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1 |----- MODULE Order -----|
  | Order related operators.
  | See https://github.com/jamesfisher/tlaplus/blob/master/examples/TransitiveClosure/TransitiveClosure.tla
7 |-----|
  | Domain of relation R.
11 Dom(R)  $\triangleq$  {a :  $\langle a, b \rangle \in R$ }

  | Support of relation R.
16 Support(R)  $\triangleq$  {r[1] : r  $\in$  R}  $\cup$  {r[2] : r  $\in$  R}

  | Inverse of relation R.
21 Inverse(R)  $\triangleq$  { $\langle b, a \rangle$  :  $\langle a, b \rangle \in R$ }
23 LT(R, a)  $\triangleq$  {}

  | Is R a reflexive relation on set S?
28 Reflexive(S, R)  $\triangleq$   $\forall a \in S : \langle a, a \rangle \in R$ 

  | Is R a transitive relation (on its support set)?
33 Transitive(R)  $\triangleq$ 
34   LET S  $\triangleq$  Support(R)
35   IN    $\forall a, b, c \in S :$ 
36          $(\langle a, b \rangle \in R \wedge \langle b, c \rangle \in R) \Rightarrow \langle a, c \rangle \in R$ 

  | Composition of two relations R and T.
41 R ** T  $\triangleq$ 
42   LET SR  $\triangleq$  Support(R)
43       ST  $\triangleq$  Support(T)
44   IN   { $\langle r, t \rangle \in SR \times ST :$ 
45          $\exists s \in SR \cap ST : (\langle r, s \rangle \in R) \wedge (\langle s, t \rangle \in T)$ }

  | Transitive closure of relation R.
50 RECURSIVE TC(-)
51 TC(R)  $\triangleq$ 
52   LET RR  $\triangleq$  R ** R
53   IN   IF RR  $\subseteq$  R THEN R ELSE TC(R  $\cup$  RR)
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  \ * Modification History
  \ * Last modified Tue Sep 25 17:21:26 CST 2018 by hengxin
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