Chapter 11
On the Efficient Dynamical
Financial Analysis Computation
Supported by UML(VR)

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ABSTRACT
Dynamic Financial Analysis (DFA) is disciplines of actuarial science developed to asses and manage risk. The structure of the problem, simulations-based approach as well as great user demands issue a challenge in terms of defining and controlling a computer software system. In order to properly support an efficient software and data allocation onto a distributed hardware environment we have to specify their basic characteristics. In this chapter we suggest using UML notation extended with vertical relations joining the information represented by different kinds of UML diagrams. Next this information is transformed into a graph notation that supports the optimal allocation of a new DFA process with the polynomial computational complexity. This way we are able to optimize DFA calculations on a given hardware environment without any changes to the software system.

INTRODUCTION
Dynamic Financial Analysis (DFA) is a relatively new discipline of actuarial science targeting risk estimation. The idea of the method is to generate a huge amount of possible scenarios and analyze the obtained samples testing risk versus profits for given strategies on a company model. As the historical data is very often limited a number of methods were selected to multiply the input set and keep its characteristics at the same time. The most important fact about DFA is that a holistic view of a company is taken, contrary to the classical analysis where isolated cases are examined.

A distinctive feature of DFA models is a great amount of data that is analyzed to deliver information
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of certain aspects of the world represented by the data as well as the way the information is extracted. A DFA model workflow consists of processes and data transferred between them; the main problem is the way it proceeds is nondeterministic. The execution sequence of processes is unpredictable up to a certain stage of computations, the size of data processed is unknown and “data explosion” effect is frequently observed. Moreover, a small change to an input vector or company strategies leads the whole data mining process to be repeated. At the same time a distinct pressure is exerted to shorten the runtime of simulations which can be achieved only by parallelizing—especially distributing—the subtasks.

Such a complex task should be more formally specified, which allows to automatically support the problems that appear in management of this dynamically changing system. For this purpose we suggest using UML diagrams extended with vertical relations (to precise the problem) and parallel graph transformations to control the task deployment process. The whole chapter is divided into three parts:

At the beginning we present a brief overview of DFA. We especially focus on problems in implementing software tools for driving such kind of analysis. We also describe the properties of a typical DFA task: large amount of data, great number of processes and unpredictability in its behavior.

In the second part we present the basic concept of vertical relations in the context of UML and introduce UML(VR) based on using the graph theory tools to represent and manage the UML based system specification. Next, we use this tool to characterize the properties of DFA processes and we show the basic idea of optimizing their execution.

The last part includes a sketch of the basic properties of aedNLC graph grammars that allow parallelizing the control of processes deployment with the polynomial time complexity. A method of the optimal allocation of a new DFA process is presented.

BACKGROUND

For a long time—up until the late 1990s—the insurance business used to be an area characterized by little strategic flexibility and innovation. Regulations heavily constrained the types of insurance and the products were relatively simple, addressing only specific types of risk. Therefore there was no need for sophisticated analysis, and those practiced covered isolated cases only without taking a global view.

However the regulations were loosened and gave more flexibility to the insurers, leading to new types of much more complicated products. The competition on the market also increased. The risk factors became more complicated and had to include social, demographic and political changes. Additionally the shareholders put more pressure on the returns. A detailed overview of these developments can be found in (Briys & de Varenne, 2001). As a result the insurers must consider all aspects that have influence on the solvency of a company, not only single isolated cases. The new discipline in finance was named Enterprise Risk Management (Crouhy, Galai, & Mark, 2001).

The traditional methods appeared to be insufficient for solving complicated problems with a large number of scenarios (Crouhy, Galai, & Mark, 2001; Kaufmann, Gadmer & Klett, 2001; Cheng, 2006; Pinheiro, Andrade e Silva & de Lourdes Centeno, 2003; Teugels & Sundt, 2004; Kaut & Wallace, 2006). Therefore Monte Carlo simulations were selected as the only means to practically deal with a huge amount of possible cases. Stochastic simulations applied to financial cash flow modeling an insurance company are known as Dynamic Financial Analysis (DFA). The two main conflicting tasks of DFA are to