

Introduction to Functional Programming in *OCaml*

Roberto Di Cosmo, Yann Régis-Gianas, Ralf Treinen

Week 1 - Sequence 5: Recursion



Recursive Functions

- ▶ Functions that are defined by calling themselves on smaller arguments
- ▶ Natural on recursively defined data structures (see Week 3)
- ▶ Example: $fact(n) = \begin{cases} 1 & \text{if } n = 1 \\ n * fact(n - 1) & \text{if } n > 1 \end{cases}$

Recursive Definitions in OCaml

- ▶ A priori, the use of f in a definition of f refers to the *previous* value of f
- ▶ The keyword `rec` changes this, and allows us to define a function by recursion

Recursive Definitions in OCaml I

```
let x = 1;;  
# val x : int = 1  
let x = x+1;;  
# val x : int = 2  
x;;  
# - : int = 2
```

```
let f x = x+1;;  
# val f : int -> int = <fun>  
let f x = f (f x);;  
# val f : int -> int = <fun>  
f 1;;  
# - : int = 3
```

Recursive Definitions in OCaml II

```
let fact n = if n <=1 then 1 else n*fact(n-1);;
```

```
# Characters 37-41:
```

```
  let fact n = if n <=1 then 1 else n*fact(n-1);;  
                                ^^^^
```

```
Error: Unbound value fact
```

```
let rec fact n = if n <=1 then 1 else n*fact(n-1);;
```

```
# val fact : int -> int = <fun>
```

```
fact 10;;
```

```
# - : int = 3628800
```

Mutually Recursive Functions

- ▶ Generalization of direct recursion
- ▶ Several functions are defined by calling each other on smaller arguments
- ▶ Natural on mutual recursive data structures
- ▶ Example:
 - ▶ n is even if $n = 0$, or $n > 0$ and $n - 1$ is odd
 - ▶ n is odd if $n = 1$, or $n > 1$ and $n - 1$ is even

Mutually Recursive Definitions in OCaml I

```
let rec even x = if x=0 then true else odd (x-1);;
```

```
# Characters 39-42:
```

```
  let rec even x = if x=0 then true else odd (x-1);;  
                                     ^^^
```

```
Error: Unbound value odd
```

```
let rec even x = if x=0 then true else odd (x-1)
```

```
and odd x = if x=0 then false else even (x-1);;
```

```
# val even : int -> bool = <fun>
```

```
val odd : int -> bool = <fun>
```

```
even 17;;
```

```
# - : bool = false
```

```
even 10;;
```

```
# - : bool = true
```