Exercise on Reasoning about Actions

Axiomatize the following scenario, appropriately with action precondition and effect axioms, and obtain successor state axioms.

Fluents:

- \texttt{doorOpen}(s) - The door is open in situation \( s \).
- \texttt{insideRoom}(s) - The robot is inside the room in situation \( s \).

Actions:

- \texttt{openDoor} - The robot opens the door. This can be done if the robot is not inside the room and the door is closed (that is, not open), and has the effect that the door will be open.
- \texttt{closeDoor} - The robot closes the door. This can be done if the robot is inside the room and the door is open, and has the effect that the door will be closed.
- \texttt{enter} - The robot enters the room. This requires that the door is open and the robot is not inside the room, and has the effect that the robot will be inside the room.

Initial situation description: Initially the robot is not inside the room and the door is closed (that is, not open).

Solution

Action precondition axioms:

\[
\begin{align*}
\text{Poss}(\text{openDoor}, s) & \equiv \neg \text{insideRoom}(s) \land \neg \text{doorOpen}(s) \\
\text{Poss}(\text{closeDoor}, s) & \equiv \text{insideRoom}(s) \land \text{doorOpen}(s) \\
\text{Poss}(\text{enter}, s) & \equiv \text{doorOpen}(s) \land \neg \text{insideRoom}(s)
\end{align*}
\]

Effect axioms:

\[
\begin{align*}
\text{doorOpen}(\text{do}(\text{openDoor}, s)) \\
\neg \text{doorOpen}(\text{do}(\text{closeDoor}, s)) \\
\text{insideRoom}(\text{do}(\text{enter}, s))
\end{align*}
\]

Effect axioms in normal form:

\[
\begin{align*}
(a = \text{openDoor}) & \rightarrow \text{doorOpen}(\text{do}(a, s)) \\
(a = \text{closeDoor}) & \rightarrow \neg \text{doorOpen}(\text{do}(a, s)) \\
(a = \text{enter}) & \rightarrow \text{insideRoom}(\text{do}(a, s)) \\
\text{false} & \rightarrow \neg \text{insideRoom}(\text{do}(a, s))
\end{align*}
\]
Successor state axioms:

\[
\begin{align*}
doorOpen(do(a,s)) & \equiv (a = openDoor) \lor (doorOpen(s) \land (a \neq closeDoor)) \\
insideRoom(do(a,s)) & \equiv (a = enter) \lor (insideRoom(s) \land true)
\end{align*}
\]

Initial situation description:

\[
\begin{align*}
\neg insideRoom(S_0) \\
\neg doorOpen(S_0)
\end{align*}
\]