Tentamen Architecturen voor Intelligentie 23 maart 1999

Although this exam is in English, you may answer in either Dutch or English. If you do not fully comprehend one of the questions, feel free to ask for a clarification.

1. Explain why constraints on the expressiveness of a cognitive architecture are so important for the success of the architecture as a theory.

2. Anderson mentions six tenets of the so-called no-magic doctrine: Experimentally grounded, Detailed and Precise accounting of data, Learnable through experience, Capable of dealing with complex cognitive phenomena, Principled parameters, and Neurally plausible. Order these six tenets from strong to weak with respect to ACT-R. So, the tenet you think ACT-R satisfies very well comes at the top of the list, and the tenet that applies only weakly to ACT-R comes at the bottom. Explain your choices.

3. Suppose we have a model with the following two rules:

```
(p retrieve
      =goal>
         isa verify-fact
         fact =x
         answer nil
      =fact>
         isa fact
         fact =x
==>
      =goal>
         answer yes
      !pop!)

(p answer-no
      =goal>
         isa verify-fact
         answer nil
==>
      =goal>
         answer no
      !pop!)

(spp answer-no :r 0.5)
```

   This model tries to retrieve a fact (it doesn't really matter what it is) from declarative memory. If the fact is found, "yes" will be answered, else "no".
   Describe how the performance of the model changes when the following parameters are changed:
   - Latency Factor (:lf)
   - Retrieval Threshold (:rt)
   - Activation Noise (:ans)
   - Expected Gain Noise (PG-C noise) (:egs)

   Performance means: reaction times for both "yes" and "no" answers, and the number of errors. An error means in this case: answering "no" while the fact was present in memory.

4. In the so-called free-recall experiment subjects have to read a list of 20 words, and try to recall as much as possible of the words in the list afterwards. The words are presented one at a time, with 5 seconds in between, so subjects have the opportu-

nity to do rehearsal. The results typically show that the first and the last words of the list are recalled best. These phenomena are called the primacy and the recency effect, respectively. Give an explanation for both the primacy and the recency effect in terms of ACT-R's learning mechanisms.

5. In the alphabet-arithmetic task subjects have to check equations involving letters and digits, like A+2=C (answer: true) or D+3=H (answer: false). Due to practice, subjects become better at this task. The explanation for this learning effect mainly involves two ACT-R learning mechanisms. Explain which mechanisms are involved, and how the two learning effects can be distinguished in an experiment.

6. According to Lovett et al., the individual differences in working-memory capacity can be modeled in ACT-R by varying the source activation (W or GA) parameter. A low value of W corresponds to a low capacity, and a high value of W corresponds to a high capacity. Since the W parameter is also involved in other aspects of ACT-R, this produces interesting new predictions. Suppose we run an experiment in which subjects have to do two tasks: a digit working memory task and the fan-effect experiment. The digit working memory task can be used to estimate a value of W for each subject. What difference between low-W and high-W subjects would you predict with respect to performance on the fan-effect task?

7. Whenever ACT-R has to choose between two production rules, it usually takes the rule with the highest expected gain. However, since noise is added to these expected gains, it sometimes chooses a sub-optimal rule. Although this can be a source of errors, it is generally very useful to add noise. Explain why.

8. One of the problems of building an architecture of cognition using neural networks is the so-called binding problem. Explain what this problem is, and how Shastri & Ajjanagadde try to solve it in their networks (give / own / can-sell example).