Chapter 7
Frontiers of Game AI Research

In this final chapter of the book we discuss a number of long-term visionary goals of game AI, putting an emphasis on the **generality** of AI and the **extensibility** of its roles within games. In particular, in Section 7.1 we discuss our vision for general behavior for each one of the three main uses of AI in games. Play needs to become general; generators are required to have general generative capacities across games, content types, designers and players; models of players also need to showcase general modeling abilities. In Section 7.2 we also discuss roles of AI that are still unexplored and certainly worth investigating in the future. The book ends with a discussion dedicated to general ethical considerations of game AI (Section 7.3).

7.1 General General Game AI

As evidenced from the large volume of studies the game AI research area has been supported by an active and healthy research community for more than a decade—at least since the start of the IEEE CIG and the AIIDE conference series in 2005. Before then, research had been conducted on AI in board games since the dawn of automatic computing. Initially, most of the work published at IEEE CIG or AIIDE was concerned with learning to play a particular game as well as possible, or using search/planning algorithms to play a game as well as possible without learning. Gradually, a number of new applications for AI in games and for games in AI have come to complement the original focus on AI for playing games [764]. Papers on procedural content generation, player modeling, game data mining, human-like playing behavior, automatic game testing and so on have become commonplace within the community. As we saw in the previous chapter there is also a recognition that all these research endeavors depend on each other [785]. However, almost all research projects in the game AI field are very **specific**. Most published papers describe a particular method—or a comparison of two or more methods—for performing a single task (playing, modeling, generating, etc.) in a single game. This is problematic in several ways, both for the scientific value and for the practical appli-
cability of the methods developed and studies made in the field. If an AI approach is only tested on a single task for a single game, how can we argue that is an advance in the scientific study of artificial intelligence? And how can we argue that it is a useful method for a game designer or developer, who is likely working on a completely different game than the one the method was tested on?

As discussed in several parts of this book general game playing is an area that has already been studied extensively and constitutes one of the key areas of game AI [785]. The focus of generality solely on play, however, is very narrow as the possible roles of AI and general intelligence in games are many, including game design, content design and player experience design. The richness of the cognitive skills and affective processes required to successfully complete these tasks has so far been largely ignored by game AI research. We thus argue, that while the focus on general AI needs to be retained, research on general game AI needs to expand beyond mere game playing. The new scope for general general game AI beyond game-playing broadens the applicability and capacity of AI algorithms and our understanding of intelligence as tested in a creative domain that interweaves problem solving, art, and engineering.

For general game AI to eventually be truly general, we argue that we need to extend the generality of general game playing to all other ways in which AI is (or can be) applied to games. More specifically we argue that the field should move towards methods, systems and studies that incorporate three different types of generality:

1. **Game generality.** We should develop AI methods that work with not just one game, but with any game (within a given range) that the method is applied to.
2. **Task generality.** We should develop methods that can do not only one task (playing, modeling, testing, etc) but a number of different, related tasks.
3. **User/designer/player generality.** We should develop methods that can model, respond to and/or reproduce the very large variability among humans in design style, playing style, preferences and abilities.

We further argue that all of this generality can be embodied into the concept of general game design, which can be thought of as a final frontier of AI research within games. Further details about the notion of general general game AI can be found in the vision paper we co-authored about this frontier research area [718]. It is important to note that we are not arguing that more focused investigations into methods for single tasks in single games are useless; these are often important as proofs-of-concept or industrial applications and they will continue to be important in the future, but there will be an increasing need to validate such case studies in a more general context. We are also not envisioning that everyone will suddenly start working on general methods. Rather, we are positing generalizations as a long-term goal for our entire research community. Finally, the general systems of game AI that we envision ought to have a real-world use. There is a risk that by making systems too general we might end up not finding applications of these general systems to any specific real-world problem. Thus, the system’s applicability (or usefulness) sets our core constraint towards this vision of general game AI. More specifically, we envi-