Object Oriented System Testing

Dafydd **Vaughan**

December 03 2006

CS339 Advanced Topics in Computer Science: Testing

Department of Computer Science, Swansea University

Outline

- System Testing
  - Overview of System Testing
  - Object Oriented System Testing

- Unified Modelling Language (UML)

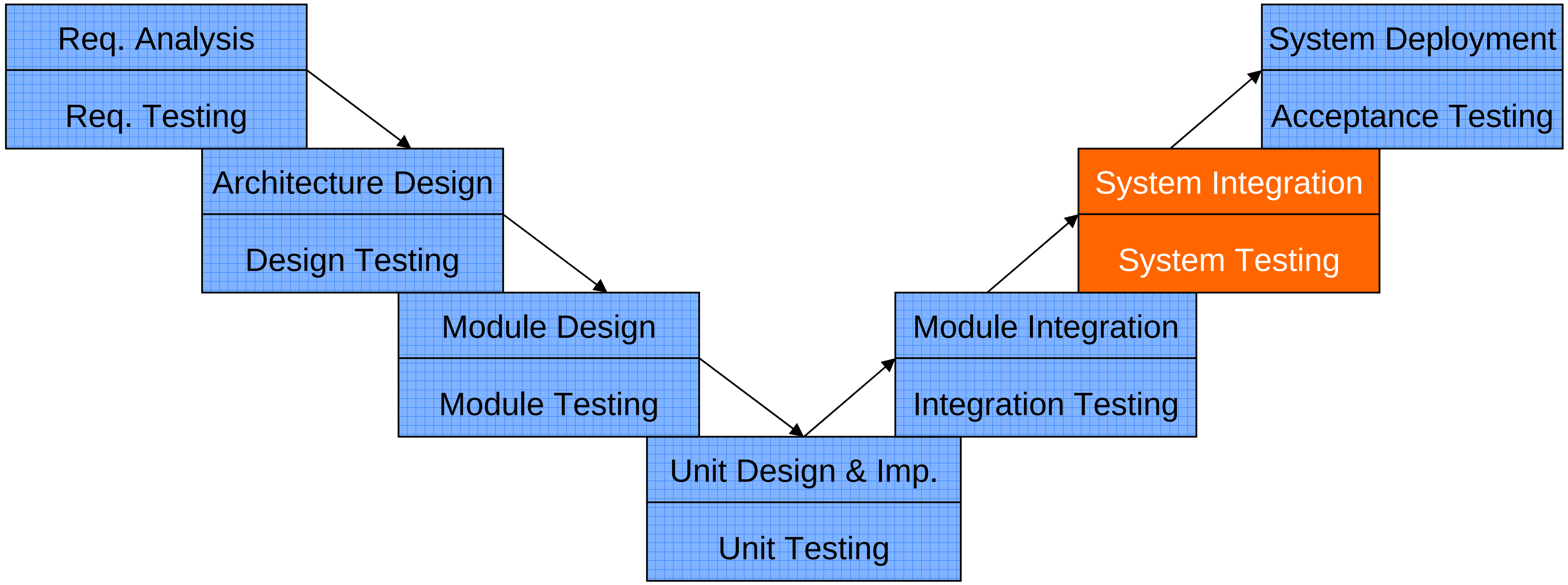
- Test Case Generation Example
  - High Level Use Cases (HLUC)
  - Essential Use Cases (EUC)
  - Expanded Essential Use Cases (EEUC)
  - Real Use Cases (RUC)
  - System Test Cases (SysTC)

- Summary

- Outline
- **System Testing**
- UML
- Test Case Generation Example
- Summary

System Testing

- System Testing
  - Tests the system as a whole
  - Concerned with what happens
  - Not how it happens
  - Black box



Object Oriented System Testing

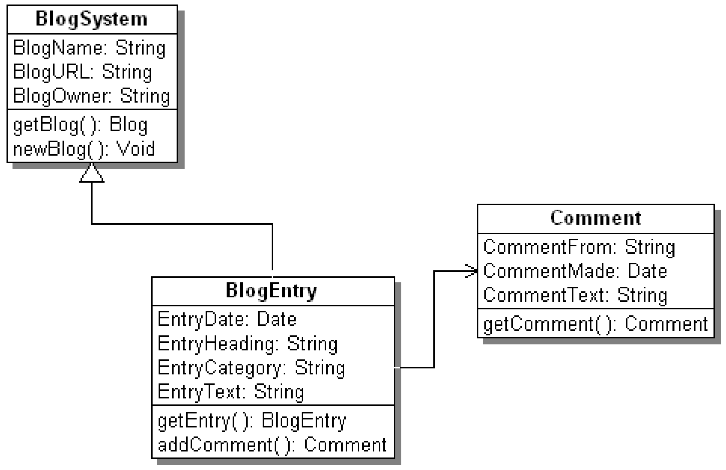
- Almost identical to normal System Testing
- Except for generation of test cases
- UML can be used to generate test cases

- Outline
- System Testing
- **UML**
- Test Case Generation Example
- Summary

UML (Unified Modelling Language)

- Standard for designing and modelling systems

- Consists of many different diagrams
  - Structure diagrams
    (Class, Object, Component etc.)
  - Behaviour diagrams
    (Use Case, Activity, State Machine etc.)
  - Interaction diagrams
    (Sequence, Communication, Timing etc.)



- Diagrams explain the specification of the system

UML (Unified Modelling Language)

- UML diagrams can be used to develop
  - Program Prototypes
  - Use Cases (Functional requirements)
  - Test Cases

- Potentially used for automated testing
  - Research area

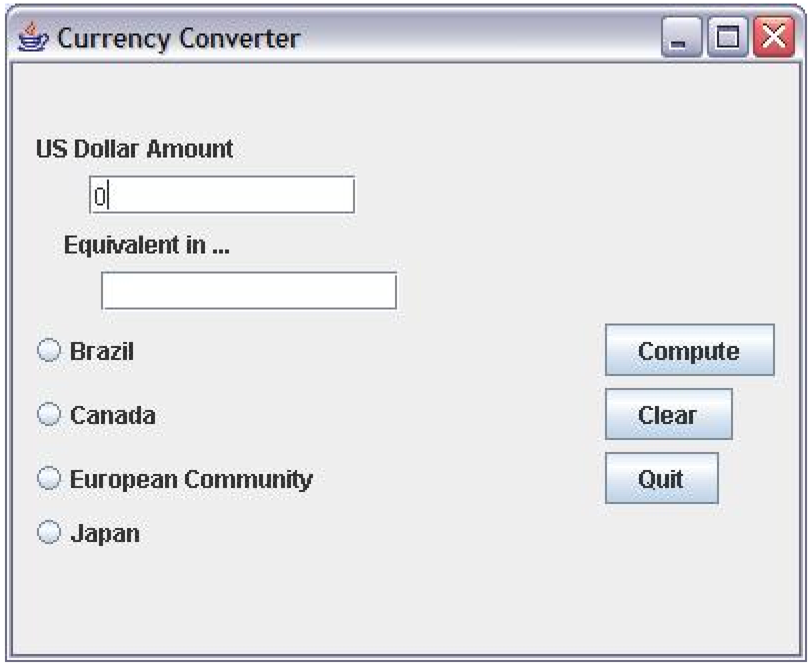
- Outline
- System Testing
- UML
- **Test Case Generation Example**
- Summary

Generating Test Cases

- Use UML description
  - Generate list of System Functions
- Generate & Expand Use Cases
  - High Level Use Cases (HLUC)
  - Essential Use Cases (EUC)
  - Expanded Essential Use Cases (EEUC)
  - Real Use Cases (RUC)
- Generate Test Cases from Real Use Cases

Currency Converter

- Example from Ian's Talk (Chapter 19)
- Converts US Dollars to:
  - Brazilian real (R$)
  - Canadian dollars (C$)
  - European Union euros (€)
  - Japanese yen (¥)
- User can revise inputs
- User can perform repeated conversions



System Functions

- The functions of the system as the user describes them
- Developed from the UML Specification
- Identifies 3 types of functions:
  - **Evident** – Obvious to the user
  - **Hidden** – Not immediately obvious
  - **Frill** – “Bells and Whistles”

System Functions

Ref. No.	*Function*	*Category*
R1	Start application	Evident
R2	End application	Evident
R3	Input US dollar amount	Evident
R4	Select country	Evident
R5	Perform conversion calculation	Evident
R6	Clear user inputs and program outputs	Evident
R7	Maintain exclusive-or relationship along countries	Hidden
R8	Display country flag images	Frill

Use Cases

- Describe the functional requirements of a system
- Each Use Case describes a scenario
- Shows how the system should interact with the user (actor)
- Several levels of use cases
  - High Level
  - Essential
  - Expanded Essential
  - Real

High Level Use Cases (HLUC)

- Brief description of the main functions of the system
- High level view of program
- Very few details shown
  - Name of function
  - Actors involved
  - Type of use case
  - Description of function
- 2 types of use cases
  - Primary (essential & required)
  - Secondary (rarely occur / not required)

High Level Use Cases (HLUC)

HLUC1	Start application
Actor(s)	User
Type	Primary
Description	The user starts the currency conversion application in Windows

HLUC2	End application
Actor(s)	User
Type	Primary
Description	The user ends the currency conversion application in Windows

HLUC3	Convert dollars
Actor(s)	User
Type	Primary
Description	The user inputs a US dollar amount and selects a country; the application computes and displays the equivalent in the currency of the selected country

Essential Use Cases (EUC)

- Identifies what user expects to happen
- Adds “actor” and “system” events to the HLUC
- Actions / Responses are numbered
- Numbers show approximate sequence in time

Essential Use Cases (EUC)

- HLUC1 → EUC1

HLUC1	Start application
Actor(s)	User
Type	Primary
Description	The user starts the currency conversion application in Windows

⬇

EUC1	Start application	
Actor(s)	User	
Type	Primary	
Description	The user starts the currency conversion application in Windows	
Sequence	*Actor action*	*System response*
	1. The user starts the application, either with a Run command or by double-clicking the application icon	2. The currency conversion application GUI appears on the monitor and is ready for user input

Essential Use Cases (EUC)

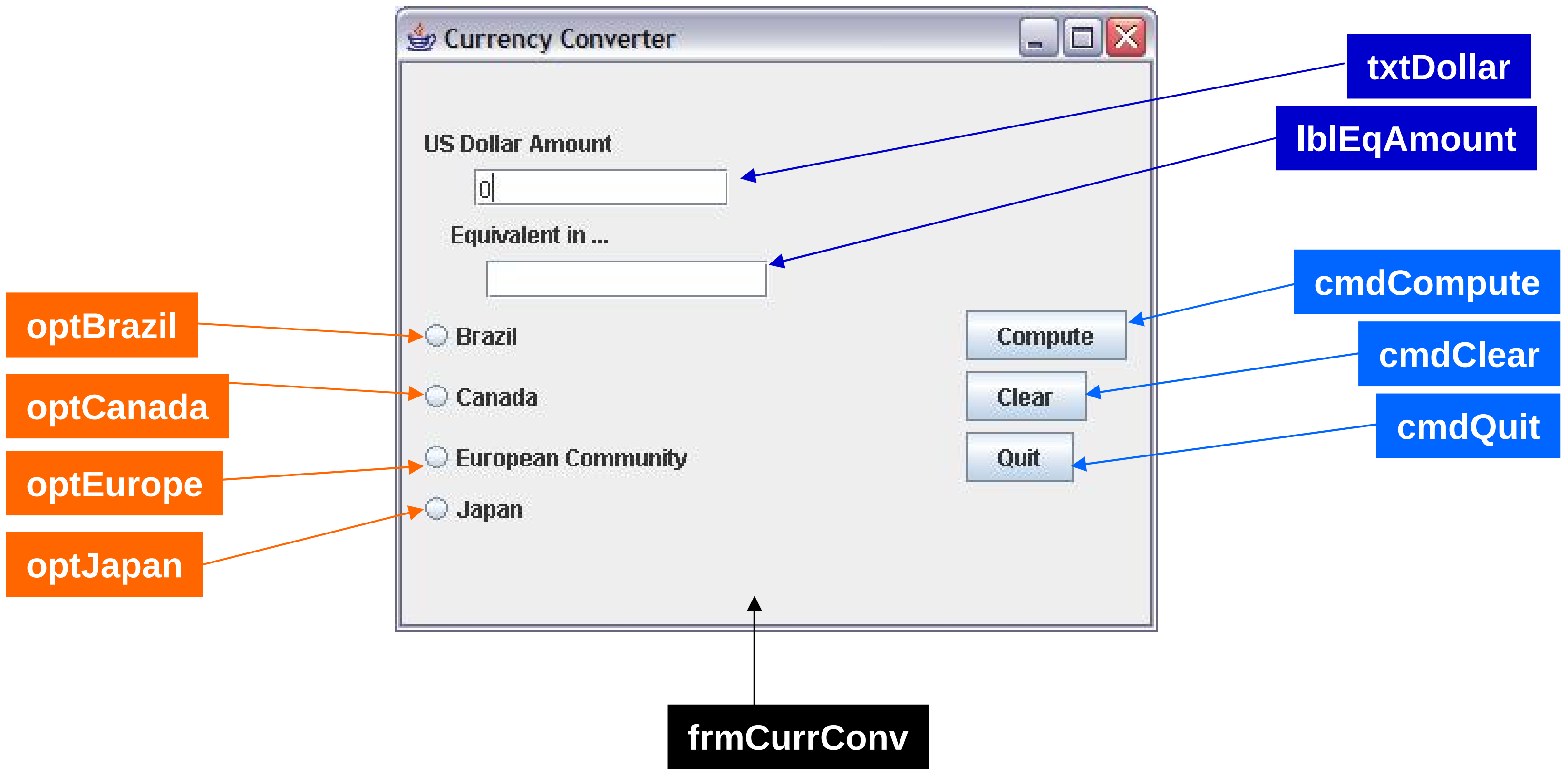
EUC3	Convert dollars	
Actor(s)	User	
Type	Primary	
Description	The user inputs a US dollar amount and selects a country; the application computes and displays the equivalent in the currency of the selected country	
Sequence	*Actor action*	*System response*
	1. The user enters a dollar amount on the keyboard	2. The dollar amount is displayed on the GUI
	3. The user selects a country	4. The name of the country's currency is displayed
		5. The flag of the country is displayed
	6. The user requests a conversion calculation	7. The equivalent currency amount is displayed

What Next?

- So far:
  - Generated a list of system functions
  - Developed a set of HLUCs
  - Extended these to create a set of EUCs
- Now:
  - Create a detailed GUI definition
- Next:
  - Use this to generate the Expanded Essential Use Cases (EEUC)
  - Generate Real Use Cases (RUC)
  - Generate System Test Cases (SysTC)

Detailed GUI Definition

- Graphical User Interface designed
- Controls in design to be used in EEUCs



Expanded Essential Use Cases (EEUC)

- Next level of Use Case refinement
- Detailed description of processes involved
- Adds:
  - Pre / Post conditions
  - Alternative sequences of events
  - References system functions found earlier
- Also:
  - New use cases are identified and added at this point
  - More detail provides greater insight

Expanded Essential Use Cases (EEUC)

EUC1	Start application	
Actor(s)	User	
Type	Primary	
Description	The user starts the currency conversion application in Windows	
Sequence	*Actor action*	*System response*
	1. The user starts the application, either with a Run command or by double-clicking the application icon	2. The currency conversion application GUI appears on the monitor and is ready for user input

⬇

Expanded Essential Use Case

Expanded Essential Use Cases (EEUC)

Essential Use Case

⬇

EEUC1	Start application	
Actor(s)	User	
Preconditions	Currency conversion application in storage	
Type	Primary	
Description	The user starts the currency conversion application in Windows	
Sequence	*Actor action*	*System response*
	1. The user double-clicks currency conversion application icon	2. frmCurrConv appears on the screen
Alternative sequence	User opens currency conversion application within the Windows Run command	
Cross-reference	R1	
Postconditions	txtDollar has focus	

Expanded Essential Use Cases (EEUC)

EEUC3	Convert dollars	
Actor(s)	User	
Preconditions	txtDollar has focus	
Type	Primary	
Description	The user inputs a US dollar amount and selects a country; the application computes and displays the equivalent in the currency of the selected country	
Sequence	*Actor action*	*System response*
	1. User enters a dollar amount on the keyboard	2. Dollar amount appears in txtDollar
	3. User clicks on a country button	4. Country currency name appears in lblEquiv
	5. User clicks cmdCompute button	6. Computed equivalent amount appears in lblEqAmount
Alternative Sequence	Actions 1 and 3 can be reversed, and consequently responses 2 and 4 will be reversed	
Cross-reference	R3, R4, R5 and R8	
Postconditions	cmdClear has focus	

System Functions Recap

Ref. No.	*Function*	*Category*
R1	Start application	Evident
R2	End application	Evident
R3	Input US dollar amount	Evident
R4	Select country	Evident
R5	Perform conversion calculation	Evident
R6	Clear user inputs and program outputs	Evident
R7	Maintain exclusive-or relationship along countries	Hidden
R8	Display country flag images	Frill

Real Use Cases (RUC)

- RUC only slightly different from EEUC
  - Instead of “`Enter dollar amount`”
  - “`Enter 10 in txtDollar`” used
  - Etc.

- System Test Cases can be derived from RUC

Real Use Cases (RUC)

EEUC3

RUC3	Convert dollars	
Actor(s)	User	
Preconditions	txtDollar has focus	
Type	Primary	
Description	The user inputs a US $10 and selects the European Community; the application computes and displays the equivalent: 7.50 euros	
Sequence	*Actor action*	*System response*
	1. User enters 10 on the keyboard	2. 10 appears in txtDollar
	3. User clicks on the European Community button	4. Euros appears in lblEquiv
	5. User clicks cmdCompute button	6. 7.50 appears in lblEqAmount
Alternative Sequence	Actions 1 and 3 can be reversed, and consequently responses 2 and 4 will be reversed	
Cross-reference	R3, R4, R5 and R8	
Postconditions	cmdClear has focus	

Finally

- So far:
  - Generated a list of system functions
  - Developed HLUC, EUC, Graphical Interface Design and EEUC
  - Created RUC

- Finally:
  - Convert RUC to System Test Cases (SysTC)

System Test Cases (SysTC)

RUC3

RUC3	Convert dollars	
Test Operator	Dafydd Vaughan	
Preconditions	txtDollar has focus	
Type	Primary	
TO Sequence	*Tester inputs:*	*Expected system response:*
	1. Enters 10 on the keyboard	2. Observe 10 appears in txtDollar
	3. Click on the European Community button	4. Observe europs appears in lblEquiv
	5. Click cmdCompute button	6. Observe 7.50 appears in lblEqAmount
Postconditions	cmdClear has focus	
Test Result	Pass/Fail	
Date Run	December 03, 2006	

Further Info

- Possible automation of Use Cases
- Automation of System Testing is being researched
- UML assists in development of test cases

- Outline
- System Testing
- UML
- Test Case Generation Example
- **Summary**

Summary

- System Testing
  - Tests the system as a whole
  - OO System Testing identical to normal System Testing

- Unified Modelling Language (UML)
  - Used to describe OO applications
  - Used to create test cases

- Use Cases
  - High Level Use Cases (HLUC)
  - Essential Use Cases (EUC)
  - Expanded Essential Use Cases (EEUC)
  - Real Use Cases (RUC)
  - System Test Cases (SysTC)

Swansea University
Computer Science

Object Oriented System Testing

Dafydd **Vaughan**

December 03 2006

CS339 Advanced Topics in Computer Science: Testing

Department of Computer Science, Swansea University