Hanus: Embedding Janus in Haskell

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Introduction

- **Janus** is an imperative reversible programming language, meaning that every computation and function can be reversed.
- **Hanus** is an extended implementation of Janus that can be compiled straight to Haskell. Because of this, Hanus contains many awesome Haskell features that are unthinkable in regular Janus!

Reverse your program

- Division example
- Show inverse side-by-side

Syntactic Checking

- By using *QuasiQuotation*, the programmer gets notified of syntactic errors at compile-time!

CODE

```
[hanus|procedure main() {
  local n : Int = 10;
    n += 10;
  delocal n == 20;
}|]
```

ERROR

```
Exception when trying to run compile-time code:
  Parsing of Janus code failed in file ....
  First error:
--  Expecting "::" at position LineCol 2 10
```

Semantic Checking (Janus side)

- *Hanus* also reports semantic errors, such as violating Janus-specific constraints for expressions.

CODE

```
count :: BinaryTree a -> Int
[hanus|
    a :: BinaryTree Int;
    procedure main() {
        createNode a;
        a.value += (count a.left) + a.value
    }
|]
```

ERROR

```
Semantic Error (line 6, col 23):
    Assigned variable appears on the left-hand side.
```

Semantic Checking (Haskell side)

- Since regular Haskell programs are generated, users also get error messages for *anti-quoted* Haskell expressions.

CODE

```
[hanus|
    init :: Int;
    a :: BinaryTree Int;
    procedure main() {
        createNode a;
        a.nodeValue += map (+ 1) init;
}|]
```

ERROR

```
- Could not match expected type Int with actual
    type [Integer]
- In the expression: map (+ 1) i
```

Haskell Power

- The programmer can add additional operators by defining functions for forward and backward execution.
- We can define an operator that works on all Functors:

DEFINITION

```
(=$$) :: Functor f => Operator (f a) (Operator a b, b)
(=$$) = Operator forward backward
  where
    forward  f (Operator fwd _, x) = fmap (`fwd` x) f
    backward f (Operator _ bwd, x) = fmap (`bwd` x) f
```

USAGE

```
procedure increase(tree :: BinaryTree Int) {
  tree =$$ (+=, 42);
}
```

https://github.com/joristt/hanus