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Research Challenges and Opportunities in Knowledge Representation, Section 2.3.2: Applications based on formal models

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2.3.2 Applications based on formal models

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For many applications, both inside and outside AI, KR provides the mechanism to define formally reasonable and desirable behaviors of agents and systems. Impact of those formal KR models is greatest in three main categories: AI-Planning (including Robotics), Natural--Language Processing (NLP), and Diagnosis of physical systems and processes. In the last decade AI Planning has looked for breakthroughs in KR as guides for building new planners with extended capabilities. That research built on the well-understood connection between formal models of action and efficient automated planners. The RCS/USA-Advisor for the Reaction Control System (RCS) in the Space Shuttle is an example of such breakthrough KR advance applied in the context of real-world application. The RCS system is responsible for maneuvering the aircraft while it is in space. The RCS/USA-Advisor is a part of a decision support system for shuttle controllers. It is based on a reasoning system and a user interface. The reasoning system is capable of checking correctness of plans and finding plans for the operation of the RCS. This application would not be possible without advances made in the 1990s and early 2000s in formal models of action.

Also in the last decade, breakthroughs in the natural language processing (NLP) have built on formal models developed in the 1990s and early 2000s. Application systems, such as Nutcracker (Balduccini et al., 2008), that understand narratives and instructions in the context of formal descriptions of the world applied established (circa 2001) formal models of action, logical representation, and taxonomy. Without those formal models the natural--language understanding tasks of question answering and entailment would be confined to statistical methods such as bag--of--words which provide poor performance. Most important, current established methods in NLP, such as semantic parsing, would not exist in their current form without their KR foundations.

Finally, many current federal--government efforts would be inefficient or suffer failures if KR--based diagnosis systems were not established in the 1990s and the past decade. For example, efforts by the DOE to overhaul the Nuclear Reactor diagnosis systems (e.g. Argonne National Lab’s PRODIAG) would be impossible without advances in KR--based Diagnosis. Formal models developed in the 1990s and 2000s have shown how to scale models of physical systems. Without those, model--based diagnosis would not exist today, and diagnosis of many vital systems would be impossible.