Formlets

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The Adventure of the Absent Abstraction

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Three Tiers

Browser (HTML, XML, JavaScript)

Server (Java, Perl, PHP, Python, Ruby)

Database (SQL, XQuery)
Links: Web Programming without Tiers
Links, before formlets

```ocaml
let request : Xml =
<form l:action="{
    let start = make_date(string_to_int(sm),
        string_to_int(sd)) in
    let finish = make_date(string_to_int(fm),
        string_to_int(fd)) in
    response(start,finish)
}">
    Start: month <input l:name="{sm}"/>
    day   <input l:name="{sd}"/>
    Finish: month <input l:name="{fm}"/>
    day   <input l:name="{fd}"/>
    <input type="submit" value="Submit"/>
</form>
```
iData For The World Wide Web
Programming Interconnected Web Forms

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counterIData :: IDataId Int → IDataFun Int
counterIData iDataId i = mkIData iDataId i ibm
where ibm = { toView = λn v → useOldView (n,down,up) v
, updView = λ_ v → updCounter v
, fromView = λ_ (n,_,_) → n
, resetView = Nothing }
(up,down) = (LButton (defpixel / 6) "+",LButton (defpixel / 6) "-"

updCounter :: Counter → Counter
updCounter (n,Pressed,_) = (n - 1,down,up)
updCounter (n,_,Pressed) = (n + 1,down,up)
updCounter noPresses = noPresses

useOldView new (Just old) = old
useOldView new Nothing = new
The Essence of Form Abstraction*

Ezra Cooper, Sam Lindley, Philip Wadler, and Jeremy Yallop

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module type \textit{Idiom} = sig
  type \alpha \rightarrow t
  val \textit{pure} : \alpha \rightarrow \alpha \rightarrow t
  val (\otimes) : (\alpha \rightarrow \beta) \rightarrow \alpha \rightarrow t \rightarrow \beta \rightarrow t
end

module type \textit{FORMLET} = sig
  include \textit{Idiom}
  val xml : xml \rightarrow unit \rightarrow t
  val text : string \rightarrow unit \rightarrow t
  val tag : tag \rightarrow attrs \rightarrow \alpha \rightarrow t \rightarrow \alpha \rightarrow t
  val input : string \rightarrow t
  val run : \alpha \rightarrow t \rightarrow xml \times (env \rightarrow \alpha)
end

\textbf{Fig. 4.} The idiom and formlet interfaces
Links, with formlets, sugared

let date_formlet : Formlet Date =
  formlet
  month {int_formlet => month}
  day   {int_formlet => day}
 yields (make_date(month,day))

let dates_formlet : Formlet (Date,Date) =
  formlet
  Start:   {date_formlet => start}
  Finish:  {date_formlet => finish}
  <input type="submit" value="submit"/>
 yields (start,finish)

let request : Xml =
  handle(dates_formlet, response)
Links, with formlets, unsugared

```ocaml
let int_formlet : Formlet Int =
  pure(string_to_int) @ input

let date_formlet : Formlet Date =
  pure(fun month day => make_date(month,day))
  @ text("month ") @ int_formlet
  @ text("day ") @ int_formlet

let dates_formlet : Formlet (Date,Date) =
  pure(fun () start () finish () => (start,finish))
  @ text("Start: ") @ date_formlet
  @ text("Finish: ") @ date_formlet
  @ submit("Submit")

let request : Xml = handle(dates_formlet,response)
```
Currying

\[(a, b) \rightarrow c \simeq a \rightarrow (b \rightarrow c)\]

\[(\text{fun } (x, y) \Rightarrow x+y) \ (3, 4)\]
\[\Rightarrow 3+4\]
\[\Rightarrow 7\]

\[(\text{fun } x \ y \Rightarrow x+y) \ 3 \ 4\]
\[\equiv ((\text{fun } x \Rightarrow (\text{fun } y \Rightarrow x+y)) \ 3) \ 4\]
\[\Rightarrow (\text{fun } y \Rightarrow 3+y) \ 4\]
\[\Rightarrow 3+4\]
\[\Rightarrow 7\]
Formlets in Links, the API

Formlets API

pure : a -> Formlet a
(©) : Formlet (a -> b) -> Formlet a -> Formlet b
text : String -> Formlet ()
tag : (Tag, Attrs, Formlet a) -> Formlet a
input : Formlet String
run : Formlet a -> (Xml, (Env -> a))

XML API

(ˆ^) : Xml -> Xml -> Xml
textXml : String -> Xml
tagXml : (Tag, Attrs, Xml) -> Xml
Formlets in Links, the implementation

```ocaml

(* type Formlet a = Int -> (Xml, (Env -> a), Int) *)

let pure(x)(i) = ([], (fun env => x), i)
let (f @ g)(i) = 
    let (u, d, j) = f(i) in
    let (v, e, k) = g(j) in
    (u ^^ v, (fun env => d(env)(e(env))), k)
let xml(u)(i) = (u, (fun env => ()), i)
let text(s) = xml(xmlText(s))
let tag(t,a,f)(i) = 
    let (u, d, j) = f(i) in
    (xmlTag(t,a,u), d, j)
let input(i) =
    let w = "i_" ^ string_of_int(i) in
    let u = xmlTag "input" ["name", w] [] in
    (u, (fun env => lookUp(env,w)), i+1)
let run(f) =
    let (x, d, j) = f 0 in
    (x, d)
```

Notions of Computation and Monads

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\[ T^3A \xrightarrow{\muTA} T^2A \xrightarrow{\mu_A} TA \]
\[ TA \xrightarrow{\etaTA} T^2A \xleftarrow{T\eta_A} TA \]
\[ T^2A \xrightarrow{\mu_A} TA \]
\[ TA \xrightarrow{\mu_A} TA \xleftarrow{id_{TA}} TA \]
Generalising monads to arrows

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Abstract

Monads have become very popular for structuring functional programs since Wadler introduced their use in 1990. In particular, libraries of combinators are often based on a monadic type. Such libraries share (in part) a common interface, from which numerous benefits flow, such as the possibility to write generic code which works together with any library. But, several interesting and useful libraries are fundamentally incompatible with the monadic interface. In this paper I propose a generalisation of monads, which I call arrows, with significantly wider applicability. The paper shows how many of the techniques of monadic programming generalise to the new setting, and gives examples to show that the greater generality is useful. In particular, three non-monadic libraries for efficient parsing, building graphical user interfaces, and programming active web pages fit naturally into the new framework. © 2000 Elsevier Science B.V. All rights reserved.
THEORETICAL PEARLS

The Arrow Calculus

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Abstract

We introduce the arrow calculus, a metalanguage for manipulating Hughes’s arrows with close relations both to Moggi’s metalanguage for monads and to Paterson’s arrow notation. Arrows are classically defined by extending lambda calculus with three constructs satisfying nine (somewhat idiosyncratic) laws; in contrast, the arrow calculus adds four constructs satisfying five laws (which fit two well-known patterns). The five laws were previously known to be sound; we show that they are also complete, and hence that the five laws may replace the nine.
FUNCTIONAL PEARLS

[ABORTED] A trail told by an idiom

Conor McBride

1 Introduction

Nobody likes their programs to be full of sound and fury, signifying nothing. Abstraction is the weapon of choice in the war on wanton waffle. This paper is about an abstraction which I find rather handy. It’s a weaker variation on the theme of a monad, but it has a more functional feel. I call it an idiom:

\[
\begin{align*}
\text{infixl 9 \langle\%\rangle} \\
\text{class Idiom } i \text{ where} \\
\text{idi} & : x \rightarrow i x \\
\text{\langle\%\rangle} & : i (s \rightarrow t) \rightarrow i s \rightarrow i t \quad \text{— pronounced ‘apply’}
\end{align*}
\]
FUNCTIONAL PEARL

Applicative programming with effects

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Abstract

In this paper, we introduce Applicative functors—an abstract characterisation of an applicative style of effectful programming, weaker than Monads and hence more widespread. Indeed, it is the ubiquity of this programming pattern that drew us to the abstraction. We retrace our steps in this paper, introducing the applicative pattern by diverse examples, then abstracting it to define the Applicative type class and introducing a bracket notation which interprets the normal application syntax in the idiom of an Applicative functor. Further, we develop the properties of applicative functors and the generic operations they support. We close by identifying the categorical structure of applicative functors and examining their relationship both with Monads and with Arrows.
Idioms are oblivious, arrows are meticulous, monads are promiscuous

Sam Lindley, Philip Wadler and Jeremy Yallop

Abstract
We revisit the connection between three notions of computation: Moggi’s monads, Hughes’s arrows and McBride and Paterson’s idioms (also called applicative functors). We show that idioms are equivalent to arrows that satisfy the type isomorphism $A \sim B \simeq 1 \sim (A \rightarrow B)$ and that monads are equivalent to arrows that satisfy the type isomorphism $A \sim B \simeq A \rightarrow (1 \sim B)$. Further, idioms embed into arrows and arrows embed into monads.

Keywords: applicative functors, idioms, arrows, monads

Monads < Arrows < Idioms
Idioms

pure : a -> Idiom a
(@) : Idiom (a -> b) -> Idiom a -> Idiom b

pure (fun x => x) @ u
   = u
pure (fun f g x => f (g x)) @ u @ v @ w
   = u @ (v @ w)
pure f @ pure x
   = pure (f x)
u @ pure x
   = pure (fun f => f x) @ u
Programming the web

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