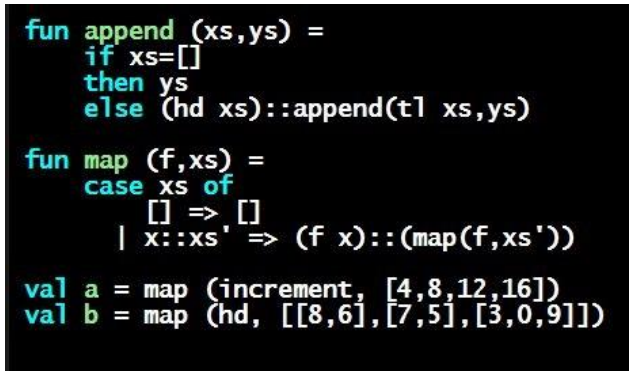


Programming Languages

Dan Grossman

A Key Benefit of Immutable Data

A valuable non-feature: no mutation

Have now covered all the features you need (and should use) on hw1

Now learn a very important non-feature

- Huh?? How could the *lack* of a feature be important?
- When it lets you know things *other* code will *not* do with your code and the results your code produces

A major aspect and contribution of functional programming:

Not being able to assign to (a.k.a. *mutate*) variables

or parts of tuples and lists

(This is a "Big Deal")

Cannot tell if you copy

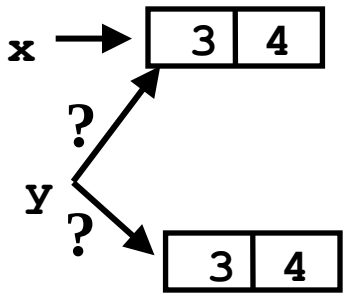
```
fun sort_pair (pr : int * int) =
  if #1 pr < #2 pr
  then pr
  else (#2 pr, #1 pr)

fun sort_pair (pr : int * int) =
  if #1 pr < #2 pr
  then (#1 pr, #2 pr)
  else (#2 pr, #1 pr)
```

In ML, these two implementations of **`sort_pair`** are indistinguishable

- But only because tuples are immutable
- The first is better style: simpler and avoids making a new pair in the then-branch
- In languages with mutable compound data, these are different!

Suppose we had mutation…

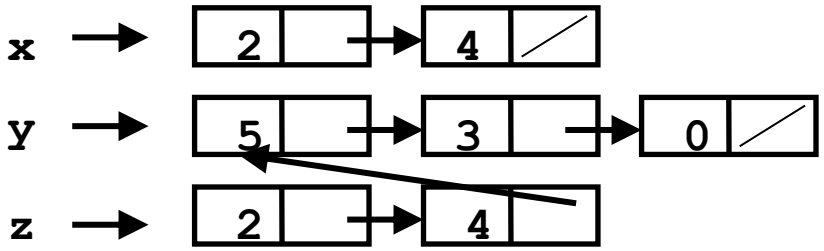
```
val x = (3,4)
val y = sort_pair x

somehow mutate #1 x to hold 5

val z = #1 y
```



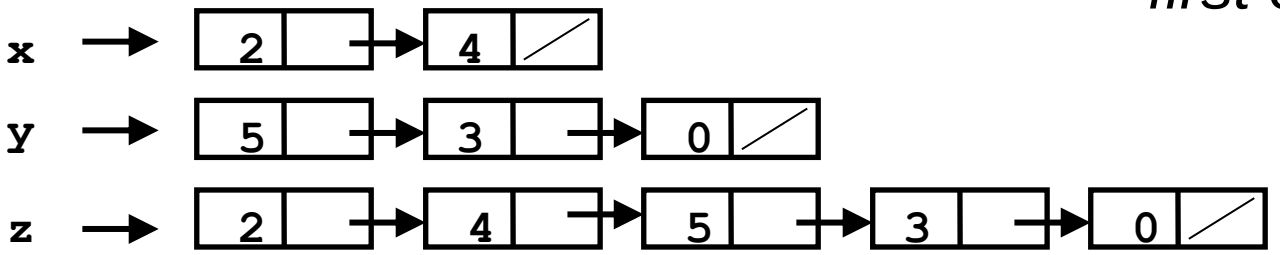
- What is **z**?
  - Would depend on how we implemented **sort_pair**
    - Would have to decide carefully and document **sort_pair**
  - But without mutation, we can implement "either way"
    - No code can ever distinguish aliasing vs. identical copies
    - No need to think about aliasing: focus on other things
    - Can use aliasing, which saves space, without danger

An even better example

```
fun append (xs : int list, ys : int list) =
    if null xs
    then ys
    else hd (xs) :: append (tl(xs), ys)
val x = [2,4]
val y = [5,3,0]
val z = append(x,y)
```



or



(can't tell, but it's the first one)

ML vs. Imperative Languages

- In ML, we create aliases all the time without thinking about it because it is *impossible* to tell where there is aliasing
  - Example: `tl` is constant time; does not copy rest of the list
  - So don't worry and focus on your algorithm

- In languages with mutable data (e.g., Java), programmers are *obsessed* with aliasing and object identity
  - They have to be (!) so that subsequent assignments affect the right parts of the program
  - Often crucial to make copies in just the right places
    - Optional Java example in next segment