Interesting Simulation（Smartphone）

08/02/2024
Sohun

1　Toss 10 Yen Coins to Find Pi

（１） Experimental Overview

Draw parallel lines at equal intervals vertically and horizontally（grid lines）. Throw 10 yen coins randomly onto it.

The width of the parallel lines that make up the grid is the same as the diameter of a 10 yen coin.

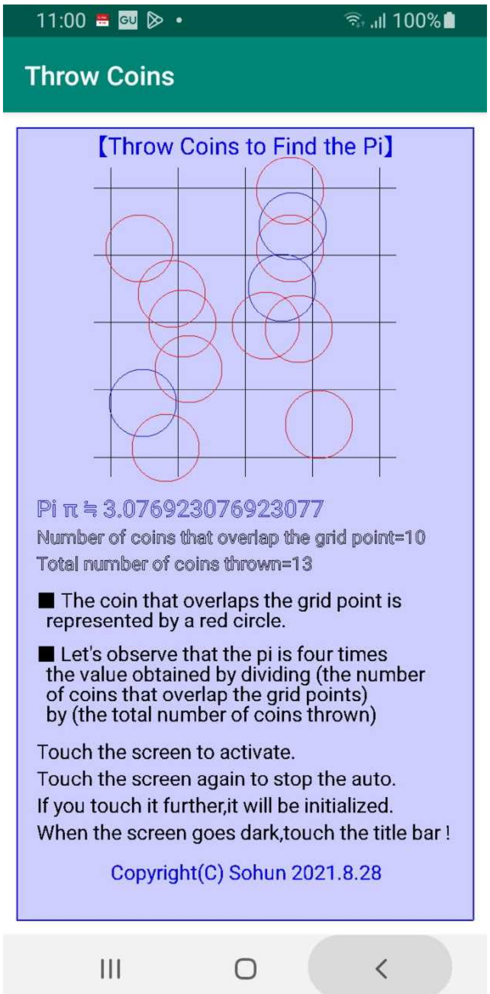
The thrown 10 yen coins will either overlap with a grid point , or be on a grid line and not overlap with a grid point（The intersections of the grid lines are called grid points.）

In this case , the approximate value of pi can be calculated using the following formula.

pi=（Number of 10 yen coins overlapping with the grid points）÷（Total number of 10 yen coins thrown）× 4

（２） Experimental Results（Android Version）

① Experiment 1



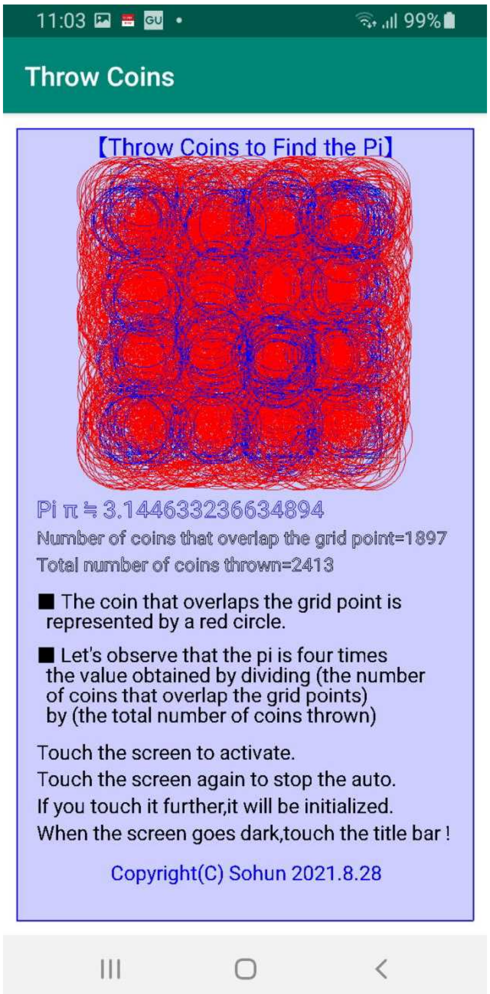
↓

Total number of 10 yen coins thrown=13

Number of 10 yen coins overlapping with the grid points=10

Approximate value of pi=10 ÷ 13 × 4
= 3.　0769230769･･･

② Experiment 2



↓

Total number of 10 yen coins thrown=2413

Number of 10 yen coins overlapping with the grid points=1897

Approximate value of pi=1897 ÷ 2413 × 4
＝ 3.　1446332366･･･

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08/03/2024
Sohun

2　Scatter Sesami Seeds to Find Pi

（１）Experimental Overview

Draw a square and a quarter circle inscrbed within it.

Scatter sesame seeds randomly on them.

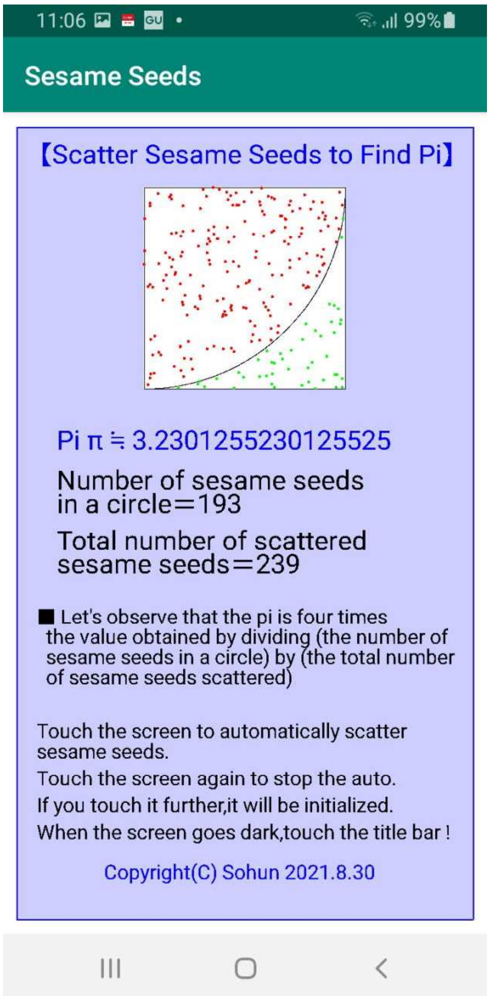
The scattered sesame seeds must either fall within a quarter circle or not fall within a quarter circle within the square.

In this case , the approximate value of pi can be calculated using the following formula.

pi=(Number of sesame seeds in a quarter circle) ÷ (Total number of scattered sesame seeds) × 4

（２）Experimental Results（Android Version）

① Experiment 1



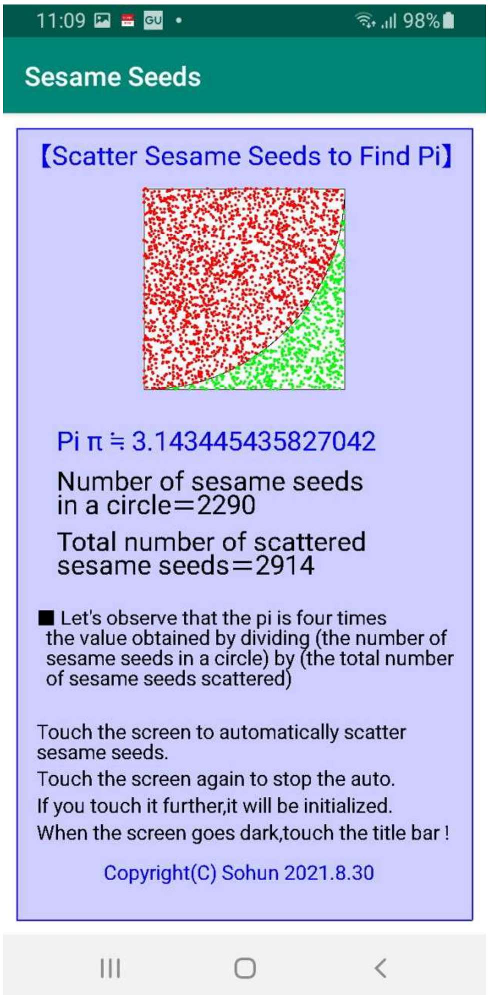
↓

Total number of scattered sesame seeds=239

Number of sesame seeds in a quarter circle=193

Approximate value of pi=193 ÷ 239 × 4
=3．2301255230･･･

② Experiment 2



↓

Total number of scattered sesame seeds=2914

Number of sesame seeds in a quarter circle=2290

Approximate value of pi=2290 ÷ 2914 × 4
＝ 3．1434454358･･･

Interesting Simulation（Smartphone）

08/05/2024
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3　Scatter Needles to Find Pi

（1） Experimental Overview

Draw parallel lines at equal intervals. Scater needles randomly over them.

All the needles are the same length , and the distance between the parallel lines is twice the length of the needle.

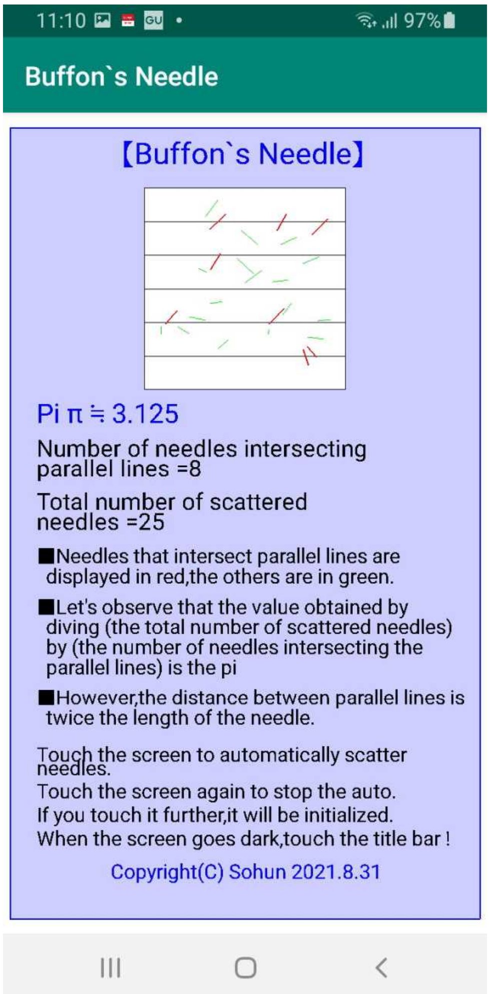
The scattered needles shall either intersect with the parallel lines or not intersect between the parallel lines.

In this case , the approximate value of pi can be calculated by the following formulsa.

pi=（Total number of scattered needles）÷（Number of needles intersecting with parallel lines）

（2） Experimental Results （Android Version）

① Experiment 1



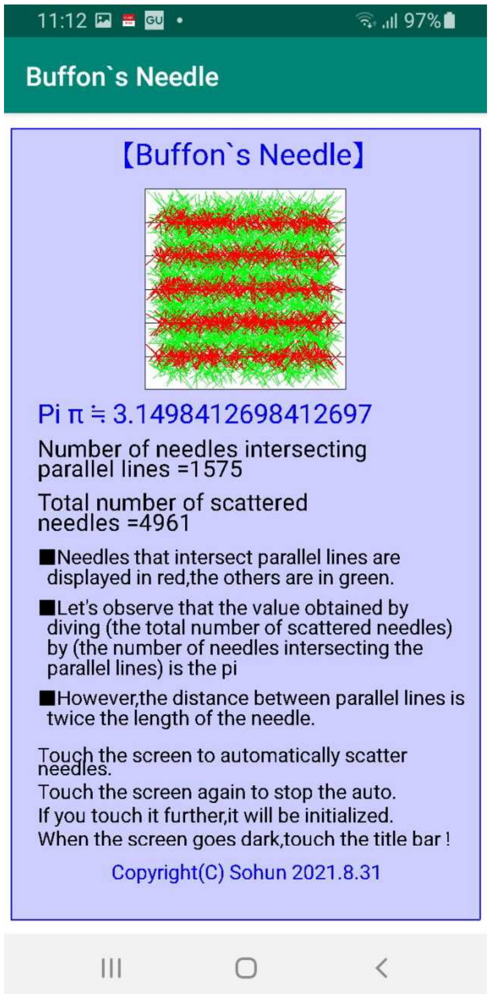
↓

Total number of scattered needles=25

Number of needles intersecting
with parallel lines=8

Approximate value of pi=25 ÷ 8
=3．125

② Experiment 2



↓

Total number of scattered needles=4961

Number of needles intersecting
with parallel lines=1575

Approximate value of pi= 4961 ÷ 1575
= 3．1498412698･･･

Interesting Simulation（Smartphone）

08/06/2024
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4　Pachinko Ball Falling Experiment

（1）Experimental Overview

When a pachinko ball hits nails and sprits into two as it falls , where will it land ?

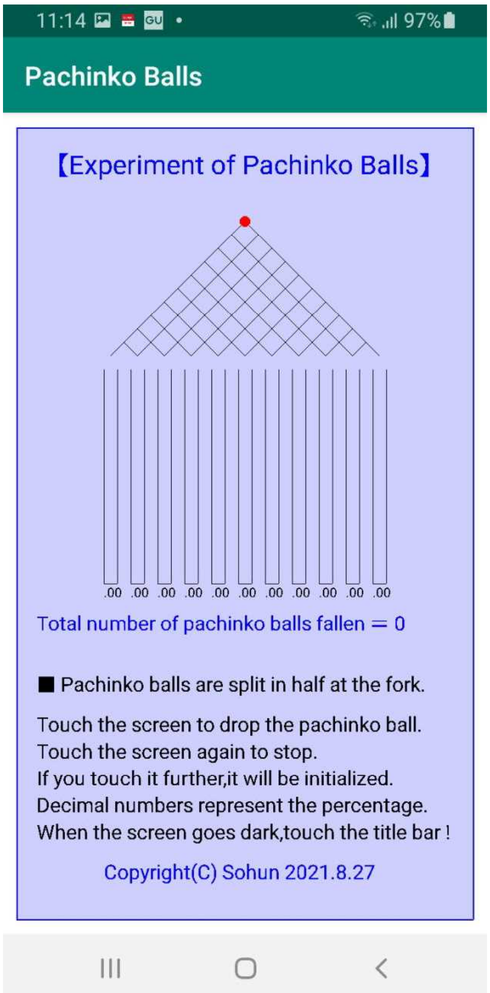
A pachinko ball（red dot） falls　along a line from the top , falling the path shown in the image below.

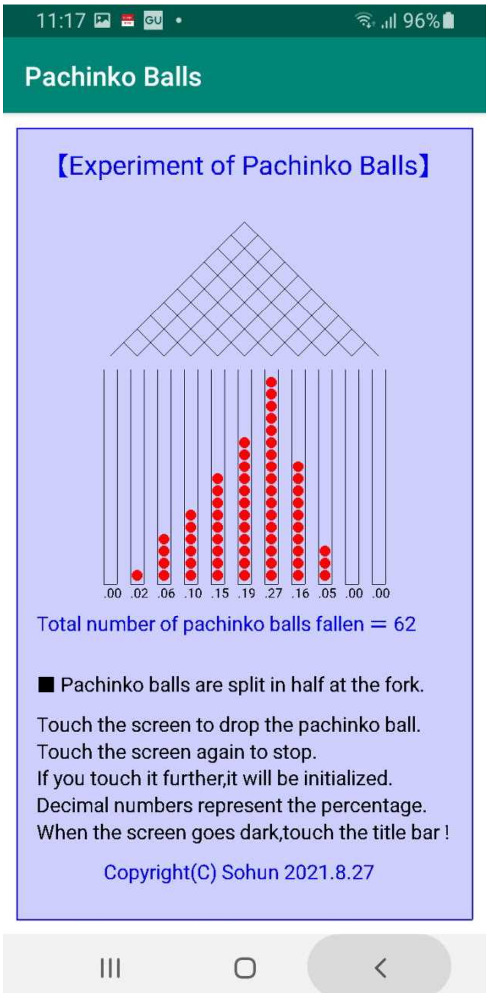
However , when the pachinko balls split into left and right at the branching points , they are split in half , left and right.

Are there any places where pachinko balla are more likely to fall ? Or , do they fall off equally easily everywhere ?

（2）Experimental Results（Android Version）

① Before the experiment begins　　　　② When 62 pachinko balls have fallen





In mathematics , we use $_{10}C_{k-1}\left(\frac{1}{2}\right)^{10}$ to find the probability that the pachinko ball will fall in the kth position from the lefct.

Using this formula , the probability of the pachinko balls falling on both ends is 0.001.

The probability increases further inward , with the probability of a pachinko ball landing in the middle being 0.246.

The experimental results also show that more pachinko balls fall towards the inside.

Interesting Simulation（Smartphone）

08/07/2024
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5　Random Walk

（１）Experimental Overview

Drunk people stagger from side to side without thinking.

Drunk people often end up returning to the same place multiple times while wandering around trying to reach their destination.

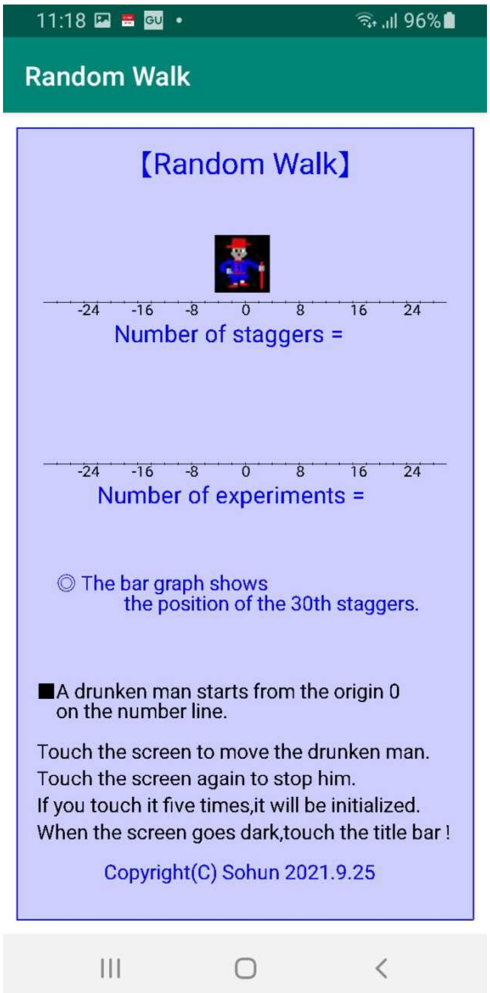
Now the drunk person is at the origin on the x-axis , as shown in the image below.

If the drunk person starts from the origin and staggers 30 times , how far away from the starting point , the origin , will he be at the 30th stagger ?

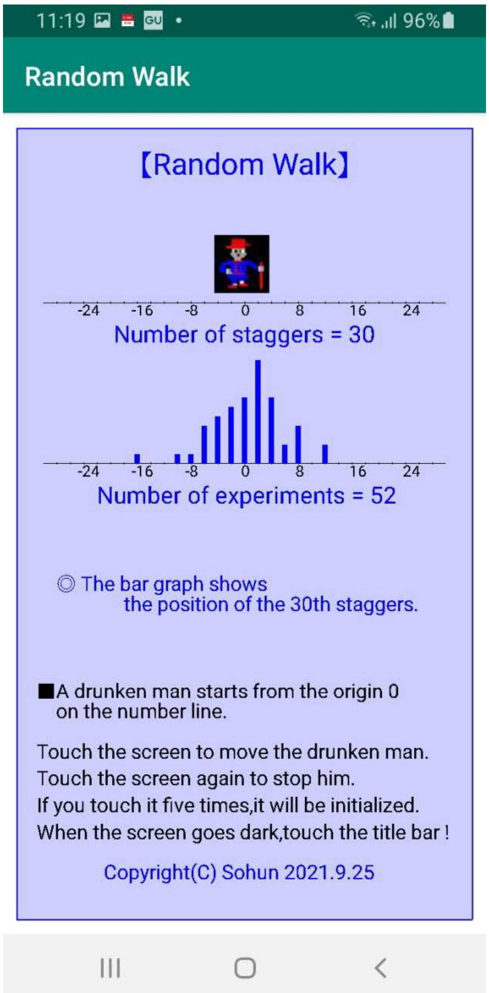
However , the drunk person only sways in two directions , left and right , and the distance traveled per sway is counted as 1.

（２）Experimental Results（Android Version)

① Before the experiment begins



② 52nd experiment



In the experiment , the drunk person starts from the origin on the x-axis and sways only from side to side. The x-coordinate of the position at which he sways the 30th times is counted and plotted on a bar graph.

The horizontal axis on the graph is rhe x-coordinate of the 30th stagger , and the vertical axis is the degree.

From the graph , we can see that he often returns to near the origin after the 30th stagger.

Therefore . we can say "A drunk person will often end up returning to the same place multiple times while wandering around trying to reach his destination."

Interesting Simulation（Smartphone）

08/08/2024
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6　Even a Poor Shotgunner Can Hit Something if He Shoots Enough Times

（１）Experimental Overview

Have you ever heard of the word "Even a poor shotgunner can hit something if he shots enough times " ?

A gun is fired by someone who is skilled enough to hit the target once out of ten shots.

Mathematically to find the probability of hitting the target at least once when firing a gun several times , subtract the probability of missing every shot from 1.

For each experiment , consider firing 20 shots from a gun.

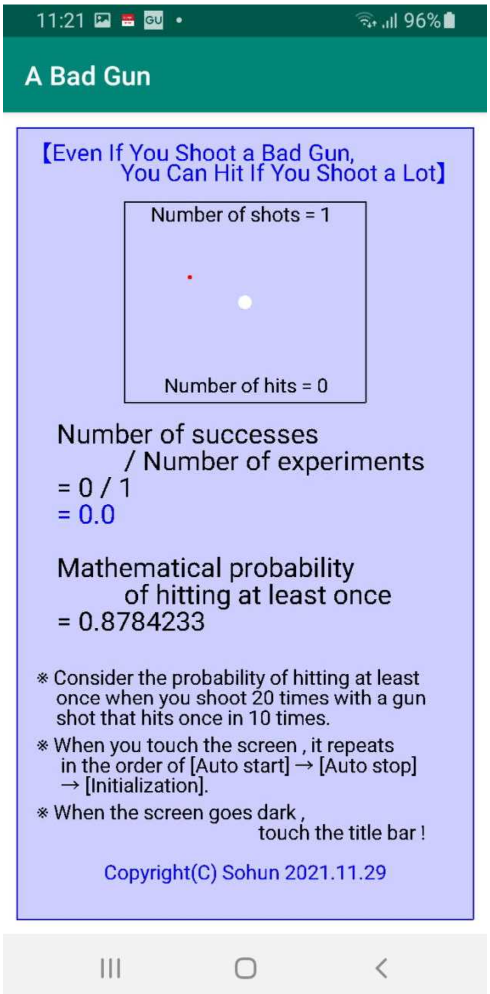
If at least one of the 20 shots hits the target , it is considered a "success" , if not , it is considered a "failure".

Conduct several experiments and calculate the probability of winning at least once（number of success / number of experiments）.

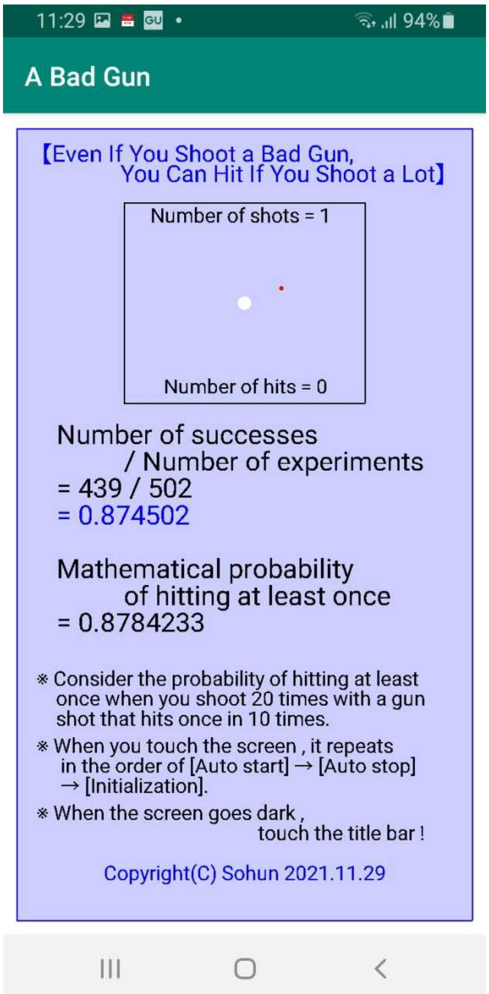
Compare the experimental results with the theoretical mathematical probabilities.

（２）Experimental Results（Android Version）

① 1st experiment



② 502nd experiment



Each shot has a 1/10 probability of hitting. For each shot , there is a 9/10 chance of missing.

The probability that all 20 shots will miss is $(9/10)^{20}$. The probability of hitting at least one out of 20 shots is $1 - (9/10)^{20} = 0.8784233$

In the experiment ,（number of success）/（number of experiments）=439/502=0.874502

It can be seen that the experimental result and the mathematically calculated theoretical probability are close to each other.

Interesting Simulation（Smartphone）

08/09/2024
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7　Is Amidakuji Fair ?

（１）Experimental Overview

Do you ever use "Amidakuji" for lotteries ?

When it comes to "Amidakuji" , is the likelihood of winning equally no mater which number you draw ?

If they are not equal , what can we say ?

As shown in the image below , draw 10 vertical bars and 50 horizontal bars randomly to create a "ladder game" called "Amidakuji".

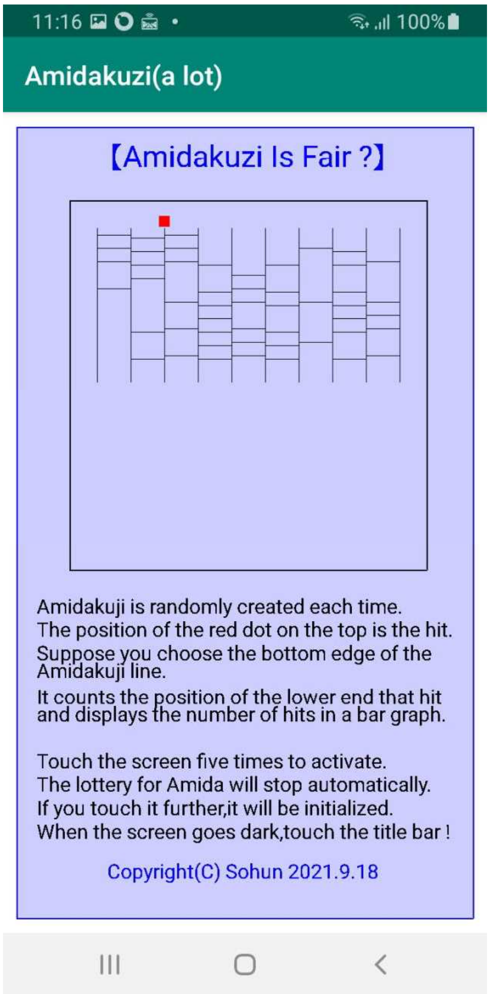
The red dot at the top end of the third vertical line from the left is the winning position.

Choose one of the bottom ends of the vertical lines and draw a "Amidakuji".（It is made upside-down compaered to a regular "Amidakuji"）.

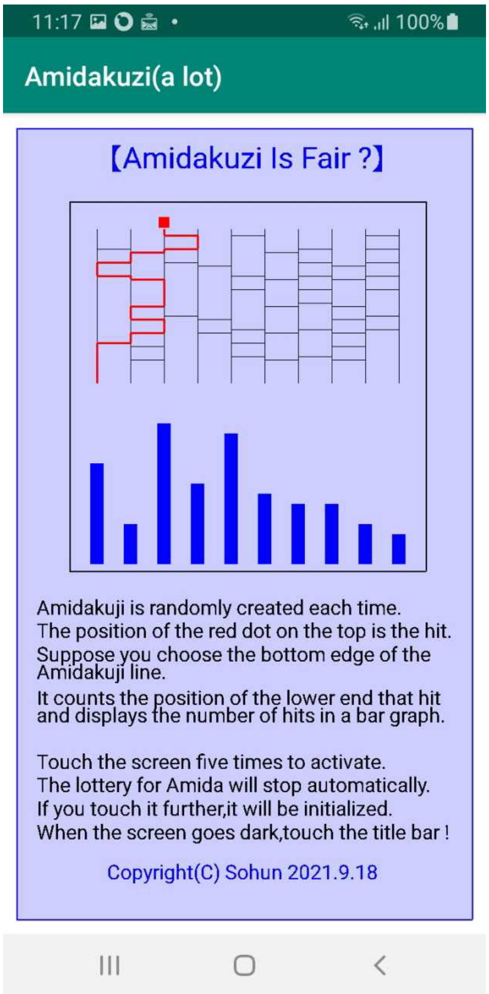
For each winning entry in a "Amidakuji" lottery , a blue dot will be displayed below the vertical line.

（２）Experimental Results（Android Version）

① Before the experiment begins



② After the experiment



An experiment will be completed until all the blue dots , which represent winnings , are filled.

After conductering several experiments , it was found that the 1st , 2nd , and 3rd positions from the left was most likely to win.

Based on the location of the hit , it is predicted that the side with fewer vertical lines is likely to hit.

However , this is only possible if you know where the hit is. In reality , since the location of the winning number is unknown , it can be said that "Amidakuji is fair."

Interesting Simulation（Smartphone）

08/10/2024
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8　Playing Cards that Are Multiplies of 3

（1）Experimental Overview

Here is a deck of cards. 52 cards are used , excluding two jokers.

The multiples of 3 are spades , clovers , diamonds , and hearts of which there are four 3 , 6 , 9 , and 12 , so there are 4 × 4=16 total cards.

When a card is drawn from these 52 playing cards , consider the probability that it is a multiple of 3.

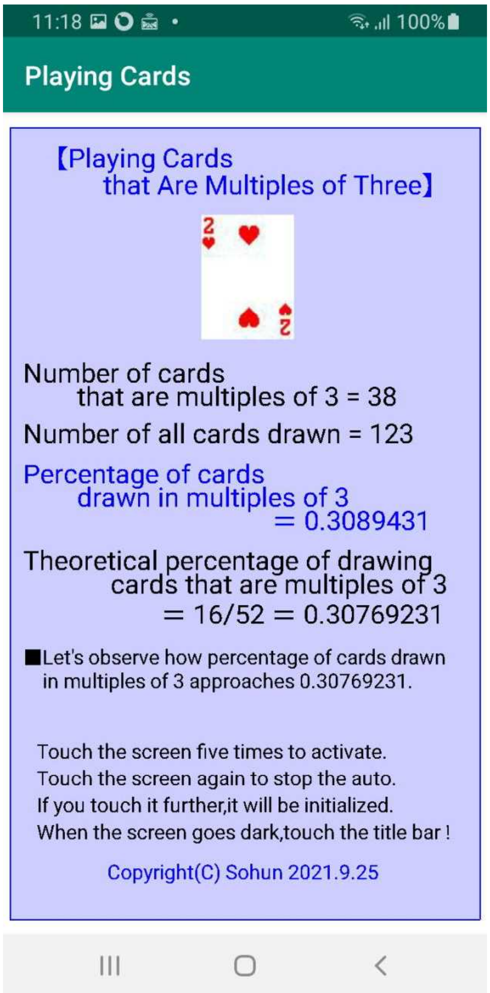
Of the 52 cards , 16 are multiples of 3 , so mathematically , it is 16/52.

However , in reality , if you draw and put back one card at a time 52 times , it is not certain that you will get exactly 16 cards that are multiples of 3.

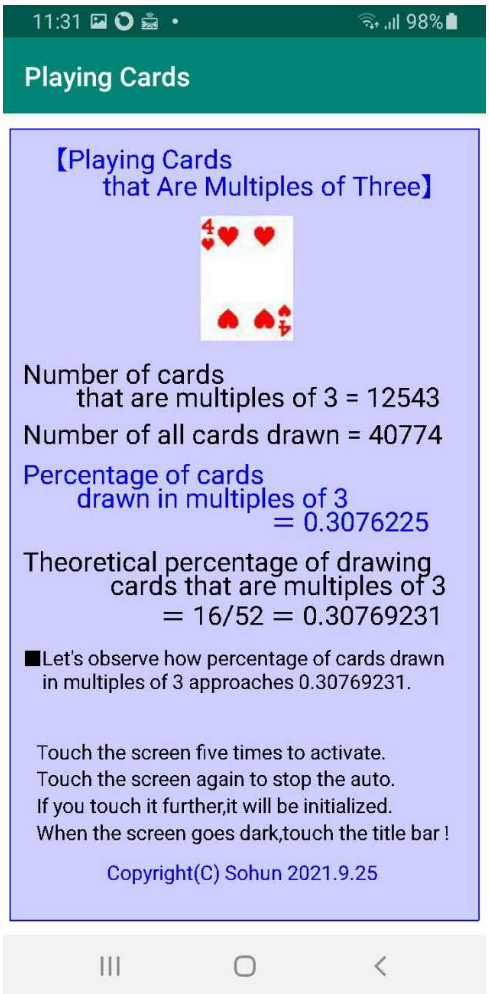
So , does this relate to the mathematically determined theoretical probability of 16/52 ?

（2）Experimental Results（Android Version）

① When 123 cards are drawn



② When 40774 cards are drawn



In the experiment shown in the image on the left below , playing cards were drawn and replaced one by one 123 times. A card that is a multiple of 3 was drawn 38 times. The probability of drawing a card that is a multiple of 3 was 38/123 = 0.3089431. In the experiment shown in the image on the right avobe , playing cards were drawn and replaced one by one 40774 times. A card that is a multiple of 3 was drawn 12543 times. The probability of drawing a card that is multiple of 3 was 12543/40774 = 0.3076225.

As we can see above , if you draw more playing cards , the probability of drawing a playing card that is a multiple of 3 aproaches the mathematically calculated theoretical probability of 16/52（0.30769231）.

Interesting Simulation（Smartphone）

08/12/2024
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9　Tossing Two Coins

（１）Experimental Overview

Toss two coins at the same time and see what happens if they land on heads or tails.

If these two coins are called coin1/coin2 respectively , there are four possible outcomes : heads/heads , heads/tails , tails/heads , or tails/tails.

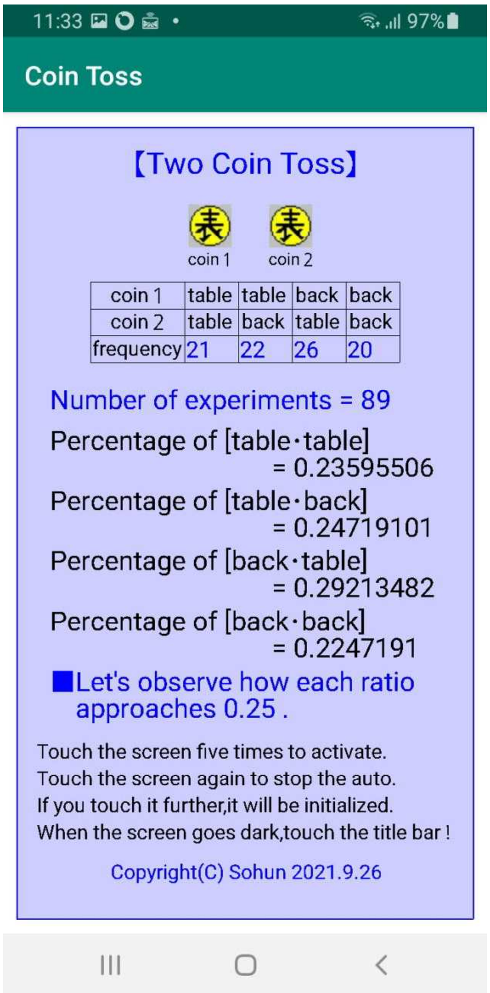
Mathematically , the probability of each of these four cases occuring is 1/4.

However , in reality , when two coins are tossed 4 times at the same time , it is not guaranteed that the following will occur once each; heads/heads , heads/tails , tails/heads , or tails/tails.

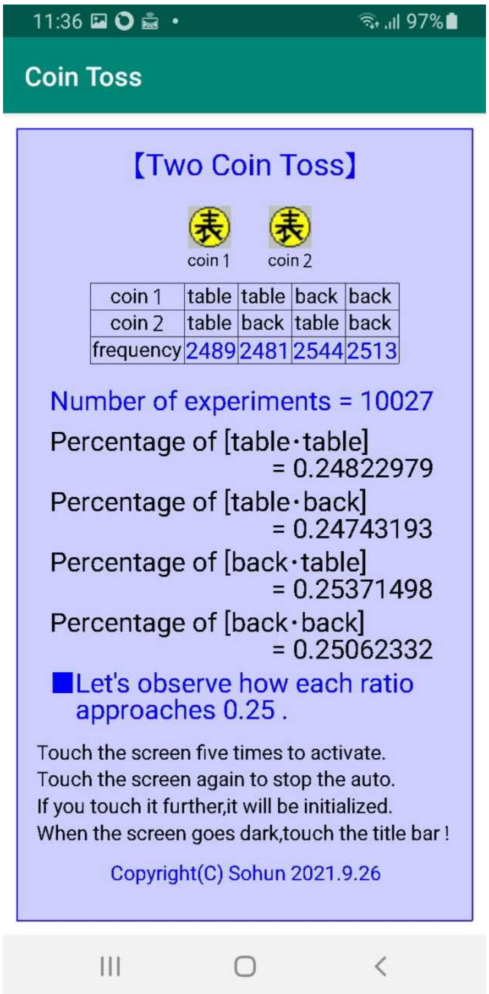
So , what is relationship with the mathematically calculated theoretical probability of 1/4 ?

（２）Experimental Results（Android Version）

① When thrown 89 times



② When thrown 10027 times



In the experiment shown in the image on the left above , two coins were tossed simultaneously 89 times. There were 21 table/table , with the ratio being 0.23595506. There were 22 table/back , with the ratio being 0.24719101. There were 26 back/table , with the ratio being 0.29213482. There were 20 back/back , with the ratio being 0.2247191.

In the experiment shown in the image on the right above , two coins were tossed simultaneously 10027 times. There were 2489 table/table , with the ratio being 0.24822979. There were 2481 table/back , with the ratio being 0.24743193. There were 2544 back/table , with the ratio being 0.25371498. There were 2513 back/back , with the ratio being 0.25062332.

As can be seen above , the more often two coins are tossed at the same time , the closer the probability of getting table/table , table/back , back/table , or back/back becomes to 1/4（0.25）, the mathematically calculated theoretical probability.

Interesting Simulation（Smartphone）

08/18/2024
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１０　Three People Playing Rock-Paper-Scissors

（１） Experimental Overview

Three people A , B , and C , play rock-paper-scissors. There are nine ways that the result can be a tie.

There are three ways in which only one person each of A , B , and C can win.

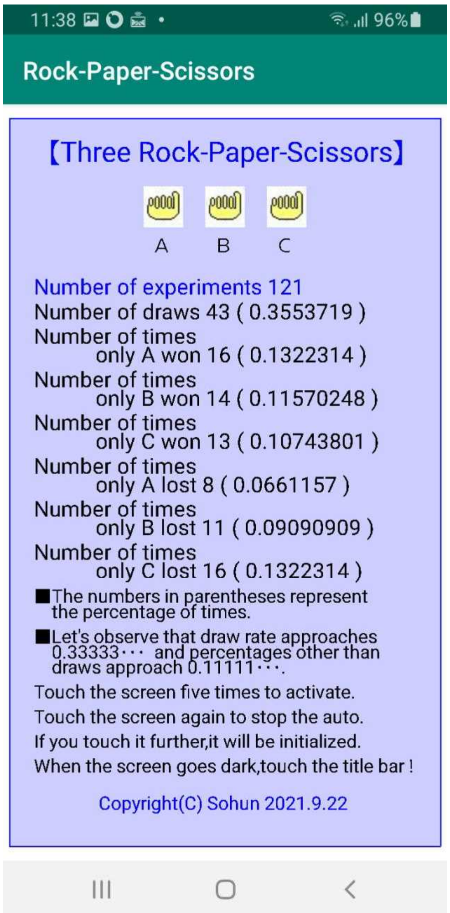
There are three ways in which only one person each of A , B , and C can lose.

In other words , when three people play rock-paper-scissors once , there are 27 possible outcomes.

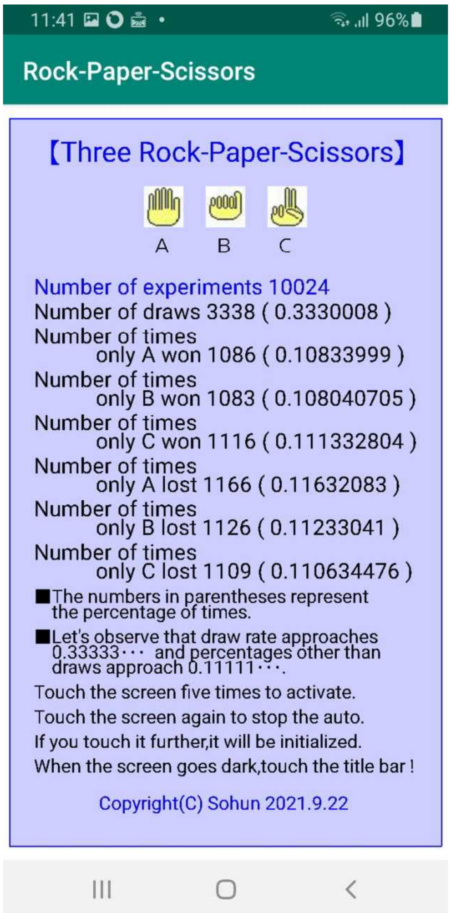
For example , since there are nine ways for a tie to occur , the mathematical probability of this happenning is 9/27 , which can be simplified to 1/3（0.333）. However , in reality , if three people play rock-paper-scissors three times , it is not guaranteed that there will be exactly one tie. So , what is the relationship between this and the mathematically calculated theoretical probability of a tie which is 1/3 ?

（２） Experimental Results（Android Version）

① When played r-p-s 121 times



② When played r-p-s 10024 times



In the experiment shown in the image on the left above , three people played rock-paper-scissors 121 times. The draw rate was 0.35537. The rate that A , B , and C each had only one winner was 0.13223 , 0.11570 , 0.10743 , respectively. Also , the rate that A , B , and C each had only one loser was 0.06611 , 0.09090 , 0.13223　, respectively.

In the experiment shown in the image on the right above , three people played rock-paper-scissors 10024 times. The draw rate was 0.33300. The rate that A , B , and C each had only one winner was 0.10833 , 0.10804 , 0.11133 , respectively. Also , the rate that A , B , and C each had only one loser was 0.11632 , 0.11233 , 0.11063　, respectively.

As can be seen above , the more three people play rock-paper-scissors , the colser the probability of a draw becomes to 1/3（0.333）, the mathematically calculated theoretical probability. The other ratios can be found similarly.

Interesting Simulation（Smartphone）

08/19/2024
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１１　Two Dice with an Odd Product

（１）Experimental Overview

Two dice , one large and one small , are thrown at the same time. There are 36 different ways the numbers can appear.

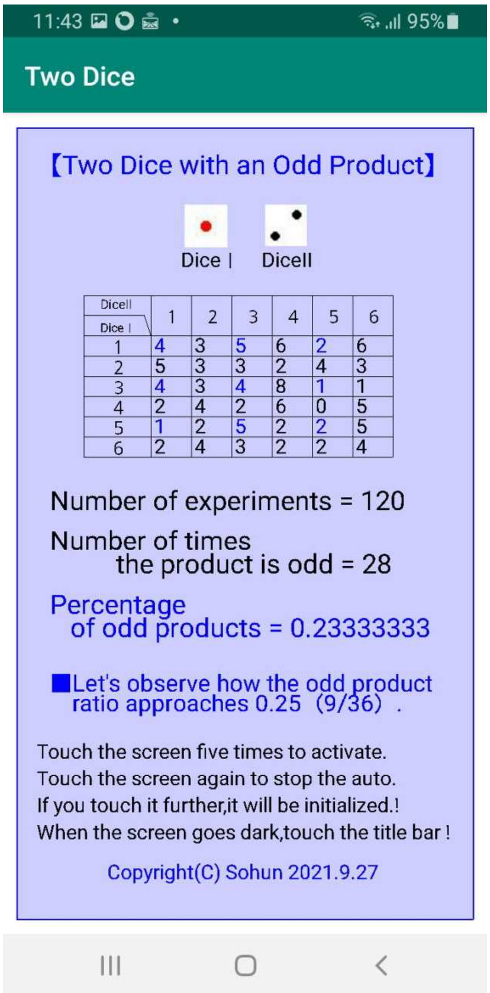
In addition , there are nine ways in which the product of the numbers on two dice , one large and one small , will be an odd number.

Therefore , mathematically , the probability that the product of the numbers on two dice , one large and one small , will be odd is 9/36 , which simplifies to 1/4（0.25）.

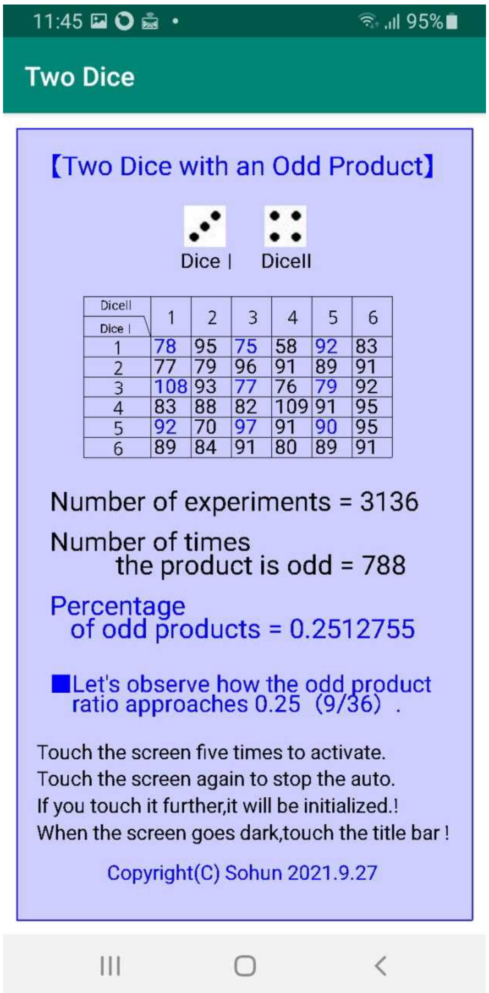
However , in reality , when two dice are rolled simultaneously four times , it is not guaranteed that the product of the numbers will be odd only once. What is the relationships with the mathematically calculated theoretical probability of 1/4 ?

（２）Experimental Results（Android Version）

① When the number of experiments is 120



② When the number of experiments is 3136



In the experiment shown in the image on the left above , two dice were thrown simultaneously 120 times. The product of the two dice was an odd number 28 times. Therefore , the probability of the product of two dice being odd was 0.2333333 .

In the experiment shown in the image on the right above , two dice were thrown simultaneously 3136 times. The product of the two dice was an odd number 788 times. Therefore , the probability of the product of two dice being odd was 0.2512755.

As can be seen above , the more often two dice are rolled simultaneously , the closer the probability of the product of the dice being an odd number becomes to 1/4（0.25）, the theoretical mathematical probability.

Interesting Simulation（Smartphone）

08/20/2024
Sohun

１２　Collatz Problem (3x+1 Problem)

（１）Experimental Overview

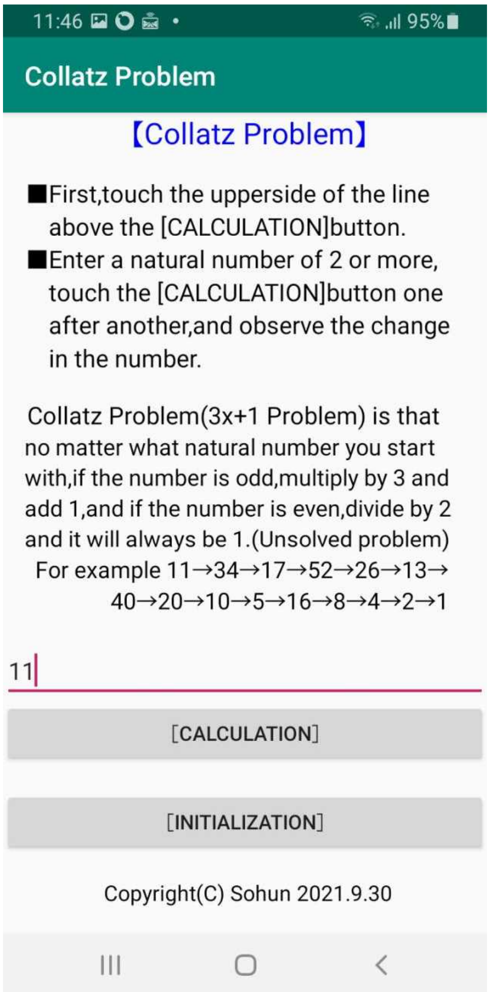
Any natural number will do , so if the number is even , divide it by 2 , and if it is odd , multiply it by 3 and add 1 , and repeat the process. So , is it true that no matter what natural number you start with , it will always end up being 1 ?

For example , starting from 11 , the result is 11 → 34 → 17 → 52 → 26 → 13 → 40 → 20 → 10 → 5 → 16 → 8 → 4 → 2 → 1.

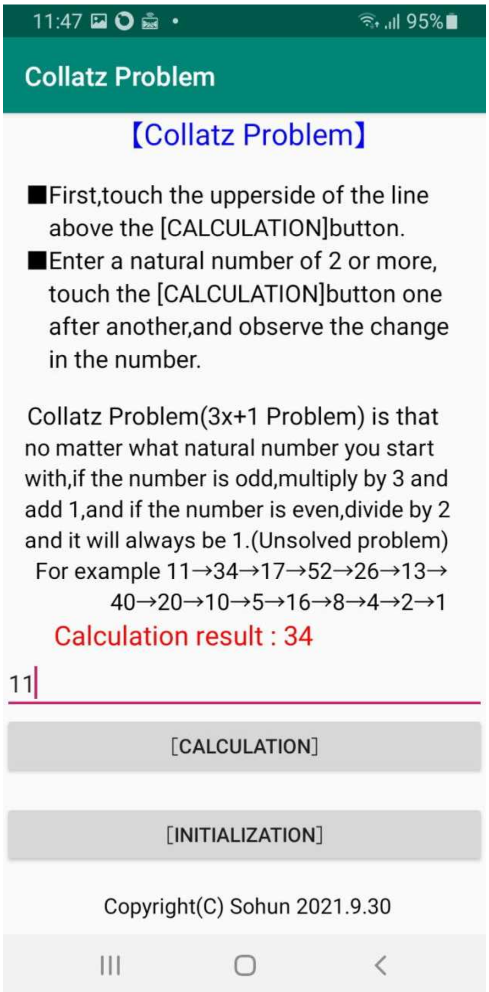
This is notoriously difficult problem that has not yet been solved. In addition , computers have been used to search for very large numbers（up to 4 trillion）, but no examples have been found that don't result in 1.

（２）Experimental Results（Android Version）

① When you enter the first number



② When you tap［CALCULATION］once



The image on the left above shows the result of tapping above the line above the［CALCULATION］button and entering the number 11 in half-width characters.

The image on the right above shows the result after the［CALCULATION］button has been tapped once. Since 11 is an odd number , we multiply it by 3 and add 1 to get 11 × 3+1=34. Therefore , "Calculation result : 34" is displayed.

Next , if you tap［CALCULATION］repeatly , "Calculation result : 17","Calculation result : 52","Calculation result : 26", ・ ・ ・"Calculation result : 2","Calculation result : 1" will be displayed in turn.

Even if you start with a natural number other than 11 , you can observe that it always ends up at 1.

Interesting Simulation（Smartphone）

08/21/2024
Sohun

１３　The Encounter Experiment

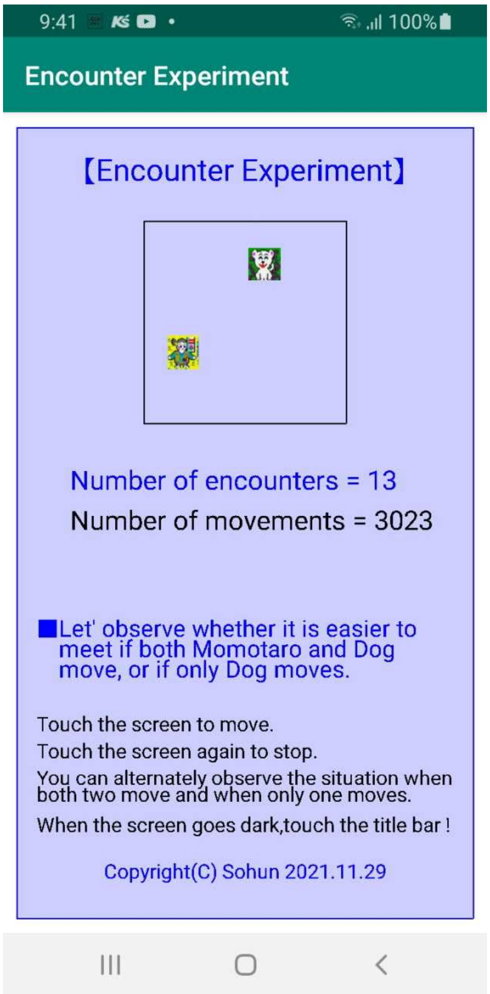
（１）Experimental Overview

Dr. Boro also occasionally dates women. However , on this occasion , the meeting place was crowded and it was getting dark. So , it took her an hour to find the doctor and they had a huge fight. In fact , Dr. Boro , who is extreamely nearsighted and has astigmatism , thought it would be better to stay rather than wander around searching. He was told to wait around here , so he stayed in a certain spot within the designated area , but she didn't like that. She argues that if they each went looking for each other , they would be able to find each other quicker. Of course Dr. Boro believes he is absolutely right as evidenced by the word that if someone are lost in the mountains , "Stay still and wait for help". However , his confidence began to waver a little when he saw her anger.

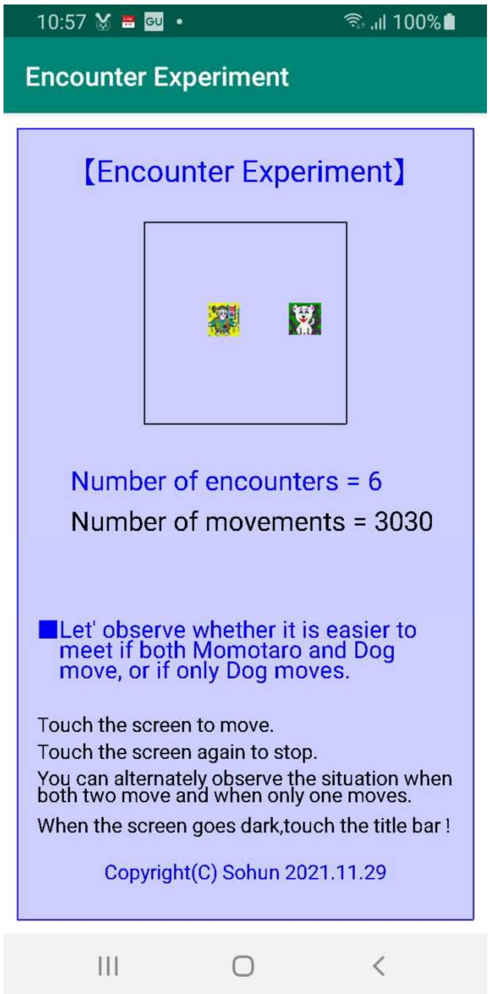
Whose side would you take ? Also , why is that ?

（２）Experimental Results（Android Version）

① When the two both move



② When only one moves



In the image on the left above , both Momotaro and the dog moved around randomly 3023 times. They met 13 times. In the image on the right above , Momotaro stayed still and the dog moved around randomly 3030 times. They met 6 times.

Even after conducting similar experiments several times , the number of encounters was greater when both Momotaro and the dog were active. So , it seems that she is more right than Dr. Boro. However, in the experiment , Dr. Boro is the Momotaro and she is the dog. In addition , the distance traveled in one go is set to 1 in either the up , down , left , or right direction.

Interesting Simulation（Smartphone）

08/22/2024
Sohun

１４　Wallis's Formula

（１）Experimental Overview

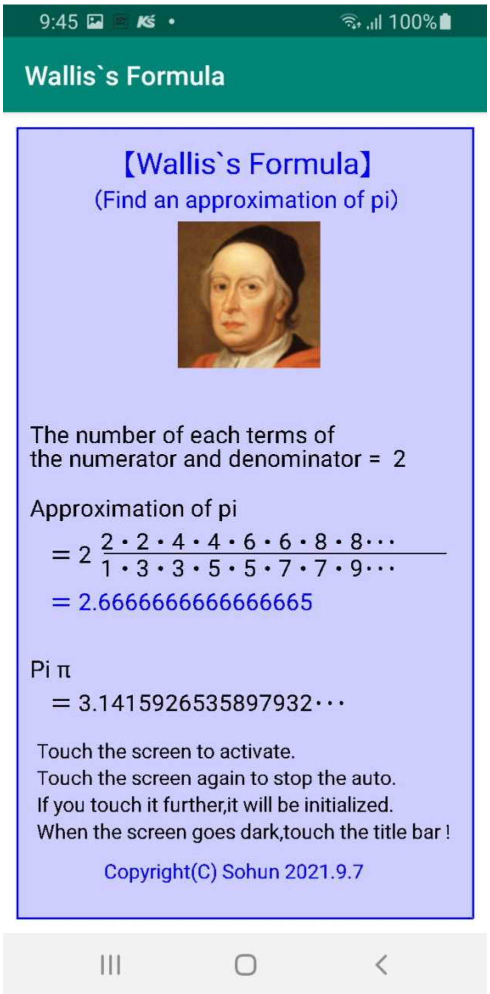
Use Wallis's formula to find an approximation of pi.

$$\pi = 2 \times \frac{2\times 2\times 4\times 4\times 6\times 6\times 8\times 8\times \cdots}{1\times 3\times 3\times 5\times 5\times 7\times 7\times 9\times \cdots}$$

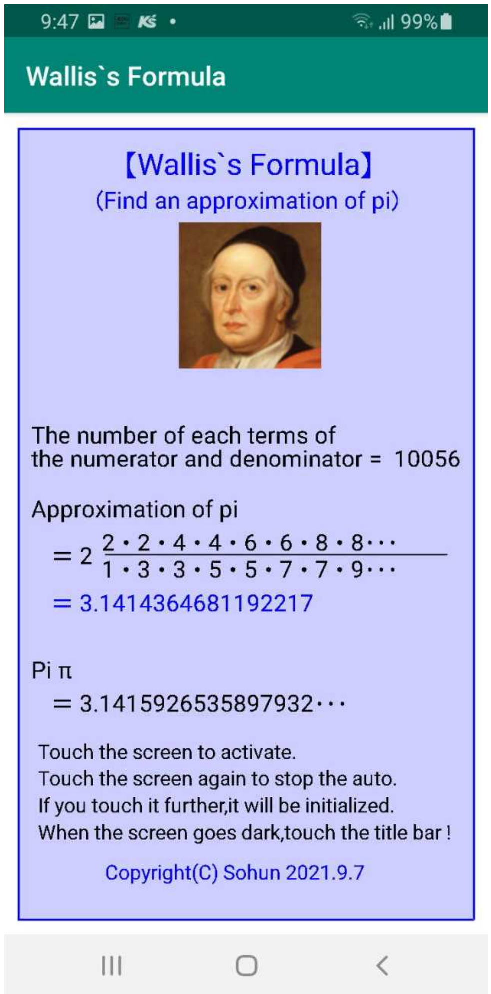
When you increase the number of numbers in the numerator and denominator by the same amount , the value approaches pi.

（２）Experimental Results（Android Version）

① When the number of numbers is 2



② When the number of numbers is 10056



The image on the left above shows the Wallis's formula when the numerator and denominator have two numbers each. This gives us an approximation of pi , 2.6666666666･･･.

The image on the right above shows the Wallis's formula when the numerator and denominator have 10056 numbers each. This gives us an approximation of pi , 3.1414364681192217･･･.

It can be seen that the more numbers in the numerator and denominator , the closer the result of the experiments gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

08/23/2024
Sohun

１５　Euler Number e

（１）Experimental Overview

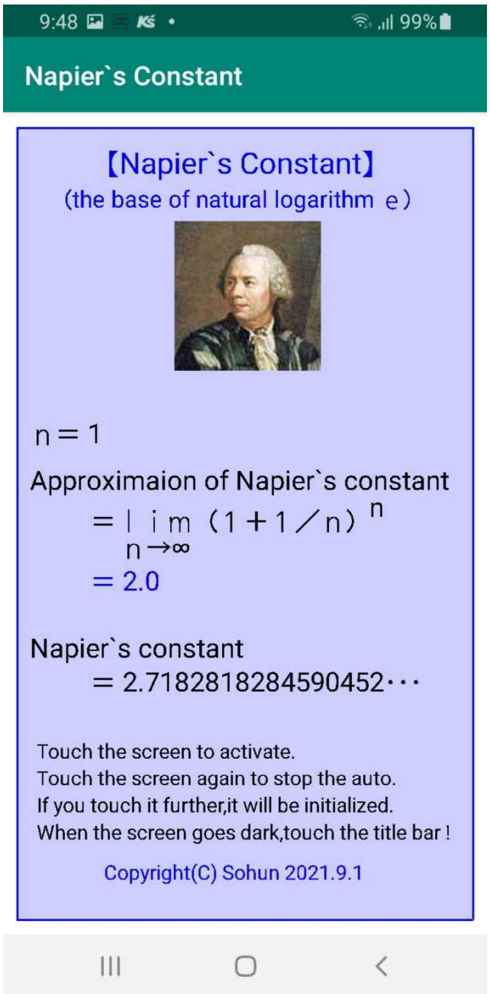
Substitute the natural numbers 1 , 2 , 3 , ･･･ into the n in following formula to find an approximation of Euler's number e （ base of natural logarithms）.

$$\left(1+\frac{1}{n}\right)^{n}$$

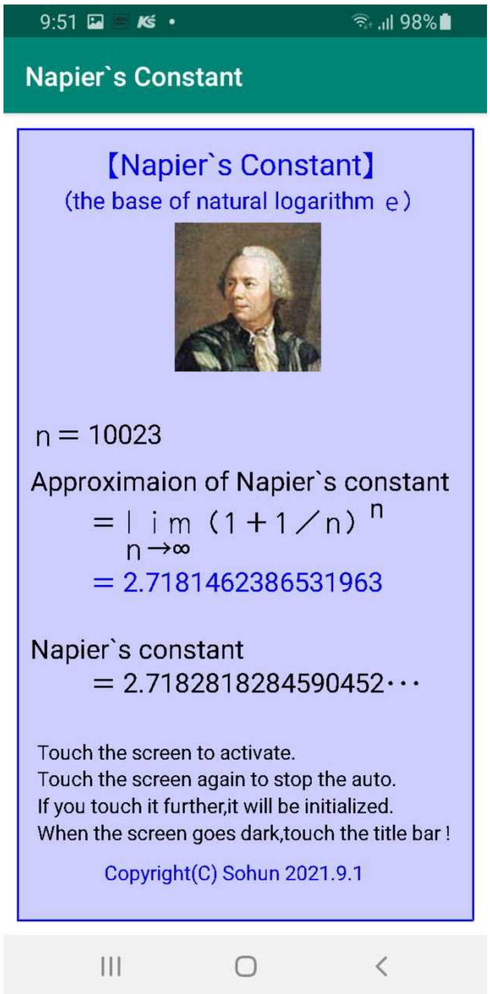
As the value of the natural number n increases , it approaches the value of Euler's number e.

（２）Experimental Results（Android Version）

① When n=1



② When n=10023



The image on the left above shows what happens when 1 is substituted for n in $(1+1/n)^{n}$.
An approximation of the Euler's number e , 2.0 , has been determined.
The image on the right above shows what happens when 10023 is substituted for n in $(1+1/n)^{n}$.
An approximation of the Euler's number e , 2.718146238･･･ , has been determined.
It can be seen that the larger the value of the natural number n , the closer it gets to the value of Euler's number e , 2.718281828･･･.

Interesting Simulation（Smartphone）

08/24/2024
Sohun

１６　Euler's Formula

（１） Experimental Overview

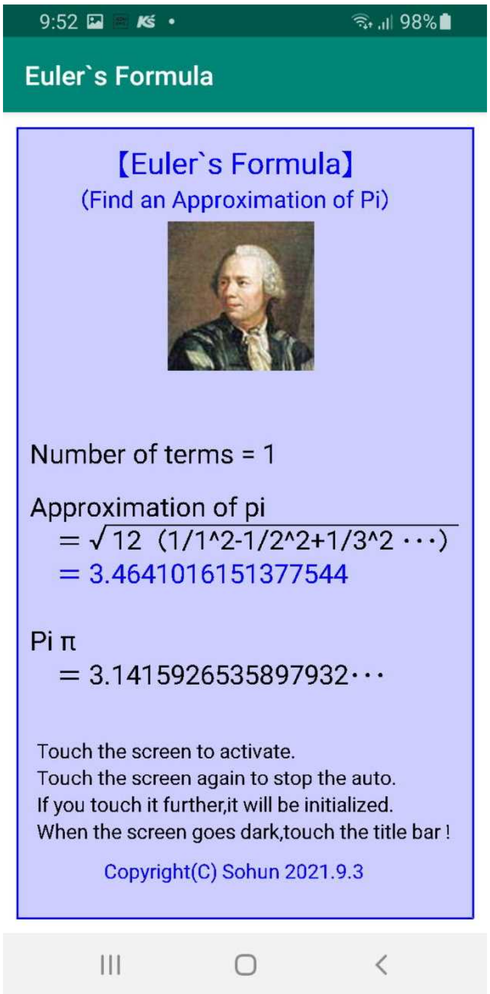
Use the following Euler's formula to find an approximation of pi.

$$\pi = \sqrt{12\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \cdots\right)}$$

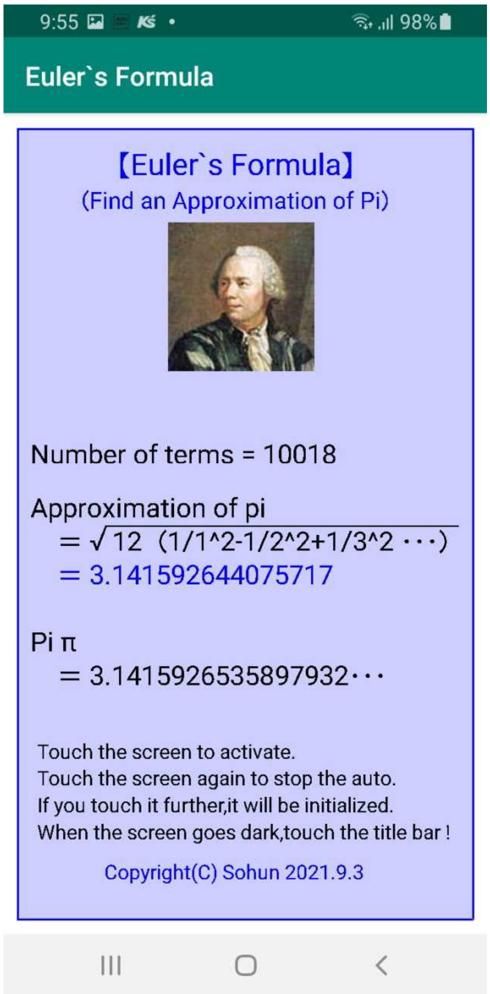
As the number of terms increases , the value approaches pi.

（２） Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10018



The image on the left above shows Euler's formula when the number of terms is 1. An approximation of pi , 3.464101615･･･ has been determined.
The image on the right above shows Euler's formula when the number of terms is 10018. An approximation of pi , 3.141592644･･･ has been determined.
It can be seen that the greater the number of terms are , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

08/26/2024
Sohun

１７　Gregory･Leibniz’s Formula

（１）Experimental Overview

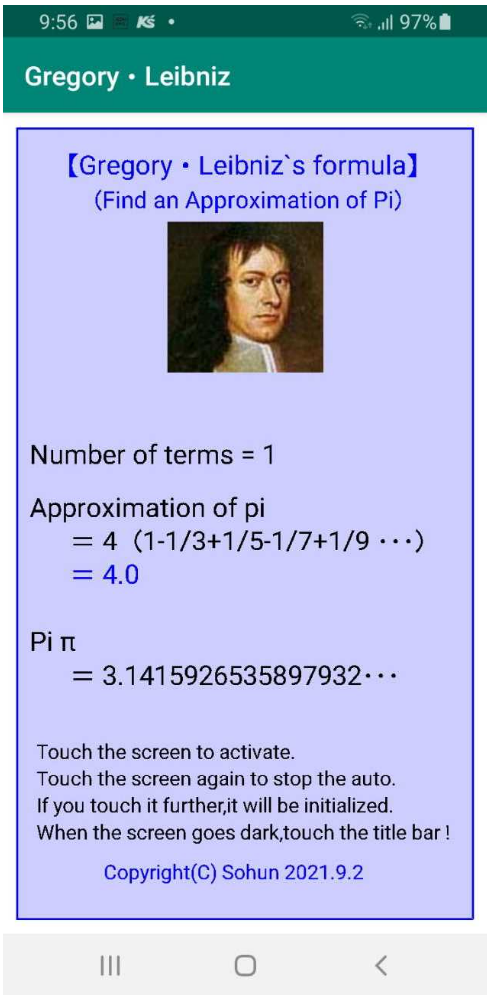
Use the following Gregory･Leibniz formula to find an approximation of pi.

$$\pi = 4\left(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \cdot\cdot\cdot\right)$$

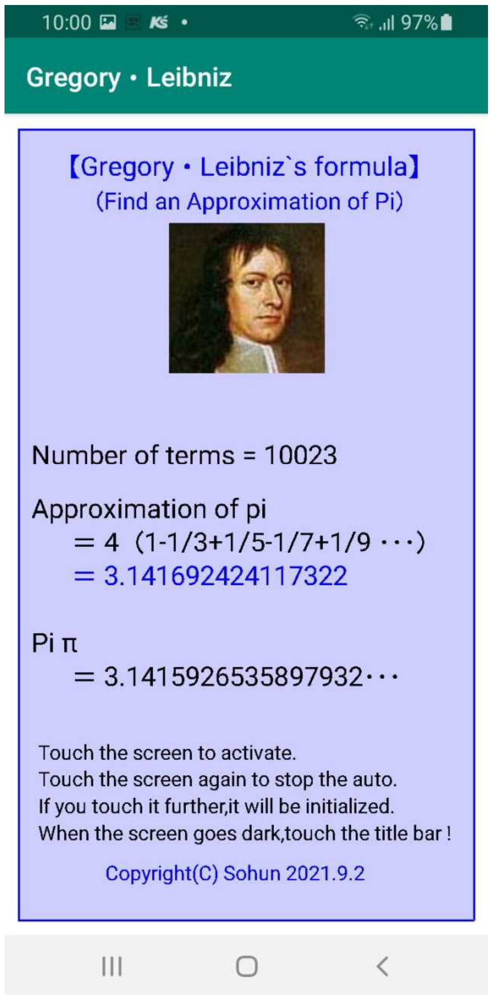
As the number of terms increases , the value approaches pi.

（２）Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10023



The image on the left above shows Gregory･Leibniz's formula when the number of terms is 1. An approximation of pi , 4.0 has been determined.
The image on the right above shows Gregory･Leibniz formula when the number of terms is 10023. An approximation of pi , 3.141692424･･･ has been determined.
It can be seen that the greater the number of terms are , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

08/27/2024
Sohun

１８　Matsunaga Yoshisuke's Formula 1

（１） Experimental Overview

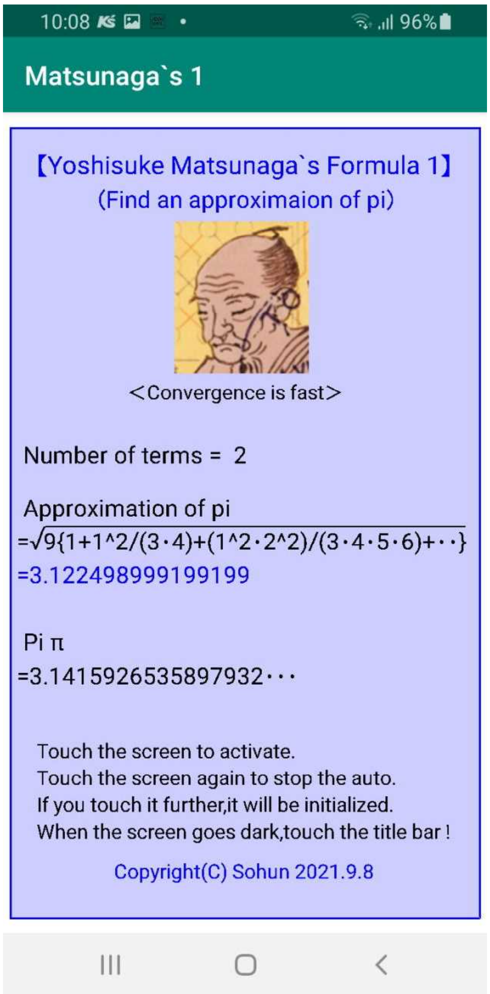
Use the following Matsunaga Yoshisuke's formula 1 to find an approximation of pi.

$$\pi = \sqrt{9\left(1 + \frac{1^2}{3\times 4} + \frac{1^2\times 2^2}{3\times 4\times 5\times 6} + \frac{1^2\times 2^2\times 3^2}{3\times 4\times 5\times 6\times 7\times 8} + \cdots\right)}$$

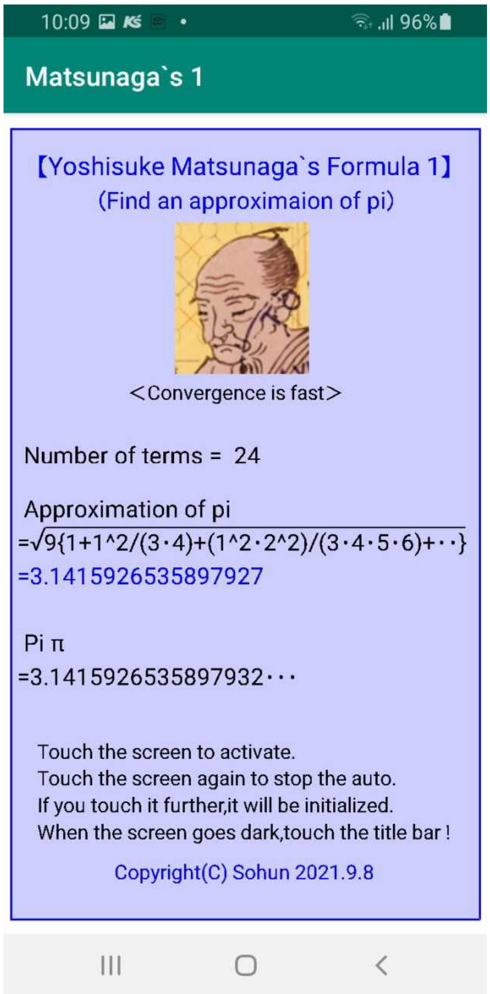
As the number of terms increases , the value approaches pi.

（２） Experimental Results（Android Version）

① When the number of terms is 2



② When the number of terms is 24



The image on the left above shows Matsunaga Yoshisuke's formula 1 when the number of terms is 1. An approximation of pi , 3.122498999･･･ has been determined.
The image on the right above shows Matsunaga Yoshisuke's formula 1 when the number of terms is 24. An approximation of pi , 3.1415926535897927･･･ has been determined.
Even when the number of terms is 24 , the value is close to the value of pi , 3.1415926535897932･･･, which shows that the convergence speed is fast.

Interesting Simulation（Smartphone）

08/27/2024
Sohun

１９　Matsunaga Yoshisuke's Formula ２

（１）Experimental Overview

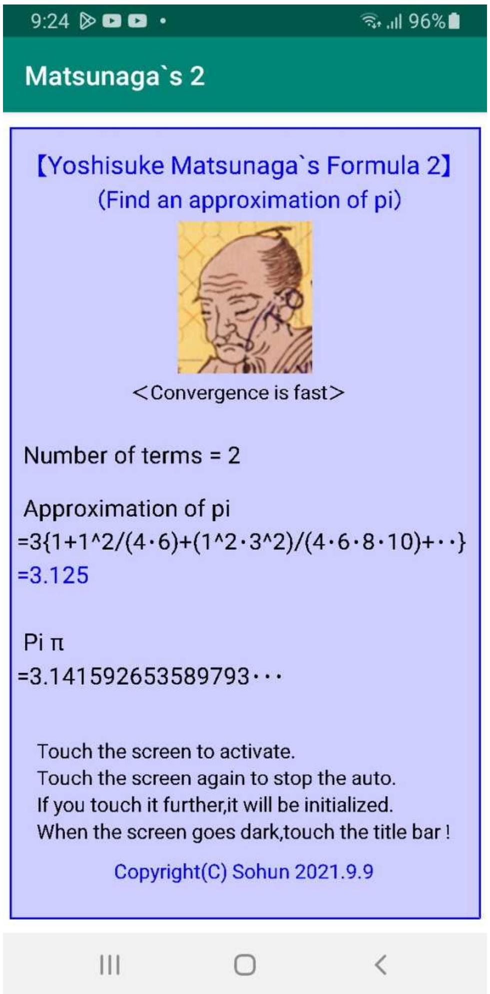
Use the following Matsunaga Yoshisuke's formula 2 to find an approximation of pi.

$$\pi = 3\left(1 + \frac{1^2}{4\times 6} + \frac{1^2\times 3^2}{4\times 6\times 8\times 10} + \frac{1^2\times 3^2\times 5^2}{4\times 6\times 8\times 10\times 12\times 14} + \cdots\right)$$

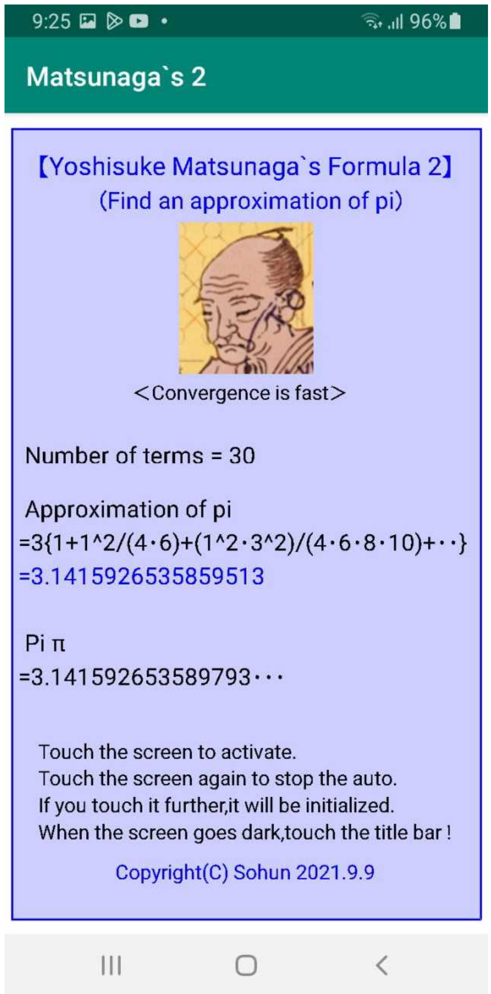
As the number of terms increases , the value approaches pi.

（２）Experimental Results（Android Version）

① When the number of terms is 2



② When the number of terms is 30



The image on the left above shows Matsunaga Yoshisuke's formula 2 when the number of terms is 2. An approximation of pi , 3.125 has been determined.

The image on the right above shows Matsunaga Yoshisuke's formula 2 when the number of terms is 30. An approximation of pi , 3.1415926535859513･･･ has been determined.

Even when the number of terms is 30 , the value is close to the value of pi , 3.1415926535897932･･･, which shows that the convergence speed is fast.

Interesting Simulation（Smartphone）

08/29/2024
Sohun

２０　Approximation of Pi by Infinite Series 6

（１）Experimental Overview

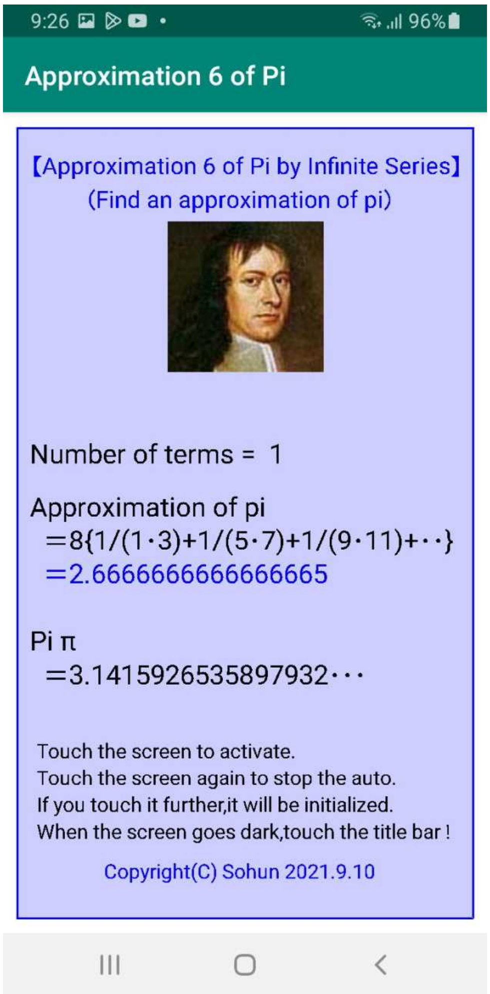
Use the following approximation formula to find an approximate value of pi.

$$\pi = 8\left(\frac{1}{1\times 3}+\frac{1}{5\times 7}+\frac{1}{9\times 11}+\frac{1}{13\times 15}+\cdots\right)$$

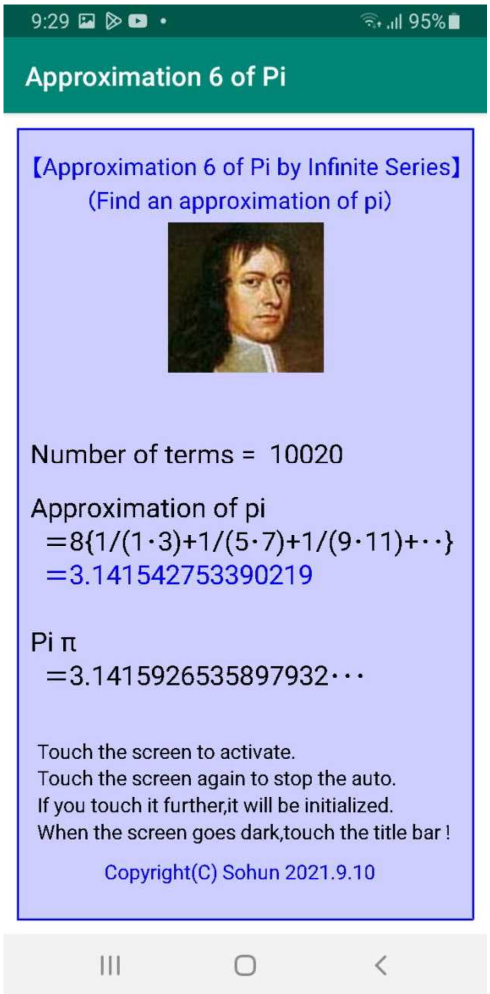
As the number of terms increases , the value approaches pi.

（２）Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10020



The image on the left above shows this approximation formula when the number of terms is 1. An approximation of pi , 2.666666666･･･ has been determined.

The image on the right above shows this approximation formula when the number of terms is 10020. An approximation of pi , 3.141542753･･･ has been determined.

It can be seen that the greater the number of terms , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

08/30/2024
Sohun

２１　Approximation of Pi by Infinite Series 7

（１）Experimental Overview

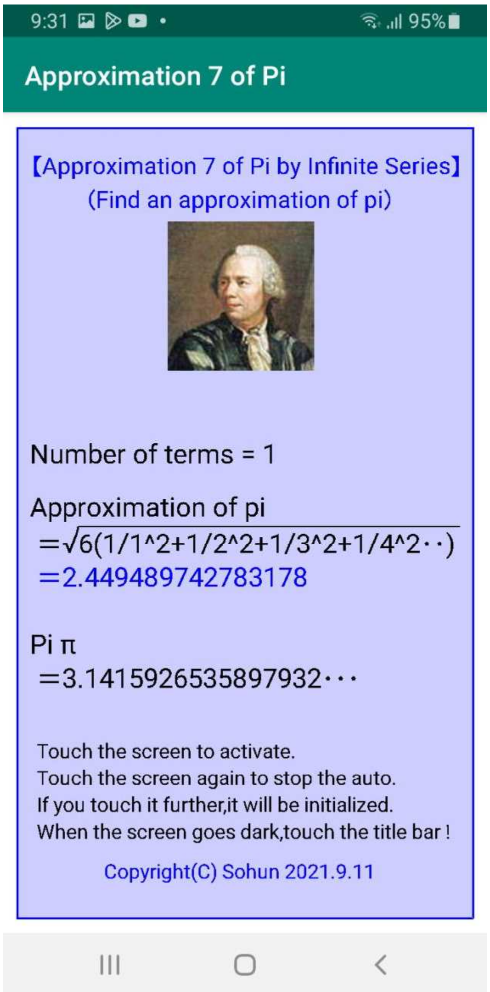
Use the following approximation formula to find an approximate value of pi.

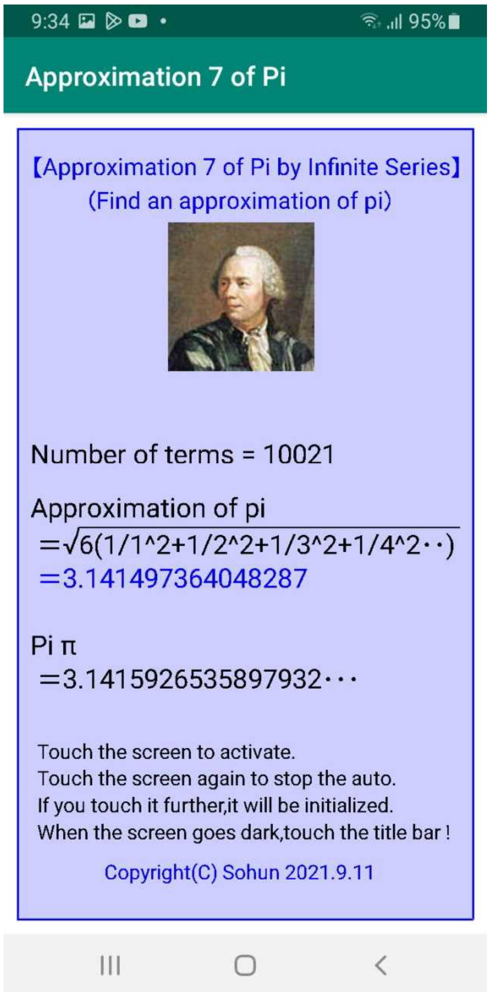
$$\pi = \sqrt{6\left(\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+\frac{1}{4^2}+\cdots\right)}$$

As the number of terms increases , the value approaches pi.

（２）Experimental Results（Android Version）

① When the number of terms is 1　　② When the number of terms is 10021





The image on the left above shows this approximation formula when the number of terms is 1. An approximation of pi , 2.449489742･･･ has been determined.

The image on the right above shows this approximation formula when the number of terms is 10021. An approximation of pi , 3.141497364･･･ has been determined.

It can be seen that the greater the number of terms , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

08/30/2024
Sohun

２２　Approximation of Pi by Infinite Series 8

（１） Experimental Overview

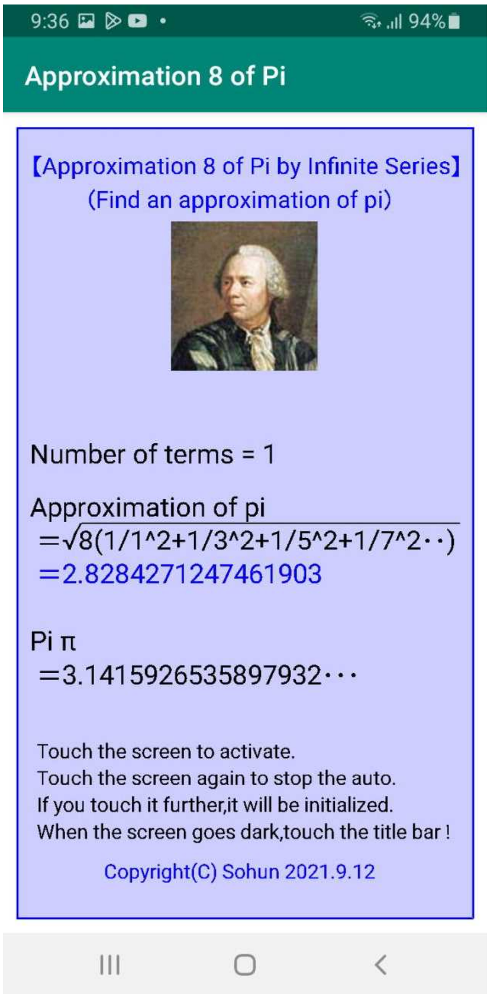
Use the following approximation formula to find an approximate value of pi.

$$\pi = \sqrt{8\left(\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\frac{1}{7^2}+\cdot\cdot\cdot\right)}$$

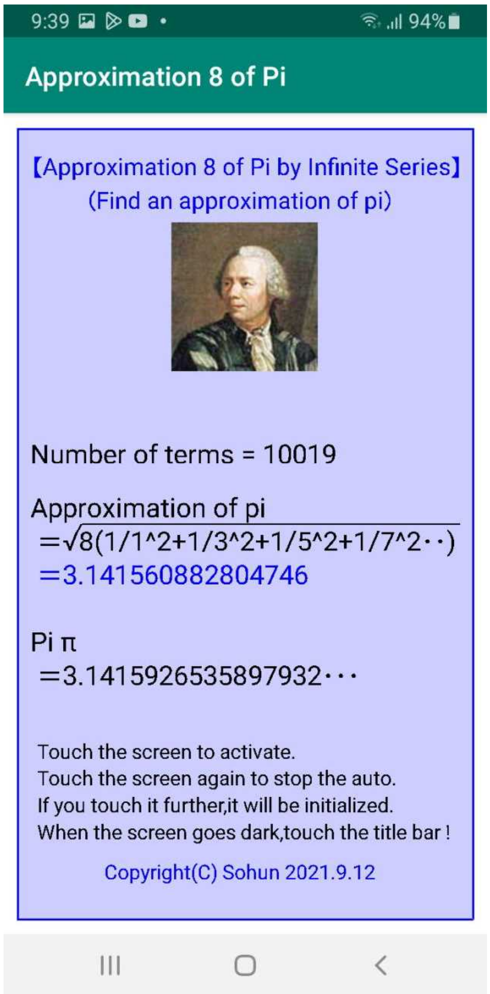
As the number of terms increases , the value approaches pi.

（２） Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10019



The image on the left above shows this approximation formula when the number of terms is 1. An approximation of pi , 2.828427124･･･ has been determined.

The image on the right above shows this approximation formula when the number of terms is 10019. An approximation of pi , 3.141560882･･･ has been determined.

It can be seen that the greater the number of terms , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

08/31/2024
Sohun

２３　Approximation of Pi by Infinite Series 9

（１） Experimental Overview

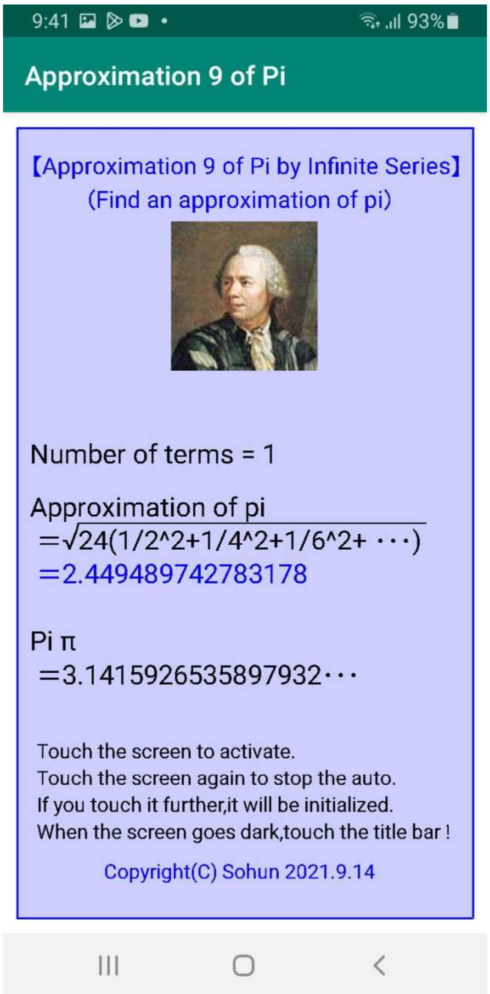
Use the following approximation formula to find an approximate value of pi.

$$\pi = \sqrt{24\left(\frac{1}{2^2}+\frac{1}{4^2}+\frac{1}{6^2}+\frac{1}{8^2}+\cdot\cdot\cdot\right)}$$

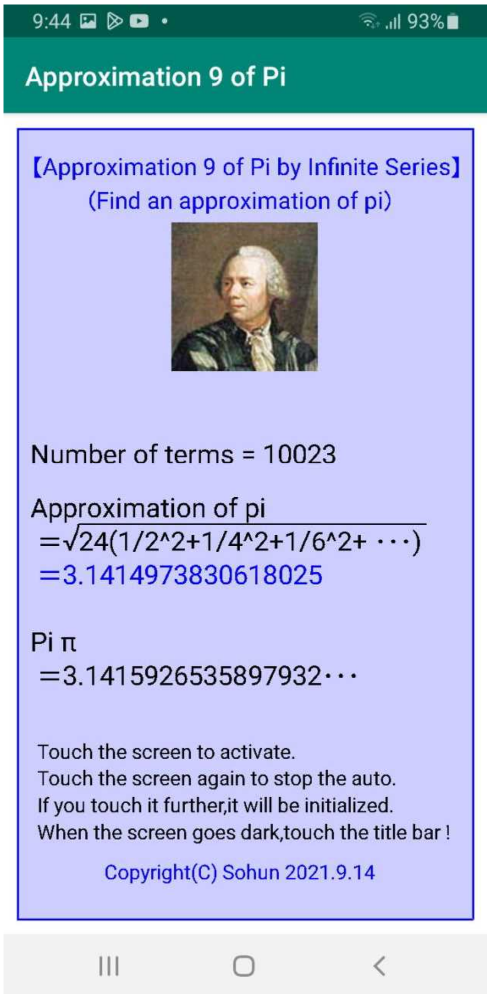
As the number of terms increases , the value approaches pi.

（２） Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10023



The image on the left above shows this approximation formula when the number of terms is 1. An approximation of pi , 2.449489742･･･ has been determined.

The image on the right above shows this approximation formula when the number of terms is 10023. An approximation of pi , 3.141497383･･･ has been determined.

It can be seen that the greater the number of terms , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

09/01/2024
Sohun

２４　Approximation of Pi by Infinite Series 10

（１）Experimental Overview

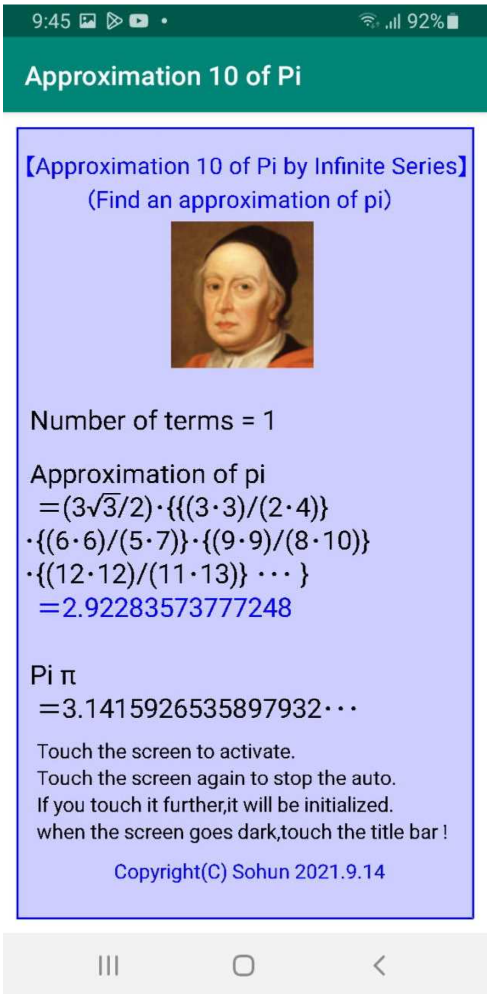
Use the following approximation formula to find an approximate value of pi.

$$\pi = \frac{3\sqrt{3}}{2} \times \frac{3\times 3}{2\times 4} \times \frac{6\times 6}{5\times 7} \times \frac{9\times 9}{8\times 10} \times \cdots$$

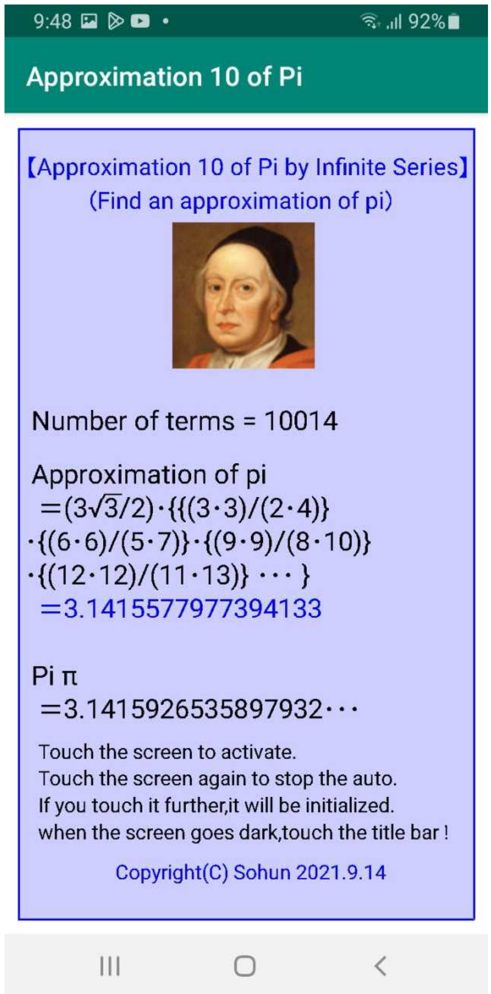
As the number of terms increases , the value approaches pi.

（２）Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10014



The image on the left above shows this approximation formula when the number of terms is 1. An approximation of pi , 2.922835737･･･ has been determined.
The image on the right above shows this approximation formula when the number of terms is 10014. An approximation of pi , 3.141557797･･･ has been determined.
It can be seen that the greater the number of terms , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

09/02/2024
Sohun

25　Approximation of Pi by Infinite Series 11

（1）Experimental Overview

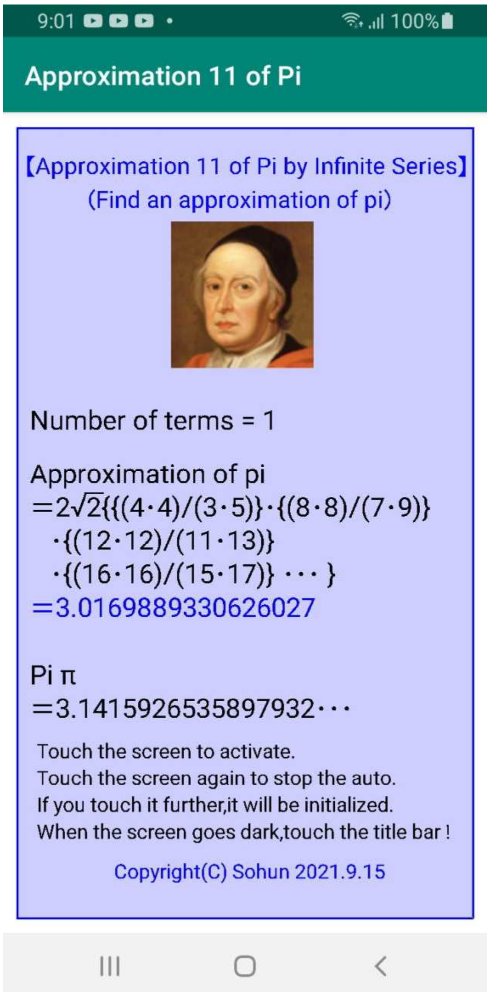
Use the following approximation formula to find an approximate value of pi.

$$\pi = 2\sqrt{2} \times \left(\frac{4\times 4}{3\times 5}\right) \times \left(\frac{8\times 8}{7\times 9}\right) \times \left(\frac{12\times 12}{11\times 13}\right) \times \left(\frac{16\times 16}{15\times 17}\right) \times \cdots$$

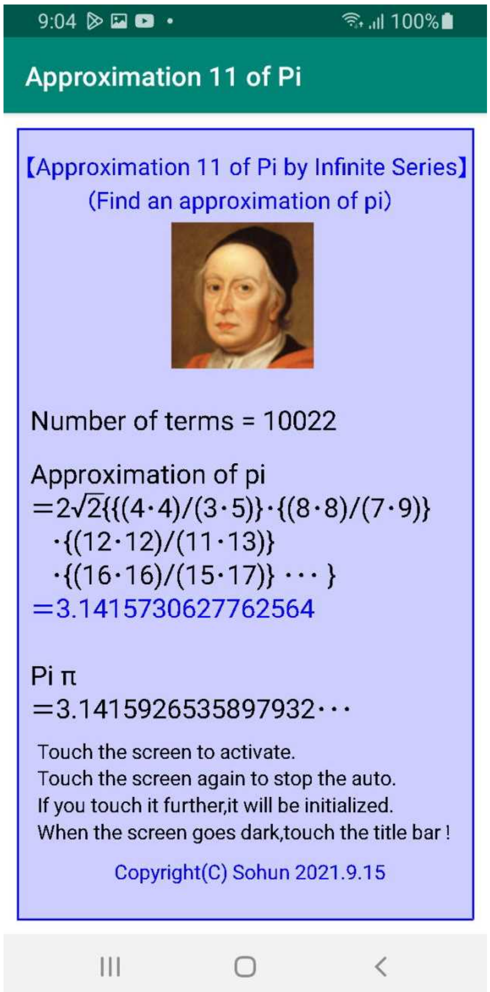
As the number of terms increases , the value approaches pi.

（2）Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10022



The image on the left above shows this approximation formula when the number of terms is 1. An approximation of pi , 3.016988933··· has been determined.

The image on the right above shows this approximation formula when the number of terms is 10022. An approximation of pi , 3.141573062··· has been determined.

It can be seen that the greater the number of terms , the closer it gets to the value of pi , 3.141592653···.

Interesting Simulation（Smartphone）

09/03/2024
Sohun

２６　Approximation of Pi by Infinite Series 12

（１） Experimental Overview

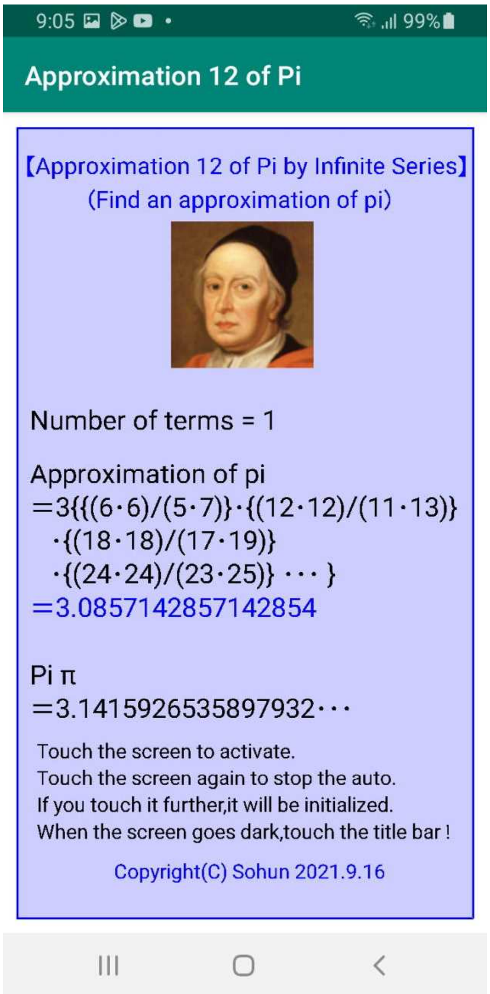
Use the following approximation formula to find an approximate value of pi.

$$\pi = 3 \times \left(\frac{6\times 6}{5\times 7}\right)\times\left(\frac{12\times 12}{11\times 13}\right)\times\left(\frac{18\times 18}{17\times 19}\right)\times\left(\frac{24\times 24}{23\times 25}\right)\times \cdots$$

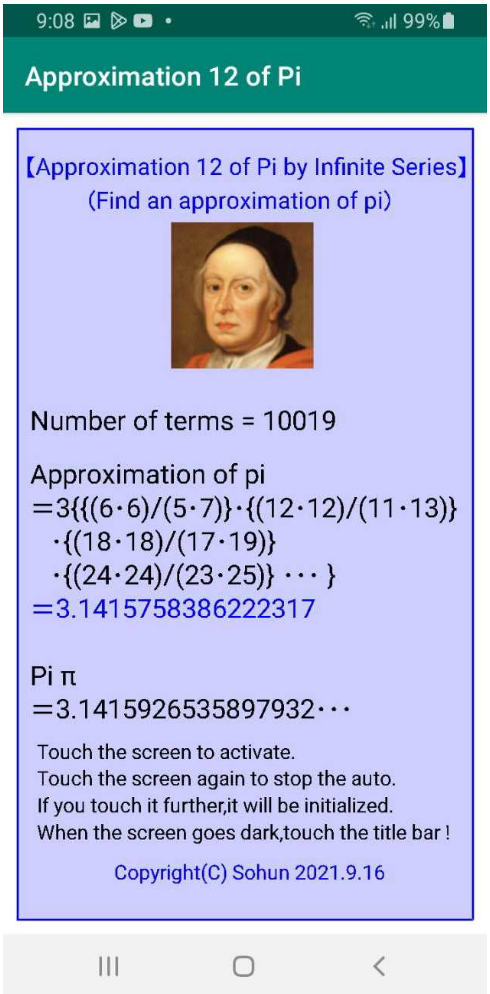
As the number of terms increases , the value approaches pi.

（２） Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 10019



The image on the left above shows this approximation formula when the number of terms is 1. An approximation of pi , 3.085714285･･･ has been determined.

The image on the right above shows this approximation formula when the number of terms is 10019. An approximation of pi , 3.141575838･･･ has been determined.

It can be seen that the greater the number of terms , the closer it gets to the value of pi , 3.141592653･･･.

Interesting Simulation（Smartphone）

09/04/2024
Sohun

２７　Approximation of Pi by Infinite Series 13

（１） Experimental Overview

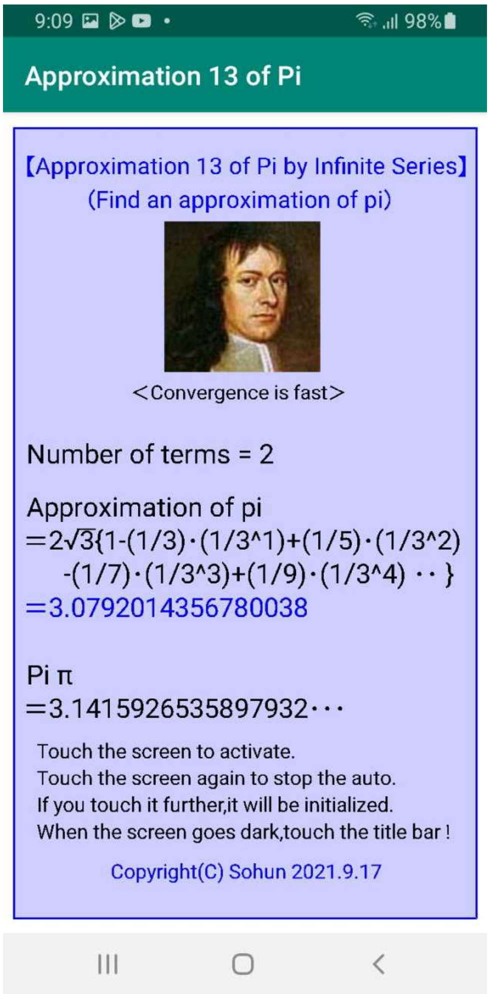
Use the following approximation formula to find an approximate value of pi.

$$\pi = 2\sqrt{3}\left(1 - \frac{1}{3}\times\frac{1}{3^{1}} + \frac{1}{5}\times\frac{1}{3^{2}} - \frac{1}{7}\times\frac{1}{3^{3}} + \frac{1}{9}\times\frac{1}{3^{4}} - \cdots\right)$$

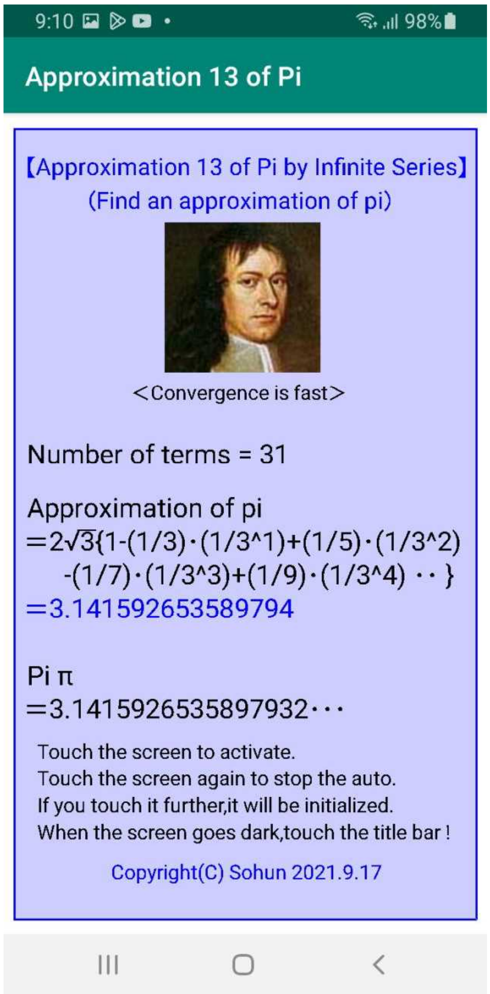
As the number of terms increases , the value approaches pi.

（２） Experimental Results（Android Version）

① When the number of terms is 2



② When the number of terms is 31



The image on the left above shows this approximation formula when the number of terms is 2. An approximation of pi , 3.079201435･･･ has been determined.

The image on the right above shows this approximation formula when the number of terms is 31. An approximation of pi , 3.141592653589794･･･ has been determined.

Even with 31 terms , the value is close to the value of pi , 3.1415926535897932･･･ , which shows that the convergence speed is fast.

Interesting Simulation（Smartphone）

09/05/2024
Sohun

２８　Approximation of the Base of Natural Logarithms e 1

（１） Experimental Overview

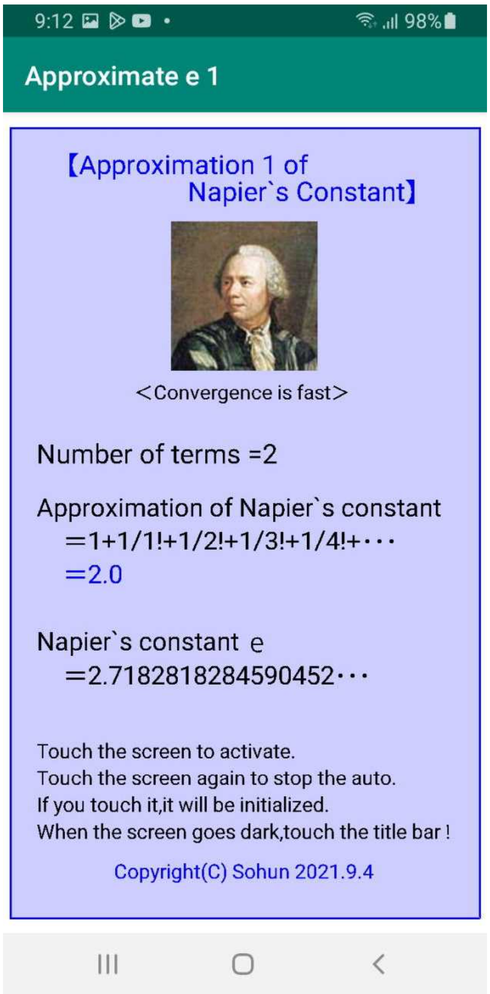
Use the following approximation formula to find an approximate value of the base of natural logarithm e.

$$e = 1 + \frac{1}{1\,!} + \frac{1}{2\,!} + \frac{1}{3\,!} + \frac{1}{4\,!} + \cdot\cdot\cdot$$

As the number of terms increases , the value approaches e.

（２） Experimental Results（Android Version）

① When the number of terms is 2



② When the number of terms is 23

The image on the left above shows this approximation formula when the number of terms is 2. An approximation of e , 2.0 has been determined.

The image on the right above shows this approximation formula when the number of terms is 23. An approximation of e , 2.7182818284590455･･･ has been determined.

Even with 23 terms , the value is close to the value of e , 2.7182818284590452･･･ , which shows that the convergence speed is fast.

Interesting Simulation（Smartphone）

09/06/2024
Sohun

２９　Approximation of the Base of Natural Logarithms e 2

（１）Experimental Overview

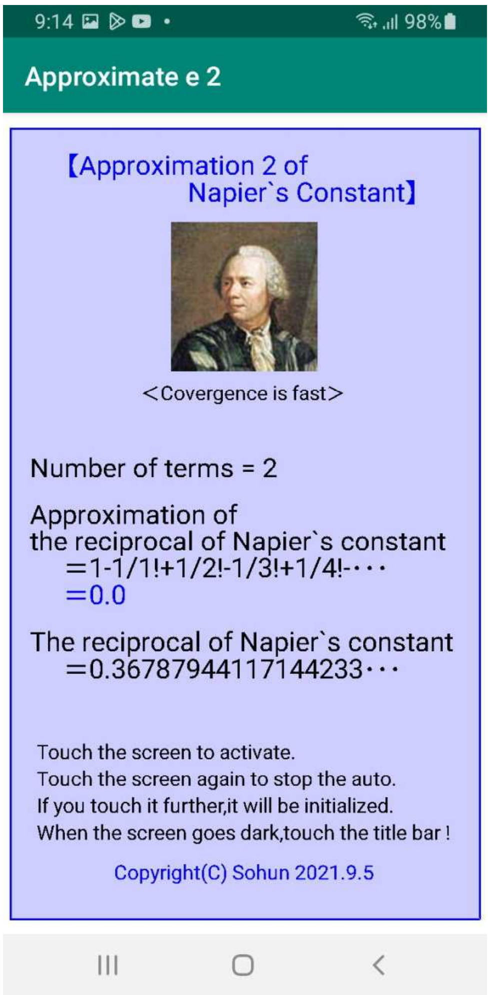
Use the following approximation formula to find an approximate value of the reciprocal of the base of natural logarithm e.

$$\frac{1}{e}=1-\frac{1}{1\,!}+\frac{1}{2\,!}-\frac{1}{3\,!}+\frac{1}{4\,!}-\cdot\cdot\cdot$$

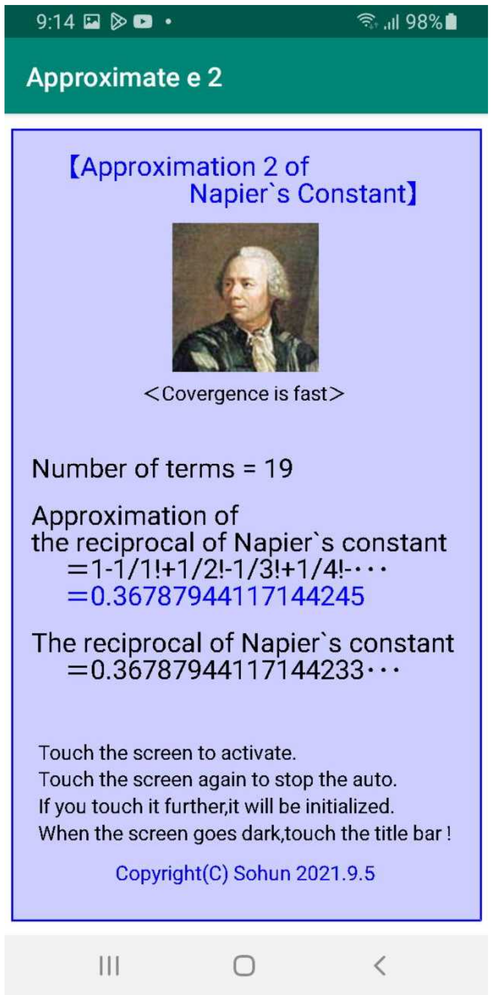
As the number of terms increases , the value approaches 1/e.

（２）Experimental Results（Android Version）

① When the number of terms is 2



② When the number of terms is 19



The image on the left above shows this approximation formula when the number of terms is 2. An approximation of 1/e , 0.0 has been determined.

The image on the right above shows this approximation formula when the number of terms is 19. An approximation of 1/e , 0.367879441171442･･･ has been determined.

Even with 19 terms , the value is close to the value of 1/e , 0.367879441171442･･･ , which shows that the convergence speed is fast.

Interesting Simulation（Smartphone）

09/07/2024
Sohun

３０　Approximation of the Base of Natural Logarithms e 3

（１） Experimental Overview

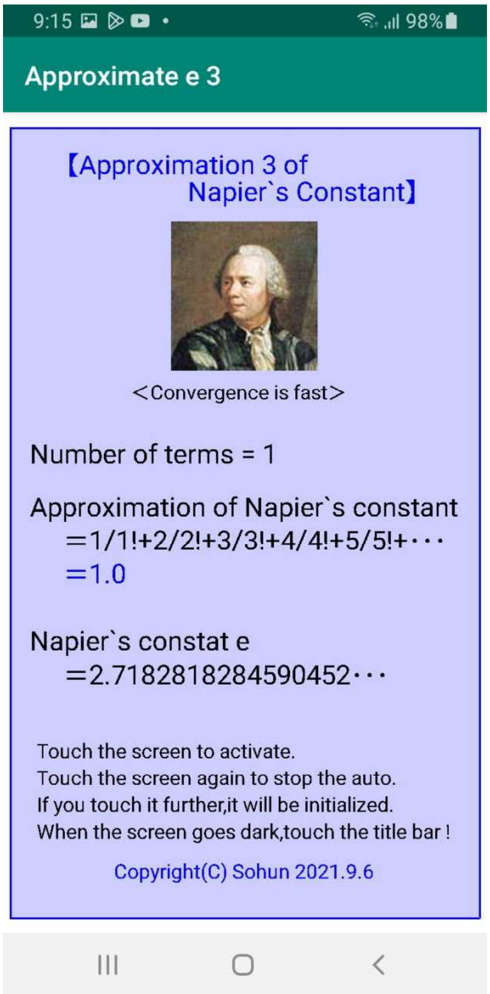
Use the following approximation formula to find an approximate value of the base of natural logarithm e.

$$e = \frac{1}{1!} + \frac{2}{2!} + \frac{3}{3!} + \frac{4}{4!} + \frac{5}{5!} + \cdots$$

As the number of terms increases , the value approaches e.

（２） Experimental Results（Android Version）

① When the number of terms is 1



② When the number of terms is 24

The image on the left above shows this approximation formula when the number of terms is 1. An approximation of e , 1.0 has been determined.

The image on the right above shows this approximation formula when the number of terms is 24. An approximation of e , 2.7182818284590455･･･ has been determined.

Even with 24 terms , the value is close to the value of e , 2.7182818284590452･･･ , which shows that the convergence speed is fast.

This approximation formula 3 for e is a variation of the approximation formula 1 for e mentioned above.

Interesting Simulation（Smartphone）

09/08/2024
Sohun

３１　Parallel Translation of a Graph of a Quadratic Fanction (Downward Convex)

（１） Experimental Overview

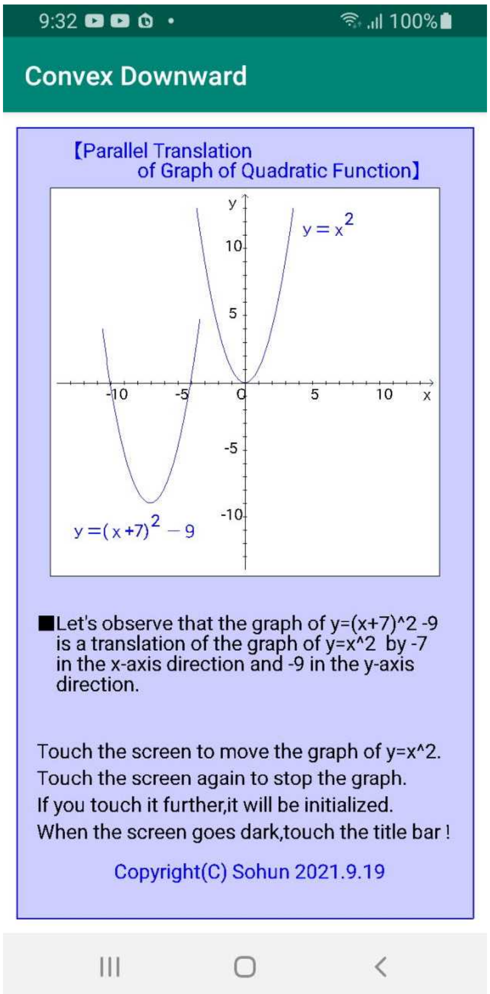
Observe that graph y=(x+7)^2-9 is a translation of graph y=x^2 by -7 along the x-axis and -9 along the y-axis.

If you translate graph y=x^2 by -7 along the x-axis and -9 along the y-axis , you will see how it overlaps with graph y=(x+7)^2-9.

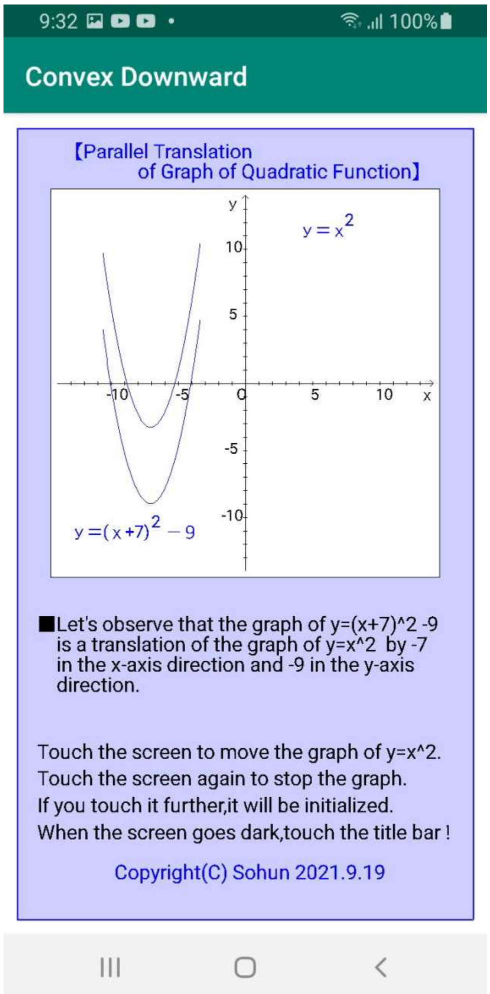
At this point , you can see that graphs y=(x+7)^2-9 and y=x^2 have the same shape and extent but differ only in position.

（２） Experimental Results（Android Version）

① Before translation



② During parallel movement



The image on the left above shows graphs y=x^2 and y=(x+7)^2-9.
When you tap the screen , gaph y=x^2 will start moving to the left.
After moving 7 to the left , it starts moving downwards.
The image on the right above shows gtaph y=x^2 moving 7 to the left and then moving downwards.
Graph y=x^2 moves further downwards and overlaps with graph y=(x+7)^2-9.

Interesting Simulation（Smartphone）

09/09/2024
Sohun

３２　Parallel Translation of a Graph of a Quadratic Fanction (Upward Convex)

（１）Experimental Overview

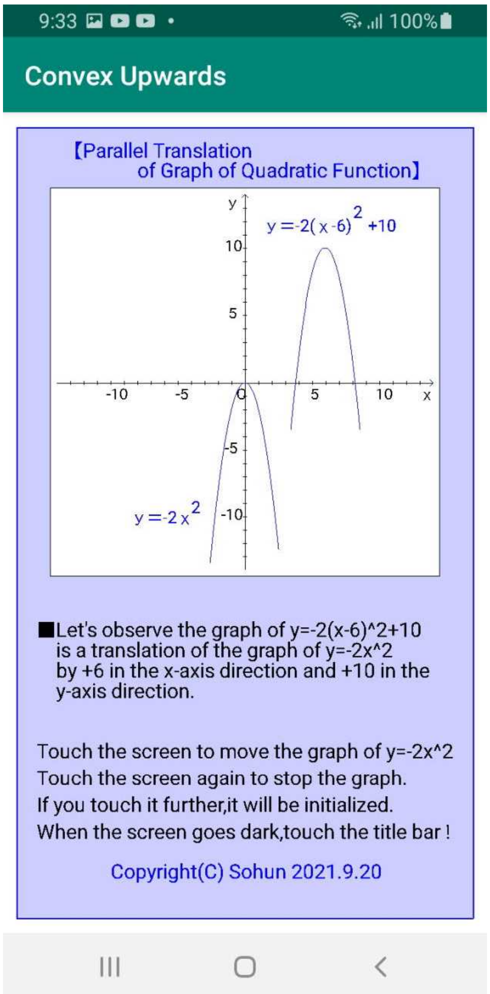
Observe that graph y=-2(x-6)^2+10 is a translation of graph y=-2x^2 by +6 along the x-axis and +10 along the y-axis.

If you translate graph y=-2x^2 by +6 along the x-axis and +10 along the y-axis , you will see how it overlaps with graph y=-2(x-6)^2+10.

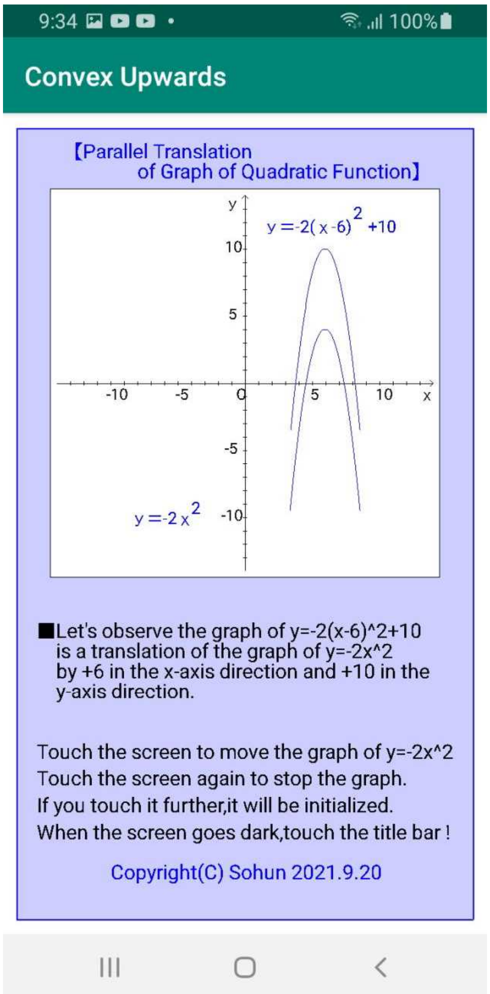
At this point , you can see that graphs y=-2(x-6)^2+10 and y=-2x^2 have the same shape and extent but differ only in position.

（２）Experimental Results（Android Version）

① Before translation



② During parallel movement



The image on the left above shows graphs y=-2x^2 and y=-2(x-6)^2+10.
When you tap the screen , gaph y=-2x^2 will start moving to the right.
After moving 6 to the right , it starts moving upwards.
The image on the right above shows gtaph y=-2x^2 moving 6 to the right and then moving upwards.
Graph y=-2x^2 moves further upwards and overlaps with graph y=-2(x-6)^2+10.

Interesting Simulation（Smartphone）

09/10/2024
Sohun

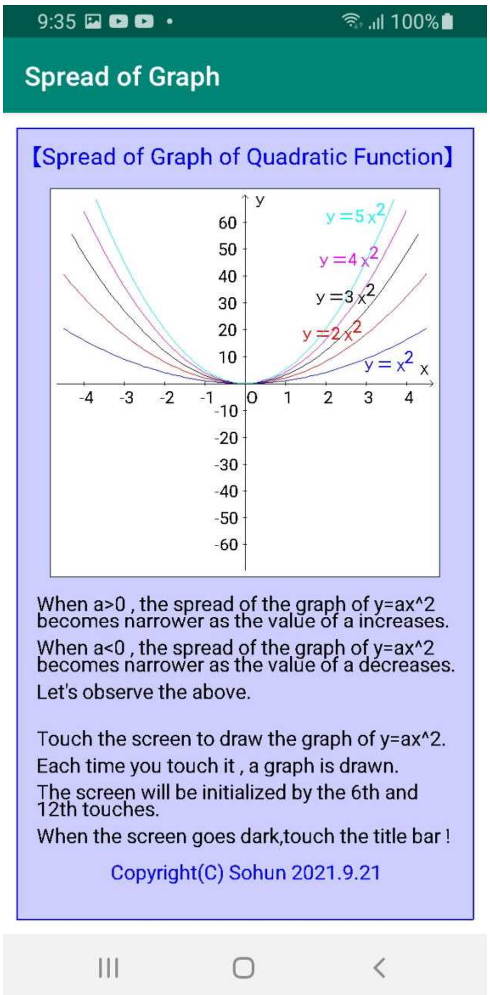
33　The Spread of a Graph of a Quadratic Function

（1）Experimental Overview

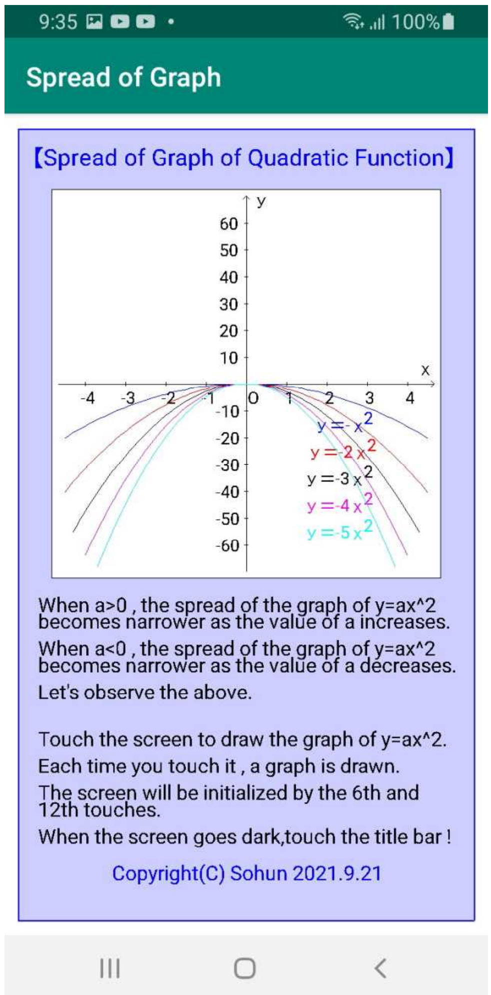
Observe the spread of graph y=ax^2.
First , graph y=ax^2 when a=1 , a=2 , a=3 , a=4 , and a=5 are displayed in sequence.
Next , graph y=ax^2 when a=-1 , a=-2 , a=-3 , a=-4 , and a=-5 are displayed in sequence.
Let's see how the spread of the graph of y=ax^2 changes depending on the value of a.

（2）Experimental Results（Android Version）

① y＝ａｘ² (When a>0)



② y＝ａｘ² (When a<0)



The images on the left above are graphs of y=x^2 , y=2x^2 , y=3x^2 , y=4x^2 and y=5x^2. You can see that as the coefficient of x^2 increases , the spread of the graph becomes narrower.
The images on the right above are graphs of y=-x^2 , y=-2x^2 , y=-3x^2 , y=-4x^2 and y=-5x^2. You can see that as the coefficient of x^2 becomes smaller , the spread of the graph becomes narrower.

Interesting Simulation（Smartphone）

09/12/2024
Sohun

３４　Parallel Translation of a Graph of a Quadratic Function

（１）Experimental Overview

Observe that y=a(x-b)^2+c is a translation of graph y=ax^2 by +b along the x-axis and +c along the y-axis.

First , enter an integer in half-width characters that satisfies -3 ≦ a ≦ 3 and a ≠ 0 into a.
Next , enter an integer in half-width characters that satisfies -7 ≦ b ≦ 7 into b.
Furthermore , enter an integer in half-width characters that satisfies -10 ≦ c ≦ 10 into c.

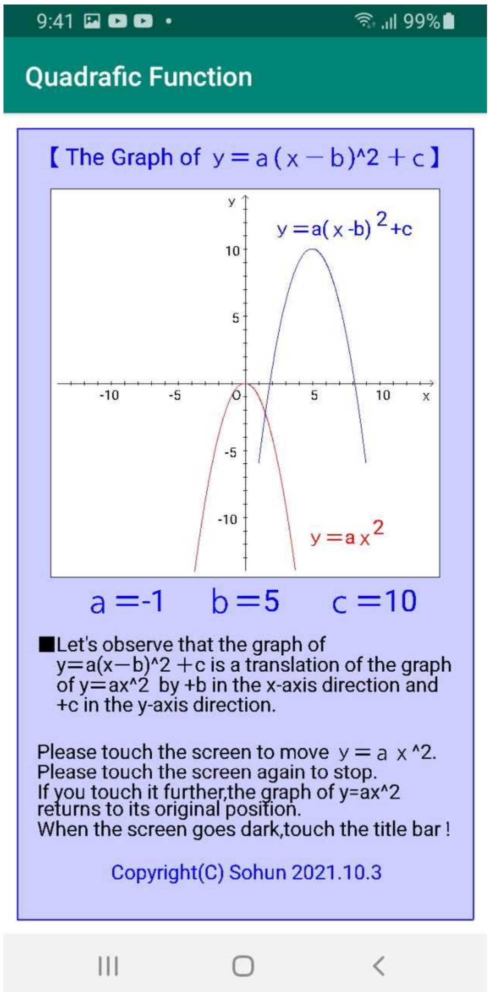
When you tap the［CLICK］ bar , graphs y=a(x-b)^2+c and y=ax^2 for the values entered in a , b , and c will be displayed.

When you tap the screen , you can see that graph y=ax^2 moves by +b along the x-axis , and then by +c along the y-axis , until it overlaps with graph y=a(x-b)^2+c.

（２）Experimental Results（Android Version）

① Input Screen for a , b , and c

② Graph Display Screen



The image on the left above shows a=-1 , b=5 , and c=10 being entered in half-width characters in y=a(x-b)^2+c.

The image on the right above shows the graph of y=-(x-5)^2+10 with the inputs a=-1 , b=5 , c=10 , and the graph of y=-x^2.

When you tap the screen , graph y= -x^2 moves by +5 along the x-axis , then by +10 along the y-axis , until it overlaps with graph y=(x-5)^2+10.