The way to win at Mawari Shogi

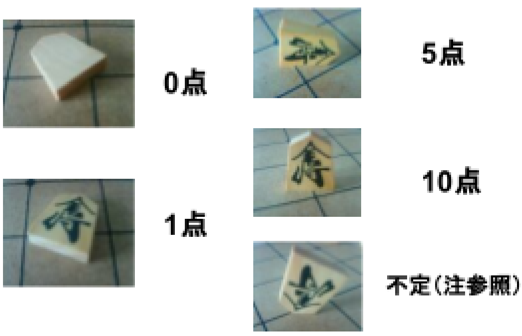
[redacted]

Mawari Shogi is a game of throwing Shogi pieces (Kinsho) and advancing another piece.The points we can get depends on how the piece stands when it falls to the ground. In rare cases, the side or bottom, which has a smaller area, stands in contact with the ground .(Now,we define this case "piece standing") .In such cases, the pieces can be advanced more. We thought that there might be an appropriate way to throw a piece to make it stand, and investigated the conditions when a piece stands using the simulation software called "blender". The condition we investigated was the angle of the piece to the ground. The angle of the piece was defined as (x,y) to be linearly independent, and the values of x and y were plotted on the xy plane when the piece stood and when it was about to stand. Then, the plotted points were arranged in a way that could be approximated as an elliptical graph. From this result, we considered that the values of (x,y) when the piece is likely to stand are such that the graph is distributed on an ellipse.

1 Backgrounds

Mawari shogi is a game using Shogi pieces.Players toss four pieces and get the point.The amount of points we can get depends on how the piece is put on the ground. The concrete points we can get are as follows of figure1. Please refer to the diagram below for the score distribution.

Figure 1: State and score of a piece



注)ローカルルールによって点数が異なるため今回は確定させない

From figure 1, we can find that when a piece is put on its side,or on the bottom(we define this case “piece stands”), we can get more points than in other cases. Although there are other local rules, the basic idea is to get as many points as possible to win. Therefore, we started to investigate the way to make a piece stand.There is no previous research on this point of view yet.There may not be any previous research about Mawari shogi.

The following two points are expected to be revealed by the experiments conducted in this study.

(1) The relationship between the height at which a piece is thrown and its score.
(2) The relationship between the angle at which a piece is thrown and its score.

2 Materials and methods, results

We conducted the following two kinds of experiments.
(1) Exploring the relationship between height and ease of standing in a manual experiment
(2) Exploring the correlation between angle and ease of standing in an experiment using simulation software.
First, let's discuss (1).
A manual experiment is literally an experiment in which data is collected by moving the hands. Pieces fall freely. The height is varied in stages. In this experiment, the height is varied from 0 cm to 10 cm in 2.5 cm increments. For each height, we conducted 250 times in each height. The number of times they stood vertically and horizontally were combined and recorded. After completing the experiment, we found many problems, such as there was no guarantee that the results were statistically correct. We will make use of these points in further research. The table below shows the results of this experiment.

Figure２　result of experiment 1

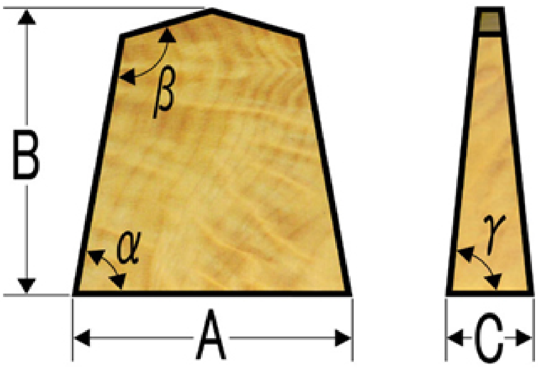
Steps(times) / Height(cm)	10 steps	5 steps	Total steps
2.5	3 times	7 times	65steps
5.0	2 times	2 times	30steps
7.5	2 times	5 times	45steps
10.0	4 times	1 time	45steps

From this experiment,we can say that the lower height we toss pieces from,the more points we can get due to less potential energy. However,This experiment is not accurate because tossing pieces by hand is not stable.Therefore,in the next experiment,we decided to use blender,a simulation software because we can experiment stably. However, there was another problem with this experiment. That is, the height is unrealistic. If you think about it calmly, there is no way you can make a piece fall freely from a height of 2.5 cm or 5.0 cm. In other words, this experiment was not very meaningful. What's more, this experiment is not repeatable. The results of the experiment will vary depending on the person conducting it. The results of the experiment were not quantitative, and we are not sure what we wanted to do with it. So, We came up with a new experiment, (2). This is not a manual experiment. This is not a manual experiment, because it uses a physics engine that can handle quantitatively.
We used a simulation software called blender.

blender®

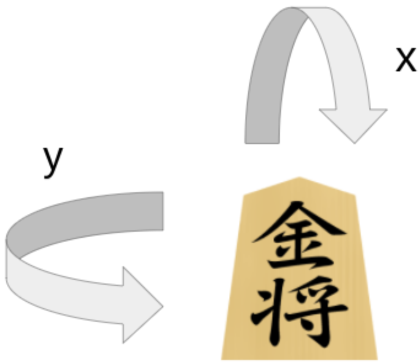
We modeled the gold general's pieces in this engine, fixing the height and varying the angle at which they free-fall. The sizes of the pieces are shown in the picture below.
A=26cm, B=29cm, C=8.2cm, α=80.5°, β=116.5°,
In the photo below, A=26cm, B=29cm, C=8.2cm, α=80.5°, β=116.5°, γ=85°. (Quoted from Ref.

Size of a piece (“Kinsho”)



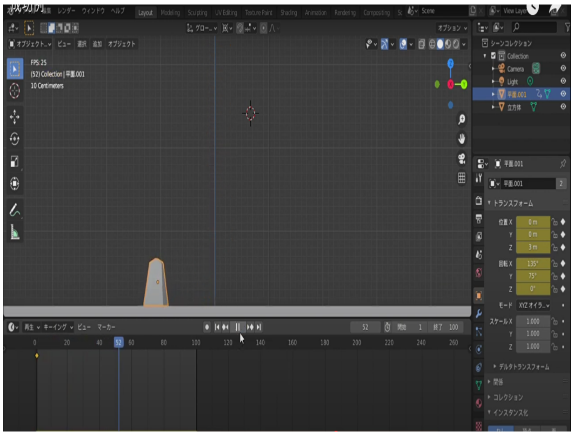
The height to be fixed is 9.0 cm . The reason for this height is that it is a height that is not unnatural for a free fall, and the actual result of the research conducted by our research team was 9.0 cm. In this experiment, the angle is used as a variable, but I will explain where the angle is used as a variable in the first place. Since the height is fixed, there are two types of angles to consider.

Figure 3　direction of rolling.



As shown in the figure above, x is the vertical direction and y is the horizontal angle. In this case, it is not necessary to consider whether the positive direction is from the front to the back or vice versa. This is because shogi pieces are symmetrical. We changed each angle in 15° increments. The photo below shows the experiment in blender.

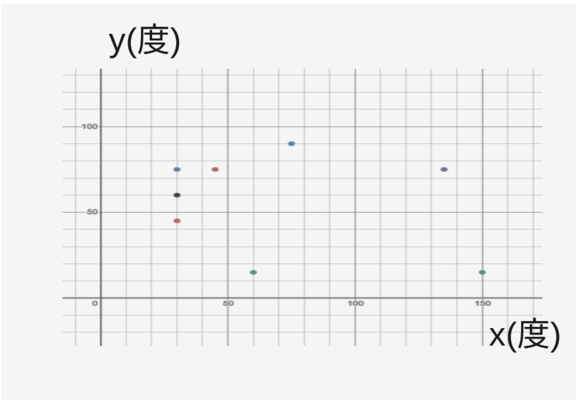
The experiment　(blender)



The coefficient of repulsion and the coefficient of friction were measured using actual Shogi pieces, as no data could be found on the Internet.
The coefficient of repulsion is a rough value because there is no standard for it, but the coefficient of friction was found to be about 0.324 by measurement.
In the experiment in (2), the angles when the piece stands and when it almost stands are recorded. Nearly standing is a kind of subjective state, but it is defined as standing vertically or as close to standing horizontally as possible for 10 frames in blender.

The result of this experiment is shown in the figure below (colored to make it difficult to see).

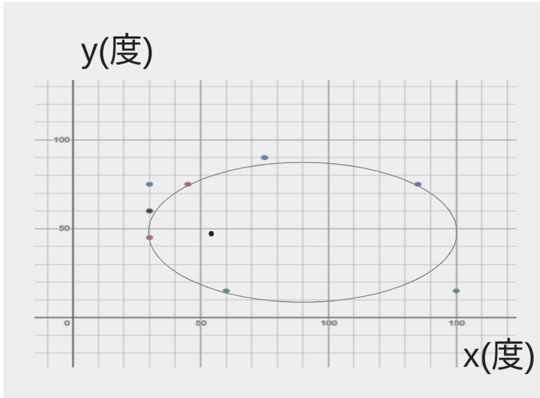
Fig. 4 Experimental results of (2)



There is not much data obtained from this experiment. However, we believe that the results of this experiment were quite successful. We will discuss this in the next section.

3 Discussion
First of all, the experiment (1) only showed that the probability of a piece standing in the first place is low. On the other hand, experiment (2) gave us an interesting result to consider. If we consider the distribution of the data in Fig. 4 above, doesn't it look like an ellipse?
The ellipses are superimposed in Figure 5 below.

Figure 5: Overlap of Figure 4 and the ellipse



It is thought that the ellipse can be superimposed in this way. By the way, the equation of this ellipse is complicated.
{(x-90)/60}^2+{(y-50)/40}^2=1.
However, there are two problems here. There are two problems here: outliers and data asymmetry that occur when using an ellipse. I think this is due to the fact that the center of rotation and the center of gravity of the piece did not match perfectly during the modeling phase in blender, and a misalignment occurred.
Therefore, by solving this problem, we can say that the desired data will be recorded. In the experiment in (2), the height was a specific 9.0 cm, but we can assume that similar ellipses can be drawn at other heights (of course, since we have not discovered the law of how the pieces fall, we cannot deny the possibility of drawing other figures or not drawing figures in the first place). From the above, we can conclude that the best way to get many points in the game is to let the pieces fall at x and y that satisfy the equation of ellipse at the height of the free fall.
When I thought about (1) and (2) in the background, I could not understand the relationship between height and score in (1). As for (2), the relationship between angle and score, it became clear that it is enough to let the object fall freely under the conditions described above.

4 Application to real life and future prospects
As mentioned in the abstract, this research will contribute not only to the development of Mawari

shogi but also to finding the law of falling. As more research is done, we will be able to control the falling.It may prevent the breaking of things,thereby reducing the amount of garbage.Then, our future work is as follows.

•Generalize the elliptic equation with height as a variable
•Expand to initial velocity, rotation, and throw-up
•Increase the number of trials and collect more accurate data.
•Collect data while varying all conditions.

【Reference】

1）Wikipedia

(https://ja.wikipedia.org/wiki/%E3%81%BE%E3%82%8F%E3%82%8A%E5%B0%86%E6%A3%8B）

2）Size of pieces（http://kijishi.html.xdomain.jp/komanosize.htm）

3）check the rule of Mawari Shogi（https://nezumileader.hatenablog.com/entry/2020/01/05/155553）