CSC 533 Presentation: Elixir

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Elixir Presentation Overview

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Elixir References

elixir

History of Elixir

José Valim

01 Origins

- Created by José Valim, a Ruby on Rails core contributor
- Built on top of the Erlang VM (BEAM)
- Inherited fault tolerance of Erlang

02 Early Development

- Introduced package manager hex (like pip for Python or npm for JS) and built tool Mix
- Appealed to devs who didn't want to sacrifice productivity for performance

03 Present Elixir

- Stable 1.0 release in 2014
- Rise of the Phoenix framework (for web-dev)
- Steady releases have cultivated the Elixir ecosystem and community

Erlang Virtual Machine (BEAM)

- Developed by Ericsson in the 80s to handle payphone calls
- Designed for massive concurrency
- Built with fault isolation
- Engineered for 99.9999% uptime
- Elixir inherits all of the benefits from the BEAM
- So it gets decades of telecom-grade reliability for free

What Were Elixir's Goals?

- Functional programming language built on BEAM
- Data transformation over state management
- Concurrency and Scalability
- Fault Tolerance
- Extensibility
- Fully Erlang Compatible

Similarities to Clojure

- Both functional languages
- Both run on VMs
- Data is immutable by default
- Both have first class functions
- Clojure can call Java, Elixir can call Erlang

Differences from Clojure

```clojure
(defn add [a b]
  (+ a b))
```

```elixir
defmodule Math do
  def add(a, b) do
    a + b
  end
end
```

- Syntax
  - Elixir: Ruby, Clojure: Lisp
- Concurrency
  - Elixir: actor model, Clojure: STM (shared memory)
- Fault Tolerance
  - Elixir: built-in supervisors
- Pattern matching
- Target use case
  - Elixir: distributed systems, Clojure: data processing
- Error philosophy

Features

- Data Types
- Variables, Bindings, & Immutability
- Control Structures
- Functions & Abstraction
- Pattern Matching
- Pipe Operator
- Processes and Message Passing
- "Let it Crash" + OTP Supervisors
- Memory Management

Data Types

Primitive types

- Integers, floats, booleans, atoms strings

Composite types

- Tuple, map, keyword list, struct

```
list = [1, 2, 3]
hd(list)          #=> 1 (the element, not a list)
tl(list)          #=> [2, 3]
[0 | list]        #=> [0, 1, 2, 3]
Enum.at(list, 0)  #=> 1
```

```
opts = [timeout: 5000, retries: 3]
opts[:timeout]    #=> 5000
```

Variables, Bindings, & Immutability

- Dynamic typing (checked at runtime)
- Data is immutable
- Variables can be rebound to new values
- Static scoping (no global mutable state)

```
iex(1)> x = 10
10
iex(2)> x = "hello"
"hello"
iex(3)> x
"hello"
```

```
iex(1)> x = 10
10
iex(2)> if true do
          x = 20
          IO.puts(x)
        end
20
:ok
iex(3)> x
10
```

Control Structures

- Case: pattern match on a value
- Cond: if-else chain
- If/Unless: simple conditionals
- No for/while loops (can't mutate a counter like i++)
  - Use recursion, Enum module, or comprehensions

```
case Enum.at(list, 2) do
  1  -> "one"
  3  -> "three"
  _  -> "catch all"
end

cond do
  x > 10 -> "big"
  x > 5  -> "medium"
  true   -> "small"
end
```

Functions & Abstraction

- Named functions (def) inside modules, anonymous (fn)
- No explicit return, last expression is the value
- Multiple function heads via pattern matching
- No classes: modules, protocols, behaviours instead

```
defmodule Math do
  def factorial(0), do: 1
  def factorial(n), do: n * factorial(n - 1)
end

iex> Math.factorial(5)
120
```

Pattern Matching

Concept

- = is the matching operator, NOT the assignment operator
- Variables bind to values through matching

```
iex(1)> {a, b} = {1, 2}
{1, 2}
iex(2)> a
1
iex(3)> b
2
```

Why it matters

- Extracts values easily
- Reduces need for complex conditionals
- Makes code more readable

```
iex(1)> {:ok, result} = {:ok, 42}
{:ok, 42}
iex(2)> {:ok, result} = {:error, 42}
** (MatchError) no match of right hand side value:

    {:error, 42}

    (stdlib 7.3) erl_eval.erl:672: :erl_eval.expr/6
    iex:2: (file)
```

Pipe Operator |>

- Pass the result of one function as the first argument to the second
- Reads left to right

```
iex(1)> "elixir" |> String.ends_with?("ixir")
true
iex(2)> "Elixir rocks" |> String.upcase() |> String.split()
["ELIXIR", "ROCKS"]
iex(3)> "Elixir rocks" |> String.split()
["Elixir", "rocks"]
```

Processes and Message Passing

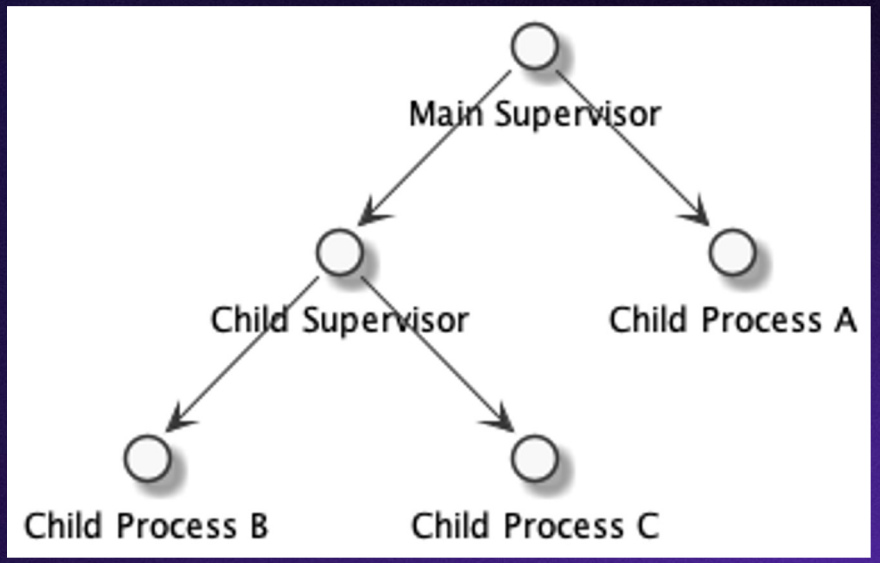
- Processes are not OS threads
- Millions of processes simultaneously
- Each process has its own memory
- Crash in one process does not affect others

```
iex(1)> pid = spawn(fn ->
          receive do
            {:hello, msg} -> IO.puts("Got: #{msg}")
          end
        end)
#PID<0.105.0>
iex(2)> send(pid, {:hello, "world"})
Got: world
{:hello, "world"}
iex(3)>
```

“Let it Crash” + OTP Supervisors

“Let it crash” Philosophy

- Serves to handle crashes rather than prevent them
- Processes are expected to fail
  - These failures should be isolated
  - Don't need defensive programming everywhere



OTP Supervisors

- Supervisors monitor processes
  - Defines restart strategies
  - Restart only what fails, not entire system
    - Only failed processes cease execution

Memory Management

```
iex(1)> list1 = [1, 2, 3, 4]
[1, 2, 3, 4]
iex(2)> list2 = [0 | list1]
[0, 1, 2, 3, 4]
```

01

Garbage Collection

- Each process has its own heap and garbage collector
- Prevents system-wide garbage collection pauses

02

Process Isolation

- Processes don't share resources
- Communication via message passing

03

Efficient Memory Usage

- Immutability allows for structure sharing
- E.g. lists reuse existing structure instead of copying

04

Process Life Cycle

- Memory is reclaimed when process terminate; lightweight processes are cheap to create and destroy

Who is using it?

Sources

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Thank you!