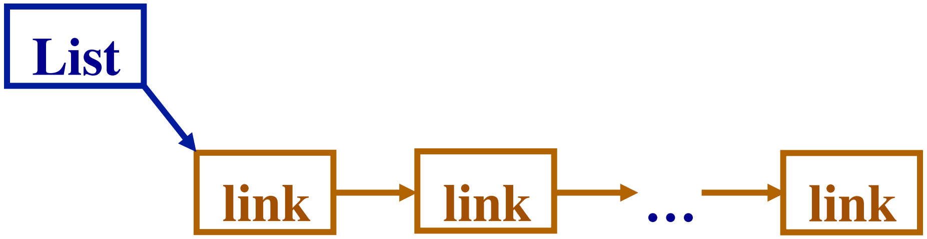
Linked List Implementation of the Queue

Review: Linked List Stack

Time complexity of **ListStack** operations:

- Push: O(1) always
- Pop: O(1) always
- Top: O(1) always

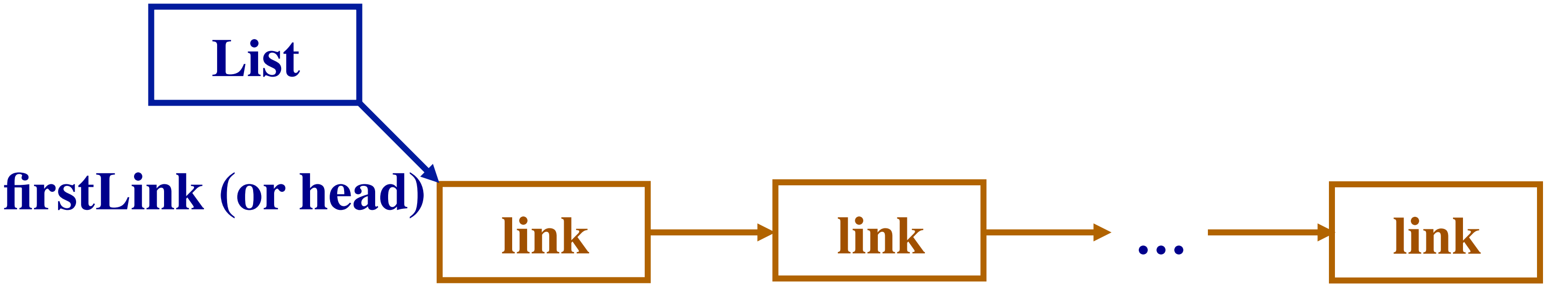


How would this compare to a **DynArr** (a dynamic array implementation of a stack)?

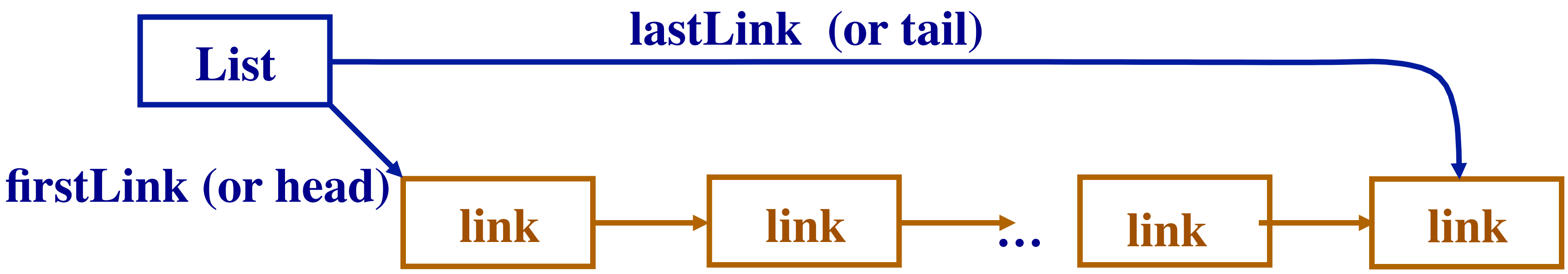
- Push: O(1+) average, O(n) worse, O(1) best
- Pop : O(1) always
- Top : O(1) always
- In practice, dynamic array is slightly faster in real timings

Linked List Queue

- Could we use our linked list as is, to implement a queue?



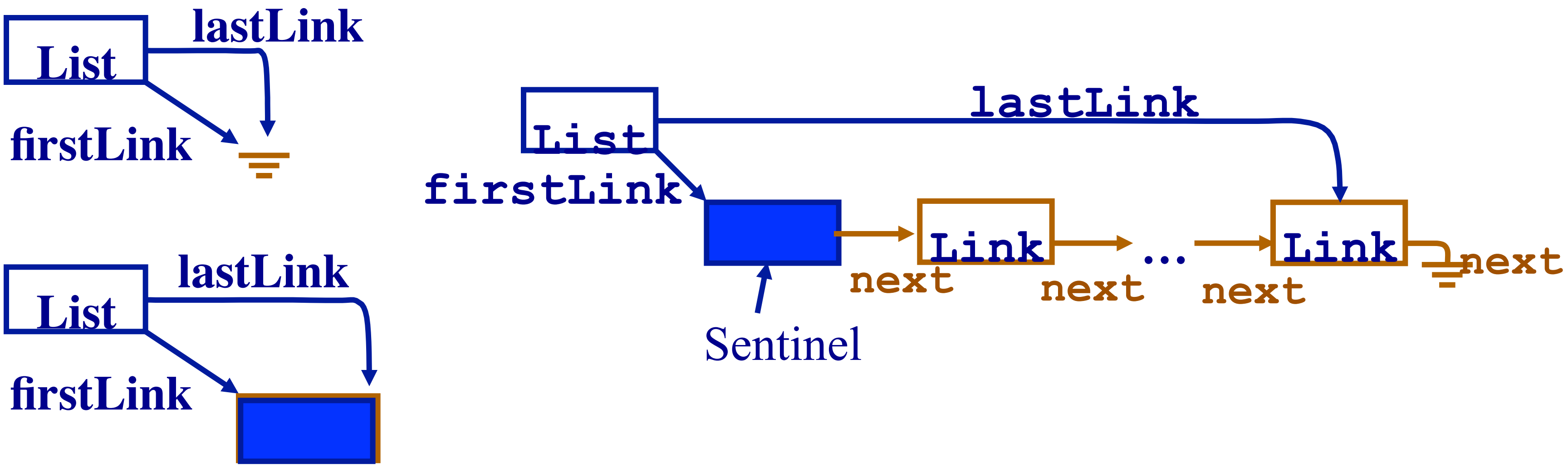
Modification#1: Tail Pointer



Which side should we make the ‘front’ of the queue?

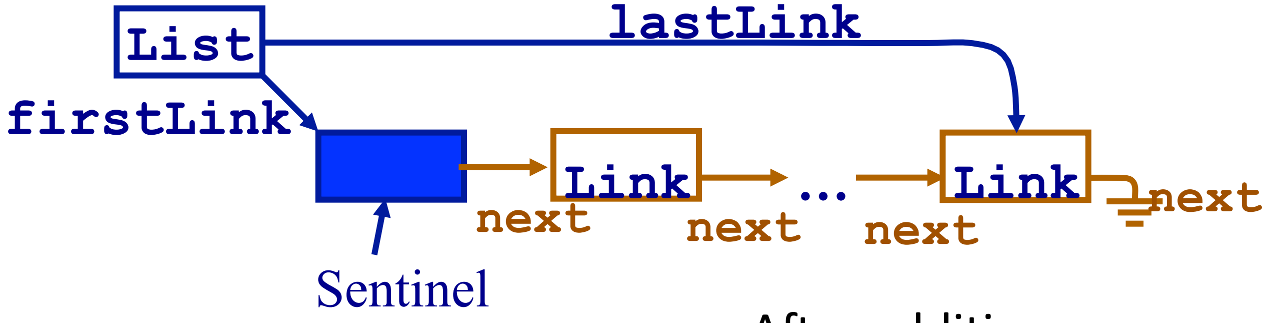
Modification#2: Sentinel

- A sentinel is a special marker at the front and/or back of the list
- Has no value and never removed
- Helps remove special cases due to null references since it's never null (e.g. first/last never point to null)
- Simplifies some operations
- An empty list always has a sentinel



listQueue struct

```
struct listQueue {
      struct Link *firstLink;/* Always pts to Sent */
      struct Link *lastLink;
}
```

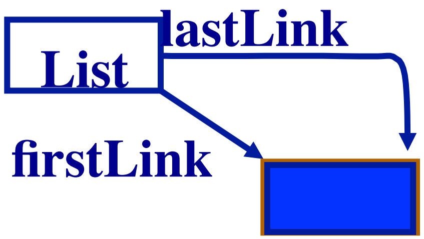


After additions

ListQueueInit

```
void listQueueInit (struct listQueue *q) {
    struct link *lnk = malloc(sizeof(struct link));
    assert(lnk != 0); /* lnk is the sentinel */
    lnk->next = 0;
    q->firstLink = q->lastLink = lnk;
}
```

Initially



addBackListQueue (Enqueue)

```
/* Sentinel */
void addBackListQueue (struct listQueue *q, TYPE e) {
   struct Link * lnk = malloc(….)
   assert(lnk != 0);
   lnk->next = 0;
   lnk->value = e;
    /* we know it has a firstLink. */
   q->lastLink->next = lnk;
   q->lastLink = lnk;
}
```

Sentinel vs. No Sentinel

```
/* No Sentinel */
void addBackListQueue (struct listQueue *q, TYPE e)
{
   struct Link * lnk = ...
   assert(lnk != 0);
   lnk->next = 0;
   lnk->value = e;
   /* lastLink may be null!! */
   if(!isEmptyListQueue(q)){
      q->lastLink->next = lnk;
       q->lastLink = lnk;
   }else q->firstLink = q->lastLink = lnk;
}
```

Your Turn

- Worksheet #18
  - Linked List Queue Implementation