When Type Checking Goes WRONG ! But Keeps Going

From **Merlin** to OCaml's Typechecker: **Integrating Typing Recovery**

Tarides - Xavier Van de Woestyne - **xvw.lol**

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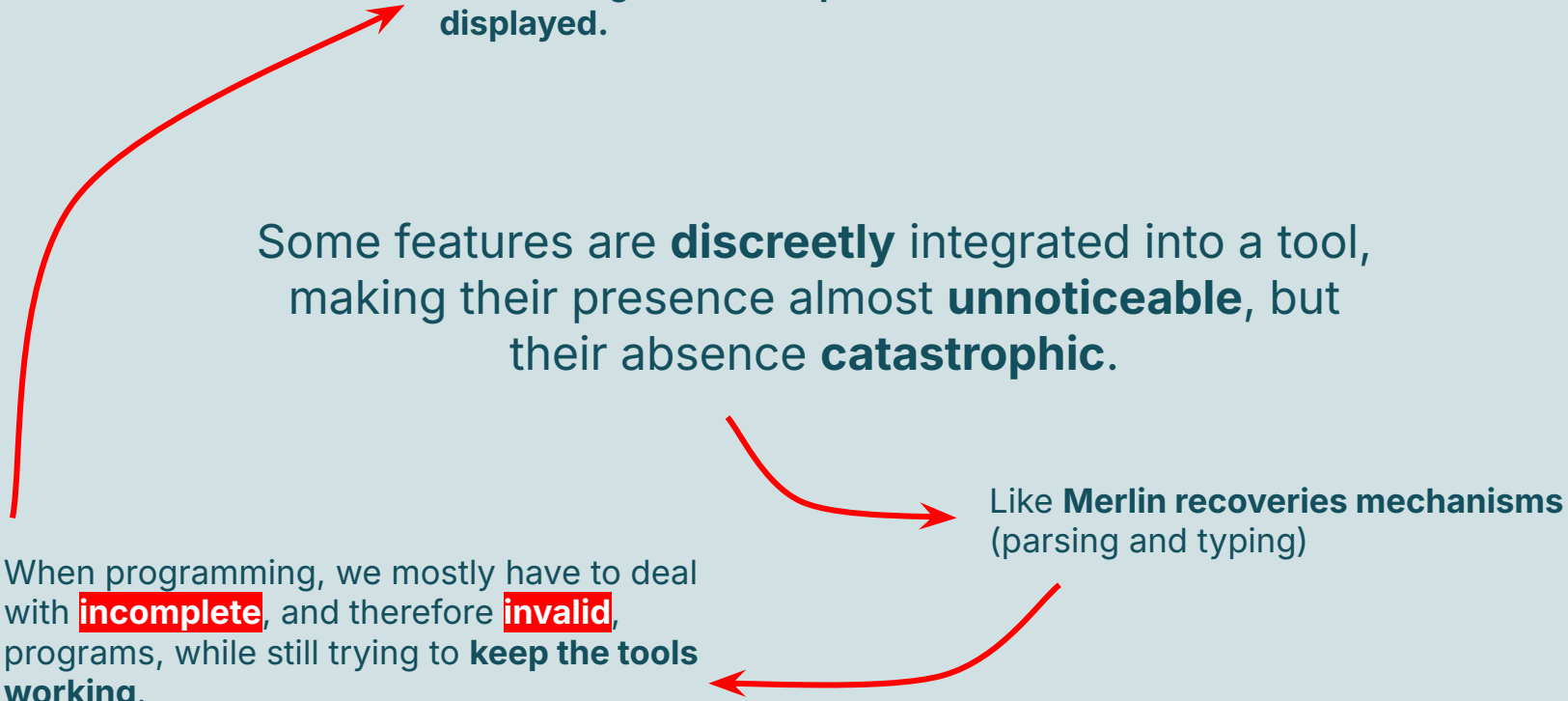

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WHAT?

Whats is Typing Recovery

WHY?

Why not keeping it into Merlin

HOW?

Design, Configuration

And last but not least: **WHERE ARE WE?**

```
let f x =
 x + 1

let g x =
 f x @ [ 1; 2; 3 ]

let h = function
 | `Foo x -> string_of_int x
 | `Bar x -> int_of_string x

let l = [ 1; 2; 3; "4"; 5; true]

type t = { x: int; y: string }

let i {x; y; z} =
 (x + int_of_string y) ^ z
```

Let's imagine the following **program**

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let f x =
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Let's imagine the following **program**

```
File "test.ml", line 5, characters 2-5:
5 |  f x @ [ 1; 2; 3 ]
     ^^
Error: This expression has type int but an expression
       was expected of type 'a list
```

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let f x =
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 f x :: [ 1; 2; 3 ]

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Let's imagine the following **program**

```
File "test.ml", line 9, characters 14-29:
9 |  |`Bar x -> int_of_string x
                ^^^^^^^^^^^^^^
Error: This expression has type int but an expression
       was expected of type string
```

```
let f x =
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Let's imagine the following **program**

```
File "test.ml", line 11, characters 19-22:
11 | let l = [ 1; 2; 3; "4"; 5; bool ]
                       ^^
Error: This constant has type string but an
       expression was expected of type int
```

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let f x =
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let i {x; y; z} =
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```

Let's imagine the following **program**

```
File "test.ml", line 11, characters 25-29:
11 | let l = [ 1; 2; 3; "4"; 5; bool ]
                            ^^^^

Error: This constant has type bool but an
       expression was expected of type int
```

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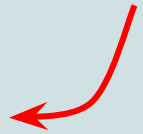
This approach is perfectly accurate.

When compiling a program where you want the most precise errors, and stopping type checking as soon as a type error is detected in a compilation unit **is perfectly reasonable for reporting precise errors.**



But when I am editing the code I problably want have **more than one-per-one error.**

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Compiling leads to the **same first error.**
Editing retrieves **more than the first error**
(accepting the price of less precises errors)

```
File "test.ml", line 5, characters 2-5:
5 |  f x @ [ 1; 2; 3 ]
     ^^^
Error: This expression has type int but an expression
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```

Here is an example using **Emacs** and **OCaml-eglot** (which **uses Merlin under the hood**)

It was working on Merlin **since almost day 1...** so

Merlin uses a patched version of the OCaml Frontend

Short Answer: because it is hard.

Why not just leave things as they are **and keep Typing Recovery in Merlin?**

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SO AT EVERY NEW OCAML'S VERSION (~6MONTHS)

Merlin's patches
(handling recoveries)

OCaml patches
(handling the rest)

Merlin

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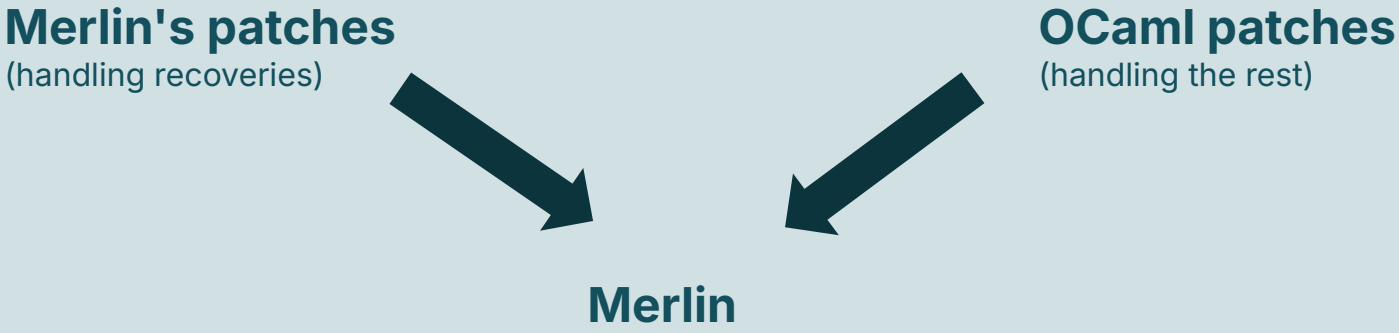

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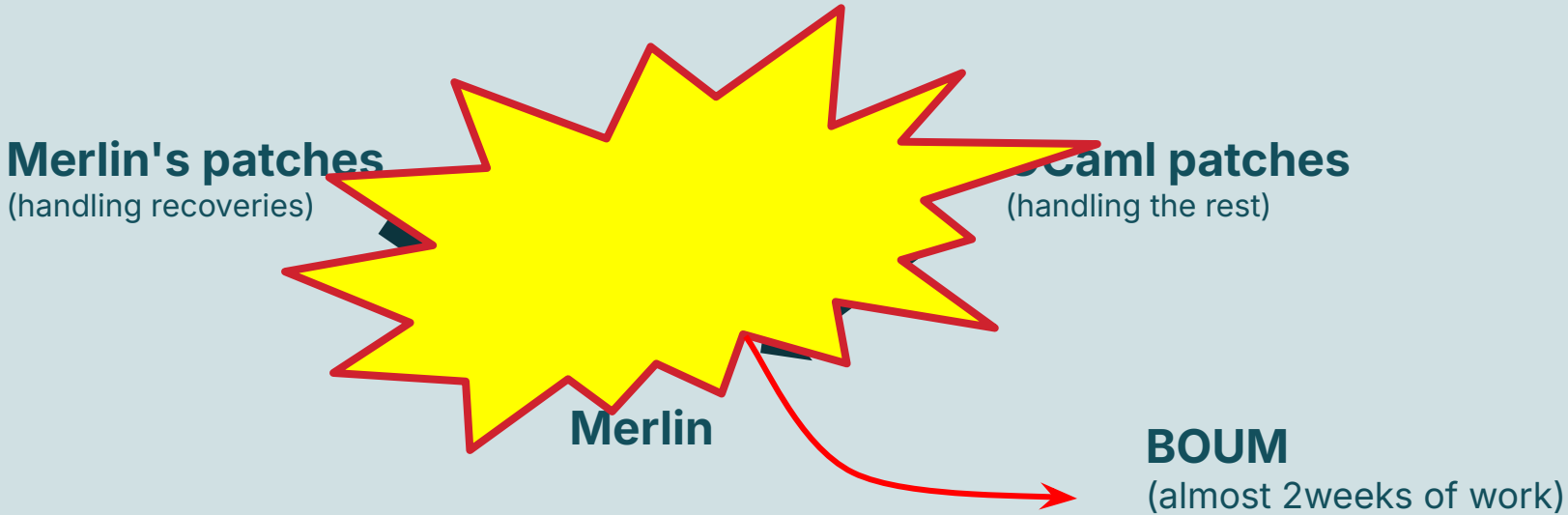

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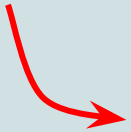

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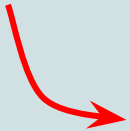

HOW?

- **Optional**
- **Systematic**
- **Simple**

THE BIG PICTURE

In Merlin, **Parsing** and **Typing** always produce a "valid" result:

- Every source produce a Parsetree (Parsing recovery)
- Every Parsetree produce a Typedtree (Typing recovery)

Make the tooling still working even on invalid buffer.

THE BIG PICTURE

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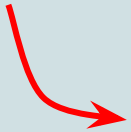

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But is **not sufficient** for producing a valid Typedtree

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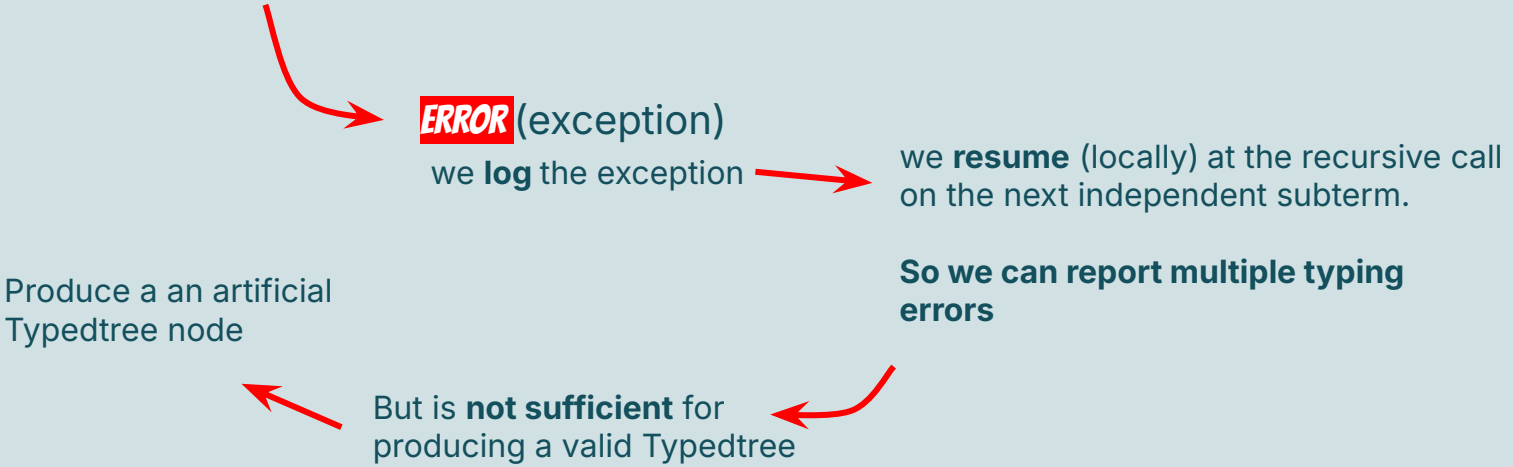

This the **Generic Recovery**
There is also **fine-grained cases** (e,g: typing record labels)

HOW TO PROCEED

A new flag **-typing-recovery** (for activating it)

The goal is to be used by Merlin and other tools
(so **not by human users**... *please*)

A SIMPLE API

Replacing Typechecking-related exception **raise** by:

- **log_and_raise** : exn → 'a
- **log_or_raise** : exn → unit

Without **-typing-recovery** they behaves exactly like **raise**

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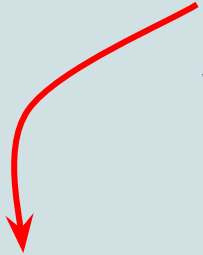

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Log the error and re-raise
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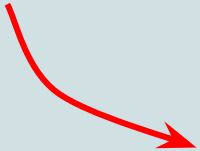

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During the re-implementation, we identify a *kind of invariant*:

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how to enforce the logging of user-facing error ?

```
exception Error of error
module Error : sig
 type exn += private In_context of error
 val log_or_raise : error -> unit
 val log_and_raise : error -> 'a
end = struct
 type exn += In_context of error

 let log_or_raise err =
   Typing_recovery.log_or_raise (In_context err)

 let log_and_raise err =
   Typing_recovery.log_and_raise (In_context err)
end
```

Let's follow the typechecker :)

We know **"When perform recovery"** but how to choose between **log_and_raise** and **log_or_raise** ?

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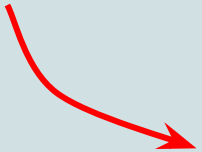

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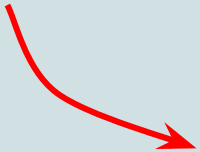

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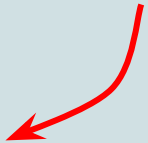

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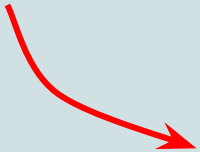

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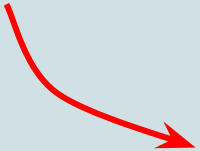

We did not find a precise approach...

WHERE ARE WE?

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the **PR** was merged and it will available in the next release of OCaml (5.6) !

Thanks to **Thomas Refis** for his **huge help and guidance** on the design, the understanding and the deep-dive review.
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We have a Merlin Branch that previews 5.6
(with a working test-suite!!!)

(It was a big migration but we know that it will drastically reduce the process for the following ones.

We can discuss more on some implementation details...

BUT THIS IS THE END. THANKS