**An Event-B Specification of Ranking**
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**CONTEXT** Ranking
**EXTENDS** Poker
**CONSTANTS**

$Rank$ The set of value of rank of hand card.
It is from 1 (Hight card) to 10 (Royal flush).
$isFour$ Check a set of cards has the four cards of a kind or not?
$isStraight$ Check a set of cards is straight or not?
$isFlush$ check a set of card is flush or not?
$getRank$ Estimate the rank of hand card.
$isHand$ Check a set of cards is a hand or not?
A hand is a set of cards has 5 cards which are unique.

**AXIOMS**

Rank_D : $Rank = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$

The set of ranking of hand
1 - hight card
2 - one pair
3 - two pair
4 - three
5 - flush
6 - straight
7 - full house
8 - four kind of card
9 - straight flush
10 - royal flush

isHand_D : $isHand \in \mathbb{P}(SetID) \rightarrow BOOL$

Check the set of cards is a hand or not?

isHand_F : $\forall a \cdot a \in \mathbb{P}(SetID) \land card(a) = 5 \land isUnique(a) = TRUE$
$\Rightarrow isHand(a) = TRUE$

If the set of cards has 5 cards and is unique,then it is a hand.

isFlush_D : $isFlush \in \mathbb{P}(SetID) \rightarrow BOOL$

Check the set card is flush or not?

isFlush_F1 : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = FALSE$
$\Rightarrow isFlush(a) = FALSE$

If a set of cards is empty, then it is not flush.

isFlush_F2 : $\forall a \cdot \exists x, y \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE$
$\land x \in a \land y \in a \land x \neq y \land getSuit(x) \neq getSuit(y)$
$\Rightarrow isFlush(a) = FALSE$

If a set of cards has two cards are difference suite, then it is not flush.
return FALSE

isStraight_D : $isStraight \in \mathbb{P}(SetID) \rightarrow BOOL$

Check the set of cards is straight or not?

isStraight_F : $\forall a \cdot \exists x, y, z, t, w \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE$
$\land\ x \in a \land y \in a \land z \in a \land t \in a \land w \in a$
$\land\ getValue(w) = getValue(t) + 1$
$\land\ getValue(t) = getValue(z) + 1$
$\land\ getValue(z) = getValue(y) + 1$
$\land\ getValue(y) = getValue(x) + 1$
$\Rightarrow isStraight(a) = TRUE$

If the value of the set of cards is a increasing sequence
and the difference of two adjacent elements are 1,
then it is straight.
return TRUE

isStraight_FA : $\forall a \cdot \exists x, y, z, t, w \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE$
$\land\ x \in a \land y \in a \land z \in a \land t \in a \land w \in a$
$\land\ getValue(w) = 10 \land$
$getValue(t) = 11 \land$
$getValue(z) = 12 \land$
$getValue(y) = 13 \land$
$getValue(x) = 1$
$\Rightarrow isStraight(a) = TRUE$

If the set of cards is in the sequenc ( 10,11,12,13,1), then it is straight.
return TRUE

isFour_D : $isFour \in \mathbb{P}(SetID) \rightarrow BOOL$

Check the set of cards has four cards of a kind of not ?

isFour_F : $\forall a \cdot \exists x, y, z, t \cdot a \in \mathbb{P}(SetID) \land card(a) > 3$
$\land\ x \in a \land y \in a \land z \in a \land t \in a$
$\land\ x \neq y \land y \neq z \land z \neq x \land x \neq t \land y \neq t \land z \neq t$
$\land\ getValue(x) = getValue(y) \land getValue(y) = getValue(z)$
$\land\ getValue(z) = getValue(t)$
$\Rightarrow isFour(a) = TRUE$

If the set of cards has four cards are the same value,
then it has four kind of card.
return TRUE

getRank_D : $getRank \in \mathbb{P}(SetID) \rightarrowtail Rank$

Get the rank of a hand card.

getRank_Royal : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land$
$isStraight(a) = TRUE \land isFlush(a) = TRUE \land$
$isA(a) = TRUE \land isK(a) = TRUE$
$\Rightarrow getRank(a) = 10$

If the hand card is straight, flush, has ACE card and King card,
then it is royal flush.
return 10

getRank_Straight_Flush : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land$
$isStraight(a) = TRUE \land isFlush(a) = TRUE \land$
$\neg(isA(a) = TRUE \land isK(a) = TRUE)$
$\Rightarrow getRank(a) = 9$

If the hand card is straight, flush,
but hasn't ACE card and King card at the same time,
then it is straight flush.
return 9

getRank_Four : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isFour(a) = TRUE \Rightarrow getRank(a) = 8$

If the hand card is four of a kind, then it is four kind of card.
return 8

getRank_FullHouse : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isThree(a) = TRUE \land isPair(a \setminus getThree(a)) = TRUE \Rightarrow getRank(a) = 7$

If the hand card is three of kind and two other cards are a pair,
then it is full house.
return 7

getRank_Straight : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isStraight(a) = TRUE \land isFlush(a) = FALSE \Rightarrow getRank(a) = 6$

If the hand card is straight but is not flush, then it is straight.
return 6

getRank_Flush : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isStraight(a) = FALSE \land isFlush(a) = TRUE \Rightarrow getRank(a) = 5$

If the hand card is flush but is not straight, then it is flush.
return 5

getRank_Three : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isFour(a) = FALSE \land isThree(a) = TRUE \land isPair(a \setminus getThree(a)) = FALSE \Rightarrow getRank(a) = 4$

If the hand card is three of a kind but two remain card are not a pair,
then it is three kind of card.
return 4

getRank_TwoPair : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isThree(a) = FALSE \land isPair(a) = TRUE \land isPair(a \setminus getPair(a)) = TRUE \Rightarrow getRank(a) = 3$

If the hand card is not three of a kind,
but has two pairs that are different value,
then it is two pair.
return 3

getRank_OnePair : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isThree(a) = FALSE \land isPair(a) = TRUE \land isPair(a \setminus getPair(a)) = FALSE \Rightarrow getRank(a) = 2$

If a hand has only a pair that are the same value, then it is pair.
return 2

getRank_HightCard : $\forall a \cdot a \in \mathbb{P}(SetID) \land isHand(a) = TRUE \land isPair(a) = FALSE \land isStraight(a) = FALSE \land isFlush(a) = FALSE \Rightarrow getRank(a) = 1$

If the hand card isn't pair, flush or straight, then it is hight card.
return 1

**END**