Practical Generic Programming with OCaml

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Instead of this . . .

```
type α tree = Node of α | Branch of (α tree) × (α tree)

val show_tree : (α → string) → (α tree → string)
let rec show_tree show_a = function
  Node a -> "Node " ^ show_a a
| Branch (l, r) -> "Branch ("^ show_tree l ^ ","
                             ^ show_tree r ^ ")"

show_list (show_pair (show_tree show_int) show_bool) t
```

You can write this!

```
type α tree = Node of α | Branch of (α tree) × (α tree)
  deriving (Show)
```

```
Show.show<(int tree * bool) list> t
```

Outline

Haskell type classes as OCaml modules[1]

```
class Show a where
  show :: a → String
```

```
module type Show = sig
  type a
  val show : a → string
end
```

Type class as signature

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[1] Dreyer, Harper, Chakravarty and Keller. *Modular Type Classes* (POPL 07)

Haskell type classes as OCaml modules

```
instance Show Int where
  show = showInt
```

```
module ShowInt
  : Show with type a = int =
struct
  type a = int
  let show = string_of_int
end
```

Instance as structure

Haskell type classes as OCaml modules

```
instance (Show a) => Show [a]
 where show l = "[" ++
    intersperse "," (map show l)
    ++ "]"
```

```
module ShowList (A : Show)
 : Show with type a = A.a list =
struct
  type a = A.a list
  let show l = "[" ^
   concat "," (map A.show l)
   ^ "]"
end
```

Parameterized instance as functor

Haskell type classes as OCaml modules

```
data Tree α = Node α
       | Branch (Tree α) (Tree α)
  deriving (Show)
```

```
type α tree = Node of α
       | Branch of (α tree) × (α tree)
  deriving (Show)
```

Haskell type classes as OCaml modules

```
data Tree α = Node α
       | Branch (Tree α) (Tree α)
  deriving (Show)
```

$\leadsto$

```
instance Show a => Show (Tree a)
   where
     show = ...
```

```
type α tree = Node of α
       | Branch of (α tree) × (α tree)
  deriving (Show)
```

Haskell type classes as OCaml modules

```
data Tree α = Node α
       | Branch (Tree α) (Tree α)
  deriving (Show)
⇝
instance Show a => Show (Tree a)
   where
     show = ...
```

```
type α tree = Node of α
       | Branch of (α tree) × (α tree)
  deriving (Show)
⇝
module Show_tree (A : Show)
 : Show with type a = A.a tree =
struct
  type a = A.a tree
  let show = ...
end
```

Haskell type classes as OCaml modules

`show t`

`Show.show<`τ`> t`

Outline

Basic idea

Customization

More customization: pickling

Conclusions

Customization

```
type intset = int list
   deriving (Show)
```

```
Show.show<intset> [4; 1; 2; 3] ⟹ "[4; 1; 2; 3]"
```

Customization

```
type intset = int list

module Show_intset
  : Show.Show with type a = intset =
Show.Defaults(struct
  let format fmt t =
    Format.fprintf fmt "{%s}"
      (concat "," (map Show.show<int> (sort compare t)))
end)
```

`Show.show<intset> [4; 1; 2; 3]` $\Longrightarrow$ `"{1, 2, 3, 4}"`

Outline

Basic idea

Customization

More customization: pickling

Conclusions

More customization: pickling

- The “Pickle” class marshals values
- Pickle preserves and increases sharing wherever possible
- Sharing detection depends on the definition of equality
- We can customize pickling by customizing equality

What is equality?

- For values?
- For references?
- For functions?
- For user-defined types?

Sharing λ terms

```
type name = string
  deriving (Eq, Typeable, Pickle)
```

```
type exp = Var of name
         | App of exp × exp
         | Lam of name × exp
  deriving (Eq, Typeable, Pickle)
```

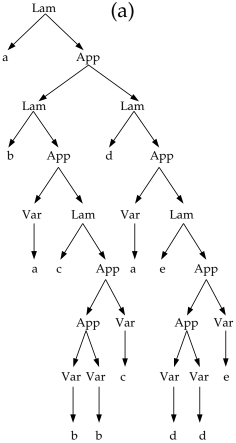
Sharing λ terms

```
type name = string
  deriving (Typeable, Pickle)
```

```
module Eq_name
 : Eq.Eq with type a = name =
struct
  type a = name
  let eq = (=)
end
```

```
type exp = Var of name
         | App of exp × exp
         | Lam of name × exp
  deriving (Typeable, Pickle)
```

```
module Eq_exp
: Eq.Eq with type a = name =
struct
  type a = exp
  let eq l r =
    (* α-equivalence *)
    ...
end
```


(a)
Lam
a
App
Lam
Lam
b
App
d
App
Var
Lam
Var
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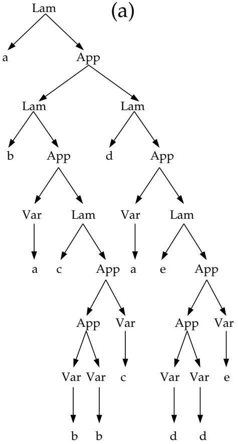
(a)
Lam
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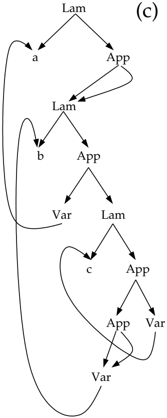
(c)
Lam
a
App
Lam
b
App
Var
Lam
c
App
App
Var
Var

Outline

Who can use *deriving*?

Regular users	*use* generic functions
Advanced users	*customize* generic functions
Experts	*write* generic functions

Coverage

Supported:

- base types
- variants
- tuples
- records
- mutable types
- polymorphic variants
- type aliases
- parameterized types
- (mutually) recursive types
- modules
- constraints (a bit)
- private types
- type replication

Not supported:

- non-regular recursion
- polymorphic record fields
- class types
- private rows

Remaining work

- more classes
- user-defined overloaded functions (not class methods)

```
(* print : Show α ⇒ α → unit *)
let print<a:Show> v = print_endline (show<a> v)
```

Thank you!

`http://code.google.com/p/deriving`
(or google “ocaml” and “deriving”)