Chapter 3

THEIR PROBLEMS ARE MY PROBLEMS

The transition between internal and external conflicts\(^1\)

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Abstract

In Multi-Agent Systems there has been quite an amount of research on how
to model conflicts in (intelligent) agent architectures for example by imitating
mental states and augmenting them with social notions. Nevertheless, a great
deal of investigation is missing on the transition between internal and external
conflicts. Arguments in favor of taking a closer look at this transition include
a practical one from applications where internal conflicts may easily become
external conflicts and vice versa, and a technical one motivated by the existence
of more efficient algorithms for solving internal conflicts.

In this chapter we will use a rather technical and restricted notion of “con-

flict” to exploit the mathematical model of distributed constraint satisfaction
problems that covers internal as well as external conflicts in a unique frame-
work. In this model conflicts can be identified as “inconsistencies” and there are
several algorithms for conflict detection, conflict avoidance and conflict resolu-
tion. After introducing models for internal and external conflicts and algorithms
to solve them, we will focus on a new concept called AUTORECON (autonomous
dynamic reconfiguration) that provides a means for balancing on the transition
between internal and external conflict.

1. INTRODUCTION

Though research in Sociology has long been investigating the so-called
micro-macro-link (Alexander et al., 1987) that concerns the close relationship
between individual behavior and social structures, research in classical Artificial
Intelligence has long neglected the strong relation between internal and ex-
ternal conflicts. The modeling and solving of conflicts within agents has long

\(^1\)This chapter summarizes the results presented in (Hannebauer, 2000a) and (Hannebauer, 2000b) and ex-
tends them in several ways.
been interpreted as being a task for expert systems, planners and schedulers motivated by results of Logic, Cognitive Science or Decision Theory. On the other hand, the modeling and solving of external conflicts among autonomous entities has been seen as a research task for Coordination Theory inspired by Sociology and Economics. Research in Distributed AI and especially Multi-Agent Systems has proven this distinction to be antiquated.

Despite the fact that there has been quite an amount of research on how to model conflicts in (intelligent) agent architectures for example by imitating mental states and augmenting them with social notions, a great deal of investigation is missing on the transition right between internal and external conflicts. But this transition is not only theoretical: as soon as an agent \( a \) decides to adopt two goals from competing agents \( b \) and \( c \), the external conflict between \( b \) and \( c \) will become an internal one for \( a \). Vice versa, an internal conflict of agent \( a \) produced by different goals will become an external conflict if the pursuing of the different goals is delegated to different agents \( b \) and \( c \). Additionally, there are often quite different algorithms available to solve internal and external conflicts. Not always but often, internal conflicts can be solved more efficiently than external conflicts because of a better understanding of the situation and the missing communication overhead. Hence, there is an obligatory and a mandatory argument for taking a closer look at the similarities and differences of internal and external conflicts and their solving procedures.

Conflicts in their broadest sense are manifold in type, quality and quantity and the concepts presented in this chapter (especially in section 4.) are generic enough to be applied to many of them. Nevertheless, we will use a rather technical and restricted notion of “conflict” to exploit a mathematical model that covers internal as well as external conflicts in a unique framework. This model will be based on research in distributed constraint satisfaction problems (DCSPs, (Yokoo et al., 1998)). The big advantage of the DCSP model is its expressiveness but simplicity. It is a canonical extension of constraint satisfaction problems (CSPs, (Mackworth, 1992)) that allow for very efficient algorithms to solve internal conflicts. In CSPs, conflicts can be identified as so-called “inconsistencies” and there are several algorithms for conflict detection, conflict avoidance and conflict resolution. In section 2. we will introduce the CSP model for internal conflicts and briefly present results of other researchers and some own contributions to solving CSPs. The CSP model will be extended in section 3. to cover external conflicts. In this section we will also describe an algorithm for solving external conflicts, called multi-phase agreement finding. The main part of this chapter is section 4. presenting AIRFCON (autonomous dynamic reconfiguration), a means for balancing on the transition between internal and external conflict and bringing internal and external conflict solving together. Some pointers to related work and further remarks conclude our chapter.