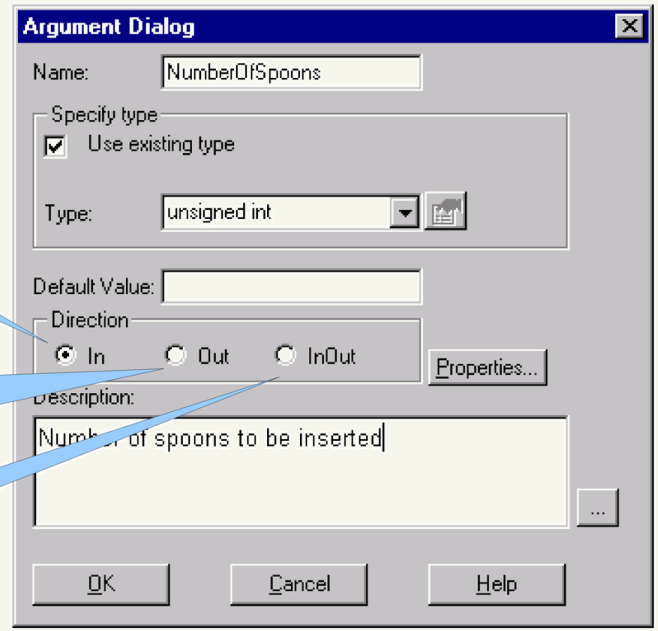
Rhapsody – next steps
Argument direction

Call by value: Parameter remains **unchanged** in the outside scope

Call by reference / pointer (depends on settings): Parameter may be **changed** within the method. Parameter is **not used to hand over a value** to the method.

Same as before, but parameter also **serves as in value** to the method.



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Creating initial instances

- In the lecture module global objects have been created (see “Make Object” slide)
- Another way to influence object instantiation is the Initialization section of the Component's Configuration, see following slide:

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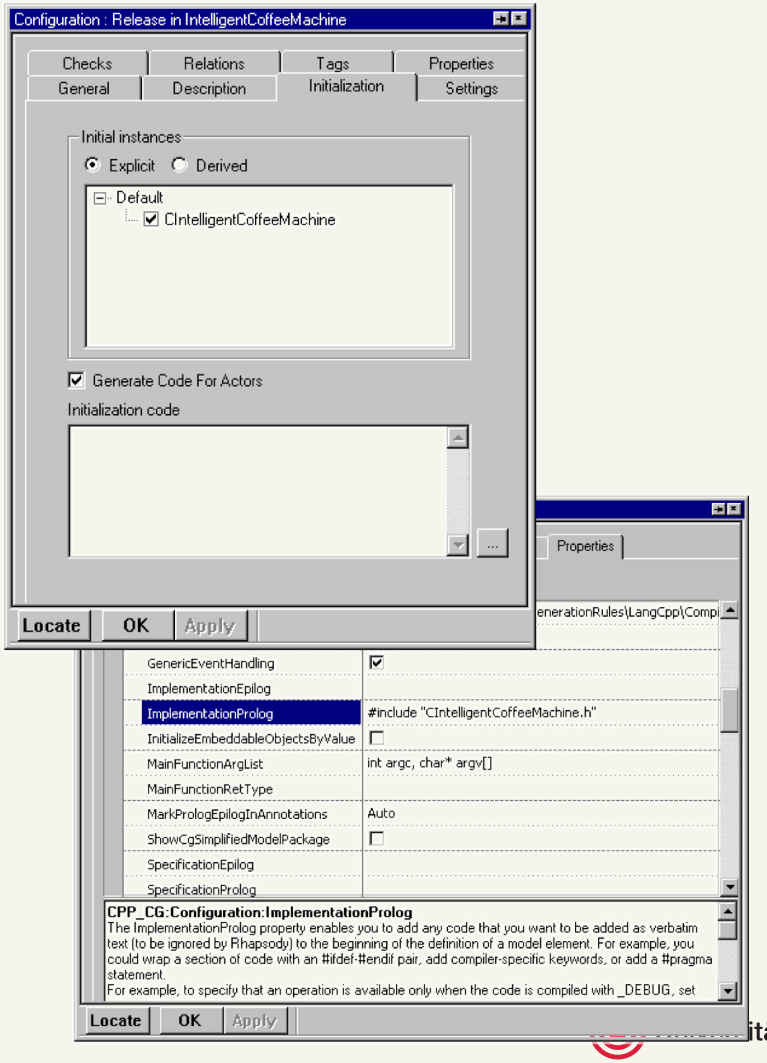
Initial instance

- In the Initialization tab of the *Configuration*, expand the package containing your desired class and select e.g. *CIntelligentCoffeeMachine* class.
- This means that the main will now create an initial instance (an object) of the class.
- If you want to pass arguments to the constructor of your class, deactivate “Generate Code for Actors”, insert initialization code manually and add **#include “Classname.h”** into the “Implementation Prolog” in the Properties under CPP_CG::Configuration (see right bottom)



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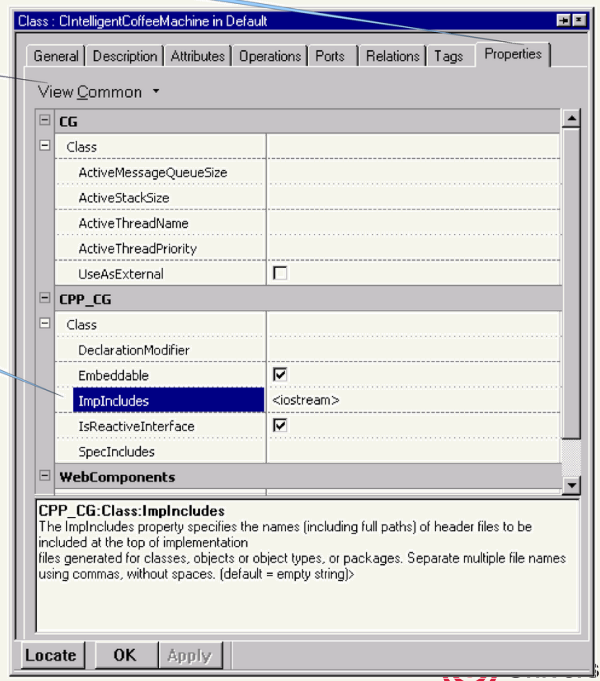
Including of headers

- In the browser, double click on the *CIntelligentCoffeeMachine* class to bring up the features dialog.
- Select the *Properties* tab, ensure that the *Common* filter is selected and enter <*libname*> into the
  - *ImpIncludes* (=Implementation Includes) property to create inclusion in the cpp or
  - *SpecIncludes* (=Specification Includes) property to create inclusion in the header



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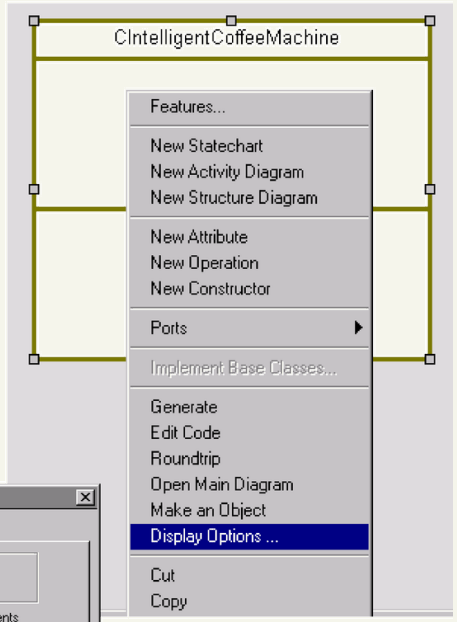
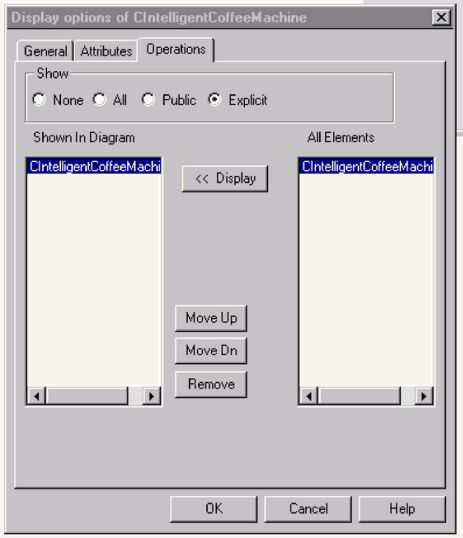
Adjust display options

- To adjust the display options of the class on the OMD, select *Display Options* from the context menu and set the option for operations to *All* or *Explicit*



- It is also possible to set default display options



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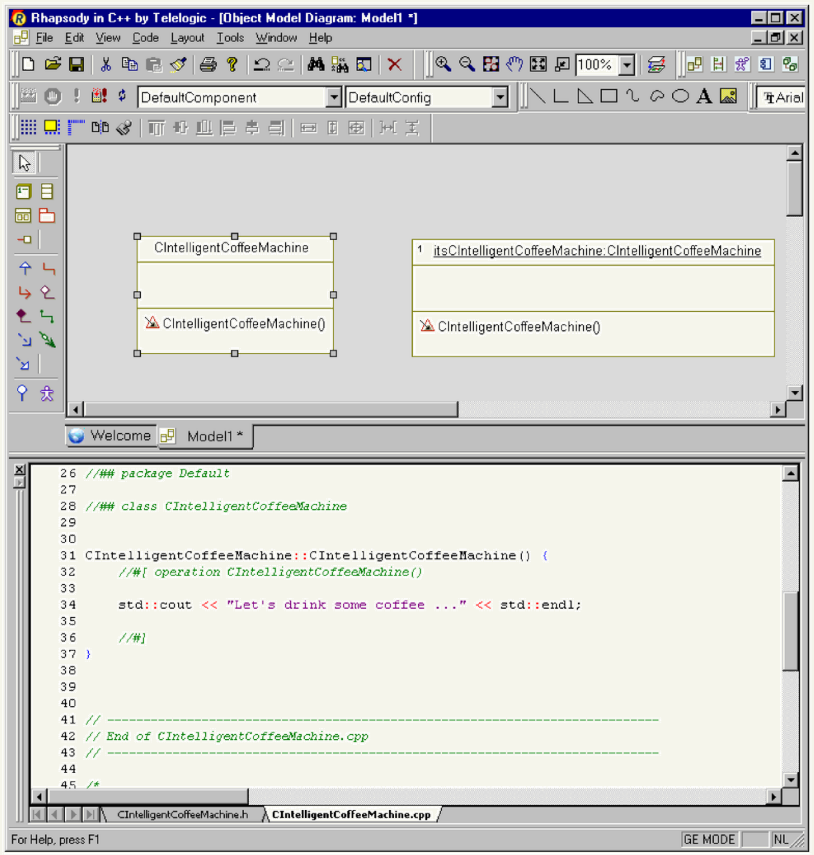
Active Code View



- To activate: “Alt + 2” or View/ActiveCodeView
- Source code focus is kept on activated model element

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Hotkeys

- Ctrl + L:Locate in Browser
- Alt + 2: Active Code View
- Ctrl + Space (in Code): Auto-completion
- Ctrl + DragNDrop: Copy elements (in model and diagram)
- Alt (+ Ctrl) + resize a package on diagram:
  Do not resize elements within

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Displaying the Main and Makefile

- Right-click on the configuration and select *Edit Makefile / Configuration Main File*

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Add model elements to project

- In the menu, go to File/AddToModel
- Select the correct file type in the appearing dialog (e.g. .sbs for packages)
- Click on “Open” button to add the element to the model

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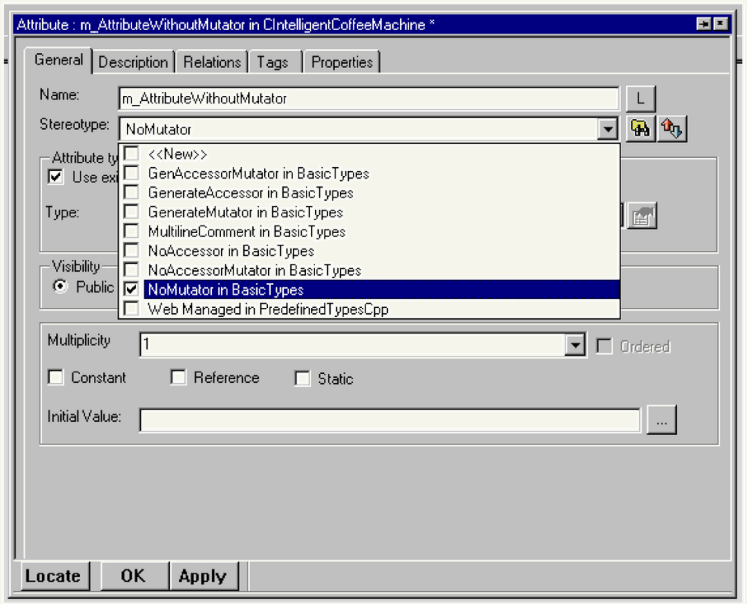
Using stereotypes

- Stereotypes simplify the application of certain settings to model elements
- The “BasicTypes.sbs” package (in elearning system) provides e.g.
  - Control of Accessors/Mutators
  - Exclusion of Rhapsody framework (to have code that is compilable without Rhapsody)
  - ...
- Add “BasicTypes” package to your project to use stereotypes



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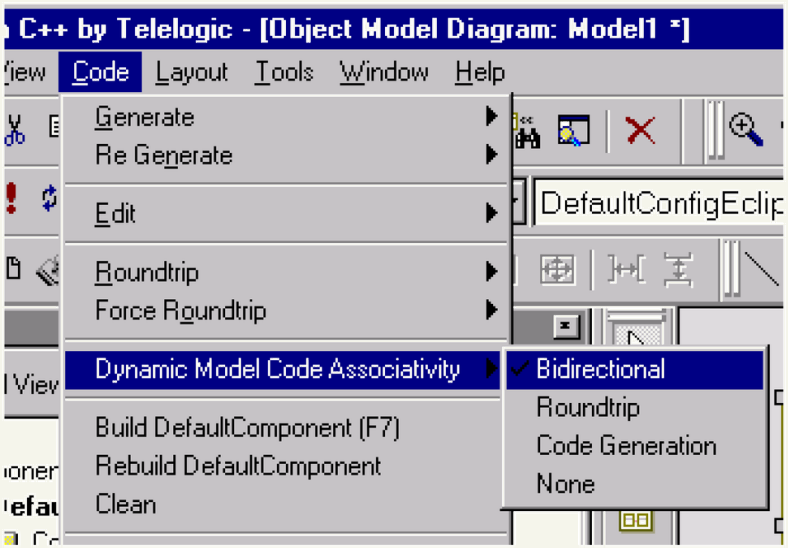
Bi-directional model-code associativity



Try it out ...

- Bidirectional
  - Changes in either the model or the code are roundtripped automatically
- Roundtrip
  - Changes in the code are updated automatically
- Code Generation
  - Changes in the model are updated automatically
- None
  - Nothing is done automatically

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