

Subject name: **Microeconomics I**

Dividend year: First/second year student

Teaching staff: Yuji Aruka

Requirements: Requirements to join in this lecture are not specified.

Aims and scope: Our society is undergoing a great change. The social ICT(Information and Communication Technology) is rapidly penetrating into the economic order at almost every layer. The modern market system of either the stock exchange or the electronic power exchange of the grid distribution are mainly running by the algorithmic intelligence at millisecond or microsecond basis. In a new system there may not be any room for human decision makings at first. So we must reconstruct a new microscopic view without resort to the subjective decision theory of homo economicus.

Summary: The traditional microeconomic theory is studying the working of the market economy in view of household and firm sector, whose agents are homogenous. In contrast to the traditional ideas, in our lecture, we argue the next issues.

(1) The human basis of the market system is replaced with the algorithmic basis. The typical example is the HTF (High Frequency Trade). Here human decision is alienated from the market transaction. A new market design in conformity with the new system must be reconsidered.

(2) The traditional attention was much paid to homo economicus. It is well known that the law of demand cannot be derived without making the income effect positive. In order to keep it positive, however, we need to assume the heterogenous consumption patterns among the different income classes. We will also examine the production set to follow some heterogenous combination of technologies.

(3) The game theoretic approach became popular. But even the prisoner's dilemma cannot give a realistic solution. In our daily life, cooperation is often rather preferred. The individualistic solution cannot explain our daily solution. We will look for several selection rules in evolutionary game theory.

Lecture plan

1. The nature of technology and the present social complexities
2. The traditional perspective of the relationship between the production function and the cost function (The implicit function theorem and the envelope theorem)
3. Production technology and the meaning of production function in view of Zonotope
4. The notion of individualistic rationality and its historical background

5. The mechanism of the classical commodity exchange
6. The mechanism of the stock exchange in view of the artificial intelligent market simulator
7. The algorithm of a stock price generation
8. The prisoner's dilemma and its evolutionary interpretation
9. The elementary proof of a utility function based on the individualistic preference ordering
10. The derivation of demand function based on an individualistic utility maximisation
11. The multi-nomial logit utility applied to an interpersonal framework
12. The ideas of Pareto optimality, gift transfer on the Edgeworth box diagram
13. An elementary proof of a core allocation (a limit theorem) by coalition formation
14. The theory of heterogenous interaction in view of the theory of duopoly

Evaluation: Two ways for grade the credit:

1. Do a paper on the given subjects.
2. Days attended

Materials: Yuji Aruka, Evolutionary Foundations of Economic Science: How Can Scientists Study Evolving Economic Doctrines from the Last Centuries?, Series: Evolutionary Economics and Social Complexity Science, Vol. 1, Springer, November 2014, 223pp.

Yuji Aruka, Complexities of Production and Interacting Human Behaviour, Physica Verlag[Springer Heidelberg], April 2011, 272pp.

Note: The distributed materials brought at lecture should be carefully kept. Each time when lecture is finished, you should make your short comment/opinion to the lecture. You are also recommended to read the textbooks in the above.

Subject name: **Evolutionary economics I**

Dividend year: First/second year student

Teaching staff: Yuji Aruka

Requirements: Requirements to join in this lecture are not specified.

Aims and scope: Evolutionary economics is interested in re-dominating the basic variables to accommodate an essentially evolving socio-economics system. It may also be demonstrated that an economic system cannot stand by itself irrespective of a particular institution and/or history. So human rationality does not necessarily play a main role in economic disciplines. This kind of approach will be connected with the idea of "social complexity science".

Summary: To use my favorite phrase, an air fighter is no longer an air fighter in the sense that stability is no longer part of its structural design. Car has a similar story. The control of modern vehicles is becoming further removed from human input with an adaptive cruising system. This also applies to the market. The revisionist approach depending on the individualistic rationality therefore does not fully describe the essential transformations emerging in the world.

The lecture will in principle refer to the leucutre's own new book:

Yuji Aruka, Evolutionary Foundations of Economic Science: How Can Scientists Study Evolving Economic Doctrines from the Last Centuries?, Series: Evolutionary Economics and Social Complexity Science, Vol. 1, Springer, November 2014, 223pp.

Another book of the reader will be helpful to aid study:

Yuji Aruka, Complexities of Production and Interacting Human Behaviour, Physica Verlag[Springer Heidelberg], April 2011, 272pp.

Lecture plan: The plan of the weeks:

1. Historical Reviews Around Evolving Ideas of the Invisible Hand
2. Some Myths of Modern Economics
3. The Historic Design of the Demand Law and Its Reconstruction
4. Reconstructing Demand theory
5. Network Analysis of Production and Its Renewal
6. historical Background to Network Thinking
7. Matching Mechanism Differences Between Classical and Financial Markets
8. The Matching Mechanism in the U-Mart Experiment

9. The Evolution of the Market and Its Growing Complexity
10. Some Instances of Technological Revolution
11. The Complexities Generated by the Movement of the Market Economy
12. Heavy Tail Distributions with heavier Randomness
13. Trader Dynamics to Generate Financial Complexity
14. Avatamsaka Stochastic Process
15. Summing up

Evaluation: Two ways for grade the credit:

1. Do a paper on the given subjects at the end of then semester.
2. Days attended

Materials: Yuji Aruka, Evolutionary Foundations of Economic Science: How Can Scientists Study Evolving Economic Doctrines from the Last Centuries?, Series: Evolutionary Economics and Social Complexity Science, Vol. 1, Springer, November2014, 223pp.

Yuji Aruka, Complexities of Production and Interacting Human Behaviour, Physica Verlag[Springer Heidelberg], April 2011, 272pp.

Note: The distributed materials brought at lecture should be carefully kept. Each time when lecture is finished, you should make your short comment/opinion to the lecture. You are also recommended to read the textbooks in the above.

Subject name: Service Sciences and the Related Economic Matters

Dividend year: First/second year student

Teaching staffs: Yuji Aruka(coordinator), Kiyoshi Izumi(U. Tokyo), Akira Ide(Otemon-GakuinU.) Hiroshi Sato(NDA), Yuriko Sawatani(TUT), Mieko Tanaka(Meiji U.), Takashi Hashimoto(JAIST), Kazuyoshi Hidaka(TIU), Hideyuki Mizuta(IBM), Takayuki Mizuno(NII)

Requirements: Requirements to join in this lecture are not specified.

Aims and scope: We aims at understandings on "services" as decisive factor in the modern mode of production. We have several newly added modern features on our society and economic system. One feature is that our society is dominated by Information and Communication Technologies (ICT). In ICT field, it is needless to say that the idea of "service" is decisively important. Another is that the service class of the society is newly emerging. The new class is also getting powers to the new society. These points of view will suggest a new science, a new service innovation, and also provide you with a new idea of social system design. See the URL of Service Research and Innovation Institute (for Deriving Innovation for IT Enabled Services):

<http://www.thesrii.org>

Summary: Service Science is a new field developed by the initiative of IBM since 2004, in particular, Alamden Research Center. Now many universities and institutions created the programs specialized for this filed. This is a study of business methods to create and capture value, technology tools to reengineer processes and organizational culture to motivate and align people, and their collective impact on evolution of effectiveness and efficiency in the performance of services. Incidentally, we invite active (or former) senior researchers from IBM Research – Tokyo and eminent professors from universities (University of Tokyo, or Tokyo Institute of Technology, for example), who are committed to studying service sciences. Incidentally, this is a serial lecture of various visiting lectures, though Yuji Aruka, the coordinator, always gives guidance and introduction in advance, as well as comments in the classroom.

Lecture plan: The class plan will be arranged in the following manner:

1. What is Service Science?
2. Analyzing the main characteristics of the economy of service providing activities by agent-based modeling or econophysics.

3. Analyzing some human behavior in service related matters.
4. The tourism in view of service science

In details as follows:

1. Introductory Guidance of Service Science
2. (Prof. Kazuyoshi Hidaka, Tokyo Institute of Technology, a former manager of IBM Research) A General theory of Service Science
3. (Dr. Hideyuki Mizuta, Senior Researcher, IBM) Service Science and Big Data Application
4. (Prof. Sawatani, Tokyo University of Technology, formerly an IBM researcher) Service Science and Its Development
5. (Prof. Yuriko Sawatani, Tokyo University of Technology, formerly an IBM researcher) Service Science and Its Innovation
6. (Professor Hiroshi Sato, National Defense Academy) Service Science and Machine Learning
7. (Professor Kiyoshi Izumi, University of Tokyo) Data/Text Mining in the Financial System,
8. (Prof. Takayuki Mizuno, National Institute of Informatics) Econophysics
9. (Professor Takashi Hsahimoto, JAIST) Knowledge Science
10. (Professor Takashi Hsahimoto, JAIST) Language Game
11. (Professor Mieko Tanaka, Meiji University) Randomness Test, and Visualization of Big Data
12. (Professor Mieko Tanaka, Meiji University) Financial System in view of Big Data
13. (Prof. Akira Ide, Otomon Gakuin University) Tourism as Service Science
14. (Prof. Akira Ide, Otomon Gakuin University) Dark Tourism
15. Summing up

Evaluation: Two ways for grade the credit:

1. Do a paper on the given subjects.
2. Days attended

Materials: The distributed materials brought by lecturers should be carefully kept. Each time when lecture is finished, you should make your short comment/opinion to the lecture.

Subject name: **Coping with Crises in Complex Socio-Economic Systems Workshop**

Dividend year: First/second year student

Teaching staffs: Eizo Akiyama, Yuji Aruka (coordinator), Akinori Isogai, Yasuhiro Inoue, Mieko Tanaka, Jun Tanimoto, Takashi Hashimoto

Requirements: No requirement; This lecture is open mainly for students from overseas. But Japanese students also are much welcome.

Aims and scope This lecture is served for reconsiderations of the current socio-economic crisis in view of evolutionary and institutional aspects.

Summary: The present world indeed is fulfilled with many such serious crises as environmental crises, the collapse of transportation systems, as well as financial and social crises such as poverty, social conflicts or wars. Complexity then is one of the key features for understanding the modern world with volatile, fluctuating, and disruptive phases, many of which might give rise to crises in the above, in particular, socio-economic systems: unstable and dangerous situations that are characterized by abrupt and large-scale changes. In the recent studies, similar common phases are often found in many different fields between society and nature: business, marketing, finance, economy, innovation, urban/traffic system, artificial/web intelligence, human behaviour/population/epidemics, biology, physics and so on. Analyzing these issues and integrating such insights could contribute to discover any useful mean for managing such a crisis. Incidentally, this is a serial lecture of visiting lectures of various fields, though Yuji Aruka, the coordinator, always gives guidance and introduction in advance, as well as comments in the classroom.

Lecture plan: The coordinators of this serial lecture will arrange the prominent lecturers inside and outside our university, sometimes, internationally, to argue and discuss these issues in order to solve our pressing problems. The lectures currently depend on the lecturers' ongoing studies. So it is better for students to know how the last lectures (Winter 2015) has been accomplished. The lecture subjects of the last year is as follows:

- 1.(Sept 29) Yuji Aruka Faculty of Commerce:(guidance) Evolutionary Foundations for Economic Science:How Can Scientists Study Evolving Economic Doctrines from the Last Centuries?
2. (Oct 6) Bertram Schefold, Goethe University, Frankfurt a/M:The applicability of modern economics to forms of capitalism in antiquity:
Some theoretical considerations and textual evidence

3. (Oct 13) Yuji Aruka Faculty of Commerce:Historical Reviews Around Evolving Ideas of the Invisible Hand
4. (Oct 20) Hideaki Aoyama, Kyoto University(Physics): Deflation and Money
5. (Oct 27) Yuji Aruka Faculty of Commerce:Matching Mechanism Differences Between Classical and Financial Markets
6. (Nov 3) Mieko Tanaka, Tottori University(computer Science): The Strongest Strategies Evolved in the IPD
7. (Nov 10) Eizo Akiyama, Tsukuba University(Informatics and engineering): Researches on the Evolution of Cooperation
- 8.(Dec 8-1) Shigeaki Ogibayashi, Chiba Institute of Technology: Introduction to agent-based modelling and simulation of macroeconomic systems (I)
9. (Dec 8-2) Shigeaki Ogibayashi, Chiba Institute of Technology: Introduction to agent-based modelling and simulation of macroeconomic systems (II)
10. (Dec 15) Hiroyasu Uemura, Yokohama National University:The Comparative Analysis of the Japanese and Chinese Economies: Institutions, Industries and Growth
11. (Dec 22-1) Jun Tanimoto, Kyushu University:Socio-physics approach on social networks & evolutionary games(I)
12. (Dec 22-2) Jun Tanimoto, Kyushu University(Interdisciplinary School of Engineering Sciences): Socio-physics approach on social networks & evolutionary games(II)
13. (Jan 5) Yoshi Fujiwara, Hyogo University(Physics/Simulation): Fiscal Sustainability and Sovereign Debt Network: Data and Discussion
- 14 (Jan 20-1) Takashi Hashimoto, Japan Advanced Institute of Technology(Knowledge Science):Knowledge Science(I)
- 15 (Jan 20-2)Takashi Hashimoto, Japan Advanced Institute of Technology(Knowledge Science):Knowledge Science(II)

Evaluation: Two ways for grade the credit:

1. Do a paper on the given subjects.
2. Days attended

Materials: Yuji Aruka, Evolutionary Foundations of Economic Science: How Can Scientists Study Evolving Economic Doctrines from the Last Centuries?, Series: Evolutionary Economics and Social Complexity Science, Vol. 1, Springer, November2014, 223pp.

Note: The distributed materials brought by lecturers should be carefully kept. Each time when lecture is finished, you should make your short comment/opinion to the lecture.

Subject name: **Artificial Intelligent Economics**

Dividend year: First/second year student

Teaching staffs: Yuji Aruka(coordinator), Hiroshi Deguchi(TIT), Hajime Kita(Kyoto U.), Yuhsuke Koyama(Shibaura Institute of Technology) , Kazuhisa Taniguchi(Kinki U.), Tako Terano(TIT), Yoshihiro Nakajima(Osaka City U.), Naoki Mori(Osaka Prefectural U.)

Requirements: Requirements to join in this lecture are not specified.

Aims and scope: We use a platform called "U-Mart system" in order to study Artificial Intelligent Market. This AI market simulator in essence is actually the same as the existing index futures trading at Osaka Stock Exchange (OSE). It is noted that the idea of U-Mart preceded the actual one. This simulator at its origin equipped with a hybrid transaction of human and algorithmic agents. The latter can imitate a so-called high frequency transaction (HFT) by the acceleration experiment. So U-Mart is a progressive simulator to imitate the reality.

First of all, we should state our U-Mar project. Originally in 1998 U-Mart Project started as V-Mart(Virtual Mart). Now it however becomes re-nominated U-Mart. The U-Mart Project has published an English textbook (Shiozawa et. al. 2008) as one of Springer Series on Agent Based Social Systems in Spring 2008. The development of the U-Mart system during these 10 years rather was mainly engineers-driven. Now the U-Mart system is internationally recognized as a good platform for AI markets. Our project has now marked Version 4 which could be compatible with spot and futures market as well as batch and double auction. Our U-Mart Lectures consists of two parts: one is this class. The other is the class for experiment, or training program. Both lectures normally are integrated into a single Aims and Scope of U-Mart lectures. So you are recommended to join into both classes of Artificial Intelligent Economics and Artificial Intelligent Market Experiment.

Summary: The U-Mart System is an artificial intelligent market system to implement a virtual futures market with reference to the actual stock price index arbitrarily chosen, by the use of agent-based simulation techniques. This system, mutatis mutandis, contains a spot market trading as a special case. It is also noteworthy to point out two outstanding features of the U-Mart system. First of all, any agent, either machine or human, does not presume a certain personal rational demand function in advance. Secondly, this system adopts a hybrid approach in a sense that a human agent can always join in the machine agent gaming setting. The latter is a technological feature, a new network innovation of artificial intelligent market system. The former is featured by an alternative

approach to the neoclassical method.

Lecture plan: This class will refer to the theories of the market mechanism or auction of the financial market. In particular, U-Mart simulator imitates the fundamental profile of Tokyo Stock Exchange (TSE) as well as Osaka Stock Exchange(OSE). Now TSE and OSE are integrated into Japan Exchange Group. We will learn two methods of dealing: Itayose (Batch Auction) and Zaraba (Continuous Double Auction). the institutional settings in TSE is also exposted. Moreover, you will learn the agent based simulation in general on which the U-Mart simulator is based.

1. Introductory Guidance of AI market
2. (Prof. Yoshihiro Nakajima, Osaka City University) Introduction to the U-Mart System
3. (Prof. Yusuke Koyama, Shibaura Institute of Technology) Institution of Futures Market
4. (Prof. Kazuhisa Taniguchi, Kinki University) Market and pricing
5. (Prof. Naoki Mori, Osaka Prefectural University) Elementary Introduction of JAVA programming
6. (Prof. Yoshihiro Nakajima) Random Walk and Time Series Analysis of Prices
7. A Short Tour to Tokyo Stock Exchange
8. A Short Tour to AI Laboratory of Tokyo Institute of Technology
9. (Prof. Hajime Kita, Kyoto University) Review on the Standard Agent Set of the U-Mart System
10. (Prof. Yoshihiro Nakajima)Phase Transition and Power Law Distribution
11. (Prof. Hiroshi Deguchi,Tokyo Institute of Technology) A New Application of Gaming Simulation
12. (Prof. Takashi Yamada, Yamaguchi University) The Analysis of Price Time Series
13. (Prof. Naoki Mori, Osaka Prefectural University) JAVA Programming of U-Mart Machine Agent
14. (Prof. Takao Terano, Tokyo Institute of Technology) A New Application of Agent Base Simulation
15. Summing up

Evaluation: Two ways for grade the credit:

1. Do a paper on the given subjects.
2. Days attended

Materials: Y. Shiozawa, Y. Nakajima, H. Matsui, Y. Koyama, K. Taniguchi, and F. Hashimoto, Artificial Market

Experiments with the U-Mart System, Springer ABSS Series Vol. 4, 2008, Springer-Verlag;

Kita, Hajime, Taniguchi, Kazuhisa, Nakajima, Yoshihiro (Eds.) Realistic Simulation of Financial Markets: Analyzing Market Behaviors by the Third Mode of Science, Springer Evolutionary Economics and Social

Complexity Science, Vol. 4, forthcoming, 2017

Note: You will be allocated the original materials each opportunities. After each lecture, you are obliged to check the materials. It is also recommended to read the textbooks for U-Mart.

<http://www.u-mart.org/html/index.html>

Special notice: This class is given co-jointly in association with the lecture titled Artificial Intelligent Market Experiment.

Subject name: **Artificial Intelligent Market Experiment**

Dividend year: First/second year student

Teaching staffs: Yuji Aruka(coordinator), Hiroshi Deguchi, Hajime Kita, Yuhsuke Koyama, Kazuhisa Taniguchi, Tako Terano, Yoshihiro Nakajima, Naoki Mori Requirements:

Requirements to join in this lecture are not specified.

Aims and scope: We use a platform called "U-Mart system" in order to study Artificial Intelligent Market. This AI market simulator in essence is actually the same as the existing index futures trading at Osaka Stock Exchange (OSE). It is noted that the idea of U-Mart preceded the actual one. This simulator at its origin equipped with a hybrid transaction of human and algorithmic agents. The latter can imitate a so-called high frequency transaction (HFT) by the acceleration experiment. So U-Mart is a progressive simulator to imitate the reality.

First of all, we should state our U-Mar project. Originally in 1998 U-Mart Project started as V-Mart(Virtual Mart). Now it however becomes re-nominated U-Mart. The U-Mart Project has published an English textbook (Shiozawa et. al. 2008) as one of Springer Series on Agent Based Social Systems in Spring 2008. The development of the U-Mart system during these 10 years rather was mainly engineers-driven. Now the U-Mart system is internationally recognized as a good platform for AI markets. Our project has now marked Version 4 which could be compatible with spot and futures market as well as batch and double auction. Our U-Mart Lectures consists of two parts: one is this class. The other is the class for experiment, or training program. Both lectures normally are integrated into a single Aims and Scope of U-Mart lectures. So you are recommended to join into both classes of Artificial Intelligent Economics and Artificial Intelligent Market Experiment.

Summary: The U-Mart System is an artificial intelligent market system to implement a virtual futures market with reference to the actual stock price index arbitrarily chosen, by the use of agent-based simulation techniques. In our experiments, we will have not only the training program for dealings as a human agent in the futures market but also for making a machine agent by JAVA programming. Our program is quit rudimentary only for beginners. . So we encourage you to join in our classes.

Lecture plan: The U-Mart learning will be constructed by the next parts.

- I. The introductory lessons for training market trades as a human agent
- II. The network experiments for human trading

- III. The introductory lessons for JAVA programming for making a machine agent
- IV. The network experiments for machine agents

The latter parts of III and IV seem advanced. The learning of the latter parts depend on the ability of participants. So we will mainly concentrate the first parts I and II in our lessons.

- 1. Introductory Guidance of the U-Mart System
- 2. (Prof. Yoshihiro Nakajima, Osaka City University) Play the elementary experiment
- 3. (Prof. Yusuke Koyama, Shibaura Institute of Technology) Play the traditional version of Itayose (Batch Auction)
- 4. (Prof. Kazuhisa Taniguchi, Kinki University) Learn the Analysis of the Market Experiment in the case of Itayose (Batch Auction)
- 5. (Prof. Naoki Mori, Osaka Prefectural University) Play the traditional version of Zaraba (Double Auction)
- 6. (Prof. Yoshihiro Nakajima) Learn the Analysis of the Market Experiment in the case of Zaraba (Double Auction)
- 7. A Short Tour to Tokyo Stock Exchange
- 8. A Short Tour to AI Laboratory of Tokyo Institute of Technology
- 10. (Prof. Yoshihiro Nakajima) An elementary method to design the market simulation by the use of the Excel sheet
- 11. (Prof. Hiroshi Deguchi, Tokyo Institute of Technology) A New Application of Gaming Simulation (continued from the last lecture unit)
- 12. (Prof. Takashi Yamada, Yamaguchi University) The Analysis of Price Time Series (continued from the last lecture unit)
- 13. (Prof. Naoki Mori, Osaka Prefectural University) Try to make a new machine agent
- 14. (Prof. Takao Terano, Tokyo Institute of Technology) A New Application of Agent Base Simulation (continued from the last lecture unit)
- 15. Summing up

Evaluation: Two ways for grade the credit:

- 1. Do a paper on the given subjects.
- 2. Days attended

Materials: Y. Shiozawa, Y. Nakajima, H. Matsui, Y. Koyama, K. Taniguchi, and F. Hashimoto, Artificial Market

Experiments with the U-Mart System, Springer ABSS Series Vol. 4, 2008,

Springer-Verlag;

Kita, Hajime, Taniguchi, Kazuhisa, Nakajima, Yoshihiro (Eds.) Realistic Simulation of Financial Markets: Analyzing Market Behaviors by the Third Mode of Science, Springer Evolutionary Economics and Social

Complexity Science, Vol. 4, forthcoming, 2017

Note: Each virtual transaction experiment you should analyse the market result containing your own result. The analysis will improve your understand of the market transaction. The analytical method will be taught during a series of lectures step by step.

<http://www.u-mart.org/html/index.html>

Special notice: This class is given conjointly in association with the lecture titled "Artificial Intelligent Economics" to understand the theories and institutions of the financial auction mechanism like Tokyo Stock Exchange.