# Project 1 Journal

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## Introduction

The CS 7637 class project is to create an AI agent that can be tested with artificial intelligence. It will use Python to address a range of issues inspired by Raven's Progressive Matrices test of intelligent in the project. It will only do visual representations. According to a set of problems provided, it will divide the issues into problems of two by two and three by three in the whole project. And in project 1, it only focuses on two by two problem. By observing these issues, it will create some assumption relationships function in the program. Based on these assumptions, the program will run all the questions at one time. If it finds the answer, it will return a correct answer and an error value will be given. If it does not find the answer, it returns a -1 -1. Anyway, It finally returns a set of answers and a set of errors. Then find the correct answer in the group with the least error.

## First time individual submission to the autograder:

Four images A, B, C, and D are generally provided in the question; we need to find the logical relationship between them for finding the fourth image. I don't think the project is too simple, so I thought about my project in advance. So I was trying to fix three relationships. The first submission was submitted on May 25, and the result will discuss below.

### Similar relationships:

In this case, we find A and B are similar, A and C are also similar. Then we need to find fourth similar image. It is the easiest part in this project.
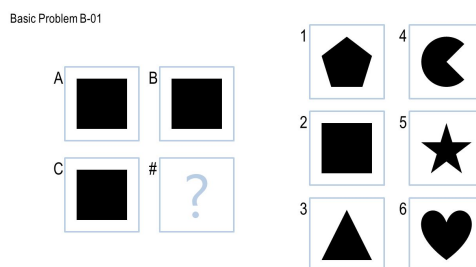


Figure 1. Similar Relationship

For example, it compares image A and B by using minus method firstly; the program finds that they are the same images, then comparison image A and C, and the program finds that they are also similar images. So the program will look for a fourth image that is the same as image C.

## Symmetrical relationships:

The symmetrical relationships include horizontal symmetry and vertical symmetry. In this case, we need to find the symmetrical relationships are between A & B or A & C. If there is symmetrical relationships between A&B, it is the horizontal symmetry relationship, so we find the D has horizontal symmetry relationship with C. If there is symmetrical relationships between A&C, it is the vertical symmetry relationship, so the D has vertical symmetry relationship with C.
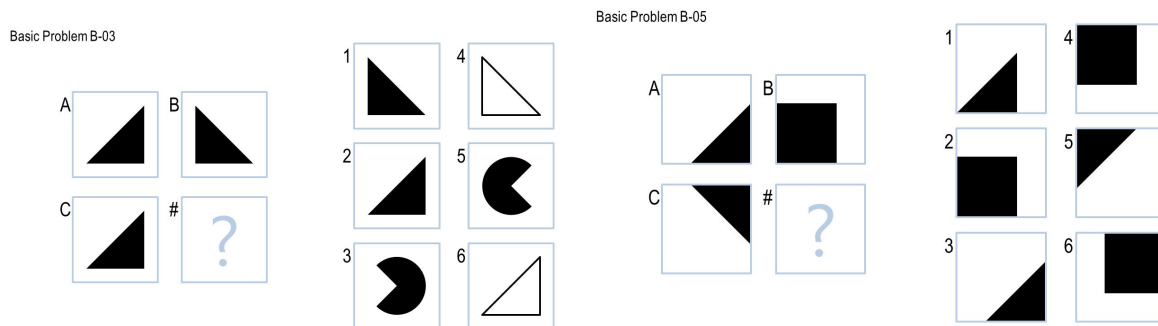


Figure 2. Left: Horizontal Symmetry; Right:Vertical Symmetry

## Rotating relationships:

In this case, there are two rotating possibles that A is rotated to B, and  A is rotated to C. I consider several different rotate degrees; they are 45, 90, 135, 180, 225, 270, and 315. It rotates 45 degrees each time. If it found that A is rotated to B, C could be rotated to D; If it found that A is rotated to C, B could be rotated to D.
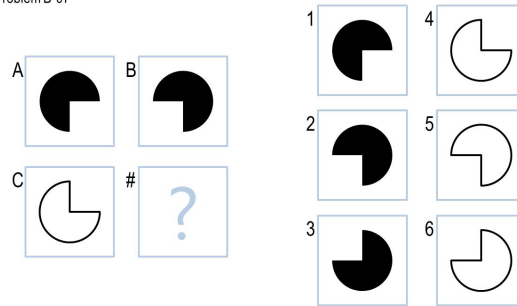
Basic Problem B-07

Figure 3. Rotating Relationship

For example, it rotates the image A for 45 degrees,  then checking if it matches B perfectly. If it does not match, the program continues to rotate until it finally matches image B and then uses the same rotation angle to find the last image that matches image C.

## First Submission Conclusion:

The first submission submitted on 5/25/2019, which made a good result because these three relationships are relatively simple; it is easy to judge the existence of the fourth picture.

In the Basic problem B set, it got eight Correct, four Incorrect and zero Skipped; In Raven's problem B set, it got eight Correct, four Incorrect and zero Skipped; In the Test problem B set, it got seven Correct, five Incorrect and zero Skipped; In the Challenge problem B set, it got seven Correct, five Incorrect and zero Skipped.

By looking at these incorrect problems, I found that there are some more relationships needed to figure out. I need to modify my code then submission next time.

# Second time individual submission to the autograder:

Besides similar, symmetrical and rotating relationships, I also found there are other relationships from given questions, which is filled relationships.

## Filled relationships:

In this case, A has a similar shape with B, but B is a filled shape. Also, it could be A identical to C, and C is a filled shape. So I am using logical_and and logical_or to find the fourth image as figure 4 showing.
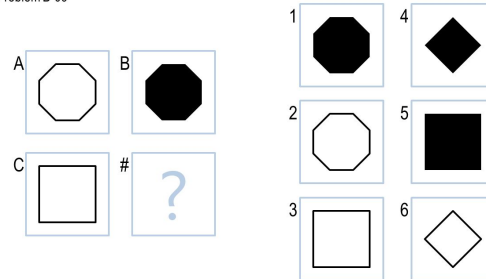
Figure 4. Filled Relationships

It uses logical_and and logical_or to find image A and image B are similar except the black shadow on image B. Then it uses the same method to detect if there is an image is identical to image C except for the black shadow.

## Second Submission Conclusion:

The second submission was submitted on 5/27/2019. I added another assumption in my code, which is the filled relationships.

In the Basic problem B set, it got ten Correct, one Incorrect and one Skipped; In Raven's problem B set, it got eight Correct, two Incorrect and two Skipped; In the Test problem B set, it got eight Correct, two Incorrect and two Skipped; In the Challenge problem B set, it got seven Correct, two Incorrect and three Skipped. Compared to the first submission, the number of correct answers has increased, except that the Challenge Problems B has maintained the same amount of correct answers.

However, there are some problems, and the results began to appear Skipped answers, which is because if the problem does not match one of the relationship function, it will return -1, -1, the problems will be Skipped.

# Third time individual submission to the autograder:

For third time, I am trying to figure out how to solve another relationships, which is Adding relationships. The relationship could happen between A&B or A&C.

## Added relationships:

In this case, A has very similar shape with B, but there is a extra shape inside of A or B, so the fourth image must have same relationship with C.
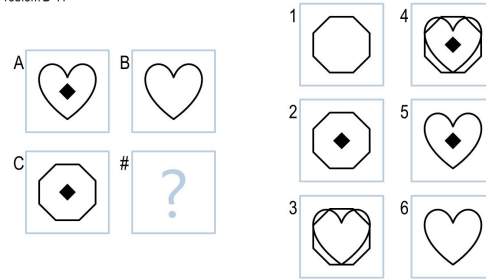
Figure 5.

It firstly removes the extra shape in the middle of image A, then compares it with image B by using subtraction two pictures method, and if the subtraction result is equal to 0, it means that they are similar images. Then, in the same way, remove the extra image in the middle of the image C, and looking for an image that subtracts image B can equal to 0.

### Third Submission Conclusion:

The third submission was submitted on 5/29/2019. I added as the last assumption in the project.
In the Basic problem B set, it got eight Correct, four Incorrect and zero Skipped; In Raven's problem B set, it got ten Correct, two Incorrect and zero Skipped; In the Test problem B set, it got eight Correct, four Incorrect and zero Skipped; In the Challenge problem B set, it got seven Correct, five Incorrect and zero Skipped.
Compared to the second submission, the results have the zero Skipped answers. It does not have Skipped answer anymore because I have some changes in the code, when the program trying to find the fourth image if it considers correct one, it will return the image if not, it will return an error. Anyway, it will not skip any problem.

## Fourth Submission and Conclusion:

I did the last submission on 5/30/2019, just for double checking the program, it got the same answer as the third submission. Thus, in the project, there are five different assumptions showing Table 1. They are similar relationships, symmetrical relationships, and rotating relationships, which run in the first submission and got a good result. The second try is to assume filled relationships. It spent more time than the first time's assumption. For the third assumption, I tried added relationships, which is also a hard part. I have submitted four times, each with a better result than the previous one except the last one. It has already created five functions to find answers based on different situations. The similar, symmetrical and rotating relationships are relatively simple to

return correct answers. However, the program a little hard to correctly find the correct answers because the filled and added relationships are more complex.

| Similar relationships | Symmetrical relationships | Rotating relationships | Filled relationships: | Added relationships: |
|---|---|---|---|---|
|  |  |  |  |  |

Table 1. Five Assumptions

In short, the program will run all the questions, the initial design of the program is either to return the " -1,-1", or the exact image. Because the "Skipped" issue happened in the result, the program has been redesigned. Similarly, the program runs through all the questions, returns "errors"; then each question matches with the function that returns the smallest error. When each question finds its function, the program has to look for the correct image through the total of six given image, and if it is not the one, it returns "error," otherwise, returns the exact image. The final result is showing Table 2.

|  | Basic Problem B | Ravens Problem B | Test Problem B | Challenge Problem B |
|---|---|---|---|---|
| Incorrect | 4 | 2 | 4 | 5 |
| Skipped | 0 | 0 | 0 | 0 |
| Correct | 8 | 10 | 8 | 7 |

Table 2. Final Results

By looking at the results, the final agent has already done the job pretty good, I think. It can judge almost 80% percent questions correctly. It has reached my expectations. But it is not perfect, and If I have enough time, I will spend more time to figure out the Filled relationship and Added relationships. How can I do to let the agent more smart to answers all the questions correctly? It must be an exciting part.

# References

1. Digital image processing. (2019, May 29). Retrieved May 30, 2019, from https://en.wikipedia.org/wiki/Digital_image_processing