SE463 / CS445 / CS645 / ECE451

Fall 2012 — Final Exam

6 December 2012, 12:30pm–3:00pm
Instructors: D. M. Berry and R. Trefler

No aids allowed (*i.e.,* closed book).

Plan your time wisely.

Answer all of the questions on this exam paper.

Your Name and Student Number

In the immortal words of the yet to be born Spock of Vulcan,

Live Long and Prosper!

Q1		/ 15
Q2		/ 20
Q3		/ 10
Q4		/ 15
Q5		/ 5
Q6		/ 15
Q7		/ 15
Q8		/ 20
TOTAL		/ 115

In this exam, a short underscore of 1 inch (= 2.54 cm) should be filled with one word. A long underscore of 3 inches (= 7.63 cm) should be filled with a phrase consisting of one to several words. In the former case, if you cannot think of exactly the right number of words, then give the best answer that you can and we'll give it as many marks as we can, possibly even full credit! If you cannot even think of words to fill in, then write an answer as a sentence, and we'll give it as many marks as we can.

In this exam, in a **True** or **False** item, each correct answer is worth the stated number of marks; each incorrect answer is worth the negative of one half of the stated number of marks, unless the item asks for an explanation as well.

1. **[22 total marks scaled to 15 marks]** Short Answer

   User's Manual

   (a) **[2 marks]** What artifacts used in verification and validation of software can have a one-to-one correspondence with scenarios in the sense that one has as complete coverage as the other and in the sense that each instance of these artifacts can be converted to a scenario and each scenario can be converted into an instance of these artifacts?

   (b) **[2 marks]** A good UM for a system written before implementing the system should be written so that the reader of the UM _____ that the system is already _____. In other words, the UM should _____ through its teeth (even though it probably does not have teeth).

   Cost Estimation

   (c) **[2 marks]** Describe circumstances in which accurate, predictable software cost estimation may be reasonable to expect.

(d) **[2 marks]** Software cost estimation may be very difficult to do accurately in practice. Give one reason why it is important to perform even though it may be difficult.

(e) **[2 marks]** If the programming team for a late project is large enough, then adding another programmer makes the project even later, because for some number of people in the project, adding one more person

who can work 8 hours per day causes more than _____ more of _____ among the people in the project.

Nonfunctional Requirements

(f) **[2 marks]** Describe what *nonfunctional requirements* are used to explain. Give two examples.

(g) **[2 marks]** Explain the significance of: "What gets measured gets done."

RE Reference Model/Requirements Determination is Unstoppable

(h) **[2 marks]** In Michael Jackson's quotation "Requirements engineering is where the informal meets the formal.", the informal is the _____'s _____, and the formal is the _____ and the _____.

Graduate Student Lectures

Answer at least 3 of the following 6 questions. If you answer more than 3 of them, we will use only 3 towards your total marks, namely the 3 with the highest marks.

(i) **[2 marks]** Ahmed HajYasien's talk about "How do Software Architects Consider Nonfunctional Requirements: An Exploratory Study":

One respondent's answer "We wait for the client to complain. He will notice when something goes wrong" was described as *extreme* _____-_____

(j) **[2 marks]** Ross Hacquebard's talk about "Monitoring and Diagnosing Software Requirements":

What is the purpose of applying a model checker to a goal model?

(k) **[2 marks]** Daniel Berry's talk about "The Impact of Domain Knowledge on the Effectiveness of Requirements Idea Generation during Requirements Elicitation":

What is the key take-away message of the talk, which follows from what the experiment weakly supported?

(l) **[2 marks]** Abrar Salman's talk about "Reconciling Multi-Jurisdictional Legal Requirements: Requirements Water Marking 'a Case Study' ":

If an organization determines that the regulations governing data transmission from the State of Ohio to the State of New York are totally logically inconsistent, what is true of sending data from Ohio to New York?

(m) **[2 marks]** Mariam Adil Hassan's talk on "Customer Requirement Management in Product Development: a Review of Research Issues":

What steps of the RE lifecycle were covered by the research reported by the paper?

(n) **[2 marks]** Nabil Abou Reslan's talk about "A Feature-Oriented Requirements Modeling Language":

The purpose of the reported use of FORML to model features is to discover implicit interaction among a set of independently described features, **True** or **False**?

2. **[20 total marks]** Domain modeling with Class Diagram and World Diagram

   Consider an HTML editor that shows the user two views of the HTML file being edited:

   (a) the browser view, that results from interpreting the HTML markup in the edited file, and

   (b) the raw text view, showing a normal text editor's view of the edited file, in which HTML markup is shown as text.

   The user is allowed to do updating commands through either view

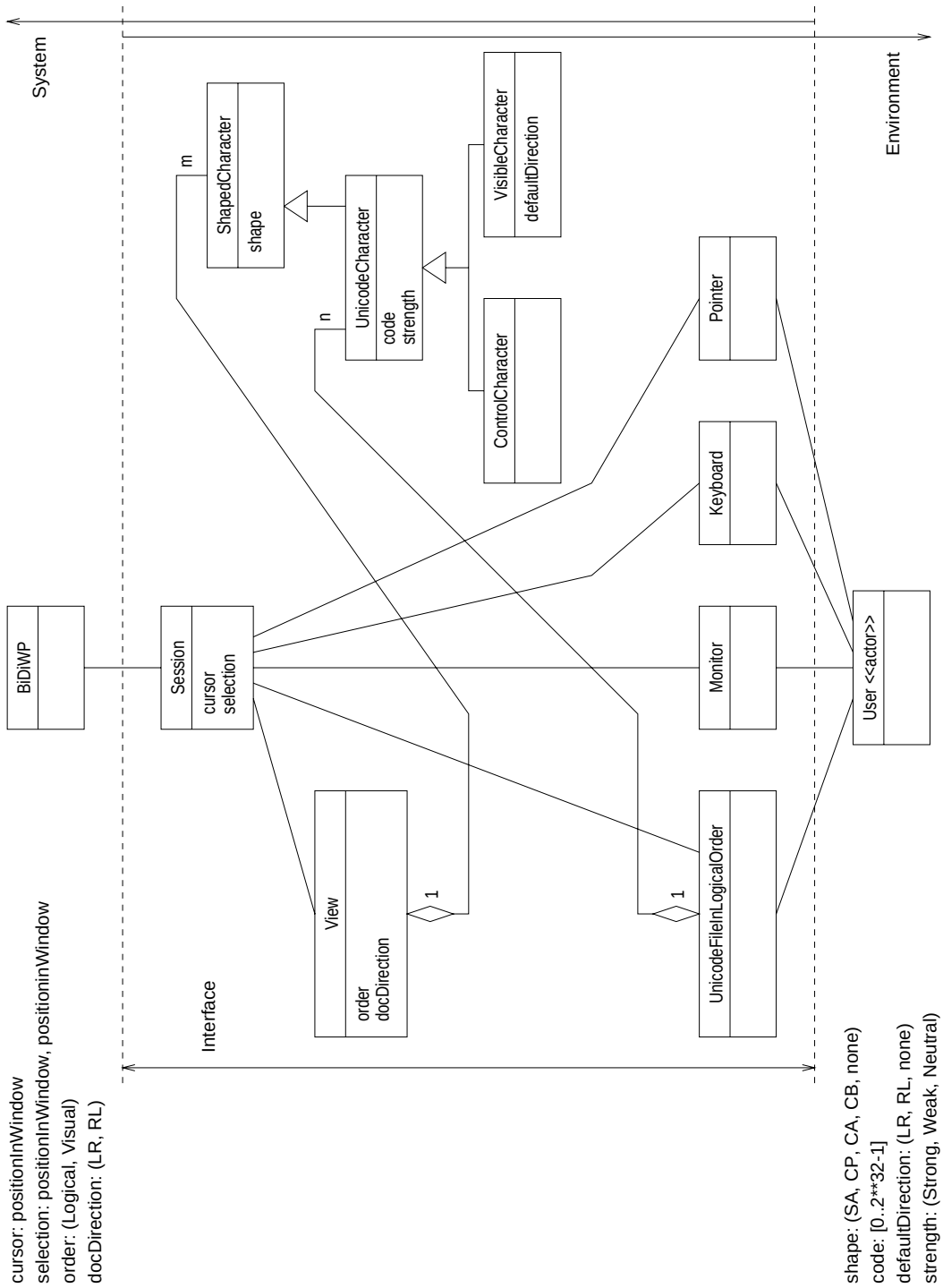
   (a) in the browser view, using MS-Word-like direct manipulation commands for creating and updating paragraphs, headers, ordered and unordered lists, tables, etc. and applying font changes to selections, etc. and

   (b) in the raw text view, by creating and updating HTML markup in textual form.

   A saved change in either view causes a corresponding change to the other view so that

   > *at all times, the browser view is that which results from interpreting the raw text by an HTML interpreter*.

   On the next page, draw a domain model of this HTML editor in the form of a UML class diagram with a superimposed world diagram. HINT: You might find it useful to look at the domain model of the bidirectional word processor (BDWP) that was produced as Berry's solution to Deliverable 2, which is reproduced on the page after the blank page.


System
Environment
Interface
BiDiWP
Session
cursor
selection
ShapedCharacter
shape
m
UnicodeCharacter
code
strength
n
VisibleCharacter
defaultDirection
ControlCharacter
Pointer
Keyboard
Monitor
User <<actor>>
View
order
docDirection
1
UnicodeFileInLogicalOrder
1
cursor: positionInWindow
selection: positionInWindow, positioninWindow
order: (Logical, Visual)
docDirection: (LR, RL)
shape: (SA, CP, CA, CB, none)
code: [0..2**32-1]
defaultDirection: (LR, RL, none)
strength: (Strong, Weak, Neutral)

3. **[15 total marks]** Scenarios and Use Cases

Find below the default scenario for the use case (UC) "Marking Your Ballot".

Change the scenario so that

(a) the whole checking of the voter's identification number, token, and registration address procedure in Steps 5 – 11 is replaced by the

> pollster's requesting and the voter's sending simply the name of the ballot and his or her registration file name (from in his or her .sensus directory). The pollster sends a request for an unvoted ballot to the correct election authority, and that election authority sends an unvoted ballot to the pollster for passing on to the voter.

(b) This whole replacement happens only soon after Step 15, in which the voter selects mark ballot from the pollster's menu and not before just viewing the ballot.

You may write directly on the scenario on the next page: crossing off removed steps; moving deleted steps by clearly indicating with arrows pointing to the places they should be moved to; or writing new steps inline or out of line, but with arrows pointing to the places they should be inserted into.

UC "Marking your Ballot"

Voter	Pollster	Election	Registrar
1. Voter invokes the *sensus* command, to run the Pollster.			
	2. Pollster displays a menu of options		
3. Voter slects the "marking ballot" option.			
	4. Pollster generates and sends a public/private key pair for Voter.		
	5. Pollster prompts voter for his/her [identification number, token, and registration address].		

Voter	Pollster	Election	Registrar
6. Voter sends his/her [identification number, token, and registration address].			
	7. Pollster requests verification of voterId from Registrar.		
			8. If voterId is registered, Registrar sends Pollster acknowledgement.
	9. Pollster requests an unvoted ballot from Election authority to send it to Voter.		
		10. Election authority sends an unvoted ballot to Pollster	
	11. Pollster sends unvoted ballot to Voter.		

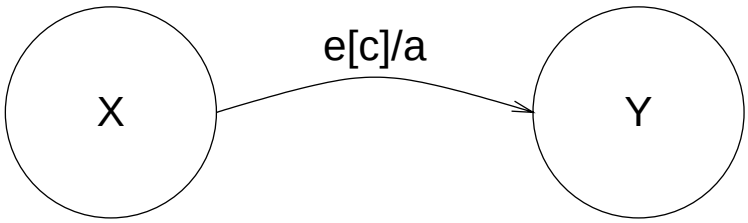
Voter	Pollster	Election	Registrar
	12. Pollster displays pollster menu.		
13. Voter selects "view ballot questions and instructions" from the pollster menu.			
	14. Pollster displays ballot questions and instructions.		
15. Voter selects "mark ballot" from the pollster menu.			
	16. Pollster prompts for the name of the ballot and Voter's registration file name.		
17. Voter sends the name of the ballot and Voter's registration file name.			

Voter	Pollster	Election	Registrar
	18. Pollster displays ballot question 1 and its voting instructions.		
19. Voter votes on ballot question 1.			
...			
	20. Pollster displays ballot question *m* and its voting instructions.		
21. Voter votes on ballot question *m*.			
	22. Pollster prompts Voter with vote-ending prompt 1.		
23. Voter answers "yes" to prompt 1.			

Voter	Pollster	Election	Registrar
	24. Pollster prompts Voter with vote-ending prompt *k*.		
25. Voter answers "yes" to prompt *k*.			
	26. Pollster sends completely voted ballot to Election Authority.		
27. Voter exits *sensus* program.			

4. **[51 total marks scaled to 15 marks]** Class Diagrams, State Machine Modeling, and State Machine Diagrams

   (a) **[4 marks]** Explain the following diagram and its components related to the definition of the extended state machine models.



   (b) **[4 marks]** Explain the differences and benefits of hierarchical state machine models over flat state machine models.

   (c) **[4 marks]** Briefly describe the distinction between a deep history variable and a history variable.

(d) **[4 marks]** Explain the differences between actions and activities in a state machine diagram. Give one modelling example that is more appropriately described as an action and one that is more appropriately described as an activity. Briefly explain your answer.

(e) **[2 marks]** In the context of state machine models, explain the idea of "completeness".

(f) **[20 marks]** Consider the following variation of a domain description from the lecture notes:

> The thingamajig snarkles the doodad, but the doohicky frommles the doodad only after the thingamajig gives the doohicky permission to do so.

Draw a UML class diagram that models this description. In this class diagram, be sure to show the multiplicities on the classes and on the arcs. Make sure that each noun and verb in the description shows up in your diagram. Show all actors by use of the ≪actor≫ stereotype.

(g) **[1 marks]** Is the doohicky an actor?

(h) **[2 marks]** Why or why not?

(i) **[10 marks]** Draw a state machine of the behavior of the doohicky. This state machine is prepared to receive the input permitToFrommle from the thingamajig and is prepared to then send the output frommle as a command to the doodad.

5. **[10 total marks]** Reference Model and World Models

   (a) **[5 marks]** Draw a graph representing the relationship between the *environment*, the *interface*, and the *system*, and label the areas representing the *requirements*, the *domain assumptions*, and the *system specification*.

   (b) **[5 marks]** Explain in detail what the relationship $S, D \vdash R$ is meant to represent, where S describes the system, D describes the domain assumptions, and R describes the requirements. HINT: You are trying to show that $S \vdash R$, but often cannot do so without more information.

6. **[18 total marks scaled to 15 marks]** Ambiguity

   (a) **[2 marks]** Ambiguity is a problem in reading or writing SRS documents — **True** or **False**? Explain your answer.

   (b) **[2 marks]** Give two reasons why natural language is needed in SRS documentation.

   (c) **[2 marks]** Give one benefit of using a formal language over using a natural language in writing SRS documentation.

   (d) **[2 marks]** Give one benefit of using a natural language over using a formal language in writing SRS documentation.

(e) **[2 marks]** Describe two kinds of linguistic ambiguity.

(f) **[2 marks]** *The spam filter delivers only the e-mail that the user wants.*
Explain a circumstance under which the position of the word "only" in the sentence is appropriate.

(g) **[2 marks]** Explain why natural-language ambiguity can be dangerous in RE.

(h) **[2 marks]** Explain the concept of subconscious disambiguation in RE and a reason why it is dangerous.

(i) **[2 marks]** Give two strategies for dealing with ambiguity in RE documentation.

7. **[16 total marks scaled to 15 marks]** Temporal and Time-Based Logic

   Recall that, for any temporal logic formula f, $\models f$ means that for all points on all sequences of states, f holds. In the following, p is an atomic proposition.

   (a) **[4 marks] True** or **False**: $\models (\Diamond\Box p) \rightarrow (\bigcirc \bigcirc p)$
   By giving the intuition, briefly justify your answer.

   (b) **[4 marks] True** or **False**: $\models (\Box p) \rightarrow (p \wedge \bigcirc(\Box p))$
   By giving the intuition, briefly justify your answer.

   (c) **[4 marks] True** or **False**: $\models (\neg\Diamond\neg p) \rightarrow (\Box p)$
   By giving the intuition, briefly justify your answer.

   (d) **[4 marks]** Suppose we show that it is not the case $M(P) \models f$. What conclusions can we draw about the behaviour of the program P with respect to the temporal specification f? Briefly justify your answer.

8. **[30 total marks scaled to 20 marks]** The Unicode Bidirectional Algorithm

(a) **[2 marks]** Consider the following sentence and LR document, VO, shown in visual order

Dan said “שלום יונוס וריכרד” to Younos and Richard.

Write here _____ the number of the line among the eight lines below that is the logically or time-ordered version of VO.

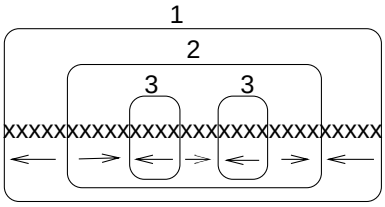
1. Dan said “וריכרד שלום יונוס” to Younos and Richard.
2. Dan said “סונוי םולש דרכירו” to Younos and Richard.
3. “ ,naD diasדרכירו סונוי סולשם.drahciR dna souoY ot ”
4. Dan said “דרכירו סונוי סולשם” to Younos and Richard.
5. Dan said “שלום יונוס וריכרד” to Younos and Richard.
6. Dan said “סולש דרכירו סונוי” to Younos and Richard.
7. Dan said “יונוס וריכרד שלום” to Younos and Richard.
8. said Dan “דרכירו סונוי סולשם” to Richard and Younos.

(b) **[2 marks]** Write here _____ the number of the pair of lines among the two pairs below that is proper breaking of VO into two lines.

1. Dan said “שלום יונוס
וריכרד” to Younos and Richard.

2. Dan said “יונוס וריכרד
שלום” to Younos and Richard.

Each of the next three questions gives a string in logical order with the convention that lower case letters are strong L-R characters, upper case letters are strong R-L characters, and the punctuation symbols are themselves. In each question you will be asked to show the visual order representation of the logically ordered line. In addition, you will be asked to indicate the Unicode Bidirectional Algorithm’s initial and second assignments of embedding level to the logically ordered line and the direction of the characters of each unidirectional run (chunk) of characters. To show embedding levels, as shown in:



please superimpose contours, with each contour labeled by its embedding level and around the characters of the line that are at the contour's level. To show the direction of each unidirectional run of characters, use arrows under the letters as shown in the figure above.

(c) **[8 marks]** Consider the following sentence LO1 in logical order.

he said: car MEANS CAR.

Then show the correct visual order representation of LO1:

Show the Unicode Bidirectional Algorithm's initial assignment of embedding level to the logically ordered line and the direction of the characters of each unidirecdtional run of characters in the line.

he said: car MEANS CAR.

Show the Unicode Bidirectional Algorithm's second assignment of embedding level to the logically ordered line and the direction of the characters of each unidirecdtional run of characters in the line.

he said: car MEANS CAR.

(d) **[8 marks]** Consider the following sentence LO2 in logical order.

he said: [car MEANS CAR].

Suppose that "[" is RLE and "]" is PDF. Then show the correct visual order representation of LO2:

Show the Unicode Bidirectional Algorithm's initial assignment of embedding level to the logically ordered line and the direction of the characters of each unidirecdtional run of characters in the line.

he said: [car MEANS CAR].

Show the Unicode Bidirectional Algorithm's second assignment of embedding level to the logically ordered line and the direction of the characters of each unidirecdtional run of characters in the line.

he said: [car MEANS CAR].

(e) **[8 marks]** Consider the following sentence LO3 in logical order.

he said: [car MEANS CAR].

Suppose that, in this case, "[" is RLO and "]" is PDF. Then show the correct visual order representation of LO3:

Show the Unicode Bidirectional Algorithm's initial assignment of embedding level to the logically ordered line and the direction of the characters of each unidirecdtional run of characters in the line.

he said: [car MEANS CAR].

Show the Unicode Bidirectional Algorithm's second assignment of embedding level to the logically ordered line and the direction of the characters of each unidirecdtional run of characters in the line.

he said: [car MEANS CAR].

(f) **[2 marks]** When a bidirectional word processor is processing a logically ordered file, in principle, the Unicode Bidirectional Algorithm is carried out on the entire logically ordered file after each _____ to the file.