Programmering og Problemløsning

5.1: Lister

Repetition af Nøglekoncepter

- Moduler og biblioteker
- Black- og white-box testing
- Højere-ordens funktioner
- Anonyme funktioner

- Closures
- Håndkøring

Navn -> (input, krop, virkefeltets værdier)

Leksikografisk

E0:
~~testScope -> ((x), testScope-body, ())~~
~~linje 6: testScope 2.0 -> ?~~ 6.0
~~stdout -> "6.0"~~
~~return -> ()~~
~~E1: ((x -> 2.0), testScope-body, ())~~
~~a -> 3.0~~
~~f -> ((z), a * z, (a -> 3.0))~~
~~a -> 4.0~~
~~f 2.0 -> ?~~ 6.0
~~return -> 6.0~~

~~E2: ((z -> 2.0), a * z, (a -> 3.0))~~
~~return -> 6.0~~

Dynamisk

E0:
~~testScope -> ((x), testScope-body, ())~~
~~linje 6: testScope 2.0 -> ?~~ 8.0
~~stdout -> "8.0"~~
~~return -> ()~~
~~E1: ((x -> 2.0), testScope-body, ())~~
~~a -> alpha~~
~~f -> ((z), a * z, (a –> alpha))~~
~~f 2.0 -> ?~~ 8.0
~~return -> 8.0~~

~~E2: ((z -> 2.0), a * z, (a -> alpha))~~
~~return -> 8.0~~

Linje	Navn	Værdi
2	alpha	3.0
4	alpha	4.0

Ting på lister

Tupler:

```
> let a = (3, "tre");;
val a : int * string = (3, "tre")
```

Forskellige typer og størrelse fastlagt på definitionstidspunkt

Strenge:

```
> "hej med jer".[4..6];;
val it : string = "med"
```

Samme type (char), og operatorer til indicering og sammensætning

Lister:

```
> let a = ['h'; 'e'; 'j'];;
val a : char list = ['h'; 'e'; 'j']
```

Ligesom strenge, kan holde andre elementer af same type og er **ikke mutérbar**

- Den tome liste:

```
> let a = [];;
val a : 'a list
```

Generisk type

- Indicering

```
> ['h'; 'e'; 'j'].[1..];;
val it : char list = ['e'; 'j']
```

Slicing (som strenge)

- Samenligning

```
> [2; 3; 5] > [2; 2; 6];;
val it : bool = true
```

'Alfabetisk' sammenligning

- Append (@)

```
> ['h'; 'e'; 'j'] @ [' '; 'm'; 'e'; 'd'];;
val it : char list = ['h'; 'e'; 'j'; ' '; 'm'; 'e'; 'd']
```

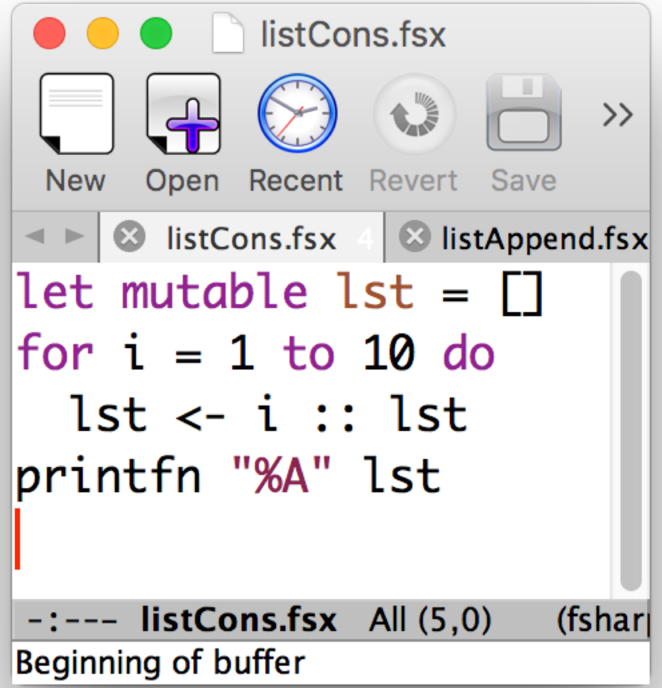
Sammensætning af 2 lister

- Cons (::)

```
> 'h' :: ['e'; 'j'];;
val it : char list = ['h'; 'e'; 'j']
```

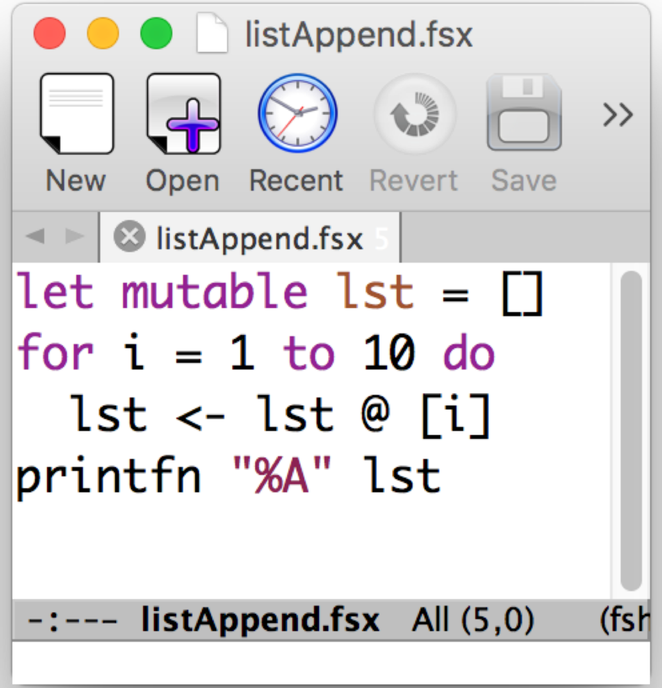
Sætte et element forest i en liste (prepend)

Hvilket program skriver "[1; 2; 3; 4; 5; 6; 7; 8; 9; 10]" på skærmen



```
let mutable lst = []
for i = 1 to 10 do
  lst <- i :: lst
printfn "%A" lst
```

Beginning of buffer



```
let mutable lst = []
for i = 1 to 10 do
  lst <- lst @ [i]
printfn "%A" lst
```

https://tinyurl.com/ycogq4ur

Køretid

listAppendLarge.fsx

```
let mutable lst = []
for i = 1 to 40000 do
  lst <- lst @ [i]
```

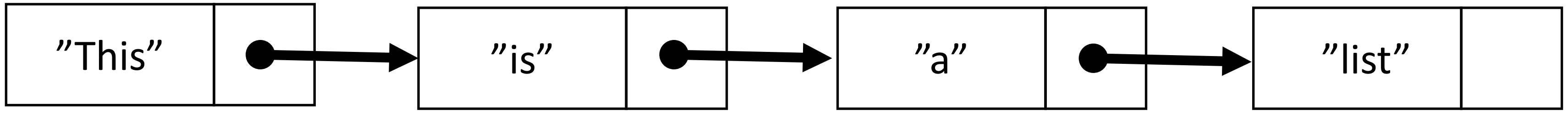
```
listAppendLarge.fsx && time mono listAppendLarge.exe
```

listConsLarge.fsx

```
let mutable lst = []
for i = 1 to 40000 do
  lst <- i :: lst
```

```
listConsLarge.fsx && time mono listConsLarge.exe
```

Lister er linkede lister:



Listeværdier og -funktioner

- Oprettelse af lister

```
> let a = List.init 5 (fun i -> i)
- let b = [0..4];;
val a : int list = [0; 1; 2; 3; 4]
val b : int list = [0; 1; 2; 3; 4]
```

- Hoved og hale

```
> let a = [0..5]
- printfn "%A %A" a.Head a.Tail;;
0 [1; 2; 3; 4; 5]
val a : int list = [0; 1; 2; 3; 4; 5]
val it : unit = ()
```

- Gennemløb af lister

```
> let a = List.init 5 (fun i -> pown 2 i)
- for i = 0 to a.Length - 1 do
-   printf "%d " a.[i]
- printfn "";;
1 2 4 8 16
val a : int list = [1; 2; 4; 8; 16]
val it : unit = ()
```

- Bedre gennemløb af lister

```
> let a = List.init 5 (fun i -> pown 2 i)
- List.iter (fun e -> printf "%d " e) a
- printfn "";;
1 2 4 8 16
val a : int list = [1; 2; 4; 8; 16]
val it : unit = ()
```

Map og Fold

Generisk type

List.map: f:('T -> 'U) -> lst:'T list -> 'U list

lst = [1;2;3] => [f 1; f 2; f 3]

- Map'e funktioner på lister

```
> let a = [0..5]
- List.map (fun e -> e * e) a;;
val a : int list = [0; 1; 2; 3; 4; 5]
val it : int list = [0; 1; 4; 9; 16; 25]
```

List.fold: f:('State -> 'T -> 'State) -> elm:'State -> lst:'T list -> 'State

lst = [1;2;3] og elm = 0 => f (f (f 0 1) 2) 3

- Folde en liste sammen: sum

```
> let a = [0..5]
- let sum acc elm = acc + elm
- List.fold sum 0 a;;
val a : int list = [0; 1; 2; 3; 4; 5]
val sum : acc:int -> elm:int -> int
val it : int = 15
```

- Folde en liste sammen: con

```
> let a = [0..5]
- let app acc elm = acc + (string elm)
- List.fold app "" a;;
val a : int list = [0; 1; 2; 3; 4; 5]
val app : acc:string -> elm:int -> string
val it : string = "012345"
```

- Vende en liste om: rev

```
> let a = [0..5]
- let rev acc elm = elm :: acc
- List.fold rev [] a;;
val a : int list = [0; 1; 2; 3; 4; 5]
val rev : acc:'a list -> elm:'a -> 'a list
val it : int list = [5; 4; 3; 2; 1; 0]
```

Arrays:

```
> let a = [|'h'; 'e'; 'j'|];;
val a : char [] = [|'h'; 'e'; 'j'|]
```

Ligesom lister, men hverken append eller cons operaterbare, og **mutérbar**

- Den tome array:

```
> let a = [||];;
val a : 'a []
```

Generisk type

- Indicering

```
> [|'h'; 'e'; 'j'|].[1..];;
val it : char [] = [|'e'; 'j'|]
```

Slicing (som strenge og lister)

- Samenligning

```
> [|2; 3; 5|] > [|2; 2; 6|];;
val it : bool = true
```

'Alfabetisk' sammenligning

- Mutérbar!

```
> let a = [|2; 3; 5|]
- a.[2] <- 4
- printfn "%A" a;;
[|2; 3; 4|]
val a : int [] = [|2; 3; 4|]
val it : unit = ()
```

Implicit mutable nøgleord

Køretid

listIndicering.fsx

```
let N = 100000
let lst = [1..N];;
let mutable max = -1
for i = 0 to lst.Length - 1 do
  let v = lst.[i];
  max <- if v > max then v else max
printfn "%A" max
```

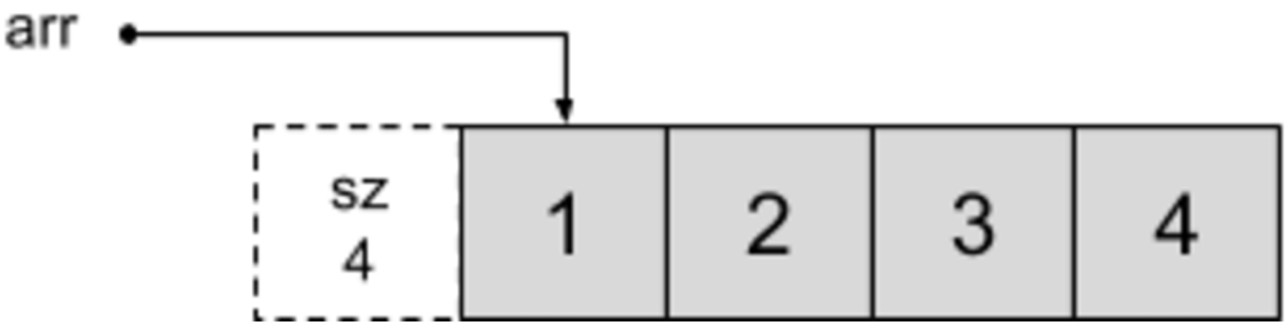
```
fsharpc listIndicering.fsx && time mono listIndicering.exe
```

arrayIndicering.fsx

```
let N = 100000
let arr = [|1..N|];;
let mutable max = -1
for i = 0 to arr.Length - 1 do
  let v = arr.[i];
  max <- if v > max then v else max
printfn "%A" max
```

```
fsharpc arrayIndicering.fsx && time mono arrayIndicering.exe
```

Arrays er lageraritmetik:


arr
sz
4
1
2
3
4