

## – UML Questionnaire –

### Part of the EmpAnADa-Project

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<http://www.win.tue.nl/~clange/empanada/>

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Within the EmpAnADa project at the TU Eindhoven we are doing empirical research into assessing the quality of designs described using the Unified Modeling Language (UML).

This questionnaire helps to develop guidelines for using UML in a manner that reduces errors in the interpretation of UML designs.

We highly value your contribution to this research by completing this questionnaire.

There are alternative ways of returning the answers to this questionnaire to us:

- Electronically:
  - o complete the on-line version of this questionnaire. It can be found at: [www.win.tue.nl/~clange/empanada/survey](http://www.win.tue.nl/~clange/empanada/survey)
- By Hard-copy
  - o Print this document and write your answers & comments on it.

Then either send or fax it to us at:

**EmpAnADa project**  
**t.a.v. Christian Lange or Michel Chaudron**

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**Fax +31 (0)40 – 247 8345**



## About the Questionnaire

The questionnaire contains 10 cases, each with one or two multiple choice questions. Completing each question should take a few minutes.

In each question you are given a set of UML diagrams and are asked to answer a question about these diagrams.

You should answer each question from the perspective of a person being responsible to implement the system according to the given UML diagrams.

The purpose of this questionnaire is not to measure your UML skills but to investigate how people interpret UML diagrams and why they do so.

## Instructions

- You are not supposed to use a UML book while filling out this questionnaire
- There is no time limit on this questionnaire, but it should take you no longer than about 45 minutes to complete.
- Read each diagram and code fragment carefully! Some diagrams/fragments look almost the same but are essentially different.
- In addition to selecting one of the answers, please provide a brief motivation of your choice and/or reason why you believe none of the options is suitable.
- This is a multiple-choice test. Please indicate your answer by ticking it like this

a)  b)  c)  d)  e)

It might be the case that

- **none** of the answers a, b, c, d is suitable → indicate this by selecting answer **e)**
- **more than one** of the answers a, b, c or d is suitable → tick all suitable alternatives

Indicate either of these cases and describe the problem you encountered and explain your thoughts / questions / solutions.

**For each question provide a brief motivation of your answer!**

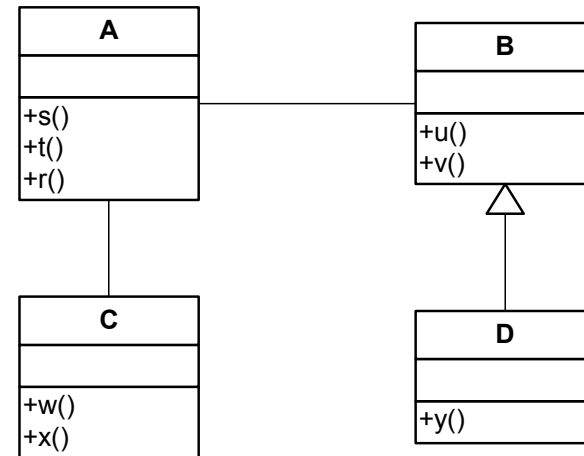
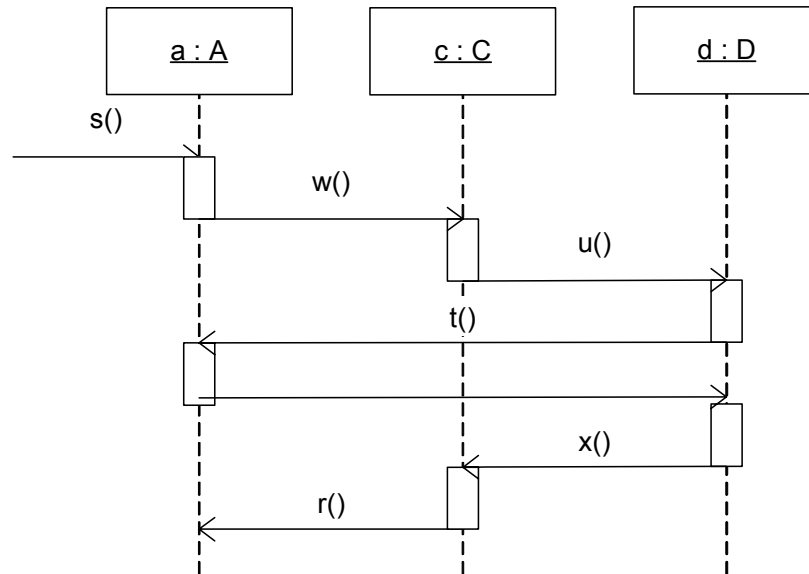
*Example motivations:*

- Message X in the sequence diagram does not correspond to a method of class Y. Dependent on which diagram is regarded as correct, either answer b) or c) is possible
- The element B is missing in the sequence diagram. The information necessary to answer the question cannot be inferred from the class diagram without making assumptions.
- I made the following assumption to answer this question: ...

**We make use of pseudo code fragments. Please note:**

- the statement `dosomething` stands for a sequence of internal operations, i.e. no interaction with other objects occurs within this statement.
- Three dots (“...”) in the pseudo code fragments indicate that code, that is not relevant to answer the question, is omitted.

## Question Q1



Suppose you are software developer and you are given the above UML model. Please indicate on the next two pages how you would implement

- 1) Class A
- 2) Class C

given these two UML diagrams.

### Q1.1: Class A

<p>a) <input type="checkbox"/></p> <pre>Class A{  function s(){     dosomething;     c.w() }  function t(){     dosomething;     d.r() }  ...}</pre>	<p>b) <input type="checkbox"/></p> <pre>Class A{  function s(){     dosomething;     c.w() }  function t(){     dosomething;     d.v() }  ...}</pre>	<p>e) <input type="checkbox"/> no answer is suitable</p>
<p>c) <input type="checkbox"/></p> <pre>Class A{  function s(){     dosomething;     c.w() }  function t(){     dosomething;     d.u() }  ...}</pre>	<p>d) <input type="checkbox"/></p> <pre>Class A{  function s(){     dosomething;     c.w() }  function t(){     dosomething;     d.y() }  ...}</pre>	

**Motivation of answer / Remarks:**

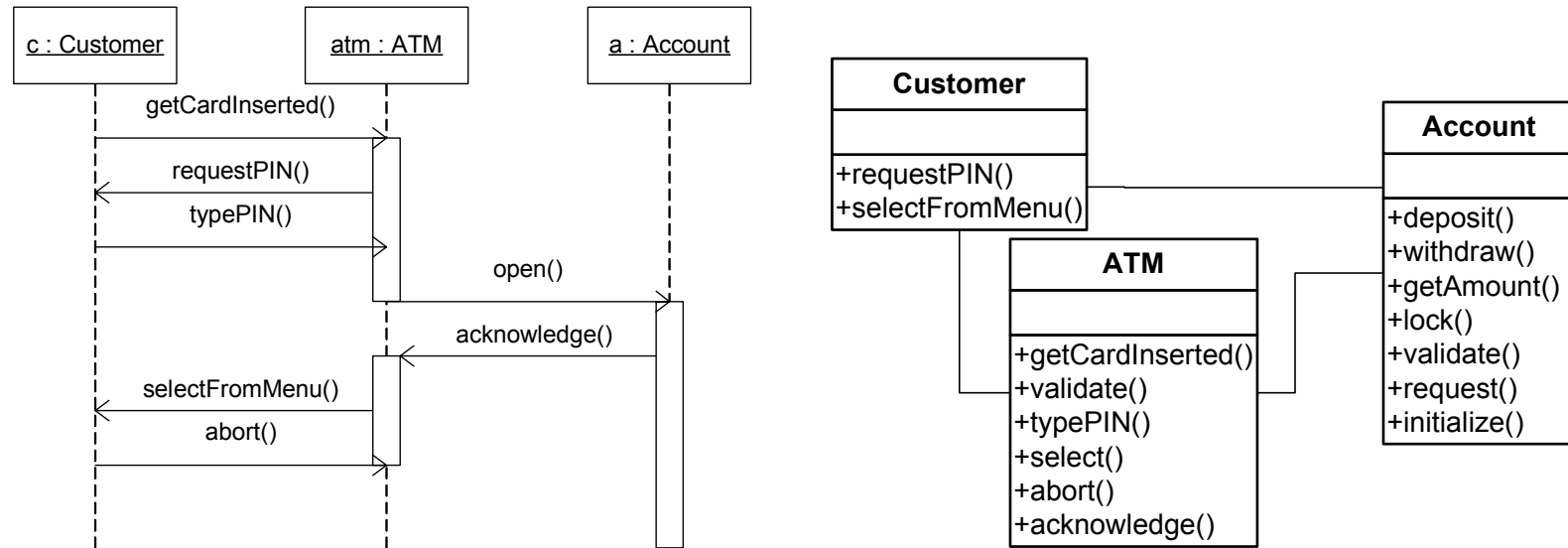


### Q1.2: Class C

<p>a) <input type="checkbox"/></p> <pre>Class C{  function w(){   dosomething;   d.w() }  function x(){   dosomething;   a.r() }  ...}</pre>	<p>b) <input type="checkbox"/></p> <pre>Class C{  function w(){   dosomething;   d.u() }  function x(){   dosomething;   a.r() }  ...}</pre>	<p>e) <input type="checkbox"/> no answer is suitable</p>
<p>c) <input type="checkbox"/></p> <pre>Class C{  function v(){   dosomething;   d.u() }  function w(){   dosomething;   a.r() }  ...}</pre>	<p>d) <input type="checkbox"/></p> <pre>Class C{  function w(){   dosomething;   d.v() }  function x(){   dosomething;   c.r() }  ...}</pre>	

**Motivation of answer / Remarks:**

## Question Q2

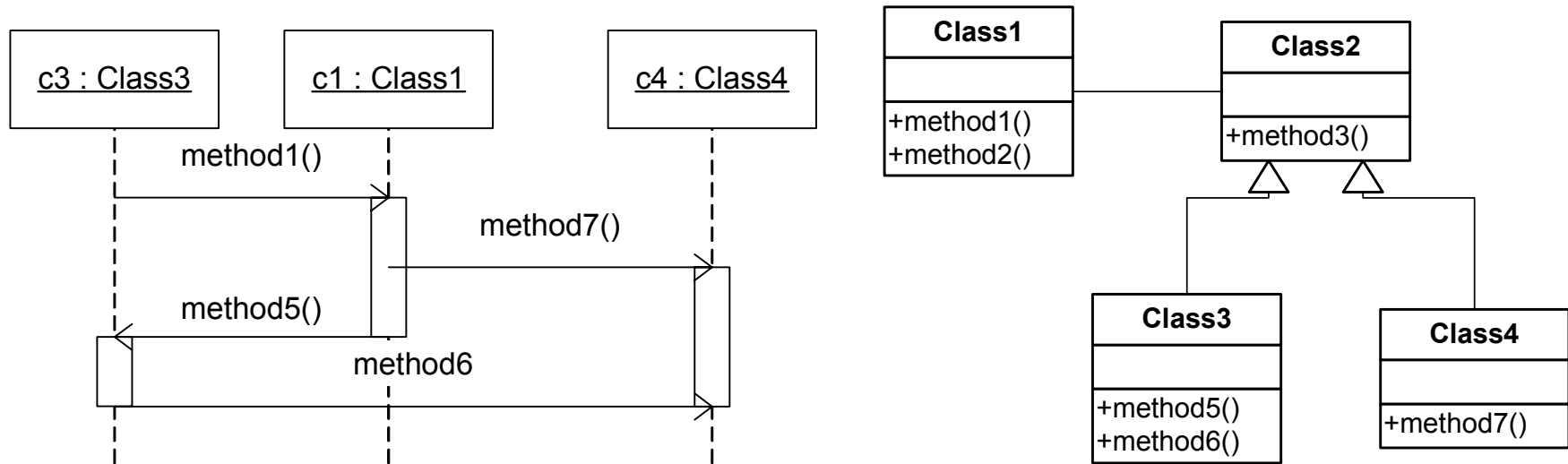


Suppose you are developer in this banking software project. It is your task to implement class ATM. Please indicate on the next page how you would implement the ATM class given these two UML diagrams? (implementation fragments see next page)

<p>a) <input type="checkbox"/></p> <pre> Class ATM{  method getCardInserted(){     c.requestPIN();     dosomething;     a.open() }  method acknowledge (){     dosomething;     c.selectFromMenu() }  ...} </pre>	<p>b) <input type="checkbox"/></p> <pre> Class ATM{  method getCardInserted (){     c.requestPIN();     dosomething;     a.lock() }  method acknowledge (){     dosomething;     c. selectFromMenu() }  ...} </pre>	<p>e) <input type="checkbox"/> no answer is suitable</p>
<p>c) <input type="checkbox"/></p> <pre> Class ATM{  method getCardInserted (){     c.requestPIN();     dosomething;     a.acknowledge() }  method acknowledge(){     dosomething;     c.selectFromMenu() }  ...} </pre>	<p>d) <input type="checkbox"/></p> <pre> Class ATM{  method getCardInserted (){     c.requestPIN();     dosomething;     a.validate() }  method acknowledge (){     dosomething;     c. selectFromMenu() }  ...} </pre>	

**Motivation of answer / Remarks:**

### Question Q3

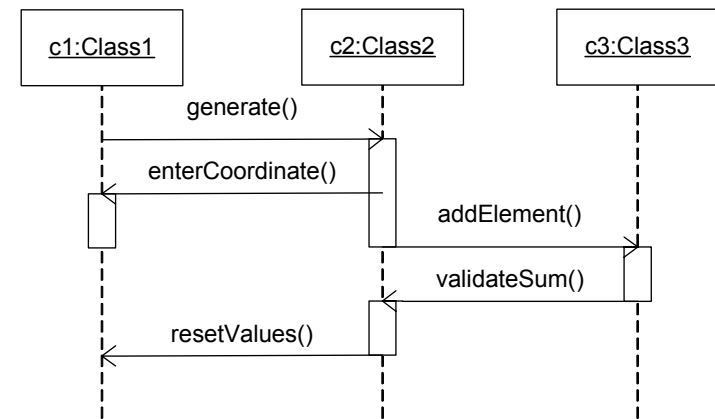
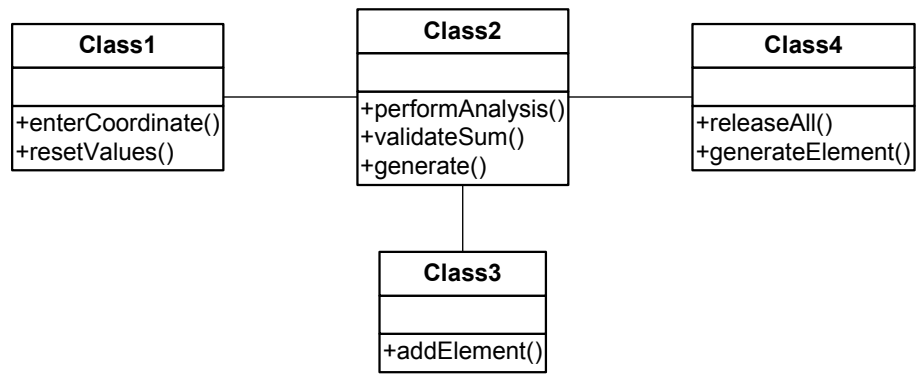


You have to implement the given scenario; please indicate according to which of the following pseudo-code fragments you would implement the classes C1, C2, C3, C4:

<p>a) <input type="checkbox"/></p> <pre> class Class1 { method method1() {     dosomething;     c4.method7();     dosomething;     c3.method5(); } ... }  class Class3{ method method5() {     dosomething;     c4.method6(); } ... }  class Class4{ method method7() {     dosomething; } method method6() {     dosomething; } ... } </pre>	<p>b) <input type="checkbox"/></p> <pre> class Class1 { method method1() {     dosomething;     c4.method7();     dosomething;     c3.method5(); } ... }  class Class3{ method method5() {     dosomething; } ... }  class Class4{ method method7() {     dosomething;     c3.method6(); } ... } </pre>	<p>c) <input type="checkbox"/></p> <pre> class Class1 { method method1() {     dosomething;     c4.method7();     dosomething;     c3.method5(); } ... }  class Class3{ method method5() {     dosomething;     c4.method3(); } ... }  class Class4{ method method7() {     dosomething; } ... } </pre>	<p>d) <input type="checkbox"/></p> <pre> class Class1 { method method1() {     dosomething;     c4.method7();     dosomething;     c3.method5(); } ... }  class Class3{ method method5() {     dosomething;     c4.method6(); } ... }  class Class2{ method method6() {     dosomething; } ... } </pre>	<p>e) <input type="checkbox"/> no answer is suitable</p>
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**Motivation of answer / Remarks:**

## Question Q4

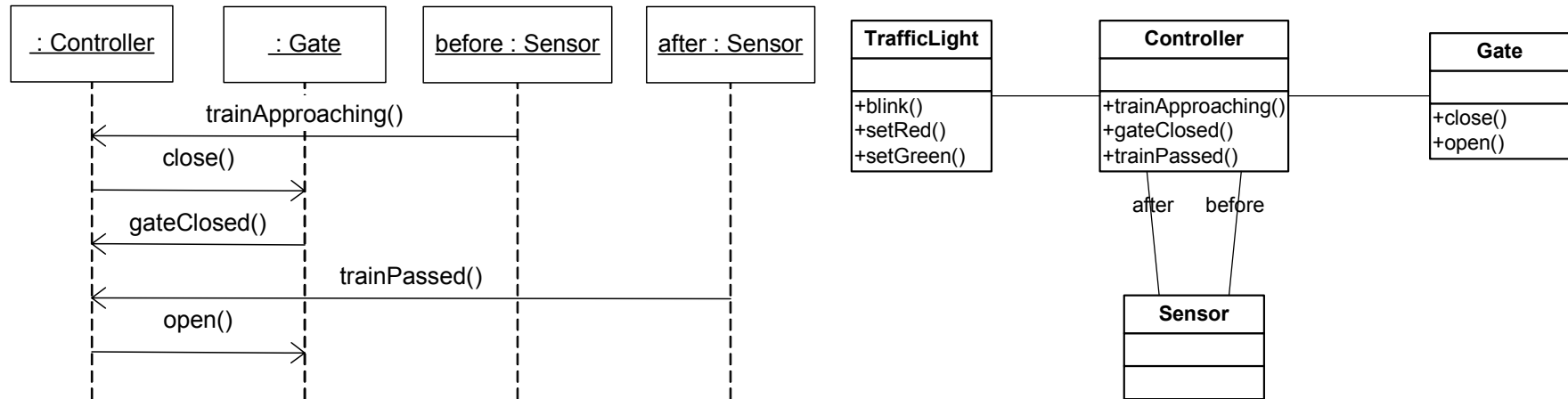


Suppose you are the developer of this software project. It is your task to implement classes Class2. Please indicate on the next page how you would implement the classes given these two UML diagrams? (implementation fragments see next page)

<p>a) <input type="checkbox"/></p> <pre> Class Class2{  method generate(){     dosomething;     c1.enterCoordinate();     c3.addElement(); }  method validateSum(){     dosomething;     c3.resetValues() }  ...} </pre>	<p>b) <input type="checkbox"/></p> <pre> Class Class2{  method generate(){     dosomething;     c1.enterCoordinate();     c3.addElement(); }  method validateSum(){     dosomething;     c1.resetValues() }  ...} </pre>	<p>e) <input type="checkbox"/> no answer is suitable</p>
<p>c) <input type="checkbox"/></p> <pre> Class Class2{  method generate(){     dosomething;     c1.enterCoordinate();     c3.addElement(); }  method validateSum(){     dosomething;     c1.enterCoordinate() }  ...} </pre>	<p>d) <input type="checkbox"/></p> <pre> Class Class2{  method generate(){     dosomething;     c1.enterCoordinate();     c3.addElement(); }  method enterCoordinate(){     dosomething;     c1.resetValues() }  ...} </pre>	

**Motivation of answer / Remarks:**

## Question Q5



You are asked to implement the system according to the two diagrams above. Indicate in which relative order the methods of the classes

- 1) Controller and
- 2) TrafficLight

are called in your implementation. (Hint: the `TrafficLight` is initially green).

**Q5.1: Order in which methods of classes Gate and Controller are called**

<p>a) <input type="checkbox"/></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 40%;">Controller</th> <th style="width: 50%;">Gate</th> </tr> </thead> <tbody> <tr> <td>t<sub>1</sub></td> <td>trainApproaching</td> <td></td> </tr> <tr> <td>t<sub>2</sub></td> <td></td> <td>open</td> </tr> <tr> <td>t<sub>3</sub></td> <td>gateClosed</td> <td></td> </tr> <tr> <td>t<sub>4</sub></td> <td>trainPassed</td> <td></td> </tr> <tr> <td>t<sub>5</sub></td> <td></td> <td>close</td> </tr> </tbody> </table>		Controller	Gate	t <sub>1</sub>	trainApproaching		t <sub>2</sub>		open	t <sub>3</sub>	gateClosed		t <sub>4</sub>	trainPassed		t <sub>5</sub>		close	<p>b) <input type="checkbox"/></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;"></th> <th style="width: 40%;">Controller</th> <th style="width: 50%;">Gate</th> </tr> </thead> <tbody> <tr> <td>t<sub>1</sub></td> <td>trainApproaching</td> <td></td> </tr> <tr> <td>t<sub>2</sub></td> <td></td> <td>close</td> </tr> <tr> <td>t<sub>3</sub></td> <td>gateClosed</td> <td></td> </tr> <tr> <td>t<sub>4</sub></td> <td>trainPassed</td> <td></td> </tr> <tr> <td>t<sub>5</sub></td> <td></td> <td>open</td> </tr> </tbody> </table>		Controller	Gate	t <sub>1</sub>	trainApproaching		t <sub>2</sub>		close	t <sub>3</sub>	gateClosed		t <sub>4</sub>	trainPassed		t <sub>5</sub>		open	<p>e) <input type="checkbox"/> no answer is suitable</p>
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**Motivation of answer / Remarks:**

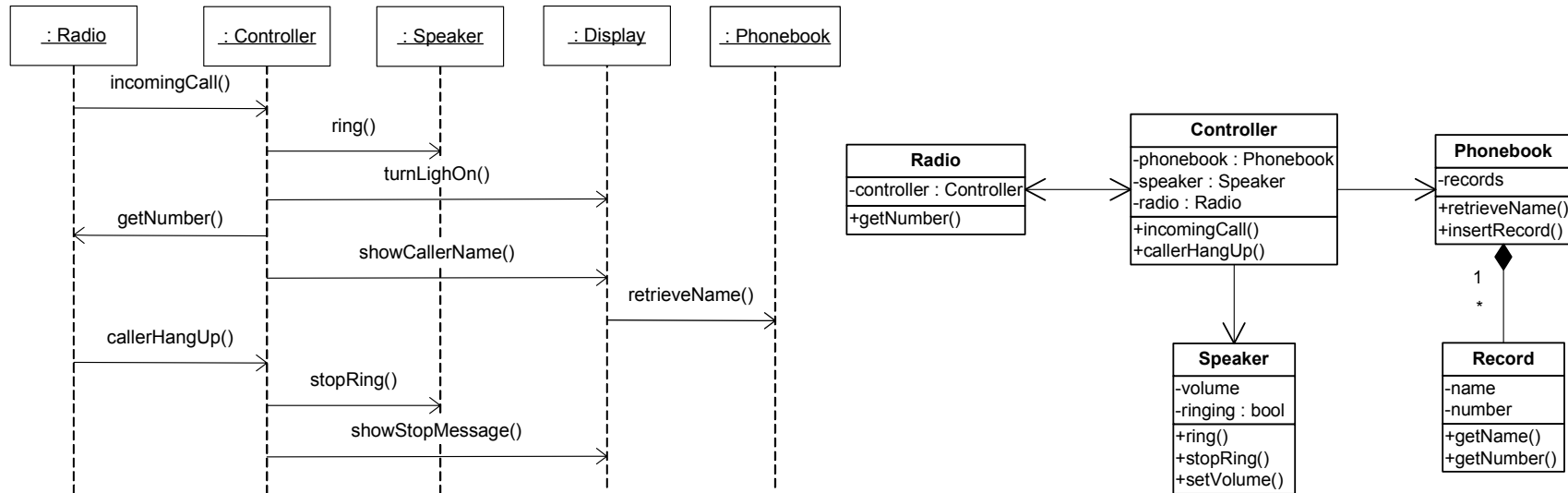


**Q5.2: Order in which methods of classes TrafficLight and Controller are called**

a) <input type="checkbox"/>			b) <input type="checkbox"/>			e) <input type="checkbox"/> no answer is suitable		
t <sub>1</sub>	<b>Controller</b> trainApproaching	<b>TrafficLight</b>	t <sub>1</sub>	<b>Controller</b> trainApproaching	<b>TrafficLight</b>			
t <sub>2</sub>		setRed	t <sub>2</sub>		blink			
t <sub>3</sub>	gateClosed		t <sub>3</sub>	gateClosed				
t <sub>4</sub>		blink	t <sub>4</sub>		setRed			
t <sub>5</sub>	trainPassed		t <sub>5</sub>	trainPassed				
t <sub>6</sub>		setGreen	t <sub>6</sub>		setGreen			
c) <input type="checkbox"/>			d) <input type="checkbox"/>					
t <sub>1</sub>	<b>Controller</b> trainApproaching	<b>TrafficLight</b>	t <sub>1</sub>	<b>Controller</b> trainApproaching	<b>TrafficLight</b>			
t <sub>2</sub>	gateClosed		t <sub>2</sub>		blink			
t <sub>3</sub>		setRed	t <sub>3</sub>		setRed			
t <sub>4</sub>		blink	t <sub>4</sub>	gateClosed				
t <sub>5</sub>	trainPassed		t <sub>5</sub>	trainPassed				
t <sub>6</sub>		setGreen	t <sub>6</sub>		setGreen			

**Motivation of answer / Remarks:**

## Question Q6



You are given these two diagrams as a description of a subsystem of a mobile phone. Use these diagrams as basis for an implementation of

- 1) class `Display` and
- 2) class `Speaker`.

Please indicate which methods must be implemented and the classes which have an association relation with `Display`, respectively `Speaker`.

### Q6.1: Class Display

a) Display has the methods ...

a) <input type="checkbox"/> turnLightOn() showCallerName() retrieveName() showStopMessage()	b) <input type="checkbox"/> turnLightOn() showCallerName() showStopMessage()	c) <input type="checkbox"/> showCallerName() retrieveName() getNumber()	d) <input type="checkbox"/> turnLightOn() turnLightOff() showCallerName() showStopMessage() clearDisplay()	e) <input type="checkbox"/> no answer is suitable
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b) Which classes have associations from/to the class Display?

a) <input type="checkbox"/> Radio Controller Phonebook Record	b) <input type="checkbox"/> Radio Phonebook Controller	c) <input type="checkbox"/> Phonebook Controller	d) <input type="checkbox"/> Phonebook Controller Display	e) <input type="checkbox"/> no answer is suitable
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Motivation of answer / Remarks:



## Q6.2: Class Speaker

a) Speaker has the methods ...

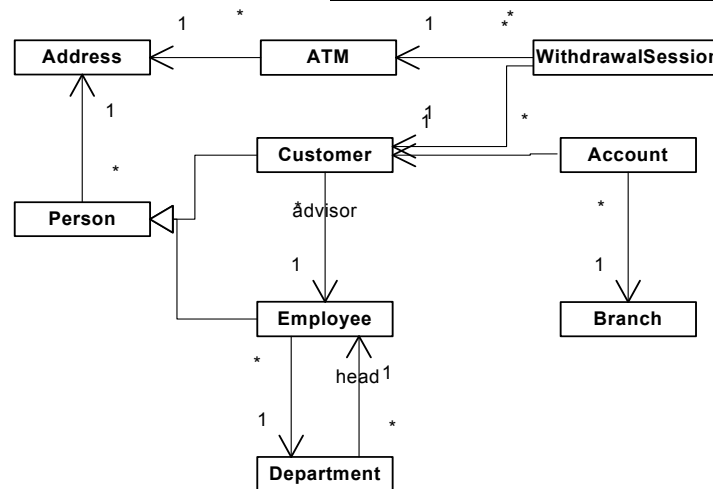
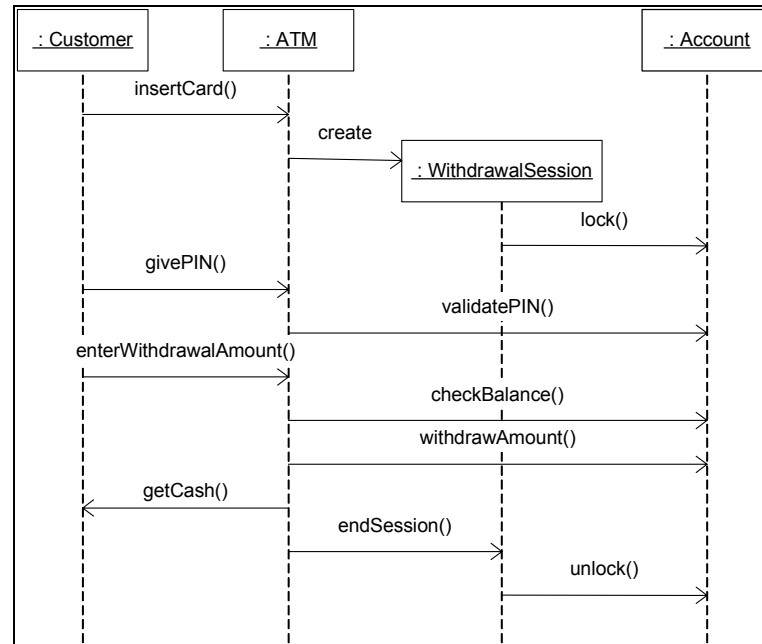
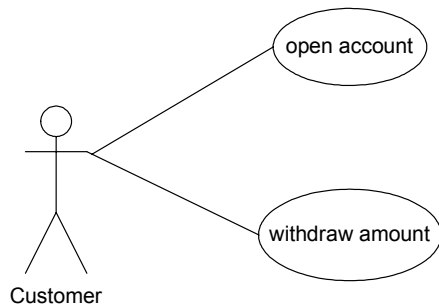
a) <input type="checkbox"/> ring() retrieveName() showStopMessage()	b) <input type="checkbox"/> ring() stopRing() setVolume()	c) <input type="checkbox"/> ring() stopRing()	d) <input type="checkbox"/> ring() setVolume() playJingle()	e) <input type="checkbox"/> no answer is suitable
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b) Which classes have associations from/to the class Speaker?

a) <input type="checkbox"/> Phonebook Record	b) <input type="checkbox"/> Display Phonebook Controller	c) <input type="checkbox"/> Phonebook Controller	d) <input type="checkbox"/> Controller	e) <input type="checkbox"/> no answer is suitable
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Motivation of answer / Remarks:

# Question Q7



The above diagrams describe (part of) a banking system. For each of the two use cases, indicate which classes are involved in its realization.

### Q7.1

The following classes collaborate to realize use case “open account”...

<p>a) <input type="checkbox"/></p> <p>Person Customer Department Employee WithdrawalSession Account Branch</p>	<p>b) <input type="checkbox"/></p> <p>Address ATM WithdrawalSession Person Customer Employee Account Branch Department</p>	<p>c) <input type="checkbox"/></p> <p>Customer Employee Account Branch Address</p>	<p>d) <input type="checkbox"/></p> <p>Customer Account Employee</p>	<p>e) <input type="checkbox"/> no answer is suitable</p>
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Motivation of answer / Remarks:

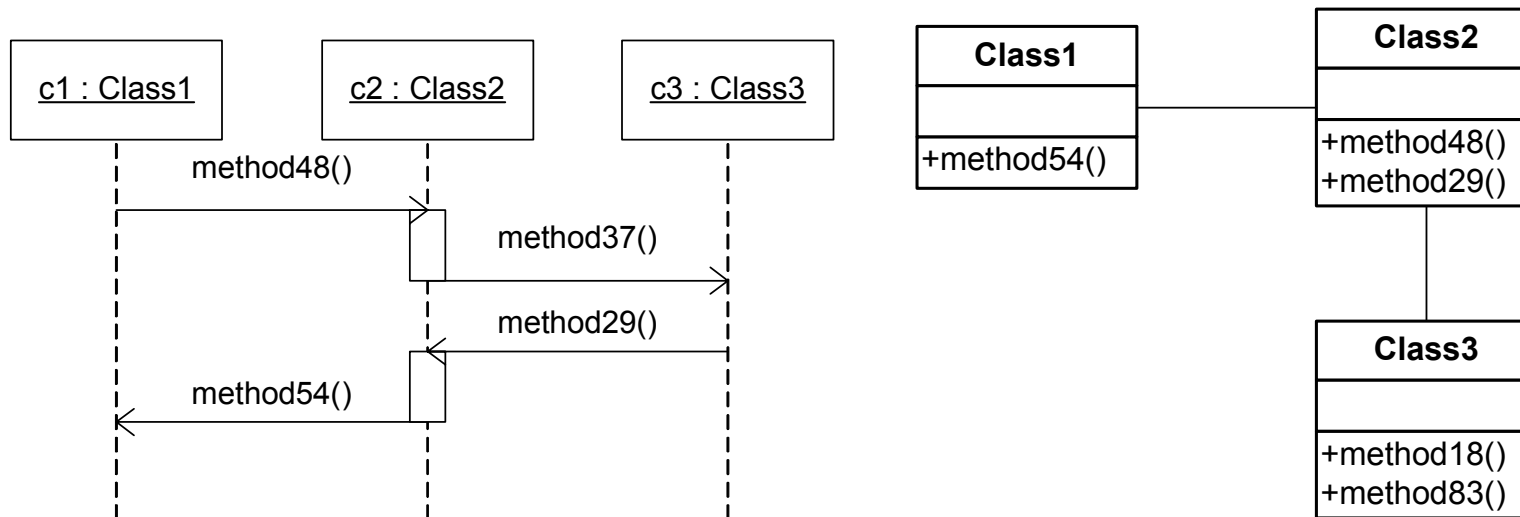
### Q7.2

The following classes collaborate to realize use case “withdraw amount”...

<p>a) <input type="checkbox"/></p> <p>Custumor Account Employee</p>	<p>b) <input type="checkbox"/></p> <p>Customer Account WithdrawalSession ATM</p>	<p>c) <input type="checkbox"/></p> <p>ATM WithdrawalSession</p>	<p>d) <input type="checkbox"/></p> <p>WithdrawalSession Customer ATM Address</p>	<p>e) <input type="checkbox"/> no answer is suitable</p>
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Motivation of answer / Remarks:

## Question Q8

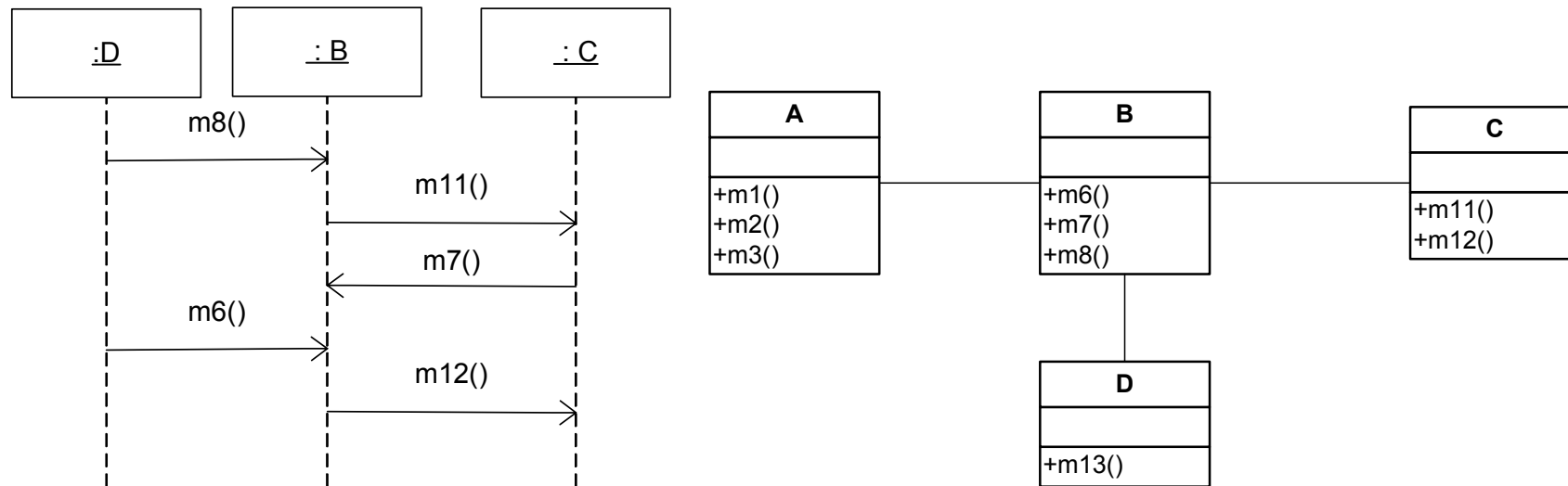


Suppose you are developer in this software project. It is your task to implement class Class2. Please indicate on the next page how you would implement the Class2 class given these two UML diagrams? (implementation fragments see next page)

<p>a) <input type="checkbox"/></p> <pre> Class Class2{  method method29 () {     dosomething;     c1.method54 () }  method method48 () {     dosomething;     c3.method37 () }  ...} </pre>	<p>b) <input type="checkbox"/></p> <pre> Class Class2{  method method29 () {     dosomething;     c1.method54 () }  method method48 () {     dosomething;     c3.method54 () }  ...} </pre>	<p>e) <input type="checkbox"/> no answer is suitable</p>
<p>c) <input type="checkbox"/></p> <pre> Class Class2{  method method29 () {     dosomething;     c1.method54 () }  method method48 () {     dosomething;     c3.method18 () }  ...} </pre>	<p>d) <input type="checkbox"/></p> <pre> Class Class2{  method method29 () {     dosomething;     c1.method37 () }  method method48 () {     dosomething;     c3.method83 () }  ...} </pre>	

**Motivation of answer / Remarks:**

## Question Q9



You are asked to implement the system according to the two diagrams above. Indicate in which logical order the methods of the classes

1) Class B and

2) Class A

are called in your implementation.

**Q9.1: Order in which methods of classes C and B are called**

<p>a) <input type="checkbox"/></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;"></th> <th style="width: 35%;">B</th> <th style="width: 50%;">C</th> </tr> </thead> <tbody> <tr><td>t<sub>1</sub></td><td>m8</td><td></td></tr> <tr><td>t<sub>2</sub></td><td></td><td>m12</td></tr> <tr><td>t<sub>3</sub></td><td>m7</td><td></td></tr> <tr><td>t<sub>4</sub></td><td>m6</td><td></td></tr> <tr><td>t<sub>5</sub></td><td></td><td>m11</td></tr> </tbody> </table>		B	C	t <sub>1</sub>	m8		t <sub>2</sub>		m12	t <sub>3</sub>	m7		t <sub>4</sub>	m6		t <sub>5</sub>		m11	<p>b) <input type="checkbox"/></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;"></th> <th style="width: 35%;">B</th> <th style="width: 50%;">C</th> </tr> </thead> <tbody> <tr><td>t<sub>1</sub></td><td>m8</td><td></td></tr> <tr><td>t<sub>2</sub></td><td></td><td>m11</td></tr> <tr><td>t<sub>3</sub></td><td>m7</td><td></td></tr> <tr><td>t<sub>4</sub></td><td>m6</td><td></td></tr> <tr><td>t<sub>5</sub></td><td></td><td>m12</td></tr> </tbody> </table>		B	C	t <sub>1</sub>	m8		t <sub>2</sub>		m11	t <sub>3</sub>	m7		t <sub>4</sub>	m6		t <sub>5</sub>		m12	<p>e) <input type="checkbox"/> no answer is suitable</p>
	B	C																																				
t <sub>1</sub>	m8																																					
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**Motivation of answer / Remarks:**

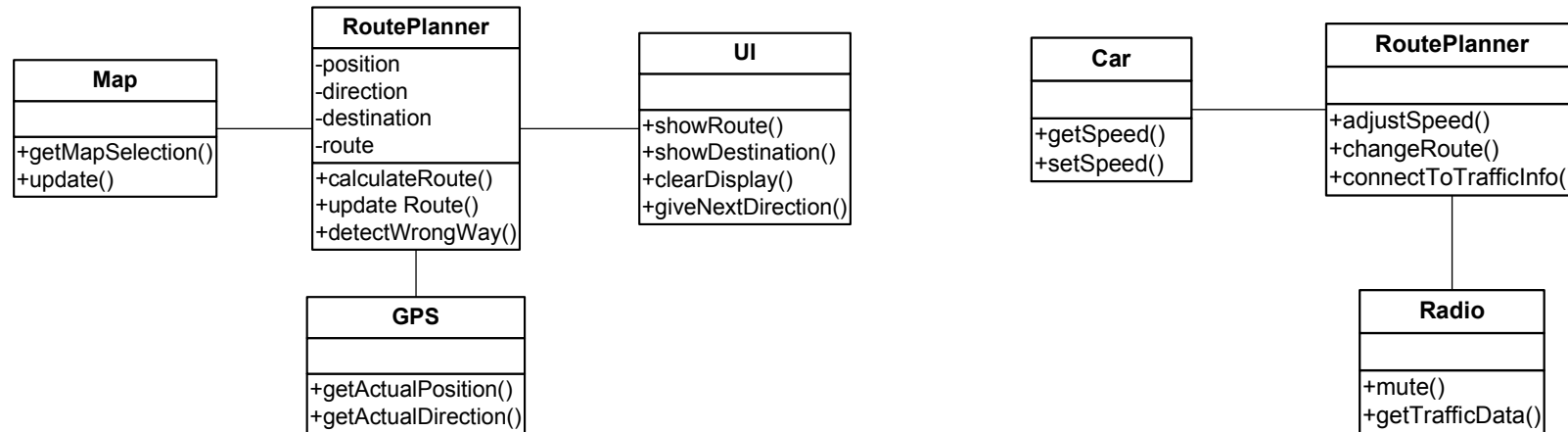


**Q9.2: Order in which methods of classes A and B are called**

<p>a) <input type="checkbox"/></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;"></th> <th style="width: 35%;">B</th> <th style="width: 50%;">A</th> </tr> </thead> <tbody> <tr><td>t<sub>1</sub></td><td>m8</td><td></td></tr> <tr><td>t<sub>2</sub></td><td></td><td>m2</td></tr> <tr><td>t<sub>3</sub></td><td>m7</td><td></td></tr> <tr><td>t<sub>4</sub></td><td></td><td>m1</td></tr> <tr><td>t<sub>5</sub></td><td>m6</td><td></td></tr> <tr><td>t<sub>6</sub></td><td></td><td>m3</td></tr> </tbody> </table>		B	A	t <sub>1</sub>	m8		t <sub>2</sub>		m2	t <sub>3</sub>	m7		t <sub>4</sub>		m1	t <sub>5</sub>	m6		t <sub>6</sub>		m3	<p>b) <input type="checkbox"/></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;"></th> <th style="width: 35%;">B</th> <th style="width: 50%;">A</th> </tr> </thead> <tbody> <tr><td>t<sub>1</sub></td><td>m8</td><td></td></tr> <tr><td>t<sub>2</sub></td><td></td><td>m1</td></tr> <tr><td>t<sub>3</sub></td><td>m7</td><td></td></tr> <tr><td>t<sub>4</sub></td><td></td><td>m2</td></tr> <tr><td>t<sub>5</sub></td><td>m6</td><td></td></tr> <tr><td>t<sub>6</sub></td><td></td><td>m3</td></tr> </tbody> </table>		B	A	t <sub>1</sub>	m8		t <sub>2</sub>		m1	t <sub>3</sub>	m7		t <sub>4</sub>		m2	t <sub>5</sub>	m6		t <sub>6</sub>		m3	<p>e) <input type="checkbox"/> no answer is suitable</p>
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**Motivation of answer / Remarks:**

## Question Q10



Suppose you are developer of this software project. It is your task to implement class `RoutePlanner`. Please indicate on the next page how you would implement the class `RoutePlanner` given these two UML diagrams? Please indicate which methods (a) must be implemented and the classes which have an association relation (b) with `RoutePlanner`.

### Q10: Class RoutePlanner

a) RoutePlanner has the methods ...

<p>a) <input type="checkbox"/></p> <p>adjustSpeed() changeRoute() connectToTrafficInfo()</p>	<p>b) <input type="checkbox"/></p> <p>calculateRoute() updateRoute() detectWrongWay()</p>	<p>c) <input type="checkbox"/></p> <p>adjustSpeed() changeRoute() connectToTrafficInfo() calculateRoute() updateRoute() detectWrongWay()</p>	<p>d) <input type="checkbox"/></p> <p>adjustSpeed() enterDestination() connectToTrafficInfo() calculateRoute() recalculateRoute() detectWrongWay()</p>	<p>e) <input type="checkbox"/> no answer is suitable</p>
------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------

b) Which classes have associations from/to the class RoutePlanner?

<p>a) <input type="checkbox"/></p> <p>Map GPS UI Car Radio</p>	<p>b) <input type="checkbox"/></p> <p>Map GPS UI</p>	<p>c) <input type="checkbox"/></p> <p>Map GPS UI Car Radio Controller</p>	<p>d) <input type="checkbox"/></p> <p>Car Radio</p>	<p>e) <input type="checkbox"/> no answer is suitable</p>
--------------------------------------------------------------------------------	--------------------------------------------------------------	-----------------------------------------------------------------------------------------------	---------------------------------------------------------	----------------------------------------------------------

Motivation of answer / Remarks:



## Information about your professional background

How many **courses on the UML** have you followed?

\_\_\_\_\_ courses

How many years of **practical work experience** in software engineering / development do you have?

\_\_\_\_\_ years

What is your **job description**? (e.g. architect, designer, programmer, student, manager...)

\_\_\_\_\_.

What is your knowledge in the following fields? Please answer according to this scale:

1 = no knowledge

2 = gained knowledge through academic classes or literature study

3 = applied it in academic context

4 = applied it in one industrial project

5 = applied it in more than one industrial project

<b>Unified Modeling Language (UML)</b>	1	2	3	4	5
<b>Designing Software Systems</b>	1	2	3	4	5
<b>Implementing Software Systems</b>	1	2	3	4	5
<b>Reviewing Source Code</b>	1	2	3	4	5
<b>Reviewing Software Designs</b>	1	2	3	4	5
<b>Software Inspections</b>	1	2	3	4	5

If you are interested in receiving the results of this research experiment, please enter your email address here:

\_\_\_\_\_

Or you can send a request to [c.f.j.lange@tue.nl](mailto:c.f.j.lange@tue.nl).