MODULE *crackers7*

EXTENDS *Naturals*, *FiniteSets*
CONSTANTS *Things*, *People*
VARIABLES *desires*, *holds*

$$
\begin{array}{l}
Init \triangleq \land\ desires = [p \in People \mapsto \{\}] \\
\qquad\quad \land\ holds\ \ = [p \in People \mapsto \{\}]
\end{array}
$$

RECURSIVE $\_SetOrdinals(\_, \_)$

$$
\begin{array}{l}
\_SetOrdinals(s, f) \triangleq \text{IF } s = \{\} \\
\qquad\qquad\qquad\qquad \text{THEN } f \\
\qquad\qquad\qquad\qquad \text{ELSE LET } e \triangleq \text{CHOOSE } x \in s : \text{TRUE} \\
\qquad\qquad\qquad\qquad\qquad\quad \text{IN } \ \_SetOrdinals(s \setminus \{e\}, [f \text{ EXCEPT } ![e] = Cardinality(s)])
\end{array}
$$

$$
SetOrdinals(S) \triangleq \_SetOrdinals(S, [x \in S \mapsto 0])
$$

$$
\begin{array}{l}
ResourceOrdinals \triangleq SetOrdinals(Things) \\
ChooseBefore(a, b) \triangleq ResourceOrdinals[a] < ResourceOrdinals[b]
\end{array}
$$

$$
Held(t) \triangleq \exists\, p \in People : t \in holds[p]
$$

$$
\begin{array}{l}
Desire(p) \triangleq \land\ holds[p] \neq \{\} \Rightarrow desires[p] \neq \{\} \\
\qquad\qquad\quad \land \exists\, t\ \in Things : \\
\qquad\qquad\qquad \land\ t \notin desires[p] \\
\qquad\qquad\qquad \land\ desires' = [desires \text{ EXCEPT } ![p] = desires[p] \cup \{t\}] \\
\qquad\qquad\qquad \land \text{UNCHANGED } holds
\end{array}
$$

$$
\begin{array}{l}
Acquire(p) \triangleq \exists\, t \in desires[p] : \\
\qquad\qquad\quad \land \neg Held(t) \\
\qquad\qquad\quad \land \neg\exists\, t2\ \in desires[p] : t2 \notin holds[p] \land ChooseBefore(t2,\, t) \\
\qquad\qquad\quad \land\ holds' = [holds \text{ EXCEPT } ![p] = holds[p] \cup \{t\}] \\
\qquad\qquad\quad \land \text{UNCHANGED } desires
\end{array}
$$

$$
\begin{array}{l}
Satiated(p) \triangleq \land\ desires[p] \neq \{\} \\
\qquad\qquad\quad \land \forall\, t \in desires[p] : t \in holds[p] \\
\qquad\qquad\quad \land\ desires' = [desires \text{ EXCEPT } ![p] = \{\}] \\
\qquad\qquad\quad \land \text{UNCHANGED } holds
\end{array}
$$

$$
\begin{array}{l}
TidyUp(p) \triangleq \land\ desires[p] = \{\} \\
\qquad\qquad\quad \land \exists\, t \in holds[p] : \\
\qquad\qquad\qquad \land\ holds' = [holds \text{ EXCEPT } ![p] = holds[p] \setminus \{t\}] \\
\qquad\qquad\qquad \land \text{UNCHANGED } desires
\end{array}
$$

$$
\begin{array}{l}
Relinquish(p) \triangleq \exists\, t \in desires[p] : \\
\qquad\qquad\qquad\quad \land\ t \notin holds[p] \\
\qquad\qquad\qquad\quad \land \exists\, t2 \in holds[p] : \\
\qquad\qquad\qquad\qquad \land\ ChooseBefore(t,\, t2) \\
\qquad\qquad\qquad\qquad \land\ holds' = [holds \text{ EXCEPT } ![p] = holds[p] \setminus \{t2\}]
\end{array}
$$

$\wedge$ UNCHANGED $desires$

$$
\begin{array}{l}
Next \triangleq \exists\, p \in People : \\
\qquad \vee\ Desire(p) \\
\qquad \vee\ Acquire(p) \\
\qquad \vee\ Satiated(p) \\
\qquad \vee\ TidyUp(p) \\
\qquad \vee\ Relinquish(p)
\end{array}
$$

$$
\begin{array}{l}
TidiesUp \triangleq \neg\exists\, p \in People : \\
\qquad\qquad \wedge\ desires[p] \neq \{\} \\
\qquad\qquad \wedge \exists\, l \in holds[p] : l \notin desires[p]
\end{array}
$$

$$
Exclusivity \triangleq \neg\exists\, p,\ q \quad \in People : p \neq q \wedge (holds[p] \cap holds[q]) \neq \{\}
$$

$$
\begin{array}{l}
Ordering \triangleq \ \wedge \forall\, x,\ y,\ z \in Things : \\
\qquad\qquad ChooseBefore(x,\ y) \wedge ChooseBefore(y,\ z) \Rightarrow ChooseBefore(x,\ z) \\
\qquad\quad \wedge \forall\, x \in Things : \neg ChooseBefore(x,\ x)
\end{array}
$$

$$
Spec \triangleq Init \wedge \Box[Next]_{\langle desires,\, holds \rangle}
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