GP - GEB Problem Set: The MIU-system

Name: Jordan Bailey

Abstract: This problem set is based on Chapter 1 of Hofstadter's GEB. In this chapter, Hofstadter describes his first Post-Production system called, the MIU-system.

Ten Salient Ideas from "Introduction: A Musico-Logical Offering"

1. What, does Hofstadter claim, is one of the most central notions running through GEB?
   Hofstadter claims *formal systems* is one of the most central notions in the book.
2. Who invented the sort of formal system that Hofstadter features in his book (the sort of system that the MIU-system exemplifies), and when did this invention take place?
   American logician Emil Post in the 1920s.
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?
   This system utilizes only three letters of the alphabet: M,I,U. Meaning the only strings within the MIU-system are strings composed of these three letters.
5. What is the goal string of the MU-puzzle?
   The goal is to produce the string 'MU' by starting out with MI and adhering to the rules of the system.
6. How many rules are in the MIU-system?
   Four
7. Carefully, precisely, write down the first rule of the MIU-system, and give two examples of its use, one from the chapter, and one that does not appear explicitly in the chapter.
   If you possess a string whose last letter is 'I', you can add on a 'U' at the end.
   Ex. MI → MIU,
   Ex. MIUII → MIUIIU
8. Carefully, precisely, write down the second rule of the MIU-system, and give two examples of its use, one from the chapter, and one that does not appear explicitly in the chapter.
   If you have a string 'Mx' (where 'x' is considered as any usable character within the formal system), you may add 'Mxx' to the collection.
   Ex. From MIU→MIUIU
   Ex. From MIM→ MIMIM
9. Carefully, precisely, write down the third rule of the MIU-system, and give two examples of its use, one from the chapter, and one that does not appear explicitly in the chapter.
   If 'III' occurs in one of the strings in the collection, you may make a new string with 'U' in place of the 'III'.
   Ex. UMIIIMU → UMUMU
   Ex. MIIIMIII→ MUM

10. Carefully, precisely, write down the fourth rule of the MIU-system, and give two examples of its use, one from the chapter, and one that does not appear explicitly in the chapter.
    If 'UU' occurs inside one of your strings, you can drop it.
    Ex. UUU → U
    Ex. MUIUUUI → MUIUI
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-system?
    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 these theorems are produced.
14. How does Hofstadter define the term *derivation*?
    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 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 axiom
    (2) MII from (1) by rule II
    (3) MIIU from (2) by rule I
    (4) MIIUIIU from (3) by rule II
17. On page 37, Hofstadter claims that there is a fundamental difference between a machine and a human? What is that difference?
    Hofstadter is claiming that it is *possible* for machines to act unobservant to their tasks, however it is impossible for a human to act unobservant.
18. With respect to formal systems, what is the difference between "working inside the system", and "working outside the system".
    Working within the system is described as completing the task without leaving that current system, while working outside of the system involves the intelligence being able to jump out of its task and reassess the situation.
19. Are there any theorems in the MIU-system that do not start with the letter M?
    No, they all start with M.
20. How is the previous question answered, by working within the system or by working outside the system?
    Working within the system, it is able to find some incorrect theorems (any theorem not starting with M), however there are some strings that start with "M" that are not considered theorems within the system. By working outside the system, we are able to identify more non-theorems by listing every applicable rule to theorems produced within each of the steps of the formal system.
21. What does "M-mode" refer to? What does "I-mode" refer to?
    M-mode refers to the mechanic mode of looking at a formal system, while the I-mode refers to the intelligent mode.

22. Do you think that humans can work in M-mode?
    I think humans *can* work in M-mode, but I don't believe they are in this mode as a default. When the time requires it, humans can hyper focus within the constraints of a formal system, however they always eventually go back to I-mode.
23. Do you think that humans can work in I-mode?
    Like stated in the previous question, I think humans often work in I-mode as default, as we are able to work outside of the system often. However, I do believe there are times where humans both rely and can force themselves into an M-mode work ethic.
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?
    Rules I and II within the MIU-system allow for lengthening the string in very rigid ways. Rules III and IV are shortening rules because they shrink the strings.
25. Define "decision procedure" with respect to a formal system.
    A decision procedure is a test given to a formal system which tests theoremhood, that terminates in a finite amount of time, and gives a concrete characterization of the nature of all theorems in the system.