# Selected Decision Procedures and Techniques for SMT

- More on combination
  - theories sharing sets
  - convex theory
- Un-interpreted function symbols (quantifier-free first-order logic)
- Ground terms (unification and dis-unification)
- Integers and bitvectors
- Quantifier instantiation

## SMT

#### decidable



State of the art SMT solvers combine formulas with **disjoint** signatures (Nelson-Oppen approach)

 $x < y+1 \land y < x+1 \land x'=f(x) \land y'=f(y) \land x'=y'+1$ 



# Essence of such existing approach is reduction to equalities

#### $x < y+1 \land y < x+1 \land x'=f(x) \land y'=f(y) \land x'=y'+1$



### Generalize this reduction to sets of elements



unsatisfiable quantifier-free formula about sets

#### Why the example is unsatisfiable



unsatisfiable quantifier-free formula about sets

#### Soundness and Completeness by Definition (3) symbols to extend are disjoint

across components

data reduction for
uctures logic of set images
r

 $|\mathsf{D}| \leq |\mathsf{A}|$ 

R

{c}∩B=Ø

 R is a consequence (in language of sets)
models of R extend to models of original formula

 $D=\{h(x). x \in A\}$ ! (c \in B) Essence of the reduction is simple  $\exists y. \exists z. \exists h. (P(h,y) \land Q(y,z))$ 

is equivalent to