Chapter 12
Distributed Intelligence for Constructing Economic Models

Ting Yu
University of Sydney, Australia

ABSTRACT

This paper presents an integrated and distributed intelligent system being capable of automatically estimating and updating large-size economic models. The input-output model of economics uses a matrix representation of a nation's (or a region's) economy to predict the effect of changes in one industry on others and by consumers, government, and foreign suppliers on the economy (Miller & Blair, 1985). To construct the model reflecting the underlying industry structure faithfully, multiple sources of data are collected and integrated together. The system in this paper facilitates this estimation process by integrating a series of components with the purposes of data retrieval, data integration, machine learning, and quality checking. More importantly, the complexity of national economy leads to extremely large-size models to represent every detail of an economy, which requires the system to have the capacity for processing large amounts of data. This paper demonstrates that the major bottleneck is the memory allocation, and to include more memory, the machine learning component is built on a distributed platform and constructs the matrix by analyzing historical and spatial data simultaneously. This system is the first distributed matrix estimation package for such a large-size economic matrix.

INTRODUCTION

The input-output model of economics uses a matrix representation of a nation's (or a region's) economy to predict the effect of changes in one industry on others and by consumers, government, and

foreign suppliers on the economy (Miller & Blair, 1985). Because the economic constantly evolves, the input-output model needs to be updated at least annually to reflect the new circumstance. Unfortunately, in most countries such as Australia, the input-output model is only constructed every 3-4 years, because the large amount of monetary and human cost is involved to complete a survey

Table 1. An example of the input-output table defined by the 3-level tree and the 2-level tree

			China (1)		U
			Shoe (1)	Retail (2)	
Australia (1)	NSW (1)	Sheep (1)	X_1	X_2	$U_1 = X_1 + X_2$
		Oil (2)	X_3	X_4	$U_2 = X_3 + X_4$
	VIC (2)	Sheep (1)	X_5	$X_6 = 0.23$	$U_2 = X_3 + X_4$
		Oil (2)	X_7	X_8	$U_2 = X_3 + X_4$
V			$V_1 = \sum_{i=2n} X_i$	$V_2 = \sum_{i=2n+1} X_i$	

(ABS, 2007a). The Centre for Integrated Sustainability Analysis (ISA), University of Sydney, is developing an integrated intelligent system to estimate and update the input-output model at different level on a regular basis.

The input-output model consists of a time series of matrices (Table 1) representing the industry structure of a given year. At Table 1, each entry X_i represents the commodity flow between the industry sections of different regions. For example, the entry X_6 represents the commodity flow from the sheep industry at Victoria (VIC), a state of Australia, to the retail industry in China. In this example, the goods worth of 0.23 million dollar are sold. Often X_i is missing as it is very detailed information and hard to be surveyed. However government agents published aggregated information more frequently, such as V and U which represent the total export of a given industry in Australia (ABS, 2007b). The aggregated information is available for a rather long period, for example agriculture information from 1861 to 2007 in the database (ABS, 2007b). It is worth clarifying that the aggregated information is not limited by the sums of rows or columns as the V and U. The main purpose of this distribute intelligent system is to utilize those available aggregated information and the economic models

from previous years to populate and update current or future X_is to build a series of this economic models for current year or coming years.

A time series of input-output models represents the evolution of industry structure within and between regions, where the region is defined as a geographic concept. Within a given time period, extra information regarding certain parts of the matrix is often available from various government agents or other public or private organizations, such as the Bureau of Statistics. However, most of this information is often incomplete and only gives a snapshot of a part of the underlying model. There are at least four sources of uncertainty in the model: 1) if the model is survey-based, then there could be classical sampling errors; 2) in the case of large surveys, an error in the inference design can arise; 3) the underlying real industry structures are not constant over the time, and in an age of structural change due to technological development, this error can be important; 4) errors in compiling the large database can affect the quality of the final model (Percoco, Hewings, & Senn, 2006). This paper does not intend to analysis the stochastic behavior of the input-output table, but presents a machine learning algorithm addressing the temporal stability or temporal patterns to account for this characteris-

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