

MODULE *CigaretteSmokers*

A specification of the cigarette smokers problem, originally described in 1971 by *Suhas Patil*.
https://en.wikipedia.org/wiki/Cigarette_smokers_problem

EXTENDS *Integers*, *FiniteSets*

CONSTANT *Ingredients*, *Offers*

VARIABLE *smokers*, *dealer*

'Ingredients' is a set of ingredients, originally $\{matches, paper, tobacco\}$. 'Offers' is a subset of subsets of ingredients, each missing just one ingredient

ASSUME $\wedge Offers \subseteq (\text{SUBSET } Ingredients)$
 $\wedge \forall n \in Offers : \text{Cardinality}(n) = \text{Cardinality}(Ingredients) - 1$

'smokers' is a function from the ingredient the smoker has infinite supply of, to a BOOLEAN flag signifying smoker's state (smoking/not smoking) 'dealer' is an element of 'Offers', or an empty set

$TypeOK \triangleq \wedge smokers \in [Ingredients \rightarrow [smoking : \text{BOOLEAN}]]$
 $\wedge dealer \in Offers \vee dealer = \{\}$

$vars \triangleq \langle smokers, dealer \rangle$

$Init \triangleq \wedge smokers = [r \in Ingredients \mapsto [smoking \mapsto \text{FALSE}]]$
 $\wedge dealer \in Offers$

$startSmoking \triangleq \wedge dealer \neq \{\}$
 $\wedge smokers' = [r \in Ingredients \mapsto [smoking \mapsto \{r\} \cup dealer = Ingredients]]$
 $\wedge dealer' = \{\}$

$stopSmoking \triangleq \wedge dealer = \{\}$
 $\wedge \text{LET } r \triangleq \text{CHOOSE } r \in Ingredients : smokers[r].smoking$
 $\text{IN } smokers' = [smokers \text{ EXCEPT } ![r].smoking = \text{FALSE}]$
 $\wedge dealer' \in Offers$

$Next \triangleq startSmoking \vee stopSmoking$

$Spec \triangleq Init \wedge \Box [Next]_{vars}$

$FairSpec \triangleq Spec \wedge \text{WF}_{vars}(Next)$

An invariant checking that at most one smoker smokes at any particular moment

$AtMostOne \triangleq \text{Cardinality}(\{r \in Ingredients : smokers[r].smoking\}) \leq 1$