Doubly Linked Lists

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Objectives

- Understand how to create a doubly linked list.
- Be able to write insertion code.
- Be able to write deletion code.
- Be able to express the tradeoff between doubly linked lists and singly linked lists.

Doubly Linked Lists

- Conceptually not much different than singly linked lists.
- They have two pointers: previous and next.
- Always mutable!

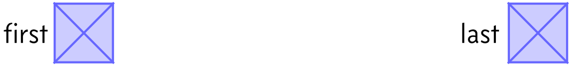


Figure : A boring empty list.

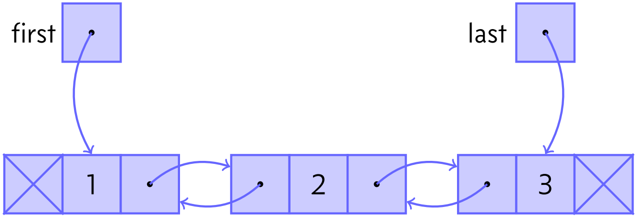


Figure : Elements 1,2, and 3.

Building the ADT

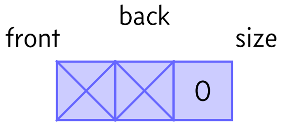
- We should keep track of front, back, and size.
- Doubly linked lists should be mutable.

```
(deftype DList [^{:unsynchronized-mutable true} front
                ^{:unsynchronized-mutable true} back
                ^{:unsynchronized-mutable true} size]
   DListP ;; accessors here...
)
(deftype DNode [^{:unsynchronized-mutable true} prev
                ^{:unsynchronized-mutable true} data
                ^{:unsynchronized-mutable true} next]
   DNodeP ;; accessors here...
)
(defn make-dlist []
   (DList. nil nil 0))
(defn make-dnode [prev data next]
   (DNode. prev data next))

```

Adding

- There are two cases to adding. For empty list:
  1. Create the node.
  2. Set front to point to node.
  3. Set back to point to node.
  4. Set size to one.



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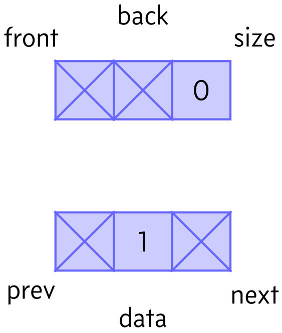

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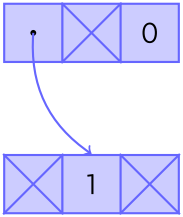

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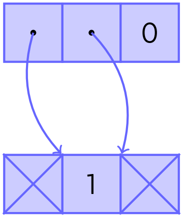

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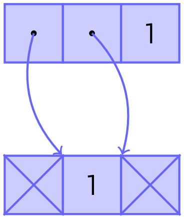
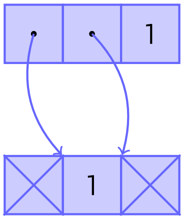


Second Case

- For list with data:
  1. Create the node.
  2. Set next of node to front of list.
  3. Set prev of front node to node.
  4. Set front of list to node.
  5. Increment size.



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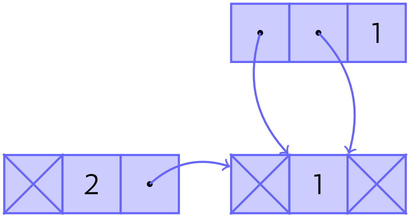

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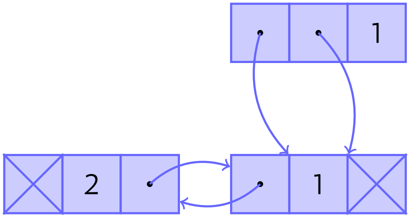

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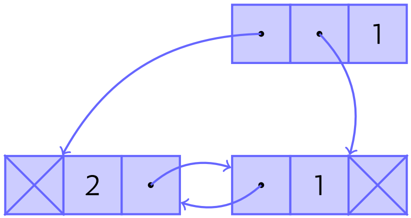

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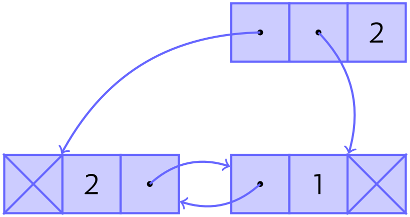


Adding

- Here is the code for adding to the front.

```
(defn insert-front [dlist elt]
  (let [node (make-dnode nil elt (front dlist))]
    (if (nil? (front dlist))
        (do (set-front! dlist node)
            (set-back!  dlist node)
            (set-size! dlist (+ 1 (size dlist))))
        (do (set-prev! (front dlist) node)
            (set-front! dlist node)
            (set-size! dlist (+ 1 (size dlist)))))))
```

Sample Run

```
(def xx (make-dlist))
;; => #'user/xx
(insert-front xx 10)
;; => 1
(identical? (-> xx front) (-> xx back) )
;; => true
(insert-front xx 20)
;; => 3
(identical? (-> xx :front) (-> xx :back) )
;; => false
(-> xx front data)
;; => 20
(-> xx front next data)
;; => 10
```

Find

- We can search from the front or from the back.

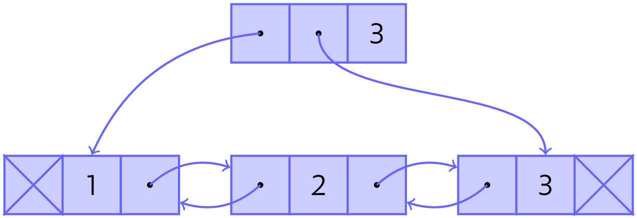
```
(defn find-fwd [dnode elt]
  (cond (nil? dnode)             false
        (= (data dnode) elt)     true
        :fine-be-that-way        (find-fwd (next dnode) elt))
```

Deletion

- There are three edge cases for delete!
  - Delete beginning
  - Delete end
  - Delete only
- Important because you have to do different things on the edge than in the middle.
- Sentinels will rescue us later.

Example: delete 2

- Set next's prev to prev
- Set prev's next to next
- Decrement size



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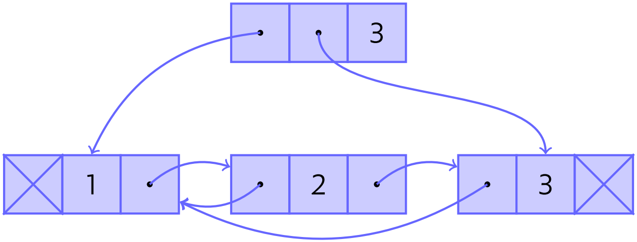

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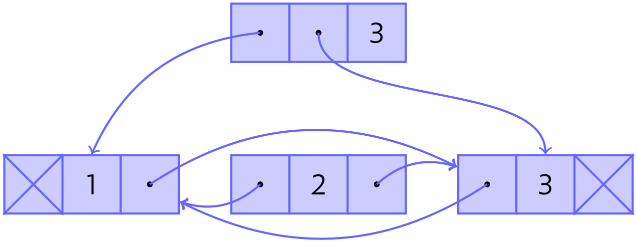

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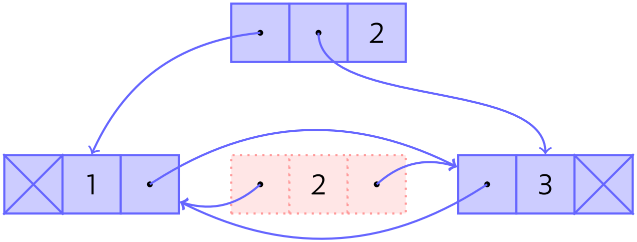

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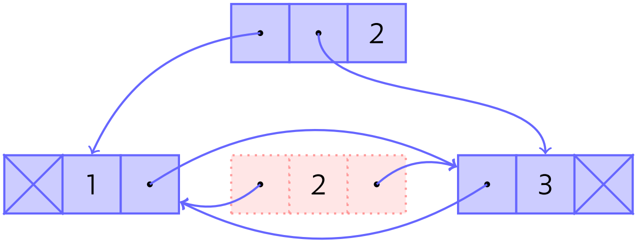

The 2 node is garbage now.