

# Choi Seok-jeong and the Magic Squares



By Trudi Henderson



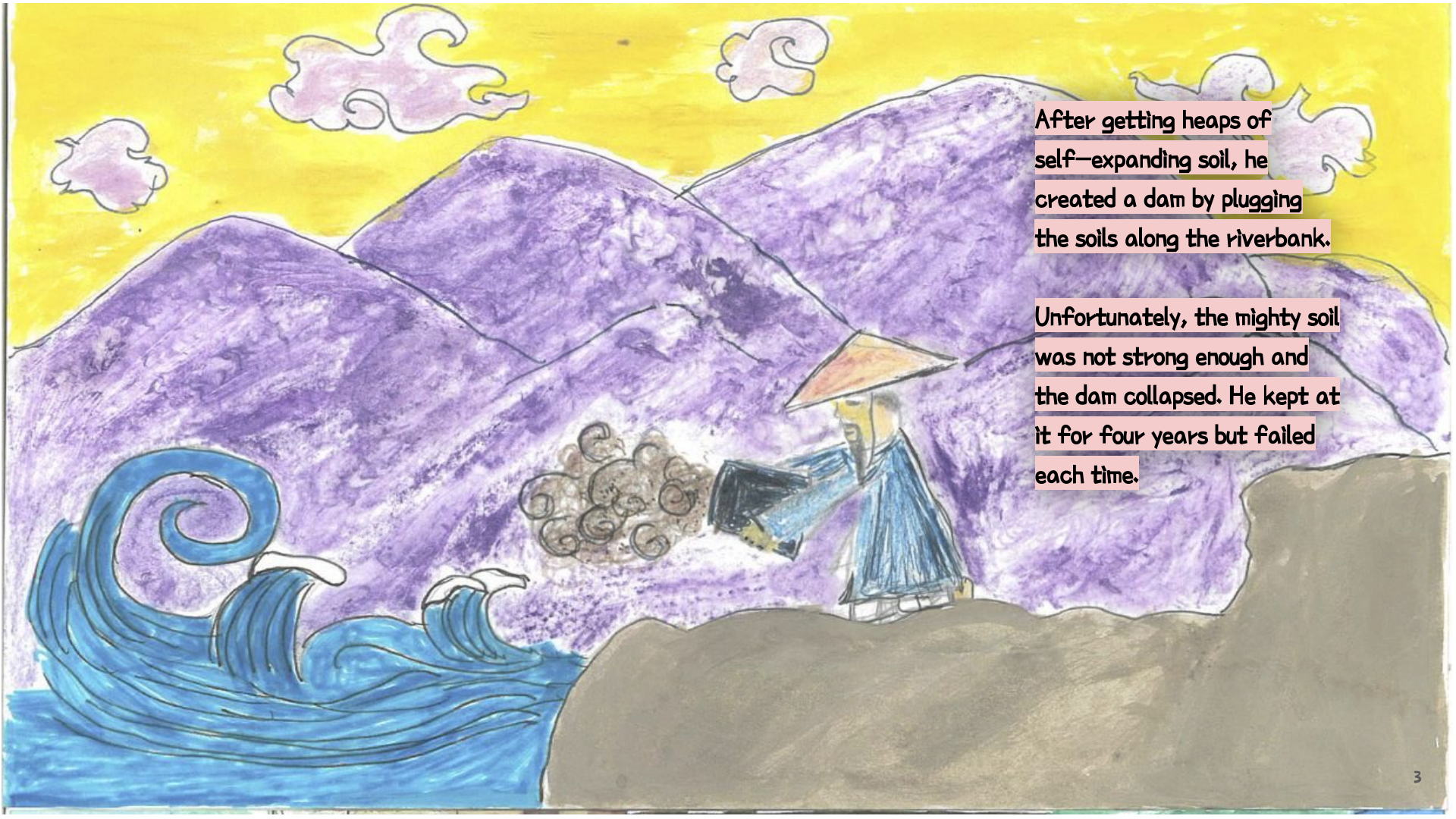
In 650 BC, a huge flood struck the Chinese land surrounding the Yellow River. The river gushed through the hills and valleys, submerging all of the villages in the area.<sup>[1]</sup> The waters were so powerful that it carried many villagers homes and belongings. This left them homeless. With broken hearts and teary eyes, they carried what was left of their belongings and moved up into the mountains.<sup>[2]</sup>



Emperor Yao who heard about the floods urged King Gun to control the floods<sup>[3]</sup>. So, King Gun tried to devise a plan to control the overflowing river.

But his plan was evil.

**"I will steal this magic soil to plug the waters, save the villagers, and become the greatest king!"** He said to himself as he snuck into the supreme deity's chambers.



After getting heaps of self-expanding soil, he created a dam by plugging the soils along the riverbank.

Unfortunately, the mighty soil was not strong enough and the dam collapsed. He kept at it for four years but failed each time.



At a loss, King Gun went to his son, King Yu, and said, **“You must do something for I cannot.”**

Troubled, King Yu, left his family and set out upon the land to come up with a plan and a map to channel the water back out into the sea.

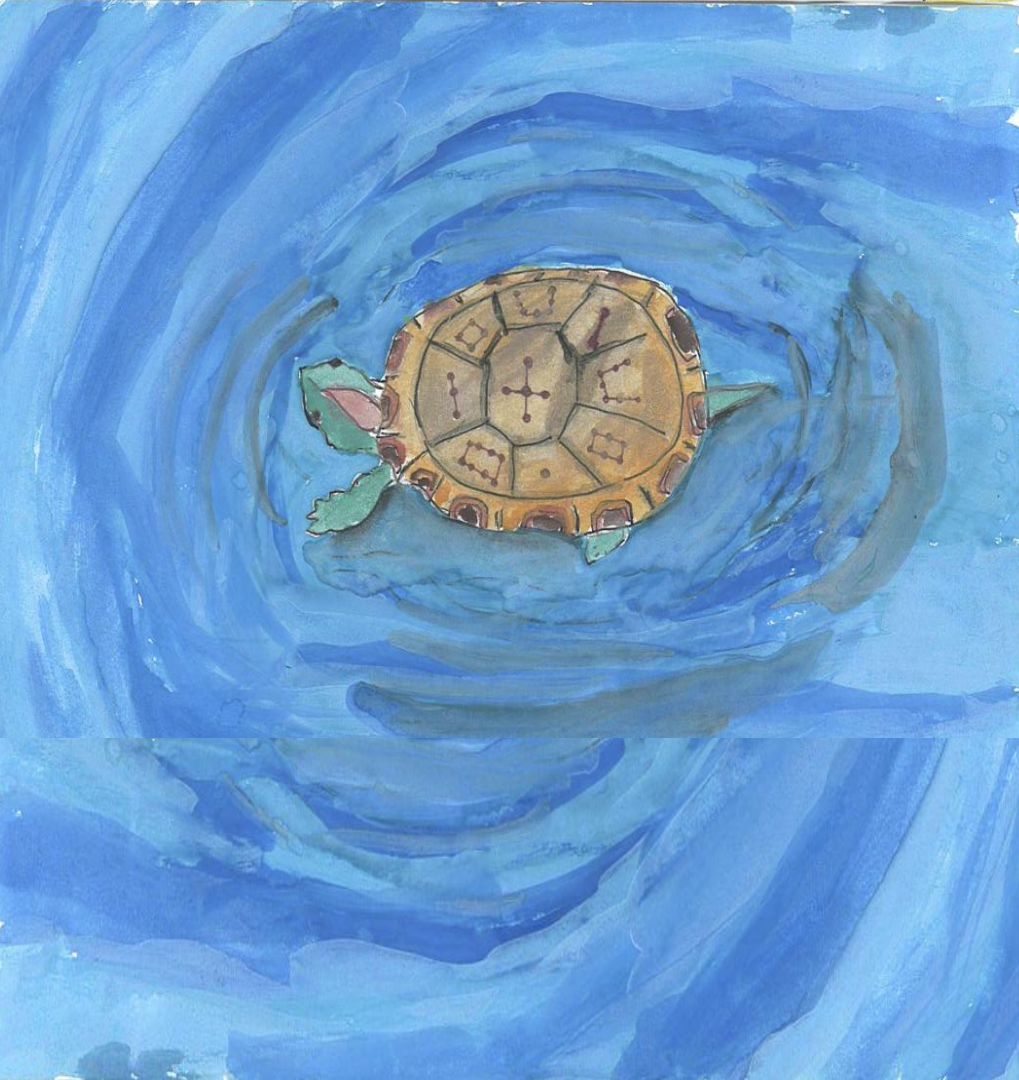
When King Yu got to the Yellow river bank, his face grew with fear as he watched the mighty dark waters rush before him.

He walked a little further to the edge of the river. Out from the waters appeared a curious small figure kicking its legs about in the water.

He took a closer look.

**“What is this creature?”** He thought.

It was a turtle!



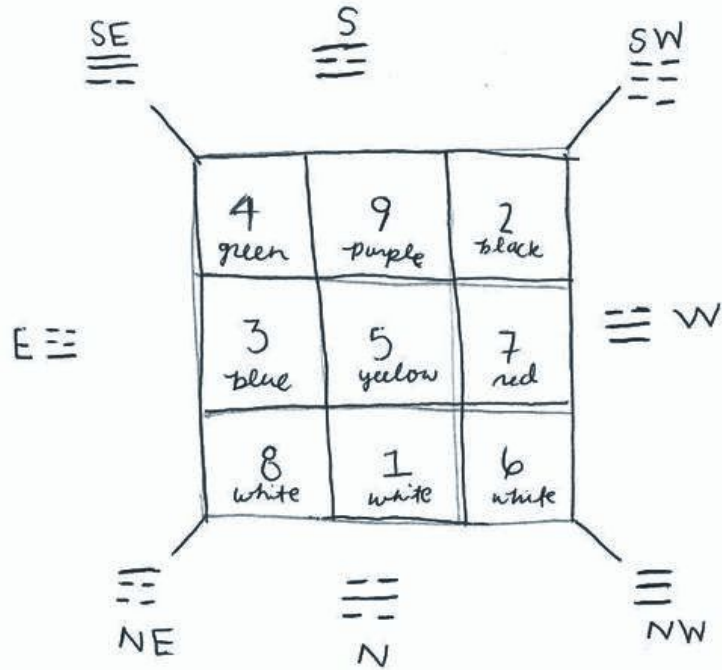
The strange pattern on the divine creature's shell caught King Yu's eye. He looked closely at the turtle's shell.

The shell looked like hard puzzle pieces glued together. On it were dots etched together appearing in different numbers organized on each grid of nine squares.

He curiously added the numbers on each square horizontally, then diagonally, and then vertically. In all directions, all of the numbers added up to 15!<sup>[4]</sup>

**"What could this be?"** He thought as he studied the **mysterious dots**. Suddenly, King Yu recognized the number of dots on each piece represented the solar year calendar of China and the four cardinal directions.

# Lo shu Rivermap



"Could this be good luck!? Could this be the divine plan to control the river!?" He said to himself.

The turtle disappeared into the murkiness of the water. On his way back home, He counted the numbers in his head. He thought that this magic pattern was a way to save his people for maybe it was a sign that he could control the flood. He thanked the gods and wrote down the divine plan to control the flood and channel its waters back into the sea.

When King Yu applied his new plan, he was able to save his people and control the flood. His discovery was recorded in a book called *The Book of Changes* <sup>[5]</sup> and was called the "Lo River Writing" <sup>[6]</sup>.



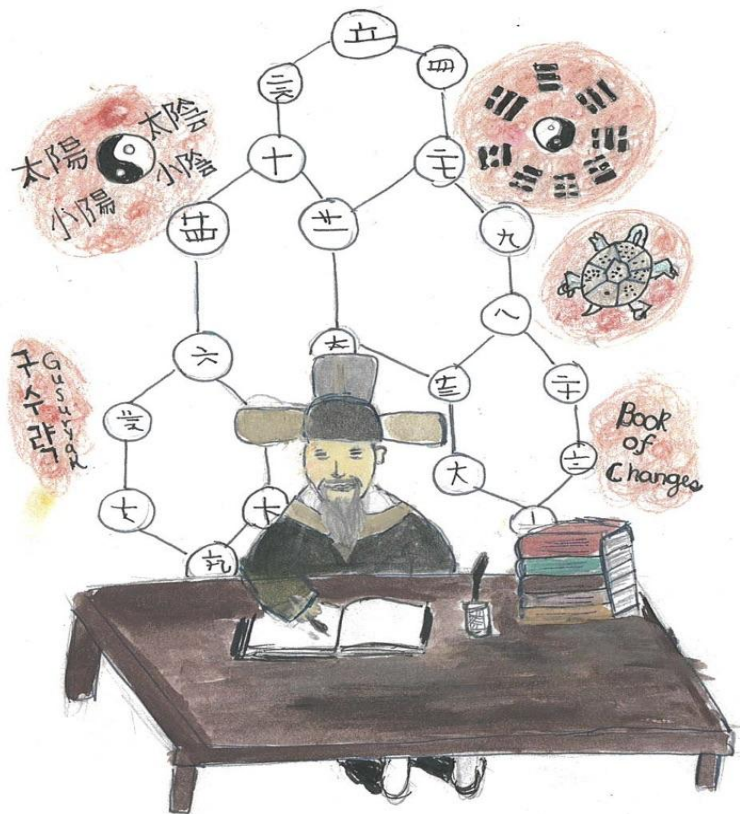
Many years later, in 1636 [7] Joseon Dynasty Korea there lived a man named Choi Seok-jeong.

Seok-jeong was the wisest amongst many Confucian scholars of his time during the Joseon Dynasty. In his time, the Joseon society was filled with Chinese thought after surrendering to China after the Manchu war.

He was a man of great Confucian and mathematical knowledge and had a passion for social justice.

Due to his great passion in adopting Chinese thought to make Joseon society better, he was appointed as the eighth prime minister.





One day, Seok-jeong sat inside his chambers near the palace, and thought, "I must do all I can to make Joseon great. It is my duty and justice for my people."

He picked up a book, *The Book of Changes*, and studied it closely. In it, he learned about the pattern discovered by King Yu to control the Lo Shu river. As he fell further into the depths of the book, he was introduced to principles of the Western World and Ancient Asian philosophy. Inspired with motivation to understand the basis of ancient mathematics of I Ching<sup>[8]</sup> and King Yu, Seok-jeong decided to write a mathematics book of his own called "*Gusuryak*,<sup>[9]</sup>" The Summary of the Nine Branches of Numbers.

Grabbing his pen, Seok-jeong began to construct the nine chapters of mathematics that included ancient Chinese philosophy of the four *sasang* symbols that represent the balance of yin and yang: Earth, wind, fire, and water<sup>[10]</sup>.

九	八	七	六	五	四	三	二	一
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1	3	2	7	9	8	4	6	5
3	2	1	9	8	7	6	5	9
2	1	3	8	7	9	5	4	6
7	9	8	4	6	5	1	3	2
9	8	7	6	5	4	3	2	1
8	7	9	5	4	6	2	4	3
4	6	5	1	3	2	7	9	8
6	5	4	3	2	1	9	8	7
5	4	6	2	1	3	8	7	9

Inspired by King Yu, Seok-jeong created his own magic square. Using the four *sasang* symbols, he ordered them into pairs within 9 squares.

None of the cells contained the same ordered pair. He started off with the number 9 and made the squares into a column of 3 by 3.

**"This is much like the turtle King Yu found!" He said.**

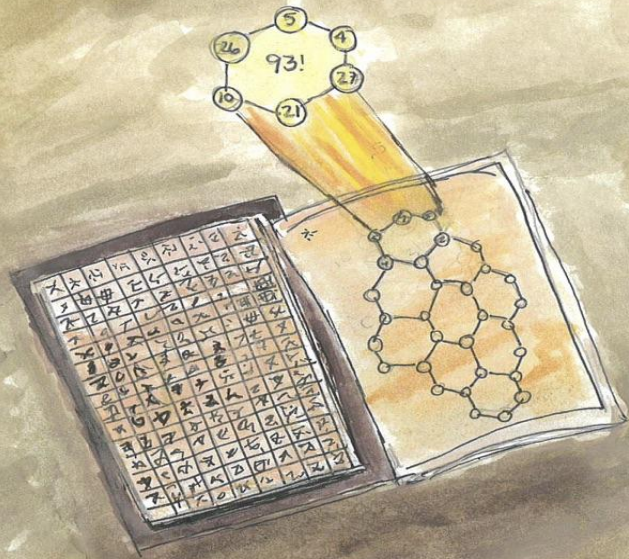
When he was done drawing, he counted the numbers in each in each direction. Every sum in each unit was the same!

This was his first magic square.



One day, Seok-jeong took a stroll outside by the stream. As he was thinking about what to write in his book, a tortoise floated down the stream by him. Looking closely at the tortoise, he remembered again the legend of King Yu, the Great Flood, and the turtle.

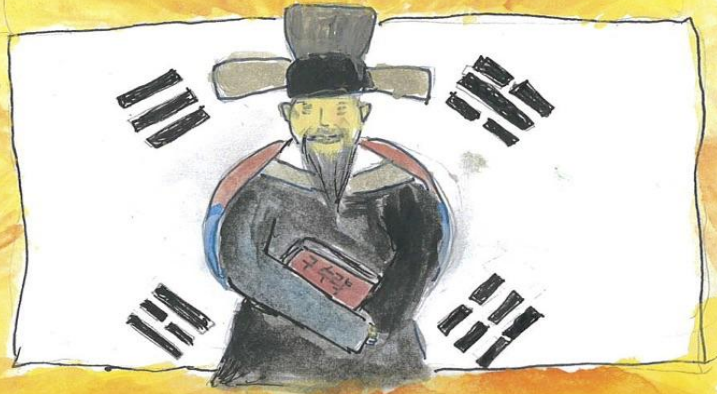
The hexagonal pattern on the tortoise's shell made him ponder. So, he went back to his chambers, grabbed his wooden block, and began to draw out the mysterious hexagonal pattern.



Three by three he lined the hexagons to create thirty vertices. Then he put in numbers at each vertex. He counted each sum of six numbers in all directions. Each of them was ninety-three!

It's magic!

His joy sat well with him for he got much accomplished.



Now, *Gusuryak* stands as Korea's most famous mathematical text because of its profound content and structure.

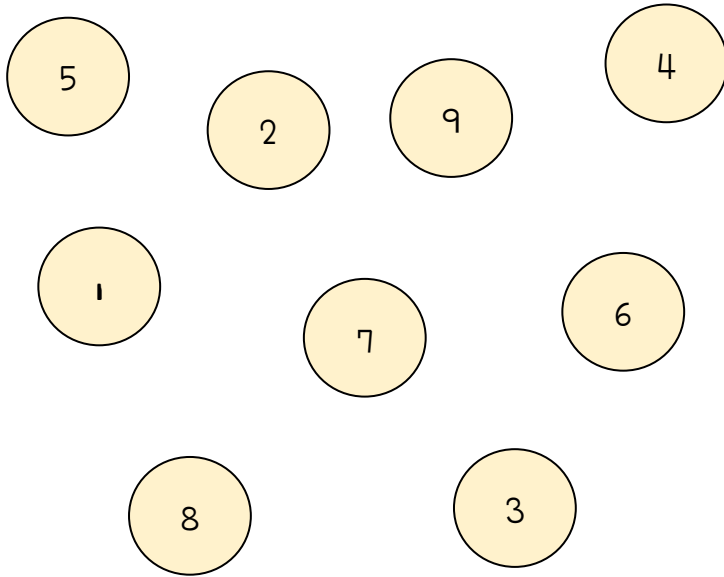
This is because Seok-jeong's use of the *Book of Changes* teachings of the universe to make mathematical magic was something not done before.

Seok-jeong helped Joseon mathematics by writing *Gusuryak*. This is because, after the Qing Empire invaded Joseon Dynasty in 1636, the Joseon Dynasty lost many books recording marvelous discoveries of mathematics and science.

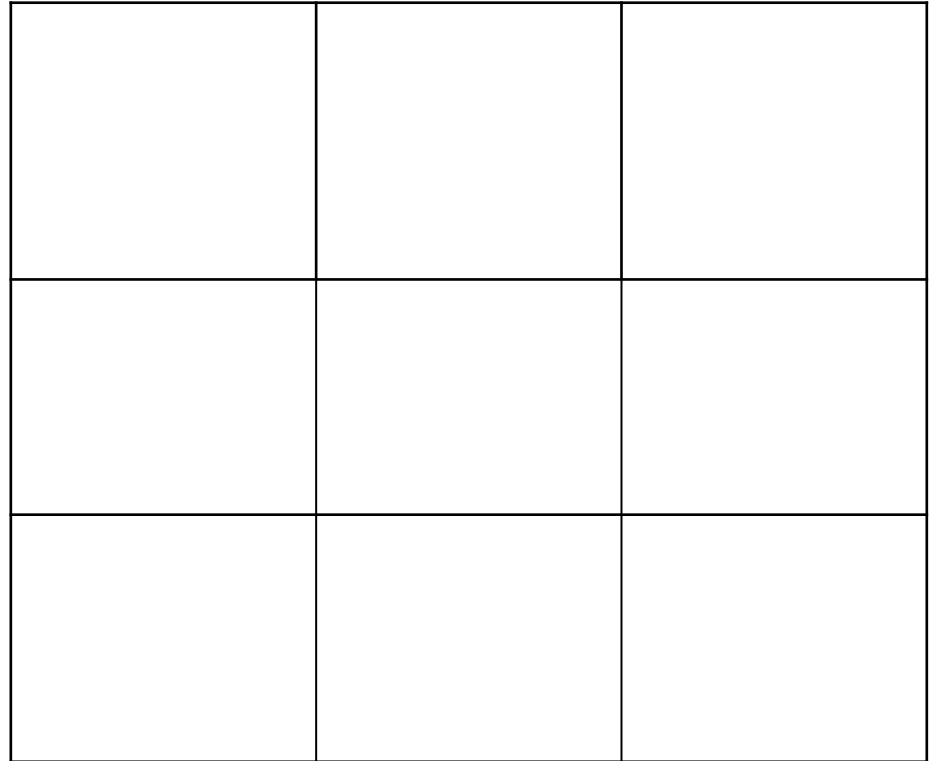
So, thanks to Seok-jeong's *Gusuryak*, the Joseon Dynasty was able to restore magnificent knowledge of mathematics<sup>[1]</sup>

# Create Your Own Magic Square

Materials:

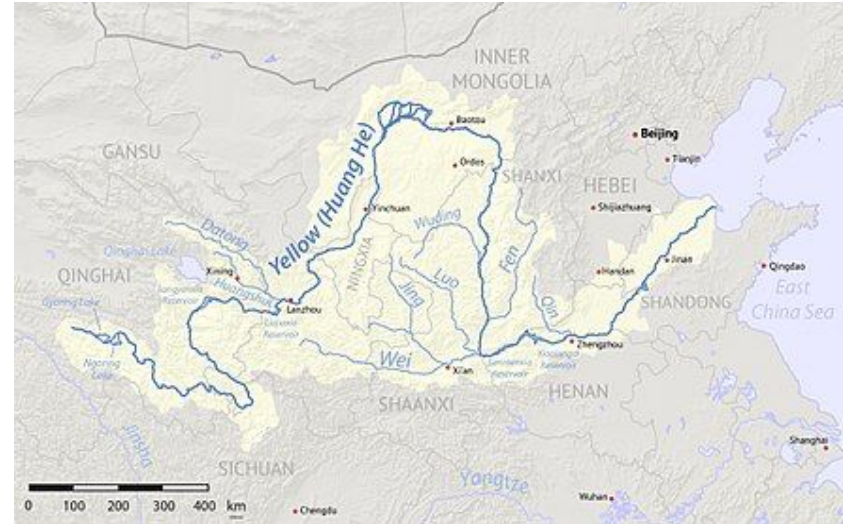


Instructions: Place the numbered dots onto the grid to make the sum the same vertically, horizontally, and diagonally.



# Endnotes

[1] Archeologists in China have discovered evidence of an outburst flood on the Yellow River, also known as “Lo-Shu,” in the beginning of 1900 BC to 2200 BC. The “Great Flood of China,” has been an important topic amongst Chinese folklore. One of them being the Gun-Yu myth or the Ancient Chinese legend of Lo Shu or scroll of the river “Lo-shu.” in which the author stated that the flood lasted two generations; the rule of Emperor Gun and Emperor Yu. This is an Ancient Chinese legend of Lo Shu or scroll of the river “Lo-shu” or the Yellow River. Cammann, Schuyler. “The Magic Square of Three in Old Chinese Philosophy and Religion.” History of Religions, vol. 1, no. 1, 1961, pp. 37–80. JSTOR, [www.jstor.org/stable/1061970](http://www.jstor.org/stable/1061970).



[2]

The Yellow River, China

[https://www.google.co.kr/imgres?imgurl=https://upload.wikimedia.org/wikipedia/commons/thumb/8/8b/Yellowrivermap.jpg/440px-Yellowrivermap.jpg&imgrefurl=https://www.wikiwand.com/en/Yellow\\_River\\_Map&tbnid=nyaIBkhitSHrYM&vet=1&docid=RHerHOxzpNMGyM&w=440&h=277&q=lo+shu+river+map&hl=ko-kr&source=sh/x/im](https://www.google.co.kr/imgres?imgurl=https://upload.wikimedia.org/wikipedia/commons/thumb/8/8b/Yellowrivermap.jpg/440px-Yellowrivermap.jpg&imgrefurl=https://www.wikiwand.com/en/Yellow_River_Map&tbnid=nyaIBkhitSHrYM&vet=1&docid=RHerHOxzpNMGyM&w=440&h=277&q=lo+shu+river+map&hl=ko-kr&source=sh/x/im)

[5] The diagram of King-Yu's river plan was known as Ho' t' u and is recorded in *The Book of Changes*. The *Book of Changes* or the *I Ching* is an ancient Chinese divine text that encompasses philosophical ideas of the universe and a guide of living, ruling, and oracle for personal life. Colagrossi, Mike. "What Is the Book of Changes?"—*Big Think*.  
<https://bigthink.com/surprising-science/what-is-the-book-of-changes-i-ching>. Accessed 27 Nov. 2019.

[6] According to the Gaia staff "The turtle gave the people the pattern on its back as a map or grid of the natural flow of chi and the elements," or later what we will learn as *sasang*. They go on to say, "this square with its numbers became a foundational tool in Feng Shui and Taoist traditions. The square is also carried as an amulet or placed in homes and offices as a protective charm." "The Lo Shu Chinese Magic Square; 1.3 Billion People Can't Be Wrong." *Gaia*,  
<https://www.gaia.com/article/how-to-use-the-chinese-magic-square>. Accessed 6 Dec. 2019.

[7] In 1636, Korea during the Joseon Dynasty period (636–1910) was invaded by the Manchus of China's Qing Dynasty. The Manchu Qing Empire devastated the Korean land and led to Korea becoming a submissive tributary state to China. Through the exchanges of envoys between China and Korea, Ancient Chinese thought and Confucianism slowly became prevalent and was integrated into Korean society. Ze, Xiaoyi. *The Manchu–Korean War in 1636: Background and Result*. [Honolulu]: [University of Hawaii at Manoa], [August 2013], Aug. 2013,  
<http://scholarspace.manoa.hawaii.edu/handle/10125/100658>.

[8] Joseon incorporated Confucianism as a national policy and not as a religion. The doctrine of Confucianism that Joseon Korea used was the "I Ching (Book of Changes). Therefore, all notable Confucian scholars like Choi Seok Jeong, were very familiar with the text. Ree, Confucian scholar's discovery predates the work of Euler." *Sangwook Choi Seokjeong and traditional Asian mathematics*. Math & Presso. 2014



[3] Emperor Yao (2333 BCE–2234 B.C.) was a very important figure in Chinese history. As an emperor he had the power to choose the successor of the throne as well as appoint other rulers to complete specific duties. While it is common that most Emperors would choose their sons as successors, Emperor Yao decided to choose King Gun because he was more competent. Thus, King Gun (2294–2184 B.C.) reigned with Yao for 30 years and continued to reign after Yao's death. This is why Emperor Yao told Gun to control the river. When Yao died, King Gun became the new emperor and appointed his son, King Yu (2123 – 2025 B.C), to control the river and be his successor shortly after his own failures and diagnosis of a deadly illness. This displays the ancient Chinese power dynamic and succession system in the relationship between Emperors and kings. Hays, Jeffrey. *THREE GREAT CHINESE SAGE KINGS: EMPERORS YAO, SHUN AND YU | Facts and Details*. <http://factsanddetails.com/china/cat2/sub1/entry-5387.html>. Accessed 6 Dec. 2019.

[4] This is the Lo- Shu magic square. According to Andrew Lin, A "magic square" is an array of numbers in which no two numbers are the same and in which the entries in each row, column, and diagonal have the same sum. The order-3 square shown below has a particular historical significance. In China, it is called the Lo-shu, and it was first discussed in writing about 300 B.C., which makes it the oldest recorded magic square." Kim, Sung-Sook, and Mee-Kyung Khang. "Orthogonal Latin squares of Choi Seok-Jeong." *Journal for the History of Mathematics*, vol. 23, no. 3, 2010, pp. 21–31, <http://www.koreascience.or.kr/article/JAK0201033538926931.page>.

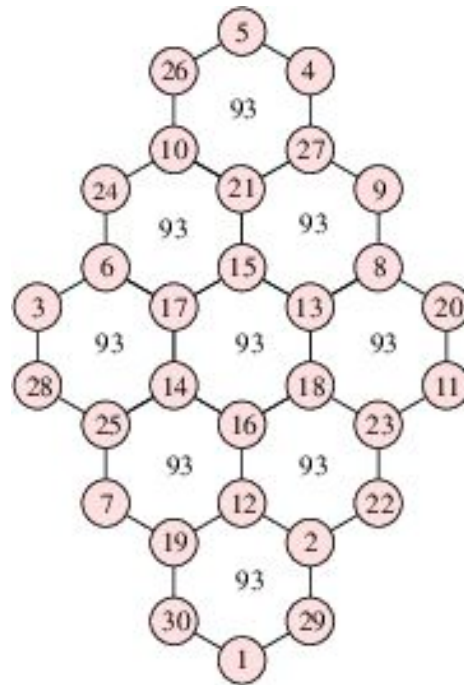
2	3	1
1	2	3
3	1	2

1	3	2
3	2	1
2	1	3

[9] The book *Gusuryak* (구수략) or the Summary of the Nine Branches of Numbers was written in 1715-1718 as an explanation of numbers through the principles of the ancient Chinese Five Elements (음양오행) and Yin and Yang. The *Gusuryak* specifically involved the concept of magic/Latin squares which is an  $n \times n$  array filled with  $n$  different symbols, each occurring exactly once in each row and exactly once in each column. Choi Seok-Jeong used the four *sasang* symbols in order 9 to create the magic square. *Gusuryak* (구수략) is Korea's most famous mathematical text because of its profound content and structure.

Kim, Sung-Sook, and Mee-Kyung Khang. "Orthogonal Latin squares of Choi Seok-Jeong." *Journal for History of Mathematics*, vol. 23, no. 3, 2010, pp. 21-31,

<http://www.koreascience.or.kr/article/JAK0201033538926931.page>.  
<http://web.archive.org/web/20170405173423/http://hpm2012.onpcs.com/Proceeding/Poster/P2.pdf>



[10] The four symbols of *sasang* were introduced by the Chinese *Book of Changes*, that explains the four elements that help philosophers understand the universe. The *Sasang* typology is composed of the yin and yang signs:

1. tae-yang( 태양, 太陽) or "greater yang"
2. so-yang( 소양, 小陽) or "lesser yang"
3. tae-eum( 태음, 太陰) or "greater yin"
4. and so-eum( 소음, 小陰))

or they can mean earth, sun and moon, water, fire, air and stone. *Korea's Pastimes and Customs: A Social History*

[11] In 1710, Choi Seok-Jeong (1646-1760) could only use the Latin squares of 9 to construct a magic square but could not find how to make the squares in orders of 10. However, later in 1782, Leonhard Euler, figured out how to solve the problem by 10.

Kim, Sung-Sook, and Mee-Kyung Khang. "Orthogonal Latin squares of Choi Seok-Jeong." *Journal for History of Mathematics*, vol.23, no.3, 2010, pp.21-31, <http://www.koreascience.or.kr/article/JAKO201033538926931.page>.

50	11	24	63	14	37	26	35
23	62	51	12	25	34	15	38
10	49	64	21	46	13	36	27
61	22	9	52	33	28	39	16
48	7	60	1	20	41	54	29
59	4	45	8	53	32	17	42
6	47	2	57	44	19	30	55
3	58	5	46	31	56	43	18

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