

Could Set-based thinking Help AI?

Exploring the Gaps between Probability and Certainty from A perspective of Chinese Logic

This paper argues that data collections are based on inductive thinking, which provides the probability of truth or falsehood to a knowledge system. Artificial Intelligence excels at analyzing data and selecting highly probable answers from its database. However, human reasoning requires both inductive and deductive thinking. Western logicians, starting from the Aristotelian tradition, have made efforts to separate the logical world from an experiential world, for pursuing certainty metaphysically. When one follows the rules of categorical syllogism to demonstrate the movement of thoughts, one looks for validity, which is certain. Certainty can be achieved in a purely logical world if one uses the symbolic language of modern logic to communicate. Analyzing data and finding a highly probable answer from an existing database limits AI's thinking within inductive logic, which makes AI fail to break free from experiential worlds. Having clarified the different tasks between seeking certainty and seeking probability, the author shall provide a few test results on what a critical thinker can do and what AI cannot do. The author shall explore the possibility of letting Chinese logic serve as a bridge between inductive and deductive thinking. The author argues that thinking with Chinese pictographic characters is akin to thinking in sets, which does not separate elements or particulars in the experiential world from abstract forms or metaphysical patterns. According to modern Set Theory, a set is defined by all the members within the set. This paper presents two comparative studies. One demonstrates similarities in data management between ancient Chinese thinkers and AI. The other highlights a major limitation of current AI thinking models: AI lacks the capacity for intuitive reasoning, a skill that ancient Chinese thinkers excelled at because of their practicing set-based thinking while doing real problem-solving project. Intuitive thinking is a form of commonsense reasoning that integrates inductive and deductive logic, as well as creative insight. The paper concludes that practicing set-based thinking requires both logical and creative faculties, along with the ability to engage in both sensory experience and abstract thought. Chinese logic may help bridge certain gaps between human reasoning and AI cognition in this regard.

Keywords: Aristotelian Logic, Sets, AI, Ancient Chinese Logic

Introduction

Data collection is based on inductive thinking, which provides only the probability of truth or falsehood to a knowledge system. Artificial Intelligence (AI) excels at analyzing data and selecting highly probable answers from its database. However, can one be satisfied with merely probable answers? Can such answers be accepted as sufficient for human intervention in the pursuit of true knowledge? This paper will investigate these questions by examining Large Language Model AI (LLM) and Image Generation AI. The former refers to a type of artificial intelligence system designed and trained to understand, generate, and interact using human

language at scale. The latter refers to a type of artificial intelligence capable of creating visual content, such as photos, images, and artwork, using machine learning models trained on large datasets of images. Both types of AI are closely tied to existing empirical datasets.

When Socrates engaged in philosophical inquiry on piety with Euthyphro, he rejected one definition after another definition of piety given by Euthyphro, because they were only probably or partially correct. They did not capture the *Form* of piety. If the pursuit of knowledge is a virtue, as Socrates believed, then it is the philosopher's duty to seek unchanging and pure *Forms* as the foundation of any human knowledge system. We, as humans, long for certainty to secure our interpretation of the world. In one way or another, we seek a manageable system of control to predict and respond to changes.

Human reasoning requires both inductive and deductive thinking. The latter provides valid patterns or rules for our reasoning. By following deductive structures, the validity of our thought processes is ensured. Validity, in turn, gives us a sense of certainty.

Western logicians, beginning with the Aristotelian tradition, have sought to separate the logical world from an experiential world to avoid the influence of temporal change and subjective judgment. Metaphysically, when one uses categorical syllogisms to demonstrate the movement of thought, one seeks validity—an achievable form of certainty. This kind of certainty can be attained mathematically in a purely logical realm, especially when using the symbolic language of modern logic.

Analyzing data and finding a highly probable answer from an existing database confines AI's thinking within inductive logic, which makes AI fail to break free from experiential worlds. In modern times, as AI increasingly takes control in many areas of life, can we allow AI's answers to get into our controlling system when pursuing so-called true knowledge?

I argue that to study real natural systems, it would be better if we shift our focus from being and categories to becoming and sets. With this shift, we may be able to evaluate AI's limitations and advantages more fairly. To carry out this significant transformation, I believe it would be beneficial to move from Aristotelian traditional logic to ancient Chinese logic. The latter emphasizes that becoming in a changing process is normal, and it uses evolving sets to define concepts, rather than relying on *Forms* and categories.

Ancient Chinese logicians accepted the presupposition that the world is constantly changing. As a logic of sets—where every element within a set, as a whole collection, can define the set, and a set can simultaneously be a set and a subset within another more general set. The absence of Aristotelian deduction did not concern ancient Chinese philosophers that much. The Law of Identity (A is A) and the Law of Non-Contradiction (A and $\sim A$ cannot both be true) were not required for their reasoning. If a set is defined by every element within it, then philosophers can subjectively design sets to map changes.

Chinese civilization has a long history, and the data collected by ancestors through experience were well recorded, serving as a foundation or database for the

1 knowledge of later generations. Thinking in sets allowed ancient Chinese
2 philosophers to remain closely connected to experiential data from the natural world.

3 In this paper, I will first examine the gap between certainty and probability
4 when analyzing AI's answers and reading AI's false deductive proofs. After
5 clarifying the different goals of seeking certainty versus seeking probability, I will
6 present a few results showing what a symbolic logician can do that AI currently
7 cannot.

8 Secondly, I will explain briefly how Chinese pictographic characters were
9 created and sorted. Learning this language involves two basic training: analogical
10 thinking and finding associations. I claim that thinking with Chinese pictographic
11 characters is akin to thinking in sets, which does not separate elements or particulars
12 in the experiential world from abstract forms or metaphysical patterns.

13 Thirdly, I will conduct a comparative study of how ancient Chinese thinkers
14 managed data control compared to how AI handles data management. I will provide
15 an example showing that when re-grouping datasets—whether by AI or ancient
16 Chinese logicians—validity is not always a relevant concept. When thinking in
17 terms of sets, creative outcomes can emerge from mixed sets. Set-based thinking
18 also allows for the inclusion of subjective time, thereby avoiding the limitations
19 imposed by the Law of Identity and the Law of Non-Contradiction.

20 Lastly, I will present a famous example of how to control change: flowing water,
21 which is constantly in flux. The renowned flood control system, Dujiangyan,
22 designed by ancient Chinese engineers, Li Bing 李冰 and his son, in 256 BCE, has
23 functioned for over two thousand years. Dujiangyan exemplifies an excellent
24 control system that operates by seeking the highest probability rather than absolute
25 certainty. Comparing to the Dujiangyan Irrigation and Flood Controlling System re-
26 designed by AI to the real project can lead out a fair evaluation of AI's capacity.
27 This comparative study highlights a major limitation of current AI thinking models,
28 LLM and Image Generation: AI lacks the capacity for intuitive reasoning, a skill
29 that ancient Chinese thinkers excelled at because of their practicing set-based
30 thinking while doing real problem-solving project. Intuitive thinking is a form of
31 commonsense reasoning that integrates inductive and deductive logic, as well as
32 creative insight. Limited within database, AI lacks the ability to do really problem-
33 solving.

34 The conclusion of this paper is that probable answers could be included in our
35 knowledge systems, as long as we treat the dataset as an infinite set, and open to
36 accepting new data over time. Ancient Chinese logic may serve as a model for
37 bridging the gap between certainty and probability. Hopefully, this comparative
38 study will offer a new perspective on the relationship between AI and human
39 knowledge, and contribute to a better understanding of AI's logic, limitations, and
40 advantages.

The Gap between certainty and Probability and AI's Limitations

I would like to open my discussion on the gap between certainty and probability by examining common definitions of deduction and induction. American logician I. M. Copi defines deduction and induction as follow:

A deductive argument is one whose conclusion is claimed to follow from its premisses with absolute necessity, this necessity not being a matter of degree and not depending in any way on whatever else may be the case. In sharp contrast, an inductive argument is one whose conclusion is claimed to follow from its premisses only with probability, this probability be a matter of degree and dependent upon what else may be the case. (Copi 2001, p. 45)

The above definition clearly outlines the different tasks and outcomes of deductive and inductive thinking. The absolute necessity in a deductive argument ensures the certainty of a valid conclusion. On the other hand, if even a single counterexample is found in inductive reasoning, its conclusion must be rejected. No matter how much data is collected, an inductive argument only provides probability, not certainty. As critical thinkers, we need both deductive rules and inductive data.

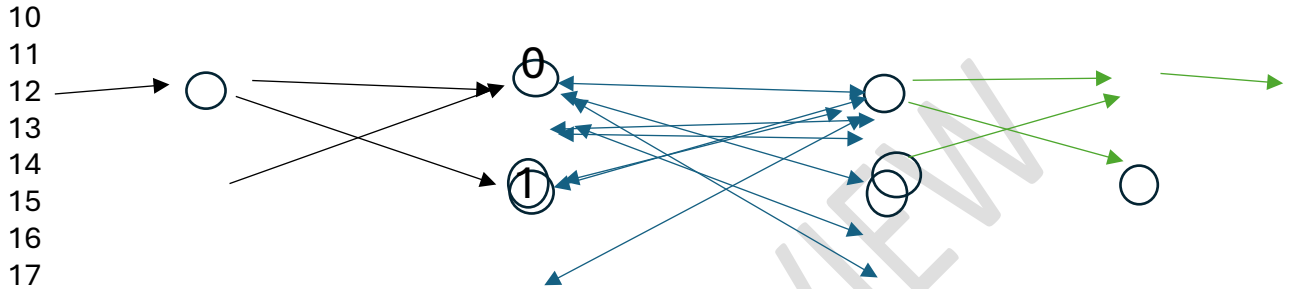
Unfortunately, AI is limited by the data it is given. The following is a brief introduction to how AI models work: AI models are programs that detect specific patterns using collections of datasets to analyze information and make predictions or decisions based on the patterns they identify. Scientists use programming languages like Python to write instructions for AI and to import data from the OpenAI API, which is part of the OpenAI library. This library contains a vast amount of digital data. Once a computer is connected to the OpenAI library, users can interact with the API and access this extensive database.¹ AI is a system that

¹The following is the Python code which indicates AI to work:

```
1. Import openai
2.
3. # Initialize the OpenAI API with your API key
4. openai.api_key = 'your-api-key'
5.
6. # Define the prompt or question
7. prompt = "What is the capital of France?"
8.
9. # Use the OpenAI API to generate a response
10. response = openai.Completion.create(
11.     engine="text-davinci-003",
12.     prompt=prompt,
13.     max_tokens=50
14. )
15. # Print the response
16. Print (response.choices [0].text.strip())
```

learns from data and discovers patterns. Once trained, an AI model can make predictions or take actions based on data it has not previously seen. By combining different datasets, AI models can even generate new images and ideas. AI models are used in a wide range of applications, including image and video recognition, natural language processing, anomaly detection, recommender systems, predictive modeling and forecasting, as well as robotics and control systems. When generating a response, the Completion.create method sends a prompt to the AI model and retrieves a response.

The following simple chart visually summarizes how AI models work:



The circles in the above chart represent existing data. It does not matter how many patterns are checked back and forth, or how fast the data-checking process is—the thinking model remains confined within the digital database. Even when generating creative images by mixing different datasets, those databases, which AI is feed, remain as empirical knowledge and maintain their posterior nature. AI processes visual information through complex algorithms and neural networks. When AI models analyze images, they still break them down into data points and patterns to interpret and generate responses. AI models can handle, manage, and select data much more efficiently than humans. However, at their current level, AI does not have the ability to perform deductive proofs, which involve not only valid thinking patterns but also critical reasoning.

I conducted the following test to demonstrate that AI fails to perform deductive thinking, because, as Copi's definition of deduction points out, it involves a fundamentally different task—pursuing absolute necessity. Deductive proofs do not overlap with the inductive probabilities derived from experimental data.

I asked AI (Chat GPT) a question: "Can you prove the **validity** of the following question: 1. $(G \ \& \ L) \vee (W \ \& \ T)$, 2. $\sim G \ \therefore T$ (Definitions: G= Raining, L=Wet, W=Sunny, and T=Dry)?"

AI said "Yes," and then in a few seconds it offered me a paragraph of nonsense, which AI called as "My Proof":

1. $(G \ \& \ L) \vee (W \ \& \ T)$
2. $\sim G$
- $\therefore T$

1. My Proof:

1. Consider the cases:

1. If (G) is true, then ((G $\wedge$ L)) is true.
 2. If (W) is true, then ((W $\wedge$ T)) is true.
 3. Since we have ($\neg$ G), we can conclude that (W) must be true.
 4. Therefore, ((W $\wedge$ T)) is true.
 5. Hence, ((G $\wedge$ L) $\vee$ (W $\wedge$ T)) is true.
 6. Since the statement is true, our goal (T) is also true.
- Therefore, the given statement is valid, and (T) holds.

I did not change a single word in the above AI-generated false deductive proof. What the AI produced is clearly not deductive proof at all, but rather a check of the truth or falsity of individual given propositions. The following is the correct proof completed by my logic students:

1. (G & L) $\vee$ (W & T)
2. $\neg$ G
3. $\therefore$ T
3. $\neg$ G $\vee$ $\neg$ L
4. $\sim$ (G & L)
5. W & T
6. T & W
7. T
- 2, Add.
3. De M.
- 1, 4, D.S.
- 5, Com
- 6, Simp.²

To sum up my investigation into what AI can and cannot do: AI is effective at generating high-probability outcomes based on data. However, it does not truly understand what “validity” means. It falsely claimed it could prove the validity of a deductive argument when it responded “Yes” to my prompt. In AI’s proof, it messed up the concepts of validity and truth/false and falsely concluded that “[T]herefore, the given statement is valid, and (T) holds.” The validity of an argument cannot be simply associated with “T” or true.

Validity is about the deductive forms when structuring relation among propositions, while true/false only relates to the truth value of one proposition which can be tested by experiences. Modern logician Copi clearly separated these concepts, and he claims:

² Add.: Deductive Rule, Addition; De M.: Deductive Rule De Morgan; D.S.: Deductive Rule Disjunctive Dilemma; Com: Deductive Rule Commutation; Simp.: Deductive Rule Simplification. These rules are valid forms or patterns which guarantee that every step of a thought movement is a valid move.

Validity refers to a relation between propositions-between the set of propositions that serves as the premisses of a deductive argument, and the one proposition that services as the conclusion of the argument...Since logic necessity is never achieved by inductive argument, validity never apply to them. *Nor can validity ever apply to any single proposition by itself, since the needed relation cannot be found with any one proposition.* (Copi 2001, p.46)

In my test, AI fails to perform even simple deductive proof. It lacks the ability to engage in deductive reasoning aimed at achieving absolute necessity or certainty.

Turning to Set-Based Thinking in Ancient Chinese Logic as an Alternative in Discussions of AI Models

As long as AI models depend on existing databases to generate answers or conclusions, Aristotelian deductive thinking is not particularly helpful for either understanding AI models fairly or communicating with them. The categorical propositions used as building blocks in constructing deductive arguments are not the building blocks by which AI generates answers through inductive models. While I agree with Descartes' claim that Aristotle's syllogism is a beautiful thinking tool in the history of human reasoning, a closer look at the history of logic reveals that different logical systems have been developed to address different kinds of problems in the world. The Aristotelian tradition is not the only logic developed in human civilization. Logic, in fact, should be considered a plural term—Logics.

In the case of AI, LLM and Image Generation, which I examine in this paper, I believe that in addition to Deductive Logic and Inductive Logic, a third type—Set Logic—deserves close attention. Set-based thinking allows subjective time to be involved. I argue that it would be promising if we turn to a logical system that bypasses the gap between induction and deduction and instead puts effort into bridging the divide between probability and certainty over time. Hopefully, such logic could help AI scientists gain deeper insight into how to support AI's growth and evolution.

For this reason, I suggest turning to a tradition outside the Aristotelian framework—such as ancient Chinese logic. Ancient Chinese logic focuses on dealing with change, complex relationships, and even metaphysical concepts by examining infinite cases in an a posteriori world. The core presumption of ancient Chinese logicians is that everything changes over time. Chinese logic structures arguments through set-based thinking rather than relying on a pre-existing order of categories, such as genus and species. Pre-Qin (before 221 BC) Chinese philosophers generally did not devote effort to discussing the mysteries of transcendence from empirical knowledge to metaphysical truth. Even among Neo-Confucian scholars in the Song and Ming dynasties (960–1644 CE), the process of grasping the universal pattern *Li* 理 was described as studying and examining cases or elements one by one in a universal set (e.g., Wang Yangming's "*ge wu zhi zhi*, 格物致知", examining cases for pursuing knowledge). Letting probability and

certainly merge across infinite time offers a path to understanding their fundamental concept, *Dao*. Chinese logic is neither inductive nor deductive, but a logic of sets.

The rationale for my claim that Chinese logic is a logic of sets is rooted in Chinese pictographic language. Language shapes not only our thoughts but also how our thoughts flow. In my paper, “Thinking through Sets: Exploring How Chinese Pictographic Language Shapes Chinese Logic,” I stated the following:

An etymological study shows that Chinese pictographic characters were created according to sets - the collections of characters. These collections consist of 364 radicals, which function as primary sets or units. All Chinese characters were created and sorted according to these 364 different radicals, which are simple sketches of the images for 364 common objects, things, or activities in human experiences. Normally, a Chinese character is a member in one of those primary sets of radicals. It associates with the radical one way or another in meaning by having the radical as a part of the character itself. The meaning of the primary radical is represented by the totality of its

members. For example, the water radical, *shui*  (simplified as “” in modern

Chinese) includes objects or elements which associate with water, such as, river .

ocean , creak , fulfill ,³ etc., and the radical  is interpreted or defined by all the members in the set of water radical (Yuan 2023, p. 248).

When learning Chinese pictographic characters, two basic training are involved: analogical thinking skills and approaches of finding associations. When thinking through Chinese pictographic language, at least three unique epistemological impacts are difficult to avoid.

First, objects tend to be categorized into distinct sets, similar to how Chinese characters are grouped based on 364 different pictographic radicals, which function as general sets. The first step of learning Chinese pictographic characters for communication involves learning how to sort characters according to these radicals

³I only listed a few members in the set of water radicals as examples. These members are also pictographic. The meaning of the characters can be interpreted by looking at the images of these characters. According to *Shou Wen*, ‘River is the water which passes around Kunlun Mountains

and then goes into the ocean. , 水。出焞煌塞外昆侖山，發原注海。” “Ocean is a pond

as large as the sky. It collects hundreds of rivers and creeks. , 天池也。以納百川者。”

“Creaks are ditches which are four feet wide and four feet deep. , 水瀆。廣四尺、深四

尺。” “Fulfill means overflow. , 盈溢也。” (*Shuo Wen*, Book 11, Water Unit)

The translations of sentences from *Shuo Wen* in this paper are mine.

or sets. Set-based thinking is a basic grammar required for learning Chinese language.

Second, the overall meaning of a general set is understood by examining each individual element or member within that set. For example, the meaning of radical



water, *shui*, is defined by every element which is associated with water in this general set. When one exams river, ocean, creak, raindrop..., one understands the meaning of water. The logic of sets is rooted in the nature of the Chinese pictographic language, since fundamental perceptions were formed on the set-based thinking. In learning this language, one is, in fact, embracing a way of thinking that practices set-based reasoning.

Third, a general set or universal concept can be defined solely through its constituent elements over time. Understanding the individual elements within a set becomes a way of grasping the set as a whole through a continuous process—especially when engaging with a universal set. For example, in Book 1 of the *Tao Te Ching*, Lao Tzu introduces *Dao*⁴ with the statement: “The nameless was the beginning of heaven and earth; the named was the mother of the myriad creatures” (Lao Tzu, 1963). *Dao*, as a universal set, is nameless. The myriad creatures—its elements or members within the universal set—can be identified. To understand *Dao* though studying and grasping the meanings of myriad things, just as one understands the concept of number by understanding one, two, three, and so on, till infinite. In this sense, Lao Tzu presents *Dao* as an infinite and universal dataset—one that is open to exploration through a continuous process. Borrowing expressions from modern Set Theory, we might say:

$$\bigcup_{\text{Dao}} \{ \text{☰} \dots \text{☷} \}^5$$

In the Universal Set *Dao*, Hexagram ☰ *qian* 乾 represents heavy; hexagram ☷ *kun* 坤 represents earth. According to the *Book of Change*, the hexagram *qian* ☰ also represents, masculinity and power; the hexagram *kun* ☷ also represents femininity and softness. All changes occur between heaven and earth. All creatures and objects exist between heaven and earth. Or within *Dao*. To study, to examine and to be elements in the Universal Set *Dao* is a way to understand *Dao*.

In the next two sections, I will use more examples to illustrate how set-based thinking works when handling datasets.

Although set-based thinking was a common logical practice in ancient China, Chinese logicians did not develop a formal Theory of Sets. German mathematician Georg Cantor (1845–1918) was one of the early founders of set theory and the author of *Mannigfaltigkeitslehre*. The concept of number is difficult to define

⁴D. C. Lau’s translation spells *Dao* as *Tao*. I use *Dao* in this paper, for it is a common spell in modern documents

⁵If ☰ *qian* represents the number 1 and ☷ *kun* represents the number 0, as an ancient binary system, this also implies that changes happen between 1 and 0

accurately using categorical propositions. One must approach it by learning particular numbers—such as 1, 2, 3, ... 100—yet numbers can be infinite. Treating the concept number as a pure Platonic Form does not satisfy many mathematicians. When Cantor used Set Number to interpret and define the concept of number, his theory blended essence with temporal membership in time. The philosophical requirement to transcend from particulars to a pure metaphysical Form was replaced by an infinite set. In this context, empirical knowledge and data collection contribute to understanding the abstract concept and play a role which cannot be overlooked.

Cantor introduces his original concept of the set as follows.

A set S is any collection of definite, distinguishable objects of our intuition or of our intellect to be conceived as a whole. The objects are called the **elements** or *members* of S ... With regard to the objects which may be allowed in a set, the phrase “objects of our intuition” gives considerable freedom (Stoll, 1963, pp. 2-3)

In the West, Cantor’s concept sets changed the traditional ways of categorizing, sorting and viewing the relationship between objects and general terms. “Starting from the early stage of studying the magnitude of infinite sets of numbers, the founders of set theory never limit the elements of sets nor types of sets.” (Yuan, 2021). I believe that Cantor’s Set Theory, in one way or another, encourages philosophers to make efforts toward bridging empirical cases and theoretical abstraction. In other words, such efforts aim to address a traditional Platonic challenge: the relationship between examples drawn from experience and the pure Form. For instance, in *Euthyphro*, piety is defined through examples by Euthyphro, while Socrates urges Euthyphro to pursue the Form itself.

Although ancient Chinese thinkers did not develop a systematic theory of sets, when Chinese logicians practiced set-based thinking, they shared a few essential principles found in Cantor’s original concept of a set. This provides a strong basis for using the term “set-based thinking” to characterize the nature of traditional Chinese ways of reasoning. Since the Chinese way of thinking involves treating, separating, and analyzing data from accumulated experiences in a constantly changing world—and given that Chinese logic has been practiced for thousands of years—it may contain valuable insights that could help AI overcome its limitations when dealing with data in our digital age.

A Comparative Study of Ancient Chinese Logicians’ Data Management to AI’s Data Management

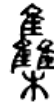
In his *Tractatus*, Wittgenstein states, “In Logic nothing is accidental: if a thing can occur in a state of affairs, the possibility of the state of affairs must be written into the thing itself.” (Wittgenstein, 1992). When ancient Chinese thinkers used their unique form of pictographic characters to represent the world, they developed a distinctive way to bridge certainty and possibility.

They treated set as a collection of objects which “is to be regarded as a single entity (to be conceived as a whole)” (Stoll 1963). “In other words, a set is defined by all members in this set, e.g., all members of Set A should have property $P(x)$. This feature of sets resembles the relationship between *dao* and myriad things

described in Daoism.” (Yuan 2021) as well as managing data from different datasets within AI’s function.

In this section and next section, I will conduct a comparative study of how ancient Chinese thinkers approached data control versus how AI manages data. I will present two examples demonstrating that when re-grouping datasets—whether by AI or ancient Chinese logicians—the concept of validity in deduction is not always a relevant concept. My first example provided in this section highlights similarities between logic of sets and AI’s data management capabilities. I will analyze this case and underscore the strengths of both set-based thinking in human and AI’s data handling methods. My second example provided in section 4 examines how and why AI can fail to provide accurate answers. It will demonstrate some unavoidable weaknesses of AI at the current level as well as the main causes of these limitations. I hope this comparative study will clarify the types of tasks AI can perform successfully and the limitations it currently cannot overcome.

Let me start with an etymological study of Chinese pictographic character of “set”. The basic feature of a set pointed out by Cantor in his Set Theory has been well represented by the pictographic character for the concept “set.” The pictographic character in classical Chinese reads as, *Ji*, a collection of all members



in a set. Its written form represents this meaning: . The pictographic character of *ji* or set, “is an image of birds collectively sitting on a tree. It demonstrates the essence of a set: a set is defined by all elements/members in itself. When a few birds sit on a tree, they are collectively in a set, *ji*. The image of *ji* shows a finite set. One domain is given, which is the tree. Birds are elements in the domain. Chinese people’s understanding of *ji* offers a good reason for one to believe that thinking with Chinese characters is thinking with sets. Another interesting feature, which I desire to mention, is that many classical Chinese characters can be both noun and verb. As a noun, *ji* means a set. As a verb, *ji* means collecting elements for the set.” (Yuan 2021)

By treating *ji* as a verb, the act of collecting elements involves time, as well as subjective intuition and experience, in the process of defining an entirety as a whole. Through the action of collecting, a finite set can become an infinite set over time. Three birds on a tree can grow into countless birds within the set of birds. The limitations of existing data collected from our ancestors’ experiential world can transform into infinite acts of examining one element after another.

This situation can be compared to how AI models work. AI expert Melanie Mitchell says,

[T]hey [AI] gradually change their weights as they process the examples in the training set again and again, over many epochs (that is, many passes through the training set), Learning to classify each input as one of fixed set of possible output categories. In contrast, even the youngest children learn an open-ended set of categories and can recognize instances of most categories after seeing only a few examples. (Mitchell 2019, p. 97)

1 If a set could be defined as an open domain, then—even though the results
2 generated from limited data can only provide probable correct answers—there is
3 still hope that these answers will improve over time as the database continues to
4 grow.

5 When practicing set-based thinking, Logic of Sets confirms the credibility of
6 collecting data, which is one of most important parts in practicing Inductive Logic,
7 while also confirms one of major characteristics of learning: continuity. Both
8 ancient Chinese Logic of Sets and modern Set Theory involve subjective time and
9 learners' intuitive ability when understand sets and knowledge provided by set-
10 based thinking. The cognitive task of transcending particulars to pure metaphysical
11 Forms could be possibly carried out by continuity⁶ and transformation. For the
12 comparative study in this secession, I would like to borrow some expressions from
13 modern Set Theory when I discuss the following examples. According to Set Theory,
14 an infinite set can be written as:

15 Set A $\{\alpha, \beta, \gamma, \delta, \varepsilon, \dots\}$ [$\alpha, \beta, \gamma, \delta, \varepsilon$ are elements in the Set A, “...” represent
16 infinite possibilities to add new elements in Set A.]

17 While a finite set can be written as:

18
19 Set B $\{\alpha, \beta, \gamma, a, b\}$
20

21 When more than one set merges, novelty might be created as a new set. Sets
22 can have intersection, e.g. $A \cup B = \{\alpha, \beta, \gamma\}$, for both Set A and Set B above have
23 these elements. A new set can also be a union set, e.g. $A \cap B = \{\alpha, \beta, \gamma, \delta, \varepsilon, a, b\}$,
24 for these elements belong to either Set A or Set B.

25 The continuity of growing databases may still offer limited knowledge via
26 specific empirical cases or elements; however, it clearly opens the door to a hope
27 for achieving greater accuracy and the discovery of new knowledge. Leaving space
28 open for continuity is leaving space open for wonders. It is one of the major
29 strengths of the Logic of Set. Moving towards this direction could also be a key
30 source of power for AI.

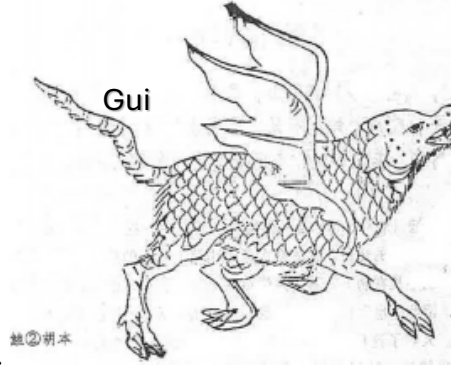
31 My example one explores the mixing of datasets across time or processes to
32 produce a creative outcome. It highlights that continuity can serve as both a hope of
33 pursuing accuracy and a means of generating new knowledge.

34 An ancient geographical text in China dating back to the Pre-Qin period, *The*
35 *Classic of Mountains and Seas* (4th century BCE–Han Dynasty), exemplifies this
36 idea. Geographical study mainly involves extensive data collection, and *The Classic*
37 *of Mountains and Seas* documents landscapes and geographical changes throughout
38 China. It describes 550 mountains and 300 channels, along with the creatures, beasts,
39 nations, and ways of life found in these regions. The book can be considered as the
40 oldest collection of detailed geographical data in China. However, many readers,
41 including scholars, also regard this book as a work of Chinese mythology, because

⁶The recognition of the importance of continuity in Chinese Philosophy while pursuing human knowledge was initially emphasized by philosopher and linguist Yuen Ren Chao in his *Continuity: A Study in Methodology* (1918), doctoral dissertation, Harvard University. Chao argues that the concept of continuity could serve as a guiding framework for understanding change, development, and structure when learning language and pursuing knowledge.

the creatures and animals in the mountains and seas are frequently described not by their real appearances observed by our empirical investigation, but by how they transform into new forms of beings. Often, they are hybrids of different species—such as fish with wings, snakes with human heads, or birds with nine heads.

Taking the following creature recorded in the book as an example. The creature's name is *Gui* and it has the head of a dog, two bird wings, and fish scales



covering its entire body.

The creature *Gui* emerged from three possible worlds or datasets, and the unknown author(s) of *The Classic of Mountains and Seas* even provided an illustration of *Gui* to show what kind of new creature one might expect to see after a transformation from birds, dogs, and fish.

w1: the world of
birds or Set Bird {...}
w2: the world of dogs
or Set Dog {...}
w3: the world of fish or
Set Fish {...}

W1

W2

Gui

W3

Thinking in terms of Logic of Sets, new knowledge goes beyond the existing experiences contained within a single set. *Gui* is a transformation derived from three datasets and exists as a creature that can inhabit three possible worlds. Although every element in each set (in this case, Set Bird, Set Dog and Set Fish) is an object collected from human experience, or in Aristotelian terms, through inductive approaches, *Gui* represents a hybrid model that transcends the limitations of each individual set. Its image, in fact, embodies the new features of the union of the three sets. This new Union Set can be viewed as a new life, or new system, empowered by the combined strengths of all three sets.

If Image Generation AI is fed with three different datasets—Set Bird, Set Dog, and Set Fish—it has the ability to create an image of a hybrid creature, similar to *Gui*, based on these diverse datasets. I asked Chat GPT: “Could you please create an image of a combination of bird, dog and fish?” Chat GPT immediately provided me with the following image:

1 *Hybrid Creature of Bird-Dog-Fish Created by Chat GPT*

2
3
4 Looking at the images of *Gui* and the hybrid creature created by AI, I want to
5 point out that, in fact, what AI does today shares a similar thinking pattern to that
6 practiced by ancient Chinese geographers thousands of years ago. This common
7 pattern is set-based thinking. “Since the 1950s, AI researchers have been trying to
8 get computers to make sense of visual data.” (Mitchell, 2019). After decades of hard
9 work by computer scientists, AI has been programmed with strong capabilities for
10 managing diverse visual datasets. Image Generation AI can—and is good at—
11 creating images of new creatures based on different datasets that we feed it. When
12 thinking within the domain of existing databases, transformations among different
13 datasets can resemble the process of summarizing a theoretical possibility. Since
14 no deductive logic is required when handling and managing data within given
15 datasets, there is no necessity to elevate empirical data to abstract Forms or
16 metaphysical certainty. The flow of thought is not measured by logical validity, but
17 by the mathematical probability of not being wrong.

18 Therefore, set-based thinking can serve as a bridge between empirical data and
19 theoretical abstraction between observation and imagination. Transformation, or in
20 modern terms, mixing datasets, offers the possibility that one creature can exist in
21 three different possible worlds or sets. The gap between probability and certainty
22 may still remain; however, novelty merges together with the hope of new
23 discoveries. AI performs this task well.

24
25

26 **A Comparative Study of Intuitive Reasoning: Ancient Chinese Logicians’ Set-**
27 **Based Thinking vs. the Lack of Deductive Reasoning in AI Performance**
28

29 Set-based thinking does not require deductive logic, but it does not reject
30 deduction either. Practicing Logic of Sets involves intuitive reasoning, especially
31 when one fully understands a set as a complete entity within the continuous process
32 of data collection. Intuitive reasoning is a form of commonsense reasoning, and
33 commonsense reasoning does not reject deductive thinking.

I am now move to my second example of set-based thinking in ancient China. This example of set-based thinking is represented by a real project, Dujiangyan (都江堰) Irrigation and Flood Controlling System, which successfully combines the functions of three different sets together and created an effective controlling system on River Min in mountains and manages flood and irrigation for thousands of years in the West China. And it still functions well today.

To further question why ancient Chinese geographers included many non-exists creatures and beings in a geographical text, looking at the power of Dujiangyan system would be helpful to understand the purpose of collecting geographical data in ancient Chinese scholars' mind goes beyond simply record those datasets. Mixing different datasets for creating new functions, new creatures, or new union sets could be the goal of those scholars. Aiming at looking for new systems which go with the flow of *Dao* is their high lever goal.

I do not have ambition to prove any direct connections between designers of Dujiangyan System and the unknown authors of *the Classic of Mountains and Seas* in this paper, except notifying the overlapped time in Chinese history. My moderate attempt is to demonstrate the common feature of set-based thinking goes alone intuitive and creative thinking.

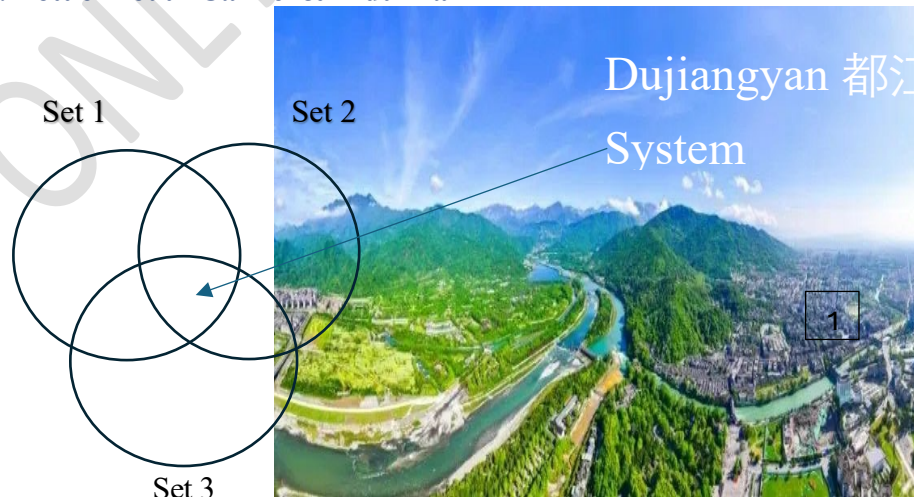
The Dujiangyan Irrigation and Flood Control System was constructed in 256 BCE during the Warring States period by ancient engineers Li Bing and his son. It is a remarkable ancient water management and controlling project located inside of the Mountain Baoping, in today's Sichuan Province, China. It's one of the oldest and most well-preserved irrigation and flood control systems in the world, and it's still in use today. Its design and construction represented how three different sets were involved but function together as a new system.

Dujiangyan system consists of three main parts or three sets:

Set 1: Fish Mouth (Dividing Water)

Set 2: Feishayan (Drainage Dam)

Set 3: Bottle Mouth Cannel & Lidui Park



1 The photo of Part One: Yuzui (Fish Mouth Levee) or Set 1 which splits the
2 River Min into inner and outer streams.
3



4
5
6 Photo of Part Two: Feishayan (Flying Sand Weir) or Set 2, which is a drainage
7 dam. It is not tall but can control the flow of River Min and remove silt. During the
8 drought season it blocks the water and guides the water to Bottle-Neck Channel and
9 then to inter river to irrigate the farming land. During the flood season, it lets over
10 flowed water go to outside river to protect the villages and farming land.
11



12
13
14 Photo of Part Three: Baopingkou (Bottle-Neck Channel) or Set 3, which
15 regulates water into the irrigation system. For dealing with changes, farmers can
16 even add a movable dam made by putting rocks in bamboo baskets based on need,
17 called Lidui. This temperate dam can be taken off based on need too.



The above three major sets work together for the whole system. The function of doing flood controlling and irrigation as a whole system is way more powerful and effective if comparing to each individual set or part works alone.

The above three photos were provided by philosopher Mary Tiles in her lecture, “Controlling Systems” (Titles 2014). Mary Tiles comments on the function of Dujianyan system or a union set as follow: “To change exhibits patterns. If we reflect on the order/pattern in our activity, then automatically our focus goes outside us to what sets our boundary conditions. To what shapes and enables us to pattern and have a degree of control in our lives (environment/infrastructure) – To the systems that control us and that we might want to alter or maintain – Shifts focus of activities from sufficient to necessary condition” (Titles 2014)

Having fed AI the information of three parts above, I asked AI: “Do you know Dujianyan?” AI said: “Yes, of course.” I asked AI: “Can you redesign Dujianyan according to given conditions and elements?” AI Said: “Yes, here it is:...”

Dujianyan Irrigation and Flood Controlling system re-designed by AI



Looking at the above AI-designed Dujianyan system, I have to say that AI thinking has not gone out of the box of data management. AI does not have real problem-solving skills which require more than database could provide.

The second comparative study highlights a major limitation of current AI thinking models: AI lacks the capacity for intuitive reasoning, a skill that ancient Chinese thinkers excelled at because of their practicing set-based thinking while doing a project for real problem-solving.

Intuitive thinking is required by set-based thinking, and it is a strength of Logic of Sets. It involves subjective reflection in learning and the process of pursuing knowledge. Intuitive thinking is a form of commonsense reasoning that integrates inductive and deductive logic, as well as creative insight. Commonsense reasoning is human strength not machines'. For example, if a piece of ceiling above my head is going to fall off, I will immediately jump away to avoid the dangers. I would do so because of my ability to do commonsense reasoning. A simple deductive thinking in my mind or even in my subconsciousness is:

The ceiling has weight.

A falling object with weight can hurt me.

Therefore, I avoided this piece of ceiling falling on my head.

Unfortunately, according to AI researcher Melaine Mitchell's report, although computer scientists have been working hard to improve AI's thinking model, current AI still cannot do this simple but hard task. Deductive thinking requires not only logical rules or patterns, but the ability of intuitive thinking and imaginative thinking. Mitchell says: "[C]hildren don't learn passively: they ask questions, they demand information on the things they are curious about, they infer abstraction of and connections between concepts, and, above all, they actively explore the world." (Mitchell 2019 p. 97). This is the path to build up our skills of doing commonsense reason. AI does not ask questions for curiosity so far. They cannot explore the world actively so far.

Both the image of hybrid creatures, *Gui* and the Li Bing's design of Dujianyan irrigation and flood controlling system represent that intuitive reasoning leads to transforming out of the limitation of existing datasets. However, AI's re-designed Dujianyan is a failure of overcoming the limitations of existing datasets.

Conclusion

Data collections are based on inductive thinking, which provides the probability of truth or falsehood to a knowledge system. Artificial Intelligence excels at analyzing data and selecting highly probable answers from its database, meanwhile, an existing database makes AI fail to break free from experiential worlds. Human reasoning requires both inductive and deductive thinking. Deductive logic guarantees the certainty of valid arguments through established rules.

AI's thinking is limited by its database, which consists of collections made through induction. It is urgent to find a way to enhance AI's capabilities, as well as

1 deepen our understanding of its limitations, especially if AI-generated answers
2 become part of human knowledge.

3 Traditional set-based thinking in Ancient Chinese Logic deserves close
4 examination when working with experimental databases. Exploring the gaps
5 between probability and certainty from the perspective of Chinese Logic may
6 provide insights for a better philosophical understanding of AI's reasoning.
7 Thinking with Chinese pictographic characters is akin to thinking in sets, which do
8 not separate elements or particulars in the experiential world from abstract forms or
9 metaphysical patterns. Allowing this logic to serve as a bridge between inductive
10 and deductive thinking could offer a promising path for the future development of
11 AI.

12 I conclude that practicing set-based thinking requires both logical and creative
13 faculties, along with the ability to engage in both sensory experience and abstract
14 thought. Chinese logic may help bridge certain gaps between human reasoning and
15 AI cognition in this regard.

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