Agent-Based Systems
Tutorial 2

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Q1 Formally define the function $new : D \times Per \rightarrow D$ that updates the agent's knowledge base for the vacuum-world example (using a schematic tabular representation or pseudo-code, if desired).

Q2 Suggest a compact and elegant decision making algorithm for the vacuum world that works for arbitrary grids using first-order logic. You can use the usual quantifiers $\exists$ and $\forall$, equality $=$, integers and normal operations on them as well as a constant S which denotes the size of the grid.

Q3 The following specification describes the famous "Snow White" example in Concurrent MetateM:

$$
\begin{aligned}
\mathsf{SnowWhite(ask)[give]}: & \\
\circledcirc ask(x) &\Rightarrow \Diamond give(x) \\
give(x) \wedge give(y) &\Rightarrow (x = y) \\
\mathsf{eager(give)[ask]}: & \\
start &\Rightarrow ask(eager) \\
\circledcirc give(eager) &\Rightarrow ask(eager) \\
\mathsf{greedy(give)[ask]}: & \\
start &\Rightarrow \Box ask(greedy) \\
\mathsf{courteous(give)[ask]}: & \\
((\neg ask(courteous)\, \mathcal{S}\, give(eager)) \wedge & \\
(\neg ask(courteous)\, \mathcal{S}\, give(greedy))) &\Rightarrow ask(courteous) \\
\mathsf{shy(give)[ask]}: & \\
start &\Rightarrow \Diamond ask(shy) \\
\circledcirc ask(x) &\Rightarrow \neg ask(shy) \\
\circledcirc give(shy) &\Rightarrow \Diamond ask(shy)
\end{aligned}
$$

Describe what the programme does and trace its operation in a table for the first three time steps. For reference, the following table summarises the MetateM operators:

$\bigcirc\varphi$	φ is true tomorrow
$\circledcirc\varphi$	φ was true yesterday
$\Diamond\varphi$	φ now or at some point in the future
$\Box\varphi$	φ now and at all points in the future
$\blacklozenge\varphi$	φ was true sometimes in the past
$\blacksquare\varphi$	φ was always true in the past
$\varphi\,\mathcal{U}\,\psi$	ψ some time in the future φ until then
$\varphi\,\mathcal{S}\,\psi$	ψ some time in the past, φ since then (but not now)
$\varphi\,\mathcal{W}\,\psi$	ψ was true unless φ was true in the past
$\varphi\,\mathcal{Z}\,\psi$	like "$\mathcal{S}$" but φ may have never become true