MODULE *Assumes*

EXTENDS *Integers*, *Sequences*

You can run this as a model using "No behavior spec" mode
Single line comment

ASSUME
$\land$ TRUE = TRUE
$\land$ $\neg$FALSE = TRUE

$Jason \triangleq$ "jason"
ASSUME
$Jason =$ "jason"

$record \triangleq [name \mapsto$ "jason", $age \mapsto 2]$
ASSUME
$\land$ $record.name =$ "jason"
$\land$ $record.name \neq$ "foo"

ASSUME
$\forall F \in \{\text{TRUE}\} : F = F$

ASSUME
$\forall F \in \{\text{FALSE}\} : F = F$

ASSUME $\Rightarrow$ means "implies", as in $A \Rightarrow B$ is "(*not* A) OR B"
FALSE $\Rightarrow$ TRUE = TRUE

ASSUME $\Rightarrow$ means "implies", as in $A \Rightarrow B$ is "(*not* A) OR B"
FALSE $\Rightarrow$ FALSE = TRUE

ASSUME $\Rightarrow$ means "implies", as in $A \Rightarrow B$ is "(*not* A) OR B"
TRUE $\Rightarrow$ TRUE = TRUE

ASSUME $\Rightarrow$ means "implies", as in $A \Rightarrow B$ is "(*not* A) OR B"
TRUE $\Rightarrow$ FALSE = FALSE

ASSUME
TRUE $\equiv$ TRUE

ASSUME
FALSE $\equiv$ FALSE

ASSUME
$\forall F, G \in \{\text{TRUE, FALSE}\} : (F \Rightarrow G) \equiv \neg F \lor G$

ASSUME
$\{1, 2, 2, 2, 3\} = \{1, 2, 3\}$

ASSUME
$\{1, 2, 3, 3, 4, 4\} \setminus \{4\} = \{1, 2, 3\}$

ASSUME
$\exists\, x \in \{3, 4, 5\} : x = 5$

ASSUME
$\{1, 3\} \subseteq \{3, 2, 1\}$

$IsPrime(x) \triangleq x > 1 \land \neg\exists\, d \in 2 \,..\, (x-1) : x\%d = 0$

For all y in S such that y is not prime or y is less than or equal to x

$LargestPrime(S) \triangleq$ CHOOSE $x \in S :$
$\land\ IsPrime(x)$
$\land\ \forall\, y \in S :$
$IsPrime(y) \Rightarrow y \leq x$
or $y > x \Rightarrow \neg IsPrime(y)$

ASSUME
$LargestPrime(\{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}) = 7$

$IsEven(x) \triangleq x\%2 = 0$

$LargetEven(S) \triangleq$ CHOOSE $x \in S :$
$\land\ IsEven(x)$
$\land\ \forall\, y \in S :$
$IsEven(y) \Rightarrow y \leq x$

ASSUME
$LargetEven(\{1, 2, 3, 4, 5, 5, 5\}) = 4$

ASSUME
$\forall\, x \in \{\} :$ FALSE

ASSUME
$\forall\, x \in \{\} :$ TRUE

ASSUME
$\forall\, x \in \{\} : 7$

ASSUME
$\forall\, x \in \{\text{FALSE}\} :$ TRUE

ASSUME
$\forall\, x \in \{\text{TRUE}\} :$ TRUE

ASSUME
$(\forall\, x \in \{\text{FALSE}\} : \text{FALSE}) = \text{FALSE}$

$IsCommutative(Op(\_, \_),\, S) \triangleq \forall\, x \in S :$
$\qquad\qquad\qquad\qquad\qquad\qquad \forall\, y \in S : Op(x,\, y) = Op(y,\, x)$

$Add(x,\, y) \triangleq x + y$
$Divide(x,\, y) \triangleq x \div y$

ASSUME
$IsCommutative(Add,\, \{1,\, 2,\, 3\})$

ASSUME
$IsCommutative(Divide,\, \{1,\, 2,\, 3\}) = \text{FALSE}$

ASSUME
$IsCommutative(Divide,\, \{1,\, 2,\, 3\}) \Rightarrow \text{FALSE}$

ASSUME
$IsCommutative(Divide,\, \{1,\, 2,\, 3\}) \Rightarrow \text{TRUE}$

ASSUME
$\neg IsCommutative(Divide,\, \{1,\, 2,\, 3\})$

ASSUME
$\neg\exists\, x \in \{1,\, 3,\, 5\} : IsEven(x)$

$Pick(S) \triangleq \text{CHOOSE } s \in S : \text{TRUE}$
RECURSIVE $SetReduce(\_, \_, \_)$
$SetReduce(Op(\_, \_),\, S,\, value) \triangleq \text{IF } S = \{\} \text{ THEN } value$
$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad \text{ELSE LET } s \triangleq Pick(S)$
$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad \text{IN } \quad SetReduce(Op,\, S \setminus \{s\},\, Op(s,\, value))$

$Sum(S) \triangleq \text{LET } \_op(a,\, b) \triangleq a + b$
$\qquad\qquad\quad \text{IN } \quad SetReduce(\_op,\, S,\, 0)$

ASSUME
$Sum(\{1,\, 2,\, 3\}) = 6$

$Min(S) \triangleq \text{CHOOSE } x \in S : \forall\, y \in S : x \leq y$

ASSUME
$Min(\{5,\, 3,\, 7,\, 10,\, 2,\, 9\}) = 2$

$Max(S) \triangleq \text{CHOOSE } x \in S : \forall\, y \in S : x \geq y$

ASSUME
$Max(\{4,\, 6,\, 1,\, 2,\, 9,\, 3,\, 5\}) = 9$

ASSUME
$\langle 1,\ 2,\ 3 \rangle \in Seq(\{1,\ 2,\ 3\})$

ASSUME
$\langle 4 \rangle \notin Seq(\{1,\ 2,\ 3\})$

ASSUME
$\langle 1,\ 2,\ 3,\ 4 \rangle \notin Seq(\{1,\ 2,\ 3\})$

Sets of tuples.

$chessboard\_squares \triangleq \{\text{“a”},\ \text{“b”},\ \text{“c”},\ \text{“d”},\ \text{“e”},\ \text{“f”},\ \text{“g”},\ \text{“h”}\} \times (1\ldots 8)$

ASSUME
$\land \langle \text{“a”},\ 1 \rangle \in chessboard\_squares$
$\land \langle \text{“a”},\ 2 \rangle \in chessboard\_squares$
$\land \langle \text{“a”},\ 3 \rangle \in chessboard\_squares$
$\land \langle \text{“a”},\ 4 \rangle \in chessboard\_squares$

$jason \triangleq (1\ldots 2) \times \{\text{“Jason”},\ \text{“DeBolt”}\}$

ASSUME
$\land \langle 1,\ \text{“Jason”} \rangle \in jason$
$\land \langle 2,\ \text{“Jason”} \rangle \in jason$
$\land \langle 1,\ \text{“DeBolt”} \rangle \in jason$
$\land \langle 2,\ \text{“DeBolt”} \rangle \in jason$

$digits \triangleq \{\text{“one”},\ \text{“three”}\} \times \{\text{“two”},\ \text{“four”}\}$

ASSUME
$\land \langle \text{“one”},\ \text{“two”} \rangle \in digits$
$\land \langle \text{“three”},\ \text{“four”} \rangle \in digits$

$A \triangleq \{1\}$
$B \triangleq \{2\}$
$C \triangleq \{3\}$

ASSUME
$\land \langle 1,\ 2,\ 3 \rangle \in A \times B \times C$
$\land \langle 1,\ \langle 2,\ 3 \rangle \rangle \in A \times (B \times C)$
$\land \langle \langle 1,\ 2 \rangle,\ 3 \rangle \in (A \times B) \times C$

Structures.

Structures are hashes. They have keys and values. You specify them as [key $\mapsto$ *value*] and query them with either [“key”] or *.key*. Both are legal and valid.

$SomeHash \triangleq [x \mapsto 1,\ y \mapsto \{2,\ 3\}]$

ASSUME
$\land\ SomeHash.x = 1$
$\land\ SomeHash[\text{“x”}] = 1$
$\land\ SomeHash.y = \{2,\ 3\}$
$\land\ SomeHash[\text{“y”}] = \{2,\ 3\}$
$\land$ DOMAIN $SomeHash = \{\text{“x”},\ \text{“y”}\}$

Aside from that, there's one extra trick structures have. Instead of key $\mapsto$ *value*, you can do key : set. In that case, instead of a structure you get the set of all structures which have, for each given key, a value in the set.

$SetOfStructures \triangleq [x : \{1\},\ y : \{2,\ 3,\ 4\}]$

If you use : syntax and any of the values are not sets, then the entire construct is invalid. In other words, while [a: {1}, *b*: {2, 3}] is the above set, [a: 1, *b*: {2, 3}] will throw an error if you try to use it.

ASSUME
$\land\ [x \mapsto 1,\ y \mapsto 2] \in SetOfStructures$
$\land\ [x \mapsto 1,\ y \mapsto 3] \in SetOfStructures$
$\land\ [x \mapsto 1,\ y \mapsto 4] \in SetOfStructures$

Type Composition

Any type can be squeezed inside any other type.

$crazy \triangleq [a \mapsto \{\langle\rangle,\ \langle 1,\ 2,\ 3\rangle,\ \langle 3,\ 2,\ 1\rangle\},\ b \mapsto \langle [a \mapsto 0]\rangle]$

A function of keys mapping to sets of tuples or of keys mapping to tuples of functions.

ASSUME
$crazy.b[1].a = 0$ Remember that tuples are 1 indexed.

\ * Modification History
\ * Last modified Sun *Apr* 21 16:44:59 *PDT* 2019 by *jasondebolt*
\ * Created Sat *Apr* 20 20:01:34 *PDT* 2019 by *jasondebolt*