Automated Ambiguity Detection in Layout-Sensitive Grammars

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Layout-Sensitive Languages

Whitespaces and indentations affect how programs get parsed.

```
def greeting():
  print('Welcome to our poster' +
    ' and our talk at 15:12 Friday!')
```

$\text{indent}(w_1, w_2) \triangleq (w_1 \neq \varepsilon \wedge w_2 \neq \varepsilon)$
$\Rightarrow w_2[0].\text{col} > w_1[0].\text{col} \wedge w_2[0].\text{line} = w_1[-1].\text{line} + 1$

```
match solver_result with
| Sat model -> Ambig (decode model)
| Unsat -> Unambig
| _ -> Unknown
```

$\text{align}(w_1, w_2) \triangleq (w_1 \neq \varepsilon \wedge w_2 \neq \varepsilon) \Rightarrow w_1[0].\text{col} = w_2[0].\text{col}$

```
do grammar <- load "my_lang.ebnf"
   sentence <- checkAmbig grammar
   return $ AmbigResult sentence $
     trees grammar sentence
```

$\text{offside}(w) \triangleq w \neq \varepsilon$
$\Rightarrow \forall t \in w : t.\text{line} > w[0].\text{line} \Rightarrow t.\text{col} > w[0].\text{col}$

Ambiguity Matters

Consider a grammar fragment:

$$\text{block} \to \text{stmt}^*$$
$$\text{stmt} \to \texttt{var = expr} \mid \texttt{while expr do block} \mid \cdots$$

This sentence has two different parses that are semantically different:

```
while x > 0 do
x = x - 1
x = x + 1
```

parse 1

```
while (x > 0) {
  x = x - 1;
  x = x + 1;
}
```

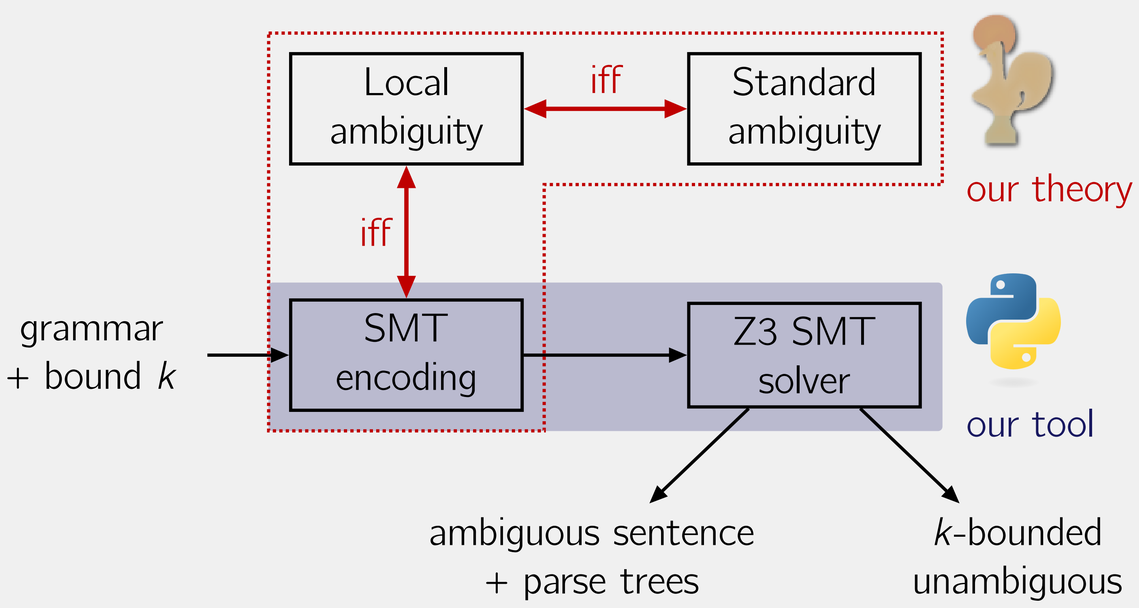
nonterminating if $x > 0$

parse 2

```
while (x > 0) {
  x = x - 1;
}
x = x + 1;
```

terminating

Lamb: Layout-Sensitive Ambiguity Detector



where k is the upper bound length of the sentences being considered

A Tour of Lamb

Step 1: Input a grammar G_{block}:

$$\text{block} \to \|\text{stmt}\|^+$$
$$\text{stmt} \to \text{nop} \mid \text{do block}$$

The alignment constraint $\|\cdot\|^+$ marks the border of the do-block body, so it distinguishes between

```
do nop
   nop
```

and

```
do nop
   nop
```

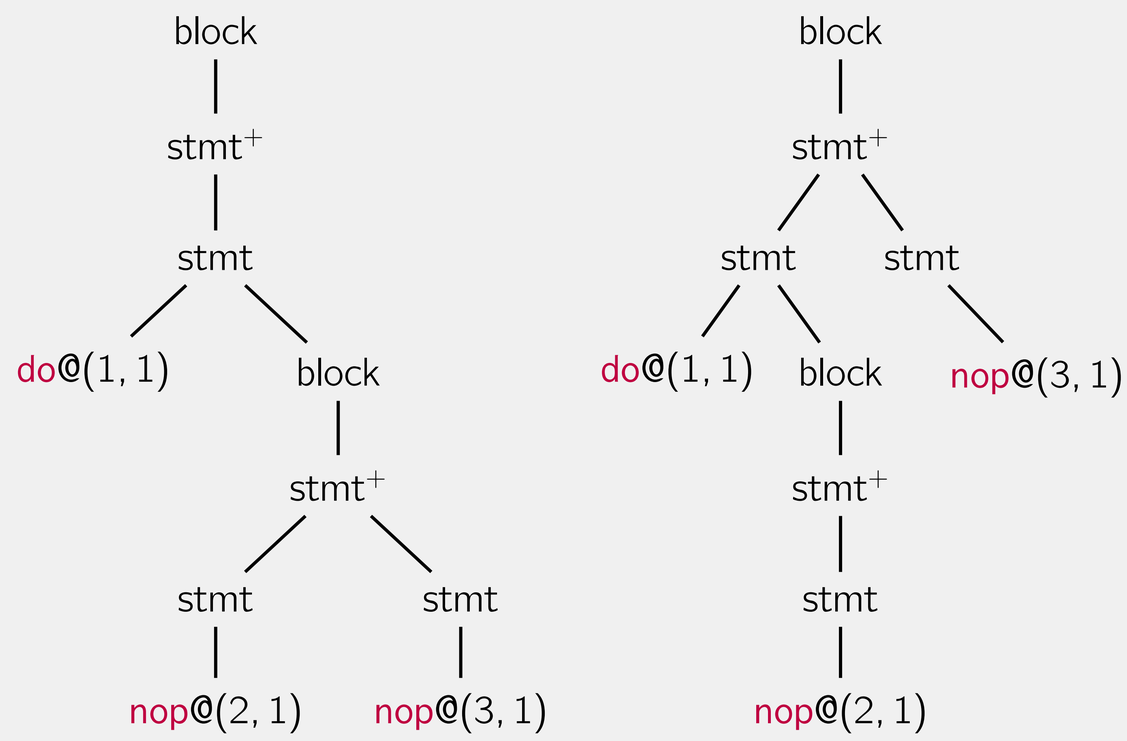
Awesome! But is G_{block} really unambiguous?

Step 2: Run Lamb

It finds a shortest ambiguous sentence (with its parse trees):

```
do
nop
nop
```

(a) ambiguous sentence



(b) parse tree t_1 (c) parse tree t_2

Users can fix the ambiguity issue manually with the aid of the produced parse trees.

Step 3: Understand the cause of ambiguity

It is insufficient to tell whether the second nop statement belongs to the do-block or the top-level block, even with the presence of the alignment constraint.

Step 4: Resolve the ambiguity

A possible solution is to reject this ambiguous sentence via an offside constraint $\cdot^{\triangleright}$ over the do-block:

$$\text{block} \to \|\text{stmt}\|^+$$
$$\text{stmt} \to \text{nop} \mid (\text{do block})^{\triangleright}$$

Step 5: Check the refined grammar again

Lamb no longer finds any ambiguous sentence within a length of 20: that is, bounded unambiguous!

More...

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