How Could Cognitive Revolution Happen To Economics? An Introduction to the Algorithm Framework Theory

Li, Bin

Center for Urban and Regional Studies, University of North Carolina at Chapel Hill

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Author (corresponding):

Bin Li

Independent scholar and a columnist

Email: libinw@sina.com libinw2011@163.com

http://blog.sina.com.cn/libinw

Author's information

Bin Li is an independent scholar and a columnist in Shanghai, China.

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How Could Cognitive Revolution Happen To Economics?

An Introduction to the Algorithm Framework Theory

Abstract

This paper introduces a highly original theory. What is human capital or knowledge *theoretically*? How do innovations happen? How could microeconomics integrate with macroeconomics? Where do institutions & organizations come from? How to define and endogenize money? How to synthesize *irrationalities* into rationalities? How to coordinate dynamics with statics (or equilibria)? Etc. All of the answers lie in the principles of computer science, which are interpreted in a distinct way transcendentally in this paper, and then reformed into a concise theory on how a person thinks. This is called the Algorithm Framework Theory, which implies the method of roundabout production of thoughts, consisting of the factors of dualism, time or *speed*, flows and stocks, etc. Reasoned *economically*, the theory surprisingly leads to pluralism, conflicts, subjectivities, irrationalities, innovations, developments, the *Combinatorial Explosions* and eventually an embracive paradigm of the society. This means that a unified social science and a unified economics takes shape. Also methodological synthesis is included briefly.

Key Words

Bounded Rationality; Instructions; Algorithm; Combinatorial Explosion; Subjectivity; Mental Distortion

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Introduction

There are many basic problems in economic theories, such as: What is human capital or knowledge *theoretically*? How do innovations happen? How could microeconomics integrate with macroeconomics? Where do institutions & organizations come from? How to define and endogenize money? How to synthesize *irrationalities* into rationalities? How to coordinate dynamics with statics (or equilibria)? How do quantitative analyses relate to qualitative analyses? Etc. These problems have divided economics. To date, the expected "Grand Synthesis", hence the single economics or social science has not come into being.

A fundamental solution to all of the above problems was found out by me at the beginning of this century, and three books of mine (see the references) on this discovery have since been published in Chinese. The aim of this paper is to report this discovery in English and introduce it internationally.

As the theory given below is highly fresh, essentially simple, and widely relative, a review of the relevant literature is omitted. Chapter I introduces some basic ideas, Chapter II gives the Algorithm Framework Theory, Chapters III to VII demonstrate how the theory can be used ontologically or methodologically, and Chapter VIII concludes the paper.

Basic Ideas

Endogeny of innovations entails thinking time, which hints that new thoughts can be produced sequentially or *historically* beyond existing old thoughts. Inspired by the Austrian concept of Roundabout Method of Production[1], it was perceived that human capital or knowledge, as a sort of capital and stock, can be generated from dynamic thinking activities. The latter means that it costs time for

[1] Eugen von Böhm-Bawerk (1891). The Positive Theory of Capital. London: Macmillan. Translated by William Smart. Chapter II Book I, Available online at: http://www.econlib.org/library/BohmBawerk/bbPTC.html

a person to think, or that thinking proceeds at *limited speeds*, or that the ability or outcome of a *unit thinking* (the minimal unit of thinking activity, if any) is quite low and, therefore, many units of thinking activities must connect together one by one to enhance the results of thinking. Further, how is a unit thinking structured? Since thinking means information-processing, what processes information? Or what is the innate (or transcendental) tool in one's brain to process information?

The above logics require a theory on how a person thinks. Philosophically, the logics suggest that thinking activities need be regarded as *real* actions or *behaviors* concurrently with physical actions, and the thoughts or minds of mankind should be *real* and *concrete* existences, facts, entities, or substances, to be objectified both like and jointly with physical objects; and both interact with each other inside a whole picture.

A theory as such will surprisingly and reasonably settle all of the above problems, the relevant reasoning will be given after the theory is outlined below.

How a Person Thinks

A half and more centuries ago, computer science (or Information Technology) provided a model on how a person thought, which, in my opinion, could meet almost all the above requirements. In my eyes, it is a big pity that the model has not been correctly interpreted for so long time.

The primary concept neglected is Instruction. A Instruction originally meant a sort of task that a user *told* a computer to do, then became a basic job that a computer could carry out. An Instruction is a tool to process information (or data), which, as a software instrument, is technically structured by hardware materials before the finished computer is delivered to a user. There are a limited number of Instructions inside a computer. The number varies from dozens to hundreds, but the *core Instructions* of a computer amount to dozens only and equal to any other

computer's. An Instruction functions differently from another, and can independently process *one or two* data and get *no more than one* result. For example, 7+5=12, "+" is an Instruction, which indicates what kind of tool is used to work on the data, 7 and 5 – it is called an Operation. Words that can represent some of the kinds of tools or Operations, and thus constitute the categories of Instructions include: Subtract, Multiply, Move, Compare, Load, Store, Repeat, And, Or, Not, Wait, Interrupt, Clear, Halt, etc. When a computer works, it executes, and only executes the Instructions and does nothing else. This is what "computation" means. At one moment, *only one* Instruction, and hence one Operation can be executed. Therefore, Instructions or Operations must be connected selectively, successively, or serially, one by one, to undertake tasks. This is called Serial Processing, which implies the roundabout method of production of thoughts. Both as conditions and results of the computations, enormous amounts of data and Programs are either stored or to be stored in a computer. An Instruction is formatted to contain some blanks to be filled with the datum or data to be processed, or with the result processed, or with the address where to find the next Instruction (see Figure 1). A Program is a set of Instructions queuing in a certain order. Various Programs were made up by relevant experts and stored in a computer in advance of Operations, which could *tell* the computer how to compute the datum or data input by users, what parameter(s) can be used, and which other Programs or Instructions should run *next*, etc. A method or idea to combine Instruction(s) and datum or data to formulate an Instruction or a Program is called an *Algorithm*.

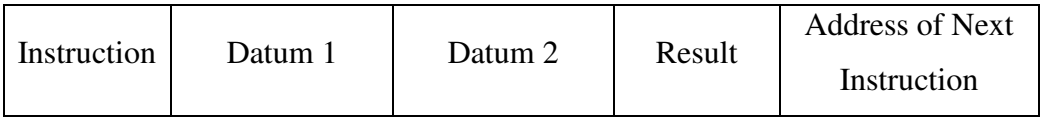

Figure 1 Instruction Format

The most important thing that the computer principles tell is that Instructions could be the innate thinking tool of a person and, could be *transcendentally* distinguished from information. It is mankind who defines Instructions and encodes them into 0 & 1 series to be executed by electronic instruments; hence, Instructions reflect the structures, or the congenital resources and the manner of human's brain. Obviously, the computations that a computer does can be carried out by a user himself (although a computer does them quicker or better). The achievements and successes of Artificial Intelligence Engineering (AI) could be evidence of the view above. Nevertheless, there has been doubt about the effectiveness of AI ever since its birth. To remedy the alleged weaknesses of AI, it could be assumed that there are some kinds of *Instructions* congenitally in one's brain, which a computer is not able to simulate, and that, hence, can be called *Artificial Instructions*.

Therefore, a theory on how a person thinks could be formulated as the following:

Thinking = Computation = (Instruction + information) × speed × time

The *Algorithm Framework Theory* (hereinafter referred as "AFT") could be verbally outlined as below: There is innately an Instruction System in a person's brain, which contains a fixed number of Instructions (Artificial or not); One person's Instructions are equal to another's; An Instruction functions constantly, or, an Instruction processing same datum or data always gets same result; "Thinking" means, and only means Operations of Instructions, or the *computations*; An Operation means an Instruction runs (or is executed) once, so it is the minimal unit of thinking activities; One's brain is able to run *limited* number of Operations within a unit of time, which indicates the computational

speed, hence it costs a certain amount of time (and other relevant resources) for a person to think. The rested details of thinking, in spite of the above, are assumed to be principally similar to a computer.

A person who thinks in the way described above is called an *Algorithmic Person*. Once the persons in the real world are supposed to be Algorithmic Persons, the world is called the *Algorithmic World*. The approach to build economic theories and social sciences using AFT is called the *Algorithmic Approach*. The word *Algorithmic(al)* in this paper means, on different occasions, either "of Algorithm Framework Theory", "Algorithmically-approached", or "of the Algorithmic world".

The Extensions and Applications

When the agents (or "actors") in economic theories are assumed to think in the way above, a great deal of consequences will logically and inevitably happen, the problems in the beginning of the paper will be answered, and an embracive model fundamentally similar to the real social world will come into being.

AFT accurately describes how human minds work; this could be a strict interpretation of the concept of Bounded Rationality. As a common computer currently runs over 100 million Operations per second, how weak the ability of an Operation is could be perceived. Since knowledge is assumed to be the results of computations, and the computational speed of a person's brain is limited, the knowledge possessed by a person at any time must be limited (unfinished or imperfect) as well, and so must the whole knowledge of the society. Meanwhile, AFT hints that human thinking, or the computations, is selectively making (and re-making) combinations or permutations between dozens of Instructions and tremendous amounts of data, the relevant mathematics proves that the total number of possible combinations and permutations can rise extremely rapidly

when the data increase, it is hence easy to conclude that the total number is very huge and close to *infinity*. This, in computer science, is called *Combinatorial Explosion*[2] (Figure 2), which could demonstrate that the potential of knowledge development is roughly unlimited, and that, with the *explosive* perspective, the knowledge of mankind must keep developing, innovations must keep happening, and both the economy and the society must keep growing and progressing, just like the universal Big Bang revealed by physics.

However, since knowledge stocks at any time are limited, how can an agent optimize his (or her) behaviors? A part of the answer to this is as: Subjectivities, *irrationalities*, pluralities, and conflicts would appear on the stage. The logics are as follows.

[2] Two examples for Combinatorial Explosions. A song is composed of dozens of sorts of sound elements only, but the songs that can be compiled are believed to be uncountable. Hebert Simon said that, the total number of strategies in chess is theoretically "comparable to the number of molecules in the universe" (Simon and Jonathan Schaeffer, 1992, p. 2).

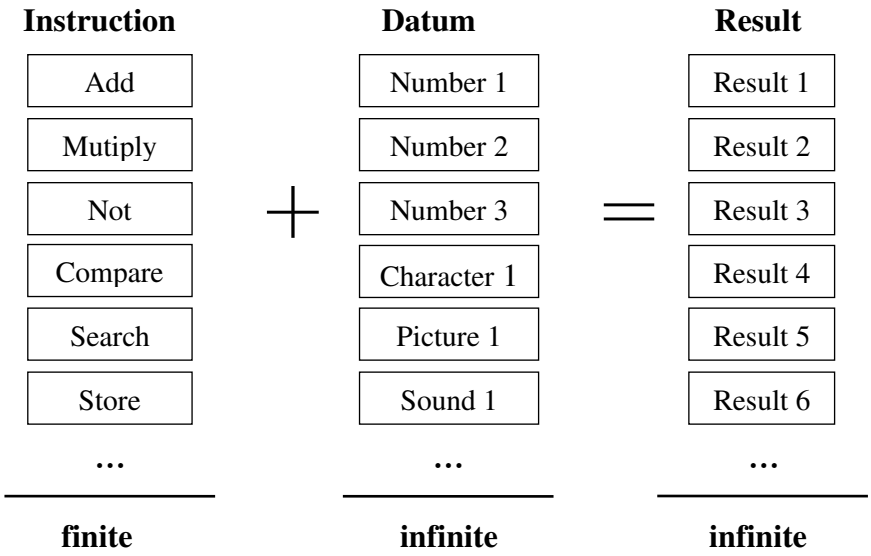

Figure 2 The Combinatorial Explosion

"Thinking" means selectively making up the combinations & permutations between Instructions and data, which explode endlessly in number over time.

As a reformed computationalism, AFT hints that any spiritual action could be a combination or permutation of some (data-filled) Instructions; hence, the common verbs referring to spiritual actions in natural languages could be regarded as the Commands in High-Level Programming Languages in computer science. A Command is either a combination or a permutation of Instructions with a fixed structure; thus, it could be treated approximately also as a new *Instruction*. This view allows the following verbs (or the gerund, nouns, or phrases referring to mental actions) to be deemed as Commands, and then *Instructions*: Deduce, Induce, Analogize, Search, Copy, Recall, Learn, Associate, Imagine, Assume, Abstract, Modeling, Simplify, Generalize, Approximate, Trial & Error, Experiment, Sortition, Persuade, Negotiation, Cheat, Force, etc. The numbers of these words could be much more than dozens, but, must be finite. The readers who are not familiar with computer science could conjecture that these

Instructions process data alternately and serially to think. This method is called the *Artificially Algorithmic Approach*, which allows theorists to use AFT without knowing well of computer science.

As the ability of an Operation is tiny and many Instructions must work jointly, it is concluded that the Instructions used for a common task must be plural and mixed (Figure 3). This is to say, not only Instruction Deduce but also the other *Non-Deductive* Instructions must be used quite frequently. Deduce is more reliable for reaching a correct result than is any other Instruction -- this is why the Neoclassical economics always uses, or makes various hypotheses so as to use deductive inferences to reach its conclusion. However, the conditions for deductive inferences in spatiotemporal environments are not always ready, the procedures of deductive Operations are quite tedious and cost too much time, solving practical problems often involves deadlines, and the resources available to solve the problems often elapse or erode timely, thus the *jobs* of decision-making often has time limits. In contrast with Deduction, the *Non-Deductive* Instructions are *relatively* easy, direct, quick and thus attractive to agents – although they are not so reliable as Deduction for obtaining correct results. Therefore, the agents have to *economically* weigh up quickness and correctness, the merits and demerits, or the benefits and costs of each "input" of Instruction to optimize their "profit" for a decision-making, just as what the agents do for a physical commodity production. The weighing-up would result in the frequent use of *Non-Deductive* Instructions, in sacrifice of deductive correctness, and inevitably leading to subjectivities, *irrationalities*[3], pluralities, and conflicts (Figure 4).

[3] Since the *irrational* behaviors often stressed by behaviorists are Algorithmically reasonable, they are really not *irrational* and should not be formally called so again.

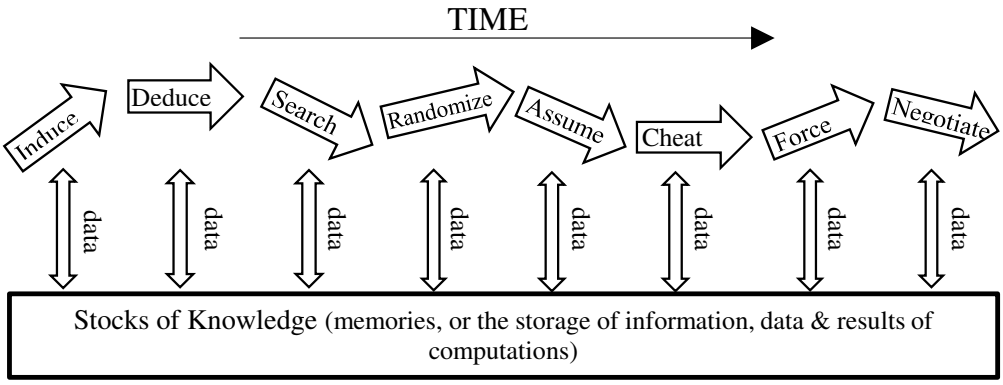

Figure 3 The Distortion and Synthesis of Computations
"Thinking" is composed of various Instructions rather than Deduction only, just like a chain made up with different sorts of segments, which winds tortuously.

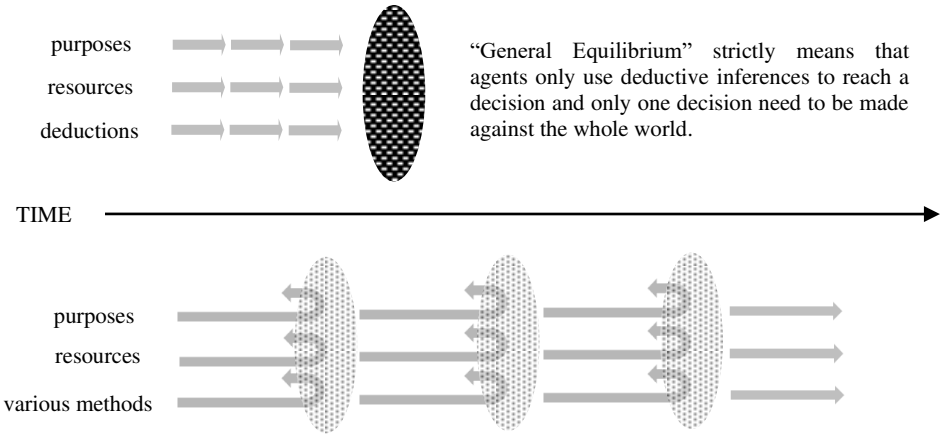

Figure 4 The Distortion and Synthesis of Computations (continued)
Conditioned spatiotemporally and Algorithmically, agents have to close computations intermittently and coarsely conclude the world, thus the different decisions conflict, diversify or improve sequentially. Each decision is both a destination and a start. The *doomsday* will never come.

The Extensions and Applications (continued)

AFT means that both information and thoughts could be dispersive or *discrete* in space and exist either solely or collectively, like molecules; and that one datum

or thought distances or relates to another either remotely or closely, geographically or logically. This is why both computations and *communications* are needed. Computations are also discrete; hence, one Operation can objectify another (or its result), regardless the latter was done by oneself or anyone else; This causes that a person can objectify either oneself or other persons. As information is originally *alien* or *strange* to Instructions in one's brain, the world is somewhat puzzling, conflictive or questionable *in one's eyes*. Thinking or Computations by human brains can answer some questions and consequently mitigate puzzles and conflicts; however, as the thinking jobs executed (and, hence, the results of the jobs) are always limited, the rested unexplained world is still *irrational* to some extent. The ultimate *truth* of the whole world, if any, must be unavailable for ever. Besides, the subjectivities as computational outcomes will put *new irrationalities* or conflicts into the (mental and then physical) world. Thus, subjectivities, *irrationalities*, pluralities and conflicts will keep on existing widely among computational results, and/or inside the knowledge system, and/or between Operations and stocks of knowledge (or data), and/or, undoubtedly, among different persons. By changing the data processed, or the Instructions processing data, or the sequences of Operations, interpersonal agreement and disagreement convert into each other.

The computational results stored, or the knowledge stocks, deliberately give variables fixed and ready-made values, so as to make subsequent relevant Operations easier and to save jobs; this is why they are helpful. However, the knowledge stocks were probably made at another spatiotemporal circumstance, and may not be fit precisely in the current Operations, but usually cannot be examined or revised at present. This suggests that current Operations are restricted by the knowledge adopted. In case the computational speed were otherwise infinite, the relevant variables would be valued more rationally, or the knowledge stocks would become helpless – as any knowledge could be re-made

at present immediately. In other words, most knowledge stocks in the real world are actually arbitrary, *impulsive*, or *irrational*, more or less, and these characteristics of knowledge could be the *Algorithmic* consequences and be really *reasonable*. Furtherly, it can be perceived that emotions, instincts, impulses, or any other alleged "innate natures" of a person that behaviorists and psychologists often stress are apparently similar to knowledge stocks; Eclectically, they could be further regarded as some kinds of *Hard-software Programs*, which are structured by hardware, are inherited biologically, and keep working jointly with the computational system. The latter can change or control the input of the hard-software, and can re-compute the output of it, but can't modify the hard-software itself (as biological evolutions proceed so slow that it seems stop), thus the gap between the hard-software and the computational system keeps on widening, and the hard-software then looks more and more *irrational*. To behaviorists, psychologists or *irrationalists*, these views might be revolutionary.

Discreteness results in heterogeneity of the world, which allows some parts or aspects of the world evolve without concurrent evolvements of the rested world. A part of the world keeps improving, computational outcomes keep getting better, errors and conflicts keep decreasing, and the marginal returns of Operations keep diminishing; finally, the computational attempts would perhaps stop at a point, where an equilibrium would be reached. This kind of process is conventionally called *Convergence*. Discreteness is a necessary condition of convergence, which prevents the other parts of the world from intervening in the equilibrium. Computational time & costs are also the barriers, preventing the whole world from either homogenization or uniformization. Nevertheless, equilibria cause savings, and the resources saved will be allocated to other computations, consequently new knowledge would possibly emerge, the equilibria might be impacted by innovations sooner or later, and, possibly collapse, then the world

would return volatile again. These reverse processes can be called *Divergences*, which, mixed with or offset against Convergences, maintain freedoms sustainably.

As the computations and their results within any period amount finitely, and as the results cannot be *timely* abstracted, generalized, or condensed into some simple forms, knowledge stocks grow both qualitatively and quantitatively. Both information input and Algorithmic improvement could cause innovations. However, as uses and lifetimes of the results vary, they are only partially selected, copied, spread, taught, or succeeded. Knowledge exists not only in the forms of formulas, rules, laws, or regularities, but also in some forms of either particularities or irregularities. The latter entails that students spend increasing amounts of time to learn and memorize. Hence, knowledge stocks must be screened and truncated to balance the costs and benefits of education. Consequently education is often cheaper than research, people like to transfer knowledge stocks intergenerationally; when communications become easier, knowledge will spread quicker, thus to avoid computational repeats and enhance economies. Embedded with more and better knowledge than before, an economy often grows or develops.

The Market-Government Synthesis

The above statements demonstrate both integration and mixture of equilibria and disequilibria, statics and dynamics, flows and stocks, certainties and uncertainties, objectivities and subjectivities, rationalities and *irrationalities*, consistencies and conflicts, absoluteness and relativities, finites and infinites, etc. In particular, the world should be Algorithmically regarded as either mixed or pluralistic -- although consistencies, relationships and wholeness are concomitant within. This is one of the Algorithmic approaches to the Grand Synthesis. The mainstream economics, or Neoclassical Economics, describe and analyze a half-

facet of the world, and the other half, objectified divisively by various non-mainstream economics, can be integrated and mixed with the former half Algorithmically.

An Economic Man is selfish, greedy, and even *myopic*, really due to various informational, communicational, and thoughtful costs, which makes him rationally prefer himself to others, prefer obvious benefit (e.g. money) to invisible benefit, and prefer nearby to the distance. However, the distance and future really exist, which he has to consider in the current situated Operations -- despite to less extent. Restricted by thinking time and costs, the *considerations* would then be distorted into different forms of algorithms or knowledge, e.g., ideas, beliefs, attitudes, values, virtues, rules, or institutions, and, hence, the agent could sometimes act altruistically or ideologically, instead of *perfectly* as Neoclassically supposed. This is the *Algorithmic* way for an agent to subsume the wholeness of the world.

With various Algorithmic restrictions, the chances of commodity exchange would be scarce. As the factors considered in commodity exchanges have to be limited, and the *consideration* must be in some distortive ways, the prices reached would not reflect so much as supposed from a Neoclassical perspective. People sometimes buy or sell, and sometimes carry out other activities. The prices, as ratios for commodity exchanges, are kind of expensive to convert from one into another; and money, as the universal equivalent, will be reasonably endogenized. As transactions are executed spatiotemporally, money has to be saved or held in hand, thereby to deliver *physically* to sellers on the spot. Hence, money has to be in some physical and credible forms (e.g. gold, printed paper, digital currency), although it is essentially an interpersonal agreement or stipulation. Money is held by haves as substitutes to commodities, thus commodities are saved for other usages. As thoughts are deemed Algorithmically the *things* or *entities*, so is money. When a market is composed of both flows and stocks, objectivities and

subjectivities, commodities and money, it would partially volatile and speculative, and partially stable.

Institutions are the agreements reached by people in advance of actions, which, caused by roundabout production, reflect the costs of interpersonal computations and can reduce the uncertainties aroused from the combinatorial explosions among interpersonal reactions. Another way to reduce the uncertainties is to build up organizations. As a group of free persons is much more chaotic, conflictive and thus not so productive, and, moreover, due to limited computational capacity, the directions for actions can't be entirely stipulated as rules or institutions ex ante, an organization is thereby formed up, which means that its members, in exchange for some returns (e.g. salaries), should act timely and harmoniously pursuant to the commands of leaders. A leader could change his (or her) minds at discretion frequently, and, correspondingly, the members change their performances, but still keep in order as before. Both institutions and organizations generate obligations, enforcements, and the *powers*, which build up hierarchic, rather than equal, relationships among persons.

As leaders' intelligences are limited, and managerial tasks are expensive, the cost-benefit ratio of an organization floats while its size changes, thereby the organizational size is bounded. Both free persons and organizations compete or interact inside the embracive society. Thus, it is concluded that a government, as an organization, could not be as big as a society, and is endogenously impossible to command everything of a country, but some aspects, sometimes or somewhere instead. Therefore, a society or a country is structured and mixed, with proper ratio between markets and governments, responding to certain social and economic conditions.

When an observer stands at a higher level, he (or she) will see broader and maybe find something new that a person at a low level cannot see. This is why and how a government differs from, competes with, and cooperates with, the

market, while both are quite myopic and are bounded by limited wisdom. In other words, the macroeconomic topics imply some externalities of micro-actions, which the governmental officials and macro-economists would re-objectify or re-internalize. As current *observations*, and/or Operations, and/or actions has limited contents only, common agents in the market have to objectify themselves or one another either serially and frequently, and their behavioral consequences occasionally go beyond their *wills*, *attentions*, or *consciousnesses* (any of which can be defined Algorithmically). A person's consequences are possibly re-observed by others, and are then reacted *furtively* but deliberately. Thus, the economy improves collectively without any observer's complete perception. This could be called *Semi-Internalization*, which might the Adam Smith's conception, the Invisible Hands, really hinted.

With accumulation of knowledge, the economy could improve and expand *automatically*. A large number of the population will make various new attempts divisively but concurrently, which are then screened, tested, copied, or exchanged at very high frequencies, and consequently some high-valued innovations will emerge that could, on a voluntary basis, be used to arouse cooperative wills from other people. Subsequently and hopefully, some incremental income will arise and then recycle at micro levels. Innovations also cause destructions and instabilities, whereas successes offset failures, constructions offset destructions, and positive net income would probably occur at the macro level. In rare cases, the aggregate net income might slow down, and even decrease, and crises might reasonably take place. All these phenomena are rooted in the informational, communicational or computational restraints. A government, by mandatorily making some social variables constant, is a tool to strategically and conservatively control innovative speed until incomes exceed losses so that a positive net income is sustainably obtained.

Governments and institutions also innovate, but usually at different paces from the market. Since the society and economy either improves or expands endlessly, the theory of General Equilibrium is Algorithmically a mistake and should be eliminated from economics.

Additional Explanations of the Grand Synthesis

The Grand Synthesis of economics has been essentially included in the above; this chapter gives some additional explanations.

Neoclassical Economics suffers from extreme determinism, which can be technically explained as a consequence of the implicit hypothesis of infinite thinking speed, or zero thinking time. Lack of a proper theory on how a person temporally thinks could be the major reason why economic theories have struggled for centuries. Once the thinking structure and processes are basically illuminated, the implicit *eschatology*, or General Equilibrium theory, will become meaningless. The start point of economic theory should not be equilibria, but the computational Operations, which are nearly hollow initially, and then grow stronger along with accumulation of knowledge. The eschatology is then fragmented Algorithmically into pieces and re-melted into historic processes, and every day or every decision is both a destination and a start. Algorithmically, equilibriums not only stay local, but also exist as some easy and distorted *conclusions* of the whole world. This is a synthesis and a reform of Neoclassic partial equilibriums and general equilibrium.

It would be somewhat confusing to include pluralities and conflicts for a *synthesis*. However, since every idea is deemed an *entity*, the space and time can *accommodate* all of the pluralistic or conflictive ideas concurrently; which, also as some temporary results of computations, someday possibly become coherent by further computations. The co-existence or the possibility can be called *Higher-*

Order Consistency. Whereas, in the Neoclassical world, pluralities and conflicts either do not exist, or exist constantly, absolutely and metaphysically.

Below are the comments briefly on some schools of economics.

The Austrian School should be highly valued for its abundance of various Algorithmic elements; however, unfortunately, the whole picture has not been drawn. The Chicago School, including the Neo-Institutional Economics, pertains widely to heterodox topics, but without awareness of the basic contradictions between the orthodox and heterodox economics. Marxism uniquely provides the concept of conflict (or contradiction) while otherwise treating it regularly and deterministically. The game theories include both conflicts and qualitative analyses that are subject to Algorithmic integration with the rested schools of economics. Evolutionary Economics is plausibly inclusive, but fails to properly concentrate on mental evolutions, the hardcore of social evolutions. Behavioral Economics reveals and enumerates the mental distortions one by one and day by day, but without theoretically explaining them. Once framed Algorithmically, rather than Neoclassically, economic reasoning would become enough to endogenize mental distortions in very high frequencies and in very diversified forms, beyond any of those enumerated.

The Methodological Synthesis

Agents objectify either the world or other agents, while economists objectify the agents who are objectifying. Hence the methods and the methodology are either similar or comparable to the economic and social ontology. Both agents and economists are bounded by rationalities. Even using all of the existing various methods, agents can only coarsely deal with the world, so can the economists to their objects. By abstractly modeling, economists theoretically conjecture states, processes, generalities, and regularities of the economy, but only to certain extents;

hence empirical, positive, statistical, experimental, historical, and other methods are all required. However, they are not enough. Quantities and qualities cannot temporally and perfectly convert into each other, so they co-exist both coherently and pluralistically. Conventionally, economists only treat physical objects or physical actions as *phenomena*, and now, framed by AFT, economists can directly objectify human minds as the partial but central phenomena. Economists can get to know them by reason, guess, enquiry, observation, listening, talking, reading, experiments, etc. Economists should treat tangible and intangible objects both equally and jointly.

The existing world includes a collection of the *theories* of agents. Since the effectiveness of most agents' *theories* has been testified by their practices for long times, the theories should efficiently be the general benchmark of economic research. Due to the limitations of computational capacities, it would be either impossible or useless to make a whole dummy model which is totally different from the real one. Economists have to work on the margins of the knowledge collection. On the other hand, it would still not be economical for theorists to repeat the agents' thoughts, and it is both necessary and possible to either differentiatedly compete or cooperate with the agents. AFT is logically the base for division of mental labor -- hence physical labor as well. Economists use their characterized work results to help practitioners -- or *trade* with them. This help includes not only theories but also data, understandings, statements, stories, ideologies, strategies, skills, and so on. Theories are useful on account of their concise *forms*, otherwise the users would rather use the materials than use the theories that the materials gave rise to. Hence, the essence of a theory is its formal simplicity or the *computational economy*. Partially advised by scholars and partially by themselves, practitioners change the world physically, then contribute their behavioral consequences to further academic studies, and this loop goes on forever. On the contrary, The Neoclassical approach cannot explain why

economists need to work and why economics is useful to practitioners. There is no role for scholars to play in the Neoclassic world.

Replacing the current role of mathematics while retaining the analytic strictness and accuracy, computer modeling could be the new and major formal method for economic and social studies.

The Conclusion

Albert Einstein's remarks are well-known: "The grand aim of all science is to cover the greatest number of empirical facts by logical deduction from the smallest number of hypotheses or axioms". Although one of the purposes of AFT is to endogenize subjectivities, *irrationalities*, pluralities, and conflicts, Algorithmic reasoning is exactly *deductive*, with simple hypotheses. This statement sounds weird, but the computational discreteness makes it quite rational. And definitely, what AFT reasons are all the common, basic, but significant realities or actualities, half of which have been unfortunately ignored by mainstream economics. Simply put, a theory as simple as "thinking = computation = (Instruction + information) × speed × time" is enough to fundamentally solve almost all current problems of economic theories, this is what the paper tries to say.

Without Programming models or details of computations, the Algorithmic approach is still viable to integrate economic theories and to build up principles of the expected unified economics. Any school of economics is meaningful to the Grand Synthesis, although any of them is partially deconstructed and replaced by some fresh contents. Apparently, the Algorithmic synthesis can be extended fluently to the other social sciences, humanities, philosophies, and, eventually, into a bigger synthesis. Especially, as the computer-based psychology, or the cognitive psychology, has changed the discipline of psychology greatly, AFT

could upgrade the movement of *Cognitive Revolution* since 1950's and finally integrate psychology, social sciences and humanities into a whole. The synthetic and revolutionary know-how can be summed up as: Objectifying human minds Algorithmically.

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