Lisp Flavoured Erlang
LFE

Adding a new flavour to Erlang

Robert Virding

What LFE isn't

- It isn't an implementation of Scheme
- It isn't an implementation of Common Lisp

In fact neither are possible on the Erlang VM

(Global data, destructive operations, ...)

What LFE is

- LFE is a (proper) Lisp based on the features and limitations of the Erlang VM
- LFE is attuned to vanilla Erlang and OTP
- LFE coexists seemlessly with vanilla Erlang and OTP

- Runs on standard Erlang VM

LFE Features

- The usual good lisp stuff – macros, sexprs, code ⇔ data, `
- Extensive use of pattern matching
- Uses Erlang data types
- Uses Erlang BIFs
- Functions of same name but different arity
- Built on small core extended with macros
- Compiler, interpreter, shell

Influensing factors

- Standard Erlang VM
  - Symbols / Atoms
  - Modules
  - Functions
  - Compiler / interpreter
  - Pattern matching
- Lisp-1 vs. Lisp-2

Symbols (atoms) and packages

- Single space for atoms (symbols)

→No CL packages

→No name munging to fake it:

~~**foo** in package **bar** -> **bar:foo**~~

Modules

- Existing module system
  - Very basic
  - Only has name and exported functions
  - Other attributes not really necessary
  - All functions in modules
  - Only functions in modules

→Must ”match” it
  - Allow attributes

Functions

- Erlang/OTP assumes functions with same name but different arities, at least exported functions
- Each Erlang function has only a fixed number of arguments

→Must do the same

Compiled/interpreted functions and macros

- Erlang VM only supports compiled functions!
- No support for seemlessly mixing compiled, interpreted functions and macros ☹

→Interpreter not useful in same way for developement

Pattern matching

- Pattern matching is a BIG WIN
- Erlang VM supports pattern matching

→We use pattern matching (and guards) everywhere

Function clauses, case, let and receive

Almost as nice as in vanilla Erlang

Lisp-1 vs. Lisp-2

- Tried Lisp-1 but it didn’t really work, resulted in funny behaviour
- Erlang function has name *and* arity
- Lisp-2 ”fits” Erlang VM better
- So LFE is Lisp-2, or rather Lisp-2+
- Result more consistent and better (I think)

Lisp-1 vs. Lisp-2

In Lisp-1:

```
(define (foo x y) ...)
(define (bar x y)
   (let ((foo (lambda (a) ...)))
        (foo x y)
        ...))
```

Which foo should be used?

- Local **foo** variable and **bad_arity** error
- Global **foo/2** and succeed

Syntax

- Pure lisp sepxrs
- **[...]** alternative to **(...)** (Scheme)
- Symbol is any atom which isn’t a number or separator
  - **|quoted symbol|**
- **( ) [ ] { } . ´ ` , ,@ #(#b(** separators
- **#(...)** tuple constant
- **#b(...)** binary constant
- **”abc”** ⬄ **(97 98 99)**, needs quoting ☹
- **#\a** or **#\xab;** characters

Core forms

```
(case expr clause ...)        ;An erlang case
(if test true false)          ;A lisp if
(receive clause ... (after timeout body))
(catch body)
(try expr (case ...) (catch ...) (after ...))
(lambda (arg ...) body)
(match-lambda clause ...)
(let ...)
(let-function ...), (letrec-function ...)
(cons ...), (list ...), (tuple ...), (binary ...)
(func arg ... ), (funcall var arg ...)
(call mod func arg ...)       ;Eval all args
(define-function name ... )
```

Core macros

```
(: mod name arg ...)         ;Literal mod name
(flet ...), (fletrec ...)
(let* ...), (flet* ...)
(cond ...)                   ;(?= pat expr)
(andalso ...), (orelse ...)
(do ...)                     ;Scheme
(lc (qual ...) expr ...)     ;[ expr || qual ... ]
(bc (qual ...) expr ...)     ;<< expr || qual ... >>
(fun name arity), (fun mod name arity)
(++ ...)
```

- Bunch of CL inspired macros – defun, defmacro, ...

Function definition

```
(defun member (x es)
  (cond ((=:= es ()) ’false)
        ((=:= x (car es)) ’true)
        (else (member x (cdr es)))))

(defun member
  ((x (e . es)) (when (=:= x e)) ’true)
  ((x (e . es)) (member x es))
  ((x ()) ’false))
```

Function scoping

- Within a module
  - – Default predefined Erlang BIFs
  - – Explicit imports
  - – Top functions in module
  - – Local functions defined by flet and fletrec
- So no problem redefining Erlang BIFs or imports. Macros!
- Core forms can ***<u>never</u>*** be shadowed!

Macros

- Macros are UNHYGIENIC!
  - – Does hygiene really work when distributing compiled code?
- No (gensym)
  - – Unsafe in long-lived systems
  - – But probably must have
- Really only compile time at the moment
  - – Except in interpreter and shell

Macros

- CL based macros, with pattern matching

  ```
  (defmacro foo (a b) ...)
  (defmacro foo
     (pat [guard] ...)
     (pat ...))
  ```

- Pattern matches whole argument list
- Scheme based syntax-rule macros with R5RS ellipsis

Binaries

```
(binary bitseg ...)
bitseg = integer | (value bitspec ...)

(1.5 float big-endian (size 32))
(bin binary)
(bits bitstring)
((foo a 35)integer little-endian (size 36))
```

- But must do `((foo a 35))` ☹

Patterns

- Like in vanilla Erlang patterns look like constructors
  - **`(binary (f float (size 32)) (rest binary))`**
- Use **`quote ’`** to match literals
  - **`(tuple ’ok val)`**
- But not for lists ☹
  - **`(a b c)`** (not **`(list a b c)`**)
  - **`(h . t)`** (not **`(cons h t)`**)

Patterns

- Have aliases
  - `(= (tuple ’ok a b) tup)`
  - Checked in lint
- Can be used in
  - `let, case, receive, match-lambda`
  - Macros `cond, lc , bc`
- Anonymous variable _

and Guards

```
(when (and (> x 5) (< x 10)))
```

- Guards are a **`(when <test>)`** expression directly after the pattern in clauses
- LFE guards are Erlang guards
- No implicit equality tests for patterns

  `{X,X}` ➔ **`(tuple x x1) (when (=:= x x1))`**
- Can be used after any pattern

Records

```
(defrecord name field-def-1 field-def-2 ...)

field-def = field-name | (field-name default-value)

→ (make-name field-name val field-name val ...)
  (is-name rec)
  (match-name field-name pat field-name pat ...)
  (set-name rec field-name val field-name val ...)
  (name-field-1 rec)
  (set-name-field-1 rec val)
  ...
```

LFE module

- A module consists of
  - Macro definitions
  - Macro calls
  - Function definitions
  - Compile time function definitions
- Macros can be defined anywhere but must be defined before being used
- Macros can define functions and other macros

LFE module

```
(defmodule foo
  (export (a 2) (b 1) (c 0))
  (export all)
  (import (from bar (x 2) (y 3))
          (rename baz ((m 4) bm)))
  (other-attribute (value)))
```

- Module definition must be the first non-macro form

LFE compiler

- 3 passes
  - Macro expansion
  - Linting
  - Code generation
- Lint and codegen only see LFE core forms
- Generates Core erlang
- LFE core forms ⇔ Core erlang
  - So compiler relatively simple

LFE compiler

- Uses back-end of Erlang compiler
- Output should be closer to Erlang compiler core output → better optimisation

LFE shell

- Simple REPL
- Can evaluate all LFE expressions
- Builtin variables **`+ ++ +++ - * ** ***`**
- Some builtin commands
- **`(slurp file)`** to load file and interpret all functions and macros
- Cannot define functions and macros (yet)
- No **`(spit file)`** yet either

The BIG question

Apart from the Answer to Life, the Universe, and Everything

Will LFE end the complaints and moaning about Erlang syntax?

The answer

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NO!

Implementing languages on the Erlang VM

A brief description of the Erlang compiler

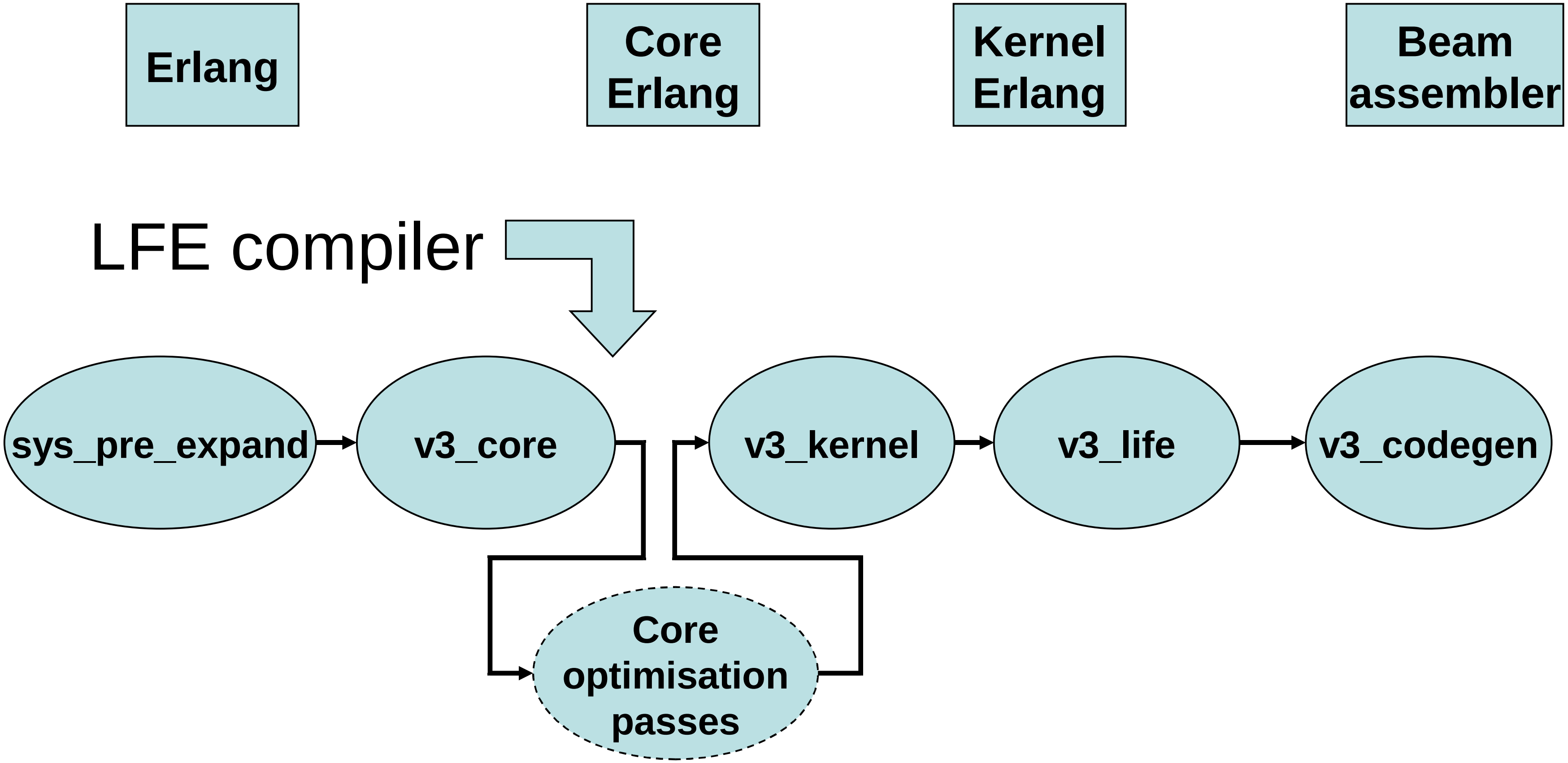
Robert Virding

Implement a language

Implement language by:

- Writing an interpreter
  - Easier but slower, more versatile
- Compiling to erlang
  - Code format complex, to file?
- Compile to ”internal” language
  - Core erlang, kernel erlang

Compiler overview



Erlang compiler

- Core Erlang
  - simple functional language
  - lexically scoped
  - local recursive functions
  - pattern matching
  - basic Erlang constructions (case, try etc.)
  - but misses some useful constructions ☹
  - Erlang features make it slightly strange

Core Erlang forms

```
(case expr clause ...)          ;An erlang case
~~(if test true false)            ;A lisp if~~
(receive clause ... (after timeout body))
(catch body)
(try expr (case ...) (catch ...) (after ...))
(lambda (arg ...) body)
~~(match-lambda clause ...)~~
(let ...)
~~(let-function ...)~~, (letrec-function ...)
(cons ...), (list ...), (tuple ...), (binary ...)
(func arg ... ), (funcall var arg ...)
(call mod func arg ...)         ;Eval all args
(define-function name ... )
```

Erlang compiler

- Kernel Erlang
  - flat code
  - lambda lifted
  - pattern matching compiled ☺
  - no nested code
  - receive expanded

Erlang compiler

- sys_pre_expand
  - Expand records, packages, annotate funs
- v3_core
  - List comprehensions, add lexical scoping, return exported variables, sequentialise code, expand =, add explicit fail clauses
- v3_kernel
  - Compile pattern matching, lambda lift local functions and funs, flatten nested calls