CS7637: Knowledge-Based AI

Homework 1

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1 QUESTION 1 - FRODO, SAM, GOLLUM, AND ONE RING

1.1 Construct Semantic network

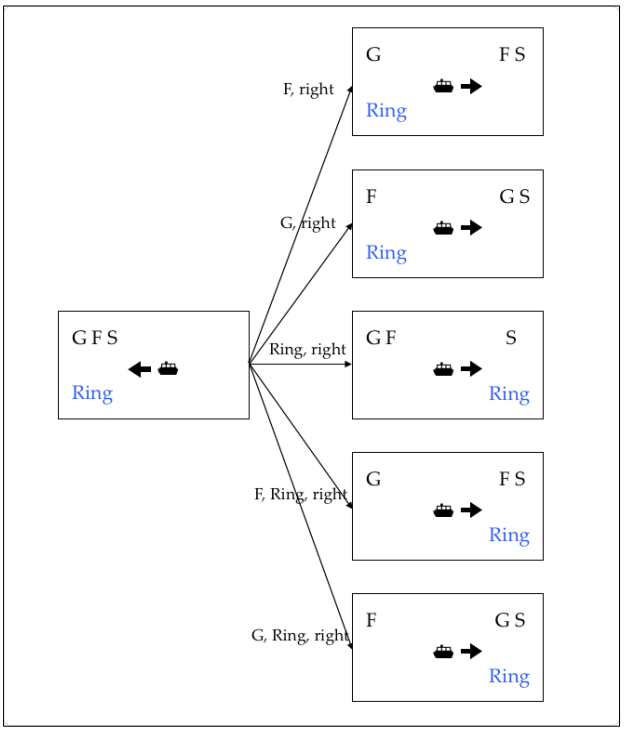

Figure 1— Two states with a transition between them.

In this semantic network, Frodo, Sam, and Gollum are represented by their initial letters: F, S, G. Since only Sam can steer the raft, there is no need to include the letter S in transitions.

Here, I represent the first two states of the problem in which the initial state contains the beginning scenario, and the second shows all 5 possible results after transitions. Transition information is shown on arrows. The generator is not smart now, so it may allow S to move F or G with the Ring together.

1.2 Apply Generate & Test

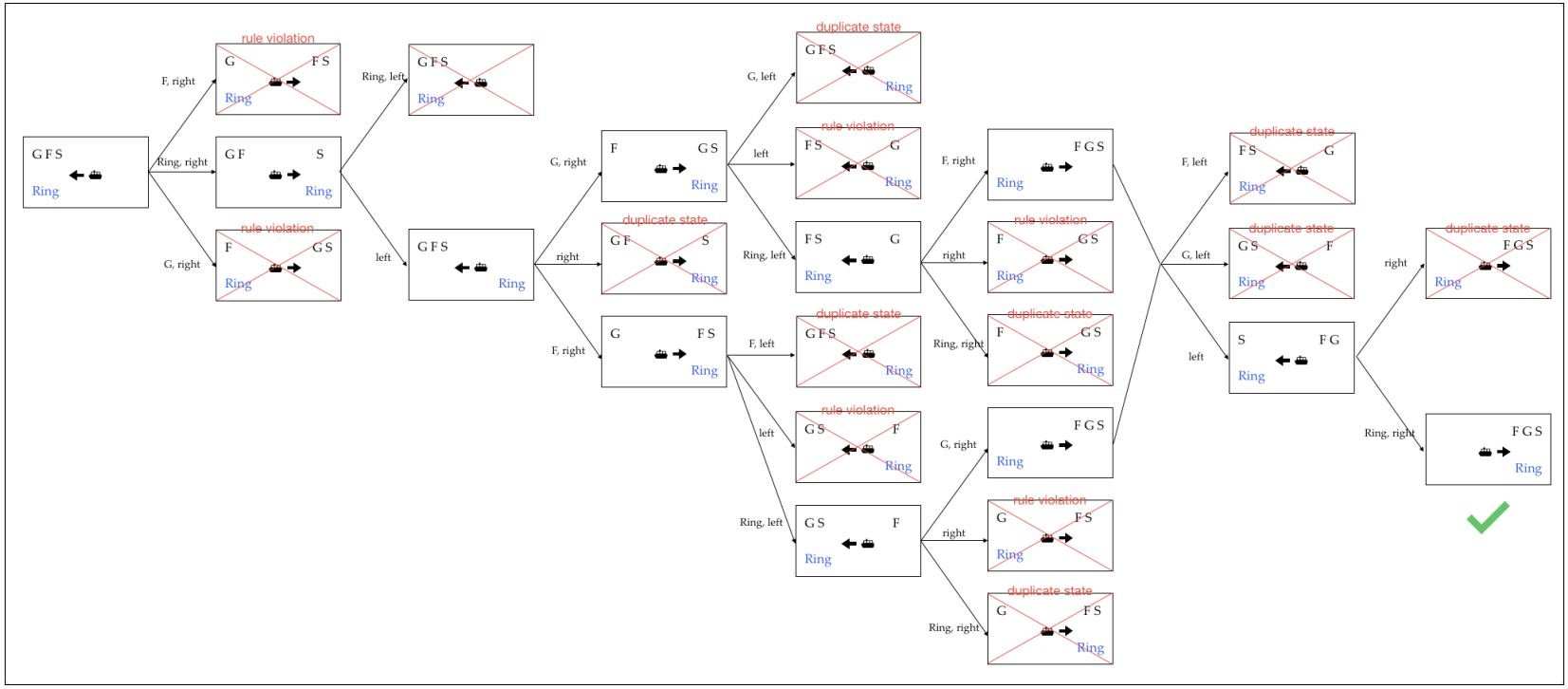

Figure 2 — The entire semantic network solves the problem. The network is created using Apple Freeform.

Figure 2 shows the entire network. Now my generator is smart to only make valid moves: it no longer moves G or F and the ring together at once.

A red cross means the tester rules out the state because 1) the One Ring is alone with either Frodo or Gollum, or 2) the state has shown up previously. The tester rules out all such states before the generator moves to the next depth. The final solution includes 7 transitions, e.g. (Ring, right), (left), (G, right), (Ring, left), (F, right), (left), (Ring, right).

2 QUESTION 2 - UNO GAME

2.1 UNO Agent Pseudocode and Rules

```
1) if my_turn, top_card in ['Skip', 'Reverse']:
        Do nothing and my_turn = False

2) if my_turn, top_card is in ['Draw 2 cards', 'Wild Draw 4 cards']:
        Draw the indicated number of cards, and my_turn = False

3) if !my_turn, any playable_card of other players == 1, “Uno!” is False:
        Says “Uno!”

4) if my_turn, card_in_hand == 2 and playable_card >= 1:
        enable play_operator to play and says “Uno!”

5) if my_turn, top_card == (color X, value Y):
        enable play_operator when card is selected later
        if color X in playable_card and value Y in playable_card:
            count num1 = the number of color X I have
            count num2 = the number of color(s) that value Y I have
            if num1 >= num2:
                if has 'Draw 2 card':
                    play 'Draw 2 card'
                elif has 'Skip':
                    play 'Skip'
                else:
                    randomly select a card of color X to play
                    my_turn = False
            else:
                if has 'Draw 2 card':
                    play 'Draw 2 card'
                elif has 'Skip card':
                    play 'Skip card'
                else:
                    randomly select a card of color X to play
                    my_turn = False
        elif color X in hands:
            randomly select a card of color X to play
            my_turn = False
        elif value Y in hands:
            randomly select a card of value Y to play
            my_turn = False
        elif: I have "Wild Draw 4 cards" or 'Wild':
            play "Wild Draw 4 cards" first, otherwise 'Wild'
            enable color_operator and my_turn = False
        else:
            Draw a new card
            if new_card is of color X or value Y:
                play new_card and my_turn = False
            elif new_card == "Wild Draw 4 card" or 'Wild':
                play "Wild Draw 4 cards" first, otherwise 'Wild'
                enable color_operator and my_turn = False
            else:
                my_turn = False

6) if play_operator in ["Wild Draw 4 cards", 'Wild']:
        enable color_operator and my_turn = False

7) if my_turn, color_operator is enabled:
        select the color that I have most cards.
        if I have same numbers of cards of different colors:
            randomly choose a color from them.
```

My rule-based UNO agent contains the following information in its working memory: the top card (color X, value Y), cards in hands (including normal cards, special cards, and black cards), number of cards in other players' hands, my turn (True/False).

Given this knowledge, the agent will play according to the above rules.

2.2 Working Rationale and Strategies?

The reason that my agent works the way it does is that it follows my own way of playing UNO. The rule of thumb is to try its best to discard a card in each round. Then, when there are several cards that it can choose to play, it first plays the one that can lead to the color that it has the most of so that the probability of continuing this color in the following rounds is higher. Otherwise, it tries special cards or black cards if has any. Finally, it draws a new card if none of the mentioned cards is available.

When deciding, it indeed considers things mentioned in the requirements such as 1) how to play Wild cards and choose color, 2) how it selects from multiple available cards, 3) the current card on top of the pile, etc. Suppose the top card played by the previous player is Red 5:

1) The agent will count the number of red cards. If it has 5 in other colors, count the number of these colors, too. Since there are only 4 cards of 5, the color is likely to play a more important role. It will play the color with a larger number of cards, so it is easier to discard cards later.
2) After choosing a color, my agent will rank the importance of cards in the following order: black cards > special cards > normal cards. It punishes the next player the most seriously with special cards or black cards once it has the chance.
3) If no card to play, it draws a card and put it into the evaluation again to see if this card can be played immediately.
4) When the top card is Wild Draw 4 or Wild, the agent chooses the color of the greatest number of cards it has. When choosing Wild Draw 4 or Wild to play, it determines the color in the same way described in 1).
5) When the top card is Draw 2 or Wild Draw 4, it draws and skips its turn.

2.3 Entire Game Progress – 4 Player, Easy Mode

	Top Card	Progress
0	W4	Initial cards: R6, R8, YR, Y1, Y8, B0, GR Agent (Player 1) action: no cards could be played after W4; choose Yellow, because it has the greatest number of the yellow card. Final cards: R6, R8, YR, Y1, Y8, B0, GR, YS, YD2, Y4, Y7
1	P2 – Y9 P3 – Draw P4 – Y1	Agent (Player 1) action: Y1 Reason: no other 1 card; random selection from yellow. Final cards: R6, R8, YR, Y8, B0, GR, YS, YD2, Y4, Y7
3	P2 – Y7 P3 – Y2 P4 – Y6	Agent (Player 1) action: Y7 Reason: it has R6, but fewer cards in red than yellow; random selection from Y. Final cards: R6, R8, YR, Y8, B0, GR, YS, YD2, Y4
4	P2 – Y3 P3 – G3 P4 – G1	Agent (Player 1) action: GR Reason: no 1 in other colors; no normal green cards to play. Final cards: R6, R8, YR, Y8, B0, YS, YD2, Y4
5	P4 – G8 P3 – W - R P2 – R7	Agent (Player 1) action: R6 Reason: no 7 in other colors; random selection from R. Final cards: R8, YR, Y8, B0, YS, YD2, Y4
6	P4 – Draw, R5 P3 – Draw, R4 P2 – W4 - G	Agent (Player 1) action: None Reason: my turn is skipped by Wild Draw 4 card. Final cards: R8, YR, Y8, B0, YS, YD2, Y4, W4, YD2, BD2, GD2
7	P4 – Draw P3 – Draw P2 – G0	Agent (Player 1) action: GD2 Reason: only this green card left. Final cards: R8, YR, Y8, B0, YS, YD2, Y4, W4, YD2, BD2
8	P4 – Skipped P3 – RD2 P2 – Skipped	Agent (Player 1) action: R8 Reason: only this red card left; Draw 2 card cannot be stacked. Final cards: YR, Y8, B0, YS, YD2, Y4, W4, YD2, BD2
9	P4 – RR	Agent (Player 1) action: YR Reason: no red card left; it has a reverse in yellow Final cards: Y8, B0, YS, YD2, Y4, W4, YD2, BD2
10	P4 – Y5 P3 – Y6 P2 – Draw- G6	Agent (Player 1) action: W4, choose yellow Reason: no green card left; it has the most of yellow cards. Final cards: Y8, B0, YS, YD2, Y4, YD2, BD2
11	P4 – Skipped P3 – Draw P2 – Draw	Agent (Player 1) action: YD2 Reason: it prioritizes Draw 2 Card over other cards in the same color to punish the next player. Final cards: Y8, B0, YS, YD2, Y4, BD2
12	P4 – Skipped P3 – Draw P2 – Draw	Agent (Player 1) action: YD2 Reason: similarly, it punishes the next player. Final cards: Y8, B0, YS, Y4, BD2

13	P4 – Skipped P3 – Draw P2 – Draw	Agent (Player 1) action: YS Reason: it prioritizes Skip Card over normal cards in the same color to punish the next player. Final cards: Y8, B0, Y4, BD2
14	P3 – RS	Agent (Player 1) action: draw a card, B2 Reason: no playable card, and the drawn card is not red Final cards: Y8, B0, Y4, BD2, B2
15	P4 – R2 P3 – R8 P2 – R7	Agent (Player 1) action: draw a card, R9, play R9. Reason: no playable card, and the drawn card is in red. Final cards: Y8, B0, Y4, BD2, B2
16	P4 – RS P2 – GS P4 – G7 P3 – G6 P2 – G3	Agent (Player 1) action: draw a card, Wild, choose Blue Reason: no playable card, Wild can be used immediately, it has most of blue cards. Final cards: Y8, B0, Y4, BD2, B2
17	P4 – B1 P3 – B7 P2 – B4	Agent (Player 1) action: BD2 Reason: it has blue cards; it prioritizes Draw 2 card to punish other players. Final cards: Y8, B0, Y4, B2
18	P4 – Skipped P3 – B9 P2 – Draw	Agent (Player 1) action: B2 Reason: no 9 in other colors; no special cards in blue to punish others; random selection between B0 and B9 Final cards: Y8, B0, Y4
19	P4 – B3 P3 – B1 P2 – B3	Agent (Player 1) action: B0 Reason: no 3 in other colors; no blue special cards; no black cards; B0 is the only blue card to play. Final cards: Y8, Y4
20	P4 – B8 P3 – B6, UNO P2 – B4	Agent (Player 1) action: call UNO for P3, play Y4, call UNO Reason: punish P3; 4 is also in yellow; it has 2 yellow cards; random selection between Y4 and Y8; one card left so call UNO! Final cards: Y8
21	P4 – Draw, Y3 P3 – Draw P2 – Draw	Agent (Player 1) action: Y8 Reason: the number of cards in hand is 1; the last card is playable. Victory. Game is over.

2.4 Reflection on the agent's rules

I select Round 3 I would have made a different move than the one dictated by my agent's rules:

3	P2 – Y7 P3 – Y2 P4 – Y6	Agent (Player 1) action: Y7 Reason: it has R6, but fewer cards in red than yellow; random selection from Y. Final cards: R6, R8, YR, Y8, B0, GR, YS, YD2, Y4

In my initial pseudocode, I treat the yellow number card and the yellow Draw 2 card the same. In other words, if the agent means to play a yellow card, it selects one randomly. Before my human reasoning, I need to mention that I disable the Special Mode: Play +4 whenever you want. You can stack +2/+4 cords on top of your opponents. Because:

Figure 3 — UNO's official tweet claims that a Draw 2 card cannot be stacked on another Draw 2 card.

Then, I suddenly realize that I would have played YD2. It is more difficult to play a yellow Draw 2 card as it only matches the same color (cannot be stacked on another Draw 2 card) while a yellow number card also matches a certain number. So, in terms of discarding cards, I think a number card should be saved for later rounds. Also, I think it is always useful to punish the next player as much as possible because the agent may not have the chance to use the Draw 2 card if the color does not match. Therefore, in this round, my agent should choose YD2 among other Y cards.

The difference **could be** resolved within the agent's rule structure. I added the priority information in the pseudocode asap and let it play Draw 2 cards once it gets the chance as shown in Rounds 11 and 12.

Note: in Round 20, my agent should be able to yell out "UNO" before P3 but failed as P3 is a computer player which won't give it the chance:

20	P4 – B8 P3 – B6, UNO P2 – B4	Agent (Player 1) action: call UNO for P3, play Y4, call UNO Reason: punish P3; 4 is also in yellow; it has 2 yellow cards; random selection between Y4 and Y8; one card left so call UNO! Final cards: Y8