Value Analysis of Multi Staged Language

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at R SAEC center 2nd workshop

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Motivation

let's go further

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we did abstract parsing for the 2-staged language

let's extend it to the n-staged language

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Multi Staged Language

multi stage features

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code is a value

code can be interpreted as a program

code can be modified

Multi Staged Language
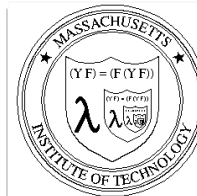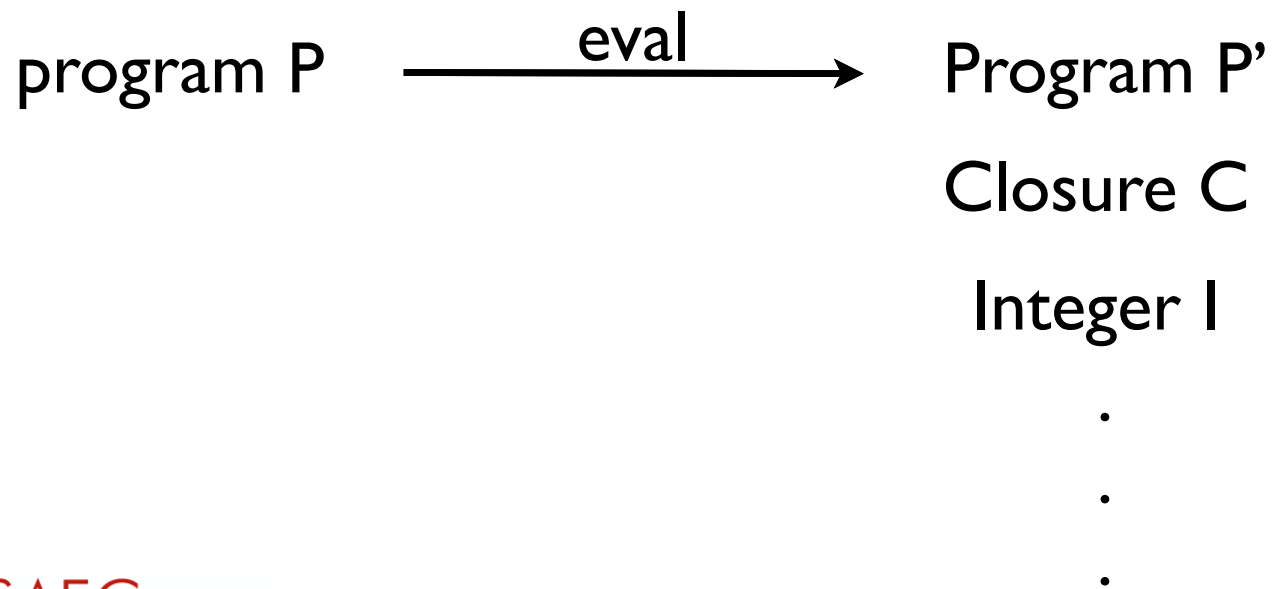
languages with multi stage features

Multi Staged Language

evaluation

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program P $\xrightarrow{\text{eval}}$ Program P'

Closure C

Integer I

.

.

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Multi Staged Language

I'm interested in the well-formedness of the resulting code

program P $\xrightarrow{\text{eval}}$ Program P'

Closure C

Integer I

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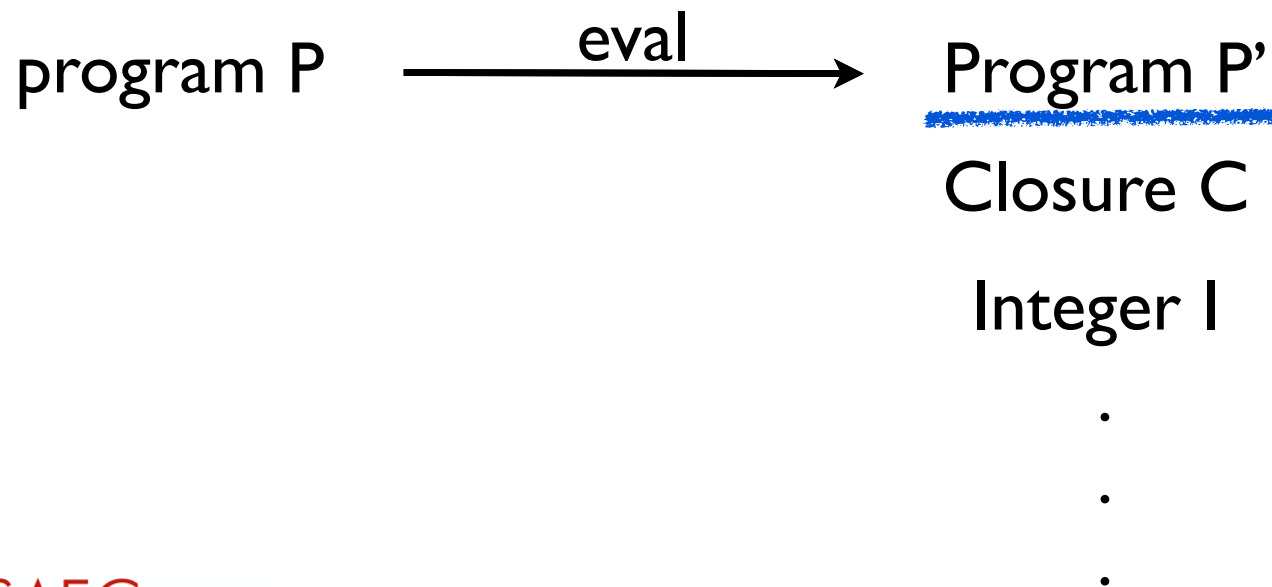
Value Analysis

what I want

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program P $\xrightarrow{\text{Analysis}}$ Set of Program
(Abstracted)

Value Analysis

But, when I tried to design a analysis, I met....

$$[\text{eval}\quad e] = \bigcup_{e' \in \gamma([e])} [e']$$

Value Analysis

But, when I tried to design analysis, I met....

$$[\text{eval} \quad e] = \bigcup_{e' \in \gamma([e])} [e']$$

result could be infinite set

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Value Analysis

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result could be infinite set

analysis may not finish

Value Analysis

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result could be infinite set

analysis may not finish

i need to find indirect analysis method

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Indirect Analysis

how ????

program P Set of Program
(Abstracted)

spent five months...

Transformation

one day,   i met a paper

[Aktemur] : Type Checking Program Generators
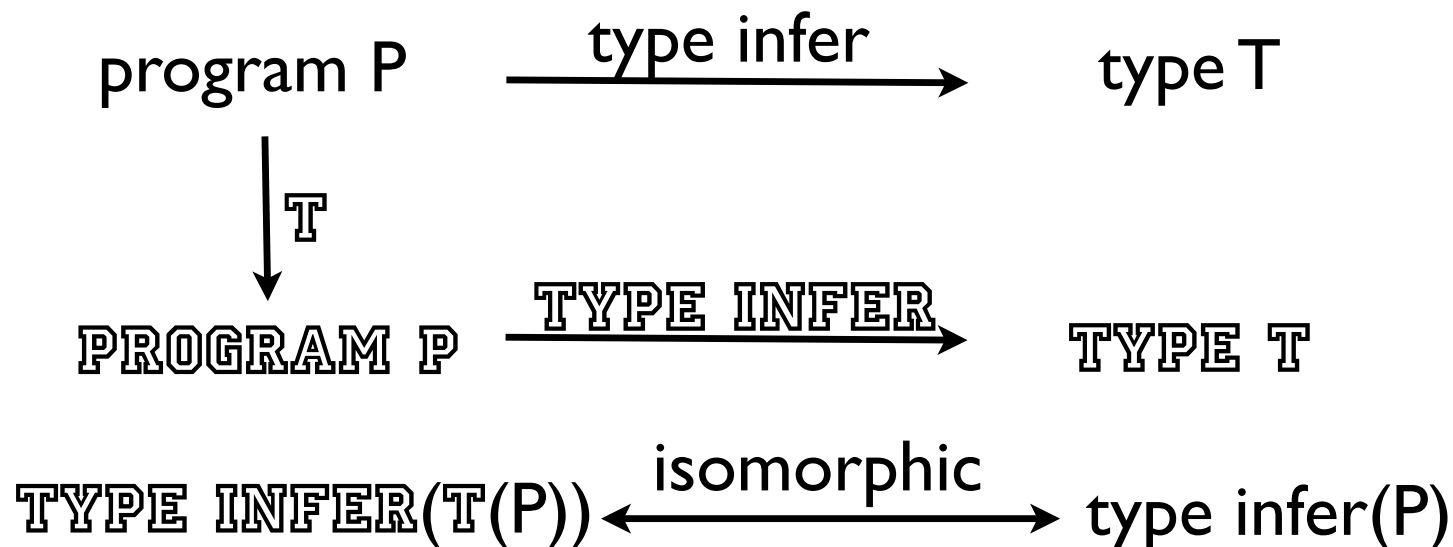   Using the Record Calculus
                   , Baris Aktemur

Transformation

[Aktemur] suggests a language $\mathbb{L}$ and a transformation $\mathbb{T}$ s.t.

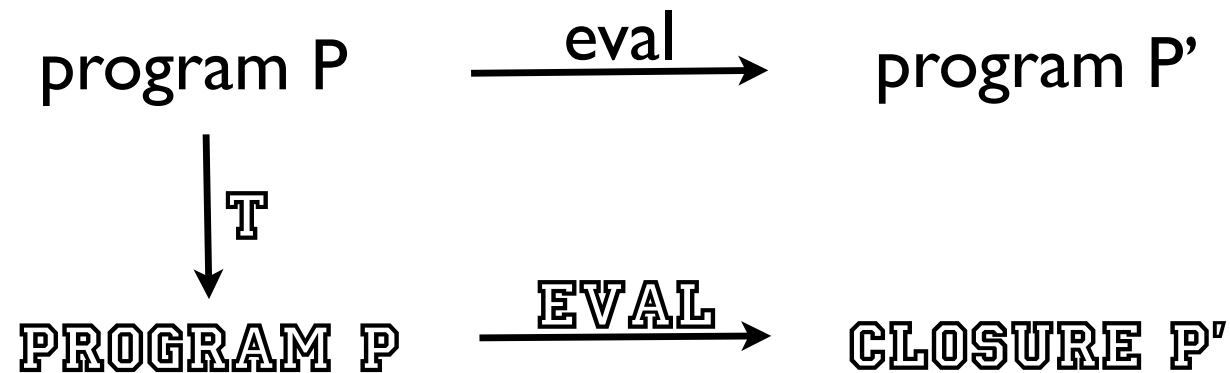language $\mathbb{L}$ = lambda calculus + record

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Transformation

[Aktemur] suggests a language $\mathbb{L}$ and a transformation $\mathbb{T}$ s.t.

program P $\xrightarrow{\text{type infer}}$ type T

$\downarrow \mathbb{T}$

PROGRAM P $\xrightarrow{\text{TYPE INFER}}$ TYPE T

TYPE INFER($\mathbb{T}$(P)) $\xleftrightarrow{\text{isomorphic}}$ type infer(P)

Transformation

[Aktemur] suggests a language $\mathbb{L}$ and a transformation $\mathbb{T}$ s.t.

$$\text{program P} \xrightarrow{\text{eval}} \text{program P'}$$

$$\downarrow \mathbb{T}$$

$$\texttt{PROGRAM P} \xrightarrow{\texttt{EVAL}} \texttt{CLOSURE P'}$$

$$\mathbb{T}(\text{eval}(P)) == \texttt{EVAL}(\mathbb{T}(P))$$

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Transformation

[Aktemur] suggests a language $\mathbb{L}$ and a transformation $\mathbb{T}$ s.t.
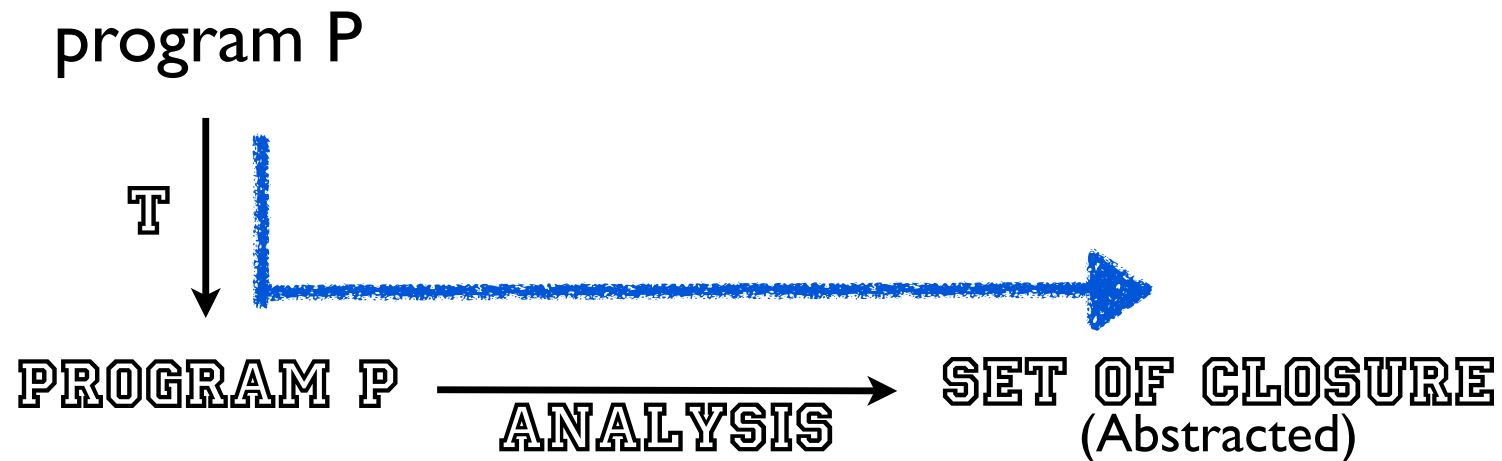
analysis algorithm is known

important!!

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Using Transformation

previously

program P $\xrightarrow{\text{Analysis}}$ Set of Program
(Abstracted)

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Using Transformation

what I have

program P

T

PROGRAM P $\xrightarrow{\text{ANALYSIS}}$ SET OF CLOSURE
(Abstracted)

Using Transformation

if I have

program P   Set of Program
                   (Abstracted)

T ↓   ↑ *Rebuild*

PROGRAM P → ANALYSIS → SET OF CLOSURE
                        (Abstracted)
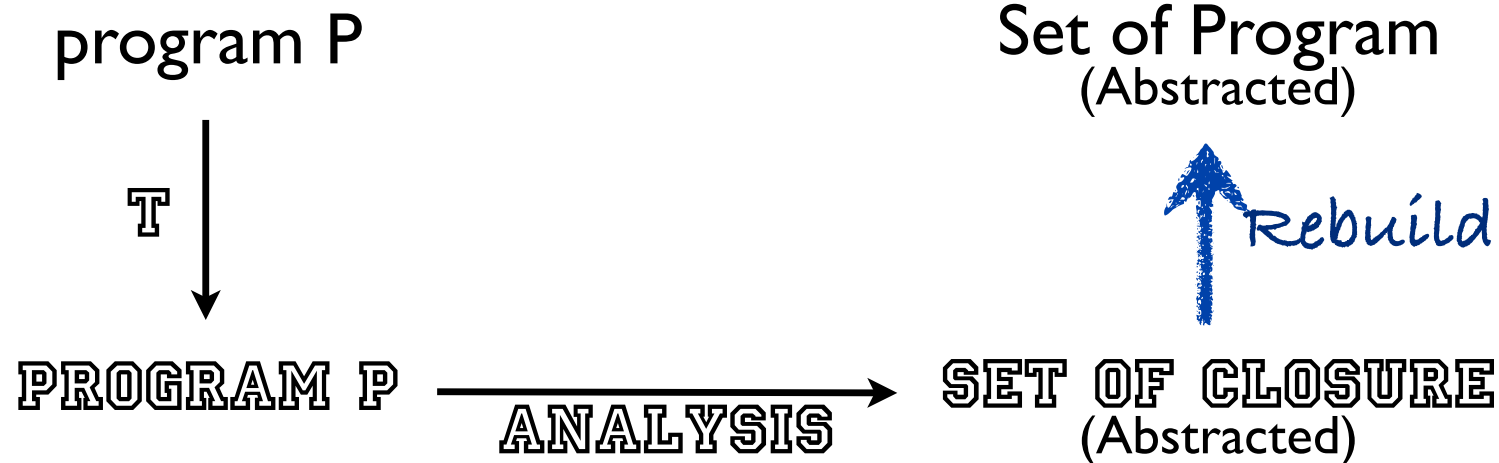
Using Transformation

then I get

program P   Set of Program
                                            (Abstracted)

T ↓   *indirect analysis*   ↑ Rebuild

PROGRAM P ──── **ANALYSIS** ────▶ **SET OF CLOSURE**
                                        (Abstracted)

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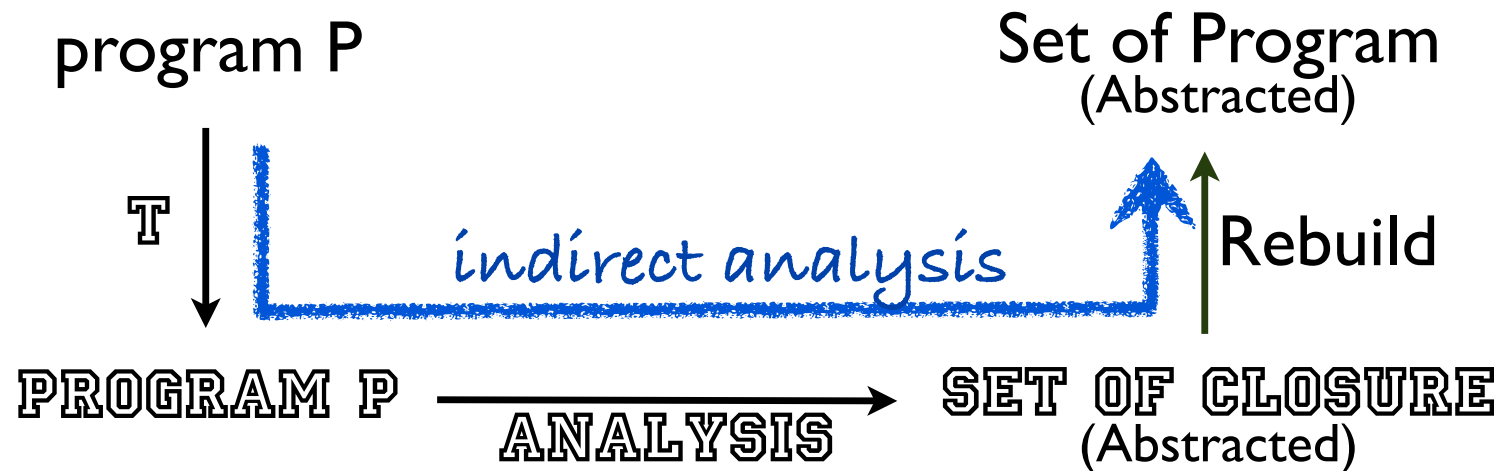
Trial

rebuilding the grammar from the CFA result

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program P

Set of Program
(Abstracted)

T ↓

↑ Rebuild

PROGRAM P → O-CFA → APPLICATION
(Abstracted)
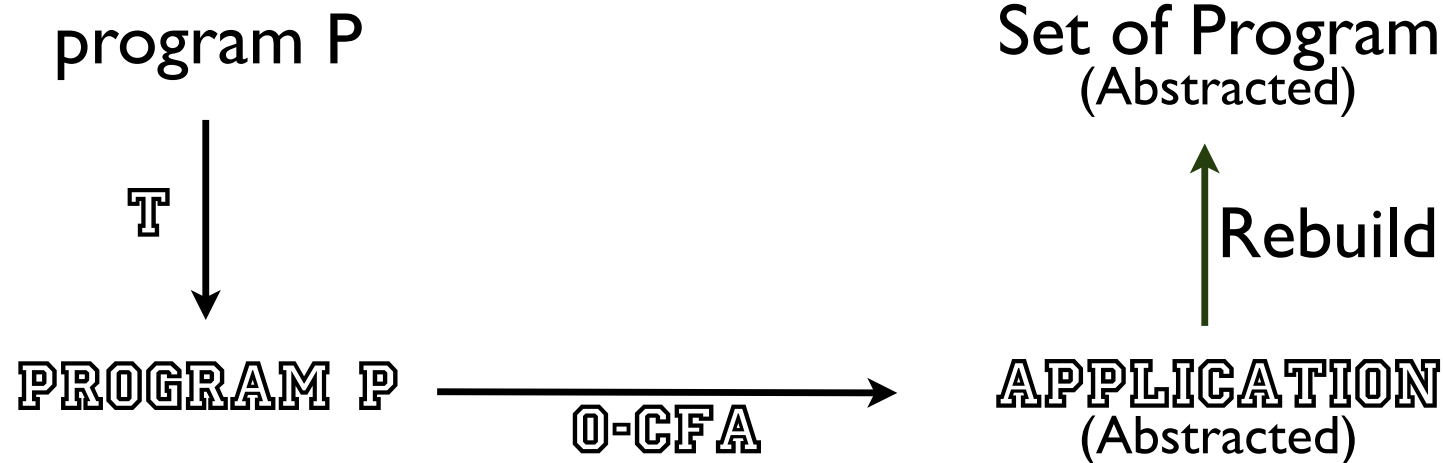
Obstacles

how to explain "Rebuild" intuitively?

program P

Set of Program
(Abstracted)

T

Rebuild

PROGRAM P → ANALYSIS → SET OF CLOSURE
(Abstracted)

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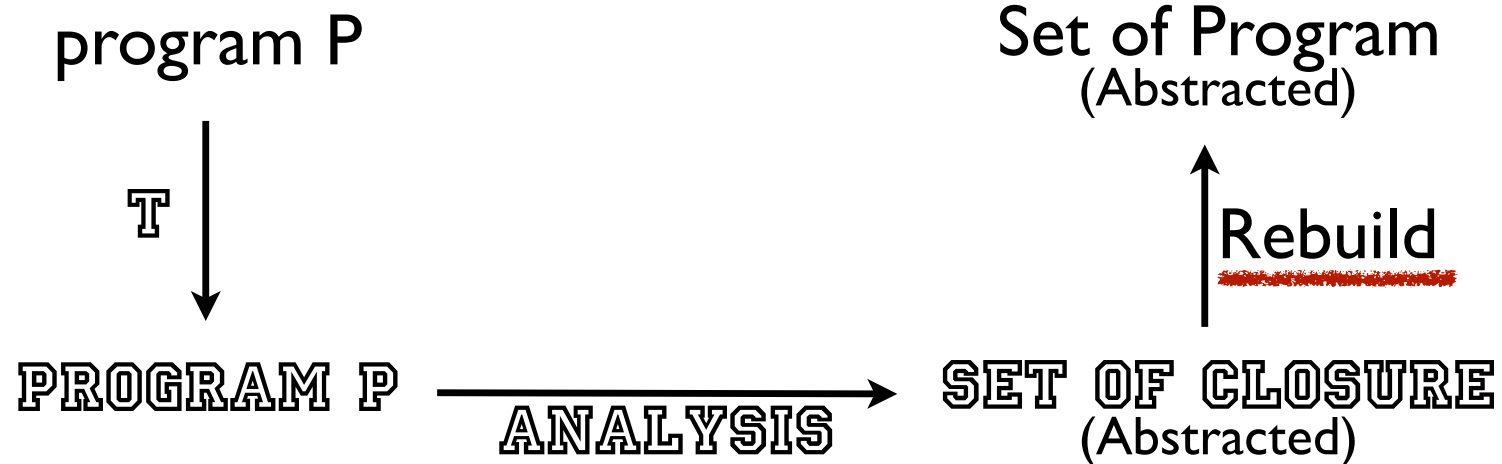
Obstacles

how to show the soundness?

program P   Set of Program
                 (Abstracted)

T   Rebuild

PROGRAM P   ANALYSIS   SET OF CLOSURE
                   (Abstracted)
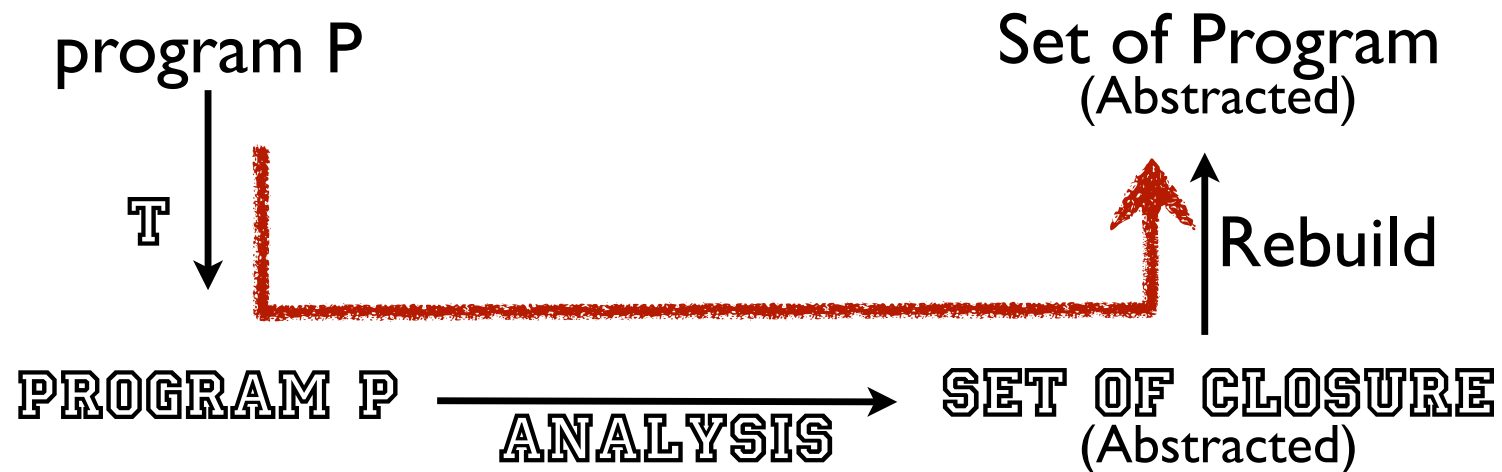
Plan

define isomorphic language $\mathbb{L}$

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program P $\xrightarrow{\quad \text{eval} \quad}$ program P'

$\hat{\imath}$ $\hat{\imath}$

program P $\xrightarrow{\quad \text{eval} \quad}$ Closure P′
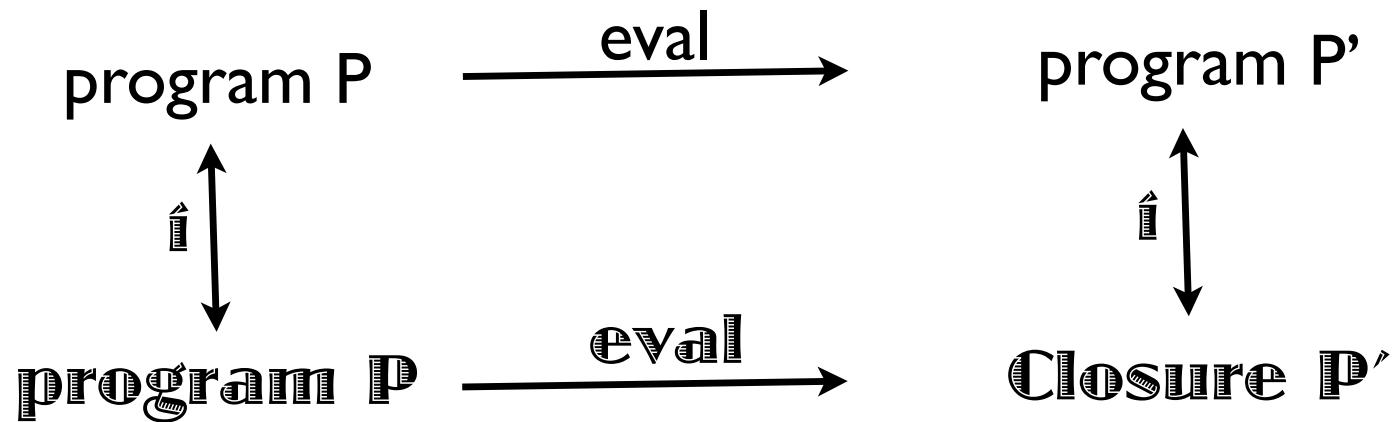
Plan

"Rebuild" may be explained and proved using $\hat{\imath}$

program P $\xrightarrow{\quad \text{Analysis} \quad}$ Set of Program

$\hat{\imath}$ $\updownarrow$ $\quad$ $P(\hat{\imath})$ $\updownarrow$

program P $\xrightarrow{\quad \text{Analysis} \quad}$ Set of Closure

Question?