absTract sOlution Analyzing Synthesis Tool (**TOAST**)

Heinz Riener
DLR, e.V.
Germany, Bremen

Rüdiger Ehlers
Uni Bremen & DFKI, GmbH
Germany, Bremen

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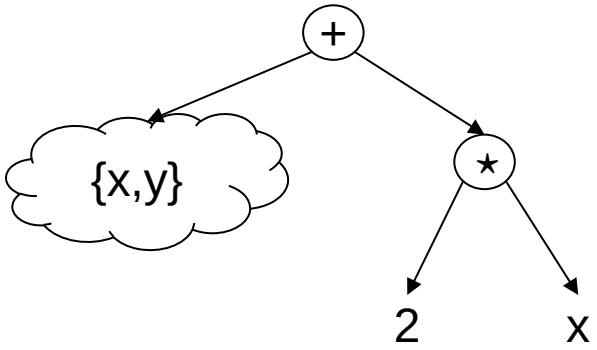
Abstract Enumeration

Grammar:
Start ::= x | y | z | (Start + Start) | (Const * Start)
Const ::= 0 | 1 | 2

Deducable concrete expressions:
x
y
z
(x + x)
(x + y)
…
(0*x)
(1*x)
…
(2*(1*x+(y+z)))
…

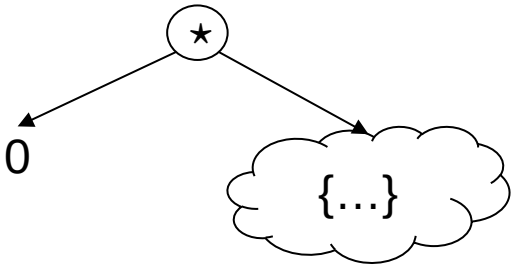
TOAST uses **abstract expressions:**

(Start{x,y} + 2*y)

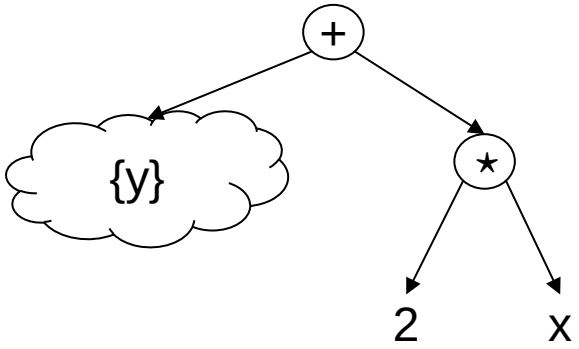


Abstract Enumeration

- Nonterminal are parametrized with support sets
- Use sanity checks to prune the search space



Discard solution if the specification requires a non-zero value for some input



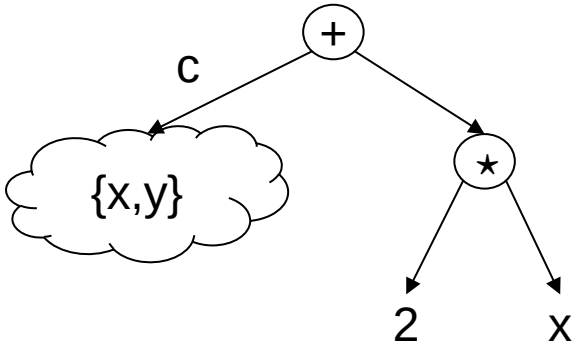
Discard solution if two inputs exists that differ only in y and must lead to the same outputs

⇨ y is not part of the solution

Functional Consistency

- SMT query to rule out abstract expression $f^{\star}$:

$$\exists i, i' \forall c, c', o, o' : \neg(Corr(i, o) \wedge \mathrm{Corr}(i', o') \wedge f^{\star}(i, c) = o \wedge f^{\star}(i', c') = o' \wedge Consistency(i, i', c, c'))$$



Abstract expression $f^{\star}(x, y) = (Start\{x, y\} + 2 \star x)$:

$$\exists x, y, x', y' \forall c, c', o, o' :$$
$$\neg(Corr(x, y, o) \wedge Corr(x', y', o') \wedge (c + (2 \star x)) = o \wedge (c' + (2 \star x')) = o' \wedge (x = x' \wedge y = y' \Rightarrow c = c'))$$

Summary

abs**T**ract s**O**lution **A**nalyzing **S**ynthesis **T**ool (**TOAST**):

- Prunes the search space by analyzing **abstract expressions**
- Several tweaks on the grammar level

- SMT queries with quantifier alternation are expensive
- Prototype implemented in Python