

Part 2 Assignment

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(L^AT_EX by Jonathan Heathcote)

[Your Name Here]

Group [Your Group Here]

A0 Introduction

Aim and content

This assignment involves creating a **model of a firm engaged in the management of cultural exhibitions**. The assignment is in three sections.

- a) Section A1 involves constructing a model of the firm in the style of Chapters 1 and 2 of the lecture notes.
- b) Section A2 involves converting the model of A1 to a **schema ExhibMngt** similar to **BookClub** of Chapter 3 or **CarRally** of Chapter 4 of the lecture notes. This is divided into two sub-sections A2.1 and A2.2. In A2.1, *every feature representable in the model of A1* is converted to the equivalent feature of an explicitly named **state e : ExhibMngt**. (If you like advanced concepts, this conversion defines an *isomorphism* between the two models.) In A2.2, **new features** are introduced, each involving *two or more states* of ExhibMngt. Such items are clearly not representable in the model of A1, so ExhibMngt is a much richer model than that of A1, an important point. (For the mathematically-inclined again, the A1 model can now be described as 'embedded' in the model of A2.2.) Note at this stage no operations on ExhibMngt are defined.
- c) Section A3 finally involves adding state transformation operations to ExhibMngt, as illustrated by the operations of **BookClub** and **CarRally**.

The assignment must be done in the same manner as all previous sets of exercises. In each case you are given a set of items in English. Some are given with the corresponding formula; they are there to provide information and models for the other items. Your task is to formalise the other items.

The general rules of previous exercises apply. They are reproduced in Section A4.

Submission

The assignment is due on **Wednesday of Week 10 by 2.00pm**. It must be handed in to SSO ***printed on A4 paper and stapled with the submission form on top duly filled and signed***. My own Word documents (version 1997-2003) will be available in electronic form in Blackboard, so that you can use them as a basis for your submission. The maths can be done entirely using **Symbol**. Working by cut, paste and replacement is quite effective. Word is available in all SCS Labs under Windows. You may use an alternative word processor but if you do, **first test its ability to produce all the formulae you may need**. The easiest way to do this is to access my files and see how its formulae are printed. **A Rich Text Format version of the files will be posted in Blackboard.**

Marking scheme

The mark for this assignment is half the coursework mark for Part 2. It is divided equally between Sections A1, A2 and A3.

Background Information

The model involves various stakeholders, the most important of whom is the **Exhibition Organiser** or **EO** for short. The main focus of the model is the activities of the EO, i.e. the process of organising a cultural exhibition. In outline, this is as follows:

The EO has access to a vast knowledge base **kB** of artefacts (paintings, sculptures, etc.). These are **owned** by various other stakeholders: museum curators, state collection curators, private collectors etc. Each artefact recorded in the **kB** has a number of attributes e.g. title, physical category (painting, sculpture, photograph, etc.), creator, size, etc. The actual creation of an exhibition involves the following stages:

- a) The EO selects a theme for the exhibition e.g. 'Art versus political revolutions in 19th century Europe'.
- b) The EO chooses a set of artefacts suitable for the exhibition's theme by performing a query on the **kB** and then a selection of a subset of the query result through individual inspection.
- c) The EO seeks to obtain as many of the chosen artefacts from the owners as possible. Each owner responds by indicating which of the artefacts requested from him/her can be supplied.
- d) If the resulting subset of available artefacts is insufficient, the process is repeated until either an adequate supply has been obtained or the project is cancelled as infeasible.

General modelling issues (applicable to all sections)

- a) As in previous models, we shall first introduce various **predefined objects: sets, relations and functions**. These are universal features, i.e. they are treated as **constant** in each version of the model. For this reason they are used in the same way in all three sections A1, A2 and A3.
- b) The main model will be developed in a **single tier**. As usual, we shall distinguish **primary features, secondary features and possible facts**.
- c) Some items are marked with an asterisk (*), to mean that these are particularly important. Note however that you must **fill in all the gaps**, as **all** items do matter in understanding the model. **Do not remove blank rows or reduce their heights.**

A1 Basic model (one tier only)

A1.1 Predefined sets, relations and functions

A1.1A Predefined sets

a	The set of all artefacts allArtefacts
b	The set of all persons, past and present allPersons
c	The set of all physical categories of artefacts allPhyCats
d	Physical categories include painting, tapestry, sculpture, ... $\text{allPhyCats} = \{\text{painting, tapestry, sculpture, ...}\}$
e	The set of all possible subjects of artefacts allSubjects
f	Subjects include portrait, landscape, marine, animal, group, ship, ... $\text{allSubjects} = \{\text{portrait, landscape, marine, animal, group, ship, ...}\}$
g	The set of all art schools (a.k.a. movements) allSchools
h	Schools include classic, impressionist, cubist, abstract, ... $\text{allSchools} = \{\text{classic, impressionist, cubist, abstract, ...}\}$

A1.1B Predefined relations and functions

a	The physical category of an artefact a $\text{phyCat}(a)$
b*	For any artefact a , the physical category of a belongs to the set of all physical categories <i>Replace $\backslash\text{answerHere}$ with the L^AT_EX for your answer!</i>
c	The creator of an artefact a $\text{creator}(a)$ ($a \in \text{allArtefacts}$)
d	For any artefact a , the creator of a belongs to the set of all persons <i>Replace $\backslash\text{answerHere}$ with the L^AT_EX for your answer!</i>
e	The set of subjects of an artefact a $\text{subjects}(a)$ ($a \in \text{allArtefacts}$)
f*	For any artefact a , the set of subjects of a is a subset of the set of all subjects <i>Replace $\backslash\text{answerHere}$ with the L^AT_EX for your answer!</i>
g	The school of an artefact a $\text{school}(a)$
h	For any artefact a , the school of a belongs to the set of all schools <i>Replace $\backslash\text{answerHere}$ with the L^AT_EX for your answer!</i>

A1.2 Main model (one tier only)

A1.2A Primary features

a	The set of artefacts recorded in the knowledge base kB		
b*	Every member of the knowledge base is an artefact <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
c	The Exhibition Organiser EO		
d	The Exhibition Organiser is a person <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
e	The set of owners of artefacts (This set may include persons who do not own artefacts of the kB) owners		
f*	Artefact owners are persons <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
g	The owner of an artefact a recorded in the knowledge base owner(a) ($a \in \text{kB}$)		
h*	For any artefact a recorded in the knowledge base, the owner of a belongs to the set of artefact owners <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
i*	The set arts1 of artefacts selected by a query on the knowledge base <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
j	The set arts2 of artefacts individually selected from arts1 (It also forms the total set of requested artefacts) <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>

A1.2B Secondary features

a	Any person owning an artefact recorded in the knowledge base is an owner Or: The set <u>owners</u> includes the set of all persons, each of whom owns at least one artefact recorded in the knowledge base <i>Note: this is an invariant implied by the primary features, not a new variable feature</i> <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
b	The set of artefacts requested from an owner p reqFrom(p) ($p \in \text{owners}$)		
c*	For any owner p , the artefacts requested from p are those belonging to arts2 and owned by p <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
d	No requested artefact belongs to more than one owner <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>

A1.2B continues overleaf...

A1.2B Secondary features (cont.)

e The set of relevant owners
rlvOwners

f* The set of relevant owners is the set of owners of whom one or more artefacts are requested

Replace \answerHere with the L^AT_EX for your answer!

A1.2C Possible facts based on features (A1.2A) and (A1.2B)

a* *Instance of a query:*
arts1 is the set of all paintings recorded in the kB, created by Courbet and whose school is ‘pre-impressionist’
Use a set-theoretical abstraction

Replace \answerHere with the L^AT_EX for your answer!

b* Every artefact *a* belonging to arts1 has at least one of the following subjects: a group, an animal, an atelier

Replace \answerHere with the L^AT_EX for your answer!

c* The kB contains twice as many impressionist paintings as classic sculptures
Use set-theoretical abstractions

Replace \answerHere with the L^AT_EX for your answer!

d* In the kB, for every painting *p* by Monet on just the subjects of people and water, there is an artefact *a* by Picasso on the subjects of *p* (and possibly other subjects)
Use appropriate quantifiers

Replace \answerHere with the L^AT_EX for your answer!

A2 Schema-based model ExhibMngt

A2.1 Schema ExhibMngt

A2.1A

a	$e : \text{ExhibMngt}$ (primary features) <i>All features 'in state e'</i>		
b	The set of artefacts recorded in the knowledge base $e.kB$		
c	Every member of the knowledge base is an artefact <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
d	The Exhibition Organiser $e.EO$		
e*	The Exhibition Organiser is a person <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
f	The set of owners of artefacts (This set may include persons who do <i>not</i> own artefacts of the kB) <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
g	Artefact owners are persons <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
h	The owner of an artefact a of the kB <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
i*	For any artefact a of the kB, the owner of a belongs to the set of artefact owners <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
j*	The set arts1 of artefacts selected by a query on the knowledge base <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
k*	The set of artefacts individually selected from $e.arts1$. (It also forms the total set of requested artefacts.) <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>

A2.1B

a	$e : \text{ExhibMngt}$ (secondary features) <i>All features 'in state e'</i>		
b	Any person owning an artefact recorded in the knowledge base is an owner <i>Or:</i> The set <u>owners</u> includes the set of all persons, each of whom owns at least one artefact recorded in the knowledge base <i>Note: this is an invariant implied by the primary features, not a new variable feature</i> <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
c	The set of artefacts requested from an owner p <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
d*	For any owner p , the artefacts requested from p are those belonging to arts2 and owned by p <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
e*	No requested artefact belongs to more than one owner <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
f*	The set of relevant owners <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
g*	The set of relevant owners is the set of owners of whom one or more artefacts are requested. <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>

A2.2 Possible facts involving several states $e : \text{ExhibMngt}$

A2.2A

a	Let e_1, e_2, e_3, e_4 and e_5 be three variable states of ExhibMngt $e_1, e_2, e_3, e_4, e_5 : \text{ExhibMngt}$		
b*	The knowledge base of e_2 is an extension of that of e_1 <i>Or:</i> Every member of the knowledge base of e_1 is a member of the knowledge base of e_2 <i>Use a set-theoretical relation</i> <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
c*	The knowledge bases of e_2 and e_3 have no common artefact <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>
d*	The knowledge base of e_4 is the result of merging the knowledge bases of e_2 and e_3 <i>Replace \answerHere with the L^AT_EX for your answer!</i>	<input type="text"/>	<input type="text"/>

A3 Three operations on ExhibMngt

Specify the three operations for which the preamble only is given below. Use the style illustrated for operation schemas in Chapters 3 and 4 of the lecture notes. In particular specify each operation with **appropriate arguments, each of appropriate domain, and with appropriate precondition(s) if any. Apply the minimality principle wherever possible, consistently with the preambles.** Note that Emp is a slight variant of the operations Emp illustrated in the lecture notes. It must be called as $\text{Emp}(p)$, where p specifies $\text{Emp}(p)$.EO.

a*

Emp

Return the ‘empty’ exhibition management state (i.e. with empty kB and no owners) with EO specified as an argument.

Use e' to denote the result

Replace `\answerHere` with the L^AT_EX for your answer!

b*

InsA

Insert a new artefact into the knowledge base, specifying its owner.

Use e to denote the first argument and e' to denote the result

Replace `\answerHere` with the L^AT_EX for your answer!

c*

RemA

Remove an artefact from the knowledge base.

Use e' to denote the first argument and e to denote the result, in order to highlight the fact that RemA essentially inverts the effect of InsA

Replace `\answerHere` with the L^AT_EX for your answer!

A4 General rules (excerpt from previous exercises)

Key points

- 3 For each question, the task is to formalise an English statement, *in a manner which is as close to the English statement as possible, and consistently with the theory provided in the notes*. In particular if variables are used in the English statement, they should be used in the formalisation.

 - 4 Some items are provided with formalisation, **as models**. They are there to provide information and/or guidance for the actual questions. **The actual questions must be answered consistently with such guidance, *mutatis mutandis*.**

 - 5 Some questions contain **instructions on answering, or comments for further guidance. They are written in italics**. In the absence of instructions, you are to use your judgement.

 - 6 In formalising statements, **accuracy in the use of special symbols, the use of capitals and the consistency of spelling is essential**.

 - 7 **Consistency in all respects is of paramount importance.** *Thus, formulae must express their English counterpart exactly; instructions and models must be followed exactly; there should be as much consistency of style, naming of variables, etc. as possible between all your answers; etc.*

 - 8 In particular: **If an answer to a question is required to be consistent with an answer to another *specific* question**, this means that the second answer must be **as close as possible to the first answer in every respect, *mutatis mutandis*.**

 - 9 For some items, several English equivalent statements are provided, of increasing precision. *In each case, study all versions carefully, satisfy yourself that they are indeed equivalent, and base your formalisation on the last statement.*

 - 10 **Think of all this as a game.** *A game may be played – and enjoyed – only if all the rules are followed exactly.*
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On notation

- 11 In your answers, *use the abbreviations that will be suggested from time to time.*

 - 12 References like (1.2.1Ca) are to items in the lecture notes.

 - 13 Unless otherwise required, whenever you have to define a set, you must do it as in the notes either as an **enumeration** (e.g. {Elsa, Fred, Geoff}) or as a set-theoretical **abstraction**. (e.g. $\{b \in \text{books} \mid \text{subject}(b) = \text{flags}\}$)

 - 14 You may use pairs of parentheses ('...') and pairs of brackets (['...']) interchangeably, to facilitate pairing.
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End of assignment