# Questions 14:
Case-Based Reasoning

Roman Belavkin

Middlesex University

Question 1

Briefly describe the main principles of a case-based reasoning (CBR) expert system, its operation process and possible differences in implementation.

Answer:

- A CBR system uses a database of cases, called the **casebase**. The description of each case normally consists of two parts: **Problem** description and its **solution**.

- The process of CBR operation can be described as four REs. A new problem compared with cases in the casebase, and the most case is **retrieved**. The solution of the retrieved case is **reused**. This solution can be **revised** (or **adapted**) to fit better the new case or based on how successful the solution turned out to be. The new case with its solution is **retained** in the casebase.
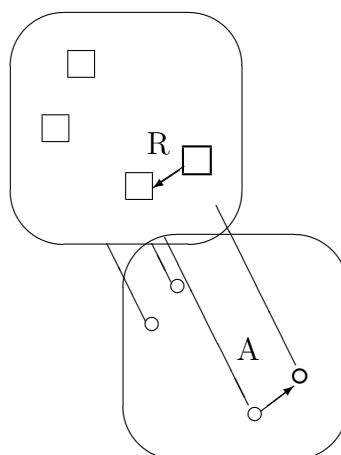
- There can be differences in the implementations of CBR systems. For example, case descriptions may use predictive **indexes**. There are different retrieval algorithms. The **nearest neighbour** algorithm uses a **similarity** measure (e.g. some metric or distance function) to identify the most similar cases. There can be different similarity functions. Other systems use **inductive retrieval**, such as the ID3 algorithm (Iterative Dichotomiser 3).

Question 2

Suppose that the database of a CBR system contains the following four cases:

Case	Monthly Income (£K)	Account Balance (£K)	Home Owner	Credit Score
1	3	2	0	2
2	2	1	1	2
3	3	2	2	4
4	0	-1	0	0

The system is using the nearest neighbour retrieval algorithm with the following similarity function:

$$d(T,S) = \sum_{i=1}^{m} |T_i - S_i| w_i$$

where T is the target case, S is the source case, i is the number of a feature, and w_i are the weights. Cases with smaller values of $d(T,S)$ are considered to be more similar. Consider the following new (target) case:

Case	Monthly Income (£K)	Account Balance (£K)	Home Owner	Credit Score
5	3	1	2	?

Answer the following questions:

a) Which case will the CBR system retrieve as the 'best match', if all the weights $w_i = 1$?

b) The solution that the CBR system should propose is the credit score rating. Suggest how should the solution of the retrieved case be adapted for the target case?

c) What can be changed in the similarity function to make feature 'Account Balance' three times more important than any other feature? Will this change influence the solution?

Answer:

a)

$$\begin{aligned}
d(T, S_1) &= |3 - 3| + |1 - 2| + |2 - 0| = 0 + 1 + 2 = 3 \\
d(T, S_2) &= |3 - 2| + |1 - 1| + |2 - 1| = 1 + 0 + 1 = 2 \\
d(T, S_3) &= |3 - 3| + |1 - 2| + |2 - 2| = 0 + 1 + 0 = 1 \\
d(T, S_4) &= |3 - 0| + |1 + 1| + |2 - 0| = 3 + 2 + 2 = 7
\end{aligned}$$

The most similar is Case 3.

b) *The Credit Score for Case 3 is 4. The only difference between the target case and Case 3 in the Account Balance ($3 < 2$). Based on the other cases, one can derive that the decrease in Account Balance should decrease the credit score (see Case 2 and 4). Thus, the solution of Case 3 can be adapted by decreasing the value. The revised solution for the new case is:*

$$Credit\ Score = 3$$

c) *Increasing the weights makes the corresponding features more important. Thus, we can set $w_2 = 3$. This change would influence which case is retrieved, because now*

$$\begin{aligned}
d(T, S_1) &= |3 - 3| + |1 - 2|3 + |2 - 0| = 0 + 3 + 2 = 5 \\
d(T, S_2) &= |3 - 2| + |1 - 1|3 + |2 - 1| = 1 + 0 + 1 = 2 \\
d(T, S_3) &= |3 - 3| + |1 - 2|3 + |2 - 2| = 0 + 3 + 0 = 3 \\
d(T, S_4) &= |3 - 0| + |1 + 1|3 + |2 - 0| = 3 + 6 + 2 = 11
\end{aligned}$$

So, now Case 2 is the most similar.

Question 3

Describe characteristics of problems in which it is better to use rule-based expert systems or problems where the case-based systems are more appropriate.

Answer: *Rule-based systems are better for problems*

- *With well-defined domain which can be easily represented.*

- *That do not change with time.*

- *Where explanation of the reasoning process is very important.*

Case-based systems are better for problems

- *Which are less understood.*

- *Which are dynamic (may change with time).*