FLEX - Erlang

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Live Coding

These are slides for accreditation purposes, but the best mode of presentation for this is a live coding demo, where the participants can also try out programming in Erlang.

Simple Data

```
42      % number
true    % boolean
false   % boolean
foo     % atom

23 + 42
42 == 23
42 >= 23
true andalso false
false orelse true
```

Data Structures

```
{1,foo,true} % tuple
[1,2,3]      % list
"abc"        % string = list of numbers
<<1,17,42>>
<<1,17,42:16>> == <<1,17,0,42>>.

#{a => "hello"}   % map
#{1 => 2, b => b}

[1,2,3] ++ [4,5,6]
"abc" ++ "ABC"
```

Maps

```
A = a,
B = b,
M0 = #{},
M1 = #{a => <<"hello">>},
M2 = #{1 => 2, b => b},
M3 = #{k => {A,B}},
M4 = #{{"w", 1} => f()}.
```

Map Expressions

```
M = #{1 => a}.

M#{1.0 => b}.
#{1 => a, 1.0 => b}.

M#{1 := b}.
#{1 => b}
```

Functions

```
double(X) ->
    times(X, 2).

times(X, N) ->
    X * N.
```

Functions with Status

```
divide(N, M) ->
    if
        M == 0 -> divide_by_zero;
        true -> {ok, N / M}
    end.
```

Pattern Matching

```
dogs_per_legs(Legs) ->
    case divide(Legs, 4) of
        {ok, People} -> People;
        divide_by_zero -> io:format("this can't happen")
    end.
```

Pattern Guard

```
divide(_N, M) when M == 0 ->
    divide_by_zero;
divide(N, M)  ->
    {ok, N / M}.
```

Functions

```
area({square, Side}) ->
    Side * Side;
area({circle, Radius}) ->
    3.14159265 * Radius * Radius;
area({triangle, A, B, C}) ->
    S = (A + B + C)/2,
    math:sqrt(S*(S-A)*(S-B)*(S-C));
area(Other) ->
    {invalid_object, Other}.
```

Functions

```
length([]) ->
    0;
length([H|T]) ->
    1 + length(T).
```

Modules

```
-module(animals).

-export([map/2, map_iterative/3]).

-include_lib("eunit/include/eunit.hrl").
```

Records

```
-record(dillo, {alive :: boolean(), weight :: pos_integer()}).
-record(rattlesnake,
        {thickness :: non_neg_integer(), length :: pos_integer()}).

d1() -> #dillo{alive=true, weight=10}.
d2() -> #dillo{alive=false, weight=12}.
r1() -> #rattlesnake{thickness=10, length=100}.
r2() -> #rattlesnake{thickness=0, length=120}.
```

Functions

```
-type animal() :: #dillo{} | #rattlesnake{}.

% run over one animal
-spec run_over_animal(animal()) -> animal().

run_over_animal(#dillo{weight=Weight}) ->
    #dillo{alive=false, weight=Weight};
run_over_animal(#rattlesnake{length=Length}) ->
    #rattlesnake{thickness=0, length=Length}.
```

Test

```
run_over_animal_test() ->
    #dillo{alive=false, weight=10} = run_over_animal(d1()),
    ?assert(d2() =:= run_over_animal(d2())),
    #rattlesnake{thickness=0, length=100} = run_over_animal(r1()),
    R2 = r2(),
    R2 = run_over_animal(r2()).
```

Functions over Lists

```
% run over a list of animals
-spec run_over_animals([animal()]) -> [animal()].

run_over_animals_test() ->
    I = [d1(), d2(), r1(), r2()],
    O = [#dillo{alive=false, weight=10}, d2(),
         #rattlesnake{thickness=0, length=100}, r2()],
    O = run_over_animals(I).

run_over_animals([]) ->
    [];
run_over_animals([A|As]) ->
    [run_over_animal(A) | run_over_animals(As)].
```

Higher-Order Function

```
map(_F, []) ->
    [];
map(F, [First|Rest]) ->
    [F(First) | map(F, Rest)].

run_over_animals(As) ->
    map(fun run_over_animal/1, As).
```

Tail-Recursive Function

```
map_iterative(_F, [], Acc) ->
    lists:reverse(Acc);
map_iterative(F, [First|Rest], Acc) ->
    map_iterative(F, Rest, [F(First)|Acc]).
```

Process and Message Reception

```
format_server_0() ->
    spawn(fun () ->
                  receive
                      Bla -> io:format(Bla)
                  after 10000 ->
                          io:format("timeout~n")
                  end
          end).
```

Message Passing in Erlang

- asynchronous (every process has a queue)
- queues are unbounded
- ordering is preserved
- cross-node message-passing may lose messages

Process as Server

```
format_server() ->
    receive
        Bla -> io:format(Bla),
               format_server()
    end.

start_format_server() ->
    spawn(process, format_server, []).
```

Replies, records as messages

```
-record(get, {sender_pid :: pid()}).
-record(inc, {i :: number()}).

inc_loop(N) ->
    receive
        #inc{i = I} ->
            io:format("incrementing ~w by ~w~n", [N, I]),
            inc_loop(N + I);
        #get{sender_pid = SenderPid} ->
            SenderPid ! N,
            inc_loop(N)
    end.
```

Interface via functions

```
start_inc(N) ->
    spawn(process, inc_loop, [N]).

inc(Pid, I) ->
    Pid ! #inc{i = I}.

get(Pid) ->
    Pid ! #get{sender_pid = self()},
    receive
        N -> N
    end.
```

gen_server

```
-module(inc_gen_server).

-export([start/1, start_link/1,
         inc/1, inc/2, get/0, get/1,
         init/1, handle_cast/2, handle_call/3]).

-behavior(gen_server).
```

Inc gen_server

```
start(N) ->
    gen_server:start({global, global_inc}, ?MODULE, N, []).

start_link(N) ->
    gen_server:start_link(?MODULE, N, []).

-record(get, {sender_pid :: pid()}).
-record(inc, {i :: number()}).
```

Inc gen_server calls

```
inc(I) ->
    inc(global_name(), I).

inc(Pid, I) ->
    gen_server:cast(Pid, #inc{i = I}).

get(Pid) ->
    gen_server:call(Pid, #get{}).

get() ->
    get(global_name()).
```

Inc gen_server callbacks

```
init(N) -> {ok, N}.

handle_cast(#inc{i = I}, N) ->
    io:format("incrementing ~w by ~w~n", [N, I]),
    {noreply, N + I}.

handle_call(#get{}, _From, N) ->
    {reply, N, N}.
```

Link

```
die_process() ->
    receive
        Msg -> io:format("~w~n", [10 / Msg]),
               die_process()
    end.

start_die_process() ->
    Pid = spawn(?MODULE, die_process, []),
    link(Pid),
    process_flag(trap_exit, true), % try removing this line
    Pid.
```

Link

- `link(Pid)` creates *bidirectional* link between `self()` and `Pid`
- `spawn_link` is `spawn` + `link`, atomically

Supervisors

```
-module(supervisor_demo).

-export([start/0, start_link/0, init/0, die_process/0]).

start() ->
    spawn(?MODULE, init, []).

start_link() ->
    spawn_link(?MODULE, init, []).

die_process() ->
    receive
        Msg -> io:format("~w~n", [10 / Msg]),
               die_process()
    end.
```

Supervisors

```
init() ->
    process_flag(trap_exit, true),
    loop().

loop() ->
    Pid = spawn_link(?MODULE, die_process, []),
    register(die_process, Pid),
    receive
        {'EXIT', _From, shutdown} ->
            exit(shutdown); % will kill the child too
        {'EXIT', Pid, Reason} ->
            io:format("Process ~p exited for reason ~p~n",
                      [Pid,Reason]),
            loop()
    end.
```