OCaml, Batteries Included

OCaml Meeting 2009

David Teller[1], Edgar Friendly, Stefano Zacchiroli[2], Gabriel Scherer, Jérémie Dimino . . .

[1] LIFO, Université d'Orléans ⇒ MLState

[2] PPS, Université Paris 7

February 4th, 2009

Before we start

Introduction

Manipulating data

- From loops to enumerations
- Other data structures

I/O

- From Channels to I/O
- Composability
- Extensibility

Text

- From string to...
- Features

Conclusion

What makes a good language?

Safety

Expressivity

Composability

Syntax

Simplicity

Fun factor

What makes a good language?

Safety	OCaml $\surd$
Expressivity	
Composability	
Syntax	
Simplicity	
Fun factor	

What makes a good language?

Safety	OCaml $\surd$
Expressivity	OCaml $\surd$
Composability	
Syntax	
Simplicity	
Fun factor	

What makes a good language?

Safety	OCaml $\surd$
Expressivity	OCaml $\surd$
Composability	OCaml $\surd$
Syntax	
Simplicity	
Fun factor	

What makes a good language?

Safety	OCaml $\surd$
Expressivity	OCaml $\surd$
Composability	OCaml $\surd$
Syntax	OCaml $\surd$
Simplicity	
Fun factor	

What makes a good language?

Safety	OCaml $\surd$
Expressivity	OCaml $\surd$
Composability	OCaml $\surd$
Syntax	OCaml $\surd$
Simplicity	OCaml $\surd$
Fun factor	

What makes a good language?

Safety	OCaml $\surd$
Expressivity	OCaml $\surd$
Composability	OCaml $\surd$
Syntax	OCaml $\surd$
Simplicity	OCaml $\surd$
Fun factor	OCaml $\surd$

Popular languages

What about:

Java
C#
VB
Python
JS

Popular languages

What about:

	Safe
Java	ok
C#	ok
VB	bad
Python	bad
JS	bad

Popular languages

What about:

	Safe	Expressive
Java	ok	ugly
C#	ok	bad →ok
VB	bad	bad
Python	bad	ok
JS	bad	bad →ok

Popular languages

What about:

	Safe	Expressive	Composable
Java	ok	ugly	bad
C#	ok	bad →ok	ok
VB	bad	bad	bad
Python	bad	ok	good
JS	bad	bad →ok	ok

Popular languages

What about:

	Safe	Expressive	Composable	Syntax
Java	ok	ugly	bad	ugly
C#	ok	bad →ok	ok	bad
VB	bad	bad	bad	ugly
Python	bad	ok	good	good
JS	bad	bad →ok	ok	bad

Popular languages

What about:

	Safe	Expressive	Composable	Syntax	Fun
Java	ok	ugly	bad	ugly	ugly
C#	ok	bad →ok	ok	bad	ok
VB	bad	bad	bad	ugly	ugly
Python	bad	ok	good	good	good
JS	bad	bad →ok	ok	bad	good

Popular languages

What about:

	Safe	Expressive	Composable	Syntax	Fun
Java	ok	ugly	bad	ugly	ugly
C#	ok	bad $\rightarrow$ok	ok	bad	ok
VB	bad	bad	bad	ugly	ugly
Python	bad	ok	good	good	good
JS	bad	bad $\rightarrow$ok	ok	bad	good

Good $\nleftrightarrow$ Popular

Popular languages

What about:

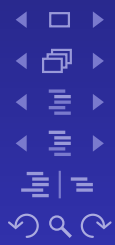
	Safe	Expressive	Composable	Syntax	Fun
Java	ok	ugly	bad	ugly	ugly
C#	ok	bad $\rightarrow$ok	ok	bad	ok
VB	bad	bad	bad	ugly	ugly
Python	bad	ok	good	good	good
JS	bad	bad $\rightarrow$ok	ok	bad	good

$$\text{Good} \nLeftrightarrow \text{Popular}$$
$$\text{OCaml} \notin \text{Popular (yet)}$$

What makes a successful language?

Maybe something like:

Well-suited library (sometimes the only available library)



What makes a successful language?

Maybe something like:

Well-suited library (sometimes the only available library)

Consistent/composable library (only one string type, only one iteration type, only one exception hierarchy...)

Extensibility (new kinds of streams may be created, virtual file system...)

Tutorials (which should be trivial to find)

What makes a successful language?

Maybe something like:

Well-suited library (sometimes the only available library)

Consistent/composable library (only one string type, only one iteration type, only one exception hierarchy...)

Extensibility (new kinds of streams may be created, virtual file system...)

Tutorials (which should be trivial to find)

either

Fun factor

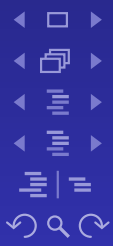
or

Public relations (either a company or open-source buzz)

And in OCaml?

And in OCaml?

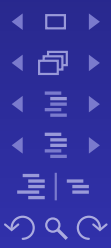
Well-suited library Low-level library in a high-level language. Minimal library sufficient for testing, not necessarily for development.



And in OCaml?

Well-suited library Low-level library in a high-level language. Minimal library sufficient for testing, not necessarily for development.

Consistent/composable library How do I convert a stream to a list? How do I map a stream or an I/O or a hashtable? How should I represent Unicode strings?

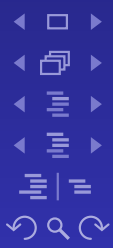


And in OCaml?

Well-suited library Low-level library in a high-level language. Minimal library sufficient for testing, not necessarily for development.

Consistent/composable library How do I convert a stream to a list? How do I map a stream or an I/O or a hashtable? How should I represent Unicode strings?

Extensibility Camlp4/Camlp5 ok. But how do I add new kinds of I/O? How do I create new streams?



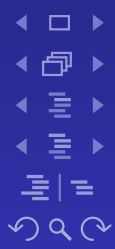
And in OCaml?

Well-suited library Low-level library in a high-level language. Minimal library sufficient for testing, not necessarily for development.

Consistent/composable library How do I convert a stream to a list? How do I map a stream or an I/O or a hashtable? How should I represent Unicode strings?

Extensibility Camlp4/Camlp5 ok. But how do I add new kinds of I/O? How do I create new streams?

Tutorials Whole-language tutorials ok. Task-specific languages not so ok. Plus newbies need to find them.



And in OCaml?

Well-suited library Low-level library in a high-level language. Minimal library sufficient for testing, not necessarily for development.

Consistent/composable library How do I convert a stream to a list? How do I map a stream or an I/O or a hashtable? How should I represent Unicode strings?

Extensibility Camlp4/Camlp5 ok. But how do I add new kinds of I/O? How do I create new streams?

Tutorials Whole-language tutorials ok. Task-specific languages not so ok. Plus newbies need to find them.

Fun factor Oh, yeah. Despite competition with Haskell.

And in OCaml?

Well-suited library Low-level library in a high-level language. Minimal library sufficient for testing, not necessarily for development.

Consistent/composable library How do I convert a stream to a list? How do I map a stream or an I/O or a hashtable? How should I represent Unicode strings?

Extensibility Camlp4/Camlp5 ok. But how do I add new kinds of I/O? How do I create new streams?

Tutorials Whole-language tutorials ok. Task-specific languages not so ok. Plus newbies need to find them.

Fun factor Oh, yeah. Despite competition with Haskell.

Public relations Insufficient. Despite competition with Haskell.

What can we improve?

Well-suited library Build a high-level library.

What can we improve?

Well-suited library Build a high-level library.

Consistent/composable library Add base abstractions & data structures, uniformize interfaces.

What can we improve?

Well-suited library Build a high-level library.

Consistent/composable library Add base abstractions & data structures, uniformize interfaces.

Extensibility Liberate the base data structures!

What can we improve?

Well-suited library Build a high-level library.

Consistent/composable library Add base abstractions & data structures, uniformize interfaces.

Extensibility Liberate the base data structures!

Tutorials Improve documentation.

What can we improve?

Well-suited library Build a high-level library.

Consistent/composable library Add base abstractions & data structures, uniformize interfaces.

Extensibility Liberate the base data structures!

Tutorials Improve documentation.

Fun factor Can always be improved. Cabal?

What can we improve?

Well-suited library Build a high-level library.

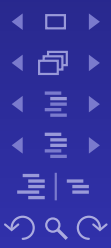
Consistent/composable library Add base abstractions & data structures, uniformize interfaces.

Extensibility Liberate the base data structures!

Tutorials Improve documentation.

Fun factor Can always be improved. Cabal?

Public relations OCaml Developer Days, OCamlCore.org, books, teaching, etc.



Introducing

OCaml Batteries Included

Our objectives

A distribution of OCaml with

- Newbie-oriented documentation.
- More comfortable syntax.
- Consistent and high-level API.
- Extensible data structures.

Our objectives

A distribution of OCaml with

- Newbie-oriented documentation.
- More comfortable syntax.
- Consistent and high-level API.
- Extensible data structures.
- More fun!

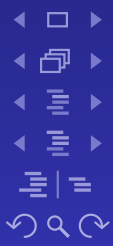
How?

API Existing libraries + uniformization “glue layer”.

Language Syntax extensions, auto-loaded.

Toolchain Existing tools + transparent shell scripts.

Documentation Largely rewritten + new doclet.



How?

API Existing libraries + uniformization “glue layer”.

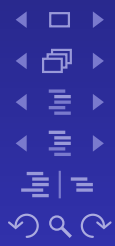
Language Syntax extensions, auto-loaded.

Toolchain Existing tools + transparent shell scripts.

Documentation Largely rewritten + new doclet.

Improve the user experience, don’t reinvent the wheel!

Don’t turn OCaml into Java!



How?

API Existing libraries + uniformization “glue layer”.

Language Syntax extensions, auto-loaded.

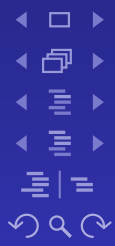
Toolchain Existing tools + transparent shell scripts.

Documentation Largely rewritten + new doclet.

Improve the user experience, don’t reinvent the wheel!

Don’t turn OCaml into Java!

Built on top of the Base library and ExtLib.



Step 1

Objective Simplify and uniformize data structure access.

Objective Decrease need for multi-paradigm for simple tasks.

What is this `for`?

OCaml has

built-in specialized loops `for`, `while`

data structure-based loops `List.iter`, `List.fold_left`, `List.fold_right`, `List.map`...

built-in general loops `let rec`

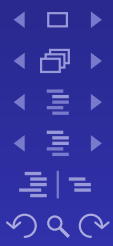
What is this `for`?

OCaml has

built-in specialized loops `for`, `while` (very specialized, very optimized)

data structure-based loops `List.iter`, `List.fold_left`, `List.fold_right`, `List.map`...

built-in general loops `let rec`



What is this `for`?

OCaml has

built-in specialized loops `for`, `while` (very specialized, very optimized)

data structure-based loops `List.iter`, `List.fold_left`, `List.fold_right`, `List.map`... (requires data structure, not homogeneous among structures)

built-in general loops `let rec`

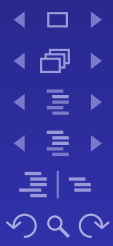
What is this `for`?

OCaml has

built-in specialized loops `for`, `while` (very specialized, very optimized)

data structure-based loops `List.iter`, `List.fold_left`, `List.fold_right`, `List.map`... (requires data structure, not homogeneous among structures)

built-in general loops `let rec` (general mechanism for implementing loops)



What is this `for`?

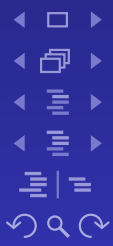
OCaml has

built-in specialized loops `for`, `while` (very specialized, very optimized)

data structure-based loops `List.iter`, `List.fold_left`, `List.fold_right`, `List.map`... (requires data structure, not homogeneous among structures)

built-in general loops `let rec` (general mechanism for implementing loops)

- Specialized loops are optimizations.
- `let rec` is (among other things) an extension mechanism.



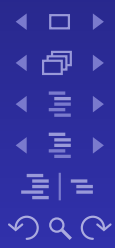
Enter enumerations

Overview Lightweight iterators, aka "like `Stream.t`, but open".

Enter enumerations

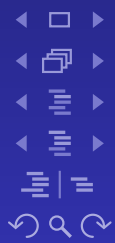
Overview Lightweight iterators, aka "like `Stream.t`, but open".

Operations `foreach/iter`, `map`, `fold`, `scanl`, `filter`, `flatten`



Enter enumerations

Overview	Lightweight iterators, aka "like `Stream.t`, but open".
Operations	`foreach`/`iter`, `map`, `fold`, `scanl`, `filter`, `flatten`
Conversion	`List.enum`/`List.backwards`/ `Array.enum`/`Array.backwards`/ `Hashtbl.enum`/`Hashtbl.keys`/`Hashtbl.values`/ `String.enum`/`String.backwards`/ ...
Construction	`( - )`, `( -- )` , `( ~~~ )`, `unfold`, etc.
Source	ExtLib, SDFlow, new stuff



Examples

Exercise Count from 1 to 10.

Examples

Exercise Count from 1 to 10.

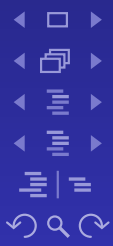
```
1 -- 10
```


Examples

Exercise Count from 1 to 10.

```
1 -- 10
```

Exercise Print all elements between 1 to 10.



Examples

Exercise Count from 1 to 10.

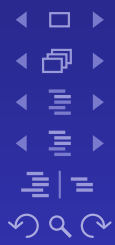
```
1 -- 10
```

Exercise Print all elements between 1 to 10.

```
let print_intln x =
        print_int x;
        print_newline ();;
foreach ( 1 -- 10 ) print_intln
```

Examples (2)

Exercise Print the square numbers of all odd numbers between 1 and 100, by decreasing order.



Examples (2)

Exercise Print the square numbers of all odd numbers between 1 and 100, by decreasing order.

```
let square x = x * x
and odd    x = x mod 2 = 1
in
foreach ( map square ( ( 100 --- 1 ) // odd) )
  print_intln
```

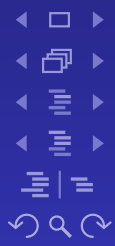
Examples (2)

Exercise Print the square numbers of all odd numbers between 1 and 100, by decreasing order.

```
let square x = x * x
and odd    x = x mod 2 = 1
in
foreach ( map square ( ( 100 --- 1 ) // odd) )
  print_intln
```

Did I mention syntax extensions?

```
foreach [? x*x | x <- ( 100 --- 1 ); x mod 2 = 1]
  print_intln
```

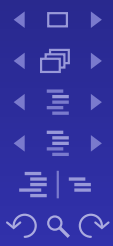
Examples (3)

Exercise Keep only the vowels of "OCaml is too cool for school".

Examples (3)

Exercise Keep only the vowels of "OCaml is too cool for school".

```
let too_cool = "OCaml is too cool for school" in
String.of_enum(
(String.enum too_cool) //
  (function 'a'|'e'|'i'|'o'|'u'
            |'A'|'E'|'I'|'O'|'U' -> true
            |  _                 -> false))
```

Examples (3)

Exercise Keep only the vowels of "OCaml is too cool for school".

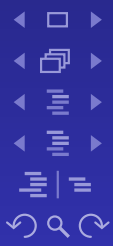
```
let too_cool = "OCaml is too cool for school" in
String.of_enum(
(String.enum too_cool) //
  (function 'a'|'e'|'i'|'o'|'u'
           |'A'|'E'|'I'|'O'|'U' -> true
           |  _                 -> false))
```

Syntax extensions, again:

```
[? String : x | x <- String : too_cool ; vowel x]
where vowel = function 'a'|'e'|'i'|'o'|'u'
              |'A'|'E'|'I'|'O'|'U' -> true
              |  _                 -> false
```


Other data structures

- Doubly-linked lists, defunctorized polymorphic maps, multi-maps, dynamic arrays, lazy lists, defunctorized polymorphic sets, ...

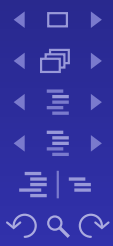


Other data structures

- Doubly-linked lists, defunctorized polymorphic maps, multi-maps, dynamic arrays, lazy lists, defunctorized polymorphic sets, ...
- Upgraded lists, arrays, big arrays, hashtables, queues, stacks, maps, sets.

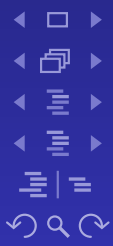
Other data structures

- Doubly-linked lists, defunctorized polymorphic maps, multi-maps, dynamic arrays, lazy lists, defunctorized polymorphic sets, ...
- Upgraded lists, arrays, big arrays, hashtables, queues, stacks, maps, sets.
- Everything supports Sexplib, printing, enumerations, etc.



Other data structures

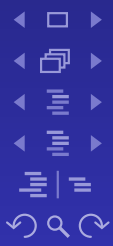
- Doubly-linked lists, defunctorized polymorphic maps, multi-maps, dynamic arrays, lazy lists, defunctorized polymorphic sets, ...
- Upgraded lists, arrays, big arrays, hashtables, queues, stacks, maps, sets.
- Everything supports Sexplib, printing, enumerations, etc.
- Most things support comprehension.



Channels are closed

```
Jan 30 00:50:25 <sanguinev>     Is there a way to make an output_channel that just
                                accepts output and doesn't do anything?
Jan 30 00:51:23 <brendan>       open_out "/dev/null" ?
Jan 30 00:54:00 <sanguinev>     brendan: I am looking for something that won't require
                                a file/any specified location.
Jan 30 00:54:47 <Yoric[DT]>     Shameless plug: with Batteries, it's possible.
Jan 30 00:55:14 <Yoric[DT]>     (other than that, you could trick it with a pipe, but
                                that's much more complicated than /dev/null)
Jan 30 00:55:50 <sanguinev>     Yoric[DT]: I am hoping for something nice and system
                                agnostic so I can run the same code on linux/unix/
                                mac OSx/cygwin...
```

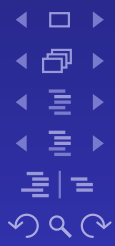
...



Channels are closed

```
Jan 30 00:50:25 <sanguinev>     Is there a way to make an output_channel that just
                                accepts output and doesn't do anything?
Jan 30 00:51:23 <brendan>       open_out "/dev/null" ?
Jan 30 00:54:00 <sanguinev>     brendan: I am looking for something that won't require
                                a file/any specified location.
Jan 30 00:54:47 <Yoric[DT]>     Shameless plug: with Batteries, it's possible.
Jan 30 00:55:14 <Yoric[DT]>     (other than that, you could trick it with a pipe, but
                                that's much more complicated than /dev/null)
Jan 30 00:55:50 <sanguinev>     Yoric[DT]: I am hoping for something nice and system
                                agnostic so I can run the same code on linux/unix/
                                mac OSx/cygwin...
```

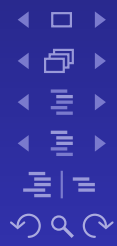
... Also, can't filter/map/... on channels.



Channels are closed

```
Jan 30 00:50:25 <sanguinev>     Is there a way to make an output_channel that just
                                accepts output and doesn't do anything?
Jan 30 00:51:23 <brendan>       open_out "/dev/null" ?
Jan 30 00:54:00 <sanguinev>     brendan: I am looking for something that won't require
                                a file/any specified location.
Jan 30 00:54:47 <Yoric[DT]>     Shameless plug: with Batteries, it's possible.
Jan 30 00:55:14 <Yoric[DT]>     (other than that, you could trick it with a pipe, but
                                that's much more complicated than /dev/null)
Jan 30 00:55:50 <sanguinev>     Yoric[DT]: I am hoping for something nice and system
                                agnostic so I can run the same code on linux/unix/
                                mac OSx/cygwin...
```

... Also, can't filter/map/... on channels. Shameless plug #2: channel `#ocaml` is open, though.



What's going on?

OCaml's `in_channel`/`out_channel` are

- operating system-level
- tied to the Unix model
- closed.

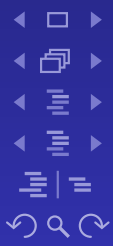
Enter input/output

Overview Drop-in replacement for `in_channel`/`out_channel` operations.

Enter input/output

Overview Drop-in replacement for `in_channel`/`out_channel` operations.

Operations All the usual operations, plus i/o filters, position, callbacks, Unicode, auto-flushing...



Enter input/output

Overview Drop-in replacement for `in_channel`/`out_channel` operations.

Operations All the usual operations, plus i/o filters, position, callbacks, Unicode, auto-flushing...

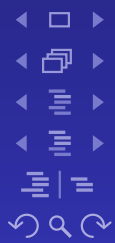
Conversion To/from enumerations, strings, file names, sockets, processes...

Construction `File.open_in`/`open_out`, `wrap_in`/`wrap_out`...

Source ExtLib, OCamlNet, Camomile, more stuff

Let's do it with Batteries

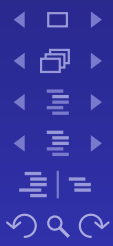
Exercise Let's implement cat with Batteries.



Let's do it with Batteries

Exercise Let's implement cat with Batteries.

```
open IO, File
foreach (args ())
  (fun s -> copy (open_in s) stdout)
```

Let's do it with Batteries

Exercise Let's implement cat with Batteries.

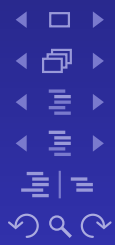
```
open IO, File
foreach (args ())
  (fun s -> copy (open_in s) stdout)
```

or

```
foreach (args ()) **>
  fun s -> copy (open_in s) stdout
```

Let's do it with Batteries (2)

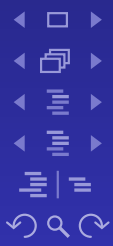
Exercise Now, let's implement a version of `cat` which prints line numbers along with line contents.



Let's do it with Batteries (2)

Exercise Now, let's implement a version of `cat` which prints line numbers along with line contents.

```
open IO
foreach (args ()) (fun s ->
 Enum.iteri
  (Printf.printf "%d %s\n")
 (File.lines_of s)
)
```

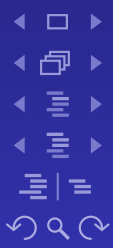



Let's do it with Batteries (2)

Exercise Now, let's implement a version of `cat` which prints line numbers along with line contents.

```
open IO
foreach (args ()) (fun s ->
 Enum.iteri
  (Printf.printf "%d %s\n")
 (File.lines_of s)
)
```

In this last version, a file was automatically opened, read (lazily), split into lines and closed.



Going further

Exercise Add gzip-decompression.

Going further

Exercise Add gzip-decompression.

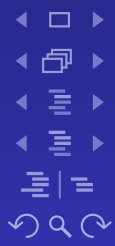
```
open IO
foreach (args ()) (fun s ->
 Enum.iteri
    (Printf.printf "%d %s\n")
    (lines_of (GZip.uncompress (File.open_in s)))
)
```


Going further

Exercise Add gzip-decompression.

```
open IO
foreach (args ()) (fun s ->
 Enum.iteri
    (Printf.printf "%d %s\n")
    (lines_of (GZip.uncompress (File.open_in s)))
)
```

Exercise Count number of bytes read.



Going further

Exercise Add gzip-decompression.

```
open IO
foreach (args ()) (fun s ->
 Enum.iteri
   (Printf.printf "%d %s\n")
   (lines_of (GZip.uncompress (File.open_in s)))
)
```

Exercise Count number of bytes read.

```
foreach (args ()) (fun s ->
 let (inp, pos) = pos_in (File.open_in s) in
 Enum.iteri
   (Printf.printf "%d %s\n")
   (lines_of (GZip.uncompress inp));
 Printf.printf "\tRead %d bytes\n" (pos ())
)
```

Going further

Exercise Add gzip-decompression.

```
open IO
foreach (args ()) (fun s ->
 Enum.iteri
   (Printf.printf "%d %s\n")
   (lines_of (GZip.uncompress (File.open_in s)))
)
```

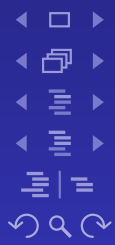
Exercise Count number of bytes read.

```
foreach (args ()) (fun s ->
 let (inp, pos) = pos_in (File.open_in s) in
 Enum.iteri
   (Printf.printf "%d %s\n")
   (lines_of (GZip.uncompress inp));
 Printf.printf "\tRead %d bytes\n" (pos ())
)
```

etc.

I/O is open

Want to read from a string, a socket, an http connexion, etc?



I/O is open

Want to read from a string, a socket, an http connexion, etc?
Writing new inputs/outputs is easy.

```
val create_in:
  read:(unit -> char) ->
  input:(string -> int -> int -> int) ->
  close:(unit -> unit) ->
  input
val wrap_in:
  read:(unit -> char) ->
  input:(string -> int -> int -> int) ->
  close:(unit -> unit) ->
  underlying:(input list) ->
  input
```

Introduction

Manipulating data

- From loops to enumerations
- Other data structures

I/O

- From Channels to I/O
- Composability
- Extensibility

Text

- From string to...
- Features

Conclusion

The problem with strings

Strings are mutable, hence:

difficult to trust

slooow to append.

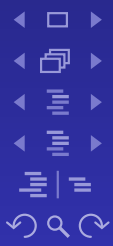
The problem with strings

Strings are mutable, hence:

- difficult to trust
- slooow to append.

Strings are arrays of `char`, hence:

- confuse *characters* and *bytes*
- have no clear notion of encoding.

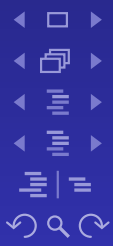


Introducing ropes

```
r"This is a UTF-8 encoded rope"
```

Overview Functional UTF-8 encoded text with $\mathcal{O}(ln(n))$ concatenation but slower `get`.

Limitations About 700Mb in 32-bit, about 220Gb in 64-bit.



Introducing ropes

```
r"This is a UTF-8 encoded rope"
```

Overview Functional UTF-8 encoded text with $\mathcal{O}(ln(n))$ concatenation but slower `get`.

Limitations About 700Mb in 32-bit, about 220Gb in 64-bit.

Operations All the operations of `String` except mutability.

Introducing ropes

```
r"This is a UTF-8 encoded rope"
```

Overview Functional UTF-8 encoded text with $\mathcal{O}(ln(n))$ concatenation but slower `get`.

Limitations About 700Mb in 32-bit, about 220Gb in 64-bit.

Operations All the operations of `String` except mutability.

Conversion `Rope.of_latin1`, `Rope.of_uchar`, ...

Introducing ropes

```
r"This is a UTF-8 encoded rope"
```

Overview Functional UTF-8 encoded text with $\mathcal{O}(ln(n))$ concatenation but slower `get`.

Limitations About 700Mb in 32-bit, about 220Gb in 64-bit.

Operations All the operations of `String` except mutability.

Conversion `Rope.of_latin1`, `Rope.of_uchar`, ...

Notes Allocation optimized (with Camlp4!), immutable implementation.

Introducing string with capabilities

```
ro"... a read-only Latin-1 string";;
wo"... a write-only Latin-1 string";;
rw"... a read-write Latin-1 string";;
```

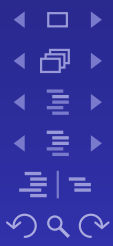
Overview Your usual strings, but with phantom types to ensure read-only/write-only/read-write capability.

Introducing string with capabilities

```
ro"... a read-only Latin-1 string";;
wo"... a write-only Latin-1 string";;
rw"... a read-write Latin-1 string";;
```

Overview Your usual strings, but with phantom types to ensure read-only/write-only/read-write capability.

Operations All the operations of `String`.



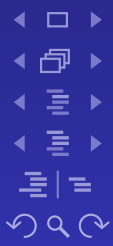
Introducing string with capabilities

```
ro"... a read-only Latin-1 string";;
wo"... a write-only Latin-1 string";;
rw"... a read-write Latin-1 string";;
```

Overview Your usual strings, but with phantom types to ensure read-only/write-only/read-write capability.

Operations All the operations of `String`.

Notes Optimized allocation for read-only strings.



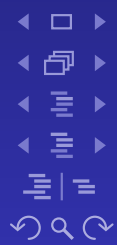
Exercise

Exercise From a string `s`, return the first 5 characters, skip the next 3, then return the next 5 characters, the next 5 characters and the rest of the string.

Exercise

Exercise From a string `s`, return the first 5 characters, skip the next 3, then return the next 5 characters, the next 5 characters and the rest of the string.

```
let hairsplit s =
 open String in
 let e = enum s in
  [? List : of_enum (f e) | f <- List :
   [take 5; skip 3 |- take 5; take 5; identity]]
```

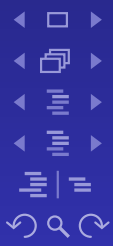



Exercise

Exercise From a string `s`, return the first 5 characters, skip the next 3, then return the next 5 characters, the next 5 characters and the rest of the string.

```
let hairsplit s =
 open String in
 let e = enum s in
  [? List : of_enum (f e) | f <- List :
   [take 5; skip 3 |- take 5; take 5; identity]]
```

Exercise Same thing, but with Unicode.



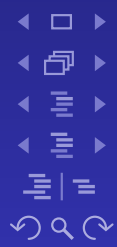
Exercise

Exercise From a string s, return the first 5 characters, skip the next 3, then return the next 5 characters, the next 5 characters and the rest of the string.

```
let hairsplit s =
 open String in
 let e = enum s in
  [? List : of_enum (f e) | f <- List :
   [take 5; skip 3 |- take 5; take 5; identity]]
```

Exercise Same thing, but with Unicode.

```
let hairsplit s =
 open Rope in
 let e = enum s in
  [? List : of_enum (f e) | f <- List :
   [take 5; skip 3 |- take 5; take 5; identity]]
```

Text features, too

All these data structures support

- iteration, map, folds, filters, replacement, enumeration, construction from enumeration, searching from left to right, from right to left, from a given index, chopping, trimming, stripping, upper/lowercasing, splitting, slicing, splicing, etc.
- printing
- transcoding
- pattern-matching.

Enough for one day

Let's not detail

- uniform number modules for functorization
- safe integers
- enumerable signature
- on-line help
- documentation by topics
- mostly flat module-space
- overlay modules for labels or exceptionless error management
- the Future module
- printing
- marshaling
- substrings
- path management
- package management
- calling the compilers from a module
- ...

Status

Latest version Alpha 3 for OCaml 3.10/3.11 being bugsquashed.

Site `http://batteries.forge.ocamlcore.org`.

License Mostly LGPL + LE, bits in BSD.

Availability Tarball, GODI package.

Tools ocaml, ocamlc, ocamlopt, ocamlcp, ocamlbuild.

Size 27,650 loc signatures, 24,407 loc implementations.

Next version Beta 1, expected ca. March.

Status

Latest version Alpha 3 for OCaml 3.10/3.11 being bugsquashed.

Site `http://batteries.forge.ocamlcore.org`.

License Mostly LGPL + LE, bits in BSD.

Availability Tarball, GODI package.

Tools ocaml, ocamlc, ocamlopt, ocamlcp, ocamlbuild.

Size 27,650 loc signatures, 24,407 loc implementations.

Next version Beta 1, expected ca. March.

Testing needed!

Status

Latest version Alpha 3 for OCaml 3.10/3.11 being bugsquashed.

Site `http://batteries.forge.ocamlcore.org`.

License Mostly LGPL + LE, bits in BSD.

Availability Tarball, GODI package.

Tools ocaml, ocamlc, ocamlopt, ocamlcp, ocamlbuild.

Size 27,650 loc signatures, 24,407 loc implementations.

Next version Beta 1, expected ca. March.

Testing needed!

Applications Extrapol static analyzer for C.

Batteries for new apps

Larger standard library No more reimplementing lazy lists or standard operators or trivial list functions.

Higher-level library More composability, more extensibility, etc.

Syntactic sugar More readable algorithms.

Batteries for new apps

Larger standard library No more reimplementing lazy lists or standard operators or trivial list functions.

Higher-level library More composability, more extensibility, etc.

Syntactic sugar More readable algorithms.

Fun!

Batteries for newbies

Documentation More examples, on-line help.

Uniformity Modules follow more rigorous patterns and should be easier to learn.

Purity Going imperative is less often necessary.

Batteries for newbies

Documentation More examples, on-line help.

Uniformity Modules follow more rigorous patterns and should be easier to learn.

Purity Going imperative is less often necessary.

Fun!

Batteries for new libraries

Conventions Standard signatures, obsolete primitives, etc.

Batteries for new libraries

Conventions Standard signatures, obsolete primitives, etc.

Better composition

Fun!

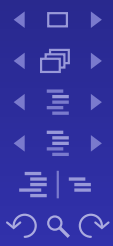
Batteries for new libraries

Conventions Standard signatures, obsolete primitives, etc.

Better composition

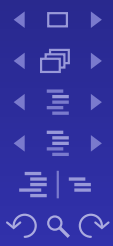
Fun!

Essentially, please consider compatibility with Batteries for your next libraries.



Problems to solve

- Huge binary size.
- Toplevel pretty-printers.
- Confusing error messages.
- Operator precedence for $\triangleleft$, $\triangleright$.
- One-tarball distribution? Symbiosis?



In the future

- More OCamlNet (β).
- Preferences (β).
- Pa-do (β).

In the future

- More OCamlNet (β).
- Preferences (β).
- Pa-do (β).
- Logging.
- Relooking the documentation with iframes.
- Locales.
- Optimizations (eg strings).
- CoThreads.

In the future

- More OCamlNet (β).
- Preferences (β).
- Pa-do (β).
- Logging.
- Relooking the documentation with iframes.
- Locales.
- Optimizations (eg strings).
- CoThreads.
- oUnit?
- CamlGraph?
- AST/bytecode generation?
- Functional unparsing with Camlp4 support?
- Graphics? Cairo? Some UI toolkit?
- OS integration?

In the future

- More OCamlNet (β).
- Preferences (β).
- Pa-do (β).
- Logging.
- Relooking the documentation with iframes.
- Locales.
- Optimizations (eg strings).
- CoThreads.
- oUnit?
- CamlGraph?
- AST/bytecode generation?
- Functional unparsing with Camlp4 support?
- Graphics? Cairo? Some UI toolkit?
- OS integration?
- Don't hesitate to use our Request for Features tracker.

In the future

- More OCamlNet (β).
- Preferences (β).
- Pa-do (β).
- Logging.
- Relooking the documentation with iframes.
- Locales.
- Optimizations (eg strings).
- CoThreads.
- oUnit?
- CamlGraph?
- AST/bytecode generation?
- Functional unparsing with Camlp4 support?
- Graphics? Cairo? Some UI toolkit?
- OS integration?
- Don't hesitate to use our Request for Features tracker.
- **And** our bug tracker, of course.

Thank you

Questions?

If you're...

- A PhD, a PhD student or a future PhD student.
- Into OCaml, similar languages or Coq.
- Into compilers, concurrency, distributed systems, semantics, proof of programs.
- Into language tools, language front-ends, language design.
- Interested by safe programming for the web.

If you're...

- A PhD, a PhD student or a future PhD student.
- Into OCaml, similar languages or Coq.
- Into compilers, concurrency, distributed systems, semantics, proof of programs.
- Into language tools, language front-ends, language design.
- Interested by safe programming for the web.

Contact me/us: MLState may have a job/PhD/internship for you.