SAT/SMT Solvers, Hindley Milner, Abstract Interpretation, other…
Announcements

- Quiz 6 today

- HW6?
  - Don’t forget the problem set

- HW7 is optional

- Final exam is out

- Presentations begin on Friday!
Outline

- Verification condition generation example, one more…
- More Hindley Milner examples
- HW5 Abstract Interpretation questions
- HW5 Lambda calculus questions
- Quiz 5
- Quiz 4
Verification Problem

\{ P \}

\{ Q \}

- Generate verification condition $vc(c, Q)$
  - It is a theorem that $vc(c, Q) \Rightarrow wp(c, Q)$
- Show that $P \Rightarrow vc(c, Q)$
  - Translate implication into SMT-LIB program
Another Example

\( P = \{ x \geq 0 \} \)

\( i := x; \)

\( z := 0; \)

while \( (i \neq 0) \) {
    \( z := z+1; \)
    \( i := i-1; \)
}

\( Q = \{ x = z \} \)
SMT Formulas
Hindley Milner Examples

let twice f x = f (f x)
in twice twice succ 4 // let-bound, types in HM
Hindley Milner Examples

\[
\text{let twice } f \ x = f \ (f \ x) \\
\text{foo } g = g \ g \ \text{succ } 4 \ // \lambda\text{-bound cannot type in HM} \\
in \text{foo twice}
\]
1.2. **Properties of Galois Connections.** (4 pts) Let $(C, \subseteq) \xrightarrow{\gamma \alpha} (A, \leq)$ be an arbitrary Galois Connection. Prove that $\alpha$ is monotone.
HW5 Lambda Calculus

$$(\lambda x.\lambda y.x)(\lambda z.(\lambda x.\lambda y.x)\ z\ ((\lambda x.z\ x)(\lambda x.z\ x)))$$
HW5 Lambda Calculus

$$(\lambda x.\lambda y. x)(\lambda z. (\lambda x.\lambda y. x) z \ ((\lambda x. z \ x)(\lambda x. z \ x)))$$
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