Jonathan Tso - CS 151 - Homework 3

Part 1:

Exercise 1:

CPU time: 0.011s
SAT -1 -2 3 -4 -5 -6 -7 -8 -9 10 11 -12 -13 -14 -15 -16 -17 -18 19 -20 -21 22 -23 -24 -25 -26 -27 -28 -29 30 31 -32 -33 -34 -35 -36 -37 -38 39 -40 -41 42 -43 -44 -45 -46 -47 48 -49 -50 51 -52 -53 -54 -55 -56 57 -58 -59 -60 -61 -62 -63 64 -65 -66 -67 68 -69 -70 -71 -72 -73 -74 75 76 -77 -78 -79 -80 -81 82 -83 -84 -85 -86 -87 88 -89 -90 -91 -92 -93 94 -95 -96 -97 -98 -99 100 -101 -102 -103 -104 105 106 -107 -108 -109 -110 -111 -112 -113 114 -115 -116 -117 118 -119 -120 -121 122 -123 -124 -125 -126 -127 128 -129 -130 -131 -132 -133 -134 -135 -136 137 -138 139 -140 -141 142 -143 -144 -145 -146 -147 148 149 -150 151 -152 -153 154 -155

A. Japanese owns the zebra (31)
B. Japanese drinks coffee (106). Japanese lives in green house (57)

Exercise 2:

A. Create a clause that basically states (And.. not this satisfiability solution). This basically means that I am going to create an inverse of the satisfiability to state that it is NOT the existing satisfiability solution.

B. 1 2 -3 4 5 6 7 8 9 -10 -11 12 13 14 15 16 17 18 -19 20 21 -22 23 24 25 26 27 28 29 -30 -31 32 33 34 35 36 37 38 -39 40 41 -42 43 44 45 46 47 -48 49 50 -51 52 53 54 55 56 -57 58 59 60 61 62 63 -64 65 66 67 -68 69 70 71 72 73 74 -75 -76 77 78 79 80 81 -82 83 84 85 86 87 -88 89 90 91 92 93 -94 95 96 97 98 99 -100 101 102 103 104 -105 -106 107 108 109 110 111 112 113 -114 115 116 117 -118 119 120 121 -122 123 124 125 126 127 -128 129 130 131 132 133 134 135 136 -137 138 -139 140 141 -142 143 144 145 146 147 -148 -149 150 -151 152 153 -154 155 0

C. CPU time: 0.009s UNSAT

Exercise 3:

A. Under the rule that says "82 0" I modified to say "82 81 0" to account for 82 or 81, which is the Japanese will smoke Parliament or Old Gold

B.CPU time: 0.012s

SAT -1 -2 -3 -4 5 -6 -7 8 -9 -10 11 -12 -13 -14 -15 -16 -17 -18 19 -20 -21 22 -23 -24 -25 26 -27 -28 -29 -30 -31 -32 -33 -34 35 -36 -37 -38 39 -40 -41 42 -43 -44 -45 -46 -47 48 -49 -50 51 -52 -53 -54 -55 -56 -57 58 -59 -60 -61 -62 -63 64 -65 -66 67 -68 -69 -70 -71 -72 -73 -74 75 -76 -77 -78 79 -80 81 -82 -83 -84 -85 -86 -87 88 -89 -90 -91 92 -93 -94 -95 -96 -97 -98 -99 100 -101 -102 103 -104 -105 -106 -107 -108 -109 110 -111 -112 -113 114 -115 116 -117 -118 -119 -120 -121 122 -123 -124 -125 -126 -127 -128 -129 -130 -131 132 -133 -134 -135 -136 137 138 -139 -140 -141 -142 143 -144 -145 -146 -147 148 -149 -150 151 152 -153 154 -155

This is a different truth assignment due to clause 3 (Englishman in house 2). This was originally true but under the modified solution, is now false.

Exercise 4:

A. My step in figuring out the remaining non-unique solutions is to include the new satisfiability rules as a "And ... not this" rule. For instance, under exercise 3, the englishman did not live in house 0. I would then include a rule that says "And the englishman did live in house 0." I will be inversing all of the clauses (effectively repeating step 2 until there is no more satisfiability).

B.

SAT -1 -2 3 -4 -5 -6 -7 -8 -9 10 11 -12 -13 -14 -15 -16 -17 -18 19 -20 -21 22 -23 -24 -25 26 -27 -28 -29 -30 -31 -32 -33 -34 35 -36 -37 -38 39 -40 -41 42 -43 -44 -45 -46 -47 48 -49 -50 51 -52 -53 -54 -55 -56 57 -58 -59 -60 -61 -62 -63 64 -65 -66 -67 68 -69 -70 -71 -72 -73 -74 75 -76 77 -78 -79 -80 81 -82 -83 -84 -85 -86 -87 88 -89 -90 -91 -92 -93 94 -95 -96 -97 -98 -99 100 -101 -102 -103 -104 105 106 -107 -108 -109 -110 -111 -112 -113 114 -115 -116 -117 118 -119 -120 -121 122 -123 -124 -125 -126 -127 128 -129 -130 -131 -132 -133 -134 -135 -136 137 -138 139 -140 -141 142 -143 -144 -145 -146 -147 148 149 -150 151 -152 -153 154 -155

SAT -1 -2 3 -4 -5 -6 -7 -8 -9 10 11 -12 -13 -14 -15 -16 -17 -18 19 -20 -21 22 -23 -24 -25 -26 -27 -28 29 -30 -31 -32 -33 -34 35 36 -37 -38 -39 -40 -41 42 -43 -44 -45 -46 -47 48 -49 -50 51 -52 -53 -54 -55 -56 57 -58 -59 -60 -61 -62 -63 64 -65 -66 -67 68 -69 -70 -71 -72 -73 -74 75 -76 77 -78 -79 -80 81 -82 -83 -84 -85 -86 -87 88 -89 -90 -91 -92 -93 94 -95 -96 -97 -98 -99 100 -101 -102 -103 -104 105 106 -107 -108 -109 -110 -111 -112 -113 114 -115 -116 -117 118 -119 -120 -121 122 -123 -124 -125 -126 -127 128 -129 -130 -131 -132 -133 -134 -135 -136 137 -138 139 -140 -141 142 -143 -144 -145 -146 -147 148 149 -150 151 -152 -153 154 -155

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92 -93 -94 95 -96 97 -98 -99 -100 -101 -102 103 -104 -105 -106 -107 -108 -109 110 -111 -112 -113 114 -115 116 -117 -118 -119 -120 -121 122 -123 -124 -125 -126 -127 -128 -129 -130 -131 132 -133 -134 -135 -136 137 138 -139 -140 -141 -142 143 -144 -145 -146 -147 148 -149 -150 151 152 -153 154 -155

SAT -1 -2 -3 -4 5 -6 -7 -8 9 -10 11 -12 -13 -14 -15 -16 -17 18 -19 -20 -21 22 -23 -24 -25 26 -27 -28 -29 -30 -31 -32 -33 -34 35 -36 -37 -38 39 -40 -41 42 -43 -44 -45 -46 -47 48 -49 -50 51 -52 -53 -54 -55 -56 57 -58 -59 -60 -61 -62 -63 64 -65 -66 -67 68 -69 -70 -71 -72 -73 -74 75 -76 -77 -78 79 -80 81 -82 -83 -84 -85 -86 -87 88 -89 -90 -91 92 -93 -94 -95 -96 -97 -98 -99 100 -101 -102 103 -104 -105 106 -107 -108 -109 -110 -111 -112 -113 114 -115 -116 -117 -118 -119 120 -121 122 -123 -124 -125 -126 -127 -128 -129 130 -131 -132 -133 -134 -135 -136 137 -138 139 -140 -141 -142 -143 -144 145 146 -147 -148 -149 -150 151 -152 -153 154 155

Englishman can own: Zebra and Fox
Japanese can own: Snail
Norwegian can own: Zebra and Fox
Spaniard can own: Dog
Ukranian can own: Horse

Jonathan Tso
HW 3

Problem 5 $(\forall X)(\exists Y)(\text{loves}(X,Y))$

a) Domain: All persons living on earth
True: Everyone in this world loves somebody
False: There exists one person that loves no one

b) $p(X) \rightarrow \neg p(X)$ $(\neg p(x) \vee \neg p(x))$

Domain: All X

True: $p(X)$ is false

False: $p(X)$ is true

c) $(\exists_x)\, p(X) \rightarrow \forall_x\, p(X)$ $\neg(\forall_x \bar{p}(x) \vee \forall_x p(x))$ $\exists_x p(x) \wedge \exists_x \bar{p}(x)$

Domain: All players on soccer team
True: If one team member got cake, everyone gets cake
False: someone got cake, but someone else on the team did not get cake

d) $(p(X,Y) \wedge p(Y,Z)) \rightarrow p(X,Z)$
Domain: All integers
True: $p(A,B)$ is true when $A < B$

X is less than Y and Y is less than Z, so X is less than Z

False: $Z - X = 1$

There is no integer between X and Z such that it is greater than X but less than Z

Problem 6

a) $\neg((\forall_x)(\exists_y)\, p(X,Y))$

$((\exists_x)(\forall_y)\, \neg p(X,Y))$

b) $\neg((\forall_x)\, p(X) \vee (\exists_y)\, q(X,Y))$

$((\exists_x)\, \bar{p}(X) \wedge (\forall_y)\, \bar{q}(X,Y))$

Problem 7 Is E a tautology when $(\exists_x)E$ is a tautology?

Yes. Consider when expression E is accounting for multiple variables such as x, y, z. Then, irregardless of y and z variables, this is still a tautology for $(\exists_x) E$. That then means that it must be a tautology even without the specific $\exists_x$, and we can then assume a different x. This then continues to hold true until we reach that $\forall_x E$ is a tautology.

Problem 8
1 Actor x was in movie 1 with actor Y
2 Actor Y was in movie 2 with actor BOB

$$\forall x \exists M_1 M_2 y \left[C(x, M_1) \wedge C(y, M_1) \wedge C(y, M_2) \wedge C(BOB, M_2) \right]$$

The above is also true if it is in less than 2 hops, as then $x = y$