

Discussion 11

Streams and Laziness

Kenneth Fang (kwf37), Newton Ni (cn279)

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Key Ideas

- ▶ Functions can be used to **delay** computation
- ▶ Streams represent **infinite** iterators

Noisy Expressions: Case Study

```
let noisy_zero : int =  
  print_endline "HELLO, THIS IS 0";  
  0
```

```
let noisy (number: int) : unit =  
  Printf.printf "HELLO, THIS IS %i\n" number;  
  number
```

Eager Evaluation

```
let noisy (number: int) : unit =  
  Printf.printf "HELLO, THIS IS %i\n" number;  
  number
```

```
let print_eager (number: int) : unit =  
  Printf.printf "PRINTING...\n";  
  Printf.printf "%i\n" number
```

```
print_eager (noisy 5)
```

Lazy Evaluation

```
let noisy (number: int) : unit =  
  Printf.printf "HELLO, THIS IS %i\n" number;  
  number
```

```
let print_lazy (number: unit -> int) : unit =  
  Printf.printf "PRINTING...\n";  
  Printf.printf "%i\n" (number ())
```

```
print_lazy (fun () -> noisy 5)
```

Laziness: Real Examples

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- ▶ Asynchronous callbacks
- ▶ `load_image "cat.png" (fun image -> (* ... *))`

Streams

```
module type Stream = sig
  (* Abstract type *)
  type t

  (* Create a stream that goes from start to infinity *)
  val make: int -> t

  (* Get current value *)
  val head: t -> int

  (* Go to next iteration *)
  val tail: t -> t
end
```

Streams: Take One

```
type t = int * t
```

Streams: Take Two

```
type t = {  
  head: int;  
  tail: t;  
}  
  
let head s = s.head  
  
let tail s = s.tail  
  
let rec make (n: int) : t =  
  failwith "Unimplemented"
```

Streams: Take Two

```
let rec make (n: int) : t =  
  { head = n;  
    tail = make (n + 1) }
```

Streams: Take Three

```
type t = {  
  head: int;  
  tail: unit -> t;  
}  
  
let head s = s.head  
  
let tail s =  
  failwith "Unimplemented"  
  
let rec make (n: int) : t =  
  failwith "Unimplemented"
```


Streams: Take Four

```
type t = Stream of int * (unit -> t)
```

Streams: Take Four

```
let head s = match s with  
| Stream (h, _) -> h
```

```
let head = function  
| Stream (h, _) -> h
```

```
let head (Stream (h, _)) = h
```

Streams: Exercises

```
(** [map s f] is the stream returning [f x] for  
    * each [x] in stream [s] *)
```

```
let map s f = failwith "Unimplemented"
```

```
(** [take s n] is the list of the first [n]  
    * elements in stream [s]. *)
```

```
let take s n = failwith "Unimplemented"
```

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- ▶ Infinite binary tree exercises in `tree.ml`