Chapter 1
Large-Scale Computational Modeling for Environmental Impact Assessment

Ting Yu
University of Sydney, Australia

Manfred Lenzen
University of Sydney, Australia

Christopher Dey
University of Sydney, Australia

ABSTRACT

Input-output table plays a central role in the Economic Input-Output Life Cycle Assessment (EIO-LCA) method. This chapter presents an integrated and distributed computational modeling system capable of estimating and updating large-size input-output tables. The complexity of national economy leads to extremely large-size models to represent every detail of an economy. In order to construct the table reflecting the underlying industry structure faithfully, multiple sources of data are integrated and analyzed together. The major bottleneck of matrix estimation is the lack of memory allocation. In order to include more memory, this unique distributed matrix estimation system runs over a parallel supercomputer to enable it to estimate a matrix with the size of more than 1,000-by-1,000 with relatively high accuracy. This system is the first distributed matrix estimation package for such a large-size economic matrix. This chapter presents a comprehensive example of facilitating this estimation process by integrating a series of components with the purposes of data retrieval, data integration, distributed machine learning, and quality checking.

DOI: 10.4018/978-1-60960-156-0.ch001

INTRODUCTION

Environmental Impact Assessment (EIA) is an assessment of the possible impact (positive or negative) that a proposed project may have on the environment; considering natural, social and economic aspects (Glasson, Therivel, & Chadwick, 2005). The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts to decide whether to proceed with the project. Environmental impact assessment brings environmental costs to the attention of corporate stakeholders who may be able and motivated to identify ways of reducing or avoiding those costs while at the same time improving environmental quality. The EIA enables decision makers to evaluate a project by data and analysis rather than a feeling that the natural product is better (Peters, Sack, Lenzen, Lundie, & Gallego, 2007). Among various EIS methods, a life cycle assessment (LCA) is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence, and an evaluation of the environmental impacts of a product or process over its entire life cycle. Environmental Life Cycle Assessment is often thought of as "cradle to grave" and therefore as the most complete accounting of the environmental costs and benefits of a product or service. Among various LCA methods, the Economic Input-Output Life Cycle Assessment (EIO-LCA) method uses information about industry transactions - purchases of materials by one industry from other industries, and the information about direct environmental emissions of industries, to estimate the total emissions throughout the supply chain (Hendrickson, Lave, & Matthews, 2006). The input-output table acts as the key engine in the EIO-LCA method. An input-output table simply uses a matrix representing the intra-industry flows and the flow between industrial sections and consumption or the flow between the value-added section and the industrial section. As economy constantly evolves, the input-output table needs to be updated, say annually, to reflect the latest circumstance. For example, a typical input-output table for Australian economy is represented in the format of seven 2,800-by-2,800 matrices (ABS, 2007a). Unfortunately, in most countries including Australia, the input-output table is released every 3-4 years by governments, due to large amounts of monetary and human cost involved. Estimating these matrices require estimating 54,880,000 variables, even though a large proportion of variables are close to zero. The purpose of this book chapter is to demonstrate computational modeling methods being capable of constructing and updating the large-size input-output tables regularly. The Integrated Sustainability Analysis (ISA) at the University of Sydney has developed these methods comprehensively covering the process of estimating and updating the input-output tables for different levels of economy, and following reporting phases based on the estimated input-output tables. In the reporting phases, Structural Path Decomposition (SPD) is the main tool which is built upon the estimated input-output tables and decomposes the upstream impact activities may have on environment.

The chapter is organized as follow: the first section introduces the background of this research work, including the related work. The second section gives an overview of the whole system. The third and forth sections discuss the method of organizing and querying the source data. The fifth and sixth sections discuss the method of parallel matrix estimation, and the last two sections present some experiments, conclusion and future works.

BACKGROUND

A typical input-output table can be represented as Table 1.

The input-output model consists of a time series of matrices, each of which (Table 1) represents the industry structure of a given year. In Table 1, each x_i entry represents the commodity

Related Content