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(Eds)

Contributions to Mathematics, Statistics, Econometrics, and Finance

Essays in Honour of
Professor Seppo Pynnönen

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FOREWORD

This volume is dedicated to Seppo Pynnönen on the occasion of his 60th birthday and consists of 24 contributions by more than 40 authors in the areas of mathematics, statis-tics, econometrics, and finance. As a consequence of his social and academic skills, Seppo Pynnönen has as a dedicated researcher, teacher, and friend over the years interacted with many people from a wide range of academic areas. This collection provides us an opportunity to express our appreciation and gratitude to him.

Seppo Pynnönen is a very friendly person who is also highly dedicated to all his professional duties such as research, teaching, and administration. Furthermore, he has an ability to stay focused and productive with a positive and inspiring attitude. He is also devoted to his family and keeps up a continuous activity with his sports interest, especially his passion for tennis. Seppo Pynnönen would not travel anywhere without his tennis gear.

We are grateful to all the contributors of this volume for their willingness to submit their work, thus joining us in honoring our dear friend and colleague Seppo Pynnönen. On behalf of all the contributors we would like to say that it is a privilege to have the opportunity to know, collaborate and interact with Seppo Pynnönen and we all look forward to continuing this for many years to come.

We would finally like to thank Tarja Salo for her valuable editorial help with this volume.

Vaasa, January 31, 2014

Johan Knif   Bernd Pape

SEPPO PYNNÖNEN 60 YEARS

Seppo Pynnönen was born on March 18, 1954, in Laukaa, Finland and he completed his matriculation exam in Jyväskylä in 1975. He stayed in Jyväskylä until he completed his MSc (1981) and Licentiate (1985) degrees in statistics at the University of Jyväskylä. In 1988 he received his PhD degree in mathematical statistics from the University of Tampere.

The academic career of Seppo Pynnönen started with shorter engagements as an acting lecturer and acting senior lecturer in statistics as well as mathematics and statistics at the universities of Jyväskylä and Vaasa over the period from 1982 to 1985. He finalized his dissertation Testing for additional information in variables in normal theory classification with equal covariance matrices as a research fellow at the Academy of Finland during the years 1986 to 1988. The dissertation was published in Acta Wasaensia No. 23 by the University of Vaasa but he defended his dissertation at the University of Tampere.

In September 1987 he was appointed to the tenure position of senior lecturer in statistics at the University of Vaasa. However, he did not actively continue as a lecturer for long. After a short period in the finance industry, he returned to the academia for several shorter appointments. Over the period from 1990 to 1998, he served as acting associate professor and acting professor in statistics and management sci-ences at the University of Vaasa. It is obvious that these appointments provided him with more time devoted to research than his position as a senior lecturer in statistics. In September 1998 he was appointed to his current position as full ten-ured professor of statistics at the University of Vaasa.

Seppo Pynnönen has a wide research interest. He is primarily concerned with the way statistical modeling and testing are applied. In his publications he has developed new testing and modeling procedures for a wide range of applications. In doing so, he has also shown a genuine interest in the theoretical foundations of the application area in question. This is one of the success factors driving his research.

Seppo Pynnönen has published over 30 articles in refereed international high-ranked scientific journals, over 20 chapters in scientific books and collections, and numerous working and conference papers. The publications cover topics such as variable selection in quadratic discriminant analysis; distributions of linear transformations of residuals from multivariate regressions; measurement and testing in short- as well as long-run event studies; measuring and testing exchange-rate risk exposure; distributional characteristics of risk factors in asset pricing;

measuring calendar effects on asset returns; statistical measurement of stock market reactions to inflation shocks; modeling of the relation between volatility and correlation; and modelling of credit-spread, just to name a few.

He has also applied his statistical knowledge within empirical studies of corporate finance; international stock markets; bond markets; fixed income markets; commodity markets; currency markets; credit markets; markets of foreign direct investments; and even medical studies of osteogenesis imperfecta.

Even though Seppo Pynnönen's main focus in his career has been on research, he has also over the years carried major administrative responsibilities. He has for three different periods been the Head of Department for Mathematics and Statistics at the University of Vaasa for a total of about eight years. After the introduction of the new Finnish university legislation in 2010, he was a member of the board of the first Collegium of the University of Vaasa for three years. Furthermore, for several years he has been active within the Finnish Professors Union.

Seppo Pynnönen has also an international perspective. As a research fellow with funding from the Academy of Finland and with a sabbatical funded by the Finnish Foundations' Professor Pool, he has been visiting Texas A&M University twice. He has actively attended many international scientific conferences and is an active member of, e.g., the Royal Statistical Society, the European Finance Association, the Southern Finance Association, and several national scientific societies. He has also repeatedly served as referee for many high-standard international scientific journals.

One of Seppo Pynnönen's most outstanding traits is his willingness to support and help his colleagues. One good example is his participation in the development of the Masters of Science Program in Computational Finance at the Hanken School of Economics in Vaasa. As one of the first international masters programs in Finland, this program was launched in 1998. Since then Seppo Pynnönen has not only been an active member of the steering group of the program but also actively participated as a teacher in program specific courses. He is also a member of the tenure track steering group at Aalto University.

As part of his profession, Seppo Pynnönen has evaluated applicants for scientific chairs at, e.g, Hanken School of Economics, Helsinki Business School, University of Jyväskylä, and Turku School of Economics. He has, besides having successfully supervised several PhD students at the University of Vaasa, been the official examiner of around 20 PhD dissertations and been the official opponent at close to 15 PhD defense seminars.

Another personal characteristic of Seppo Pynnönen is his ability to take initiative. This characteristic is most obvious within his research projects, but it is also evident from his ability to initiate and manage the organization of scientific workshops. He chaired the organizing committee of the Noon-to-Noon Workshops in 1998 and 2005 and organized the Annual Meeting of the Finnish Statistical Society in 2001.

The work of Seppo Pynnönen has been recognized both nationally and internationally. In 2011 he received an award from the Suomen Arvopaperimarkkinoiden Edistämissäätiö for publishing his paper "Event study testing with cross-sectional correlation of abnormal returns" in one of the three top tier journals in finance. In 2010 he received the best paper award in international finance from the Midwest Finance Association. Furthermore, in the same year he was honored with the 1st degree knight insignia of the Finnish White Rose Orden. This insignia is awarded by the President of Finland.

We have all experienced Seppo Pynnönen as a person with a very positive attitude. No scientific problem seems to be too complicated for him to solve. However, life is sometimes hard and unjust. Seppo Pynnönen has been forced to meet the un-fairness of life too many times. Despite this, with his positive attitude, kindness, and dedication, he has fought back and is today a happy grandfather and one of Finland's most respected academics in his areas of research.

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I

MATHEMATICS

SYMMETRY BETWEEN KNOWING ABOUT THE FUTURE AND ABOUT THE PAST: A SYSTEMIC APPROACH APPLYING FUTURIBLES AND HISTORIBLES

Ilkka Virtanen
University of Vaasa

1 Introduction

Knowing about the future has its intrinsic canon of sufficient scientific legitimation. Futurological canon legitimizes beliefs and opinions about the future as knowledge of the future. Instead of considering the future as a single predetermined case, a fan of possible futures, called futuribles is considered as a proper object of futurological conjecture. The manifold conceptualization of the future has a long history from Luis de Molina and others in the 16th century to Bertrand de Jouvenel in the 1950's and 60's. Malaska and Virtanen developed, based on this conceptualization, a general set-theoretic construction, called a theory of futuribles for futures knowledge inquiry. A short summary of the futures manifold and futuribles is presented as the first part of the paper. Before this, the three dimensions of time and their interdepencies are dis-cussed.

The paper further shows that the theory of futuribles can be applied also in history context, to describe and analyze the past and the present. Concepts of historible and presentibles are introduced for that purpose. Examples of historible applications are given in the areas of biological evolution, history of habitation, decision analysis and contrafactual history doctrine.

1.1 Three dimensions of time

A wish to know about the future has been a human intellectual characteristic since Antic Greece and Rome, as we know from the historic stories about the Delphic oracle Sibyl. Human interest in the future can be traced back even to the ancestors of Homo sapiens, as exemplified for instance by Y. Coppens with archaeological findings (Malaska & Virtanen 2009: 65). We can, therefore, say that the future was invented by the emerging consciousness of mind already at the dawn of humankind.

The future is one dimension or part of the total time flow we have already met and still will meet. Consciousness about these three dimensions is typical to humans as presented in a fascinating children's poem "Aika (Time)" (Korolainen 2005: 48-49):

Time

Man has yesterday, today,
man has tomorrow,
grandpa mouse pondered.
And wrinkle in his brow deepened.

Man has all the times,
the mouse has only ***now***, that's tight boundaries.
But – and here grandpa held back:
Is the man really more happy?

Is it really possible to know about the future in a firm and trustworthy way? Scientific knowledge is nothing else than a well-grounded true belief. All sciences from mathematics and natural sciences to social and humanistic sciences stick to this as an epistemological commitment. It means that a subjective belief, intuition or opinion is accepted as an objective knowledge when there is sufficient evidence to convince the others that the belief is true and credible. Knowing about the future makes no exception in this respect.

Knowing about the future is, however, different from knowing about the two other dimensions of the time, the past and the present. Unlike the past or present events, future events do not materialize to our senses, when a desire to know about them appears in our minds. Knowing about the past and present can be grounded on observable factual material evidence whereas conjecturing the future relies on non-factual and intentional data, i.e. mind images and rational conjectures. Pentti Malaska has described the three dimensions of time with a poem "When the time becomes reality" (Malaska & Virtanen 2009: 65; original Finnish version Malaska 1979).

When the time becomes reality

Time flows to the present from two directions,
from the past and from the future.

From the past
as our deeds accomplished and
events materialized
observable to our senses, and

From the future
as our aims and intensions,
objectives targeted, hopes or despairs
experienced by our mind.

The present attracts the times
and moulds them together
as a cosmic black hole,
whereupon they cannot help
but creating our reality.

The three dimensions of time are in close relation with each other. Thinkers have emphasised this relation for centuries. As a Finnish example we can take Michaele Wexionio, a member in the professoriate at the Royal Academy of Turku (the present University of Helsinki) at the time of the Academy's inauguration in 1640. In 1642 he wrote in his doctoral dissertation Discursus Politicus De Prudentia (Wexionio 1642):

Fundamentals of the wisdom are that we choose the good and avoid the bad. In order to get this wisdom we need a threefold ability:

- firstly, memory to analyse the past,
- secondly, understanding to observe the present, and
- thirdly, attention to foresee the future.

1.2 Relativity and duality of time

Since the works by Albert Einstein it has been generally accepted that time is relative by nature. The time passed depends on the observer. This holds good also for history and future. History and future can even be dualistic for each other. This can be exemplified – following the idea presented by a former member of the Academy of Finland, professor Oiva Ketonen – with a hypothetical case from astronomy.

Let us assume that an astronomer observes with a telescope a star which is at a distance of 2500 light years from the earth. Things which the astronomer now observers to happen on the star have happened there 2500 years ago. Things happened since then are historical from the point of view of the star but for the observer on the earth they are events in the star's future, and it is not possible to get any information about them until in the course of time (e.g. about the star's present after 2500 years from now). And vice versa, if there were on the star an observer, who would at the moment (at the earth's present) watch the state of affairs on the earth, the observer could see for example the on-going battle between Athens and Persia on the fields of Marathon. We would have no means to tell the observer what has happened here on the earth after those days.

Our example above has demonstrated that although knowing about the future is different from knowing about the past and the present, these three dimensions of time have much in common and they are closely related. Therefore, it is natural to think that there must be a methodology in the framework of which it is possible to give a common formal presentation for the processes which have been going on in the past and are continuing towards the future through the present.

Malaska and Virtanen (2009) have presented a systemic approach, the theory of futuribles, for describing in a formal way scenarios and future images used in futures studies. They also presupposed that the same approach could be applied to processes already happened in the past. In analogy to futuribles used to analyse the future they called tools for describing the past historibles. A more detailed presentation of historibles was, however, left for further research. The objective of this paper is now to present, using analogy emerging from the theory of futuribles, a formal definition for the historibles and to show how they can be applied in historical contexts, and further to demonstrate the conceptual symmetry between futuribles and historibles.

2 Generic design of futures manifold

Futurible-conception, i.e. the manifold of possible futures instead of a single future, is well accepted in modern futurological inquiry. Growth of the popularity of scenario writing since the 1960's demonstrates this well, as exemplified by the sample of the references in Malaska and Virtanen (2009: 68). Bertrand de Jouvenel coined the term futuribles to a fan of futures in his futurological classic The Art of Conjecture (de Jouvenel 1967). Malaska and Virtanen (2009) utilised the possibilities which this conceptualization offered to futures studies and presented a logical framework for the futurible-conception and called it the theory of futuribles.

This section deals with a formal presentation of futures manifold and futures mapping in the form of generic futures tables, futuribles and futures synopsis. It is based on the work cited above (Malaska and Virtanen 2009). A concise summing up of this work is motivated by the need to present the general methodology earlier applied in futures mapping for inventing the methodology also in history context to describe and analyse the past.

2.1 Futures manifold

Designing a futures map or image starts by identifying the issues which are regarded as vital and relevant in the study; they are called futures variables. Examples of future issues and variable names could be “economic growth”, “export”, “aging rate of population”, “literacy rate”, “dematerialization”, “equality”, “rebound”, “environmental stress”, “energy need”, “material consumption”, “technology development”, and “welfare productivity of GDP” etc. Each issue is itemized into mutually exclusive, alternative possibilities of the issue variety. The items of the issue variety are called values of the variable and the total set of them forms the domain of the variable in the study.

Let the futures variables be denoted by X_i, ($i = 1, 2,\ldots, K$), where K is the number of identified variables. The domain of the variable Xi is a set of the varieties $\{x_{ij} \mid j=1, 2,\ldots, n_i\}$, where n_i is the number of the different values of X_i.

When an issue is apt to quantitative measurement, the values of the variable are quantities. A future variable may also be measurable only on an ordinal scale, or it may represent plain qualitative aspects of the future on a nominal scale. If the variable has only one value, the variable is called a future constant. For instance, until today the planetary conditions on the Earth have been generally regarded as constant. Nowadays the possibility of an irreversible climate change has transformed that aspect from a future constant to the class of variable. A variable having a domain of a few values only may be taken to serve as a future parameter. The parameter can be used for partitioning the futures space into mutually exclusive sub-spaces. In summary, the futures manifold is defined in the form of formulas (1) to (3).

Let the collection of the future variables Xi be symbolically denoted by the variable set X. We then have

$$X = \{X_i \mid i = 1,...,K\}. \tag{1}$$

The value domains of the variables are

$$X_i = \{x_{ij} \mid j = 1,...,n_i\}, \quad i = 1,...,K. \tag{2}$$

The elementary system defined by (1) and (2) is called a *futures manifold* $\mathcal{X}$. It can be interpreted as a K-dimensional coordinate system spanned by the variable set X. The futures manifold X can be symbolically presented as a set of K-dimensional Cartesian points or vectors $\times\boldsymbol{X}_p$:

$$\mathcal{X} = \{\times\boldsymbol{X}_p \mid \times\boldsymbol{X}_p \in X_1 \times X_2 \times \ldots \times X_K\}. \tag{3}$$

2.2 Generic table of the futures manifold

The futures manifold $\mathcal{X}$, i.e. the system (1) to (3) is possible to represent alternatively in the form of a table. For each future variable X_i a row i of the table is designated and to each value x_{ij} of the variable X_i a cell (i, j) in that row is designated. The resulting table of the manifold is called the *generic table*. The generic table obviously has K rows and n_i cells in the rows. A design of the generic table is illustrated in Table 1.

Table 1. Generic table design for a futures manifold

<table>
<tr><th>Futures variable</th><th colspan="12">Generic table</th><th># cells</th><th>Interpretation of the type of the variable</th></tr>
<tr><td>X_1</td><td colspan="6">x_{11}</td><td colspan="6">x_{12}</td><td>2</td><td>an optional parameter</td></tr>
<tr><td>X_2</td><td colspan="3">x_{21}</td><td colspan="3">x_{22}</td><td colspan="3">x_{23}</td><td colspan="3">x_{24}</td><td>4</td><td>a variable</td></tr>
<tr><td>X_3</td><td colspan="4">x_{31}</td><td colspan="4">x_{32}</td><td colspan="4">x_{33}</td><td>3</td><td>a variable</td></tr>
<tr><td>X_4</td><td colspan="4">x_{41}</td><td colspan="4">x_{42}</td><td colspan="4">x_{43}</td><td>3</td><td>a variable</td></tr>
<tr><td>X_5</td><td colspan="12">x_{51}</td><td>1</td><td>a futures constant, background</td></tr>
<tr><td>K=5</td><td colspan="12">M=13</td><td>$\bar{n}$ =2.6</td><td></td></tr>
</table>

In Table 1, the bottom row (variable X_5) has only one value in its domain indicating that the respective issue is a constant futures background and the variable is a future constant. The variables X_2, X_3, and X_4 have four or three values in their domains. They represent conventional future variables with given domains. The first variable X_1 has two values. This variable could be regarded, if relevant, as a future parameter.

2. Technology / Organisation	3. Culture / Values	4. Globalisation	5. Macro economic policies (EMU)	7. Social and employment policies
No major breakthrough. Downsizing. Continuing de-specialisation of Europe in high-tech.	Increasing individualism. Fear of the future.	Globalisation continuing, sectoral resistances, local difficulties.	Broad EMU with limited coordination and no major tensions.	Continuing "decremental" adjustment of social protection.
No major breakthrough. Increasing dualism. Increasing de-specialisation of Europe in high-tech.	Strongly increasing individualism. Social and geographical segregation. Power of lobbies.	Globalisation accelerating. "Borderless world"	Broad EMU with limited coordination and major tensions.	Strong labour market deregulation. Residual welfare state.
Major breakthrough. Europe innovating and/or catching up.	Renaissance of social/ecological awareness. Regions/localities experiments.	Globalisation slowing down, trade conflicts, regional blocks.	Broad EMU with strong coordination.	Strong resistance against welfare state reform.
Major breakthrough. Increasing technologically induced inequality. Europe catching up.	Revolt of the bottom-half against globalisation.	Global crisis	Failure of EMU	Radical reform of welfare state: universalism and individual incentives.
Major breakthrough. Increasing technologically induced inequality. Europe falling behind.				

Figure 1. Generic table of an EU study; the futurible of the non-shaded cells is called the "Laissez faire" future in the study. The table layout is transposed as indicated in the text. (Bertrand et al. 1999, 94)

Figure 1 shows a concrete example of a generic table taken from an EU study (Bertrand et al. 1999). For layout reasons the table is presented in a "transposed form", i.e. the five (K=5) future variables appear horizontally and their values (with 4 to 5 cells) vertically. The non-shaded white cells in the table combined represent a point in the K-dimensional futures space having received a verbal definition of the "Laissez faire" future in the study.

The generic table is a morphological setting of the future "sceneries", i.e. a representation of the possible futures. Each future issue or a variable has multiple varieties such that the rows in the table may have a varying number of cells. The number of the cells in a variable row gives an indication of the coarseness of resolution of the issue presentation. The more cells there are, the finer is the resolution, and vice versa.

Let M denote the total number of cells in the table and $\overline{n}$ the mean number of cells per row. We can then write

$$M = \sum_{i=1}^{K} n_i = K \cdot \overline{n}. \tag{4}$$

Metaphorically, the number of future variables K refers to the *extension of the futures space*, the bigger K the farer the horizon of the space from a centre. The mean number of cells $\overline{n}$ implies the *mean issue resolution*. The total number of cells M, interpreted in (4) as the product of the extension and the mean resolution, indicates the total *expressiveness* of the futures manifold under study.

2.3 Synoptic design of futures mapping

An element of the futures manifold in (3) and its equivalent presentation as a point in the K-dimensional coordinate system is called a synopsis. A synopsis is an exhaustive and exclusive collection of values of the successive variables in the generic table. The synopsis is a design composed of one and only one cell from each variable row of the table. Formally a synopsis F_q is defined by

$$F_q = \left(x_{1q_1}, x_{2q_2}, \ldots, x_{Kq_K}\right),\ q = 1,\ldots,N;\ q_i \in \{1,\ldots,n_i\},\ i = 1,\ldots,K. \tag{5}$$

In Formula (5), N stands for the number of all potential synopses. It depends on the number of the possible values of the variables in their domains according to the multiplication formula (6). There may be some bans which negate the simultaneous presence of some values of distinct variables wherefore the number of feasible synopses may be smaller than the number of all synopses N.

$$N = \prod_{i=1}^{K} n_i = n_1 \times n_2 \times \ldots \times n_K . \qquad (6)$$

For rationalizing the notation the following Dirac's Delta type table D^q is introduced. D^q is a table with the same number of rows and cells and the same format as the generic table. Each cell value of the D^q-table is either 0 or 1 in such a way that each row contains one and only one 1. Let the i^{th} row ($i = 1,2,\ldots,K$) of the D^q-table be denoted by D^{q_i} and let us further assume that it has its non-zero element in the position $p_i \in \{1,2,\ldots, n_i\}$, i.e. $D^{q_{ip_i}} = 1$ and $D^{q_{ij}} = 1$, when $j \neq p_i$. The table element $D^{q_{ip_i}}$ can be used to pick a cell value x_{ip_i} from address p_i of the futures variable X_i in the generic table. Together all the cells in the D^{q_i}-rows with $i = 1,\ldots, K$ and with $p_i = 1,2,\ldots, n_i$ pick an exhaustive set of the value elements of the future variables that constitutes a synopsis. The Dirac's Delta table thus defines the formal picking of a specific synopsis from the set of all synopses within the generic table. The set of all Dirac's Delta tables is presented by a notation of $\boldsymbol{D} = \{D^q\}$.

With the D^q-table notation a synopsis F_q of $\mathcal{X}$ can be presented with scalar product operations (operation denoted by ·) between corresponding rows of the generic table $\mathcal{X}$ in (3) and of the Dirac's Delta table D^q:

$$F_q = (\, D^{q_i} \cdot X_i \mid i = 1,2,\ldots,K \,) = (\, D^{q_1} \cdot X_1,\ D^{q_2} \cdot X_2, \ldots,\ D^{q_K} \cdot X_K). \qquad (7)$$

The operation in (7) results in a vector F_q whose components are scalar products of the row vectors of the tables D^q and $\mathcal{X}$. There is one to one correspondence between this result and the previous notations of $\{\times \boldsymbol{X}_p\}$ and $\{F_q\}$.

The set of all synopsises $\{F_q\}$ spanned by the generic table $\mathcal{X}$ is called the futures space $\boldsymbol{F}$. With the notation of $\boldsymbol{D}$ the futures space will have a simple expression as a "multiplication" operation (denoted by $\circ$) with the generic table $\mathcal{X}$

$$\boldsymbol{F} = \{F_q \mid q = 1,\ldots, N \} = \{(\, D^{q_1} \cdot X_1,\ D^{q_2} \cdot X_2, \ldots,\ D^{q_K} \cdot X_K) \mid q = 1,\ldots,N \} = \boldsymbol{D} \circ \mathbf{X} \quad (8)$$

2.4 Futurible – a basic unit of futures mapping

The synopsis concept belongs to the syntactical design of futures mapping. It is a logical form of a possible future. Synopsis and futurible are synonymous equivalents in the sense that futurible is a semantic counterpart of synopsis. Futurible refers to the content, while synopsis gives the logical form in which the content is to be presented. Therefore, the whole set of synopses in (8) also means the fan of the futuribles mapped onto the generic table $\mathcal{X}$, and F_q stands for a single futurible.

Each future variable defines an independent dimension of the future into which direction the futures stories can be told and varied within the domain of the variable. The generic table with its K variables spans a K-dimensional futures space, where each futurible represents a map of a possible future "scenery".

It is plausible that certain relations may exist between future variables denying a possibility of some of their values to coexist. In addition, constraints may occur also between futuribles to follow each other. Some futurible may be a necessary condition for another one, and this in turn to yet another one etc., while constraints of another type may deny a succession between futuribles. For instance, the present which in the logical and formal sense – although not semantically – is also a synopsis and a futurible, is a necessary though not sufficient condition for any future to come. The present does not predetermine the course of the successive futuribles, but neither does it leave the course of the future unconstrained. From the synopsis of the present several possibilities are available for futuribles to unfold. Some possible courses of the future may divert from each other irreversibly depending on the different constraints, while other courses may pass partly through the same futuribles. It is, in addition, well- grounded to assume that in the course of the future a given futurible may be reachable from several preceding ones but not from whichever futuribles. A possible chain of futuribles is called a course of the future. Futuribles as well as futures courses may be attached with specific attributes such as probable, desirable, avoidable, non-feasible, or a threat, a utopia or a dystopia.

3 Historibles and presentibles – counterparts to futuribles for the past and the present

As considered in the Introduction, the conception that knowing about the future in a firm and confident way is conceivable, has received a common commitment in modern futures studies. On the other hand, knowing about the future is different from knowing about the past and the present. The latter two can be grounded on observable factual material evidence whereas conjecturing the future relies on non-factual and intentional data, on mind images and rational conjectures. Future is no entity but a continuously unfolding process to be forethought in the mind scenery. In addition, we pointed out that the three dimensions of time, the past, the present, and the future are mutually related. The past and the present make the future possible but they also constraint the future unfolding. The future remembers some of the past and present, but they never fully determine the future course.

At the end of the preceding section we already shortly considered these interdependencies in the terms of futuribles and synopses. We brought forward that the present can in the logical and formal sense be regarded as a synopsis or a futurible which is a necessary though not sufficient condition for any futures to come. The same is equally true for the past. The objective of this section is to present both the past and the present applying the formalism developed for the future and covered by Formulas (1) to (8).

3.1 Design of historibles and presentibles

As already stated, knowing about the past and about the present are – when compared with knowing about the future – are conceptually more similar with each other. Knowing can be grounded on observable factual material evidence. Therefore, the synoptic design of the past and the present can be done uniformly. The design is presented for the past, for the present it is analogous. We call the counterpart for futurible in the design of the past a historible, and a presentible when the present is considered.

Let the issues identified for the past, the history variables, be denoted Y_i, (i = 1, 2,…, L), where L is the number of identified issues. The domain of the history variable Y_i is a set of the varieties $\{y_{ij} \mid j=1, 2,\ldots, l_i\}$, where l_i is the number of the different values of Y_i. It is clear that the term variable has a different meaning in the case of the past (and the present) than in the case of the future. This will be considered more closely by examples later on. Analogously with the elementary system of Formulas (1) and (2), we can define the *histories manifold* as a system of formulas

$$Y = \{Y_i \mid i = 1,...,L\}\text{, and} \tag{9}$$

$$Y_i = \{y_{ij} \mid j = 1,...,l_i\},\quad i = 1,...,L. \tag{10}$$

Again, it can be interpreted as an L-dimensional coordinate system spanned by the variable set Y. The histories manifold, denoted by Υ, can thus be symbolically presented as a set of L-dimensional Cartesian points or vectors $\times\boldsymbol{Y}_p$:

$$\Upsilon = \{\times\boldsymbol{Y}_p \mid \times\boldsymbol{Y}_p \in Y_1 \times Y_2 \times ... \times Y_L\}. \tag{11}$$

The histories manifold Υ, i.e. the system of Formulas (9) to (11) is also possible to be represented, following the lines in forming Table 1, in the form of a generic table. The design of the generic table is straightforward and is therefore omitted here.

Equivalently to the future synopsis, a history synopsis is a design composed of one and only one cell from each variable row of the histories manifold table. Formally a history synopsis, H_q, is defined by (12):

$$H_q = (y_{1q_1}, y_{2q_2}, ..., y_{Lq_L}),\ q = 1,...,\Lambda;\ q_i \in \{1,...,l_i\},\ i = 1,...,L. \tag{12}$$

In Formula (12), Λ stands for the maximum number of all potential synopses and is given by

$$\Lambda = \prod_{i=1}^{L} l_i = l_1 \times l_2 \times ... \times l_L. \tag{13}$$

Again, as in the case of future synopses, there may be some bans which negate the simultaneous presence of some values of distinct variables in which case the number of feasible history synopses is smaller than Λ.

3.2 *Characteristics of history and present variables*

What has been said above indicates that variables in histories and presents manifolds are semantically different from those in the futures manifold. One may even ask if it is possible to think any variability in the present and history courses. Is it quite the contrary true that what has happened in the past is a fact and contains no variability? The answer is naturally yes when the physical process itself is in concern. But our knowledge about the history is imperfect, and along with the progress of research the historical facts may change. As a consequence, when the past is described in the form of a historible or a history synopsis the resulting entity value depends on the time of data on which the creation of the entity value is based. In the following some examples are given to describe the characteristics of variables in histories manifolds, i.e. in historibles and history synopses.

Biological evolution

One of the most revolutionary discoveries in last two centuries' science is the isolation of the DNA molecule and its applications in biology, evolution, history and anthropology, and in various areas of technology. For example, knowledge about the evolution of living plant and animal species on the earth has changed dramatically along with wide-ranging invocation of DNA technology after the 1960's. In history tables, where the variables represent certain issues about the development of living species on the earth, the values of the variables rest highly on the time the knowledge used is from. A historible which is constructed by picking from the history table variable values based on knowledge in the 1950's may be radically different from another historible from the same table when the newest knowledge of 2010's is used. The physical process on the background of the variable values is the same but changes in the knowledge have changed the values. Differences in historibles are a result of progress in science. Increase of knowledge has created new historibles into the histories manifold.

Habitation history of Finland

As an anthropological example we can take the history of habitation of Finland. According to the current view of the habitation history of Finland the first people came to Finland about 10000 – 11000 years ago after the thick continental glacier had drawn back from our country. The first people came from east because most southern and western parts of the country were under water. Afterwards, along with the land rising also people from west settled the southern and western parts of the country. The borderline between these two groups of people follows approximately the border between Sweden and Russia established in Pähkinäsaari

Peace in 1323. It is possible to see some anthropological, linguistic, cultural and religious signs of this historical borderline even in today's Finland.

Until the latter half of the 20th century the dominant view on the habitation history was that the birthplace of the Finns was solely upon the bend of the river Volga in Eastern Europe. Later archaeological, genetic and linguistic findings have shown, however, that the Finns have ancestors both in the East and in the West. New information has produced a different historible than the old knowledge.

Recent archaeological and geological findings in Ostrobothnia have opened another quite dramatic view for the habitation history of Finland. The origin of this invention is in the discovery and excavation of the Wolf cave in Kristiinankaupunki municipality in Southern Ostrobothnia in the 1990's.

Wolf Cave (Wolf cave 2013) is a wide horizontal crevice in the primary rock and is named for its location on Wolf Mountain. The cave was formed as a result of erosion, and it is estimated to be more than 2.6 million years old. In the interglacial period, when the sea level was just outside the mouth of the cave, it was filled with layers of sediment and remained untouched until 1996, even though the cave was widely known in the area. The cave opening is 116.5 meters above the current sea level, and the ceiling of the cave is 2.2 meters high at the highest point. It is difficult to precisely determine the size of Wolf Cave because it is still partially filled by sediment layers, but it is estimated to be over 400 m². According to the Wolf cave research group, the cave is the only place on earth where evidence of human inhabitancy has been found in a place that was later, during the ice age, covered by a continental glacier. Wolf Cave is northern Europe's oldest known human dwelling site.

The research group (Wolf cave 2013) further presents that they have found in the sediment levels of Wolf Cave evidence of human habitation that includes stone tools, stone chips left from the making of such tools and old hearth remains. Based on the sediment level in which these artefacts were found and age calculations from analysis of pollen samples, these artefacts are estimated to be at least 120 000 years old. This means that the inhabitants must have been Neanderthal men and they have dwelt in the cave prior to the last ice age.

The interpretation of the findings is, however, very controversial, and the conclusions of the research group, although supported by some experts of archaeology and from National Board of Antiquities and Historical Monuments, have not yet gained any common acceptance. But if the claims of the research group turn out to be valid, the habitation history of Finland changes totally.

Both of the examples above show that knowing about the past is not necessarily static. New discoveries and new ways to observe and interpret the vestiges from the past may change our understanding of the times gone. The historical process itself is a definite fact but our knowledge about the process may change along with time. When the past is described in the form of historibles or history synopses a fan of histories may be found. The present knowledge indicates the most relevant and trustworthy historible or synopsis of the history manifold.

Uncertainty of the future – uncertainty in the past and in the present

The following text-book example shows that uncertainty which is linked to the future may have its source deeply in the past. In fact, the uncertainty may not be a physical feature of the future at all. On the contrary, it is a feature of the past – and it has physically born in the past. The example to be presented is the classical Oil drilling problem by Howard Raiffa (Raiffa 1968).

Oil drilling problem

The general problem. An oil wildcatter must decide whether or not to drill at a given site before his option expires. He is uncertain about many things: the cost of drilling, the extent of the oil or gas deposits at the site, the cost of raising the oil, and so forth. He has available the objective records of similar and not-quite-so-similar drillings in this same basin, and he has discussed the peculiar features of this particular deal with his geologist, his geophysicist, and his land agent. He can gain further relevant information (but still not perfect information) about the underlying geophysical structure at this site by conducting seismic soundings. This information, however, is quite costly, and his problem is to decide whether or not to collect this information before he makes his final decision: to drill or not to drill.

Specified problem in a simple form. The oil wildcatter must decide either to drill (act a_1) or not to drill (act a_2). He is uncertain whether the hole is dry (state θ_1), wet (state θ_2), or soaking (state θ_3). His payoffs are given in the following table:

Table 2. Payoffs in the Oil drilling problem

State	Act	
	a_1	**a_2**
Dry (θ_1)	-\$70000	0
Wet (θ_2)	\$50000	0
Soaking (θ_3)	\$200000	0

We assume here that the cost of drilling is \$70000. The net return of the consequence associated with the (Wet, a_1)- or (θ_2, a_1)-pair is, for example, \$50000, which is interpreted as a return of \$120000 less the \$70000 cost of drilling. Similarly the other figures.

<u>Sample Information.</u> At a cost of \$10000, our wildcatter could take seismic soundings (experiment e_1) which will help determine the underlying geological structure at the site. The soundings will disclose whether the terrain below has (a) no structure (outcome NS) – that's bad, or (b) open structure (outcome OS) – that's so-so, or (c) closed structure (outcome CS) – that's really hopeful. The experts have kindly provided us with the following table, which shows the joint and marginal probabilities.

Table 3. Joint and marginal probabilities associated with seismic soundings

State	Seismic outcome			Marginal probability of state
	No S	Open S	Closed S	
Dry (θ_1)	.300	.150	.050	.500
Wet (θ_2)	.090	.120	.090	.300
Soaking (θ_3)	.020	.080	.100	.200
Marginal probability of seismic outcome	.410	.350	.240	1.000

From the table we can see, for example, that the joint probability of θ_1 (dry) and OS (open structure) is .150; the (marginal) probability of θ_1 is .300 + .150 + .050 = .500; the probability of OS is .150 + .120 + .080 = .350.

Discussion. The future of the oil business depends on many wild cards: the amount of oil at the site, the result of seismic soundings (if applied), and the cost of drilling. To run the business, the wildcatter has many decisions to do: to drill or not to drill, to take or not to take seismic soundings before the drilling decision and, in the case of taking seismic soundings, the way of using this approximate seismic information. To use these elements, it is possible to present the future of the oil business in the form of a futures manifold, as a collection of futuribles or future synopses. Values of the future variables come partly from the wildcatter's decisions, partly from the "decisions of the nature", i.e. due to uncertainties. The use of futuribles does not offer, however, any particularly efficient way to "solve" the wildcatter's decision problem. Its value is rather in opening a view to the future of running the business. It maps all potential outcomes of the future oil business for the wildcatter. As efficient measures to solve the problem Raiffa presents the traditional decision tree analysis and strategy matrix technique.

When we take a closer look at the future variables whose source of variability is in uncertainty, we will find that they differ by nature from each other. The cost of drilling and the result of seismic soundings are pure future variables, the processes will happen and the values of the variables will be determined in the future. But the case is different when the amount of oil at the site is concerned. It is physically no uncertainty in the amount of oil. The amount of oil, if any, has existed at the site already for millions of years. Physically, the amount of oil is rather a history (and a present) than a future variable, and its value has been fixed for a long time ago. The uncertainty in the amount of oil and thus unawareness of the value of the corresponding variable comes from the lack of information available for the decision maker.

Following the physical process in the oil drilling case, the natural way to proceed would thus be to present the past as three historibles with differing amounts of oil as the values of the proper variable. These three historibles lead to three potential presents (possible to be described in the form of three presentibles). Each of these potential presents has futures specific to it. Each historible-presentible chain forms the basis for a separate fan of futuribles.

Contrafactual history conception

The concept of historible offers an elegant way to illustrate the treatment of history by the means of contrafactual history doctrine. In applying this doctrine it is thought that something in the history might have happened otherwise than it really happened. From this alternate starting point a new course of contingencies is generated. This course of contingencies leads to an alternate present for the really existing present. It is, of course, possible to create several such contrafactual histories. Each separate contrafactual history can be presented in the form of a historible.

It is easy to see that this type of historible possesses technically the properties of a futurible. The starting point in the past corresponds the present in futurible formation. The issues considered in a contrafactual historible are not based on observable factual material evidence but on non-factual and intentional data, on mind images and rational conjectures as is the state of affairs for a futurible. Due to the speculative nature of contrafactual history conception it is not considered, however, in more details here.

3.3 Conclusions

The three dimensions of time: the past, the present, and the future were presented in the paper. Interdependencies between these three dimensions were discussed and exemplified with excerpts from literature and philosophy.

Knowing about the future has a different canon of legitimation than that of knowing about the past and present. It can be regarded as more general in the scientific sense because of the intentional characteristic of knowledge of the future. In the paper a logical construction developed by Malaska and Virtanen (2009) and based on a morphological setting called the generic table of the futures manifold was presented together with a syntactic theory of futurible.

The theory of futuribles was utilized to enlarge it to cover also the past and the pre-sent. Analogously to futures manifold the concepts of histories manifold and presents manifolds were developed. A histories (presents) manifold can be presented as a set of historibles (presentibles) or as a set of history (present) synopses. Logically these systemic concepts relating to the different dimensions of time are equivalent, but due to the fact that knowing about the future differs from knowing about the past and the present, the semantic interpretation of the concepts is different. Examples of historible (and presentible) applications were given in the areas of biological evolution, history of habitation, decision analysis and contrafactual history doctrine.

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