Meeting 2.6: Optimization and Analysis

Project
- Set milestones and stage your work so that you have something to show at the end
- Be concrete by sketching examples.
  \[ \text{input} \rightarrow \text{expected output} \]
  (1) easy examples (initial tests)
  (2) expect to handle by end
  (3) stretch examples

- UG/Grad:
  Example: Implement an optimization or analysis
  Grad requirement: Find something to tweak/improve and evaluate improvement.

Type Specialization (as an example compiler optimization)

- flow-sensitivity vs. flow-sensitivity
  1 dict of types 1 dict per program point
  for each variable

Analysis - Find some facts about the program (possible executions)
  types of an expression

Transformation - Use facts to generate better code
  minimize the runtime type dispatch
\[
\begin{align*}
P & \quad \Rightarrow \quad \text{SSA} \quad \Rightarrow \quad P' \\
\text{"poor man's} \quad \text{flow-sensitivity"}
\end{align*}
\]
print \( i \leftarrow i + 1 \)

(1) Finite height lattice of facts
(2) Updates always move in one direction
  \( \uparrow \) monotonic

Language

\[ P_1 \quad e ::= x \mid n \mid \text{True} \mid \text{False} \mid [e_1, \ldots, e_n] \]

1. \( wpe \)
2. \( e_1 \downarrow wpe \)
3. \( e_1 \text{ if } e_2 \text{ else } e_3 \)
4. \( e_1 [e_2] \)
Evaluation

Define what is the value of an expression

\( \sigma \) state - dict from variables to values

\( v ::= n \mid \text{True} \mid \text{False} \mid \{ v_1, \ldots, v_n \} \)

Define evaluation relation

\[
\sigma \vdash e \Downarrow v
\]

\[
\sigma \vdash n \Downarrow n.
\]

"In any state \( \sigma \),
Constant \( n \) evaluates to \( n \)."

\[
\sigma \vdash \text{True} \Downarrow \text{True}
\]
\[ \Gamma \text{ dict maps variables to types} \]
\[ \forall : \text{int} \rightarrow \text{int} \rightarrow \text{int} \]
\[ \Gamma \vdash e : \text{int} \]
\[ \overline{\Gamma \vdash n : \text{int}} \]
\[ \Gamma \vdash e_1 : \Gamma \vdash e_3 : \text{int} \]
\[ \Gamma \vdash \text{if } e_2 \text{ then } e_1 \text{ else } e_3 : \text{int} \]

**CSCI 5535 Fund of PL**

**CSCI 7135 Program Analysis**