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# The Synthesis of Various Economics: An All-in-One Solution

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## Abstract

This paper gives a deliberate solution on how to synthesize various economic theories into a unified and general one. Human minds, or thoughts, should be regarded as the *objective actualities* or *major objects* in economics and social sciences, which co-exist and interfere with physical ones, featuring time-and-cost-spending. This means that we need an *economic* theory on how human minds work and how we apply *Roundabout Method of Production* to thinking activities. The *Algorithm Framework Theory* interprets the principles of computer in a way distinct from any known approaches. Consequently, Consciousness, Semi-Internalization, Knowledge or Human Capital, Innovation or Evolution or Dynamics, Interpersonal Heterogeneity or Personality, Interpersonal Asynchrony, Patterns, Institutions, Organizations, Subjectivity, Pluralism, *Irrationality* and a large number of other conceptions or principles will be endogenized. The result is that a big turn of methodology of economics and social sciences needs to be initiated, and even all existing theoretical or applied economics and social sciences need to be re-examined, re-structured, re-built or re-interpreted under the *Algorithmic* framework.

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<sup>1</sup> This paper is mainly a summarized introduction of two Chinese books of mine entitled respectively *Algorithm Framework Theory: a basis for the unification of social Sciences* (Beijing: China Renmin University Press, 2009) and *A Preliminary Inquiry Into Principles Of The General Social Science* (Beijing: China Renmin University Press, 2011, to be published soon), and this is the debut of Algorithm Framework Theory in English world. I appreciate Dr. Qiang Chen who helped me in many ways including polishing the English in this paper. I appreciate the openness of and the assistances from the organizers of AHE 2011 Conference who decided to accept this paper.

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A great challenge for future general equilibrium models is how to formulate a sensible notion of bounded rationality, without destroying the possibility of drawing normative conclusions.

-- *The New Palgrave: A Dictionary of Economics*<sup>2</sup>

In establishing epistemology as a theory of knowledge, the philosopher implicitly assumes or asserts that there is in the intellectual effort of man something that remains unchanged, viz., the logical structure of the human mind...We must never forget that our representation of the reality of the universe is conditioned by the structure of our mind as well as of our senses.

-- *Ludwig Von Mises*<sup>3</sup>

## I. Introduction

Economics is a very important discipline for the society. People use it not only to comprehend the economy and social lives, but also to project the actions, including making public policies and enacting laws. Unfortunately, the current situation of economics is not desirable. It is heavily divisive. There are ordinary scientific disputes here, besides, different *Economics* conflict fundamentally with one another, particularly in their basic ideas, premises and methods. As these conflicts keep growing, more and more economists start rethinking the fundamental issues of this discipline, it seems that economics is returning to the 19<sup>th</sup> century when the methodologies were discussed heatedly. In short, currently we have to face the following problem: will there be a *real* solution to fundamentally settle the conflicts between the mainstream and various heterodox economics and consequently ground economics in a unified and single basis and thus open the door to a new economics of tomorrow?

Perhaps those who prefer pluralism dislike the above idea; nevertheless, according to my arguments, the theory given in this paper below will also reasonably lead to the inclusion and synthesis of pluralism, uncertainty, subjectivity, *irrationality* and humanities. As a result, it could be regarded as a *lump-sum* or *all-in-one* solution. Any *Economics*, any theory or any topic will have a proper position inside this new framework. The upcoming complete synthesis of such kind has never happened in the history of economics, although there were a few similar events on smaller scales. The scope that this paper will cover includes any known Economics or theories such as Neoclassical Economics, Rational Expectation, Innovation, Human Capital, Bounded Rationality, Risk & Uncertainty Economics, Information Economics, Game Theory, Macroeconomics, Behavioral Economics, Evolutionary Economics, Institutional & Neo-institutional Economics, Neuroeconomics, Economics of the Austrian School, the Classic

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<sup>2</sup> Eatwell, Vol. 1, 1996, page 132. The entry was entitled *Arrow-Debreu Model of General Equilibrium* and written by John Geanakoplos.

<sup>3</sup> Mises, 1962, page 16, 19.

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Historical School, Marxist Economics, Feminist Economics, etc. Furthermore, the synthesis will inevitably extend to social sciences, social engineering, humanities and philosophies other than economics. In my view, the reason why these disciplines are not fundamentally coherent is similar to economics, i.e. they all lack the *Algorithmic principles*, the *Algorithmic theory* or the *Algorithm Framework Theory*, which this paper will propose formally. This frameworking theory is composed of a series of concepts, hypotheses and propositions, and, it is quite simple. As a highly effective catalyst, when it is placed into the pool of economics and social sciences, a series of vigorous chemical reactions would happen and everything inside would integrate with one another and would finally coagulate into a solid whole body.

The *Algorithmically-approached* arguments hereafter are not completely fresh, they are based partially on the existing economics and social sciences and arise from their defects. Nevertheless, in order to solve these problems, we have to start first from a remote place where we are always familiar with, we will develop a structure beyond the existing literature and then return to apply it to them. Considering the width of the topics in this paper, I have to state in a refined way. Our focus will always be the unification, consistency or wholeness of the whole picture. Maybe it means a big discovery, maybe not, anyway, I wish the following trip is worthy of your attention.

The structure of the paper is as follows: Part II gives the basic ideas of the Algorithm Framework Theory; Part III offers some philosophical reviews on the basic ideas; the philosophical points are crucial to the upcoming theory. Part IV presents the core of the theory, Part V provides some important extensions, corollaries and applications, how the various economics is synthesized will be shown or hinted in turn respectively, Part VI makes additional comments on the existing economics and contains a brief discussion on methodology, Part VII concludes this trip and offers a vision of the future.

## II. Basic Ideas

Since the formation of the Neoclassic Economics, many criticisms upon it, and a few theories supplementary or substitutive to it have emerged, which we will discuss in turn in different parts below. Most of the critics emphasized only the incompleteness of the scope and topics of neoclassic economics, it seemed they did not think there was any logical mistake; in another word, the attacks on it were often from the flanks instead the front. When a theory was deemed weak heavily, I guessed, it must contain some logical mistakes, therefore, we should try to start a critique toward neoclassical economics from the front. As a Chinese saying goes, the strategy is called *use his own spear to thrust his own shield*.

The General Equilibrium Theory is at the centre of neoclassic economics, which means the agents think and calculate rationally and seek maximum under various constraints, and consequently the General Equilibrium would be reached. The thinking activities or calculations undertaken here seem quite reasonable, viable or executable, although they are really and highly complicated. The critics usually said that the degrees of the complication were beyond the capabilities of common people, and it was hinted that this weakness could be remedied if the agents are mathematicians instead of common people. The Evolutionary Economics reforms neoclassical economics in just this way: the agents in the models often appear shallow-brained more or less, after some evolutionary processes of calculating and acting, the solutions similar to those in neoclassical economics will be eventually discovered.

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In my opinion, the Evolutionary Economics goes in a totally-wrong way. The mistake that neoclassical economics made is not the calculational complication, and it has nothing to do with complication. A very important assumption hidden behind the General Equilibrium Theory, which has been ignored all along, is that no time was spent on calculations. This is not true. This is the major mistake of neoclassical economics, which could account for almost all the neoclassical weaknesses directly or indirectly. In case we revise this assumption by introducing the time of calculation into the mainstream economic theory, a collapse will happen, and a huge synthesis of various economic theories will emerge consequently. This would be the real key to solve the current puzzles in our discipline.

In comparison with physical actions, thinking activities or calculations proceed rapidly and freely, hence the time spent on them is often neglected understandably. However, the time restricts human minds heavily and obviously. If we regard the existing civilization of mankind as the results of historical thinking and accumulations over thousands of years, we will have no reason to neglect the calculational time. The mathematical calculations in the mainstream economic models seemed unarguable to us, but it is only because we have learned mathematics in advance; otherwise, assuming that we haven't learned the knowledge yet and our brains are entirely empty, how long would it take for us to arrive there? Human minds proceed sometimes in parallel with physical actions, but in other times one has to stop to concentrate on thinking, this means the opportunity costs. The fact that agents sometimes in a quite simplified and direct way is not due to their incapability to conduct the advanced calculations. Provided unlimited time common people could be expected to be able to carry out any calculations the economists require with any degrees of complication, the complicacy could even keep growing continuously and endlessly. On the other hand, because some resources and time is allocated to the physical actions, the agents appear to be not so adept at calculations as the economists (things are not always so necessarily). Without introducing calculational time, the division of labor and the interpersonal heterogeneity of this kind would be incomprehensible. Restricted by calculational time, the timing of decision-making becomes an issue, and the agents would have to make up their minds in time, the decisions will consequently be *re-shaped* (not *distorted*) and run out of the neoclassical tracks. These effects are possibly not perceived by the economists who take calculational time as trivial.

In some sense, the absence of calculational time is the root cause of the predicaments of the mainstream economics. Since a trans-space-and-time optimality was reached immediately under the neoclassical framework, what meaning could be found for the elapse of time really? As the movements of physical objects or physical actions cannot be refused obviously, I noticed, what the Neoclassical Dynamics could do was therefore just to describe the processes of accumulation of physical wealth, otherwise the economists on growth would have to tighten some parts of the premises in the static theories so as to make their models look closer to the real world. We could say that the missing of calculational time is the real reason why the mainstream economics loses dynamics. Based on common sense, it could be deemed that the economic dynamics arise from three sources: (1) the dynamics of the physical world (including the physiology); (2) the dynamics of human minds which proceed and progress historically; (3) the interactions between the above two and between different persons. Once the dynamics of human minds were *anceled*, the only dynamics left would be that of the physical world. Just like a tricycle, when two of the three wheels are removed, it is doomed to limp or stay put.

Secondly, the negligence of calculational time has led the General Equilibrium Theory

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directly into determinism or Doomsday which even the mainstream economists admitted and nobody could deny. Criticisms on it have been heavily all along. As the problem of probability was settled in a *standard* or definite way in neoclassical economics, it was believed that the Uncertainty by far had not been included essentially in the mainstream framework. The emphasis on informational constraints can do nothing to remedy it either. Few economists have seemingly realized that the determinism or Doomsday, which I suppose the mainstream economists were unready to be involved in, was caused just by the negligence of calculational time. No calculational time, how could the agents be hesitant, vague or argumentative? If so, that could mean the intelligent activities would have not reached their maximum and thus need to continue until an ultimate, sound, absolute or undoubted destination were arrived at. Mainstream economists have to hold the rationalistic idea that the mankind will sooner or later reveal all the mysteries of the world—since they cannot choose the contrary, agnosticism, which would possibly make things worse. Since the destination is presupposed, none of the cognitive processes or interpersonal differences looks significant. Until the submission of this paper, it seems that nobody has perceived another approach that might be lying under.

My idea is the following: as long as the calculational time is imported into economic theories, Uncertainty will automatically appear. Since the agents now will always be calculating, and the knowledge is just the results of calculations, the agents cannot know everything very much, so they are not always very *certain*, this means that Uncertainty is exactly a kind of co-existence with calculational time, or Uncertainty and calculational time are the two faces of one body respectively. This point could also be demonstrated in another way: if you agree that knowledge was usually developed by the method of trial and error, the import of calculational time will believably put the agents in occasional errors at least before calculations are expected to arrive their *final destinations* neoclassically; assuming that there is only one answer correct, the answers incorrect must be credibly diversified, this means further that the differences or confusions both among different persons and between a person and his own pasts will reasonably happen, and therefore Uncertainty will happen too. The inferences above tell us that the conceptions, terms or phrases in economic literature such as Uncertainty, Limited knowledge, Innovation, Development, subjectivity, pluralism, interpersonal heterogeneity are essentially similar to one another, we need to treat them within a whole or unified framework. The inferences above also tell us that we could use scientific techniques instead of philosophical propositions to endogenize Uncertainty, and simultaneously we could obtain the *philosophical neutrality*.

Thirdly, the negligence of calculational time causes the exclusion of the stock of knowledge or thoughts out of economic theories and models. Zero calculational time means that anybody can carry out all or any calculation in any circumstance, whatever possible or impossible, necessary or unnecessary, useful or useless; hence, where would the knowledge be used? Isn't that a pure burden to the agents? We could recall some statements in a few works, didn't any writer state knowledge in this kind of tone? When the agents act on habits, some economists will say "that is irrational"; they called institutions "constraints". In my opinion, information, memories, theories, skills, technologies, habits, institutions, rules, ideas, values, personalities and so on are all different kinds of knowledge, each of them have been discussed under a certain economics respectively, and each of them help the limitedly-intelligent agents in a certain way; without the assistances of them, the practical calculations will credibly become blind and idiotic rather than free or perfect.

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The existence of positive calculational time means further that the calculational capability of an agent in one unit of time, or the calculational speed is finite. I think this is an accurate illustration of the concept of Bounded Rationality which, in my opinion, should not be explicated in any metaphysical way. Based on a finite calculational speed, similar to the Method of Roundabout Production of physical goods, knowledge as a kind of intangible capital will be endogenized, and its proper position in economic theories would therefore be found out. We could say that Bounded Rationality, knowledge and Innovation are in such a relationship as *Trinity*, i.e. when one of them is talked about, the other two should not be forgotten. This structure is critical to the synthesis of various economic theories. It is merely an extension of the original thoughts of the Austrian School.

Additionally, we need to be aware of the independence of calculational time in contrast to the concept of Calculational Expenses which has been included neoclassically in Herbert Simon's works as an item of the costs. The *extreme* mistake exposed an important neoclassical hint as the following: since changes of any variables will generally result in certain responses of prices, it could conclude that the prices would have *summed up* or *represented* all the other types of variables and information, therefore, only the information of prices should the agents consider during decision-making and correspondingly only commodity transactions should the agents care for during economic acting. This is a serious distortion of Hayek's famous points on the price system. Once we break the chains of determinism and keep a distance from it, the truth could become clear, i.e. in a circumstance where time staying, the fact that some changes of a variable result in some responses of prices does not necessarily mean that the prices have reflected or represented the meaning of the changes *completely so much* that the variable needs not to be considered any more. The intention to transform all kinds of variables and information into one single variable or one single type of information is merely one of the various forms of determinism or Doomsday. Although it could be regarded as a sort of calculation expense in principle, the calculational time cannot be measured entirely by currency because, in *Algorithmic* term, it is a *structural* item of expenses. Through similar discussions, it would also become clear that the mainstream economics have attempted to eliminate the independence of time itself as a general structural factor, and the concept of Interests or accrual has been used to achieve this goal.

Calculational time is so important, and its absence in economics results so extensively that we need to give the negligence of calculational time (together with the results it causes) a new name of *Neoclassicism*<sup>4</sup>. Neoclassicism is actually a pure and transparent system of thoughts, a milestone in the history of economics, and also a major reference for Algorithmic Theory. Through comparing to it, criticizing it and absorbing its merits, and along with the achievements of other economics, we could start to build a new system, that is, to enter into the *Algorithmic* era. Without Neoclassicism, there will be no Algorithmic Theory; furthermore, no understanding Neoclassicism, no understanding Algorithmic Theory.

Economic theories have ever been much close to the Algorithmic world. For instance, since Human Capital means mainly knowledge, it could suggest further for economists to treat thoughts or thinking activities in the way same as physical objects. As a proponent of the new growth theory, Paul Roamer assumed that investments in research and development will accelerate technological progresses. This is an indirect acceptance of thinking activities as subject to the cost-benefit laws. The concept of Expectation hints that economics should care for not only

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<sup>4</sup> It is said that Thorstein Veblen has ever used this word.

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information, but also the method of information-processing which, or the *Algorithm* is often uncertain and thus should be treated as an independent variable. Expectation possibly is the real beginning for the mainstream economics to introduce thoughts. The economist with the most advantageous conditions to initiate the Algorithmic Theory is Simon, as he is a giant both in economics and computer science. However, for decades of years, economics has wandered beside it all along.

The reason why the Algorithmic Theory was not proposed earlier lies possibly in technology. Both the introduction of calculational time and application of the Roundabout Method of Production require an appropriate theory on how human minds work. Among senior economists, most are aged and few have a deep understanding of computer. The technology and the engineering of Artificial Intelligence (referred to as “AI” hereafter) witnessed a historical and developmental process since the birth of computer. So far, a scientific explication on human brains and the cognitive processes has not been reached desirably, and the real answer to the riddle of life and intelligence, if existing somewhere, is not available yet.

The other reason why the Algorithmic Theory has not been proposed earlier lies apparently in philosophy. When we accept calculational time and the costs and benefits of thinking activities, this means that we are looking on human thoughts in a way very different from the traditions of philosophy, economics and social sciences. Pursuant to traditional ideas, thoughts should be behind the eyes instead in front of them; if thoughts are pushed to be the direct objects of social sciences in front of the eyes, a wide range of philosophical and methodological problems would arise consequently. The powers of traditions and habits are huge, which unless are revealed, criticized and attacked properly my readers would not grasp the essence of the Algorithmic Theory, and this new theory would not be rooted in the fields of economics and social sciences.

### **III. Philosophical Reviews**

Philosophical reviews will spread throughout the paper, and only some of them are included in this part. We review philosophy first, then turn to the philosophical aspects of social sciences, especially the discipline of economics.

If we apply the terms such as time, speed, cost and benefit to human minds, it means that we are treating the thoughts of mankind in the *same* attitude and the *same* method as physical objects, and we are treating both of them as objective realities which co-exist *equally* and interact with each other upstream or downstream. First of all, thoughts and physical objects exist in different places of the world independently and respectively; Second, the human minds cognize physical objects, which is the “upstream”, and the human minds command the body to work on physical objects, this is the “downstream”; Third, in principle, the above interactions ruin neither independence of them. Is this attitude appropriate philosophically? According to the results of my reviews, this attitude is really heterodox, although it is familiar to common sense. Philosophy has been exploring in relevant areas historically all along. The stagnation of economics is causally related to the confusion of philosophy. Nevertheless, the philosophies after Hegel (in China, they are entitled Modern Philosophies) have been approaching the standpoint above for over one hundred years, which exceed the progress of economics largely. Various ideas or approaches similar to the standpoint could be found in different kinds of works in philosophy, social sciences or humanities respectively. However, the standpoint and the relevant method by far have not been

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clarified clearly or formally. We could literally point out that the confusion in philosophy is also causally related to the absence of theories such as the Algorithmic Framework.

Thoughts exist in human brains. What kinds of thoughts are there inside a brain? What kinds of thinking activities have ever happened there? How different are they from the other person's? Have they changed or not? The answers to all these questions depend only on facts. Thoughts grow after one's birth, and disappear when one dies, this is just like what an organ inside a body or a plant does. The answers to the above questions do not depend on whether or not thoughts could be easily known. On the contrary, as we have been thinking everyday, we know thoughts very well. Descartes is famous for the viewpoints that thoughts should be regarded as the primary existence rather than anything else and thoughts could be known by us much easier than the physical world.

It has been a long time since the scientific community accepted the invisible or untouchable things as objective realities and objects of scientific research. However, when these objects extend to thoughts, the scholars balk and hesitate. Why? Some typical ideas need to be mentioned here first, that thoughts *reflect* the outside world just like a mirror reflects one's face, and all secrets or codes of the world have been hidden in human brains and eventually the world would get a complete insight of itself in the mirror of human thoughts; summing up, thoughts have actually been treated in a very special way, it has been unacceptable to present thoughts in parallel with physical objects; otherwise, assuming somebody insists in doing so, he will be accused of committing a logical mistake just as an income is counted twice in national income statistics.<sup>5</sup> This idea influenced the minds of intellectuals deeply and widely, including most of the scientists, even some of its critics.

The opposite to the *reflectionism* is the idealism, such as Hegel's Absolute Spirit, which takes thoughts or spirits exactly as objective realities but physical objects were depreciated or even excluded at the same time. German philosopher Theodor W. Adorno criticized traditional philosophies in an impressive way; he said, the traditional philosophies had being always pursuing *identity*, or it was assumed in advance that subjects are identical to objects. Subsequently, in Chinese saying, *either the east wind overwhelms the west wind, or is overwhelmed by the west wind*; philosophy struggled in the dilemma.

It was Kant who broke it. He initiated the Copernican Revolution in philosophy. According to Kant, since everything in the world is quite concrete and special, so is human intelligence, which would be neither ideal or sound nor absolutely incompetent to cognize the world. Furthermore, Kant believed that there was a series of logical tools congenitally in human brains, which could process the materials coming from the outside world, and thoughts would then be produced. Kant's philosophy appears like an economics. Simply put, the Algorithm Framework Theory could be regarded as an application of the Kant's idea.

Husserl is a successor of transcendentalism. However, transcendentalism did not enjoy a good reputation, because the ideal forms of the logical tools a priori in human brains have not been found so far. Restricted to the shortage of language, Husserl, Heidegger and lots of *Modern Philosophers* had to write in strange, eccentric or obscure terms or styles. Nevertheless, the atmosphere in philosophy has changed greatly since Hegel. Most Modern Philosophies entail some reactions to the traditional. Generally speaking, Modern Philosophies care for humanity and the society, emphasize phenomena, factors or ideas such as perpetual changes and generation, time, intuition, common sense, irrationality, limited knowledge, subjectivity, uncertainty, practice,

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<sup>5</sup> Gilbert Ryle is well-known for his arguments as such (Ryle, page 4-13).

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difference, pluralism, constructionism, etc. A prevailing relevant viewpoint is that the topics of Modern Philosophies are diversified and there is no structure on the whole; furthermore, few dialogues occurred among the philosophers in different schools. However, this is not true. There was actually a highly unified structure or a highly consistent logic among different streams of Modern Philosophies, while each stream discussed a certain aspect of the structure. All the philosophical arguments after Hegel could be regarded totally as preparations for a unified social science (even including the humanities). The Algorithm Framework Theory would be a summing-up or a conclusion of Modern Philosophies, and also would be a basis for the upcoming general and single social science. The consistent logic or the structural wholeness is briefly presented below:

The congenital logical tools in human brains process the information acquired, and the so-called *rational thinking activities* are therefore formed up. Due to the introduction of time and finite calculational speed, the knowledge achieved at any time is finite and incomplete; however, time do not wait for us, most real problems that people face in the real world need hence to be solved in a limited period, and how would the agents do then? Therefore, also as a part of the congenital spiritual equipment, irrationality, subjectivity, common sense and intuition will work in practice. A project constructed in this way would not be a pure reflection of the outside world, which is what constructionism means. Finite knowledge means the world would always volatile and mysterious in our eyes, which not only needs theoretical comprehensions but also non-theoretical descriptions, understandings and feelings. Thus, historical and literary works could be regarded as some parts of social sciences which are complementary and indispensable to the social-science theories.

The consistency or unification of Modern Philosophies could further interpreted as a preparation for a desirable dynamic social science. A proper dynamics needs to go a long roundabout way, which few people have seemingly perceived. For instance, the philosophers who cared for time and changes often stressed some permanence or perpetuation. Heraclitus said that the world was fluctuant on one hand, while on the other hand, permanence still remained, which was exactly the logos. The approach as such was also employed when anthropologist and philosopher Claude Lévi-Strauss compared mythology with science, or when Noam Chomsky analyzed language. Additionally, as mentioned above, there is a natural relationship between dynamic theories and pluralism. Differences cause thinking and hence actions, so thinking activities and behaviors mean the intentions and attempts to construct consistency among diversities. Jacques Derrida preferred the principle of *Difference in Priority*; he believed that differences should be prior to identity, diversity should be prior to singleness, finiteness should be prior to infiniteness, volatility should be prior to definiteness, particularity should be prior to universality, etc. Derrida holds an exceptional point that we could not really grasp differences until time and events become the basic elements of our cognitive framework. This point proves that Derrida has already perceived some wholeness among the various topics of Modern Philosophies.

Among the pioneers of Algorithm theory, Ernst Mach has to be referred here. His *Thinking Economics* proposed that significant costs would occur during thinking therefore the thoughts or theories had to be reshaped adaptively to lower the costs and to enhance the efficiency of thinking. Husserl, who was in disfavor of the Thinking Economics as a philosophy, had to admit that Mach's approach could lead to extremely important results<sup>6</sup>. In fact, the pragmatism in America

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<sup>6</sup> Husserl, 1994, page 172.

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was derived partially from Mach's ideas. Apparently, the intellectual circles have misunderstood Mach and the relationship between his points and other philosophies for long times.

Now we turn into a brief review on some philosophical aspects of social sciences. There are much more approaches or tendencies adjacent to my standpoint in social sciences, especially in sociology. Emile Durkheim is one of them. He maintained that social facts or social phenomena should be regarded as *things*, and only in this way could we be able to study them scientifically, and this idea should be the primary principle of social sciences. Wittgenstein called social objects *facts*. The Sociology of Knowledge treats human thoughts as its direct objects or objective existences. Nevertheless, none of the relevant writers above had reached the point that human thoughts as a kind of objects of social sciences should be placed in a position completely equal to physical objects; Durkheim even refused it clearly. We need to ask the following questions. Are social phenomena composed both of physical objects and mental objects? If the latter were non-existent, should social phenomena equal physical phenomena? Do laws equal the paper that the laws are written on? Do organizations equal the buildings the organizations are located in? Do speeches equal the sound waves where the speeches are loaded? Apparently, thoughts should be treated not only as existences, actualities or realities, but also the major or central objects of social science.

The missing of thoughts in social sciences was strengthened by the emergence of behavioristic psychology, and the internal conflicts of social sciences were hence aggravated. However, along with the expansions of the Cognitive Revolution, behaviorism has been retreating for decades. By now, the movements have already spread into economics.

Possibly on account of the material wealth as its major object traditionally, economics could be the remotest discipline to our standpoint among social sciences. It has been a long-lived and deep-rooted tradition of economics to prefer substance to human, or prefer material to thoughts; only physical phenomena and human's physical actions were accepted actually by economics as its objects to study (in Marx's words, this was called *commodity fetish*). The presence of material elements was regarded as a guarantee or symbol of scientificity or reliability of *economic science*, meanwhile, human elements diminished to the minimum level. An evidence reflecting the methodological attitude above could come from the historical debate on what kinds of activities were really creating values, or hence from the definite separation of commodity circulations from commodity productions. During the early stage of classic times, nothing but land was alleged to create values; the manufacturing industry was not accepted as a value-creator until later. According to Marx's labor value theory, productive labor created values because it was deemed as a kind of physical action rather than mental activity and it was connected closely to commodity production; meanwhile, the commercial or financial activities, due to their separation from commodity production and their homogeneity to human minds and interpersonal communications, were excluded from the value-creators. The modern mainstream economics is actually a successor of this tradition. In order to safeguard the hardcore, some protective belts were equipped with, one of them was to make analogies or parallels. For example, the Service was a parallel to the Commodity, the Demand (which exists only inside one's brain) was a parallel to the Supply, the Mental Labor was a parallel to the Physical Labor, the Transaction Cost was a parallel to the Transformation Cost, and the Human Capital was a parallel to the Material Capital. The method of analogy helped expand economic conceptions. Another belt was political ethics or the Hume's Lever-Knife, which was used to separate rational analyses from subjectivities, irrationalities,

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human natures, value judgments or personal preferences, therefore, it appeared that all thoughts, minds or mentalities have been seemingly included in the frame of economic analyses. Although these deceptive tactics could placate critics temporarily, they are essentially superficial. In Chinese saying, *a fire cannot be packaged with paper*.

Various writers realized to different extents where the crux was. For instance, Karl R. Popper said there are three worlds, and Carsten Herrmann-Pillath proposed the Bimodal Evolutionary Ontology<sup>7</sup>. However, until now, it seems that almost all relevant writers are attempting to avoid the above simple, direct and clear standpoints of this paper, and everybody seems to want to retain some privilege or vagueness for human thoughts (Husserl's *Intentionality* could also be an example as such). In my opinion, it is crucial for the Algorithmically-approached social science to clarify this issue. A thought is like a *concrete* thing inside the human brain, and it means a person's own affair and none of the business of the world outside. Exactly like different things feature different characteristics and relate to each other in certain ways, certain interactions would occur among different thoughts and between a thought and a physical thing. We should treat social sciences and natural sciences equally in this whole picture. Neither substance nor thoughts should we worship, neither should we make individualities absolute, nor put relationships or wholeness prior to individuals. A task of social-science research means *a thought* is facing and studying *another thought*, thus a theory on discreteness of thoughts is needed, and a certain method to define a minimum unit of thoughts is needed further. All these tasks will be undertaken by the Algorithmic Theory. A prerequisite condition for research of thoughts is that both the differences among thoughts of different persons and among a person's different thoughts should be endogenized; only the condition is satisfied, the thought could be able to *watch* and *study* the other thought easily, deliberately and effectively. In another word, a necessary condition for the research of thoughts is that theories of social science should be consistent with the methodology of social science.

The Algorithm Theory is quite similar to the Structuration Theory of the well-known sociologist, Anthony Giddens, which has allegedly established some essential consistencies among various sociological theories. We could be encouraged by Giddens' success. Nevertheless, the Structuration Theory is immature, inaccurate and vague, with some mistakes still inside. The Algorithm Theory should be an omni-directional upgrade of it. The birth of computer is partially a result of Analytic Philosophy which is also a member of Modern Philosophies. Economics and social sciences have been impacted by computers in various ways. There is prominently some transcendentalism in cognitive sciences, but it seems that the cognitive sciences by far have not realized the necessity for a theory as presented here, which, in my opinion, would be a proper tunnel for social sciences to absorb the findings of cognitive sciences.

The current literature of economics and social sciences look quite old-aged, obscure, complex and fragmented. It was widely believed that the truth were often simple. Simplicity is just what the Algorithmic Theory features.

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<sup>7</sup> Dopfer, 2004, chapter III.

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## IV. The Theory

### 4.1 A Brief Introduction to Computer Principles

In order to analyze human thoughts as objective realities, and to illustrate the finite speed of calculation, and also to meet the scientific requirements of accuracy and rigor, we need a desirable theory of social sciences on how the human minds work, and the Algorithmic Theory is then proposed hereafter, which is based on the principles of computer. Considering our particular purposes, the theory differs again from computer science significantly and essentially.

As another preparation for the Algorithmic Theory, a brief introduction to the principles of computer is needed. Since computers have already become usual tools to almost everybody, the introduction should be limited to the central contents. First, an idea or basic principle could be contributed to social sciences that logical thinking is fundamentally similar to mathematical calculations, both of them can be generalized into one concept which is called *computation*, and any of them can be regarded merely as a certain sort of computations. The service or functional jobs a human brain carries out can also be regarded as some sorts of computations. A basic sort of computation is called an *Instruction*, which originally meant a basic type of job a user *commanded* the computer to do and then was extended to the basic type of job a computer is able to do. A commodity computer usually contains a finite number of Instructions, the number of which varies from tens to hundreds. All Instructions are classified generally into five types: Data Transmission, Data Processing, Program Control, Input & Output, and Hardware Control. Any task of the users must be transformed or expressed in the form of “Instruction + data” and hence the computer is able to execute them. The Instruction System remains unchanged during a computer’s whole life and only an Instruction in the Instruction System or the *Instruction list* can be recognized and executed by the computer. Instructions process various sorts of information. Paralleled with the diversity of instructions, information or data are also diversified. A certain Instruction matches certain data; each Instruction is formatted particularly and fixedly, which processes only the datum or data of particular type or of particular nature in a very limited amount. One Instruction is executed once, it is called *one operation*. Only one operation proceeds at any moment in a classic computer. A computer runs at a limited speed, this means, a finite operations are undertaken in a unit time. Therefore, in order to fulfill a complicated task, enormous Instructions need to be connected in series or in queue to be executed. This method is called Serial Processing, and the series or queue is called Program. Serial Processing requires the ability of memorization or storage of data. Once an Instruction is executed, the result will be stored in memory, which could possibly be recalled later, and then the next Instruction is executed continuously; thus the method of Serial Processing is exactly the method of Roundabout Production in economics. Both as the results of previous operations and the resources for upcoming operations, enormous programs and data are usually stored inside a computer. The structure and methods as a whole is called the *Von Neumann Architecture* (see Figure 1), which is a commemoration of John Von Neumann as one of the major inventors of computer, who is also the major founder of Game Theory.

Now, a brief comment on the computer science or engineering is in order. First, I would like to use the word *shocked* or *excited* to express my feelings when I got to know the computer principles above. It has been over one century for economists to search for principles as such



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computer, the cognitive scientists generally accept that there are some parts or arrangements responsible for short-term memory and long-term memory respectively inside a human brain, so do we assume too. All thinking activities including memorization take time and energies, and therefore ought to be regarded as *behaviors*.

Let us turn to the Instruction System, which was generally ignored in relevant literature, but I think it should be put at the centre of our framework. Based on existing scientific discoveries, the results in AI, relevant philosophical thoughts and consideration of convenience, similar to a computer, it could be assumed that there is an Instruction System congenitally inside a human brain, and the set of Instruction of a computer is a subset of the human's. A human's Instruction System keeps constant during his life and equals to one another's, that is, we assume that the mankind has been sharing one Instruction System which has never changed since the initiation of history. Although the organs' nature or its performance varies interpersonally and physiologically, it does not influence the nature of Instruction System but the efficiency of thinking activities in general, unless some organs fall in heavy diseases. We assume that thinking and calculation, or the so-called *rational thinking activities* are composed only by the way of "Instruction + information" which, as an imitation of computer, are called *computations*; information or the materials memorized could hence be called *data* sometimes. Are the other mental or psychological activities, i.e. *irrational thinking activities*, composed also by the way of "Instruction + information"? Let us do not answer this question for the time being. We care for computations first, then we will attempt to demonstrate that among daily thinking activities, most of them could be included in the concept of computations, and most of the *irrationalities* are essentially or significantly similar to *rationalities*; the gulf between them was caused mainly by some mistakes, which further divided both economics and social sciences into fragments.

The assumptions above need to be explained shortly. Apparently, the Instruction System exists only inside a computer, it actually reflects the structure and mechanism of human brain. It is a person as the user who *tells* the computer what to do, it is also the person who understands the natures and meanings of the computational results. The Instructions are transformed into digital series of 0 and 1, which are represented by high and low potentials in electronic components respectively and are processed at a high speed, the computer does not *know* really what is being done. Although the Instruction Systems of different type of computers differ from each other to some extent, they are commensurable in principle and therefore the differences could be deemed inessential. It is not necessary for social scientists to treat the Instruction System as a black box. The Instructions could be deemed approximately the common kinds or forms of logics although each of them could be decomposed and re-structured in a complicated way in computer. As long as we believe that the logical tools are congenital, universal and constant, or they reflect some mechanisms or functions more fundamental or more stable in human brain, the above assumptions would be significantly reasonable. The impressive achievements of AI could be another support. Nevertheless, considering some negative opinions on the future of AI, some human Instructions are supposed not able to be emulated by computer, which hence are entitled *Artificial Instructions*, by which the agent in our theories is certified hopefully to be a real person instead of a robot. Simplicity and convenience are also among our considerations. Any other approaches than *the Algorithmic* would make things too complicated and less effective; in my opinion, this is just the lesson we could learn from the existing transdisciplinary approaches where the scholars were unduly careful and consequently yielded little. For example, the Neuroeconomics looks quite

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*scientific*, however, when records of electronic pulses are directly used as evidences to support some social propositions, it looks quite absurd. This kind of method, in my opinion, should not be a major approach of social sciences before the secrets of life and human brain are revealed. I will show below that the above assumptions allow us to solve the problems of social sciences while continuing to use the traditional methods of social sciences. The Instruction System of computer is deemed a kind of *interface* between hardware and software, which frees programmers from involving in hardware problems while programming. Corresponding arrangements as such are also needed in social sciences.

We assume that there are a finite number of Instructions inside the human brain which could be listed definitely, although we do not know the accurate details for the time being. An Instruction processes data and gets a result independently. This is called *Independence of Instruction*. One Instruction is executed once, it is called one computation, one operation or *Meta Operation*, which could be deemed the minimum unit of human's thinking activities and cannot be divided meaningfully. Only a finite number of Meta Operations can be executed in a limited period, which means that the speed of computation is finite or limited. A certain Instruction processes certain data or information, always gets the same result regardless of who is computing, when or where. Therefore, in case that a result of certain computations is different from another, the difference must be caused by one of the following reasons: (1) using different Instructions to process the same data; (2) using the same Instructions to process different data, or (3) the operations were conduct in different orders.

The sorts of human Instructions can be discussed further. We consider only the fundamentality of Instructions despite whether or not they can be executed by a computer. Identified by the criteria including the above consideration, apparently the Conception, Judgment and Inference (both deductive and inductive), or the basic elements to form them, ought to be deemed Instructions. Based on literature in the Intelligence Science, Analogy, Analysis, Synthesis, Abstraction, Generalization, Learning, Search, Association, Imagination, Lotting and so on, or the basic elements to form them, can be included also in the Instruction List. Search and Association are very important, which are indispensable for inferences and we will discuss them in the next part. Imagination as an emulating tool can assist to build virtual environments and consequently to save physical actions or practices. Thanks to the free will, the human is capable of lotting, which a computer is unable to do really and thus can be deemed an Artificial Instruction. Except lotting, most Instructions above can either be emulated by computer or AI engineers are attempting to emulate them. AI is progressing daily.

Similar to computers, human's computations are carried out by the method of Serial Processing. A series of operations aiming to solve a certain problem(s) are called a program. A program can be fairly abstract so as to solve a group of similar problems. Programs and data are different types of knowledge, but they are stored in the same way. We assume that there are enormous and various programs and data stored inside the brain of an adult, for example, Cognitive Programs (opinions as the output), Decision-making programs (decisions as the output), Managerial (service) Programs (manage and coordinate the operations of the brain, just like the operation system of a computer), Controlling Programs (a subsystem of the managerial programs, which controls the operation of the body and runs in parallel with physical actions), etc. One program could be affiliated to another, so the execution of one program can be triggered by the execution of the other. The method to structure a program using Instructions and data is called the

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*Algorithm*, which is the core of a program; therefore, the proposed theory is entitled the *Algorithmic Theory, Algorithmic Framework or Algorithm Framework Theory*; the approach to build economic theory and social sciences using the Algorithmic Theory is called the *Algorithmic approach*, which is distinct from that emphasizing only the constraints of information supplies. Correspondingly, a person who thinks in the way described above is called an *Algorithmic Person*. Once the people in the real world are substituted by the *Algorithmic Persons*, we will enter the *Algorithmic world*. The word *Algorithmic(al)* in this paper sometimes means “of Algorithm Framework Theory”, “Algorithmically-approached” or “of the Algorithmic world”.

The running of a program means a roundabout method as “flow-stock-flow” is used. As results of earlier computations and historical accumulations, data and the programs are pre-stored in a computer; when an Algorithmic Person need to decide on something (the computations needed for the time being are called Temporary Computations), data and programs, as the stock of knowledge, *tell* him the relationship between his problem and certain information, provide for him the parameters the Temporary Computations requires, and guide data-searching, etc. The roles, functions or importance of knowledge are apparent and definite here. Traditional approaches can do nothing to reveal the importance of knowledge. For this purpose, the most important, in my opinion, is to comprehend how empty or hollow the Temporary Computations become under the context of limited computing speed and zero stock of knowledge. This is what the Algorithmic Theory could provide.

Based on the Instruction System, interpersonal communications could be realized in the way similar to the computer. The Communication System is a system composed of complicated series of software and hardware, which transforms computational results into physical symbols such as the natural language and characters and vice versa. In this way, we could understand the relationship between thinking and languages appropriately, while the latter, in my opinion, has been placed in an unduly high position somewhere in social sciences or humanities. Furthermore, in this way topics such as contracting, deception and persuasion will enter into our visual fields, which wholly as a category of *Algorithms*, mean that the *Algorithmic Persons* can intervene positively in formation of desirable environments for them so as to make their actions easier, therefore we call the category of Algorithms “Positive Algorithms”.

What presented above are the major points, and other details of human thinking are assumed in principle to be similar to the computer.

## **V. Extensions, Corollaries and Applications**

Albert Einstein said, “Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed.” The Algorithmic Theory will produce a series of concepts, tools and corollaries in turn and lead us into a large and colorful theoretical world.

The finite speed of Computation means that the power and capacity of consciousness are finite, which, matching with one’s limited observing ability, means one’s limited attention. Thus, concepts such as Computation, Consciousness and Attention could be deemed roughly the same thing. Consequently, *unconsciousness*, which appears quite different from or independent to consciousness, will emerge. We discuss consciousness first, and then turn to unconsciousness. Since they are inside the consciousness, purposes, intentions and expectations can be distinguished

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from physical actions and their results. The subsequent comparison of a purpose with a result will lead to the concepts of Success and Failure. Thanks to memorization and the independence of Meta Operations, an Algorithmic Person can record his computations and recall them in retrospect at another time, this is called Retrospection or Self-objectification. Algorithmic persons can observe one another's behaviors and get to know one another's thoughts and vice versa, this is called Inter-objectification (which could be renamed jointly with Retrospection as Re-objectification). Isolated from the outside world, an Algorithmic Person can compute the data and programs existing inside his brain for a significantly long time, this is called Pondering.

The *Algorithmic world* is structural. We define the *Structurality* as any characteristics that can not be measured quantitatively. Structurality, including discreteness, heterogeneity, etc., causes relative motions and various non-linear phenomena. The structural Algorithmic world is the beginning of the Algorithmically-approached social science. This means that we choose a starting point distinct from the Neoclassicism which started from a fictitious environment customized for a particular purpose. The Algorithmic world should be regarded as a general environment for theoretical developments, although fictitious environments are sometimes still necessary; the latter could be deemed affiliated to the Algorithmic world.

Now let us conjecture what would happen in the first day of the human history. Since cognitions of various existences in the world and relationships among them were results of human's computations, the agents must be utterly ignorant, everything stayed independently in their eyes and no consistency was found at all. Now they started to receive information. As each body stayed in different positions and their visual fields were limited, the information received must be quite different from one another's and could not be unified *fully* until the computations were *fulfilled*. The differences of the information received must be reflected to some extent in the results of everybody's computations and therefore in their discourses and actions, which is called Exogenous Subjectivity. The fact that agents were utterly ignorant means that none of them knew how to process the information received. Apparently, what an agent could do was just to lot or compute randomly, which means he used an Instruction to match one or more data arbitrarily. We call this kind of computations the Pure Simple Computations, which could lead to different results even using the same original information, and we called the Random Subjectivity. Pure Simple Computation would be a very important concept or *Algorithm*, which could play an indispensable role in human thinking almost at any time.

Once some Pure Simple Computations were finished, the agents had to distinguish the correct results from the mistaken. There were two methods, one was to practice, to try or to experiment, and then compare the physical consequences with the computational results. This is what we know well. The other method was to test them by logic. Why can logical tests be used to judge what is right or wrong? First, since Instructions were formatted congenitally and fixedly, this means that the criteria between correctness and wrongness had already existed in human brains prior to any computations being conducting. Why are we so certain about logics and mathematics? According to Kant, this is because these disciplines mean that the human intelligence deals with itself<sup>9</sup>; they could also be deemed self-portraits or exercises of intelligence.<sup>10</sup> Meanwhile, we need to

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<sup>9</sup> Kant, 1890, page XXV.

<sup>10</sup> Mises said: "The a priori categories are the mental equipment by dint of which man is able to think and to experience and thus to acquire knowledge. Their truth or validity cannot be proved or refuted as can those of a posteriori propositions, because they are precisely the instrument that enables us to distinguish what is true or valid from what is not (Mises, 1962, page 18)."

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distinguish “*computing in correct formats*” from “*computing compatibly with the outside world*”; the former, which is just what a person can do only, is unnecessarily equal always to the latter.<sup>11</sup> Second, as a Meta Operation was carried out independently to another, naturally the result would need to be coordinated with the other’s, which hints that the subsequent logical tests would be both necessary and fruitful. In the wake of the tests, identifications and screening, some results were given up, and the others retained as knowledge which were deemed correct or useful. Knowledge would generally make computations more directional, more efficient and more useful.

However, the amounts of computations accomplished would always remain finite regardless of how long the history of mankind have lasted or how many computations have been done, and it would be unreasonable to expect the status including the predicaments of mankind on their first day described above to be improved fundamentally or substantially over time. Due to various constraints on interpersonal communications or coordination, huge numbers of computations happened isolatedly and repeatedly. When people died, knowledge was destructed and therefore the reconstructions were needed. The total stock of knowledge both of mankind and of a person must be limited. On the other hand, considering the continuous supplies of information, and the fact that computational results can be re-computed as input, as well as the mathematics of permutation and combination, we could conclude that the potential or possibilities of knowledge should be infinite.

Agents would retrospect their pasts occasionally. Their experiences and failures would force them into perceiving both the extensity of the world and the relative finiteness of their own knowledge. In addition, practical problems in their lives are tough and urgent, and some decisions must be made in time; then how would they compute and decide? A question as such is called *Algorithmic Person’s Question* which could be quite real and typical and essentially distinct from the problems faced by neoclassical Persons. One of the answers is this: the Algorithmic Persons would deviate from the pure deductive approach or the neoclassical track. If the latter is deemed *Orthodox Algorithm*, where the Algorithmic Persons will go could be called *Heterodox Algorithms*, some of which are detailed such as Induction, Assumption, Trial & Errors, Experimentation, Adventure, Simplification, Approximation, Intuitions, and the *Social Algorithms* such as Learning, Inheritance, Positive Algorithms, Enforcing, Fighting, etc. Any of these Algorithms can be used to save time and enhance efficiency in order to make decisions in due time. As each of the Algorithms is special or *characteristic*, the Algorithmic Person will have to structure a combination of Algorithms or Instructions as optimized as possible, just like a manager has to decide input combinations for the production of commodities. Subsequently, the daily thinking activities and the thoughts are formed up.

The above is one of the central points of the Algorithmic Framework, which could be further illustrated by an analysis of a syllogism. A syllogism means that we can reliably deduce one conclusion from two propositions as premises. But how are the premises formed? In fact, they are formed usually by the *Heterodox Algorithms* such as Induction or Assumption. Another related question is: how do these two propositions gather together? This is just the result of Searching or Association. A proper association is actually not easy to achieve and therefore deserves a high value, which is often what a syllogism really tells. Given a finite speed of computation, it will be

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<sup>11</sup> Mises wrote: “In stressing the fact that the logical structure of the human mind is common to all specimens of the species *Homo sapiens*, we do not want to assert that this human mind as we know it is the only or the best possible mental tool that could be devised or that has ever been and will ever be called into existence (Mises, 1962, page 17).”

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impossible to associate all of the knowledge properly and consequently any deductions achieved must be partial and the relationships among them will not be known entirely, the knowledge system is hence fragmented. The additional consequences are, the search for knowledge is important, but it has to be undertaken locally or partially. This implies the Searching Subjectivity.

Various economic theories usually emphasize different Algorithms, different Instructions and their economic results; this is where the unification of them lies in. Decision-making includes not only the cognitive processes, but also the projection for actions. Next we are going to illustrate the relationship between cognition and projection or between social science and social engineering.

Neoclassicism implies an ideal assumption that computations could be done in sacrifice of nothing, the projects for actions could be structured and evaluated one by one until an absolute optimum is found. However, this ideal is unreachable Algorithmically. Since knowledge is limited, the problems in Temporary Computations may not be completely covered by the knowledge available, and typically the latter could just be an intersection of the former. The agent has to handle those variables outside his stock of knowledge temporarily by himself. Under finite computational speed, he could neither structure all possible projects nor evaluate each of them, therefore he has to appeal to the *Heterodox Algorithms* for help. He will speculate, and in the end only a few projects could be structured, evaluated or adopted. This is called Constructive Subjectivity, which is what *engineering* really means and how it differs from science, as both are confounded or hidden under the neoclassical framework. A decision is hence made and followed afterwards by an action. A behavior or an action, which we say frequently, means not only what were considered *ex ante* by the behavior or the actor, but also what were neglected and how the negligence was carried out. The factors or elements that a behavior or an action contains must be very limited, partial and finite in comparison with those available, which until is perceived, we will not know the *behavior* or the *action* really.

The above does not imply that Temporary Computations are essentially distinct from the stock of knowledge, as the latter can be further deconstructed with the concept of Pattern. Algorithmic Person's Questions means that an agent is always in the following dilemma: in order to compute precisely, any knowledge of anything is necessary; nevertheless, unless he cognize and handle the problems before his eyes correctly, he can not grasp the whole world appropriately; on the other hand, unless he grasp the whole world appropriately, considering the computational time and costs, he cannot confirm that Temporary Computations had started prudently and proceeded properly. The agent is apparently impossible to solve the problem neoclassically. An Algorithmical answer to it is to structure a *Pattern*, which means among many variables some parts of them have *fixed* or *constant* values, although they could otherwise be valued flexibly. The flexibilities are sacrificed in order to save computational time and costs. A Pattern is usually based on experiences or some partial analyses, and therefore not fully reliable; the adoption of it is more or less risky. The *Patternized* Computations means that computations are structured as "some variables on Pattern + the rest on discretion". Although the variables related to any Temporary Computations are ultimately uncountable, most of them would be valued by the Patterns existing in human brains in great amounts, so that the rest could amount quite less and hence be handled in time quite easily.

Most programs or knowledge can be regarded as Patterns. Except the Self-Portraits of Intelligence above<sup>12</sup>, the existences of Patterns mean that any *practical* or temporary computations

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<sup>12</sup> The *Self-Portraits of Intelligence* should not be regarded as a precise word. Pushed by computer science, the

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and decisions in the Algorithmic World would not be precise *enough* and could only be undertaken simplifiedly, approximately and fuzzily; this is the other face of knowledge that has not been revealed by rationalists until now.

Pattern should be an extremely important concept in economics and social science<sup>13</sup>. A person can build up some Patterns for his own, including rules for self-discipline (e.g. I must get up at 7:00am everyday, or eat supper as less as possible). For a group of people or a society, the Institutions could work as a kind of Pattern regulating interpersonal actions, which are usually established via interpersonally contracting and implemented under supervisions, and the violation of Institutions will be punished. Correspondingly, organizations can also be explained in this way: in a society consisting of interpersonal differences and conflicts, as the interpersonal conflicts cause wastes of resources, it will be quite profitable to unify the intentions of different persons and coordinate their actions appropriately in certain scopes, and therefore a person or a team as a center to make decisions and command all its members would be needed. On the other hand, the unified decisions, as results of Temporary Computations, need to be made also by the method of “some variables on Pattern + the rest on discretion”, and consequently there are both intensive institutions or rules and the head(s) for discretionary decisions in an organization, the latter means further an economic definition of *Power*. In particular, the sizes of organizations can be interpreted by considering computational abilities of the head(s), expenses of Communication, etc.

The finite computational speed implies that human intelligence is like an arrow, which has to point at a particular direction rather than all directions at a certain moment. Therefore, the *aim* or *purpose* is actually an Algorithmical concept, which relates closely to behaviors or actions; in some cases, it can also be deemed a part of the Algorithm. On the other hand, the limited knowledge could lead to mismatches between the aims and the consequences of actions, and therefore the occurrence of Unintended Consequences; the latter might be positive in some cases. Thus, we arrive at Adam Smith’s *Invisible Hands*, which implicitly takes human thoughts and consciousness as variables independent relatively to the physical world. In the Algorithmic world, computations or behaviors usually would not be synchronous; in other words, different persons often do different jobs at the same time, or the same job is often being done by different persons at different times. This phenomenon is called *Asynchrony*, which means further that a certain phenomenon can be deemed the aim of A, but only an unintended consequence for B or even nothing; a person could be led unwittingly or ignorantly by some hidden means from others, this is called *Semi-Internalization*, which is a common and important social effect. When the *Invisible Hands* were visualized by Adam Smith, the Unintended Consequences became *semi-internalized* and the national welfare or macroeconomic performances became the concerns or aims of legislators and government leaders, although they still remained *unintended* for common people.

In the Algorithmic world, it would not be difficult to prove that the differences or discords among different persons or among the different computations or thoughts of a certain person would frequently occur; but because internal transmissions of data inside a person’s body are much more convenient than interpersonal communications, the degree of internal consistency of a person would be much higher than a group’s. This point can be used to understand the consistency, relativity and competition between methodological individualism and holism, as well as the necessities and possibilities of Innovations. The relationship between the present and the history is

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traditional logics have progressed significantly.

<sup>13</sup> The scholars in AI are always confused with patterns, which, I think, have been clarified by the economics-based Algorithmic method; this could be a return of economics to computer science and AI.

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treated by Neoclassicism as that between a part and a whole, while the whole is deemed a picture and everyday merely a fragment of it. However, under the Algorithmic framework, because the agent cannot avoid the problem of wholeness in any practical Temporary Computations, he has to draw one *panorama* of the world for each Temporary Computation or each practical problem, we could assert that there must be some vagueness, approximation and mistakes inside each *panorama* and the later one would contradict with the previous one in some senses, somewhere or to some extent. This is our interpretation of Schumpeter's *Creative Destruction*. Because both information and Algorithm varies Innovations can be classified into two types as Information-Driven and Algorithm-Improving, while the former is caused by the introduction of new information and the latter is caused mainly by Pondering. In the wake of an active process of Innovations, the marginal computational benefits will decrease finally and progressively; this effect can be called *Convergence*, which could, temporarily or permanently, lead to an equilibrium occurrence *within a finite scope*. On the other hand, while Convergence happening, some resources for computations are saved, which could be invested again in new areas or topics, and therefore computations will return active; this is called *Divergence*, which would probably break the existing equilibrium. Social processes are a mixture of convergence and divergence. As the world is infinite, the human society progresses just like the universal Big Bang described by physicists, despite retrogressions happening occasionally and understandably. The accumulation of knowledge and Innovation could be deemed the major causes of the roughly unidirectional progresses of the society.

We could reasonably demonstrate that there are appropriate positions in the Algorithmic World respectively for ideas, attitudes, preferences, beliefs, values, habits, experiences, reputations, virtues, altruism, personalities, fondness, etc. Each of them is either computational results or a part of computations. An important consequence is that the *Rational Thinking Activities* are absolutely not what they are conventionally supposed. Algorithmically and literarily speaking, *Rational Thinking Activities* are actually quite tendentious, habitual, ethical, individual, and even emotional! Based on the above views, now we will enter into a discussion on *irrationality*. Behavioral Economics emphasizes the human nature, and prefers to attribute any non-neoclassical characteristics of human behaviors to the human nature. However, in case that most of the *human natures* could be explicated Algorithmically, pursuant to the rule of Occam's Razor, *human nature* ought not to be excluded from the Algorithmic Framework, and Behavioral Economics therefore should also be synthesized into it. This point may be rejected because some quite reliable evidences have shown that some traits of personality come believably from biological inheritance, and the human emotional system is prominently different from the intelligence system, hence the topic of *irrationality* should be separated from *rationality*. However, when the *irrationalities* are contrasted with Patterns, the differences between them can be viewed as technical rather than essential. With respect to their functions or the effects to the rational system, instincts, impulses, human natures, emotions, sentiments, intuitions and psychologies could generally be deemed fairly *Patternized*, which process information in fixed ways automatically outside the consciousness, we believe, at finite speeds. The results of the processes could enter into the consciousness and then influence decision-making. On the contrary, the fact that a mind sometimes can cause emotional responses demonstrates that the intelligence system is able to influence the *irrational* system by way of providing materials or input for it. In summary, the thinking system is active or positive, which can be supposed capable of collecting all the results

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and output from each system (both rational and irrational) and then make the final decision. The thinking system is apparently able to intervene in any spiritual activities, although it may not always do so because of limited attention. One of the technical differences is that a Pattern can be revised easily but these *irrational Patterns* are like *hard software*, which means that they are fixed in certain organs or tissues and can only be influenced from outside but cannot be changed or revised directly.<sup>14</sup>

The term *Cultural Evolvement* can be used effectively to compare the above two systems. Evolvments of the *irrational* system might be caused by the evolvments of organs and tissues biologically, which proceeds extremely slow and is hardly perceived by observers; on the contrary, evolvments of the intelligence system, or the *Cultural Evolvments* go very fast. *The tremendous advance of Homo Sapiens (i.e. the human) in the last 10,000 years must almost all be due to harnessing the plasticity of that brain in radically new ways -- by creating something like software to enhance its underlying powers.*<sup>15</sup> The most important is not how much *knowledge* we have inherited from our ancestors, but the mechanism of computations as well as the facts that the intelligence system requires knowledge and produces them in enormous amounts daily, which are comparable to the *irrational and fixed knowledge* above. Moreover, measured quantitatively, the latter might be much less than the former. Although psychologies could, as Freud said, be guided or managed by some methods (e.g. the talk therapy), the methods should belong to the intelligence system. It is helpless to emphasize *irrationalities* solely and repeatedly, which we have to face and accept. In contrast to *irrationalities*, the *rational* system is prominently dominant and leading, which we should put in the priority and make it clear first.

## VI. Additional Comments on Current Economics and Methodology

The synthesizing of existing economics has been included fundamentally and mainly in the statements above. In this part we will give some additional comments on them, and then briefly discuss the issues of methodology.

The introduction of a finite speed of computations would constitute a fatal attack on the neoclassical framework and guide us into a huge theoretical world, where various oppositions of the mainstream have stayed for a long time and they could assemble now. I believe this means both a great synthesis of economics and a gateway to the future social science.

The mainstream economic theory is mainly a theory on price-formation, therefore economists of the Chicago School have properly named it the *Price Theory*. The original intention of classical economists was to see how the prices were formed while ignoring any indirect or long-term factors for the time being. Consequently, Marshall's classification of the short-term and the long-term could be quite appropriate. The equilibrium, whatever short-run or long-run, static or dynamic, is not meaningful until it is defined in a finite or partial scope or environment. However, as Hayek's information economics was distorted, things began to get out of control. Agents in the static or short-term models started to consider everything, and thus the scope of economic analyses expanded gradually and an overall *General Equilibrium* had to be structured finally. It seems nobody knows what is troubling, and nobody could stop it. The truth is indeed quite simple.

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<sup>14</sup> Based on many attempts, the scholars in AI realized that the robot which was expected to act as a real person should be equipped with some systems analogous to the motives, intentions, emotions, individualities, ideals of mankind (Boden, 2001, page18-19). The point could enlighten us much more.

<sup>15</sup> Dennett, 1991, Page 190.

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The *General Equilibrium* is a mistaken concept, which we could criticize *Algorithmically* in many ways. Moreover, the *Dis-equilibrium* should not be a disaster, as it merely means the necessity of some new actions. If the civilization of mankind were not enough to form a huge market, the market can be smaller; on the contrary, provided a huge market existing, it would be believable that relevant mechanisms have already grown up. It is not necessary for economists to care about market clearance too much.

As long as agents' computations are limited in a finite scope, together with the introduction of various subjectivities, flexible prices will happen immediately. In fact, the market is often cleared dynamically and usually cannot be completely cleared; uncountable errors, accidents, changes and blindness are offset by one another, and not so many problems left for consideration by economists or government officials. Money could be used to reduce the times of price conversion and therefore save computational costs, this is obviously a very convenient and effective approach to introduce Money into the center of economic theories. Money is critical to the performances of market and should not be excluded from the discussion of market clearing. It appears that the mainstream economics has not perceived it at all. All of these arouse exactly from the mistaken attitude toward thoughts. Just as explanations of physical movements requires both thrust and resistance, Neoclassicism could be deemed at best explanations of the positive economic processes, while all of the rest, or the negative processes are subject to future economics. Without a systematic explanation of economic phenomena, even the most basic fact can not be understood or explained properly; this is what we could learn from the failure of the mainstream.

In contrast to microeconomics, the Keynesian macroeconomics is kind of *Algorithmical*, although the *Algorithmic elements* there are still quite weak. The Austrian School of Economics could be valued highly in respect to its emphasis on time, subjectivity and limited knowledge, etc. It would be a great pity that the Austrian scholars did not recognize the wholeness among their ideas, and consequently their Economics fell into fragments. They praised the free market highly but unilaterally, this reflected the defects of the logics inside their economic reasoning. Marx had been ambitious to build up an anti-mainstream economic system. Although the Marx system is strong with respect to the inclusion of dynamics, inter-relationships, personal interactions, subjectivities, inequalities, constructiveness, etc., Marx's points on the positions and natures of human thoughts were vague, confused, and even contradictory. All of the above integrated into a *weird complex*. In order to construct the internal consistency among the *complex*, it is apparently necessary to import the *Algorithmic Principles*. For instance, it could be easily realized that there will be no absolute equality in the Algorithmic world.

Now we turn to comments on some recent economics. Evolutionary Economics has become popular recently. This popularity reflects the strong and general desires for a proper dynamics. However, one of the most important problems was avoided that what Skills and Routines really are, or where they come from. Unless this question is answered appropriately, Evolutionary Economics would be essentially superficial. This defect is similar to that of Behavioral Economics. Although historic continuities of events were particularly stressed in the evolutionary literature, the real lives are diversified and mixed, therefore, the evolutionary models could only be deemed a kind of partial theory. The prevailing of Game Theory reflects an emphasis on the Structuralities of the world, which demonstrates how important the non-quantitative computations are. Based on the above arguments, we can see that discussing institutions and organizations under the neoclassical framework is a pure mistake, and how big the mistake is! Some of the institutionalists

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sanctified institutions, this means they did not know their objects at all.

The Algorithmic Framework can also be used to synthesize the feminist economics. The Algorithmic Persons with limited knowledge and limited computational abilities would be vulnerable to any impact from either outside or inside, so any physiological factors including gender will inevitably participate in shaping their personalities; not only the division of labor will occur between the male and the female, but also the different or conflictive knowledge, ideas, characters and interests.

The Algorithmical theories could be simplified as an attempt to construct a general, essential and ideal dynamics, and the rest of economics can be integrated into the attempt. Joseph Schumpeter hesitated and wandered between the paradigms of static equilibrium and dynamic development throughout his life, and the method to coordinate the two paradigms could be deemed discovered now. Somebody maybe ask: how shall we take up scientific researches in this world consisting of differences, confusion and conflicts? The general answer is that the Algorithmic methodology should be coherent with the agents' Algorithms or the Algorithmical social-science theories themselves, the differences among them are merely technical. This is the uniqueness of Algorithmic approach. Next, let us turn to a brief introduction to the methodology.

The mainstream brought to us the principle of rationality or maximization. Due to the existences of structuralities and subjectivities, in my opinion, the *maximization* can be replaced by the word *optimization*. The rule of rationality or *optimization* should always work, which motivates economists to think, research, communicate, compare and feel necessary to distinguish the correct from the error, the good from the bad, the helpful from the harmful, and the clever from the foolish. On the other hand, the subjectivities explicated above mean that the optimization is merely inside the eyes of the agents and the consensus cannot always be reached and sometimes unnecessary either.<sup>16</sup> This does not mean that objectivity is meaningless. Instead, a system consisting of objectivity, certainty, generality, typicality, simplicity and deductibility would not be meaningful until it is placed inside the environment including differences and ignorance. Both theorists and agents ought to pursue such knowledge as a priority. Meanwhile, in case that these standards cannot be satisfied entirely, the inductive, empirical, statistical, historical, experimental methods and case studies should also be applied. As a formalized new method distinct from mathematics, the computer-based emulation should play a more important role in economic studies, which could bring strictness, accuracy and transparency to the Algorithmically structuralized computations no less than the mathematical approach. Just like the Algorithmic diversities of the agents, scientific methods should also be diversified, with different methods competing and complementing with one another. Meanwhile, we cannot believe there will be a general, perfect and overall method, and it would be impossible to explain the social realities entirely, soundly and timely. A theorist needs to treat himself also as an Algorithmic Person equally with the agents, instead of such a special character who is deemed incomparable with them. Neoclassicism appears to highlight the deductive method, it actually intends to eliminate the diversity and unity of various methods, and hence has failed to evaluate deduction appropriately. Ultimately, Neoclassicism denied the values and the roles of scientific work in the society.

Due to the independence of consciousness to social realities, the studies of economics and social sciences could be divided into three parts: (1) inquiries into the consciousness or thoughts

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<sup>16</sup> In my opinion, the term Satisficing is an unnecessary or theoretically mistaken concept. Simon failed to perceive that Satisficing was actually a kind of optimization.

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of agents; (2) inquiries into the influences of agents' decisions and behaviors on the outside world; (3) suggestions for agents. Now let us briefly explain the above points. The thoughts may not be all causes of actions, but it is at least one of the direct, real and major causes, thus it is necessary for us to investigate the human thoughts. Behaviorists stressed the difficulties of these investigations while neglecting some advantages of them. Since our objects are human, which we *happen to* be exactly, hence we are able to put ourselves in the places of the agents and conjecture for them. In addition, we can ask the persons face to face. For example, in case that a big event happens, we usually acquire its social responses easily and quickly, which we could even guess without any real investigation. On the contrary, we can neither communicate with the substances nor ask an animal why it acts so, which means that we could never be certain whether or not we have learned the truth of the non-human objects. On the other hand, the inevitability of interpersonal differences would force us to investigate the consciousness of the agents instead of simply equating our own thoughts to theirs. Notwithstanding the emphasis on consciousness vocally, the mainstream actually prefers to eliminate the importance of the agents' consciousness, because generally they do not understand what *subjectivity* means really. Given subjectivities and the independence of thoughts, the consequences of actions would gain independent meanings, and the studies on interactions among different behaviors or between behaviors and physical objects will become even more anticipated.

In the world consisting of ignorance and subjectivities, the work of scholars as a particular kind of agents would inevitably cause practical, physical or *real* consequences. Scholars, if they would like, could clearly declare that they take reformation of the world as their missions. Meanwhile, due to limited resources, scholars had to both compete and cooperate with practitioners just as two different economic sectors. Therefore, scientists must develop their comparative advantages in order to establish themselves in the world, which determines the natures and characteristics of science. The Algorithmic Framework would lead to the inter-constructural processes as below: theories are developed by theorists from certain social realities first, then spread among the agents before accepted or even implemented by some of them; consequently, the world changes, and some unintended consequences possibly occur simultaneously, which could further cause new theories; thus repeating in cycles. Perhaps there is no new point here, but the consistency among diversified ideas on methodology or scientific philosophy is being Algorithmically built. Although social sciences are different from natural sciences in some senses, it is mainly the natures of objects rather than anything else that cause the interdisciplinary differences. As long as a proper agent is structured and introduced, the proper methodology would form up naturally and relevant confusions would be fundamentally cleared. Actually, there are some general or self-evident rules and standards for all scientific work, which could parallel with the specificities of a certain discipline.

## **VII. Conclusion**

Until now we have accomplished roughly the construction of a unified structure or system. Based on the Algorithmic Theory, the consistency between the following categories or topics was built: statics vs. dynamics, flow vs. stock, finiteness vs. infiniteness, subjectivity vs. objectivity, absoluteness vs. relativity, rationality vs. irrationality, deduction vs. non-deduction, cognition vs. action, individual vs. society, the economic vs. the social, quantitative analysis vs. qualitative

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analysis, theory vs. methodology, science vs. humanity, etc. Although these categories or topics are seemingly chaotic, a consistent logic is underlying, which in case we discovered, everything would, I can say, be the same thing. The Algorithmic Persons think and act *rationally*, however, *irrationalities* and various social phenomena were endogenized instead; the Algorithmic system is deductive, but various non-deductive Algorithms arise as the consequences; this is exactly the special, higher-order and Algorithmical consistency, which is based jointly on Independence of Instruction, Retrospection and Inter-objectification. This logic has been presented by a behaviorist as follows: An agent has *rationally* done an *irrational* behavior.

The Algorithmic wholeness has been hidden in the past literature for a long time. For instance, as the oppositions or complements to the mainstream, the Classic Historical School have pointed out almost all factors we stress today, which were discussed continuously by different scholars in different languages, terms, and styles with increasing vigor. We should justly value every economic theory, whatever mainstream or heterodox. We should appreciate neoclassical economics, which brought to us both the rule of rationality and analytical accuracy. It is exactly the extreme development of the Neoclassicism that served as a foil to highlight the defects of traditional economic analyses, and therefore accelerated the growth of the heterodox economics, which correspondingly should be treated roughly as a necessary stage during the evolvement of economics. Now, I believe, we are standing at a great turning point.

Aiming to structure the economics and social science of tomorrow, the principle needs to be established that everything is valuable and every behavior creates value. It is not necessary for us to care too much for the final result of history; everyday is both a destination and a start. We could discuss new topics Algorithmically everyday, and the Algorithmically-approached social science actually grows everyday. For example, with respect of periodic length and asynchrony, many discussions could be undertaken. Compared with markets, the defects of government are neither due to its title of *government* nor the corruptions or foolishness of its officials; instead, the governments are weakened generally by their huge sizes; consequently, a mistake of the governmental leader usually cannot be offset in a timely manner by another correct decision correspondingly, which leads to significant social instability, social risks and intertemporal inequities. Monopoly suffers the similar weakness. It is vocally agreed that scientists should not replace political leaders but could instead tell decision-makers the social consequences of a certain choice, however, the leaders of former Soviet Union and eastern European countries had not been warned at all for the possible consequences of their choice of the Shock Therapy, such as how long the cure would last and what the process would be. The strategy of China's reformation and development could be deemed *a strategy of knowledge-development and process-management*. I am not intending to judge whether the Washington Consensus or the Beijing Consensus is better; instead, since it has been widely agreed that the Neoclassic Economics is not an ideal tool to explicate the effectiveness of market economy, freedom and democracy, we need to build up a general and embracive framework or methodology to analyze and compare both of them. Regardless of their defects, economics or social sciences have significantly affected the practical social affairs indeed. The Algorithm Framework Theory maybe is not satisfactory to everybody, nevertheless, it could greatly and fundamentally improve current economics and social sciences; even if it were deemed inapplicable finally, the future ideal economics and general social science would have still been grounded by some theories close to it or applicable to answer the *Algorithmic* questions.

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## References (limited to those specifically cited in the text only)

- Boden, Margaret, ed. *The Philosophy of Artificial Intelligence (Chinese edition)*. Shanghai: Shanghai Translation Publishing House, 2001.
- Chomsky, Noam. *Syntactic Structures (Chinese edition)*. Beijing: China Social Science Press, 1979.
- Dennett, Daniel C. *The Consciousness Explained*. New York: Back Bay Books/Little, Brown and Company, 1991.
- Derrida, Jacques. *La Voix Et Le Phenomene (Chinese edition)*. Beijing: The Commercial Press, 1999.
- Descartes, Rene. *Discours De La Methode (Chinese edition)*. Beijing: The Commercial Press, 2001.
- Descartes, Rene. *Meditationes De Prima Philosophia (Chinese edition)*. Beijing: The Commercial Press, 2001.
- Dopfer, Kurt, ed. *Evolutionary Economics: Program and Scope (Chinese edition)*. Beijing: Higher Education Press, 2004.
- Durkheim, Emile. *Les Regles De La Methode Sociologique (Chinese edition)*. Beijing: The Commercial Press, 1995.
- Eatwell, John, Murray Milgate and Peter Newman. ed. *The New Palgrave: A Dictionary of Economics (4 volumes, Chinese edition)*. Beijing: Economic Science Publishing House, 1996.
- Giddens, Anthony. *The constitution of Society (Chinese edition)*. Beijing: Sdx Joint Publishing Company, 1998.
- Hayek, Friedrich A. Von. *Individualism and Economic Order (Chinese edition)*. Beijing: Sdx Joint Publishing Company, 2003.
- Heidegger, Martin. *Being and Time (Chinese edition)*. Beijing: Sdx Joint Publishing Company, 1987.
- Husserl, Edmund. *Logical Investigations (Chinese edition)*. Shanghai: Shanghai Translation Publishing House, 1994.
- Kant, Immanuel. *Critique of Pure Reason*. London: George Bell and Sons, 1890.
- Levi-Strauss, Claude. *Structural Anthropology (Chinese edition)*. Beijing: Culture and Art Publishing House, 1989.
- Li, Bin. *Algorithm Framework Theory: a basis for the unification of social Sciences (in Chinese)*. Beijing: China Renmin University Press, 2009.
- Li, Bin. *A Preliminary Inquiry into Principles of the General Social Science (in Chinese)*. Beijing: China Renmin University Press, 2011, to be published soon.
- Mach, Ernst. *Erkenntnis und Irrtum (Chinese edition)*. Beijing: Hua Xia Publishing House, 2000.
- Marshall, Alfred. *Principles of Economics (Chinese edition)*. Beijing: The Commercial Press, 1997.
- Marx, Karl Heinrich. *On Capital (Chinese edition)*. Beijing: People's Publishing House, 1975.
- Mises, Ludwig Von. *The Ultimate Foundation of Economic Science*. New York: D. Van Nostrand Company, Inc., 1962.
- Roamer, Paul M. *Endogenous Technological Change*. The Journal of Political Economy, 1990, Volume 98, Issue 5, Part 2, S71-S102.
- Ryle, Gilbert. *The Concept of Mind (Chinese edition)*. Beijing: The Commercial Press, 2005.

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- Simon, Herbert. *Selections of Simon (Chinese edition)*. Beijing: Capital University of Economics & Business Press, 2002.
- Smith, Adams. *The Theory of Moral Sentiments (Chinese edition)*. Beijing: Central Compilation & Translation Press, 2008.
- Song Huanzhang, Zhang Chunyuan and Wang Baoheng. *The Principles and Designation of Computer (2 Volumes, in Chinese)*. Changsha, China: National University of Defense Technology Press, 2000.
- Wittgenstein, Ludwig. *Philosophische Untersuchungen (Chinese edition)*. Beijing: Sdx Joint Publishing Company, 1992.
- Zhang, Rulun. *Fifteen Lectures on Modern Philosophies (in Chinese)*. Beijing: Peking University Press, 2003.