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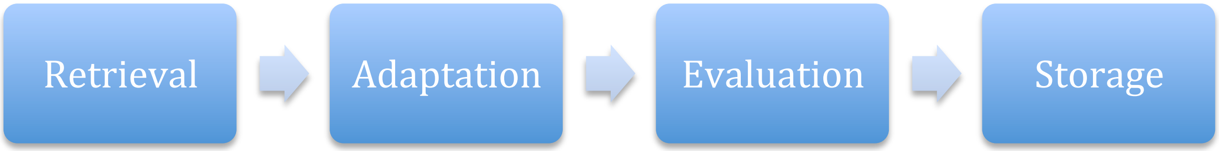
Assignment 7

Using Case-Based Reasoning to solve Raven's progressive matrices

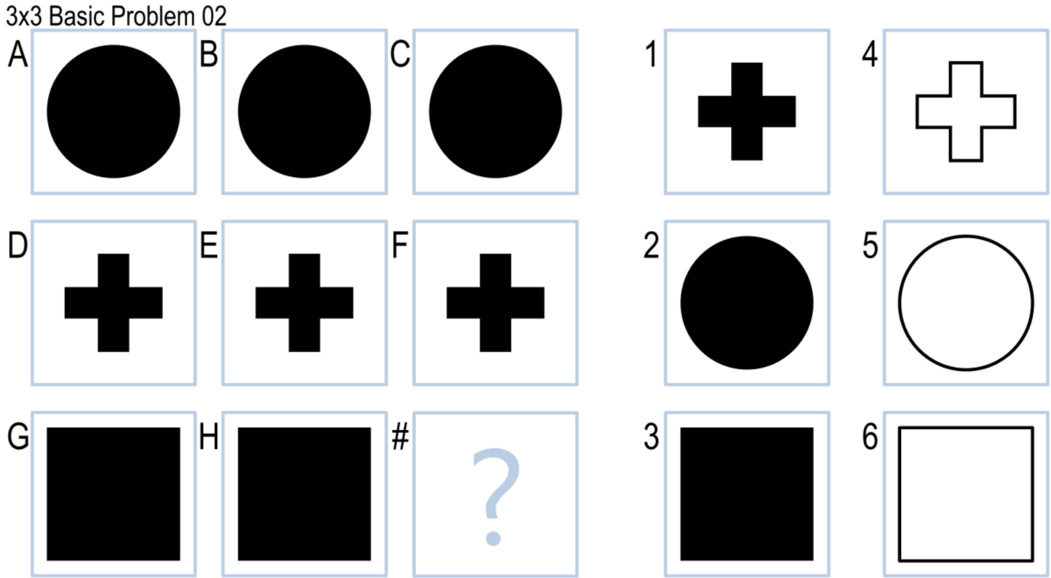
The world is a complex place, with infinite permutations of possible scenarios occurring on a daily basis. How does one ever find a way to perceive these situations, and then act on them? We successfully accomplish this on a daily basis by navigating the simplest of tasks that we now don't even notice it. Some of these might include finding your way to class, ordering food on grubHub, and even deciding what brand of shampoo you will buy next. Life is full of decisions and actions, each of these combining to form scenarios. What should I eat for breakfast? Should I shower before or after dinner? Where is the best sushi place near Tech's campus for a reasonable price? Human beings successfully perceive and interact with the world on a daily basis using Case-Based Reasoning.

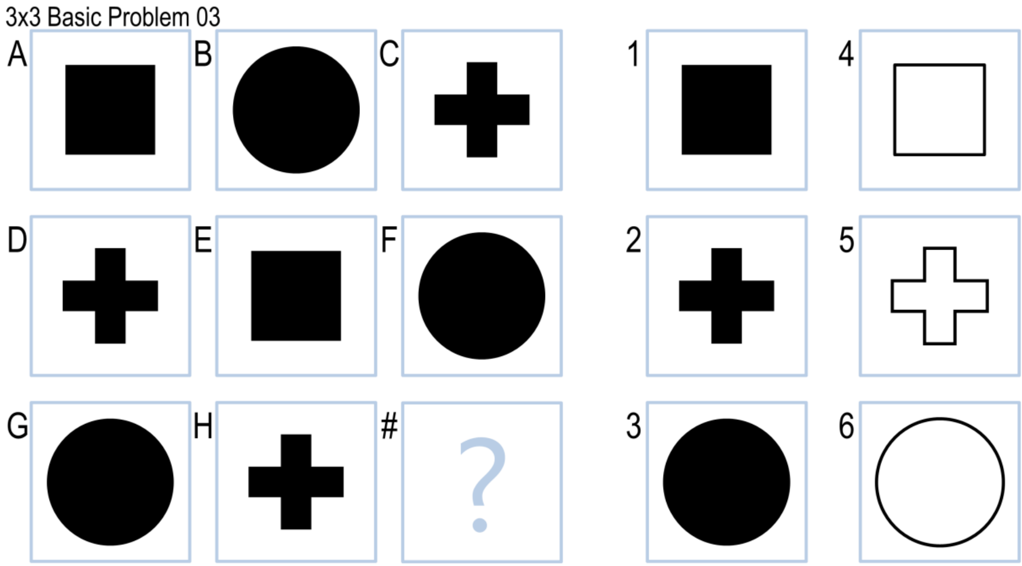
But what exactly is Case-Based Reasoning? Simply put, it is just the process of using past problems and scenarios as inference to solve or react to the current one. But why exactly does this work, as earlier it was stated that the world produces an infinite amount of possibilities due to the billions of factors. Well, Case-Based Reasoning is valuable because the world acts in patterns. Generally, when involved in a situation, the odds are that the exact same situation or one extremely similar will occur in your life again. Take for instance the task of filling up your car for gas. Or opening up a Word Document file on your computer. These tasks might slightly vary in that it may be a different file or gas station, but the action needed to be performed is replicated. Therefore, Case-Based Reasoning is a valuable representation of knowledge simply because our world acts in patterns. But how exactly does it work? Well here is a diagram of the process that has to occur in order for an agent to successfully use Case-Based Reasoning to solve a problem:



The most critical functionalities that separate intelligent beings from unintelligent are the retrieval and adaptation stages. An agent has to have some way to retrieve a similar memory or experience and use that in a proper way to be helpful for the current situation. This method of retrieval means that the agent needs lightening fast similarity heuristics and pattern matching algorithms to find a relevant past situation. Then, it needs to fully understand the past and current situation in order to map the information that will prove to be useful and discard the extra that is irrelevant. Both of these skills are extremely critical in Case-Based Reasoning, which can play a useful role in problem solving.

So I have named several everyday tasks that are solved with Case-Based Reasoning, but how would an agent use it to solve Raven's progressive matrices? Well, each individual problem can be viewed as a case. A majority of the problems have occurring patterns of similarity that can be solved with a generic strategy. First, our agent can store each problem it faces as a particular case, rating it on the amount of differences, number of objects, shape of objects, and etc. We know through the check answer function that an answer can be found, which then can be compared to figures A – H. After this rating is given, our agent can store the problem as well as this rating into a memory space. Then, after facing each problem it can retrieve a past one that is similar if it exists, and use the correct strategies on that problem for the current one. For example, these two problems:





would be considered extremely similar to the amount of objects in each figure, the shapes of the objects, and also the fill and angle. Therefore, after our agent has experienced Basic Problem 02, he could then reference that to solve Basic Problem 03. The agent would just intuitively look for the shape that has not occurred three times, and also one that is filled. This is just a simple example of how an agent could index its memory space to use a past problem for solving the current one.

The complexity of using Case-Based Reasoning here isn't high due to the finite number of problems and answer choices, but it some situations the world the agent resides may just be too abundant for it's memory space. It would then heuristically have to broaden the way it categorizes different cases to be sure that there are enough memory slots in its architecture to support efficient indexing. The data structure such as a hash table could be extremely efficient for storing memory when an agent is using Case-Based Reasoning.