Fall 2006 was a Two-Period Exam

(20) Conversion to Clause Form

I. Transform the wff \( A \) below into CNF (clause form) matrix form. For each of the 10 “official steps” required give a brief description of the step and perform the step or write N/A (not applicable) on the space provided. Failure to follow this format will result in no credit. In \( wff \ A \) the set \( \{w,x,y\} \) are variables, the set \( \{E\} \) are functions and there are no constants.

\[
\{ \text{wff } A \} : (\forall x) \{ \sim E(x,v) \rightarrow (\exists y) (\exists w) (E(y,w) \land (\forall x) \{ E(x,w) \rightarrow E(y,x) \} ) \}
\]

(2) Step 0: 

(2) Step 1: 

(2) Step 2: 

(1) Step 3: 

(2) Step 4: 

(1) Step 5: 

(4) Step 6: 

Fall 2006
I. Conversion to Clause Form (continued)

(1) Step 7: ____________________________________________________________

(1) Step 8: ____________________________________________________________

(2) Step 9: ____________________________________________________________

(2) Step 10: ____________________________________________________________
II. Resolution Refutation

THE CUSTOM OFFICIALS searched EVERYONE who entered THIS COUNTRY who was NOT a VIP. SOME of the DRUG PUSHERS entered THIS COUNTRY and THEY were ONLY searched by DRUG PUSHERS. NO DRUG PUSHER was a VIP. PROVE that SOME of the CUSTOM OFFICIALS were DRUG PUSHERS.

Solve by drawing a Refutation Graph resulting from your choice of strategy. (Make sure you mark clearly the required substitutions).

[Required: Please note the assigned point values. Each part MUST be answered with something. If left blank, then no credit will be assigned]

(5) a. Represent the axioms/goal in the Predicate Calculus. Let E(x) mean “x entered this country,” V(x) mean “x was a VIP,” S(x,y) mean “y searched x,” C(x) mean “x was a custom official” and P(x) mean “x was a drug pusher.”

(2) b. Represent any commonsense knowledge needed to solve the problem using Predicate Calculus,

(5) c. Convert your axioms, goal and commonsense knowledge (if any) to clause form,

(10) d. Draw your Refutation Graph, show substitutions are consistent.

(3) e. Describe how your graph meets the strategy. What other strategy could you have used and why?

(5) Answers Part a:

(2) Answers Part b:

(5) Answers Part c:
Fall 2006

II. Resolution Refutation (continued)

(10) Refutation Graph Part d:

(3) Answer Part e: My strategy is __________________________________________________________
IV. Computation Deduction.

We wish to make a set of UF basketball centers from a list of tall players. Using Resolution Refutation deduce the following computation to obtain a value for the goal (2 pts) by performing a consistent Refutation Trace (19 pts) for the goal and prove (or provide a good argument for) its consistency (4 pts.).

Make sure your resolution refutation trace is clearly marked and it follows a complete strategy. Assume that the evaluation of member is built-in, e.g., member(a,(a b)) returns true, and member (c,(a b)) returns nil.

Facts:

\[ F_1: \text{makeset}(\text{nil}, \text{nil}). \]

Rules:

\[ R_1: \{ \text{member}(X_1,Y_1) \land \text{makeset}(Y_1,Z_1) \} \rightarrow \text{makeset}(\text{cons}(X_1,Y_1),Z_1). \]

\[ R_2: \{\lnot \text{member}(X_2,Y_2) \land \text{makeset}(Y_2,Z_2) \} \rightarrow \text{makeset}(\text{cons}(X_2,Y_2),\text{cons}(X_2,Z_2)). \]

Goal: \( (\exists z)(\text{makeset}(\text{cons}(\text{AL},\text{cons}(\text{JOAKIM}, \text{cons}(\text{AL},\text{nil}))), z)) \)

{ Note: If you prefer, you may use the notation makeset( (AL JOAKIM AL), z ) }

Required: Give the entire resolution trace (18 pts) using a complete strategy (tell me what strategy (1)), show the substitutions are consistent (4pts), and obtain the value of the goal (2 pts).
Fall 2006

IV. Computation Deduction. (continued)
Fall 2007
(20) Conversion to Clause Form

I. Transform the wff A below into clause form. For each of the 10 “official steps” {the order is important!} required give a brief description of the step and perform the step or write N/A {not applicable} on the space provided. Failure to follow this format will result in no credit. In wff A the set {v, x, y, z} are variables, the set {P,Q,R} are functions and there are no constants.

\[\{wff \ A\} : (\forall x)(P(x) \rightarrow \{\forall y[\neg Q(x,y) \rightarrow P(v)] \land \forall y \exists z[R(x,y) \rightarrow P(x)]\}\)
I. Conversion to Clause Form (continued)

(1) Step 7: ________________________________

(1) Step 8: ________________________________

(2) Step 9: ________________________________

(2) Step 10: ________________________________
Fall 2007

(30) II. Resolution Refutation
The mathematical definition of the factorial function is: (i) Fact(0)=1, (ii) Fact(k)=k*Fact(k-1)

Some suitable axioms for factorial are: (i) Fact(0)=1
(ii) \([k-1=j \land Fact(j)=m \land k*m=n] \rightarrow [Fact(k)=n]\)
(iii) \((\forall x)(\forall y)[x=y] \text{ with side effect } \{\text{eval}(x)/y\}\)

Using the axioms find the value of 2! by using Resolution Refutation and answer extraction. Solve by drawing a Refutation Graph resulting from your choice of strategy. (Make sure you indicate clearly the required substitutions). Note: the function \(x=y\) evaluates the left argument and unifies it (equates it) with the right argument, e.g., 4-2=q evaluates 4-2 to 2 and sets q=2 (i.e., it stores the substitution \{4-2/x, eval(4-2)/y, q'y, 2/q\} or \{2/q\} in the system.)

[Required: Please note the assigned point values. Each subpart MUST be answered with something. If left blank, then zero credit]

a. Represent the axioms/goal in clause form.
b. Is any commonsense knowledge needed to solve the problem using Predicate Calculus? Explain.
c. Give the Resolvents with the required substitutions.
d. Draw your Refutation Graph.
e. Prove formally that your substitutions are consistent.
f. Describe how your graph meets the strategy. What other strategy could you have used and why?

Answers Part a:
Fall 2007

II. Resolution Refutation (continued)

(5) Refutation Graph Part d:

(3) Consistency Check Part e:

(2) Answer Part f. My strategy is ________________________________

What other strategy could you have used and why? Explain:
Fall 2007

(25)

III. Adversarial Search

Consider the following game tree in which the static scores (in parentheses at the tip nodes) are all from the first player’s point of view.

(5) a. Assuming that the first player is the maximizing player, what move should the first player choose?

(5) b. Assuming that the first player is the minimizing player, what move should the first player choose?

(5) c. What nodes would not need to be examined in part (a) using the alpha-beta algorithm—assuming that the nodes are examined in left-to-right order?

(5) d. What nodes would not need to be examined in part (b) using the alpha-beta algorithm—assuming that the nodes are examined in left-to-right order?

(5) e. Is the first player’s move in parts (a) and (c) or in parts (b) and (d) different? Explain.

(5) Part (a):

(5) Part (b):

(5) Part (c):
Fall 2007

III. Adversarial Search. (continued)

(5) Part (d):

(5) Part (e):
IV. Computation Deduction.

The following facts and rules accomplish the evaluation of the inner product of two vectors. Note that \{A, As, B, Bs, N, Z\} are variables

Fact:
\begin{itemize}
  \item F\textsubscript{1}: inner(nil, nil, 0).
  \item F\textsubscript{2}: is(X, Y) with side effect \{eval(X)/Y\}.
\end{itemize}

Rule:
\begin{itemize}
  \item R\textsubscript{1}: \[\text{inner}(A, As, Bs, N, Ns) \land \text{is}(Ns + A \times B, N) \] \rightarrow \text{inner}(cons(A, As), cons(B, Bs), N).
\end{itemize}

Goal: \((\exists Z)\)\(\text{inner}(\text{cons}(1, \text{cons}(2, \text{nil})), \text{cons}(3, \text{cons}(4, \text{nil})), Z)\)

\{ Note: If you prefer, you may use the notation inner( (1 2), (3 4), Z ) \}

Required: Tell me what your strategy is (1 pt). Give the clause form (4 pts) of the axiom set & the negation of the goal. Give me the Resolution resolvents (15 pts) using a complete strategy. Prove the substitutions are consistent (4 pts). Obtain the value of the goal (1 pt). Note: the function is(X, Y) evaluates the left argument and unifies it (equates it) with the right argument, e.g., is(4+2, Q) evaluates 4+2 to 6 and sets Q=6 (i.e., it stores the substitution \{4+2/X, eval(4+2)/Y, Q/Y, 6/Q\} or \{6/Q\} in the system.)

(1) Tell me your strategy _______________________

(4) Give me your axioms & negation of the goal in clause form

(15) Give me the resolution resolvents
Fall 2007

IV. Computation Deduction. (continued)

(4) Prove the substitutions are consistent.

(1) Give me the solved goal, i.e., the answer:
Fall 2008

(20) Conversion to Clause Form

1. Transform the wff $A$ below into clause form. For each of the 10 “official steps” (the order is important!) required give a brief description of the step and perform the step or write N/A (not applicable) on the space provided. Failure to follow this format will result in no credit. In $wff \ A$ the set \{w, x, y, z\} are variables, the set \{Animal, Loves\} are functions and there are no constants.

\[\{wff \ A\} : (\forall x)(\exists w)((\forall y)\{Animal(y) \to Loves(x,y)\} \to ((\forall z)(\exists y)Loves(y,x))\]
Fall 2008
I. Conversion to Clause Form (continued)

(1) Step 7: ________________________________

(1) Step 8: ________________________________

(2) Step 9: ________________________________

(2) Step 10: ________________________________
II. Resolution Refutation (30)

The law says that it is a crime for an American to sell weapons to hostile nations. The country Nono, an enemy of America, has some missiles, and all of its missiles were sold to it by Colonel West, who is an American. Is Colonel West a criminal?

Prove that West is a criminal by using Resolution Refutation. Draw a Refutation Graph resulting from your choice of strategy. (Indicate clearly the required substitutions).

[Required: Please note the assigned point values. Each subpart MUST be answered with something. If left blank, then zero credit]

(5) a. Represent the axioms/goal in the Predicate Calculus. (If you cannot do this, I will give it to you for the 5 points)

(4) b. Represent the axioms/goal in clause form.

(2) c. Is any commonsense knowledge needed to solve the problem? Explain. (If you can’t do it, I will give it to you for 2 pts)

(10) d. Give the Resolvents with the required substitutions.

(5) e. Draw your Refutation Graph.

(2) f. Prove formally that your substitutions are consistent.

(2) g. Describe how your graph meets the strategy. What other strategy could you have used and why?

(5) Answers Part a:

(4) Answer(s) Part b:

(2) Answer(s) Part c:

(10) Answers (Resolvents & required substitutions) Part d:
Fall 2008
II. Resolution Refutation (continued)

(5) Refutation Graph Part d:

(2) Consistency Check Part e:

(2) Answer Part f. My strategy is: _______________________________

What other strategy could you have used and why? Explain:
III. Adversarial Search

Consider the following game tree in which the static scores (in parentheses at the tip nodes) are all from the first player’s point of view.

a. Assuming that the first player is the maximizing player, what move should the first player choose? (5)
b. Assuming that the first player is the minimizing player, what move should the first player choose? (5)
c. What nodes would not need to be examined in part (a) using the alpha-beta algorithm—assuming that the nodes are examined in left-to-right order? (5)
d. What nodes would not need to be examined in part (b) using the alpha-beta algorithm—assuming that the nodes are examined in left-to-right order? (5)
e. Is the first player’s move in parts (a) and (c) or in parts (b) and (d) different? Explain. (5)
III. Adversarial Search. (continued)

(5) Part (d):

(5) Part (e):
In EEL-5840 Exam 1 we have a tail recursive LISP function count-top-atoms (CTA for short) to count the number of top level atoms in a given list expression. Here are fact(s) and rule(s) to define the equivalent predicate is_cta(lis,n). is_cta(lis,n) is true when n equals the count of the number of top level atoms in lis.

\[ F_1: \text{is\_cta}(\text{NIL}, 0). \]
\[ R_1: [\text{ATOM}(U) \land \text{is\_cta}(T,N) \land IS(N+1,ANS)] \rightarrow \text{is\_cta}(\text{CONS}(U,T),ANS) \]
\[ R_2: [\text{LISTP}(U) \land \text{is\_cta}(T,ANS)] \rightarrow \text{is\_cta}(\text{CONS}(U,T),ANS) \]

Evaluate \( \exists Z \) \text{is\_cta}((\text{CONS}(\text{CONS}(A,\text{NIL}),\text{CONS}(B,\text{CONS}(\text{CONS}(C,\text{NIL}),\text{NIL}))))),Z) using computation deduction.

{ Note: If you prefer, you may use the notation is\_cta(((A) B C)),Z), and ATOM and LISTP are the built-in LISP functions we already know }

Required: Tell me what your strategy is (1 pt). Give the clause form (4 pts) of the axiom set & the negation of the goal. Give me the Resolution resolvents (16 pts) using a complete strategy. Prove the substitutions are consistent (3 pts). Obtain the value of the goal (1 pt). Note: the function is(x,y) evaluates the left argument and unifies it (equates it) with the right argument, e.g., is(4+2,Q) evaluates 4+2 to 6 and sets Q=6 (i.e., it stores the substitution \{4+2/X, eval(4+2)/Y, Q/Y, 6/Q\} or \{6/Q\} in the system.)

(1) Tell me your strategy________________________

(4) Give me your axioms & negation of the goal in clause form

(16) Give me the resolution resolvents
Fall 2008

IV. Computation Deduction. (continued)

(3) Prove the substitutions are consistent.

(1) Give me the solved goal, i.e., the answer:
(20) Conversion to Clause Form

I. Transform the wff $A$ below into clause form. For each of the 10 “official steps” {the order is important!} required give a brief description of the step and perform the step or write N/A {not applicable} on the space provided. Failure to follow this format will result in no credit. In wff $A$ the set $\{w, x, y, z\}$ are variables, the set $\{R,S\}$ are functions and there are no constants.

$$
\{wff \ A\} : (\forall x)(R(x,y) \rightarrow \exists z \{\neg \forall y[S(x,y) \rightarrow R(x,w)] \land \forall y[S(x,y) \rightarrow R(x,y)]\})
$$

Fall 2009

Step 0: ____________________________________________________________

Step 1: ____________________________________________________________

Step 2: ____________________________________________________________

Step 3: ____________________________________________________________

Step 4: ____________________________________________________________

Step 5: ____________________________________________________________

Step 6: ____________________________________________________________
I. Conversion to Clause Form (continued)

(1) Step 7: ________________________________

(2) Step 8: ________________________________

(2) Step 9: ________________________________

(2) Step 10: ________________________________
II. Resolution Refutation (30)

The only members of the EEL-5840 Gator club are Joe, Sally, Bill, and Ellen. Joe is married to Sally. Bill is Ellen's brother. The spouse of every married person in the club is also in the club. The last meeting of the club was at Joe’s house. Was the last meeting of the club at Sally’s house? Is Ellen not married?

Prove the two goals by using Resolution Refutation. Draw a Refutation Graph resulting from your choice of strategy. (Indicate clearly the required substitutions).

[Required: Please note the assigned point values. Each subpart MUST be answered with something. If left blank, then zero credit]

(5)  a. Represent the axioms/goal in the Predicate Calculus. {If you cannot do this, I will give it to you for the 5 points}
(4)  b. Represent the axioms/goal in clause form.
(2)  c. Is any commonsense knowledge needed to solve the problem? Explain. {If you can’t do it, I will give it to you for 2 pts}
(10) d. Give the Resolvents with the required substitutions.
(5)  e. Draw your Refutation Graph.
(2)  f. Prove formally that your substitutions are consistent.
(2)  g. Describe how your graph meets the strategy. What other strategy could you have used and why?

(5)  Answers Part a:

(4)  Answer(s) Part b:

(2)  Answer(s) Part c:

(10) Answers (Resolvents & required substitutions) Part d:
II. Resolution Refutation (continued)

(5) Refutation Graph Part d:

(2) Consistency Check Part e:

(2) Answer Part f: My strategy is:

What other strategy could you have used and why? Explain:
Fall 2009

(25) IV. Computation Deduction.

The following facts and rules establish that an English Noun Phrase (NP) is defined as a determiner, followed by an adjective, followed by a noun or a determiner followed by a noun. Set \{a,b,c,d\} are variables, set \{THE,GATORS,UNDEFEATED\} are constants, and set \{NP,DET,N,ADJ\} are functions/predicates.

F₁: DET(CONS(THE,a),a).
F₂: ADJ(CONS(UNDEFEATED,a),a).
F₃: N(CONS(GATORS,a),a).
R₁: [DET(a,b) ∧ N(b,c)] → NP(a,c)
R₂: [DET(a,b) ∧ ADJ(b,c) ∧ N(c,d)] → NP(a,d)

Evaluate the goal: NP(CONS(THE,CONS(UNDEFEATED,CONS(GATORS,NIL))),NIL) using computation deduction.

(Note: If you prefer, you may use the notation NP((THE UNDEFEATED GATORS),NIL).

Required: Tell me what your strategy is (1 pt). Give the clause form (3 pts) of the axiom set & the negation of the goal. Give me the Resolution resolvents (16 pts) using a complete strategy if you use Top-Down/Left-Right as a selection strategy. Prove the substitutions are consistent (4 pts). Obtain the value of the goal (1 pt).

(1) Tell me your strategy

(3) Give me your axioms & negation of the goal (the set \(\Gamma\)) in clause form

(16) Give me the Resolution Resolvents (there are a minimum six of them).
(4) Prove the substitutions are consistent.

(1) Give me the solved goal, i.e., the answer:
Fall 2010
(20) Conversion to Clause Form
I. Transform the wff \( A \) below into clause form. For each of the 10 “official steps” (the order is important!) required give a brief description of the step (1 point) and perform the step or write N/A (not applicable) on the space provided. Failure to follow this format will result in no credit. In wff \( A \) the set \( \{x, y\} \) are variables, the set \( \{P, Q, R\} \) are functions and there are no constants.

\[ \{wff \, A\}: (\forall x)[(\forall y)[P(x,y)] \rightarrow \sim(\forall y)[Q(x,y) \rightarrow R(x,y)] \]  

(1) Step 0: 

(4) Step 1: 

(2) Step 2: 

(2) Step 3: 

(2) Step 4: 

(1) Step 5: 

(4) Step 6: 
Fall 2010

I. Conversion to Clause Form (continued)

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II. Resolution Refutation (30)

Prove by using **Resolution Refutation with the answer literal**. Draw a **Refutation Graph** resulting from your choice of strategy. (Indicate clearly the required substitutions).

(5) a. Represent the axioms/goal in the Predicate Calculus. {If you cannot do this, I will give it to you for the 5 points}
(2) b. Is any commonsense knowledge needed to solve the problem? Explain. {If you can’t do it, I will give it to you for 2 pts}
(4) c. Represent the axioms/goal in clause form.
(10) d. Give the Resolvents with the required substitutions.
(5) e. Draw your Refutation Graph.
(2) f. Explain how your substitutions are consistent.
(1) g. Describe how your graph meets the strategy. What other strategy could you have used and why?
(1) h. Does anyone have an exciting life? Who has an exciting life?

(5) Answers Part a:

(2) Answer(s) Part b:

(4) Answer(s) Part c:

(10) Answers (Resolvents & required substitutions) Part d:
II. Resolution Refutation (continued)

(5) Refutation Graph Part e:

(2) Are your substitutions Consistent? Explain Part f:

(1) Answer Part g: My strategy is: __________________________________________

   What other strategy could you have used and why? Explain:

(1) Answer Part h: Does anyone have an exciting life?: ________________________________

   Who has an exciting life? ______________________________
III. Adversarial Search

Consider the following game tree in which the static scores (in parentheses at the tip nodes) are all from the first player’s point of view.

(a) Assuming that the first player is the maximizing player, what move should the first player choose?

(b) Assuming that the first player is the minimizing player, what move should the first player choose?

(c) What nodes would not need to be examined in part (a) using the alpha-beta algorithm—assuming that the nodes are examined in left-to-right order?

(d) What nodes would not need to be examined in part (b) using the alpha-beta algorithm—assuming that the nodes are examined in right-to-left order?

(e) Is the first player’s move in parts (a) and (c) or in parts (b) and (d) different? Explain.

Part (a): What move should the first player choose? ____________________________

Part (b): What move should the first player choose? ____________________________
III. Adversarial Search (continued)

Part (c): What nodes would not need to be examined in part (a)?____________________________

Part (d): What nodes would not need to be examined in part (b)?____________________________

Part (e): Is the first player’s move in parts (a) and (c) or in parts (b) and (d) different? ________________

Explain: