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Problem Set: Recurion, RTNs, and More!

Abstract: This is a problem set that is based primarily on Chapter 5 of Hofstadter's GEB. Just a bit of Chapter 7 comes into play, as well.

Task

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1. Hofstadter writes about recursion in a *very informal way* in the first three sections of Chapter 5. Please write down five easily articulable ideas about recursion that he expresses in those sections of this chapter, **ideas that resonate with you** in a meaningful way.

    a. The **phone call** example in which recursion appears in daily life, resonated with me more based on the simple, mechanical, and "informal" way of expressing/explaining recursion.
        i. An executive has a fancy telephone and receives many calls on it. He is talking to A when B calls. To A he say,, "Would you mind holding for a moment?" Of course he doesn't really care if A minds; he just pushes a button, and switches to B. Now C calls. The same deferment happens to B. This could go on indefinitely, but let us not get too bogged down in our enthusiasm. So let's say the call with C terminates. Then our executive 'pops' back up to B, and continues. Meanwhile A is sitting at the other end of the line, drumming his fingernails against some table, and listening to some horrible Muzak piped through the phone lines to placate him ... Now the easiest case is if the call with B simply terminates, and the executive returns to A finally. But it could happen that after the conversation with B is resumed, a new caller-ID-calls. B is once again pushed onto the stack of waiting callers, and D is taken care of. Aft D is done, back to B, then back to A

    b. One of the **first languages of AI** were 'push,' 'pop,' and 'stack.' Again, these terms are explained in a way where daily life is mentioned and it seems more "informal," but relating things to daily life are more helpful in understanding recursion as a whole.
        i. To push means to suspend operations on the task you're currently working on, without forgetting where you are-and to take up a new task. The new task is usually said to be "on a lower level" than the earlier task. To pop is the reverse-it means to close operations on one level, and to resume operations exactly where you left off, one level higher. But how do you remember exactly where you were on each different level? The answer is, you store the relevant information in a stack.

    c. The **news report** example in which recursion appears in daily life. These examples resonate with me because I am able to relate them to something in my own life.
        i. When you listen to a news report on the radio, oftentimes it happens that they switch you to some foreign correspondent. "We now switch you to Sally Swumpley in Peafog, England." Now Sally has got a tape of some local reporter interviewing someone, so after giving a bit of background, she plays it. "I'm Nigel Cadwallader, here on scene just outside of Peafog, where the great robbery took

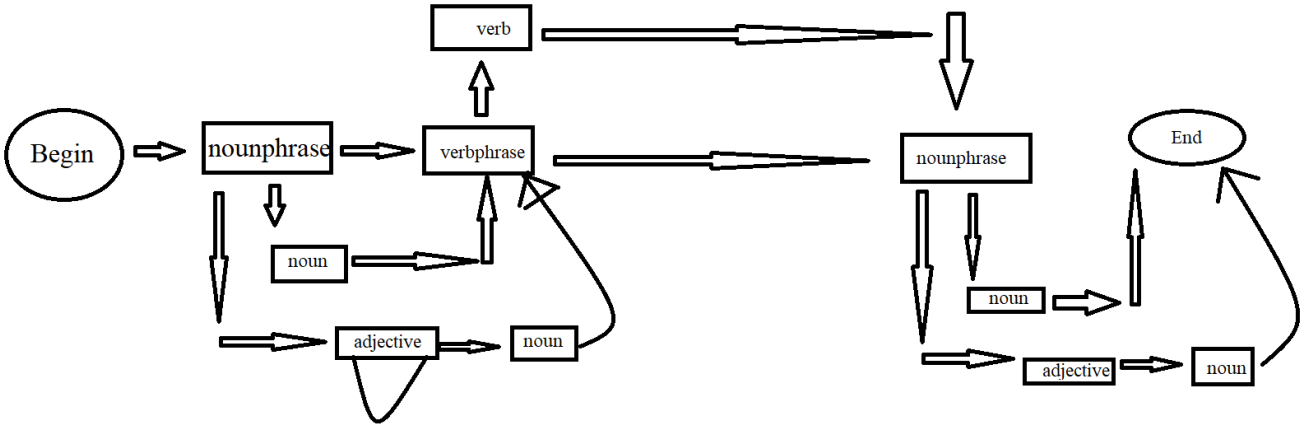
place, and I'm talking with ..." Now you are three levels down. It may turn out that the interviewee also plays a tape of some conversation. It is not too uncommon to go down three levels in real news reports, and surprisingly enough, we scarcely have any awareness of the suspension. It is all kept track of quite easily by our subconscious mind. Probably the reason it is so easy is that each level is extremely different in flavor from each other level. If they were all similar, we would get confused in no time flat.

d. The **stack in music** example resonates to me because I appreciate music and the way recursion can be explained among music aspects.
    i. We maintain a mental stack of keys, and that each new modulation pushes a new key onto the stack. implication is further that we want to hear that sequence of keys retrace reverse order-popping the pushed keys off the stack, one by one, until the tonic is reached.
e. The **Bach music** example is more meaningful to me because Bach is a part of my study life (I listen to him when I study).
    i. Let's take the gigue from the French Suite no. 5, which is quite typical of the form. Its tonic key is G, and we hear a gay dancing melody which establishes the key of G strongly. Soon, however, a modulation in the A-section leads to the closely related key of D (the dominant). When the A-section ends, we are in the key of D. In fact, it sounds as if the piece has ended in the key of D! (Or at least it might sound that way to Achilles.) But then a strange thing happens-we abruptly jump back to the beginning, back to G, and rehear the same transition into D. But then a strange thing happens-we abruptly jump back to the beginning, back to G, and rehear the same transition into D. Then comes the B-section. With the inversion of the theme for our melody, we begin in D as if that had always been the tonic-but we modulate back to G after all, which means that we pop back into the tonic, and the B-section ends properly. Then that funny repetition takes place, jerking us without warning back into D, and letting us return to G once more. Then that funny repetition takes place, jerking us without warning back into D, and letting us return to G once more

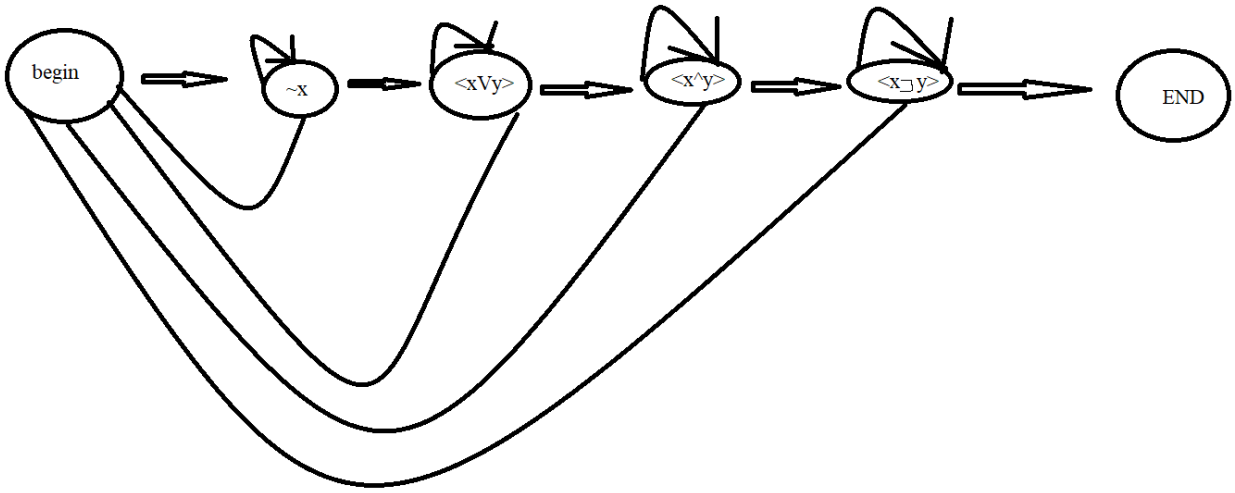
2. In a paragraph or two, without providing any explicit examples, describe “recursive transition networks”. Please say something about (1) what they are used for, (2) what elements they are composed of, and (3) their relationship to context free grammars.

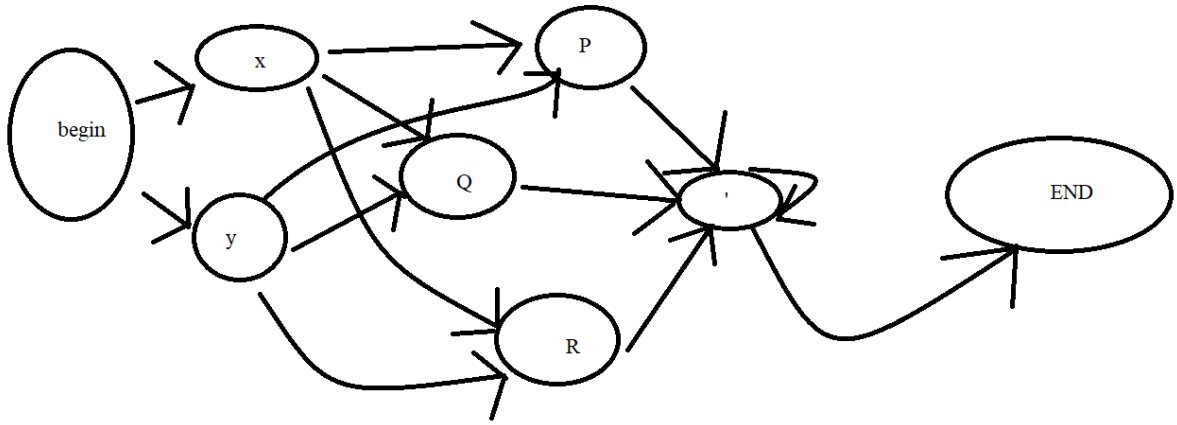
These diagrams are used to accomplish a specific task, such as constructing an English noun phrase (as Hofstader used). The RTN is composed of a path consisting of a number of nodes, or little boxes with words in them, joined by arcs, or lines with arrows. The rules of a context-free grammar (CFG) are represented or defined with an RTN, which is a graph - theoretic schematic.

3. Faithfully mimicking Hofstadter’s representation of RTNs, draw a set of recursive transition networks which defines the “English Like Language” that was featured in the CFG/CFG assignment. That is, **draw a set of recursive transitions** that correspond in a faithful manner to the CFG provided for the “English Like Language”.

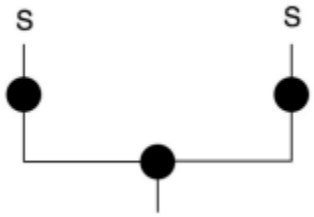


4. Please read the first page and a half of Chapter 7 “The Propositional Calculus”. Then **draw a set of recursive transition networks** for Hofstadter’s particular variant of WFFs, as presented in the first page and a half of Chapter 7.





5. Consider Diagram S shown below, which I constructed in the spirit of Diagram G and Diagram H that Hofstadter presented in the chapter.



Please:

(a) Draw Diagram S yourself.

(b) Draw Diagram S, once expanded.

(c) Draw Diagram S, twice expanded.

Below is a picture of all three

Diagram S

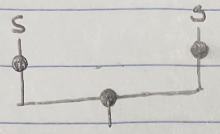


Diagram S ; once expanded

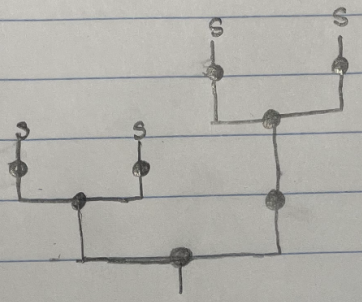


Diagram S ; twice expanded