Introduction to Erlang and the Erlang shell

Module 8 - Erlang tutorial 1

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Erlang from the far distance (top down)

Erlang (programming language) (1)

From Wikipedia, the free encyclopedia

Erlang is a general-purpose concurrent, garbage-collected programming language and runtime system. The sequential subset of Erlang is a functional language, with strict evaluation, single assignment, and dynamic typing. For concurrency it follows the Actor model. It was designed by Ericsson to support distributed, fault-tolerant, soft-real-time, non-stop applications. It supports hot swapping, so that code can be changed without stopping a system.[1]

Source: http://en.wikipedia.org/wiki/Erlang_(programming_language) 2012-03-18

Evaluation strategies

In computer programming, strict evaluation, eager evaluation or greedy evaluation is the evaluation strategy in most traditional programming languages.

In **eager evaluation** an expression is evaluated as soon as it gets bound to a variable.

Erlang from the distance (top down)

Small syntax

The Erlang language is small but expressive.

- ★ Small set of built in data types (a.k.a terms)
- ★ Pattern matching
- ★ Variables (but not really)
- ★ Function clauses
- ★ Modules

Data types

Data types

A small set of built in **immutable** data types.

- **Number**
- **Atom**
- Bit strings and binaries
- Reference
- **Function identifier**
- Port identifier
- **Pid**
- **List**
- **Tuple**
- Map

Among the built in data types we will initially only study and use numbers, atoms, function identifiers, pids, lists and tuples.

Booleans

There is no special built in boolean data type in Erlang.

In Erlang the boolean values are represented by the two atoms **true** and **false**.

An **atom** is a literal, a constant with name.

Strings

There is no special built in string data type in Erlang.

In Erlang **strings** are represented by **lists** of integers.

The string “Hello World!” is represented by the following list of ASCII values:

```
[72, 101, 108, 108, 111, 32, 87, 111, 114, 108, 100, 33]
```

There exist syntactic sugar that allows you to write "Hello World!" instead of the list of ASCII values.

Custom data types

To represent a custom data type you typically use a **tagged tuple**.

To store data about muppets a three element tuple may be used with the first element being the atom muppet, the second element the name (string) of the muppet and the third element the species (string) of the muppet.

```
{muppet, "Kermit", "frog"}

{muppet, "Fozzie", "bear"}
```

Each tuple is **tagged** with the **atom** **muppet**. This makes it possible to distinguish these muppet tuples from other three element tuples.

Variables

Variables

Erlang uses **immutable single assignment** variables.

Variables in Erlangs are not so variable.

Variables can only be bound once.

Pattern matching

Pattern matching

Variables are bound to values through the pattern matching mechanism.

In a pattern matching, a left-hand side **pattern** is matched against a right-hand side **term**.

If the matching succeeds, any unbound variables in the pattern become bound. If the matching fails, a run-time error occurs.

```
A = 127.      Variable A is bound to the number 127

B = A + 99.   Variable A is bound to the number 127

A = A + 1.    This is an invalid pattern match (error)
```

Erlang - a closer look (bottom up)

The Erlang shell

Try yourself

This is a short introduction to Erlang and the Erlang interactive shell.

You are strongly recommended to type in the examples given in this introduction yourself to the Erlang shell.

You may use SSH to log in to the department Linux system to start the Erlang shell.

If you prefer, you can install Erlang on your private computer and then start the Erlang shell.

The Erlang shell

A good way starting to learn Erlang is by playing around in the interactive Erlang emulator, the Erlang shell.

To start the shell, open a terminal and then type in `erl` and press enter.

```
$> erl
```

Here `$>` is used to denote the **Linux** shell **prompt**. You may see a different prompt depending on the system you are using.

If you have Erlang installed, the Erlang shell will start.

```
$> erl
Erlang R16B (erts-5.10.1) [source] [smp:8:8]
[async-threads:10] [hipe] [kernel-
poll:false]

Eshell V5.10.1  (abort with ^G)
1>
```

This is the **Erlang** shell

Arithmetic expressions

Arithmetic expression

An arithmetic expression is an expression that results in a numeric value.

At the Erlang shell prompt we can enter and evaluate arithmetic expressions.

```
1> 4+1.
```

Note: every expression must end with a period.

```
1> 4+1.
```

If we press enter the shell will respond with the result of evaluating the expression.

```
1> 4+1.
5
2>
```

The result of adding **4** and **1**, **5**, is printed on the next line.

Note: the prompt changed from `1>` to `2>` .

The prompt counts the number of evaluated expressions!

```
1> 4+1.
5
2> 4-1.
3
3> 4*2.
8
4> 4/2.
2.0
5> 4/3.
1.3333333333333333
6> 17 rem 5.
2
```

Lets try some more **arithmetic expressions**.

Note: an expression must end with a period.

X rem **Y** gives the integer remainder of **X**/**Y**.

```
1> 4+99 - 7*18
```

If we forget the ending period and press enter ...

```
1>
```

... the Erlang shell responds with the same prompt again, here the prompt is still `1>`. We can now provide the missing period and press enter.

```
1>  .
-23
2>
```

Finally the value of the expression is printed and we get a new prompt `2>`.

Comments

A comment begins with the character %, continues up to, but does not include the next end-of-line, and has no effect.

Boolean expressions

Boolean expressions

A boolean expression is either `true` or `false`.

```
1> 1 =:= 2. %% equal
false
2> 1 < 2.   %% less than
true
3> 1 > 2.   %% greater than
false
4> 1 =/= 2. %% not eaqual
true
5> 1 =/= 1.
false
6> 2 =< 1.  %% less than or equal
false
7> 1 =< 2.
true
8> 1 >= 2.  %% greater than or equal
false
9> 2 >= 2.
true
10> 3 >= 2.
true
```

Variable binding

Binding values to named variables

```
7> A = 39.
39
8> A+3.
42
9> A*A.
1521
10> Beta = A*A - 99.
1422
11> Beta.
1422
```

Variable names must begin with an upper case letter.

The **equal sign** is is used to bind a value to a variable.

```
12> A = Beta.
```

Lets try this. What do you think will happen?

```
12> A = Beta.
** exception error: no match of
right hand side value 1422
```

The value of **A** is not equal to the value of **Beta**.

```
13> A.
39
14> Beta.
1422
15>
```

```
16> A = A.
39
17> Beta = Beta.
1422
18>
```

Unbound variables

```
18> X.
```

Lets try this. What do you think will happen?

```
18> X.
* 1: variable 'X' is unbound
```

We haven't bound the name **X** to any value yet!

As before, we can bind the name **X** to a value.

```
19> X = Beta + 1.
1423
```

Variables and pattern matching

Variables and pattern matching

```
19> X = Beta + 1.
1423
```

X and **Beta** are called variables in Erlang.

- A variable is an expression.
- If a variable is bound to a value, this value is the value of the expression.
- Unbound variables are only allowed in something called patterns (more about patterns later).
- In the above pattern match expression, **X** is unbound and on the left-hand side of the match operator **=**. The result of the pattern match expression is for the name **X** to be bound to the value of the right-hand side.

Variables and single assignment

Variables must start with an uppercase letter or underscore _ and may contain alphanumeric characters, underscore and @.

Erlang uses **single assignment**, a variable can only be bound once.

Examples of valid variable names

```
X

Name1

PhoneNumber

Phone_number

_

_Height
```

Expression sequence

Sequences of expressions

You can sequence expression by separating them by commas (**,**).

```
10> A = 33, B = 2*A.
66
```

The value of a sequence of expressions is the value of the last expression, in the above example the value of **B** (**66**).

```
11> A.
33
12> B.
66
```

Both **A** and **B** where bound to values when evaluating the expression sequence.

Atoms

Atoms

An atom is a literal, a constant with a name.

An atom should be enclosed in single quotes (') if it does not begin with a lower-case letter or if it contains other characters than alphanumeric characters, underscore (_), or @.

Examples of valid atoms

```
hello
phone_number
'Monday'
'phone number'
```

Atoms and pattern matching

```
20> cat = dog.
** exception error: no match of
right hand side value dog
21> cat = 42.
** exception error: no match of
right hand side value 42
```

An atom can only match itself.

```
22> cat = cat.
cat
```

Using pattern matching, an unbound variable can be bound to an atom.

```
23> Pet = cat.
cat
24> Food = fish.
fish
```

The following pattern match fails.

```
25> Pet = Food.
** exception error: no match of
right hand side value fish
```

The following pattern matches are valid.

```
26> fish = Food.
fish
27> Food = fish.
fish
28> cat = Pet.
cat
29> Pet = cat.
cat
```

Lists

Lists

Compound data type with a **variable number of terms**. The elements of a list can be any valid Erlang term.

```
[Term1,...,TermN]
```

Examples of lists.

```
[]
[1,2]
[1,3,fish, 4, cat]
[[1,2], a, [b,c], 77, z]
[[1,2,[88,cat]],[44,88],0]
```

A list can contain other lists … which also contains lists …

Anatomy of a list

Head - the first element of a list.

Tail - the list that remains if we cut of the head.

```
1> L = [1,2,3,4].
[1,2,3,4]
```

Head of **L**: **1**

Tail of **L**: **[2,3,4]** head.

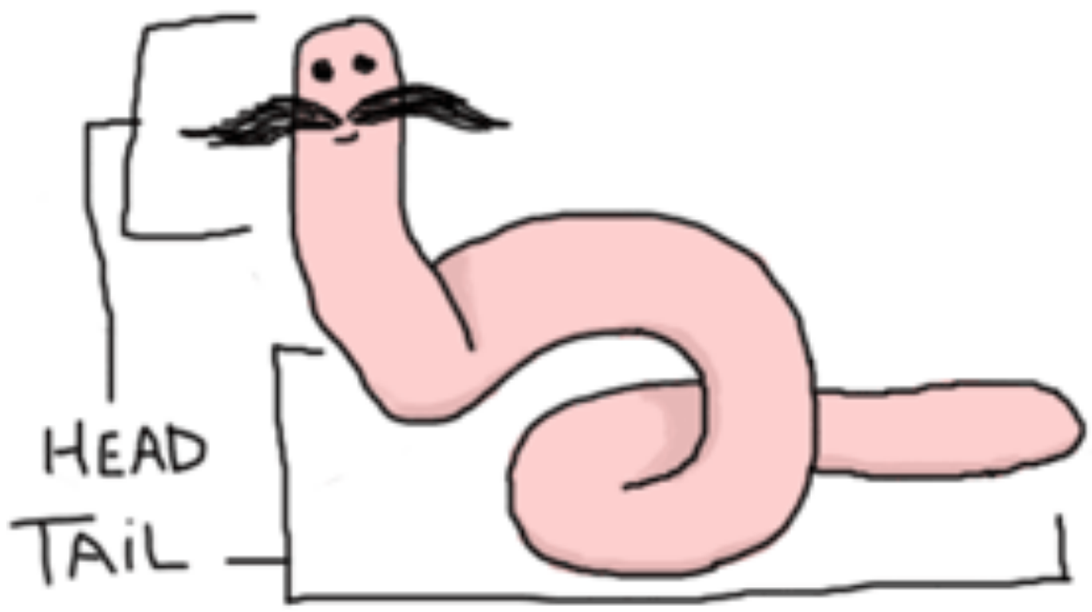


Image: http://learnyousomeerlang.com

Adding elements to the head of a list

The list construction operator | can be used to add one ore more elements to the head of a list.

```
1> L = [1,2,3,4].
[1,2,3,4]
```

Add **0** to the head of **L**.

```
2> [0|L].
[0,1,2,3,4]
```

Extracting the head and tail of a list

Using the list constructor operator together with pattern matching, the head and tail of a list can be extracted.

```
1> L = [1,2,3,4].
[1,2,3,4]
2> [Head | Tail] = L.
[1,2,3,4]
3> Head.
1
4> Tail.
[2,3,4]
```

Length of a list

The built in function (BIF) **`length`** returns the number of elements in a list.

```
1> L = [1,2,3,4].
[1,2,3,4]
4> length(L).
4
5> length([]).
0
6> length([1,2, [a,b,c], 99]).
4
```

Strings are lists

Special lists

Lets type in this list and press enter.

```
15> [97,98,99].
```

The Erlang shell responds with ”**abc**”.

```
15> [97,98,99].
"abc"
```

ASCII

The American Standard Code for Information Interchange (ASCII).

Character	Code
A	65
B	66
C	67
↓	
Z	90
[	91
↓	
a	97
b	98
c	99
↓	
z	122

```
15> [97,98,99].
"abc"
```

All elements of this list are valid ASCII codes. The Erlang shell therefore chooses to show us the corresponding characters enclosed between quotes as a human readble string.

Characters

Character codes in Erlang

Character	Code
A	65
B	66
C	67
↓	
Z	90
[	91
↓	
a	97
b	98
c	99
↓	
z	122

To get the character code for a given character, precede the character with a dollar sign.

```
1> $a.
97
2> $A.
65
3> $[.
91
28> [$a,$b,$c].
"abc"
```

Strings

In Erlang, a list of valid ASCII characters is called a string. Strings are usually denoted by enclosing a sequence of characters between double quotes.

Examples of strings.

```
""
" "
"a"
"ab"
"Hello!"
"This i a longer string."
```

Strings are lists

All operations on lists are valid on strings since strings are lists.

```
2> [H|T] = "ABC".
"ABC"
3> H.
65
4> T.
"BC"
5> [$a | "ABC"].
"aABC"
6> length("").
0
7> length("Hello").
5
```

Tuples

Tuples

A tuple is a compound data type with a **fixed number of terms**.

```
{Term1,...,TermN}
```

Examples of tuples of various sizes.

```
{}
{cat}
{137}
{"Hello"}
{cat, 5}
{cat, 5, "Kitty"}
```

Tuples and pattern matching

Using pattern matching we can extract individual values from a tuple.

```
28> Pet = {cat, 5, "Kitty"}.
{cat,5,"Kitty"}
29> {Species, Age, Name} = Pet.
{cat,5,"Kitty"}
30> Species.
cat
31> Age.
5
32> Name.
"Kitty"
```

Tuples are often used to collect related information.

The anonymous variable _

The anonymous variable is denoted by underscore _ and can be used when a variable is required but we want to ignore its value.

```
1> [H|_] = [1,2,3]
[1,2,3]
2> H.
1
3> Pet = {cat, 5, "Kitty"}.
{cat,5,"Kitty"}
4> {Species, _, _} = Pet.
{cat,5,"Kitty"}
5> Species.
cat
```

Pattern matching twice

Sometimes it is useful to pattern match twice in order to bind the whole match to one variable and parts of the match to other variables.

```
1> T = {A, B} = {a, tuple}.
{a, tuple}
2> T.
{a, tuple}
3> A.
a
4> B.
tuple
```

Here **T** is bound to the the tuple **{a, tuple}** at the same time as **A** is bound to the atom **a** and **B** to the atom tuple.

Exit the Erlang shell

Exit from the Erlang shell

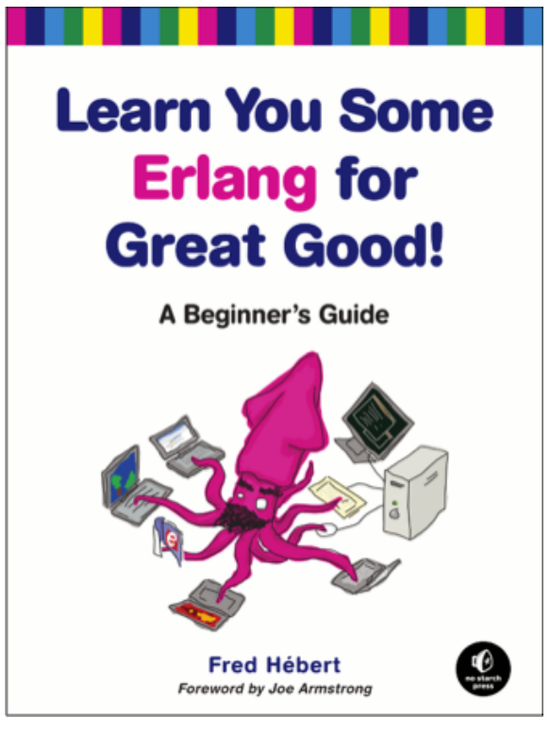
To exit from the Erlang shell, type `q().` and press enter.

```
1> 1 + 4.
5
2> q().
ok
$>
```

Recommended reading

Learn you some Erlang for Great Good! A Beginner's Guide

Fred Hérbert



Available for free online
http://learnyousomeerlang.com

Erlang Programming A Concurrent Approach to Software Development

Cesarin & Thompson

You might also like this book as a complement to online resourses.