CS4051

UNIVERSITY OF WARWICK
MSc Summer Examinations 2013/14
Introduction to Empirical Modelling

Time allowed: 3 hours.

Answer **question 1** and **TWO** other questions.

Question 1 carries 40 marks. The other questions carry 30 marks.

Read carefully the instructions on the answer book and make sure that the particulars required are entered on each answer booklet.

Credit will be given for evidence of familiarity with a variety of standard illustrative models.

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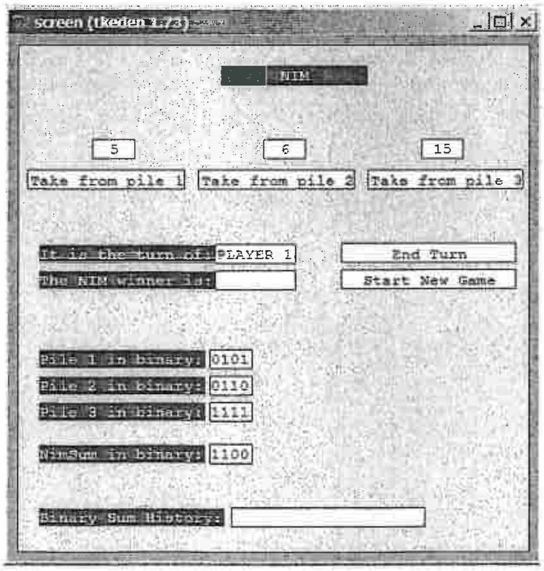
1. (a) Briefly explain, with the aid of a simple diagram, how a *construal*, its *referent*, the *context* for interaction and the model-builder's *understanding* co-evolve in the Empirical Modelling (EM) process. [8]

   (b) Describe the role of *observables*, *dependencies* and *agents* in EM. [9]

   (c) Explain what is meant by *a definitive script* and *a definitive notation*. Describe how the EDEN interpreter supports "modelling with definitive scripts". [12]

   (d) Illustrate your answers to (a), (b) and (c) with reference to the construal of the game of Nim as depicted *both* in this screenshot:



5 6 15

It is the turn of: PLAYER 1

The NIM winner is:

Pile 1 in binary: 0101

Pile 2 in binary: 0110

Pile 3 in binary: 1111

NimSum in binary: 1100

Binary Sum History:

and (as embedded in the EM presentation environment) on page 4 overleaf. [11]

2. (a) Making construals and traditional computer programming offer radically different perspectives on computing. Contrast these perspectives with reference to how they treat:

   i. the relationship between *interaction* and *interpretation* [2]

   ii. the relationship between *the formal* and *the informal* [2]

   iii. the relationship between *the personal* and *the public* [2]

   iv. the relationship between *state* and *behaviour*. [2]

   (b) Discuss the nature of the state that can be captured by making a construal, relating your answer to

   i. Alan Turing's conception of the Turing Machine as a way "to capture the state of mind of a person *following rules*" [3]

   ii. David Gooding's characterisation of construals and their significance for science [3]

   iii. how construals accommodate situation, ignorance and nonsense. [3]

   (c) Discuss the way in which making construals can help to identify plausible explanations for behaviours, relating your answer to

   i. Daniel Keer's *Ant Navigation* construal [4]

   ii. anomalous real-life events (such as the 'adventures in a lift' scenario that was discussed in the module) [4]

   iii. the range and subtlety factors that influence the way in which behaviours are explained, as illustrated e.g. in the *Ficts* fiction. [5]

3. (a) Explain the key principles behind:

   i. Bruno Latour's *constructivist* philosophical stance [3]

   ii. Seymour Papert's notion of *constructionism* [3]

   (b) Discuss the proposition: "Making construals is an activity that is much better aligned to a constructivist outlook and a constructionist approach to learning than conventional programming." Relate your answer to:

   i. Moti Ben-Ari's contention that teaching computer science is constrained by the nature of the computer as an "accessible ontological reality" [5]

   ii. Bret Victor's advocacy of Papert's constructionism in his online article *Learnable Programming* [5]

   iii. Problems in enabling *active learning* in online education identified by Edinburgh University researchers in their *Manifesto for Teaching Online*. [5]

   (c) Illustrate your answer to (b) with reference to relevant EM construals. [9]

4. In his book *Object Thinking*, Dave West makes a distinction between a *formalist* and a *hermeneutic* approach to software development. Explain what is meant by the italicised terms. [4]

   Discuss the prospects for exploiting EM in software development that can blend hermeneutic and formalist approaches.

   Your discussion should include

   (a) an account of the key characteristics and aspirations for EM in software development [8]

   (b) brief reviews of topical issues, such as

   i. the scope for combining different programming paradigms in a coherent fashion [2]

   ii. the challenges for database theory and practice identified by Chris Date, Hugh Darwen and Mike Ridley [2]

   iii. Michael Jackson's view of "what we can expect of formal verification" [2]

   iv. David Harel's advocacy of *visual formalisms* [2]

   v. Fred Brooks's contention that *the* most important characteristic of software is *conceptual integrity.* [2]

   (c) appropriate illustrative examples and diagrams. [8]

5. (a) Describe the characteristics of the *Abstract Definitive Machine (ADM)* with the aid of a diagram. [8]

   (b) Give a brief overview of the role the ADM plays

   i. in clarifying the semantics of models constructed using the traditional EDEN interpreter. [4]

   ii. in supporting EM for concurrent systems. [6]

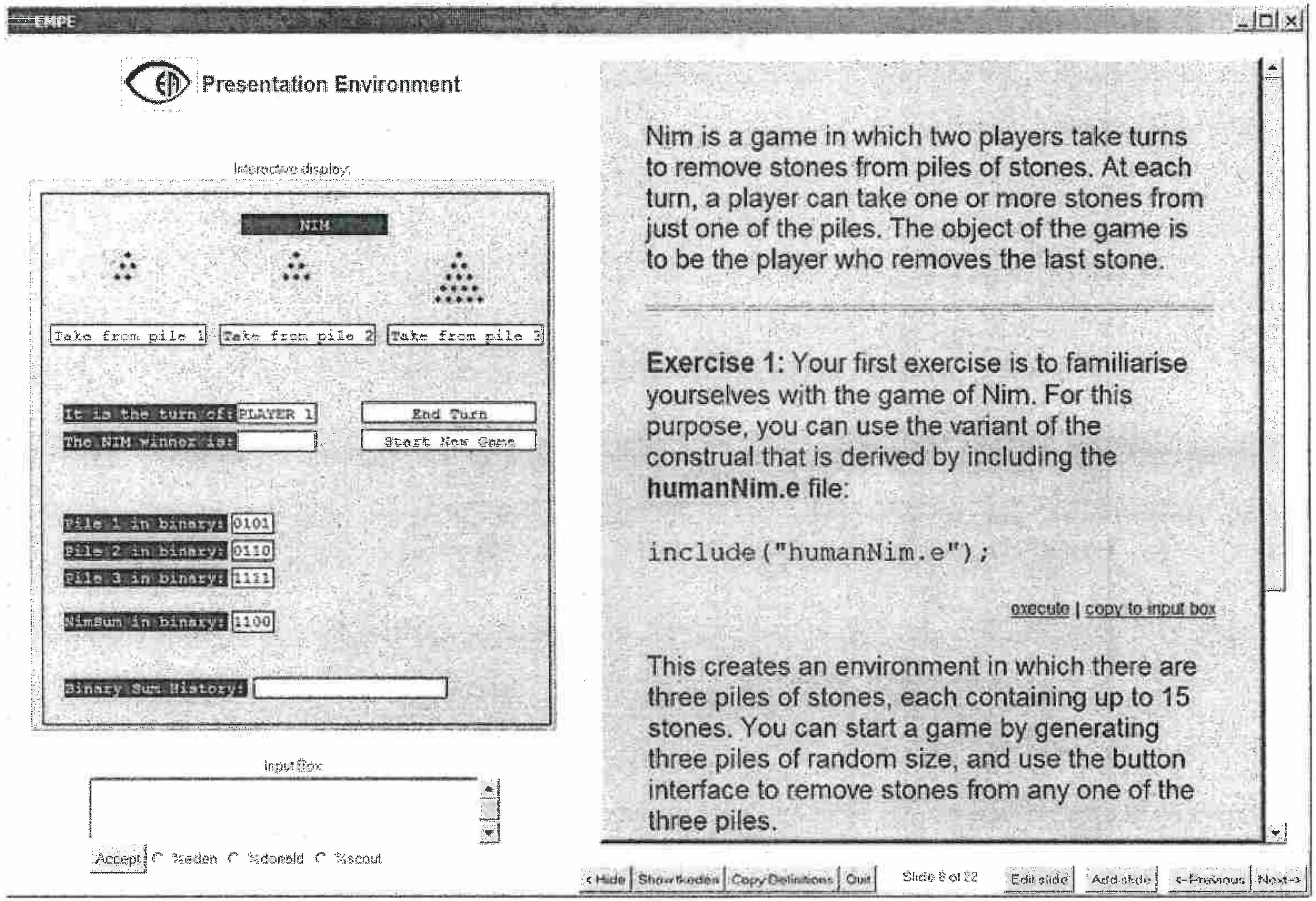
   (c) Discuss the potential applications of the ADM, with reference to:

   i. machine-oriented and human-oriented perspectives on its interpretation [3]

   ii. the analogy that can be drawn between the development of a system using EM principles and the emergence of a complex engineering system (such as a modern railway). [3]

   (d) Complement your answers to (a), (b) and (c) with appropriate illustrative examples. [6]

Appendix: The screenshot of the Nim construal referred to in Question 1.



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Binary Sum History:

Nim is a game in which two players take turns to remove stones from piles of stones. At each turn, a player can take one or more stones from just one of the piles. The object of the game is to be the player who removes the last stone.

Exercise 1: Your first exercise is to familiarise yourselves with the game of Nim. For this purpose, you can use the variant of the construal that is derived by including the **humanNim.e** file:

```
include("humanNim.e");
```

execute | copy to input box

This creates an environment in which there are three piles of stones, each containing up to 15 stones. You can start a game by generating three piles of random size, and use the button interface to remove stones from any one of the three piles.