Immutability: obstacle or tool?

Discuss based on:

- Programming experience in 251 and previously
- Readings about language implementation and GC

- Efficiency?
- Reliability?
- Ease of making/avoiding mistakes?
- Clarity?
- …

- Try for at least 3 pros and 3 cons; OK to disagree.

"In a world where bindings and values are immutable…"

- Have you noticed?

- Patterns for accumulating results
  (when your Java brain says "x++", etc.):
  - Build result recursively
  - Create fresh copy
  - "Thread state through" in the style of foldl
    - Small function "does one step"
    - HOF passes result on to the next step.

Cannot tell if you copy

```
(define (sort-pair p)
  (if (< (car p) (cdr p))
    p
    (cons (cdr p) (car p))))

(define (sort-pair p)
  (if (< (car p) (cdr p))
    (cons (car p) (cdr p))
    (cons (cdr p) (car p))))
```

Without mutation, these two implementations are indistinguishable

- Change at any time without introducing bugs outside.

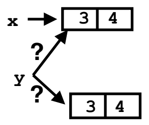
Motivating examples/slides adapted from Dan Grossman

Suppose we had mutation…

```
(define x (mcons 3 4))
(define y (sort-pair x))

; mutate car of x to hold 5
(set-mcar! x 5)

(define z (mcdr y))
```

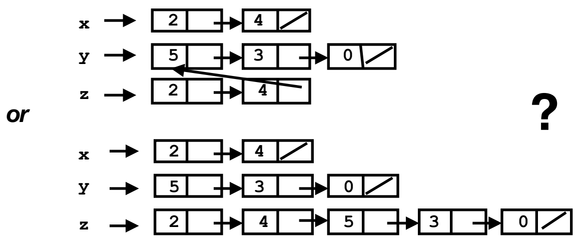


- What is **z**?
  - Depends on **sort-pair** implementation
    - Document and be **very** careful.
    - Changing implementation requires changing uses

This code is close to (but not quite) working Racket…

An even better example

```
(define (append xs ys)
  (if (null? xs)
      ys
      (cons (car xs) (append (cdr xs) ys))))
(define x (list 2 4))
(define y (list 5 3 0))
(define z (append x y))
```



Java security nightmare (really happened)

```
class ProtectedResource {
   private Resource theResource = ...;
   private String[] allowedUsers = ...;
   public String[] getAllowedUsers() {
      return allowedUsers;
   }
   public String currentUser() { ... }
   public void useTheResource() {
      for(int i=0; i < allowedUsers.length; i++) {
         if(currentUser().equals(allowedUsers[i])) {
             ... // access allowed: use it
             return;
         }
      }
      throw new IllegalAccessException();
   }
}
```

Mutant users!

The problem:

```
p.getAllowedUsers()[0] = p.currentUser();
p.useTheResource();
```

The fix:

```
public String[] getAllowedUsers() {
   … return a copy of allowedUsers …
}
```

Could this happen without mutability?

A biasing on aliasing

Immutability

Aliasing choices **do not** affect correctness, just performance.

Other code **can't** break your code.

Changing your choice **can't** break other code.

Document what, **not** how.

Start with safety, optimize for performance.

Mutability

Aliasing choices **do** affect correctness and performance.

Other code **can** break your code, depending on your choice.

Changing your choice **can** break other code.

Document what **and** how.

Start with performance (maybe), optimize for safety.

A broader PL theme:

- Limiting how programs can be expressed can be very useful!
- **Not** limiting **what** computable functions can be implemented, just **how**.
- Less is more (reliable)?