CSE341 – Section 7

ASTs, Interpreters, MUPL

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Legal vs. Nonlegal ASTs

Consider the Following

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(add 3 4)
(add (const 3) (const 4))
(add (const 3) (bool #t))
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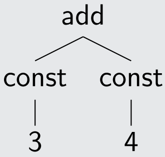
- Syntax vs. semantics
- No need to check for syntax
- Must check semantics

Checking Semantics

Nice Case



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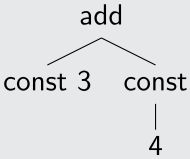


add

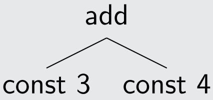
const 3

const

4

Checking Semantics

Nice Case



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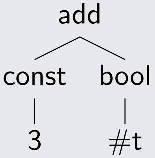

add

const bool

3 #t

Checking Semantics

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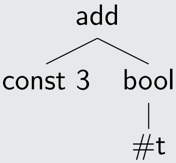

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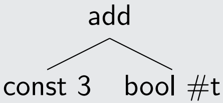

Checking Semantics

Nice Case

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Not Nice Case

Error: add applied to non-number!

Valid Assumptions

Allowed to Assume

- Input AST is “valid”
- Each node in AST has right “types”
  - Remember that nodes such as `add` and `multiply` take *ASTs*, not numbers!
- Illegal input ASTs may crash the interpreter – this is OK

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Need to Check

- Return types from subexpressions
- E.g. `(add (const 3) (bool #t))` is a legal AST, but has a wrong value being passed to `add`

Reviewing Macros

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- Extends language syntax (allows new constructs)
- Written in terms of *existing syntax*
- Expanded before language is actually interpreted/compiled

MUPL “Macros”

A Clever Trick

- Interpreting MUPL using Racket
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- Interpreting MUPL using Racket
- MUPL is represented as Racket structs
    - In Racket, these are just more data types
- Why not write a Racket function that returns MUPL ASTs?

Note on Hygiene

Implementing “macros” in this manner doesn’t give very good macro hygiene

Racket's quote function

Quoting a Set of Tokens

- Syntactically, Racket statements can be thought of as lists of tokens
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Examples

```
(+ 3 4) => 7
(quote (+ 3 4)) => '(+ 3 4)
(quote (+ 3 #t)) => '(+ 3 #t)
(+ 3 #t) => Error
```

Self Interpretation

Notes on "eval"

- Many languages provide an `eval` function or something similar
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Use of eval

- It's useful, but there's usually a better way
- Makes analysis, debugging difficult

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Examples

```
(define quoted (quote (+ 3 4)))
(eval quoted) => 7
(define bad-quoted (quote (+ 3 #t)))
(eval bad-quoted) => Error
```

Quasiquoting

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Examples

```
(quasiquote (+ 3 (unquote (+ 2 2)))) => '(+ 3 4)
(quasiquote (+ 3 (unquote (quote (I love CSE 338))))) => '(+ 3 (I love CSE 338))
```

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- Inserts evaluated tokens into a “quote”
- Convenient for generating dynamic token lists

Examples

```
(quasiquote (+ 3 (unquote (+ 2 2)))) => '(+ 3 4)
(quasiquote (+ 3 (unquote (quote (I love CSE 338))))) => '(+ 3 (I love CSE 338))

(quasiquote (+ (unquote (eval (quote (- 5 2))))
               (unquote (eval (quasiquote (+ (unquote (/ 4 2)) 2)))))) => '(+ 3 4)
```

Cute Little Typographical Shortcuts

```
'(a b c) <=> (quote (a b c))
`(a b ,(+ 2 2) d) <=>
  (quasiquote (a b (unquote (+ 2 2)) d))
(λ (x) (+ x 1)) <=> (lambda (x) (+ x 1))
```