

# Project 2 Journal

Shanshan Jiang

[sjiang97@gatech.edu](mailto:sjiang97@gatech.edu)

## Introduction

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 problems, and I used visual method. In project 2, it will focus on solving three by three problem. By observing these issues, I found the problem C in project 1 is more complex than problem B in the project 1. So unlike project 1, I will use verbal method in the project 2. It also will create some assumption relationships function in the program, then using the code to implement these assumptions until they found the correct answer. So in project 2, I will use Contour Recognition & Reasoning, Shape-Agnostic Transformation Recognition and Hybrid Reasoning to solve all the questions. In this paper, individual squares in a problem are called 'frames', while individual shapes within each frame are called 'objects'.

## First time submission:

1. The first submission was submitted on 2019-06-26 06:34:26 UTC.
2. For the first submission version, I just did one assumption, that the changes are depend on the shape, pattern and quantity to find the rule. Because project 2 is harder than the project 1. I would like to make sure I am on the right track.

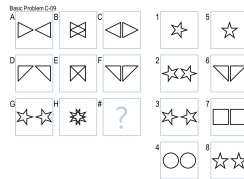


Figure 1. Shape Relationship

3. In this case, I find A,B, and C have the same shape and quantity but different patterns; D,E, and F have the same shape and quantity but different pattern. So I assume that G, H and ninth frame should have the same objects that are the same

shape and quantity but different pattern. We need to find the logical relationship between them in order to find the ninth image. The result shows that the Agent could find the right answer. Also I think its thoughts is similar to my ways.

4. In the Basic problem C set, it got one Correct, which is Basic-C09, I am using Contour Recognition & Reasoning to solve the problem. I firstly find the shape relationships in each row. And the last column is rotation relationship with the first column. So it finds the correct answer what I am trying to find. The main struggle is because there are a lot of frames, so I need to find out what the most significant rules are and have minimal time complexity. Finally, the time complexity is  $O(1)$ .

	Basic Problem C	Ravens Problem C	Test Problem C	Challenge Problem C
Incorrect	11	10	10	11
Skipped	0	0	0	0
Correct	1	2	2	1

Table 1. First Submission Result

#### **Second time submission:**

- 1.The second submission was submitted on 2019-06-27 06:07:05 UTC.
2. I added another assumption in my code, which is the Quantity relationships, which means the quantity of objects in each row or column of frame increase regularly. I did the Quantity assumption because I want to solve C-03, C-04 and C-07 problems. I found these problems are related to quantity of objects by observing them.

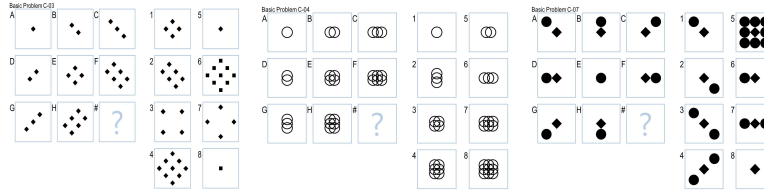


Figure 2.Second Submission Solved Problem

3. I am using Contour Recognition & Reasoning and Shape-Agnostic Transformation Recognition to solve the problems. First step, it uses Contour Recognition & Reasoning method. It firstly finds the shape, then using top-down recognition to find each column's relationship. The second step, it will use Shape-Agnostic Transformation Recognition. For each column, I found that each object's quantity has increased, they also keep the same position for each column. According to the rule, the last image can be chosen. So it is similar to human's assumption.

4. They did perfect performance. For C-03 and C-04, they find the right answer based on the rule that objects' shape is the same, but the number of objects is multiplied. For C-07, it finds the right answer based on the rule that its pattern is the same, and they have a symmetrical relationship. According to the results, the types of problems I am trying to find have found the right answer. So the quantity relationship is the easiest problem. In the process of solving problems, the main struggle is how to find the correct answer with the least time complexity. The time complexity is  $O(1)$ .

	Basic Problem C	Ravens Problem C	Test Problem C	Challenge Problem C
Incorrect	9	10	10	11
Skipped	0	0	0	0
Correct	3	2	2	1

Table 2.Second Submission Result

### Third and Fourth time submission:

1. For the third time, I submitted on 2019-06-27 06:24:43 UTC. And I got Execution: "Your code caused RavensProject to crash." I got "Crash" because of the order of the problem. The fourth submission submitted on 2019-06-28 06:55:10 UTC.

2. I added three more functions to solve more problems. It also related to quantity relationships. It uses both Contour Recognition & Reasoning and Shape-Agnostic Transformation Recognition. I chose the following three questions to solve because based on the result of Submission1&2, I think it is a good way to find the rule through the objects' shape and quantity.

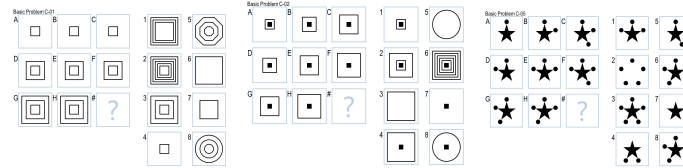


Figure 3. Fourth Submission Solved Problem

3. For C-01, I found it is the similar relationship by observing each column of the first row. The way I look for the last one in the given selection is to find the one with the highest matching rate to the G and H. For C-02, it finds the most similar pattern and quantity from the given selection, and the shape's size is increase.. For C-5, they keep the same STAR and the solid dots increase by the number of differences. The agent find the correct answer, which I think is similar to my thoughts.

4. Compared to the above submission, the results of the fourth submission get significant improvements. Especially for finding the correct answer based on quantity. It is the most efficient way. And C-1 and C-5 have time complexity  $O(K)$ ,  $k$  is the how many shadow circle it has. C-2 has the time complexity  $O(k)$ ,  $k$  is the how many objects it has in a frame. The main struggle is also how to find the correct answer with the least time complexity.

	Basic Problem C	Ravens Problem C	Test Problem C	Challenge Problem C
Incorrect	3	10	6	11
Skipped	0	0	0	0
Correct	9	2	6	1

Table 4.Fourth Submission Result

**Fifth time submission:**

1. The fifth submission was submitted on 2019-06-28 18:18:22 UTC.
2. I added another two assumption in my code. Ones is related to the shape of the objects, another one is related to pattern and shadow.I used both Contour Recognition & Reasoning and Shape-Agnostic Transformation Recognition to solve the problem.

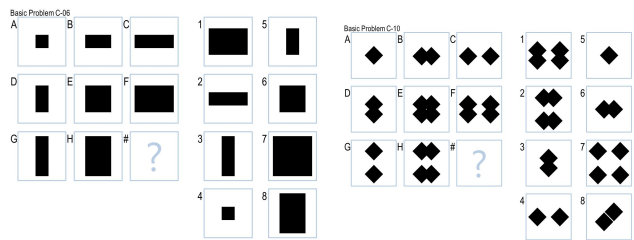


Figure 4. Fifth Submission Solved Problem

3. For C-06, I found that the object is gradually wider on each row, and they gradually become longer on each column. So I could just find an object that is wider than H and longer than F. For C-10, by looking at each row or column, so it could find the right answer by following the rule that count quantity and use the bounding box. According to the result, it is similar to how human's think.

4. The whole perform is list as Table 4. Until now, the problems related to shapes or quantities is the simplest. But if a problem, including shadows, quantity, and shape will be more difficult. The time complexity for both problems are  $O(1)$ .

	Basic Problem C	Ravens Problem C	Test Problem C	Challenge Problem C
Incorrect	3	10	6	11
Skipped	0	0	0	0
Correct	9	2	6	1

Table 4.Fifth Submission Result

#### **Sixth time submission:**

1. The second submission was submitted on 2019-06-28 18:51:13 UTC.
2. Because I have been struggling to achieve the 7/12 correct answers in the test problem, I modified my code to make the sixth submission. I asked 12 questions to run each corresponding function. Some problems could return a correct answer after running on each function, if it did not return a correct answer, I would let the remaining questions guess the answer.
3. In this modification, the agent still does not produce a satisfying answer. I think it may be because the AI agent also feels hard to get the correct answer after "reading" all these rules. So it is not similar to what I am thinking.
4. Until now, the problems related to shapes or quantities is the simplest. But if a problem, including shadows, quantity, and shape will be more difficult. But the AI agent still cannot learn from my rule, so I need to struggle with making more function to let the AI agent choose. It has low efficiency.

	Basic Problem C	Ravens Problem C	Test Problem C	Challenge Problem C
Incorrect	3	10	6	11
Skipped	0	0	0	0
Correct	9	2	6	1

Table 5.Second Submission Result

**Seventh and Eighth time submission:**

1. The seventh submission was submitted on 2019-06-29 04:44:13 UTC. For the seventh submission, I forgot to delete the code that asked to save the picture at local, so it got the CRASH error. And the eighth submission was submitted on 2019-06-29 04:56:03 UTC.
2. I added another two assumptions in this submission. One is the quantity of objects in each row or column of frame increase or decrease regularly. Another one is about shadow. So I write another two functions related to quantity and shadow. Also, I changed the code to return -1 if it does not answer the problem, because I would like to know how many problems cannot be solved.

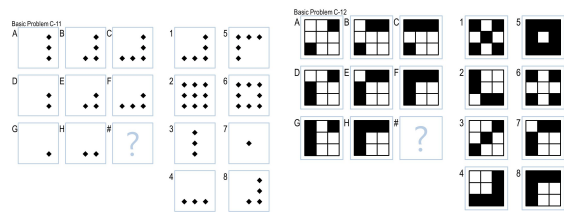


Figure 5. Eighth Submission Solved Problem

3. For these two problems, I used the Visual method. And the Hybrid reasoning. I find a rule by using XOR to find if there is a difference between each frame. Then I used the rule to get the correct answer. For this problem, it is similar to how human's think.

4. Until now, it performs very well and goes smoothly. It did a good job on quantity relationship problems. But I am still struggle with Shadow problems, especially Basic problem C-8. And the time complexity for both C-11 and C-12 is  $O(1)$ .

	Basic Problem C	Ravens Problem C	Test Problem C	Challenge Problem C
Incorrect	0	0	1	0
Skipped	1	12	2	12
Correct	11	0	9	0

Table 6.Eighth Submission Result

**Ninth time submission:**

1. The second submission was submitted on 2019-06-29 05:06:04 UTC.
2. For last submission. I let the AI agent to guess an answer which is 7 if the problems can not be solved by the functions. Because by observing all the problems, I found most of them have the 7 as the correct answer.
3. It Just like a student in an exam, if there are some multiple-choice question that a student really can't understand, it will choose a specific answer for such questions, so I think this question is very similar to human thought..
4. The perform did not get improvements on both Basic problems C and Test problems C. I am still struggling with problem C-8. For C-8, by looking at each row or column, the white squares are getting less and less, so it could find the right answer by following the rule. But it actually decided by the middle frame.



So it does not like human's thoughts, I had a hard time to solve it. The efficiency is the same.

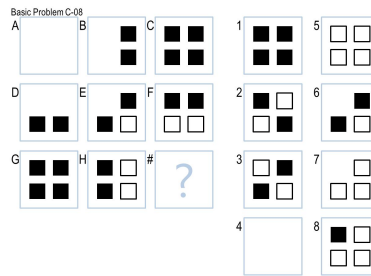


Figure 6. Basic Problem C-8

	Basic Problem C	Ravens Problem C	Test Problem C	Challenge Problem C
Incorrect	1	9	3	12
Skipped	0	0	0	0
Correct	11	3	9	0

Table 7.Ninth Submission Results

### Conclusion:

I did nine times submissions. It got the 1 correct answer on Basic problem C and 2 correct answers on Test Problem C in the First time submission . It got the 3 correct answers on Basic problem C and 2 correct answers on Test Problem C in the second time submission. It got the 9 correct answers on Basic problem C and 6 correct answers on Test Problem C in the third time submission. It got the 9 correct answers on Basic problem C and 6 correct answers on Test Problem C in the fifth time submission. It got the 9 correct answers on Basic problem C and 6 correct answers on Test Problem C in the sixth time submission. It got the 11

correct answers on Basic problem C and 9 correct answers on Test Problem C in the eighth time submission. For the last presentation, It got the 11 correct answers on Basic problem C and 9 correct answers on Test Problem C. So it finally got satisfied performance. Unlike project 1, I used both verbal and visual methods in project 2. C-1, C-7, C-11, and C-12 used the Visual method. For C-2, C-3, C-4, C-5, and C-6, they used the Verbal method. C-9 and C-10 used both Visual and verbal method. I mainly focus on dealing with one type of problem each time. I divide the problem into finding by quantity relationship, or by shape and pattern, or by XOR. In general, finding the method by quantity is the easiest. Because 12 questions have their own particular problems, I wrote a function for each problem. In the process of solving the problem, when some problems challenging to find a correct answer, I tried two ways to solve them: One is that when the rule of those problems is not in my function, I will let them randomly guess one answer. Another way is that when the rules of those problems are not in the function, I let them all choose 7 as the answer. But neither method produces better results. So I continue to find the rule to solve the left problem. Finally, only C-8 cannot find the correct answer. The AI agent's ideas of other problems are similar to human thoughts. Only C-8, I thought It can only count the number of white squares but has some rules that I cannot figure out. So If I have more time, I will focus on solving the C- 8. In addition to C-2 and C-5 got time complexity  $O(k)$ ( $k$  is the objects in a frame), others got time complexity  $O(1)$ .

## References

1. Digital image processing. (2019, May 29). Retrieved May 30, 2019, from [https://en.wikipedia.org/wiki/Digital\\_image\\_processing](https://en.wikipedia.org/wiki/Digital_image_processing)
2. S. Jiang, Project 1 Journal
3. Joyner, D. A., Bedwell, D., Graham, C., Lemmon, W., Martinez, O., & Goel, A. K. (2015, June). Using Human Computation to Acquire Novel Methods for Addressing Visual Analogy Problems on Intelligence Tests. In *ICCC* (pp. 23-30).