Exercise 1

Make 2 examples of learning tasks not mentioned in the first lecture of the course. For each task:

• Informally describe task in few lines in English;
• Describe it more formally focusing on the task $T$, the performance measure $P$, and the training experience $E$;
• Propose a target function be learned and a target representation.

Solution

You find below 2 examples of learning tasks

Task 1: skiing wax prediction

The problem consists of recommending the wax that maximizes the gliding of the skis given the snow and weather conditions, the features of the skis, and the skills of the skier.

$T$: prediction of the wax, among those that are produced by a company, that is most suitable to be used

$P$: percentage of skiers who are satisfied with the suggestion

$E$: database of records memorizing ski experience. Each records contains information about the weather and snow conditions, the type of ski and the skill level of the skiers, and the wax that was successfully used

Target function: $F:X\rightarrow Y$ where $x\in X$ is a specific skiing condition, and $y\in Y$ is a label, corresponding to a specific wax.

Task 2: poisoned mushrooms recognition

The task consists of identify poisoned mushrooms given descriptions of the mushrooms.

$T$: give a classification of a mushroom as poisoned or not poisoned

$P$: accuracy in the classification of the mushrooms.

$E$: a database containing the description of the mushrooms, as well as their correct classification as poisoned or not poisoned.

Target function: $F:X\rightarrow Y$ where $x\in X$ is a mushroom description $y\in Y=\{\text{POISONED, NOT\_POISONED}\}$ is the class of the mushroom
Exercise 2

Suppose that $A_1, \ldots, A_n, C$ are random variables. Demonstrate that

• if $A_1, \ldots, A_n$ are conditionally independent given $C$
  • then $P(A_1, \ldots, A_n|C) = P(A_1|C) \times \ldots \times P(A_n|C)$

Hint: demonstration by induction
  • inductive base: $P(A_1, A_2|C) = P(A_1|C) \times P(A_2|C)$

Solution

1. Inductive base.
   We demonstrate that if 2 variables $A_1$ and $A_2$ are conditionally independent given $C$ then $P(A_1, A_2|C) = P(A_1|C) \times P(A_2|C)$

   
   
   
   $P(A_1, A_2|C) = P(A_1|A_2, C) \times P(A_2|C) = P(A_1|C) \times P(A_2|C)$ by chain rule

   
   
   

2. Inductive step.
   The property holds for $n-1$ variables:
   $P(A_1, \ldots, A_{n-1}|C) = P(A_1|C) \times \ldots \times P(A_{n-1}|C)$

3. We prove the property for $n$ variables
   $P(A_1, \ldots, A_n|C) = P(A_1, \ldots, A_{n-1}|A_n, C) \times P(A_n|C) = P(A_1|C) \times \ldots \times P(A_n|C)$ by chain rule

   
   
   

Q.E.D.
Exercise 3

Write a small program in Java that calculate the maximum likelihood hypothesis $h_{ML}$ of the “tennis problem” when

- The available data is the table on page 8 (up) of lecture 2
- The dataset $X$ is the set of sunny days with weak wind

Solution

Writing a Java program for this task is quite simple. You can, for example, store the available data in a file. Your program could read the file and store the data in memory. Then, the program could take a weather condition (e.g. outlook=sunny, wind=weak) as input and calculate the probability of the two hypotheses (classes). Finally the program could return the maximum likelihood hypothesis.