

CPS506 - Comparative Programming Languages

Elixir

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History

- Joe Armstrong worked at Ericson
- Erlang originally for lab development 1986
- 1995 became production on a phone switch - 9-9's
- 2006 became multi-processor

Overview

- Paradigms
 - Functional
 - Mostly immutable
 - Rich concurrency support
- Syntax
 - Erlang was Prolog-like; Elixir is more conventional
 - Infix multi-precedent operators
 - control structures are pattern matching
 - Functions are defined in modules
 - Only control structures are matching, recursion, list comprehensions
 - fixed arity functions, but can share a name with different arity
 - spawn, receive, send for communication
- Semantics
 - tail recursion is recognized
 - everything returns a value, control are parts of expressions
 - parameters are call-by-value
 - dynamically typed
 - functions can be spawned as processes - can receive messages
- Pragmatics

Elixir Example

```
defmodule Sequential do
  def square(collection) do
    collection
    |> Enum.map(fn x -> x * x end)
  end
end

result =Sequential.square 1..1000
```

Elixir Example

```
defmodule Sequential do
  def map(collection, func) do
    collection
    |> Enum.map(fn x -> func.(x) end)
  end
end

result = Sequential.map 1..1000, &(&1 * &1)
```

Elixir Example

OO is about manipulating state Elixir is about transforming data

```
defmodule Parallel do
  def pmap(collection, func) do
    collection
    |> Enum.map(fn x -> Task.async(fn -> func.(x) end)
    |> Enum.map(&Task.await/1)
  end
end

result = Parallel.pmap 1..1000, &(&1 * &1)
```

Elixir Example

```
defmodule Parallel do
  def pmap(collection, func) do
    collection
    |> Enum.map(&(Task.async(fn -> func.(&1) end)))
    |> Enum.map(&Task.await/1)
  end
end

result = Parallel.pmap 1..1000, &(&1 * &1)
```

Functional Programming

- Object orientation is not the only way to design code.
- Functional programming need not be complex or mathematical.
- The foundations of programming are not assignments, if statements, and loops.
- Concurrency does not need locks, semaphores, monitors, and the like.
- Processes are not necessarily expensive resources.
- Metaprogramming is not just something tacked onto a language.
- Even if it is work, programming should be fun.

from Elixir book

Binding and Immutability

- = is the binding operator
- *not* assignment
- assignment relates to GOTO

Expressions

- `1 + 2`
- `1 < 4.0`
- `:atom like #symbol`
- `variable`
- `= is pattern-match/binding - once`
- `[[3, 4], 5, 6] [3, 4 | [5, 6]]` can have improper lists
- `{2, 3, 4}`
- `{:valid, [h|t], x} = {:valid, [1, 2, 3], :blat}`
- **generally use function patterns instead**
- `if e0 do e1 else e2 end`
- `cond do c1 -> e1
c2->e2 end`
- `case e0 do p1 -> e1
p2->e2 end`

Definitions

- `c "matching_function"`
- `Matching_function.number(one)` - can apply as functions to index
- `negate = fn x -> -x end`
- `guards`

Higher Order Functions & Lists

- `Enum.reduce(numbers, 0, fn x, sum -> x + sum end)`
- `Enum.map(numbers, fn x -> x + 1 end)`
- `Enum.filter(numbers, small)`
- `Enum.all?([0, 1, 2], small)`
- `Enum.any?(numbers, small)`
- `Enum.take_while(numbers, 3)`
- `Enum.take_while(numbers, small)`
- `Enum.drop_while(numbers, small)`.
- **list comprehensions**
 - `for x <- [1, 2, 3, 4], x < 3, y <- [5, 6], y < x, do: {x, y}`
 - **generators and filters**
 - `import Enum`
 - `deck = for rank <- '23456789TJQKA', suit <- 'CDHS', do: [suit, rank]`
 - `deck |> shuffle |> take(13)`

Loops and Recursion

- tail-calls properly recognized
- loops are simply tail-recursive function calls
- full power of function pattern-matching for loop control

Processes, Concurrency & Failure

- `receive do pattern -> ...
 pattern -> end`
- `pid = spawn(fn xxxx)`
- `pid = spawn(Module, :fun, [args])`
- `send pid, :message`
- `link(pid)` **leads to signal on exit**
- `pid = spawn_link(fn xxxx)`
- `register(:atom, pid)`
- `self`
- `receive ... after`
- `exit(status)`

Map

- `%{key: value}`
- `map[:key]`
- keys can be anything

Keyword lists

- `[key: value]`
- options parameter
- keys must be atoms

Stream

- lazy evaluation
- equivalent to Enum
- `concat`, `cycle`, `take`, `drop`

Workflow & mix

- `mix` - project builder + package manager
- `mix new projectName`
- `mix test`
- `iex -S mix`

Macros

- `defmacro`
- `hygenic`
- `use keyword` usually defines macros
- used in test definition

- module dynamically loaded into running server
- current/old versions
- existing old code continues
- fully qualified function calls access current code
- another load kills old, moves current to old, new to current
- `-on_load(name/)` allows checking if load should proceed
- there are higher-level task managers in OTP

Evaluation

- Simplicity
 - Size of the grammar
 - complexity of navigating modules/classes
- Orthogonality
 - number of special syntax forms
 - number of special datatypes
- Extensibility
 - functional
 - syntactically
 - defining literals
 - overloading