Timeline view of interest in forecasting tools seen across categories

State-of-the-art in technological forecasting methods has gathered a set of tools and data about their appearance in scientific journals. The intensity of discussion has been measured as a timeline that gives a chance to observe shifts in intensity of discussion among different groups of forecasting tools.

1 Introduction

This white paper refers to a work done within the task T2.3 'Technology Forecasting – State of the art update' of FORMAT project. A list of forecasting tools has been collected, as a reference to be used later in forecasting method construction process.

The search for these tools has been performed in scientific publications in a form of books, manuals and scientific journals. It was decided to begin with reviews of forecasting tools that are already done. Following step would be to update them with recent developments, which have taken place since review's publication until present. List of forecasting tools has been built basing on references listed in Table 1.

Table 1 Bibliographic sources and number of forecasting tools extracted

#	Name of source	Number of tools extracted
1	A.L. Porter et al. "Technology futures analysis: Toward integration of the field and new methods" 2004 [1]	51
2	Makridakis et al. "Forecasting methods and applications" 1998. [2]	19
3	J.Scott Armstrong et al. "Principles of forecasting" 2002. [3]	10
4	Vanston, "Technology futures", 2005 [4]	28
5	FORLEARN [5]	26
6	J.P. Martino "Technological forecasting for decision making", 1993. [6]	39
7	Futures Research Methodology Version 2.0, Millenium Project, 2002. [7]	27
8	Futures Research Methodology Version 3.0, Millenium Project, 2011. [8]	35
9	Technological Forecasting and Social Change, Special issues since 2004	9
10	International Journal of Forecasting, Special issues and sections since 2000	4
11	M3 competition, [9]	24
12	A.L. Porter – presentation, 2005. [10]	19

Collected forecasting tools have been reviewed for repetitions. Some tools considered as upgrades or additions to basic version of a tool have been replaced by a single name of a main tool e.g. Delphi, Delphi techniques, Real-Time Delphi have been replaced by Delphi.

Another aim was to gather information about significant applications of forecasting tools. A number of scientific publications citing a particular forecasting tool have been chosen as an indirect measure of number of tools' applications.

2 Number of scientific publications

Number of papers that refer to a particular forecasting tool have been used as a measure of importance. It was assumed that a tool that is more used in practice, is also more frequently discussed in scientific publications. The strength of this approach is accessibility of a measurements through indexing search engines like Scopus and Google Scholar. Scientific publications provide also a good quality reference to further information about tools [11] [12]. A weakness of such a measure is reliance on an appearance of a tool's name, without considering a context. One way to increase an importance of tool's mentioning in a scientific paper is default restriction to search only in three places i.e.: title, abstract and keywords.

In order to use a list of collected forecasting tools in a more practical way, they have been split into four categories. Four categories divide tools into groups with particular application profiles [13]. Forecasting projects usually apply a composition made of tools from different groups. At different stages, tools from different groups are used, e.g. one to work with experts, other to work on statistics in data series and another one to build causal models. Allocation of tools into particular categories has been performed by the author, following tools' description in literature. However, it should be noted, that allocation of some tools (2-3 per group) may be discussable and subjected to interpretation. Some tools may be used in different ways and then belong to one or another group.

In case of a Scopus service, at the time of utilization of a search query, it is possible also to retrieve data in a form of data series. Thanks to data series it is possible to see dynamics of appearances of content referring to particular forecasting tool over time. These data are important especially when number of appearances is going to be used in tool selection. In this way it is possible to distinguish between tools gaining recognition in scientific publications just recently and tools gaining recognition over a longer period.

It would be interesting to see how categories of forecasting tools behaved in terms of popularity over the years. For instance, an equal split between these four groups would mean that they have been equally discussed and suggests that all four groups are equally important. In terms of a measure, it would mean that a number of appearances of forecasting tools among tools in each group were close from one group to another.

Table 2 List of tools with historical data series collected, with DK categories

Causal models	Phenomenological models	Intuitive models	Monitoring and mapping
Agent Modeling	Box Jenkins	Brainstorming	Adaptive policies
Artificial Neural Networks	Correlation Methods	Delphi	Technology frontiers
Backcasting	Demographics	Expert Panels	Bibliometrics
Combining forecasts	Dynamic regression	Field Anomaly Relaxation	Cost–benefit analysis
Complex adaptive system	Econometric	Field Anomaly Relaxation	Environmental monitoring
Cross-Impact Analysis	Fisher Pry	Focus groups	Environmental Scanning
Decision Modeling	Grey model	Futures Wheel	Feedback models
Diffusion modeling	Growth curve	Interviews	Institutional analysis
Causal models economic and social	Logistic curve	Judgmental	Non-Linear Dynamics
Expert Systems	Long wave	Nominal groups	Normative method
Genetic Algorithms technology innovation	Long-term	Rule Based	Patent analysis
Heuristics Modeling	Lotka-Volterra	Science fiction	Potential Breakthrough Technologies
Impact analysis	Multiple regression	Wild Cards	Probabilistic scenario
Irreversibilities	Multivariate autoregressive		Scenario planning
Morphological analysis	Non-linear		Scenario-simulation
Multi-Criteria Analysis	Simple regression		Correlation Stages of Development
Normative	Statistical Modeling		Stakeholder analysis
Personal Futures	Time series decomposition		Structural Analysis
Probabilistic Methods	Trend extrapolation		SWOT
Relevance Trees	Trend Impact Analysis		Tech Mining
Risk analysis	Analytical hierarchy process		Technological progress function
Science technology Road Mapping			
Stochastic Cellular Automata			Technology assessment
Stochastic Projection			Technology frontiers
System dynamics			Text Mining
Systems Perspective			
Technological substitution			
TRIZ			

3 Results

Set of tools for which a historical data series have been collected is presented in Table 2. The list arranges tools into four categories proposed by Dmitry Kucharavy i.e.: causal models, phenomenological models, intuitive models, monitoring and mapping.

The list of tools presented in Table 2 slightly differs from the complete list of tools analyzed within the FORMAT project and listed in the project deliverable (D2.3). The original table in D2.3 lists 134 tools, whereas Table 2 lists 87 tools. The reason is that not for every tool a historic data series was available. As historical data series were missing, it can be assumed that this case concerned less frequently used tools. Number of tools with and without data series can be compared in Table 3.

The objective was to measure a share of a particular category of forecasting tools charted for all years given in data series 1970-2013. A share of a single category in a particular year is measured as a number of publications that have appeared since 1970 until a particular year, with this year included. A measure sums all forecasting tools from a particular category.

In order to obtain these data, data series have been converted from a standard form listing appearances per year into cumulative form listing for every year a sum of publications that have appeared since 1970 (Figure 1).

Before looking into historic changes in each category, it is important to learn about original composition of each category. With the exception of difference in total number of tools for which data series have been collected, explained earlier in this point, presented material does not introduce further changes into composition of categories.

Each of four groups to be equal would have to have 25% of total number of collected tools. In such a case it would assure that even a single publication mentioning a tool has an equal weight among groups. Current disproportion around 25% measured by standard deviation is 7% (Table 3). It has been decided to keep this level of inequality as a one representing natural proportions in collected set of tools.

Table 3 Number of tools per category

Name of a category	Number of tools in category with percentage in total number of tools in brackets (tools with or without data series)	Number of tools in category with percentage in total number of tools in brackets (tools with data series)
Causal models	44 (33%)	28 (32,2%)
Phenomenological models	25 (19%)	20 (23,0%)
Intuitive models	22 (16%)	14 (16,1%)
Monitoring and mapping	43 (32%)	25 (28,7%)

Current representation of data assumes that an increase in number of journals indexed in Scopus data base, as also an increase in the number of scientists working on the subject of forecasting does not have an influence on popularity of some categories over another.

Data supporting this study can be accessed online with GoogleDrive (on request).

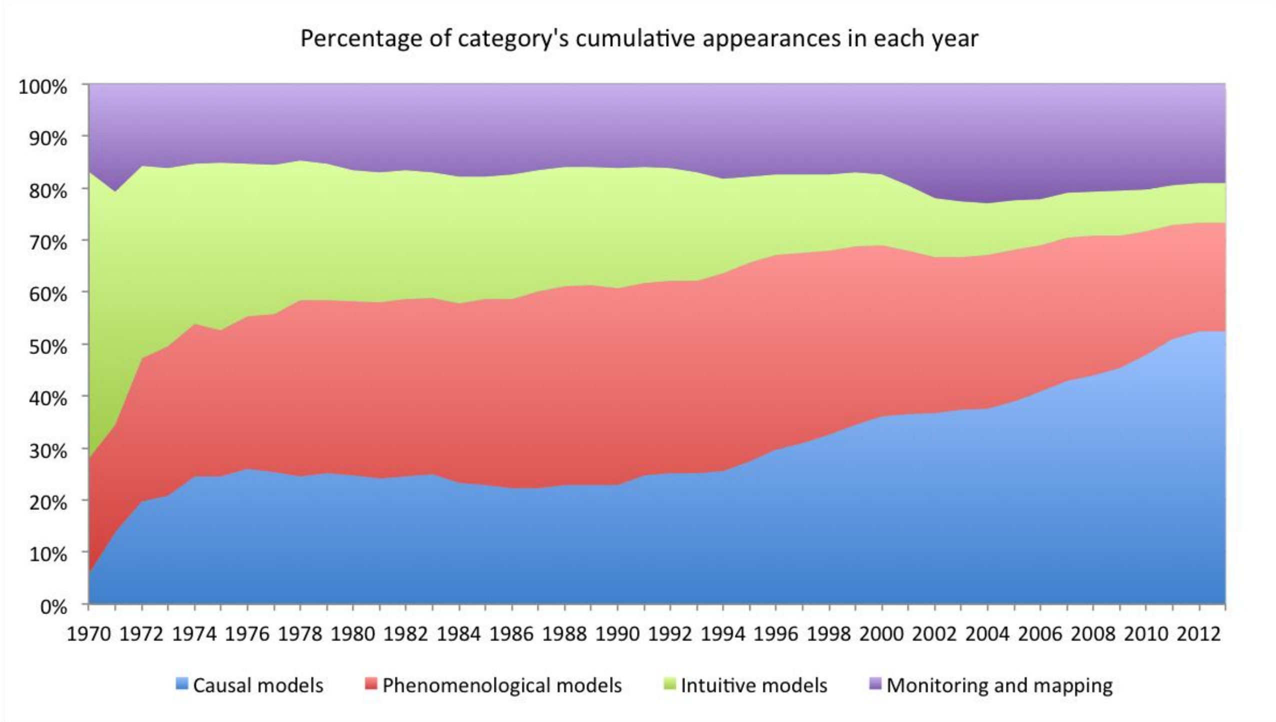

Figure 1. Cumulative appearances split into categories

4 Conclusion

Figure 1 presents a composition of scientific publications referring to tools from four categories. Available data series from Scopus scientific publication indexing service cover a time between 1970 and 2013.

What can be observed on Figure 1 is a maintained stabile share of monitoring and mapping tools among all four categories. Tools from this group are used mostly at the beginning stages of forecasting studies, in order to prepare background and data series. This category of tools can be as well used as self-standing tools e.g. for early discovery of new solutions and trends.

Other observation is an increase in role of causal models reaching finally the highest share among four categories at present. Dominance of causal models has been gained mainly on expense of intuitive models and less, but still, from phenomenological models.

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