Inductive Programming: Tutorial 6
Comprehensibility

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The aim of this tutorial is to help you understand concepts in Lecture 6, involving Comprehensibility.

Question 1

1. Explain Johnson-Laird's Mental Model Theory (MMT).
2. According to MMT, what is the Load associated with $p \wedge q$? Explain your answer.
3. What is the Load associated with $p \implies q$?

Solution

1. According to MMT humans understand logical sentences by considering their semantic models. Errors in reasoning are produced by overloading human short-term working memory.
2. Given $F = (p \wedge q)$ the MMT gives $Load(F) = 1$ since the only model of F is $\{p, q\}$.
3. Given $G = (p \implies q)$ the MMT gives $Load(G) = 3$ since there are three models of G: $\{p, q\}, \{\neg p, \neg q\}$ and $\{\neg p, q\}$.

Question 2

Describe one similarity and one difference between comprehension tests for natural language text versus those for logic programs.

Solution One similarity is that in both cases a comprehension test can identify whether someone understands both facts and implications of text and programs. One difference is that whereas natural language text can be ambiguous, the ground implications of a definite logic program are not.

Question 3

1. What is the main difference between Michie's and Mitchell's definitions of Machine Learning?
2. Give two reasons why it might be valuable to have an operational definition of Comprehensibility?

Solution

1. Michie (1988) defined Machine Learning in terms of both Predictive Accuracy and Comprehensibility of the machine learned model. Mitchell (1997) defined Machine Learning in terms of Predictive Accuracy alone.
2. An operational definition of comprehensibility allows symbolic AI to distinguish the degree of communicability of a model and also opens the possibility of supporting two-way Human-Machine Learning.

Question 4

Give a definition of

1. Predicate Invention.
2. Comprehensibility.

Solution

1. **Predicate Invention.** In the case background knowledge B of an ILP problem is extended to $B \cup H$, where H is a definite program we call predicate symbol $p \in \mathcal{P}$ an Invention iff p is defined in H but not in B.
2. **Comprehensibility, $C(S, P)$.** The comprehensibility of a definition (or program) P with respect to a human population S is the mean accuracy with which a human s from population S after brief study and without further sight can use P to classify new material sampled randomly from the definition's domain.

Question 5

1. Give Michie's definitions of
   (a) Weak Machine Learning.
   (b) Strong Machine Learning.
   (c) Ultra-Strong Machine Learning.
2. What was the main outcome of the 2018 experiment to test the existence of Ultra-Strong Macine Learning?
3. What is the significance of the result?

Solution

1. (a) **Weak ML.** System uses training set to generate model with improved performance on subsequent data.
   (b) **Strong ML.** Satisfies weak criterion and communicates model to a human in explicit form.
   (c) **Ultra-Strong ML.** Satisfies strong criterion and model is operationally effective for humans.
2. Human out-of-sample performance was significantly higher after inspecting the model than after inspecting the data.
3. Machine Learned models can be used to teach humans unfamiliar concepts.