Exercises
Introduction to Schemas

Exercise 1.
Define a robust schema *UpKey* to define the operation of pressing the up key.

Exercise 2.
Define a schema *LinesRemaining* which delivers the number of lines below the cursor as an output parameter. Use the schemas we have already built.

Exercise 3.
Write a schema *DownKey* to define pressing the down key so that the cursor does not move at all if the cursor is at the bottom of the screen. Use all the schemas we have already seen.

Exercise 4.
Devise a schema *RightKey*to define pressing the right key where the cursor does not move at all if it already on the last column of the screen.

Solutions
Introduction to Schemas

Solution 1.

$$
\begin{array}{|l}
\hline
UpKeyNormal \\
\Delta Cursor \\
key? : KEY \\
\hline
key? = up \\
line \geq 1 \\
\\
line' = line - 1 \\
column' = column' \\
\hline
\end{array}
$$

$$
\begin{array}{|l}
\hline
UpKeyAtTop \\
\Delta Cursor \\
key? : KEY \\
\hline
key? = up \\
line = 1 \\
\\
line' = num\_Lines \\
column' = column' \\
\hline
\end{array}
$$

The full behaviour of the Down key is defined as

$$UpKey == UpKeyNormal \lor UpKeyAtTop$$

Solution 2.

$$
\begin{array}{|l}
\hline
LinesRemaining \\
\Xi Cursor \\
answer! : \mathbb{N} \\
\hline
answer! = num\_Lines - line \\
\hline
\end{array}
$$

Solution 3.

$$
\begin{array}{|l}
\hline
DownKeyAtBottomUpdated \\
\Delta Cursor \\
key? : KEY \\
\hline
key? = down \\
line = num\_Lines \\
\\
line' = line \\
column' = column' \\
\hline
\end{array}
$$

or

$$
\begin{array}{|l}
\hline
DownKeyAtBottomUpdated \\
\Xi Cursor \\
key? : KEY \\
\hline
key? = down \\
line = num\_Lines \\
\hline
\end{array}
$$

The full behaviour of the Down key is defined as

$$DownKey == DownKeyNormal \lor DownKeyAtBottom$$

Solution 4.

$$
\begin{array}{|l}
\hline
RightKeyNormal \\
\Delta Cursor \\
key? : KEY \\
\hline
key? = right \\
column \leq num\_Columns \\
\\
line' = line \\
column' = column + 1 \\
\hline
\end{array}
$$

$$
\begin{array}{|l}
\hline
RightKeyAtEdge \\
\Xi Cursor \\
key? : KEY \\
\hline
key? = right \\
column = num\_Columns \\
\\
\hline
\end{array}
$$

The full behaviour of the Down key is defined as

$$RightKey == RightKeyNormal \lor RightKeyAtEdge$$