

人工智能 A 复习卷 II

COMP130031.01

2. (8 points) Prolog programs:

(1) *Member(X,Y)* : Determine if X is a member of Y. (4 points)

Example:

?-*Member*(a,[a,b,c])

Yes

Please design *Member(X,Y)*

(2) *Append(X,Y,Z)* : Append list X and Y. You can get $L = [X, Y]$. (4 points)

Example:

?-*Append*([a,b,c],[1,2,3],L)

$L=[a,b,c,1,2,3]$

Yes

Please design *Append(X,Y,Z)*

3. (9 points) Given the following deftemplates for facts describing a family tree,

(deftemplate father-of (slot father) (slot child))

(deftemplate mother-of (slot mother) (slot child))

(deftemplate male (slot person))

(deftemplate female (slot person))

(deftemplate parent-of (slot parent) (slot child))

(deftemplate brother-of (slot brother) (slot person))

write rules that will infer the following relations.

(1) Parent

(2) Brother

4. (10 points) Rewrite the following rule to make it more efficient.

```
(defrule three-distinct-points
  ?point-1 ← (point (x ?x1) (y ?y1) (z ?z1))
  ?point-2 ← (point (x ?x2) (y ?y2) (z ?z2))
  ?point-3 ← (point (x ?x3) (y ?y3) (z ?z3))
  (test (and (or (eq ?x1 25)
                  (eq ?x1 56))
              (neq ?point-1 ?point-2)
              (neq ?point-2 ?point-3)
              (neq ?point-1 ?point-3)
              (neq ?x3 89))
  )
=>)
```

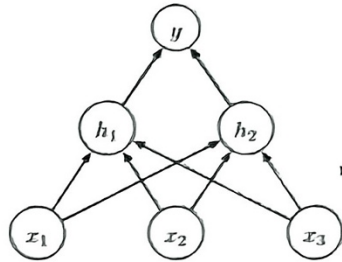
5. (10 points) Use resolution to solve the following problem.

- 1) Everyone who loves all flowers is loved by someone.
 - 2) Anyone who smashes a flower is loved by no one.
 - 3) Rockery loves all flowers.
 - 4) Rose is a kind of flower.
 - 5) Either Rockery or Tommy smashed the rose named Derrick.
- Question: Did Tommy smash Derrick?

7. (10 points) Considering the following database of houses represented by 5 training examples. The target attribute is 'Acceptable', which can have values 'yes' or 'no'. This is to be predicted based on the other attributes of the house. Construct the **decision tree** from the following examples and show the value of the information gain for each candidate attribute at each step in the construction of the tree.

House	Furniture	Num of Rooms	New kitchen	Acceptable
1	No	3	Yes	Yes
2	Yes	3	No	No
3	No	4	No	Yes
4	No	3	No	No
5	Yes	4	No	Yes

9. (15 points) The following figure shows the architecture of a simple neural network with a single hidden layer with an input as $x = [x_1, x_2, x_3]^T$. Its hidden layer has two neurons $h = (h_1, h_2)$ and the output is denoted as y (no bias).



The activation function of the hidden and output layers takes the form of Relu $\sigma(x) = \max(0, x)$. The loss function is defined as $L(y, t) = \frac{1}{2}(y - t)^2$, where t is the target value of y , the weight of input layer is W , and the weight of hidden layer is V .

(1) Show how to use W , V , σ , x to obtain y . (2 points)

(2) We assume that $W = \begin{bmatrix} 1 & 0 & -1 \\ 0 & 2 & 1 \end{bmatrix}$, $V = \begin{bmatrix} 0 & 1 \end{bmatrix}$, $x = [1, 0, 2]^T$, and $t = 1$,

please calculate the values of y , $\frac{\partial L}{\partial W}$, and $\frac{\partial L}{\partial V}$. (5 points)

(3) “Dead Neuron” is defined as a neuron whose output is always equal to 0 during the training. With the assumption of (2), which neuron in the hidden layer is “Dead Neuron”? (2 points) Analyze what can we do to maintain the property of ReLU while reducing or avoiding the existence of dead nodes. (2 points)

(4) There is a neural network model for classification task and it takes the cross entropy as its loss function. Assuming that the label of a sample is $(0, 1, 0)$, its output is $(0.1, 0.8, 0.1)$ at the 1st epoch of training, and its output is $(0.3, 0.4, 0.3)$ at the 2st epoch, please calculate the loss of those two epochs for this network. (2 points) (note: $\ln 0.1 \approx -2.30$, $\ln 0.8 \approx -0.22$, $\ln 0.3 \approx -1.20$, $\ln 0.4 \approx -0.92$). Based on the above analysis, can we use accuracy as our target function? Why? (2 points)

10. (10 points) Considering a convolutional layer **C** and a Max-Pooling layer **P** in a convolutional neural network.

- a) The input of the layer **C** has 8 channels and the size of each channel is 16×16 .
- b) The layer **C** has 16 convolutional kernels and the size of each convolutional kernel is $4 \times 4 \times 8$.
- c) The margin padding size is $p = 1$ and the step is $s = 2$.
- d) The layer **P** adopts 2×2 max pooling strategy to produce the output feature map of the layer **C** and the pooling step is 2.

(1) How many parameters does the layer **C** have? (1 points) What is the dimensionality of the output feature map of the layer **P**? (2 points)

(2) Suppose we need to analyze the images that show certain emotions expressed on the human faces. The input face image is a 3-channel RGB image with a size of 32×32 . We assume that:

- a) Emotions can be divided into two categories (positive and negative)
- b) Emotion strength can be measured between 0 and 1.

Therefore, the output of an input image is its emotion categories and its emotion strength. Please design a neural network based on the network layers **C** and **P** to perform this task. You need to describe your network architecture, hyperparameters (such as the size of the convolution kernels), the loss function and your explanation to your design. (7 points)