Final Project

Fall 2006, cs112 – James Pustejovsky

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Due Date: LAST DAY OF FINALS - December 15, 2006
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Introduction

For the final project of this course, you must show that you have a good understanding of the logics we discussed this semester, including how they can be helpful in different areas of computer science. The project is in two parts. For the first part, you have a choice to either implement a few of the logics from class in the programming language of your choice or to write a paper that discusses the strengths and weaknesses of a few of the logical systems. Each of these options is described in detail below. The second part of the project must be done regardless of what you choose to do for part 1. This part involves a short essay (2-4 pages) that describes how logic can be used to help with artificial intelligence problems.

You may work in small groups as you develop your ideas for this project, but the program or paper and essay that you turn in should be your own work. The project is due the last day of finals, December 15. No late assignments can be accepted so that we have time to grade the projects. Therefore, you may want to get an early start on your project to be safe.

Part 1: Understanding of Logical Systems

In this class, we discussed several different logical systems that each have their own strengths and weaknesses. Each logic has a specific syntax and semantics, as well as a method for doing inference. This part of the project tests your understanding of a few of these logical systems either by creating an implementation of these systems or by providing a thorough discussion of them.

Option 1: Logical System Implementation

This option requires you to implement two logical systems, one of which must be First Order Logic. You may choose to implement any other logic we presented in this class except Propositional Logic. Your implementation should include the following:

1. A function that decides if a given formula is well-formed in the logic. For example, in FOL '$\forall x P x$' is well-formed, but 'Px' and '$F(Gx)$' are not. Optionally, this function could also output what was wrong with the formula.

2. A function that takes a set of premises and a conclusion and generates a proof using some method of inference. The inference method will depend on which logic you are using. For FOL, this function should generate a natural deduction proof (you may do a sequent calculus proof if you prefer). For modal logic, you have a choice: natural deduction or model-based reasoning. Recall that there are several different ND systems for modal logic. You must implement each of these. So, for modal logic ND, your function should also take as input which system the proof should be generated in. Alternatively for modal logic, you may write your inference function for model-based reasoning. Your program should take a model as input. The inference function(s) should determine if a given formula is valid in the model and if it is true for a particular world. A similar model-based system of inference should be implemented if you choose temporal logic or dynamic logic. If you would like to investigate linear logic natural deduction, please let us know and we can provide you with a good primer. The following table summarizes your options for this part of the project.

Logic	**Natural Deduction**	**Model-based Inference**
FOL(required)	Yes	No
Modal Logic	Yes(all systems)	Yes
Temporal Logic	No	Yes
Linear Logic	Yes	No
Dynamic Logic	No	Yes

Option 2: Discussion of the Logical Systems

Since the purpose of this part of the project is to demonstrate your understanding of the logical systems presented in this class, you have the option to write a paper instead of a program. You should choose which ever option you believe will give you the best opportunity to show what you have learned.

The paper option requires you to write a 12-15 page paper that discusses two of the logical systems in detail. As with the program option, one of these systems must be First Order Logic. You may choose any other logic except propositional logic as your second logical system. Your paper should cover both the syntax and semantics of the logical systems you choose. It should be made clear what a well-formed formula in the logic is and how we do inference. Therefore, for FOL, your paper should include a discussion of natural deduction. Refer to the table for Option 1 above to see what inference methods can be discussed for the other logical systems. Be careful in this part of the paper to put the discussion in your own words.

In addition to the discussion on well-formed formulas and inference, your paper should include a section on the strengths and weaknesses of the logical

systems you are describing. That is, for example, what is good about FOL and what is missing from it? This part of the paper may require some additional research. If you are uncertain about this part of the paper, please contact Professor Pustejovsky or Jess.

To summarize, the paper should be 12-15 pages, including any proofs or diagrams. It should discuss FOL and one other logic of your choosing. For each logical system, the following topics should be covered:

1. Syntax and Semantics (What is a well-formed formula and what do the formulas mean)
2. System of Inference
3. Strengths and Weaknesses

Extra Credit

Regardless of which option you choose for this part of the project, you may also do the following for extra credit. Choose two or more of the logical systems discussed in this class and propose a useful and interesting way to combine them. For instance, you may want to think about combining linear logic with temporal logic. Your proposal should explain why you chose to put these logics together and why the resulting combination is useful. For full points, you should also discuss how inference might work in your proposed logic. If you would like, you may also propose an implementation of your logic, but this is not necessary to get the maximum extra credit points.

Part 2: Using Logic in AI

For this mandatory part of the project, you must write a 2-4 page essay that discusses how the logical systems we discussed in this class are used in work on artificial intelligence. Throughout the semester, we have mentioned some of these applications. You may also want to do a little independent research. Your essay must include at least two examples of how logic is used to solve AI problems.