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A solution of dialectical systems theory to P/NP problem

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Abstract. The key to solve the NP problem is how to judge the existence of an algorithm for a conversion from NP to P? For this purpose, dialectical systems theory is introduced for a transformations which processes “self-denial” from its structure and function conversely and interactively of some kind of NP, a dualistic contradiction indeed. Mathematics is subject to the “identity” rule and difficult to tackle self-denial transformations. Furthermore, mathematics, being of incompleteness, isn't helpful to solve the NP problem. Dialectics is an evolutionary theory, a dynamic process, demanding connection all aspects of things, so a systematic approach is adopted. Regarding the transformation from NP to P as an emergence of self-organization evolution, four requirements for dissipative structure can be proposed for the judging possibility of emergence of evolution: opening, non-equilibrium, non-linearity, fluctuation. Taken the “Travelling Salesman Problem” as a typical example of NPC, it be concluded that none of the four requirements could be met. The reason is that the condition given by TSP is one-dimensional data only, which is the essence of Monism that couldn't boost evolution and emergence quickly and efficiently.

1. Introduction to NP problem

Established by Clay Mathematics Institute as the first ranking of seven Millennium Prize Problems, “P versus NP” puzzles many mathematicians today. Being of great importance in computational complexity theory, NP problem has also drawn great attention of scholars of CS.

The question is whether or not, for all problems for which an algorithm can verify a given solution quickly (that is, in polynomial time), an algorithm can also find that solution quickly. Since the former describes the class of problems termed NP, while the latter describes P, the question is equivalent to asking whether all problems in NP are also in P.[1]

2. Introduction of dialectical thinking

Try to solve the problem $NP=P?$, one must take a basic stand: how to deal with the symbol “=”? At the beginning of problem solving process, the first step I want to do is presuming that it would be better regard this symbol as a transformation; i.e. a dialectical logic form rather than a mathematical equality. Was it yes presumably, then the next question would be stated: what type of problem can evolves itself from class NP into class P? In Symbolic expression it will be: $NPP?$ If it is set as possibly, then we ask further: Under what conditions can it evolve by itself?

Why would it be better as “” instead of “=”? Let's take a look at the mathematical equation-like form for this problem as $NP=P?$ there are significant asymmetries in the form and content, in the structure and function, between the left and right side of the symbol “=” in the equation: the left one is a non-deterministic solution with the time complexity of exponentiation while the right is deterministic with polynomial solution. This is just the significant difference in computability between the two sides,



so that it is very difficult for us to link the two simply by counting both quantity form without a transformation of its qualitative form.

One NP problem to has been solved implies that a great transformation occur inside the NP between its form and content through self-denial way. Here the transformation means that an effective algorithm be found out in the process of solving. So, during this process, the internal structure and function of a NP system have to be transformed into the opposite side respectively. That means a interaction processes between a subject and a object, representing respectively the system' s structure and function and vice versa, so that a contradictory process of self-reflexion must be staged.

We know the fact that all mathematical equation with symbol “=” must obey the principle of identity. Formal logic, mathematical logic and mathematics, though they belong to different disciplines, have a similar regulation: obeying the laws of thinking in the intellectual stage of human cognition, and their laws require maintaining the identity of thinking form and content respectively. That is to say, “Quality” is homomorphic expression of “Quality” , under the condition that the regulations remain unchanged, so it only reflects the quantitative relationship of things, that is, the accumulation process of all quantities that occur without qualitative changes. This kind of process means a “monism” of metaphysics in essence.

Formal logic, as an example, in Hegel's view, is intellectual thinking of universal truth. “In intellectual logic, thinking is regarded as a purely subjective and formal activity.” Hegel stated: “Thought, as Understanding, sticks to fixity of characters and their distinctness from one another: every such limited abstract it treats as having a subsistence and being of its own.” [2] In other words, there is no content of object nature within intellectual thinking . This type of reasoning is only applicable to predicate calculus situation where the position of the relationship between subject and object keeps unchanged. Where there is no need for practical character and “self-negation” conversion, simply seek the self-consistency and compatibility of the form, as a result, it be proved by Gödel' s theorem that incompleteness within the first-order formal system.

The computability theory of Turing machine shows that the conditions and solution of the proposition must conform to the univalent logic. In terms of form of value, the functional operation of any computer is to formalize a calculation problem and then restore it to a “first-order logic” operation, which is classified as an object. In dealing with highly nonlinear and complex things, traditional formal logic, mathematical logic, and mathematics, even equipped with advanced computer, are still difficult enough to handle. Only is it the creative people who can promote the initiative of the subject. Therefore, thinking is sublimated to the contradiction category of dialectic “interaction” :

“In the Dialectical stage these finite characterisations or formulae supersede themselves, and pass into their opposites.” [3] Said Hegel, and he continued: “The Ground is the unity of identity and difference, the truth of what difference and identity have turned out to be – the reflection-into-self, which is equally a reflection-into-other, and vice-versa. It is essence put explicitly as a totality.” [4]

Since the first-order form of thinking couldn' t reflect its own contradictory, instead, we need to use dialectics to focus on movement, change and development, which is of capability to deal with the self-contradictory transformation of things. Described by Hegel as a contradiction category of interaction, dialectical thinking is capable of doing higher-order non-linear process, as NP problem needs solving far beyond the Gödel' s Incompleteness Theorems.

Notable for his deep understanding of dialectical thinking, complexity expert Edgar Morin emphasized a core point of view, constructing complex systems through employing "dialogue--double logic" [5]. Here the French word La dialogique Morin often used means a discourse, is the origin of dialectics also. So, in the view of many scholars, what Moran understood the complexity be as the same as dialectics. [6] The key to complexity is mentioned here: at least must be constructed by duality (determinism and non-determinism go on at the same time), and even pluralism. Pure certainty is monism only, also as uncertainty. Any monistic structure cannot promote the evolution of dialectics. The reason why class-NP is considered so hard to be determined fast transformation of class-P is that a

non-strict non-deterministic quasi-binary existed in its structure. NP problem is such one: very difficult to find out an algorithm in polynomial time but easy for verification. The real complexity always exists at the junction of order and disorder, where chaos often contained. Such a pattern of chaos constitutes a typical symmetry breaking proposition, i.e. so-called Asymmetric Creates the world. All asymmetric topics require multiple elements to participate in the construction. The evolution catalyzed by complex things implies self-denial, which requires dialectics for us to get well thinking. American physicist Joseph Ford pointed out "Evolution is chaos with feedback." We regard "feedback" as the self-negative participation in system evolution.

Chinese philosopher Deng Xiao-Mang said: "The highest form of logic is freedom." and "The essence of dialectical logic lies in the principle of self-negating" [7] The spirit of dialectics reflects human spirituality of freedom, which is the highest-form of logic, being too complicated to be formalized through mathematics or logic way. "Because of the fundamental spirit of dialectic, subject and its basic characteristics of dialectics are incompatible with formalization." [8]

3. Introduction to system theory

The above statement can be regarded as an application of Gödel's theorem: the first-order form cannot completely express the contradictory movement of things themselves. If one wants to make a distinguishment between true and false, therefore one get it improvable only. Thus NP problem is that "NP is the set of languages expressible in existential second-order logic—that is, second-order logic restricted to exclude universal quantification over relations, functions, and subsets." [9]. For this, it is necessary for us to break through the paradigm framework, and to use dialectics and systems theory methods. "Since the birth of complexity theory, mankind's understanding of the nature of the world has been quietly changing. First of all, people have gradually realized that universal, deterministic, orderly, linear, reversible, quantifiable and other thinking modes have obvious bias of thinking. Because of the nature of the universe, in addition to the above characteristics, there are obviously contingency, randomness, uncertainty, disorder, non-linearity, irreversibility, unquantifiable, etc., as well as self-reinforcement and consumption. Dispersion structure, entropy and negative entropy, etc." [10] The latter type of characteristics is exactly what the NP problem appears. Knowing the fact that, to solve NP, you have to determine the problem based on an exact concept of "polynomial time". However, academic circle of mathematics is unable to formulate a precise definition for it, so that the polynomial time can be hard enough expressed the actual useful time! Based on the realm of value, people's utility appears to be of meaning, i.e. the vector of one's subject utilitarian purpose. Here David Hume's proposition is always true: The fact - value distinction is a fundamental epistemological distinction. Therefore, for the problem of value, it is impossible to be solved by mathematical means only. For this reason, people need "a sound form of thinking should be a community of multiple thinking modes such as logic and intuition, form and content, rationality and sensibility, which complement each other, and interact with each other." [11]

Complexity issues have its paradigm. Edgar Morin indicated: there is a paradigm within the study of complexity problem, which Moran summed up as "three principles": 1) dialogue—dual logic interaction, 2) organizational recursion—self feedback of mutual cause and effect, 3) holographic—miscibility of part and whole. [12] These concepts may be concentrated as "the dialogic principle allows us to maintain the duality at the heart of unity." [13]

As many scholars have pointed out, there is a high degree of correlation and compatibility between dialectics and system theory, and they seem to be two sides of one thing under same structure. In order to gain a better understanding of complex things, in the process of progressing from low-level to high-level, people find that it be necessary to replace static thinking with dynamics one, i.e. dialectical thinking. If it is said that dialectics unfolds the "movement, change and development" of things on the axis of time, thereafter system theory expands the unit (dimension) and first-order of things to multiple (dimension) and higher-order in spatial coordinates. When complexity upgrades. time and space are

interdependent and inseparable. Things will inevitably "fork" in their movement, change, and development for their evolution. If a single element or dimension is not enough to describe and analyze the situation, a systematic approach is bound to be needed; in the same way, systems on the need to analyze the broken-symmetry of things, it will inevitably produce a sense of the dynamics of things, that is, the difference in time, so dialectical thinking must be applied. To understand the full picture of a thing of complexity, the two must be extracted from each other. The intersection obtained can be called: "Dialectical System Theory" or "System Dialectics".

If someone try to solve a NP problem by traveling, inquiring and filtering, being the simplest way in the first-order domain, which is an exponential non-deterministic solution. However, if you try to break the convention and find a convenient algorithm, you needs your inspiration, a high-level Formal (formal cause)", required to participate, so that it can interact with the NP-type Material (material cause) and interact with each other, That is what the reflexivity is, fully presented during the process of problem solving of complexity. R. L. Flood pointed out, complexity originates from (1) objective things themselves and (2) our abstraction of objective things [14]. Therefore, getting a solution of NP needs the solver' s inspiration, which also rely on the understanding of a specific time and space as the prerequisite for the content of the object, that is, relying on the characteristics of the form and content, structure and function of the NP problem itself. Calling its own resources in the problem itself, absorbing the nourishment of power from it, and then reacting to oneself, it can be seen that it is an intertwined dialectical process, which reflects the evolution of the self-organizing system due to the break of symmetry, so that the dialectical system theory be applied.

The NP problem is derived from mathematical propositions. However we adopt a system theory approach to any NP problem solving, we have to abandon most precise calculations of mathematics in the following discussion, instead, use the "intersection" between system science and mathematics, that is, the combination of the two scientific field. Because system science is a cross-cutting science, requiring that the basic philosophical concepts possess great universality. Besides, people must also take into account that "through using mathematics to describe the basic concepts and principles of system science, which could be only used another form of mathematics, namely Structural Mathematics" [15]. It is necessary for us to know that the effective time of the polynomial P is very difficult to precisely define, therefore it is also difficult for us to make a difference between P and NP accurately. This is the reason why we must abandon the precise method of pure mathematics, instead, use structural mathematical methods to solve NP problems.

4. Solving means an emergence of a system

We regard a certain NP problem together with the solver as a whole problem solving system. Human is of self-organizing with self-awareness, so a whole problem solving system becomes a self-organizing one. We might as well assume that someone who tries to solve the problem has enough wisdom and inspiration to comprehend the subtlety of the structure and function of a certain NP and find out a polynomial algorithm that is much more convenient than the traversal method. In terms of algorithms, such "problem solving" means that the system "emergence" occurs, that is, the structure and function of the system are evolved and upgraded. The order of the system changes from low order to high order. Emergence is the central topic of system theory and complexity issues.

Regarding the concept of order and disorder, we adopt Edgar Morin' s idea, "Order refers to everything that is repetition, constant, invariant, everything that can be put under the aegis of highly probable relation, framed within the dependence of a law. Disorder refers to everything that is irregularity, deviation as regardas a given structure, random, unpredictability." " [16]

Physicist Schrödinger said: What an organism feeds upon is negative entropy. It is the same thing as NP system involving self-organizing. Negative entropy can be expressed by information entropy:

$$I = -\log 1/P = -\log P$$

Here, I, the amount of information, is the reciprocal of the event probability P Logarithm. Since information entropy is negative, the larger the amount of information in the system, the smaller the

entropy value, the higher the order of the system would be. Therefore, Moran's "High Probability" means that the probability P value is large, and the large P value means that the absolute value of negative entropy is large.

The purpose to solve a NP problem is obviously closely related to the value vector of solver's interests. How is the higher or lower level of order of a NP can be based on its problem-solving speed, which is reflected in the subjective person's utilitarian purpose. Quick problem-solving means "highly probable relation", vice versa. Undoubtedly, in terms of the time limit of the same scale for the same NP problem, polynomials are much faster than exponentials. If a polynomial solution is found out to a NP problem, which evolves to higher order of P, also vice versa.

5. Take Traveling Salesman Problem as a sample

By statistics, most NP problems are either P or NP-Complete, also there are still others. NPC can be divided into 6 categories. Among them, being the sequential ordering problem, "Traveling Salesman Problem, TSP" is the most studied problem in NP. Since TSP is categorized as NP-Complete set, any other NP problems belong to NPC set can recurse to it. Therefore, once the TSP is solved, the entire NPC-set are meant solved. This article only uses TSP as an example to analyze the emergence of the NP system. Surely, was TSP figured out, it would not be considered finishing the task of solve all NP problems, but it might be regarded as a key breakthrough.

The standard definition for TSP: asks the following question: "Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city exactly once and returns to the origin city?" It is an NP-hard problem in combinatorial optimization, important in theoretical computer science and operations research. The exhaustive algorithm of TSP is the number of traversals of the full arrangement at the worst luck: $(n-1)!/2$, and its complexity is factorial: $O(n!)$, and the exponent of the problem is obtained by expert calculation The complexity of the formula is:

$$\sum_{k=2}^{n-1} k(k-1) \binom{n-1}{k} + n - 1 = O(2^n n^2)$$

6. Necessary conditions for emergence figures

To solve TSP, a foolish method is enumeration by traversing various possible combinations of all closed loops, therefore being considered as a non-determination solution in exponential time. Just like a low-conscious life with weak subjectivity, it takes "natural selection" evolution policy relying on randomness and drift, and relying on non-deterministic attempts to find the way to evolution, thus presenting a "low order" mechanism. The other is of a relatively strong subjective with "self-organized algorithm". Self-organization refers to the process of chaotic systems forming a dissipative structure during random identification. With the participation of higher intelligence, it is necessary for the system's own "configuration" to become a trend for itself, allowing intelligence to comprehend, that is, to produce advanced functions of self-evolution from the distinct structural specificity within the system.

The theory of dissipative structure created by Ilya Prigogine believes that whether a self-organizing dissipative structure can be established depends on whether it conforms to: openness, non-equilibrium, nonlinearity, fluctuations—these seem to echo Aristotle's Entity Theory and the "Four Causes" for its system development: material cause, formal cause, dynamic cause, and purpose cause. The four conditions are discussed below in detail.

6.1. Openness

An open system refers to the exchange of information and energy with the outside, and mutual feedback. For this purpose, its internal structure must provide sufficient data to meet external needs.

The solution to a large-scale NP problem requires the solver to exercise the instruction of thinking with the mission of solving the problem, that is, as a spiritual life body to serve as receiver and transmitter for "negative entropy", absorbing all kinds of useful information outside. Next step, the problem solver must presuppose the Kantian innate pure and intuitive form of time and space in his mind. (Here to save space, I omit the paradigm theory of contemporary Kuhn et al.) Meanwhile the problem solving order persuades him make a combination between a priori time-space-form and the "material cause" of a certain NP problem to be solved. Combining experience and reality to refine perceptual knowledge, the solver get several interactive feedbacks in his mind, then grow to mature intellectual knowledge, which enables him to make clear judgments on specific NP problem.

From this point of view, the solver is the "formal cause" of system evolution and the subject of value-type thinking. Surely such self-organization has some degree of openness. However, there is a key problem left—the degree of openness to determines the speed of problem solving.

Since NP problem solving is a self-organizing process, its openness must be manifested by its own characteristic condition, i.e. structure and function. However, looking at the conditions given by TSP, it is only the distance between all two vertexs, and such distance data is purely scalar which is equivalent to saying that the conditions provided are purely one-dimensional. Knowing these scalars, it is still difficult for the problem-solver to know the exact location of these scalars quickly based on intuition and perception, especially when the scale of the problem becomes larger, even through with the help of machine calculations, it is difficult to quickly know the exact locations of all endpoints, and still the structure of the position of each point. Those who play the role of "configuration" in problem-solving urgently need two-dimensional information covering each endpoint and each edge. Actually, from TSP, the amount of effective problem-solving information that can be obtained by the problem solver is:

$$I = -\log P = -\log 2/(n-1)!$$

here P is the probability of solving the problem. Obviously enough the absolute value of I is too small.

A complete establishment of a planar geometric structure requires two-dimensional data. To solve a problem of graph theory, a two-dimensional data set of $G(V, E)$ is needed. However, TSP is an undirected strongly connected graph. Each of its endpoints is equivalent to reaching in all others. The position of the endpoints is established purely by a one-dimensional array, even the established lattice is still the essence of the one-dimensional form. When the number of endpoints becomes larger, it is very difficult for a solver to get a configuration for TSP quickly and accurately. In general, solving geometric problems particularly needs to rely on human visual function to construct position judgments in order to know the spatial form of the problem. It is well known that, including humans, the visual, auditory, and olfactory organs of all animals in the world are all in pairs, not a single one, in order to quickly perceive the exact spatial location of objects. This is the animal's sensory nervous system merit gained from evolution. However, if there are more than one pair of sensory organs on one life body, take three as example, it must results in being trapped in the chaos of the entanglement of the three-sensory bodies. It is Henry Poincaré who first proved that the "three-body problem" has no general closed-form solution.

6.2. Non-equilibrium

In thermodynamics, the equilibrium state means that there is no net macroscopic flows of matter or of energy, either within a system or between systems. The non-equilibrium state is the destruction of the equilibrium state. Balance (equilibrium) and symmetry, unbalance (non-equilibrium) and asymmetry, the two concepts are relatively close in meaning, the difference lies in the level, side and scope of application. The so-called symmetry refers to the invariance of a certain feature of an object under a certain transformation (motion or operation). Order and symmetry are with a reverse relationship: the greater the symmetry, the smaller the order; also vice versa. The concept of thermodynamics can of course be extended into NP problem.

In system theory, the so-called order is the concept of "difference between similarities, or similar differences", whereas order is the manifestation of layers in the system. The emergence is the principle of difference, which is manifested by the rise of order and can be expressed by quantified Order Parameter, while Layer Theory is applied to describe the difference of system .

The essence of NP problem solving is to process the system transformation from disorder to order, or from lower order to higher order, as Prigogine emphasizes: "non-equilibrium is the source of order." A system must break its equilibrium and symmetry if it is in order. Order is the result of the emergence of the symmetry break. The non-equilibrium state is the hierarchical difference in the state of the system, which is not only reflected in the state difference between before and after the symmetry break, but also in the increase in the difference between the structure and function after the break. Only when the obvious distinguish-ability of the difference exists in the system structures and becomes the source of the orderly function for the system level, can the system break the equilibrium state and implement emergence quickly and forcefully. To achieve a dissipative structure with non-equilibrium, it is necessary to stimulate "non-equilibrium phase transition" to produce a new layer for structure itself, named phenomenon of system "bifurcation" or "layering" in catastrophe theory. Whether the non-equilibrium is sufficiently far away from the equilibrium state to produce a new order for structure depends on whether the system can pass the threshold point of phase change. The function and structure in the system are often interactive and interchangeable with each other.

"Layering is the place and condition for emergent phenomena to appear, but the foothold is still at the layer. Therefore, the 'layer' is the core of all layering theories. On the one hand, layering is a kind of spreading of scale sequence in space, on the other hand, it is also a control sequence arranged in sequence in time." [17]

Furthermore, "complex natural phenomena are organized in layers, and each layer is constructed by several integrated systems." "The reason why nature is organized in layers is that for any system, even it is a moderately complex system, the hierarchical structure provides the most feasible form." [18]

Let's look at the TSP's scenario, there is a near equilibrium state of the system, i.e. not far from the equilibrium point. All knowable conditions provided are only one-dimensional form of data set, so that no more than one dimensional layer exists obviously inside the system. The system could catalyze the emergence to do is only by weak force field resulted from simple structure of the hierarchy. So that, it is not forcible enough to cross the threshold point of phase change. If you want to quickly obtain emergence, it can only be determined purely by randomness.

6.3. Non-linearity in thickness

Things that constitute linear or non-linear types can be transformed into symmetrical or asymmetrical forms through linear transformation (spatial inversion). Therefore, the functions of linear or non-linear types in a system of self-organization are the embodiment of symmetry or asymmetric. The essence of non-linearity that can make the system emergence is exactly the symmetry breaking.

Conversely, the reason why the symmetry will be broken and result in emergence is the nonlinear interaction among the system components inside, which crosses the critical threshold and catalyzes the system's state mutation and bifurcation effect (multiple choice), and coherent effects (long-range correlation). In this regard, Prigogine stated: "Another basic feature necessary for the dissipative structure is that there is a nonlinear mechanism in the interaction among the various elements of the system." [19]

In algebra, a mathematical function $L(x)$ is called linear, which means:

Definition 1: $L(x)$ is a first-order polynomial function with only one variable, that is expressed in the form of $L(x)=kx+b$ (here k, B are constant).

Definition 2: $L(x)$ has the following two properties:

Additivity: $L(x+t)=L(x)+L(t)$

Homogeneity: $L(mx)=mL(x)$

We take the TSP graph with n endpoints as an example, if only one path to be selected is the shortest. If we take the exhaustive search to solve the problem, the probability of success in the first query:

$$P(1) = 1/[(n-1)!/2] = 2/(n-1)!$$

If the query is verified as not match, then the second query will be performed. The probability of checking is:

$$P(2) = 2/[(n-1)!-1],$$

• • • • •

When process the K -th query, we get the probability is:

$$P(k) = 2/[(n-1)!-(K-1)] = 2/[(n-1)!-K+1],$$

when $(n-1)! \gg k$

Thereafter $P(k-1) \approx P(k) \approx P(k+1)$

The above shows that in the initial stage of query, the time scale distribution is quite similar, and the probability of each query is almost the same. We conclusion that at this stage, there is a high degree of linear correlation between the path selection of TSP and the probability of query. Therefore, the probability of guessing the right answer is extremely small, that is, it is difficult to obtain the system's emergence.

From the homogeneous formula:

$$L(mx) = mL(x),$$

substitute in: $P(mk) \approx m \cdot 2/[(n-1)!-K+1]$, if $(n-1)! \gg k$,

k is the ordinal number of guesses (query), m is the total number of guesses, $m \leq k$.

It can be seen that in the initial stage of the relationship between the total number of guesses (queries) m and the probability of correct guessing is of approximately linear relationship, which indicates that the system is in the near equilibrium zone at this time. If the exponential exhaustion is continuously carried out, the accumulation will increase, from quantitative change evolve into qualitative change, gradually leaving from the near equilibrium zone and slowly entering the non-equilibrium zone. Then the probability of finding the answer gradually increases, and the system slowly tends to emerge. Because as the value of k gradually tends to $(n-1)!$, $P(k)$ gradually approaches 1, so the TSP system gradually changes from approximately linear to nonlinear, and the probability of emergence of the system gradually increases. Since $(n-1)!$ is exponential, the value of k has reached the scale of exponential at this time.

No matter which path is selected for query, the linear feature of TSP has an equivalent guessing rate, so that being of almost complete symmetry. Because TSP is an undirected strongly connected graph, each of its endpoints can lead to any other endpoint, so in terms of endpoints, their individual differences are in the margins only, but this is exactly a one-dimensional form.

However, in terms of spatial combination, TSP is a complex system structure after all, as it is not additive. Let's imagine, try to split the n endpoint sets V_n ($n \in V_n$) of the graph TSP into two subsets: V_m and V_o , $n = m + o$.

That is: $V_n = V_m \cup V_o$, $V_m \subseteq V_n$, $V_o \subseteq V_n$, $V_m \cap V_o = \Phi$.

Form these two subsets into two new TSP sub-graphs to solve the problem independently, then, suppose the maximum number of traverses for solving the problem of the top n TSP is:

$$T(n) = (n-1)!/2$$

The maximum number of traverses for solving the two smaller TSP sub-graphs are respectively: $T(m) = (m-1)!/2$; $T(o) = (o-1)!/2$

Obviously, $T(n) = T(m+o) > T(m) + T(o)$

This clearly shows that, in terms of the spatial structure, a TSP system cannot be analyzed in discrete elements, that is, it presents a strong nonlinear relationship. Therefore, the analysis of the spatial structure of the TSP is just the way to solve the problem.

However, the real problem is that in the form of the spatial structure, TSP provides only a one-dimensional array, that is, only one variable. Although it provides all the margins of the strongly connected graph, as long as it enters the actual planning operation, there will always be "Short-range entanglement", which means that each element of a complex system always first obtains information from its nearest element, and responds to this information in a short period of time (i.e., polynomial expression). Almost all the elements of the complexity system interact in a short range. As for the long-range impact, the scenarios that need to be considered are much more complicated, and the horizon space needs to be greatly expanded, which requires exponential completion. Therefore, whether it is a human brain or a computer-operated problem-solving application, as long as the problem scale is large enough, you can only start at a close range, and gradually and step by step think about the problem-solving plan, by non-optimal solutions such as heuristics, backtracking technique, greedy algorithm, etc.

Looking at the structure of the whole picture, it is difficult to find the optimization solution for a problem of a considerable scale if it is short-range and not long-range.

6.4. Fluctuation

Fluctuation refers to a deviation from a system's stable state which usually maintained in equilibrium state, symmetry, linear region, steady-state. The theory of dissipative structure believes that fluctuations provide the possibility for symmetry breaking of the system. This is the principle of "generation of order" or "ordering through fluctuations", i.e. "order out of chaos" said Prigogine. Fluctuations do not necessarily lead to the phase change, evolution, or new order of the system. This is because system has its own characteristics in its hierarchical structure, which indicates different layers have different functions. Usually, the law of fluctuation dissipation occurs near a critical threshold point, and only here does the "giant fluctuation" occur, that is, when different elements interact, the system may break the threshold and get too far from equilibrium, beyond resilience.

Therefore, the key to emergence problems is to determine whether there is a giant fluctuation by scale. Only those with significant differences constitute different elements and form a significant layer of "potential difference" makes the great interaction.

TSP's steady-state can be maintained only on condition that unsolved at its beginning, for it is an unstable system. Each guess for a loop can be regarded as a fluctuation of random, which is a deviation from the original steady-state. If n edges are selected arbitrarily from total $(n-1) \times 2^{-1}$ of TSP, the solution of guess would be imaginary regarded as the "particle thermal motion" carrying out by n elements of the system after nonlinear mapping. According to the law of relative fluctuation of thermodynamics, the fluctuation degree is with the system size as $1 \times n^{-1/2}$. It can be seen that when n tends to a larger number, there is a slight fluctuation, which is the so-called "Breaking of the law of large numbers". This means that the evolution of complex systems often has sensitive dependence on initial conditions, not strictly abide by determinism.

TSP is an undirected strongly connected graph. All its endpoints are fully connected one another without difference. The distance between the endpoints is the individual difference, which is only provided by a one-dimensional array. Such a one-dimensional excitation, as discussed above, is of such characteristic as: the inadequate openness, near equilibrium state, and short-range space in the near linear region within the hierarchy are approximated to a linear function relationship of n variables, that is, approximate linear type. Trying to add up many multiple queries (micro-fluctuations) of this problem in turn, can form an arithmetic series with increasing probability of guessing. This series is of course a deviation of the arithmetic series from the original steady-state of the TSP system. However the deviation value is a homogeneous non-essential feature difference. Attempts to catalyze huge fluctuations by traversal are often exponential when luck is bad. If the deviation from the steady-state of the system is increased rapidly to promote giant fluctuations, so that the geometric progression (i.e.

non-linearity) would be achieved. But the structure of the system must be at least a two-dimensional expression in the form of geometric problems. However what the conditions TSP provides are not so.

7. Conclusion

Life evolve beyond their limits. Science development needs self-transcendence to get over its incompleteness, specifically in methodology, teleology, paradigm, etc. To solve NP problem, I try to get an inspiration from dialectical systems theory rather than mathematics, as a result, I realize that the conditions TSP provides are unary data, monism in essence, which boosts system evolution of solving hardly.

References:

- [1] Wikipedia: https://en.wikipedia.org/wiki/Millennium_Prize_Problems
- [2] G.W.F.Hegel: Shorter Logic·[c] Syllogism of Necessity§80(a)
- [3] G.W.F.Hegel: Shorter Logic·[c] Syllogism of Necessity§81(b)
- [4] G.W.F.Hegel: Shorter Logic·[c] Syllogism of Necessity§121
- [5] Qin HY. Dialogue or dual logic — A basic principle of Edgar Morin's complex thought [J]. Dialogue Transcultural, Vol. 29, Sanlian Bookstore, 2012
- [6] Huang XR. Science and philosophy of complexity [M]. Central Compilation & Translation Press. 2017, pp.11-13.
- [7] Deng XM. On the essence of dialectical logic [J]. Thought and Wisdom, 1994.
- [8] Ge YN. Critical thinking under formalization of dialectics [J]. Journal of Tangshan University, 2016: 04
- [9] Wikipedia: https://en.wikipedia.org/wiki/P_versus_NP_problem
- [10] Xiang CJ. On complexity and reforms of thinking [J]. Education for Chinese After-school (Theory), 2019: 03
- [11] Ma XM. Settlement of the self-reference paradox by Gödel's incompleteness theorem and the self-organization emergence mechanism [J]. Chinese Journal of Systems Science, 2020:01.
- [12] Edgar Morin: On Complexity, Hampton Press Inc., Cresskill New Jersey, p.49.
- [13] Rika Preiser·Paul Cilliers: Complexity, Difference and Identity| SpringerLink (Pages.265-287)
- [14] Xu GZ. Systems science and engineering [M]. Shanghai Science and Technology Education Publishing House, 2000, p.598.
- [15] Su M. On the cross-disciplinary characteristics of broad-spectrum philosophy [J]. Journal of North China University of Water Resources and Electric Power (Social Science Edition), 2016: 04.
- [16] Edgar Morin: On Complexity, Hampton Press Inc., Cresskill New Jersey, p.62.
- [17] Wu J., Li RZ. Interpretation of Broken Symmetries by Systematics [J]. Chinese Journal of Systems Science, 2008: 01.
- [18] Simon H.A. The Organization of Complex Systems [C]//Howard Patter, ed. Hierarchy Theory. Braziller, New York :1973:205.
- [19] Zhan KH. Shen XF. Prigogine and the theory of dissipative structure [M]. Shaanxi Science & Technology Press, Xi'an. 1982, p156.