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
Influencing 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 seamlessly mixing compiled, interpreted functions and macros 😞

→ Interpreter not useful in same way for development
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 sep xrs
- \[ \ldots \] alternative to ( \ldots ) (Scheme)
- Symbol is any atom which isn’t a number or separator
  - \texttt{|quoted symbol|}
- ( ) [ ] { } . ` , @ #( #b( separators
- #( \ldots ) tuple constant
- #b( \ldots ) binary constant
- “abc” ⇔ (97 98 99), needs quoting 😞
- \#\texttt{a} or \#\texttt{xb}; 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, ...
(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 never 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

\[(\text{when } (\text{and } (> x 5) (< x 10)))\]

- Guards are a \((\text{when } <\text{test}>\)) expression directly after the pattern in clauses
- LFE guards are Erlang guards
- No implicit equality tests for patterns
  \[
  \{X,X\} \Rightarrow (\text{tuple } x \ x1) \ (\text{when } (=:= x \ x1))
  \]
- 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
• Built-in variables: + ++ +++ - * ** ***
• Some built-in 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

42

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

LFE compiler

Erlang
Core Erlang
Kernel Erlang
Beam assembler

diagram:

sys_pre_expand → v3_core → v3_kernel → v3_life → v3_codegen
Core optimisation passes
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