International Journal of Philosophy and Social Sciences.
Volume 5, Number 1 (2015), pp. 1-19

http://www.ripublication.com

Guidelines For Exploring An Unknown World: The Universality of Military Principles

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Abstract

Despite its pertinence to every field of study, no systematic theory exists for the exploration of the unknown world of new knowledge. In order to construct such a theory, this paper draws on the unique and highly refined principles of military strategy, in the process demonstrating the universal applicability of such principles and developing an effective analogy for the process of research. Such principles include diverging advance, converging attack, and selecting the superior and eliminating the inferior. In seeking further discoveries, one should search for more possibilities, attack more aims, and confound the front line. The theory presented in this paper is also a means to further the unification of science. For no matter what the individuals look like, (soldiers, particles, cells, consumers, producers, stockholders, or concepts), what they pursue, (victory, negative action, viability, pleasure, profit, investment return, or knowledge), or what relationship exists between opponents, (hostile, mysterious, adaptive, reciprocal, cooperative, or explanatory), the result is always an unknown world in which individuals are exploring. It is reasonable to suppose that the exploration of the unknown world is a common property among individuals.

Keywords: unknown knowledge world, attacking problem, detachment, diverging advance and converging attack, selecting the superior and eliminating the inferior

Introduction

Epistemology concerns the necessary and sufficient conditions of knowledge; however, an epistemological stance alone cannot guide researchers all the way to discovering knowledge, lacking both necessity and sufficiency. A successful discovery depends on the employment of appropriate methods and resources, such as effort, time, money, and knowledge. How does one select short-term aims and long-term goals? How does one start a research project? How are resources distributed in various projects to arrive at a myriad of possible solutions? Most importantly, how does one solve a difficult problem? The existing literature on systematical methodology does not provide efficacious systematic guidance for researchers. Numerous mistakes result. Great scientists, such as Newton and Einstein, simply followed correct principles instead of the dominant ones but greatly exceeded the average levels of their contemporaries. If correct, the theory presented here will significantly improve the average level of research ability.

According to the principle of Occam's razor, all other things being equal, the simplest theory is the most likely to be true. Compared with different methodologies for different projects or subjects, universal methodology is the simplest. Hence universality strengthens the methodology in this paper. Compared with opponents in wars, the unknown knowledge world has several characteristics: a constant defence with infinite depth and width, the absence of attack, protected information, the retention of morale, and the readiness to defend. The strategies of researchers include creating more battlefields, besieging problems, boldly pursuing victory, and averting repeated failures. This paper not only systematizes the comparison; it also generalizes to various unknown worlds, thus proving that the exploration of an unknown world is another universal property. If there is a simple and universal methodology well tested in various systems and by great researchers, it is unnecessary to use complex and limited methodologies which are inefficient. Thus, with simplicity and universality, methodology for the exploration of an unknown world ought to be posited at the centre of philosophy, especially epistemology.

After numerous wars and casualties, military theorists have discovered certain principles that have been proven repeatedly in armed conflicts. Hostility creates the motivation for each side to conceal information and to explore the opponent's information in the pursuit of victory. In a war, each side keeps secrets, cheats, and deploys to invalidate the opponent's intelligence. In an ideal state of war, both sides operate with equal intelligence, initial conditions, and battlefield assets, and victory belongs to the side that best explores the unknown world and discovers more information. Hence, the best military principles are those that facilitate the most efficacious exploration of the unknown world. They provide the basis for this theory, and some long-tested ones are listed below. Although some are inaccurate, they are

all illuminating. With some revision, these maxims can be universally applied to the exploration of unknown worlds.

Fuller [1] lists seven principles: (1) the maintenance of an aim or objective; (2) the security of action; (3) the mobility of action; (4) the expenditure of offensive power; (5) the economy of force; (6) the concentration of force; and (7) surprise.

Clausewitz [2] advances four principles: (8) Use an entire force with the utmost energy in seeking to attain an objective. Any moderation leaves the objective unachieved. (9) Concentrate power as much as possible against the section where the chief blows will be delivered and incur disadvantages elsewhere; thus the chances of success increase at the decisive point. (10) Never waste time. (11) Follow up successes with the utmost energy. Only pursuit of the beaten enemy gives the fruits of victory.

Jomini [3] presents four principles: (12) throwing the mass of an army, successively, upon the decisive points of a theatre of war as well as on the communications of the enemy, without compromising one's own communications; (13) manoeuvring to engage fractions of the hostile army with the bulk of one's forces; (14) throwing the mass of one's forces upon the decisive point of a battlefield or upon that portion of the hostile line whose overthrow is of first importance; and (15) arranging masses so that they are not only sent against a decisive point but that they engage at the proper times and with energy.

About Napoleon, Hart [4], writes, 'From Bourcet he learnt the principle of calculated dispersion to induce the enemy to disperse their own concentration preparatory to the swift re-uniting of his own forces'. He also imbibed the value of a 'plan with several branches, and of operating on a line that threatened alternative objectives'. These axioms imply the following principles: (16) advancing extensively and attacking concentratedly and (17) adopting a plan that threatens multiple objects.

Hart [5] presents eight axioms: (18) Adjust the end to the means. (19) Keep the object always in mind, while adapting a plan to circumstances. (20) Choose the line (or course) of least expectation. (21) Exploit the line of least resistance. (22) Take a line of operation that offers alternative objectives. (23) Ensure that both plan and dispositions are flexible and adaptable to circumstances. (24) Do not throw weight in one stroke while the enemy is on guard and well placed to parry or evade it. (25) Do not renew an attack along the same line (or in the same form) once it has failed.

Researchers study two sets, a fact set and a concept set. They reorganize the fact set into a simpler concept set, while keeping most of its information. Facts are invariant; concepts are variable. Each concept maps many known facts and vice versa. The concept set and the known facts form the known knowledge world. The unknown facts form the unknown knowledge world. Similar to soldiers, researchers

are ready to sacrifice. For example, a concept can be revised or abandoned when it is wrong or lacks economy.

For researchers, an attack is an attempt to establish or revise explanations. Observation ability and attack ability correspond to the field of vision and the range of fire, respectively. A small group of resources, sufficient to advance and attack independently, form a detachment. The logical relations of explanation-proof between concepts and known facts are paths in the known world. When a concept or fact connects widely and closely, it is called a terminal. A base is a hub of paths and provides the logical foundation for detachments. Lines of communication are the paths linking detachments with bases. Problems are the paths connecting the known world with the unknown world. A front line is the area between the known world and the unknown world, which is full of unexplained known facts and unproven or inconsistent explanations. A line of defence is the side of front line that is near the unknown world. The shortest line from the known to the unknown world points in the direction of the front. The difference between a front and flank is found in the security of bases. If a part of the sum of available bases is well known, one has a flank attack. When facing almost entirely new bases, one has a rear attack. When detachments are distant from the main bases, it is an expedition.

Explanation of Military Principles

Stability of purpose (1) should be used together with flexibility, as in principles (17), (18), and (22). Purposes can be roughly classified into short-term aims, middle-term objects, and long-term goals. A pure researcher, an ideal researcher who uses all his means to explore the unknown world, pursues only one goal: to capture more knowledge from the unknown world. (There is no limitation of subjects. Hence, the effort covers all concepts and facts, similar to a total war.) Progress toward the goal is roughly measured by the number of discoveries, weighted by importance.

Stability of purpose has several advantages. First, stability strengthens the ability and knowledge tied to a pursuit, since unused ability and knowledge gradually depreciate. Second, it costs time and effort to acquire ability and knowledge; thus, the yield is low if they are not sufficiently used. Third, stability helps establish persistent pursuits. For example, Darwin, who had a high and stable goal in his career, kept seeking success.

However, as there is no reliable information about the unknown world, it is impossible to have a clear aim and distribute resources accordingly. Hence, purpose is adjustable, both horizontally and vertically. The former refers to replacing a target with similar progress in knowledge and the latter to lowering or improving the target, as in reducing the number or importance of discoveries. Though helpful, the lowering of purpose is passive, while the enhancing of efficiency and effort is active.

Therefore, an actual purpose is distributed across certain aims, such as a group of topics. When a researcher deploys more specialized ability and knowledge, the distribution is narrower, and the purpose is less flexible.

On security, principle (2), researchers usually make two serious mistakes. First, because researchers tend to underestimate their potential and the power of correct methods, they usually attack one small aim in a short time. However, Newton and Einstein attacked many important aims alternately over a long time. Moreover, researchers tend to be less adventurous with only one aim; thus they often violate the principle of surprise and ultimately increase risk. This can be seen, to a lesser degree, in Planck's exclusive focus on thermodynamics, in which it was possible to discover Planck constant but impossible to interpret.

Second, the choice of wrong bases increases risk. For example, the success of special relativity mainly depends on the choice of principles. (Einstein chose the principle of the constancy of light velocity and not the Galilean transformation.) Wrong knowledge is treacherous and may be called a traitor. Some traitors hide well. (For instance, the traitor in Newton's law of gravity remained concealed for more than two hundred years.) Some even become widely accepted beliefs (as with some religious beliefs). The diversity of aims reduces the dependence on a single path or basis and the danger of a traitor.

Flexible resources and flexible purposes, principle (3), help each other: if one improves, the other also improves. Flexibility of knowledge includes two parts. First, applicable conditions are variable, such as applying a military principle in research. Second, meaning is variable, such as revising a principle. When detachments are closer to the unknown world, uncertainty increases both parts of flexibility.

To improve flexibility, a researcher imitates a field army. Good researchers increase their flexibility and free themselves from distracting tasks so as to strengthen their attacking ability and litheness. (Stronger attacking ability reduces attacking time and thus improves flexibility.) Knowledge-maintaining resources, such as teachers, libraries, and schools, correspond to garrisons. Flexibility is impaired when learning and remembering too much and too well.

Principle (4) aims at improving attacking efficiency. Its key lies in the principle of selecting the superior and eliminating the inferior, which requires that the researcher strengthen the detachments attaining an advantage and weaken those forfeiting it. When positive signs appear, such as improving an explanation, researchers assemble more resources; when negative signs appear, they attack less and release resources.

Meanwhile, researchers should avoid wasting important resources, such as time and effort. Flexibility protects effort and economizes offensive power. If the knowledge and skill required for attacking a problem are renewed too fast and too much, too much effort is expended. Virtues often help to minimize loss. First, human

beings have an inborn dread of the unknown world; hence, they exaggerate difficulties. Unwillingness to assault and willingness to withdraw are the common reactions, but courage and confidence prevent such losses. The first victory helps upgrade confidence and morale and is often more important than the discovery itself. (However, overconfidence is risky, such as Einstein's objection to quantum mechanics.) Second, attacking an aim repeatedly is wearisome, and patience is a helpful trait.

Regarding (5), the economy of force and multiple aims complement each other. It is hard to pay attention to economy when there is only one aim. A researcher can be a commander of a large army instead of a squad and send many detachments to attack many aims.

Attacking multiple aims, (6) and (9), does not mean one detachment per aim, or one aim each time, or distributing force evenly. It means attacking freely. Consequently, there are more battlements on some battlefields; some attacks last longer and require more resources. However, those with more resources attract attention because they are usually decisive (otherwise, victories would be cheap).

Concentration in research is different from that in war, since a characteristic target makes the maximum degree of concentration unnecessary. The lack of efficiency is a much more common shortcoming than the lack of resources. In war, defeat is a serious threat, and the certainty of victory is more important than efficiency. As force increases, security continuously improves; however, efficiency improves before reaching its maximum, and then begins to decline. In research, where resources exceed what is necessary, the assault on more aims or in more directions is better. A good researcher does not always win. In research, number of victories (weighted by importance) is a much better standard of evaluation than rate of victory.

Consequently, there are more failures. A researcher always has a long record of defeats before success, and many potential researchers quit before attaining it; therefore, the motivation to explore the unknown world is uncommon. Motivation derives not only from rewards, but also from virtues. The virtues of research include loving inquiry, patience, rationality, determination, and so on. If one has enough love and rationality, other virtues are unnecessary; however, nobody has sufficient love and rationality to override the need for other virtues. Thus, a proper combination of virtues is required. For example, quitting a job is similar to escaping from the battlefield and increasing loss. No matter the motivation, loss in the field of research is smaller when the scale of withdrawing is smaller, thus withdrawing is better than quitting, quitting from aims is better than that from objectives, and never quitting the goal is necessary. The correct reaction is to withdraw somewhat and then wait and redistribute resources (even a diminished purpose is acceptable). Hence, one had better be courageous, temperate, and patient. Different researchers need different

virtues. For example, when advancing along a path without support, being somewhat independent would be a virtue; if there are many researchers along the path, being communicative would be better.

Turning to (7) and (20), the unknown world is never the target of a stratagem. Surprise aims at weakening competition between detachments or resources. It is a method that shows respect for previous attacks. If many high quality assaults have occurred and the problem remains unsolved, some missing – usually surprising – pieces must be found before resuming the attack. Relative to frontal attack, those on the flanks and rear are usually startling. Hence, one should try to find more bases that are linked with the problem. (No problem links with the rest of world through a unique path). Moreover, two competent and responsible researchers should not attack the same problem from the same direction independently (thus there is only one competent team on a project), just as two identical particles are incompatible. Hence, researchers must search for new battlefields. At present, battlefields and attacking paths are scarce, while assailants are abundant, especially on popular topics.

As (8) indicates, every effort is valuable. However, no one actually tries his best, since no one is a pure researcher. Moreover, the difficulty and the length of an attack are unpredictable; hence, effort must be controlled on a sustainable level. When it is easy, one can relax a little and prepare for the upcoming difficulty. Thus it may be true that moderation can be harmful – though it is not, as (8) would have it, always harmful.

As (10) indicates, time is a prerequisite for any exploration. If time is short, one pursues an aim instead of an object or goal, otherwise he cannot finish. Time also helps one outdo his competitors, but it never surprises research opponents. Determination, a common trait for good researchers and commanders, helps save time, especially in difficult and pessimistic moments. It can lead to wrong decisions, but it is still better than irresolution, which wastes time and opportunities. Determination keeps on acting, thus covering many mistakes.

After conquest, pursuit (11) significantly enhances efficiency, which is especially important after a large-scale attack. (However, since the opponent never panics, pursuit is less effective in research than it is in war.) First, it saves the cost of shifting resources. Second, pursuit easily reaps benefits. Defence is not uniform in the unknown world, and difficulty is unrelated to the importance of a factor. Hence, an important discovery is sometimes achieved by simply pushing the front line to the next fortress. However, pursuit is not mandatory. When a need arises elsewhere, it can be abandoned. Einstein fulfilled a brilliant expeditionary pursuit from special relativity to general relativity; he thus missed part of the quantum revolution, while his pursuit of unified field theory was excessive.

Principle (12) emphasizes the importance of communication, both improving one's own and obstructing the opponent's. When the relation between two facts is unexplained, they cover each other; when explained, an attack path emerges. Closely connected topics form a battlefield. Compared with warfare, the unknown world is so broad that it holds many main battlefields and many decisive points. However, there have been several decisive engagements, such as the discoveries of Aristotle and Newton. Significant discoveries depend on the cooperation among several fields and long pursuits in many directions. For example, in Newton's era, the motion of objects, the area under a curve, and celestial movement were largely unrelated problems. Newton drove them closer, established his laws of motion, calculus, and the law of universal gravity. Relationships between facts can be weakened also, as when Newton alienated theology and astronomy.

Principle (13) is partially correct. Some decisive wars happen by accident and with little force, as when the Vietnam war began with civil conflicts (and neither of the two superpowers fully participated) or when Wegener proposing the continental drift theory by noticing landmasses fitting each other on the map. Second, the principle that better ensures victory may endanger efficiency; thus, proper resources must be used against certain opponents. Besides, there is no distinct relation between effort and difficulty, which is a statistical quantity with varying degrees of distribution. Sometimes a difficult problem can be fairly easily solved through a surprising path; nevertheless, such chance occurrences are rare. Hence, researchers are regularly stalemated before difficult problems, and wisdom is often more decisive than quantitative resources, such as capital, time, and people. First, the accumulation of resources with low preference lowers efficiency. If working on a wrong problem, such as trying to prove geocentric theory, failure looms and resources are wasted. Second, quantitative advantage is not sufficient to conquer a problem. A clear victory sometimes requires fewer resources than a murky one because wisdom helps discover the decisive paths; thus, the principle can be violated.

Considering (14), (20), and (21), a converging attack after concentration on a decisive point is the best method to destroy an integrated defence; thus, fruitful pursuit is anticipated. However, compared to warfare, the importance of a converging attack decreases and that of a dispersing one increases in research, since the number of important victories becomes the purpose (with a good endurance of failures as a prerequisite).

Thus, there are many battlefields and aims in research, and distributing resources becomes an important task. Importance is the only factor in (14); competition is the only factor in (20) (psychical influence does not exist in the unknown world); difficulty, ability, and probability are involved in (21). Contents that are inaccurate should be unified into the largest preference principle.

$$Preference = (importance + ability - difficulty - competition) \times probability \quad (1)$$

For a detachment, the formula includes present difficulties, the attack ability, the importance of an advance or attack, the probability of success, and competition from other detachments. These factors depend on the problem, path, and distribution of forces. For example, compared with Lorentz's interpretation of the Lorentz transformations, Einstein's was more important, less competitive, and more skilful. Even if Einstein's probability is smaller, his preference may be higher, a fact which ensures its priority but not its correctness.

The formula embodies all the main factors of preference and makes it much easier to select the superior and eliminate the inferior: when preference is increasing, a detachment receives resources; when it is decreasing, it loses resources. A better estimation of these factors improves the distribution. For instance, if it is foreseen that there will be easy paths for pursuit after solving the problem, its importance and thus preference increases and resources flow to it (i.e. after a general theory is discovered, various specialized forms will follow). The simplicity and universality of a possible answer usually imply easy and large-scale pursuit afterward. However, foresight is a somewhat occult ability.

The law of diminishing marginal preference, which corresponds to the law of diminishing marginal utility, refers to the fact that the marginal preference of each homogenous unit decreases as the supply of these units increases. Marginal preference is a constant when resources are best distributed. Otherwise, resources flow from low marginal preference to high marginal preference. Resources in a detachment are divisible, and each unit searches for the optimum detachment. Resource exchange between detachments is usually weak, but when close enough, it becomes strong, similar to a nuclear reaction. For example, a physical theory borrows mathematical tools when the fields are closely related.

In relation to (15), opportunity is created by improving preference. First, difficulty can be lowered by solving peripheral problems and finding new paths. Second, a strengthened ability increases the number of assailable problems. Third, probability can be enhanced, for example, by prolonging time and improving bases. Fourth, competition can be weakened. Along with surprise, obstructions – such as a shortage of capital and ability – lessen competition. Fifth, the relative importance of factors can be adjusted; however, it is difficult to do so intentionally, since importance is usually influenced by the work of other people. For example, when a new theory emerges, decisive experiments relevant to that theory sharply increase in importance and preference. Sixth, motivation may be reinforced by deliberately undervaluing difficulty or overvaluing ability, probability, and importance. It helps to offset short-term disadvantages; however, it also reduces efficiency in the long-term, unless the adjusted evaluation is more accurate.

With (16) in mind, divergence is the sending of detachments outward in multiple directions; advancing involves the search for opportunities; a converging attack is a multi-directional inward attack. Without dispersion, no information is obtained by which to decide where to concentrate and converge.

Unlike in war, researchers do not disperse the opponent; it disperses itself. There are two motivations for dispersion: improving the search and creating opportunities for converging. Detachments should be independent so as to find more surprises. Because researchers exchange information much more effectively now, they are less independent. The disadvantage is partially offset by the growing number of researchers and research areas. Good researchers use information to improve cooperation, not to reduce independence.

Unlike in war, convergence in research should be unplanned and voluntary. The opportunity for it emerges naturally when many detachments are concentrated in a small area. When new detachments join an attack, difficulty falls and probability rises, along with the disadvantage of stronger competition. Voluntary participation ensures that the advantage is larger than the disadvantage; thus, the aim is attractive.

As implied in (17), (19), and (23), the purpose of an endeavour should be flexible and adjustable through adaption. When detachments encounter difficulty or surprise, flexibility is helpful. When a frontal attack fails, they can assault the flank or rear, attack other problems, search for paths and problems, improve methods, and so on. Different resources have different flexibilities. Time, effort, and capital are applicable to various topics; therefore, they are more flexible than most equipment, specialized knowledge, and skills.

As (18) and (22) imply, the unknown world often surprises researchers; hence, one cannot gamble on one plan, especially a detailed or long-term plan. Many of these principles deal with the contradiction between flexibility and stability and the relationship between flexible purpose and flexible resources, reflecting both their importance and difficulty.

Flexibility and stability have advantages and disadvantages, and the optimum state is equilibrium. Equilibrium is the result of the interaction between resources and purposes. The distribution of resources and the distribution of purposes influence each other. If resources are less flexible than purposes, purposes undergo more change; if resources are more flexible, they are more involved. This situation is similar to that of a binary star, which involves two stars turning around each other; if less flexibility represents a larger mass, the star with smaller mass moves in a larger area. Time is another variable, since resources are adjustable, if temporal space exists. Thus, resources influence the aims of the strongest and not the goal.

With regard to (24) and (25), the unknown world is always ready to defend itself; therefore, it is dangerous to make desperate attempts. A risk-averse researcher seeks more objects, more detachments, more attacking paths, more converging attacks. The

former two provide more chances for the latter two. Consequently, resources have more freedom. (Less freedom always leads to higher risk; therefore, explorers should avoid limiting paths, time, and so on.)

Analysis of the process of exploration

This section regroups the preceding section and explains how to apply the principles in the research process. A successful exploration includes three stages: divergence, which realizes dispersion; adaptation, which realizes concentration; and convergence, which realizes attack and conquest. Pursuit just begins a new divergence. There are two important variables. One is the total area of the front line, which favours searching chance. The other is the attack force in relation to unit area, which favours seizing chance. Divergence increases the former, and convergence increases the latter. Thus, detachments initially disperse and finally converge.

In the first stage, resources are organized into detachments and sent from various bases. Detachments from a base are similar to the various inferences and conjectures of a theory. Both change direction when interacting with problems and competitors. After sufficient evolution, dispersion is realized, and detachments are transformed into an experienced army. A researcher is a commander of detachments, as Newton represented the main army of his era. Specialization reduces the variety of bases and detachments and the chance of large-scale concentration; hence, a modern researcher seldom makes large-scale cross-disciplinary discoveries. Cooperation between researchers just partially solves this problem, since the thought process of a single brain is more efficient than those between or among brains.

From the law of diminishing marginal preference, the optimum behaviour is always a combination or balance among different behaviours. For example, each detachment is a combination of resources, not a single resource; it reaches a balance between the searching path and the attacking path. One evaluates all factors vaguely rather than a few precisely; one attacks multiple problems multi-directionally, not a particular problem or a particular direction.

To broaden a front, one must keep it deep, tortuous, and obscure. It is ideal to create an infinite long line in a finite research area, similar to a fractal structure. With a complex front line, every defender is assailed from multiple directions (and higher fractal dimensions offer more directions). A siege helps to ‘capture’ a problem. When a problem is assaulted from N directions simultaneously, the probability of conquest usually increases more than N times. In this way, researchers extend contact with the unknown world. One can complicate the front line by temporarily permitting problematic knowledge, such as that which is unproven or contradictory. Around the front line, treacherous knowledge is neither frightful nor dangerous; one must simply not be overconfident.

Dispersion is the most effective means of deepening and blurring the front line. Since the unknown world never attacks, there is nothing to fear in divergence; otherwise, vulnerability is not fully exploited. For example, an expedition into the rear provides a large space with little competition, as when Cantor established set theory. Proposing new concepts by induction or intuition is typical of such expeditions. Needless to say, the failure rate is high; however, without casualties, the risk is much lower in research. Although the probability is low, the importance and the competition are superior; thus, high preference is possible in such an expedition.

If a problem must be conquered, various tactics and strategies may be employed. Pure frontal attack is a poor approach; flank and rear attacks are better; siege and converging attacks are the best. If all fails, one enlarges the zone and attacks adjacent problems. (The time is longer, but the achievement is greater.) If the zone is full of difficult problems, an expedition into the rear is worthy of consideration. (Time is the longest; achievement is the greatest.) For example, to explain the movement of celestial bodies, Ptolemy adopted frontal attack from geocentic theory, Copernicus adopted flank attack and replaced the basis with heliocentric theory, and Galileo and Newton adopted whole new bases and fulfilled an expedition. The beginning of a new subject is usually the best opportunity for an expedition, since the difference between front and rear diminishes. As time goes on, the gap widens and motivation sinks. This explains why expeditions usually appear at the start of a new subject.

Dispersion strengthens flexibility, while the principle of continuity improves stability. The movement of resources is continuous. It is imitated in the Universe [6], in which particles move continuously. Hence, the solution of a problem involves an order: closer detachment has priority. For example, a researcher uses familiar tools first. The principle itself is overlooked because one mainly follows instinct, both in war and in research.

The second stage is adaption, which aims at concentration. During advance and conquest, information and thus preference keep changing; therefore, resources and purposes must be constantly redistributed. For instance, a decisive victory sometimes appears by surprise on subsidiary battlefield, with few initial resources; it is then upgraded to a main battlefield, and resources flood to it. Some reinforcements have travelled a long way, such as non-Euclidean geometry helping establish gravitational theory.

The principle of selecting the superior and eliminating the inferior guides the adaption of resources. Thus, success is evolutive and spontaneous rather than planned. In war, the principle is often violated because commanders believe that they have enough information to plan victories. However, planning an exploration violates the nature of the unknown world: no exploration, no information, and thus no planning. In research, the benefit of planning is determined by whether it corrects wrong propensities. For example, an impetuous or pessimistic researcher can

stabilize his behaviours and purposes by planning. Adaption should be moderate. Eliminating the inferior too fast is a sign of timidity; eliminating it too slowly or even selecting the inferior is a sign of bellicosity; selecting the superior excessively is evidence of avarice; selecting the superior deficiently lacks initiative. However, it is unnecessary to adapt precisely, since the optimum behaviour is an extreme point, at which the benefit is not sensitive to small variations (the first order derivative is zero).

Concentration is the prerequisite condition for the third stage. To facilitate voluntary converging attacks, detachments must concentrate in order to increase their numbers and density in a small area (faraway detachments cannot attack concentrically without a plan, unlike in war). There are two mechanisms to confine detachments. Researchers usually confine themselves to a topic or subject. This approach is effective in the short-term, as in a nuclear reactor. However, because of the attraction (gravity) between the components of knowledge [7], a natural mechanism called spontaneous concentration exists by which detachments concentrate into a small area, as in the formation of a star. (A concept and a fact attract each other, and two concepts or two facts repel each other, as in the attraction of two opposite charges and the repulsion of two like ones. Since knowledge consists of a group of concepts and facts, some components of knowledge may appear to be repelling each other because repulsion between their facts or concepts overwhelms the attraction, just like electromagnetic repulsion exceeding gravity.) The choice of a mechanism depends on purpose, time, and effort. When purposing to succeed in a short time, forced concentration is better, and expeditions should be forbidden. With bigger objectives, more effort, and a longer time, spontaneous concentration is much better, since it usually attracts more detachments, including some surprising ones; thus, it is more productive and persistent.

Attacking concentrically to achieve an aim is the third and final stage. An attack is short, but a spontaneous concentration usually activates hundreds of attacks and leads to a fruitful period, as Aristotle and Newton experienced. Enough time for evolution is a prerequisite for an expedition and a spontaneous concentration. Also essential is increasing the freedom of resources, sending as many detachments as early and as far as possible. Then, the opportunities for concentric attack emerge naturally.

Detachments sometimes run into each other when probing a problem, thus forming a converging attack (whereas victory is still uncertain). This occurrence is rare. However, after the number and density of detachments reach a threshold value, a winning converging attack releases more detachments, some of which meet before escaping the area. Thus, a chain reaction is established, corresponding to nuclear chain reaction [8]. Larger numbers of detachments reduce the threshold value for

density and vice versa. A higher flexibility and attacking ability also lowers the threshold.

Because of other advantages, the number of detachments is more important than the density, (similarly, density is smaller in a bigger star, but mass is larger and releases more energy). First, the rate of reaction and the number of converging attacks in unit time usually increase faster than the number of detachments because the possible combinations of the latter increase very fast. Second, more pursuits occur after conquest. Third, the safety of spontaneous concentration is enhanced. Fourth, the larger number allows for the preparation of special skills. The development of detachments is statistical. Some detachments advance along correct paths, participate more in attacks and victories, and become specialized, all of which are valuable resources.

In any designated problem, soft spots always exist, but these are not necessarily in the most apparent part of the front line. Some soft spots are exposed by chance; others are exposed naturally. A fortress of problems must be attacked simultaneously at several soft spots; this initiative is sometimes very difficult because problems arise on the way to these spots, such as the discovering of special forms before establishing a general theory. For instance, electromagnetism began with static electricity and then expanded to currents and moving charges.

The most efficient mechanism for research is still unclear; hence, it is a common battlefield for every researcher. To improve methods, one must search carefully, advance extensively (trying methods), and attack concentrically (seeking cooperation among methods and comparing their effects). This is a long overlooked but important battlefield.

Communication

Apart from principles, environmental conditions are also important for exploration. First, communication between the known world and the unknown world offers an attack path. Second, the total traffic on a fact or concept measures importance; for instance, a terminal controls many paths but it is often replaced by total traffic in the known world, thus leading to wrong judgments. For example, human beings and the earth are trivial in the knowledge world, but they are significant in the known part; this imbalance has misled numerous researchers. Third, the percentage of traffic leading to the unknown world roughly measures difficulty.

It is possible to observe the unknown world indirectly by observing the known world. Its importance grows with the size of the known world. For instance, the more complex science becomes, the more scientists study flaws and contradictions. Einstein discovered general relativity from the contradiction between special relativity and Newton’s law of gravity, not from new experimental results. Indirect

observation, especially contradiction, helps identify traitors. For example, monarchy was based on trustworthy knowledge, but it contradicted equality. Subsequently, equality offered a good direction by which to attack monarchy and to establish new knowledge.

The unknown knowledge world is virtual; thus imagination more than experience is necessary to observe virtual paths. However, after acquiring experience, researchers usually appreciate them much more than imagination; they thus sacrifice freedom and increase competition.

There are three kinds of attacking paths. First, sometimes there is just one vertical path. If it leads directly to a solution, one is lucky. If problems are encountered midway, there are three solutions: striving to conquer, waiting aggressively, and abandoning the effort. Both striving and abandoning are highly risky. Waiting aggressively combines waiting in one place and redistributing some resources elsewhere, searching a path to bypass or shift to adjacent problems, recruiting nearby detachments to attack concentrically. It risks delaying, but rarely blunders.

Second, meeting a transverse path is both a chance and a challenge, especially when there is a difficulty along the original direction. It helps shift the direction, reducing the loss of effort. However, keeping an invariant path may result in plain sailing after the difficulty (and the transverse path may be difficult afterwards). The best decision is still a combination and includes attacking, shifting, and waiting. The shifted part becomes an independent detachment when advancing long enough; hence, the number of detachments increases naturally if correct principles are followed.

Third, it is not certain that good communication will bring good news. A researcher usually begins at the vicinity of the known world, where there are many paths. However, after choosing one, communication worsens quickly and sometimes leads to an impasse. He then goes back and tries another. Though the detours waste time, the advantage is that there is always hope.

Attacking several widely separated aims from a base is called an interior condition, and attacking an aim from several widely separated bases is called an exterior condition. When it is impossible to be attacked, it is safe to exploit an interior condition, which provides better movability and an array of successive aims to attack (in accordance with principle of continuity). For the former, the communication line grows longer and attacking force decrease with time. For the latter, communication improves and the attacking force increases with time. The two operations compensate for each other. An exterior line operation is the main means to conquer a difficult problem, as in a terminal; while an interior line operation is the main means to pursue from the terminal. For example, electromagnetism was conquered by an exterior line operation and became a terminal.

Some terminals are so decisive that they should be conquered at all costs, such as freedom, efficiency, and so on. They are old knowledge and old problems but never lose their importance. For example, geometry is very old but has experienced several breakthroughs, such as non-Euclidean geometry, general relativity, axiomatization, and so on. These terminals are part of the uncertain knowledge that is partially controlled by both worlds. Victories against these terminals usually come from large-scale concentrations, mostly by many researchers over a long time, but there are exceptions. For instance, many physicists participated in the quantum revolution; however, Einstein conquered relativity alone from many important terminals, such as constant light velocity, the principle of relativity, the isotropy and homogeneity of space, theoretical simplicity and beauty, simultaneity, Maxwell electromagnetism, and so on. However, these terminals obstruct each other sometimes because they are not well understood, such as the contradiction between efficiency and equality. It is valuable to reduce the uncertainty of these terminals; however, they widely connect with unknown world, and every victory reduces uncertainty only a little; hence, uncertainty is unavoidable.

The Universality of Military Principles

Besides hostility, some other relations also create unknown worlds. Reciprocal relations between producers and consumers create an unknown world of new products for consumers to explore and an unknown world of consumptive desires for producers to explore. The purpose of consumers is pleasure, while that of producers is profit. Because they are not aware of all consumer desires, producers design various products to find a successful one. A converging attack represents the attempt to sell multiple products to the same consumer simultaneously, as in selling park tickets, hotel rooms, foods, beverages, and souvenirs to a traveller. Obviously, spontaneous concentration is better than binding.

In the stock market, investors seek the cooperation that generates the highest investment return. This realm is a well-known unknown world, and the decentralization of investment, which corresponds to dispersion, is a proven principle. A successful converging attack corresponds to positive cooperation among the stockholders of a company, which results in good management and thus higher than average returns.

The Universe is an unknown world of particles, and every particle is a detachment. Particles pursue mysterious negative action and form various local structures through nuclear reactions.

Unintelligent cells are detachments exploring the unknown life world. Viability is their purpose. The evolution of species is the result of countless groupings, advances, and attacks. Successful converging attacks enhance viability and attract

resources, thus forming tissues, organs, and so on. Biological systems have multilayer structures, including cells, tissues, organs, individuals, and populations. Cooperation on higher levels is more effective. For example, cooperation among organs to form animals brings more differences than that among cells to form tissues.

It seems that detachment is not free in biology, since DNA is fixed. However, the life span of a cell represents a short track of advance; heredity and mutation represent the redistribution of resources and purposes. Most mutations are small, thus advance is mainly continuous. Even if a mutation is not totally free, its diversity is sufficient for dispersion. Although cells are unintelligent, natural selection (death and reproduction) is a rational response to information: selecting the superior and eliminating the inferior. (Thus, rationality is neither necessary nor sufficient for exploration.)

Therefore, in a system, no matter what individuals look like (soldiers, particles, cells, consumers, producers, stockholders, or concepts), what they pursue, (victory, negative action, viability, pleasure, profit, investment return, or knowledge), or what relationships they have, (hostile, mysterious, adaptive, reciprocal, cooperative, or explanatory), the result is always an unknown world.

Then, correct principles are the decisive factors for exploration; any violation must be corrected. For instance, the principle of continuity is followed instinctively in war, the biological world, and the knowledge world; however, in the economy, the fact that job alternation is discontinuous is logical proof that advantage hurts the economy [9]. (These principles are proposed by induction and tested empirically. There is no logical proof for advantage. The principles can only be proved empirically. Hence, violation is harmful.) The effects of principles are statistical, and several repetitions are necessary to affirm the inefficacy of an attack. Thus, one cannot brand one observation of microscopic behaviour a failure.

Some military principles are not universally valid. In war, after conquest, attackers destroy an opponent's military resources. In other systems, no such outrages occur. In the economy, producers satisfy consumer desires and new desires emerge. Meanwhile, consumers defend their desires with an offered price, and producers defend their interests with an asked price. Unlike in war, each side defends moderately and always provides new aims for its opponents. Hence, it is reasonable to suppose that a beneficial unknown world is infinitely large and is called sustainable. Explorers can constantly succeed without heavy loss.

Conclusions

Researchers try their best to explore the unknown world. The process is similar to a war between the known world and the unknown world. Many brilliant researchers have followed a series of military principles, such as diverging advance and

converging attack, multiple aims, stability of aims, pursuit after conquest, and surprise. They have also possessed the instincts to select the superior, eliminate the inferior, and advance continuously. Their achievements were not accidental.

The unknown world of knowledge never attacks or changes its deployment, but it well defends itself. It is a model for the sustainable unknown world, in which exploration is a succession of partial combats without end. Researchers ought to distribute resources to places with higher marginal preference. This approach involves three steps for detachments: advance, adaption, and concentric attack. One should send more detachments; each detachment is flexible, sustainable, and rational; the front line ought to be tortuous, obscure, and deep.

Unknown is common for all unknown worlds and is a sufficient and necessary condition for the validity of important military principles. In all types of unknown worlds, individuals are free, continuously changing, and reducing uncertainty and improving stability through numerous adjustments and adaptions; they concentrate spontaneously and attack voluntarily to form various special structures. Thus, the universality of the unknown properties and principles guiding exploration is well supported.

At present, this theory is experiential and inductive, but it should be developed analytically. There is much room for the application of this theory, which covers all economical, social, and research-related activities. Application and analysis will have to be the subject for a future project.

Acknowledgement
I would like to thank Rebecca Langley for her work on English language editing in this paper.

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