

MODULE *CigaretteSmokers*

A specification of the cigarette smokers problem, originally described in 1971 by *Suhas Patil*.  
[https://en.wikipedia.org/wiki/Cigarette\\_smokers\\_problem](https://en.wikipedia.org/wiki/Cigarette_smokers_problem)

EXTENDS *Integers*, *FiniteSets*

CONSTANT *Ing*, *Offers*

VARIABLE *smokers*, *dealer*

'Ing' is a set of ingredients, originally  $\{matches, paper, tobacco\}$

'Offers' is a subset of subsets of ingredients, each missing just one ingredient

ASSUME  $\wedge Offers \subseteq (\text{SUBSET } Ing)$

$\wedge \forall n \in Offers : \text{Cardinality}(n) = \text{Cardinality}(Ing) - 1$

'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

$TypeOK \triangleq \wedge smokers \in [Ing \rightarrow [smoking : \text{BOOLEAN}]]$

$\wedge dealer \in Offers \vee dealer = \{\}$

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

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

$\wedge dealer \in Offers$

$startSmoking \triangleq \wedge dealer \neq \{\}$

$\wedge smokers' = [r \in Ing \mapsto [smoking \mapsto \{r\} \cup dealer = Ing]]$

$\wedge dealer' = \{\}$

$stopSmoking \triangleq \wedge dealer = \{\}$

$\wedge \exists r \in Ing : \wedge smokers[r].smoking$

$\wedge smokers' = [smokers \text{ EXCEPT } ![r].smoking = \text{FALSE}]$

$\wedge \exists s \in Offers : dealer' = s$

$Next \triangleq startSmoking \vee stopSmoking$

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

$FairSpec \triangleq Spec \wedge WF_{vars}(Next)$

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

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