Zach Baker

COG 356 Assignment 2

This is a problem set based on chapter 1 of Hofstadter's Goedel, Escher, Bach. In this chapter, a post-production system regarding the letters M, I, and U is discussed.

1. What does Hofstadter claim is one of the most central notions running through GEB?

One of the most central notions is that of a formal system.

2. Who invented the sort of formal system that Hofstadter features in his book (the sort of system that the MIU-system expemplifies), and when did this invention take place?

The sort of formal system featured here was invented by the American logician Emil Post in the 1920's.

3. In one four-word question, state the puzzle that is featured in this chapter.

Can you produce MU?

4. What is the given string in the MIU-system?

The given string is MI.

5. What is the goal string of the MU-puzzle?

The goal string is MU.

6. How many rules are in the MIU-system?

There are four rules in the MIU-system.

7. Carefully, precisely, write down the first rule of the MIU-system, and give two examples of its use, one directly from the chapter, and one that does not appear explicitly in the chapter.

RULE I: If you possess a string whose last letter is I, you can add on a U at the end.

EX: MI -> MIU

EX: MII -> MIIU

8. Carefully, precisely, write down the second rule of the MIU-system, and give two examples of its use, one directly from the chapter, and one that does not appear explicitly in the chapter.

RULE II: Suppose you have Mx. Then you may add Mxx to your collection.

EX: MIU -> MIUIU

EX: MII -> MIIII

9. Carefully, precisely, write down the third rule of the MIU-system, and give two examples of its use, one directly from the chapter, and one that does not appear explicitly in the chapter.

RULE III: If III occurs in one of the strings in your collection, you may make a new string with U in place of III.

EX: MIII -> MU

EX: MUUIIIU -> MUUUU

10. Carefully, precisely, write down the fourth rule of the MIU-system, and give two examples of its use, one directly from the chapter, and one that does not appear explicitly in the chapter.

RULE IV: If UU occurs inside one of your strings, you can drop it.

EX: UUU -> U

EX: MUUU -> MU

11. What is the word used to describe strings that are producible by the rules of a formal system from strings that have already been produced?

Theorem.

12. What is the technical term for the string MI in the MIU-ystem?

Axiom.

13. In a formal system, is it more appropriate to say that theorems are proven or that theorems are produced?

It is more appropriate to say that theorems are proven, as they are concrete in that they already existed before the proof.

14. How does Hofstadter define the term derivation?

Hofstadter defines derivation by saying "A derivation of a theorem is an explicit, line-by-line demonstration of how to produce that theorem according to the rules of the formal system."

15. Reproduce, line by line, character by character (including "reasons" (rule citations))

Hofstadter's derivation of the string MUIIU.

(1) MI - from (0) by axiom

(2) MII - from (1) by rule II

(3) MIII - from (2) by rule II

(4) MIIIIU - from (3) by rule I

(5) MUIU - from (4) by rule III

(6) MUIUUIU - from (5) by rule II

(7) MUIIU - from (6) by rule IV

16. Write down, line by line (including "reasons" (rule citations)) a derivation of the string

MIIUIIU.

(1) MI - from (0) by axiom

(2) MII - from (1) by rule 2

(3) MIIU - from (2) by rule 1

(4) MIIUIIU - from (3) by rule 2

17. On page 37, Hofstadter claims that there is a fundamental difference between a machine and a human? What is that difference?

Hofstadter claims that the difference between machines and humans is that humans are incapable of not operating observantly.

18. With respect to formal systems, what is the difference between "working inside the system" and "working outside the system".

Within formal systems, working inside the system means using only the rules available within the system, while working outside the system can involve more complex processes and reflective thinking or metacognition.

19. Are there any theorems in the MIU-system that do not start with the letter M?

No.

20. How is the previous question answered, by working within the system or by working outside the system.

The question can be answered by observing that the rules available offer no ability to change the first letter of the string.

21. What does "M-mode" refer to? What does "I-mode" refer to?

M-mode stands for mechanical mode, while I-mode stands for intelligent mode.

22. Do you think that humans can work in M-mode? Please defend your answer.

I think that humans can approximate M-mode with practice, though there might have to be some definition stretching. We will likely never operate in M-mode exactly like a machine can, due to the difference in proclivities of our hardware.

23. Do you think that machines can work in I-mode? Please defend your answer.

Yes, I think that some machines might be able to work in I-mode, though it is not such a binary thing. As far as I can tell, I-mode is the expression of general intelligence, and while no computer has yet to express the level of general intelligence found in most human children, we are making regular progress in the field, and so it is possible in theory. It also depends greatly on the task in question.

24. Two of the rules of the MIU-system are lengthening rules. What does this mean? Two of the rules of the MIU-system are shortening rules. What does this mean?

Two rules of the MIU-system can be used to make a string in our collection smaller, while the other two rules, when applied, will make a given string longer.

25. Define "decision procedure" with respect to a formal system.

A decision procedure is a method which can be consistently used to determine the state of existence of any given element in a given system in a finite amount of time.