CS 8803
Logic in Computer Science

Project 1 – Interim Report

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Link to Github: https://github.com/saranya-05/DPLL-SAT-Solver

CNF Encoding

There are 125 possible variables, each representing a unique combination of house number and category within five different categories.

1: color(1, red)
2: color(2, red)
3: color(3, red)
4: color(4, red)
5: color(5, red)
6: color(1, green)
7: color(2, green)
8: color(3, green)
9: color(4, green)
10: color(5, green)
11: color(1, white)
12: color(2, white)
13: color(3, white)
14: color(4, white)
15: color(5, white)
16: color(1, blue)
17: color(2, blue)
18: color(3, blue)
19: color(4, blue)
20: color(5, blue)
21: color(1, yellow)
22: color(2, yellow)
23: color(3, yellow)
24: color(4, yellow)
25: color(5, yellow)
26: nation(1, british)
27: nation(2, british)
28: nation(3, british)
29: nation(4, british)
30: nation(5, british)
31: nation(1, swedish)
32: nation(2, swedish)

33: nation(3, swedish)
34: nation(4, swedish)
35: nation(5, swedish)
36: nation(1, danish)
37: nation(2, danish)
38: nation(3, danish)
39: nation(4, danish)
40: nation(5, danish)
41: nation(1, norwegian)
42: nation(2, norwegian)
43: nation(3, norwegian)
44: nation(4, norwegian)
45: nation(5, norwegian)
46: nation(1, german)
47: nation(2, german)
48: nation(3, german)
49: nation(4, german)
50: nation(5, german)
51: drink(1, tea)
52: drink(2, tea)
53: drink(3, tea)
54: drink(4, tea)
55: drink(5, tea)
56: drink(1, coffee)
57: drink(2, coffee)
58: drink(3, coffee)
59: drink(4, coffee)
60: drink(5, coffee)
61: drink(1, water)
62: drink(2, water)
63: drink(3, water)
64: drink(4, water)
65: drink(5, water)
66: drink(1, beer)
67: drink(2, beer)
68: drink(3, beer)
69: drink(4, beer)
70: drink(5, beer)
71: drink(1, milk)
72: drink(2, milk)
73: drink(3, milk)
74: drink(4, milk)
75: drink(5, milk)
76: cigar(1, prince)
77: cigar(2, prince)
78: cigar(3, prince)
79: cigar(4, prince)

80: cigar(5, prince)
81: cigar(1, blends)
82: cigar(2, blends)
83: cigar(3, blends)
84: cigar(4, blends)
85: cigar(5, blends)
86: cigar(1, pallmall)
87: cigar(2, pallmall)
88: cigar(3, pallmall)
89: cigar(4, pallmall)
90: cigar(5, pallmall)
91: cigar(1, bluemasters)
92: cigar(2, bluemasters)
93: cigar(3, bluemasters)
94: cigar(4, bluemasters)
95: cigar(5, bluemasters)
96: cigar(1, dunhill)
97: cigar(2, dunhill)
98: cigar(3, dunhill)
99: cigar(4, dunhill)
100: cigar(5, dunhill)
101: pet(1, dog)
102: pet(2, dog)
103: pet(3, dog)
104: pet(4, dog)
105: pet(5, dog)
106: pet(1, cat)
107: pet(2, cat)
108: pet(3, cat)
109: pet(4, cat)
110: pet(5, cat)
111: pet(1, bird)
112: pet(2, bird)
113: pet(3, bird)
114: pet(4, bird)
115: pet(5, bird)
116: pet(1, horse)
117: pet(2, horse)
118: pet(3, horse)
119: pet(4, horse)
120: pet(5, horse)
121: pet(1, fish)
122: pet(2, fish)
123: pet(3, fish)
124: pet(4, fish)
125: pet(5, fish)

The relation for generating CNF for each formula is mentioned below:

Using pair_relationship function, we generate relations between 2 different categories with $(-x \cup y) \cap (x \cup -y)$ for every possible variable with this relation. For this formula, we convert it to CNF for every possible combination of relation for every literal.

Brit lives in the red house. $(Brit \cup -red)\ ) \cap (-Brit \cup red)$

-26 1 0

26 -1 0

-27 2 0

27 -2 0

-28 3 0

28 -3 0

-29 4 0

29 -4 0

-30 5 0

30 -5 0

Swede keeps dogs as pets. $(Swede \cup -dog)\ ) \cap (-dog \cup Swede)$

-31 101 0

31 -101 0

-32 102 0

32 -102 0

-33 103 0

33 -103 0

-34 104 0

34 -104 0

-35 105 0

35 -105 0

Dane drinks tea. $(Dane \cup -tea)\ ) \cap (-Dane \cup tea)$

-36 51 0

36 -51 0

-37 52 0

37 -52 0

-38 53 0

38 -53 0

-39 54 0

39 -54 0

-40 55 0

40 -55 0

green house is on the left of the white house. Color(i, white) ∩ Color(i-1, green)

-11 -10 0

-11 -9 0

-11 -8 0

-11 -7 0

-12 -10 0

-12 -9 0

-12 -8 0

-13 -10 0

-13 -9 0

-13 -6 0

-14 -10 0

-14 -7 0

-14 -6 0

-15 -8 0

-15 -7 0

-15 -6 0

green house's owner drinks coffee. $(Green \cup -coffee)\ ) \cap (-coffee \cup Green)$

-6 56 0

6 -56 0

-7 57 0

7 -57 0

-8 58 0

8 -58 0

-9 59 0

9 -59 0

-10 60 0

10 -60 0

person who smokes Pall Mall rears birds. $(PallMall \cup -Bird)\ ) \cap (-Bird \cup Pallmall)$

-86 111 0

86 -111 0

-87 112 0

87 -112 0

-88 113 0

88 -113 0

-89 114 0

89 -114 0

-90 115 0

90 -115 0

owner of the yellow house smokes Dunhill. $(Yellow \cup -Dunhill)\ ) \cap (-Dunhill \cup Yellow)$

-21 96 0

21 -96 0

-22 97 0

22 -97 0

-23 98 0

23 -98 0

-24 99 0

24 -99 0

-25 100 0

25 -100 0

man living in the center house drinks milk. Beverage(3,milk)

73 0

Norwegian lives in the first house. house(1, Norwegian)

41 0

man who smokes Blends lives next to the one who keeps cats. Cigar(i,blends) $\cap\ pet(i - 1, cat) \cap pet(i + 1, cat)$

-81 107 0

-85 109 0

-82 106 108 0

-83 107 109 0

-84 108 110 0

man who keeps the horse lives next to the man who smokes Dunhill. pet(i,horse) $\cap\ cigar(i - 1, Dunhill) \cap cigar(i + 1, Dunhill)$

-116 97 0

-120 99 0

-117 96 98 0

-118 97 99 0

-119 98 100 0

owner who smokes Bluemasters drinks beer. $(Bluemasters \cup -beer)\ ) \cap (-beer \cup Bluemasters)$

-91 66 0

91 -66 0

-92 67 0

92 -67 0

-93 68 0

93 -68 0

-94 69 0

94 -69 0

-95 70 0

95 -70 0

German smokes Prince. $(German \cup -Prince)\ ) \cap (-Prince \cup German)$

-46 76 0

46 -76 0

-47 77 0

47 -77 0

-48 78 0

48 -78 0

-49 79 0

49 -79 0

-50 80 0

50 -80 0

Norwegian lives next to the blue house. House(1, Norwegian)

41 0

man who smokes Blends has a neighbor who drinks water. cigar(i,blends) ∩ $drink(i-1, water) \cap drink(i+1, water)$

-81 62 0

-85 64 0

-82 61 63 0

-83 62 64 0

-84 63 65 0

SAT Solution

[-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]

The SAT solution above provides a set of positive literals for each category, indicating which relations are true. Based on this solution, we can infer the following truths:
To answer the question, "Who owns the fish?" - Literal 124: "pet(4, fish)" implies that the person with house number 4 owns the fish. Therefore, the German, who also smokes Prince, drinks coffee, and lives in the green house, is the one who owns the fish.

✓ 73: drink(3, milk)
✓ 17: color(2, blue)
✓ 124: pet(4, fish)
✓ 117: pet(2, horse)
✓ 113: pet(3, bird)
✓ 106: pet(1, cat)
✓ 105: pet(5, dog)
✓ 96: cigar(1, dunhill)
✓ 95: cigar(5, bluemasters)
✓ 88: cigar(3, pallmall)
✓ 82: cigar(2, blends)
✓ 79: cigar(4, prince)

✓ 70: drink(5, beer)
✓ 61: drink(1, water)
✓ 59: drink(4, coffee)
✓ 52: drink(2, tea)
✓ 49: nation(4, german)
✓ 41: nation(1, norwegian)
✓ 37: nation(2, danish)
✓ 35: nation(5, swedish)
✓ 28: nation(3, british)
✓ 21: color(1, yellow)
✓ 15: color(5, white)
✓ 9: color(4, green)
✓ 3: color(3, red)