Preface

With the advent of wide-area networks such as the Internet, distributed computing has to expand from its origins in shared-memory computing and local-area networks to a wider context. A large part of the additional complexity is due to the need to manage asynchrony, which is an unavoidable aspect of high-latency networks. Harnessing asynchronous communications is still an open area of research.

This monograph studies a natural programming model for distributed object-oriented programming. In this model, objects make asynchronous method invocations to other objects, and then concurrently carry on until the results of the requests are needed. Only at that point may they have to wait for the results to be completely computed; this delayed wait is called wait-by-necessity. Aspects of such a model have been proposed and formalized in the past: futures have been built into early concurrent languages, and various distributed object calculi have been investigated. However, this is the first time the two features, futures and distributed objects, have been studied formally together.

The result is a natural and disciplined programming model for asynchronous computing, one worthy of study. For example, it is important to understand under which conditions asynchronous execution produces predictable outcomes, without the usual combinatorial explosion of concurrent execution. Even the simplest sequential program becomes highly concurrent under wait-by-necessity execution, and yet such concurrency does not always imply that multiple outcomes are possible. One of the main technical contributions of the monograph, beyond the formalization of the programming model, is a sufficient condition for deterministic evaluation (confluence) of programs.

This monograph addresses problems that have been long identified as fundamental stumbling blocks in writing correct distributed programs. It constitutes a significant step forward, particularly in the area of formalizing and generalizing some of the best ideas proposed so far, coming up with new techniques, and providing a solid foundation for further study. The techniques studied here also have a very practical potential.

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