# The state of OCaml, 2012

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INRIA Paris-Rocquencourt

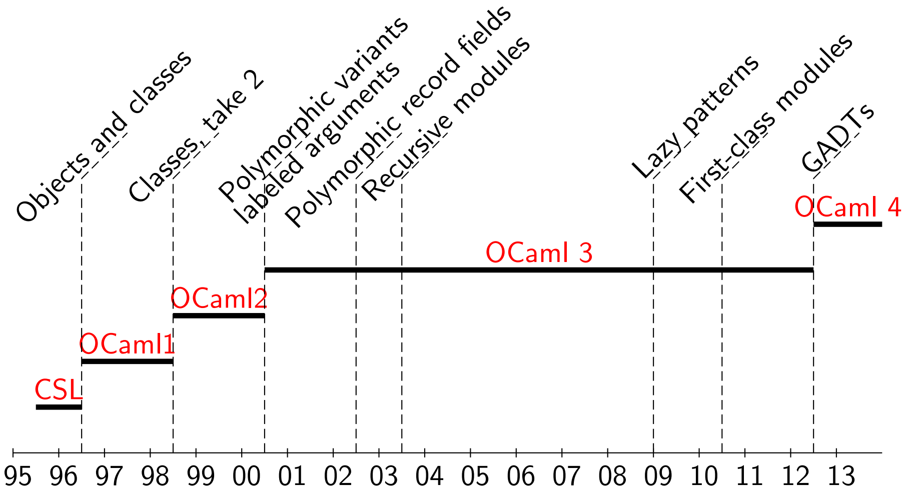
OCaml Users and Developers Workshop, 2012-09-14

## Outline

1 OCaml development news

2 OCaml community news

## The new major release: OCaml 4.00



## What's new

Language features:

- Generalized Algebraic Data Types
- More lightweight support for modules packed as first-class values.

Implementation features:

- Exposing rich typed ASTs and compiler internals (for IDEs and more)
- Lots of new warnings
- Revamped ARM code generator
- Improvements in marshaling and generic hashing.

Development process:

- More external contributions
- 160 issues fixed, 50 feature wishes granted
- More rigorous (but slow) release process.

## Zoom #1: Generalized Algebraic Data Types (GADTs)

J. Garrigue, J. Le Normand (U. Nagoya)

A (seemingly minor) extension to the declaration of variant data types that enables programmers to

1. express properties of data structures via type equalities;
2. have the type-checker enforce these properties.

## Without GADTs: tagged interpreters

```
type expr =
  | Lit of string
  | Pair of expr * expr
  | Fst of expr
  | Snd of expr
and value =                       (* results of evaluation *)
  | VString of string             (* “tagged” with their types *)
  | VPair of value * value

let rec eval : expr -> value = function (* produces a tagged value *)
  | Lit s -> VString s
  | Pair(e1, e2) -> VPair(eval e1, eval e2)
  | Fst e1 ->
      (match eval e1 with VPair(v1, v2) -> v1 | _ -> raise Error)
  | Snd e1 ->
      (match eval e1 with VPair(v1, v2) -> v2 | _ -> raise Error)
                                 (* dynamic typing during evaluation *)
```

## With GADTs: tagless interpreters

Can define $\tau$ expr as the type of symbolic expressions that safely evaluate to a Caml value of type $\tau$.

```
type _ expr =
  | Lit: string -> string expr
  | Pair: 'a expr * 'b expr -> ('a * 'b) expr
  | Fst: ('a * 'b) expr -> 'a expr
  | Snd: ('a * 'b) expr -> 'b expr
```

The evaluator, then, needs not tag result values, and cannot fail.

```
let rec eval : type v. v expr -> v = function
  | Lit s -> s                           (* v = string here *)
  | Pair(e1, e2) -> (eval e1, eval e2)   (* v = v1 * v2 here *)
  | Fst e -> fst (eval e)                (* statically safe *)
  | Snd e -> snd (eval e)
```

## Zoom #2: working with typed ASTs

T. Turpin, F. Le Fessant, T. Gazagnaire (OCamlPro)

A new compiler option, `-bin-annot`, causing the production of a `.cmt` file containing a rich Abstract Syntax Tree annotated with

- Source file locations
- Scoping and binding information for identifiers
- Types inferred by the typechecker.

(Generalizes the `-annot` option, which generated only a subset of this information, in an Emacs-specific format.)

## The OCaml compilation chain, before 4.00

$$\begin{tikzcd}
 & \text{Source} \arrow[d] & \\
 & \text{Parsetree} \arrow[d] & \\
 & \text{Typedtree} \arrow[d] & \\
 & \text{Lambda} \arrow[dl] \arrow[dr] & \\
\text{Bytecode} & & \text{ULambda} \arrow[d] \\
 & & \text{C--} \arrow[d] \\
 & & \text{Mach} \arrow[d] \\
 & & \text{Linear} \arrow[d] \\
 & & \text{Assembly}
\end{tikzcd}$$

**Parsetree:** (produced by the parser)

- Very close to source text
- Annotated by source locations (file name, line #, column #)
- No types, no scoping information

**Typedtree:** (produced by the typechecker)

- Annotated by (inferred) types
- Explicit scoping and binding of idents
- Some source constructs eliminated (`open`, `include`, type constraints)
- No source locations
- All source constructs represented
- Same location info as in Parsetree

# The OCaml compilation chain, in 4.00

$$\begin{tikzcd}
 & \text{Source} \arrow[d] & \\
 & \text{Parsetree} \arrow[d] & \\
 & \text{Typedtree} \arrow[d] \arrow[dl] & \\
\texttt{.cmt}\ \text{file} & \text{Lambda} \arrow[dl] \arrow[dr] & \\
\text{Bytecode} & & \text{ULambda} \arrow[d] \\
 & & \text{C--} \arrow[d] \\
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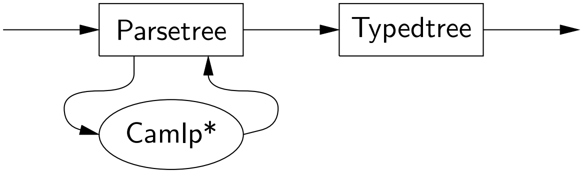
## Using typed ASTs

**Current use: for IDEs** (e.g. TypeRex, OCamlSpotter)
show inferred types; jump to definition; scoping-aware identifier renaming; type-aware completion; etc.

**Possible future use: for code generation**
Camlp4-style preprocessing that has access to type & scope info.



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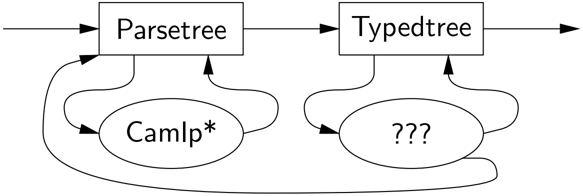

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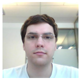
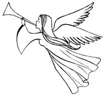
## This release brought to you by . . .


Jérémie Dimino



Xavier Clerc

Thomas Gazagnaire

Alain Frisch

Jacques Garrigue

Damien Doligez

Wojciech Meyer

Jacques Le Normand

Fabrice Le Fessant

Xavier Leroy

Tiphaine Turpin

Benedikt Meurer

Gabriel Scherer

Jonathan Protzenko

(More help is welcome.)

## Future directions

A bug-fix release 4.00.1 this Fall.

Work in progress on:

- Name space management
- Run-time representations of types.
- Performance improvements (native compiler, run-time system).

Shedding more weight off the core system.
(By splitting off some libraries and tools as independent projects.)

## Outline

1. OCaml development news
2. OCaml community news

## News from the community
(not exhaustive)

Some new or recently open-sourced projects:

- TypeRex (OCamlPro's IDE)
- OPAM (OCamlPro's package manager)
- Opa (MLstate's Web programming framework)
- Mirage (OCaml as a Xen guest OS)
- JS-of-OCaml (OCaml running in any browser)
- Functory and Parmap (parallel computation)
- ZArith (arbitrary-precision integers)
- Async (Jane Street's lightweight cooperative threads)

## News from the community
(not exhaustive)

New releases of major libraries and frameworks, such as:

- Batteries and Core (comprehensive standard libraries)
- Frama-C (static analysis framework)
- Ocsigen (Web programming framework)
- OCaml "companion tools"
- ODT (Eclipse plug-in)
- OUnit (unit testing framework)
- Plasma (distributed file system and map-reduce)

## News from the community
(not exhaustive)

Cool factor:

- OCaml iPhone/iPad apps (psellos.com, M. Hayden, J. Kimmit)
- TryOCaml (toplevel in browser)

Textbooks:

- *Real-World OCaml* (J. Hickey, A. Madhavepeddy, Y. Minsky) (soon?)
- *Think OCaml: How to Think Like a Computer Scientist* (N. Monje and A .Downey)
- *Programmation de droite à gauche (et vice-versa)* (P. Manoury)

## In closing. . .

A lively language; a lively implementation; a very lively community.

Some growing pains.

Many individual contributions, deserve better integration & accessibility.

High hopes in a future OCaml Platform.