University of Wisconsin-Madison
Computer Sciences Department

CS 760 — Machine Learning

Spring 1989

Midterm Exam

100 points

March 24, 1988

Neatly answer the following questions in the space provided. If you feel a question is ambiguous, clearly state any assumptions you make. Notice that all questions do not have the same point-value. Divide your time appropriately.

1. Concept Representation (5 points)

Assume you are trying to describe a *badger*, as a positive example of the concept *animal*. For each of the following feature types, provide a specific feature of that type. Illustrate some possible values of the feature in such a way that the differences among the three types is apparent.

nominal

linear

structured

2. Version Spaces (15 points)

Assume you are given the following two nominal features, with the possible values shown. Draw the full version space for conjunctive concepts constructed from these two features.

color ∈ {red, blue, green}

shape ∈ {round}

Assume the version space algorithm is given the single *negative example*

(- (color red) (shape round))

Circle, with a solid line, the nodes that are in *G* after this instance is processed. Circle, with a dotted line, the nodes in *S*. (Note: The version space code provided for HW 2 assumes, for efficiency reasons, that a positive example can be processed first. However, this is not necessary.)

3. Learning from Examples (20 points)

Often only positive examples are available for learning (for example, consider a baby learning to speak).

Part A What would be the major issue to contend with when only positive examples are available?

Part B Discuss how well the following systems would perform using only positive examples. For the version spaces algorithm, consider how the collection of generalizations it produces could best be used to classify new examples.

Version Spaces

AQ(or Induce)

ID3

4. Learning without a Teacher (20 points)

Consider the UNIMEM system. Show the concept hierarchy that results after *each* of the following instances are processed. (That is, you should draw *four* concept hierarchies, one to the right of each instance.)

Assume that an instance is considered to be a member of a concept if it does not differ from the concept in *more* than one feature value. Make the same assumption when deciding if two instances are "close enough." If a new concept is to be formed, its description must contain at least one feature. Do *not* worry about discarding and "freezing" features, nor consider discarding a concept.

instance 1

expensive	true
large	true
fragile	false
shiny	true
heavy	false

instance 2

expensive	true
large	true
fragile	true
shiny	true
heavy	true

instance 3

expensive	true
large	true
fragile	false
shiny	true
heavy	true

instance 4

expensive	false
large	false
fragile	false
shiny	false
heavy	false

5. Explanation-Based Learning (25 points)

Consider the following "domain" theory. Terms beginning with ?'s are implicitly universally quantified variables.

A(?x,?y) *and* B(?y,?z,5)	→	C(?x,?y,?z)
D(?x,?y) *and* E(?x,?y)	→	A(?x,?y)
F(?x,?y,?z)	→	B(?x,?y,?z)
G(?x,?x)	→	D(?x,?x)

Assume the following problem-specific facts are asserted.

E(1,1)	F(1,1,5)	G(1,1)
E(1,2)	F(1,1,3)	G(1,2)

Part A Explain, with a proof tree, that C(1,1,1) is true. Draw to the right of your proof tree the corresponding *explanation structure* (before pruning at operational nodes). Clearly indicate the necessary unifications.

Part B Under each of the following two assumptions, what new rule would the EGGS algorithm produce?

Only the predicates E, F, and G are operational.

In addition to E, F, and G, the predicate D is operational.

6. Noise Handling (15 points)

Briefly discuss how some of the following systems address the issue of noisy data. Choose *any* **five out of the six** systems to discuss.

ID3

AM

UNIMEM

BAGGER

Cluster/RD

Bacon