1B Lecture #18: Assorted Topics

implementations

ked: tradeoffs

sequences: stacks, queues, deques

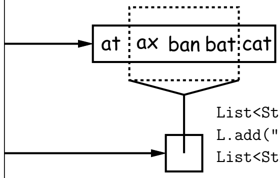
fering

d stacks

Views

A *view* is an alternative presentation of (interface to)
ct.

, the `sublist` method is supposed to yield a "view of"
isting list:



```
List<String> L = new ArrayList<String>();
L.add("at"); L.add("ax"); ...
List<String> SL = L.sublist(1,4);
```

er `L.set(2, "bag")`, value of `SL.get(1)` is `"bag"`, and
`(1,"bad")`, value of `L.get(2)` is `"bad"`.

er `SL.clear()`, `L` will contain only `"at"` and `"cat"`.

ge: "How do they *do* that?!"

Maps

d of "modifiable function:"

```
util;
ace Map<Key,Value> {
bject key);              // Value at KEY.
Key key, Value value);   // Set get(KEY) -> VALUE

-----------------------------------------
ring> f = new TreeMap<String,String>();
 "George"); f.put("George", "Martin");
 "John");
"Paul").equals("George")
"Dana").equals("John")
"Tom") == null
```

Map Views

```
ace Map<Key,Value> { // Continuation

Views of Maps */

of all keys. */
Set();

iset of all values that can be returned by get.
set is a collection that may have duplicates). */
alue> values();

of all(key, value) pairs */
y<Key,Value>> entrySet();
```

View Examples

rom a previous slide:

```
ing> f = new TreeMap<String,String>();
"George"); f.put("George", "Martin");
"John");
```

ious views of `f`:

```
String> i = f.keySet().iterator(); i.hasNext();)
==>  Dana, George, Paul
cinctly:
me : f.keySet())
 Dana, George, Paul

rent : f.values())
>    John, Martin, George

<String,String> pair : f.entrySet())
    (Dana,John), (George,Martin), (Paul,George)

ove("Dana");   // Now f.get("Dana") == null
```

Simple Banking I: Accounts

t a simple banking system. Can look up accounts by name
sit or withdraw, print.

ure

```
 name, String number, int init) {
 name; this.number = number;
e = init;

lder's name */
ame;
mber */
umber;
lance */


 on STR in some useful format. */
tStream str) { ... }
```

Simple Banking II: Banks

```
bles maintain mappings of String -> Account.  They keep
keys (Strings) in "compareTo" order, and the set of
bunts) is ordered according to the corresponding keys. */
ng,Account> accounts = new TreeMap<String,Account>();
ng,Account> names = new TreeMap<String,Account>();

nt(String name, int initBalance) {
 =
nt(name, chooseNumber(), initBalance);
t(acc.number, acc);
ame, acc);


tring number, int amount) {
= accounts.get(number);
ull) ERROR(...);
+= amount;

r withdraw.
```

Banks (continued): Iterating

count Data

```
l accounts sorted by number on STR. */
unt(PrintStream str) {
alues() is the set of mapped-to values.  Its
roduces elements in order of the corresponding keys.
account : accounts.values())
nt(str);


l bank accounts sorted by name on STR. */
(PrintStream str) {
account : names.values())
nt(str);
```

ion: What would be an appropriate representation for d of all transactions (deposits and withdrawals) against

Partial Implementations

rfaces (like `List`) and concrete types (like `LinkedList`), provides abstract classes such as `AbstractList`.

ke advantage of the fact that operations are related to

e you know how to do `get(k)` and `size()` for an imple- List, you can implement all the other methods needed *nly* list (and its iterators).

h `add(k,x)` and you have all you need for the additional f a growable list.

) and `remove(k)` and you can implement everything else.

The java.util.AbstractList helper class

```
t class AbstractList<Item> implements List<Item>

ed from List */
bstract int size();
bstract Item get(int k);
ean contains(Object x) {
 i = 0; i < size(); i += 1) {
 == null && get(i) == null) ||
 != null && x.equals(get(i))))
rn true;

alse;

: Throws exception; override to do more. */
t k, Item x) {
 UnsupportedOperationException();
```

remove, set

xample, continued: AListIterator

```
 abstract class AbstractList<Item>:
r<Item> iterator() { return listIterator(); }
rator<Item> listIterator() {
 AListIterator(this);


 class AListIterator implements ListIterator<Item> {
t<Item> myList;
or(AbstractList<Item> L) { myList = L; }
 position in our list. */
 0;

ean hasNext() { return where < myList.size(); }
 next() { where += 1; return myList.get(where-1); }
 add(Item x) { myList.add(where, x); where += 1; }
```

s, remove, set, etc.

e: Another way to do AListIterator

e to make the nested class non-static:

```
r<Item> iterator() { return listIterator(); }
rator<Item> listIterator() { return this.new AListIterator(); }

AListIterator implements ListIterator<Item> {
position in our list. */
0;

an hasNext() { return where < AbstractList.this.size(); }
next() { where += 1; return AbstractList.this.get(where-1); }
add(Item x) { AbstractList.this.add(where, x); where += 1; }
```

remove, set, etc.

`actList.this` means "the `AbstractList` I am attached `ew AListIterator` means "create a new `AListIterator` hed to X."

you can abbreviate `this.new` as `new` and can leave off `ctList.this` parts, since meaning is unambiguous.

Example: Using AbstractList

t to create a *reversed view* of an existing List (same
erse order). Operations on the original list affect the
ersa.

```
 ReverseList<Item> extends AbstractList<Item> {
nal List<Item> L;

erseList(List<Item> L) { this.L = L; }

 size() { return L.size(); }

m get(int k) { return L.get(L.size()-k-1); }

d add(int k, Item x) { L.add(L.size()-k, x); }

m set(int k, Item x) { return L.set(L.size()-k-1, x); }

m remove(int k) { return L.remove(L.size() - k - 1); }
```

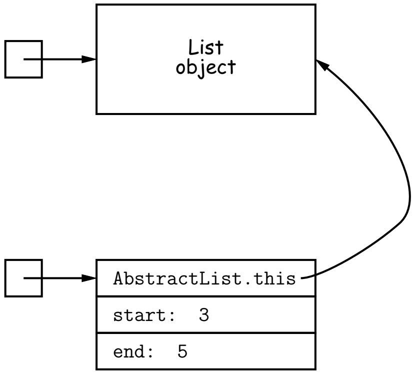
Getting a View: Sublists

```
blist(start, end)
```
is a List that gives a view of part
st. Changes in one must affect the other. How?

```
ion of class AbstractList.  Error checks not shown.
ublist(int start, int end) {
s.new Sublist(start, end);


s Sublist extends AbstractList<Item> {
t start, end;
t start, int end) { obvious }

 size() { return end-start; }
m get(int k) { return AbstractList.this.get(start+k); }

d add(int k, Item x)
ctList.this.add(start+k, x); end += 1; }
```

What Does a Sublist Look Like?

```
= L.sublist(3, 5);
```



Arrays and Links

ys to represent a sequence: array and linked list

ary: `ArrayList` and `Vector` vs. `LinkedList`.

es: compact, fast ($\Theta(1)$) *random access* (indexing).

ages: insertion, deletion can be slow ($\Theta(N)$)

es: insertion, deletion fast once position found.

ages: space (link overhead), random access slow.

Implementing with Arrays

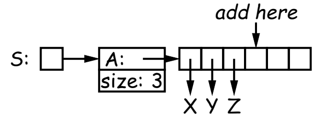
lem using arrays is insertion/deletion in the *middle* of a
ove things over).

ting from ends can be made fast:

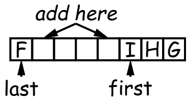
ray size to grow; amortized cost constant (Lecture #15).

r one end really easy; classical stack implementation:

```
X");
Y");
Z");
```



rowth at either end, use *circular buffering:*

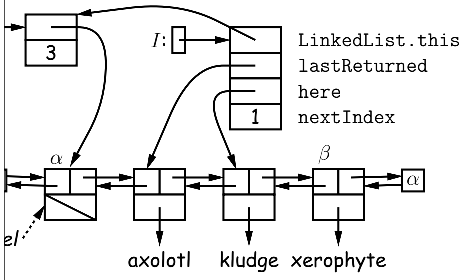


ccess still fast.

Linking

f linking should now be familiar

a `LinkedList`. One possible representation for linked
erator object over it:



```
dList<String>();       I = L.listIterator();
l");                   I.next();
");
yte");
```

Specialization

pecial cases of general list:

ld and delete from one end (LIFO).

dd at end, delete from front (FIFO).

Add or delete at either end.

easily representable by either array (with circular buffer-
or deque) or linked list.

`List` types, which can act like any of these (although
ditional names for some of the operations).

`va.util.Stack`, a subtype of `List`, which gives tradi-
("push", "pop") to its operations. There is, however, no
face.

Stacks and Recursion

ed to recursion. In fact, can convert any recursive al-
tack-based (however, generally no great performance

me "push current variables and parameters, set param-
ew values, and loop."

comes "pop to restore variables and parameters."

```
)

mb(start))
t start;
re, x,
 start:
start,x) && !isCrumb(x)
t(x)
```

```
findExit(start):
  S = new empty stack;
  push start on S;
  while S not empty:
    pop S into start;
    if isExit(start)
      FOUND
    else if (!isCrumb(start))
      leave crumb at start;
      for each square, x,
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            push x on S
```

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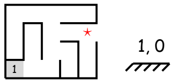

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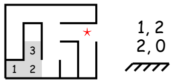


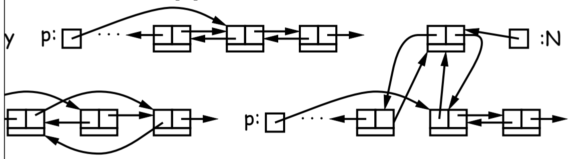
Clever trick: Sentinels

a dummy object containing no useful data except links.

inate special cases and to provide a fixed object to
der to access a data structure.

al cases ('**if**' statements) by ensuring that the first and
a list always have (non-null) nodes—possibly sentinels—
fter them:

```
list node at p:    // To add new node N before p:
 p.prev;           N.prev = p.prev; N.next = p;
 p.next;           p.prev.next = N;
                   p.prev = N;
```



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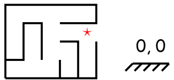

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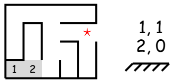

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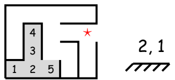

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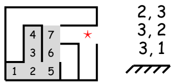

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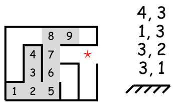

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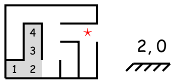

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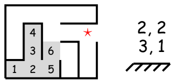

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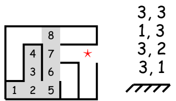

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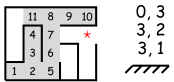

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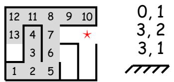

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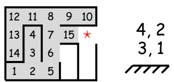

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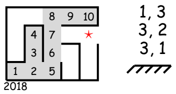
            push x on S
```



Stacks and Recursion

ed to recursion. In fact, can convert any recursive al-
tack-based (however, generally no great performance

me "push current variables and parameters, set param-
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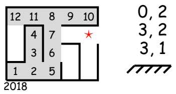
comes "pop to restore variables and parameters."

```
)
mb(start))
t start;
re, x,
 start:
start,x) && !isCrumb(x)
t(x)
)))
```

```
findExit(start):
  S = new empty stack;
  push start on S;
  while S not empty:
    pop S into start;
    if isExit(start)
      FOUND
    else if (!isCrumb(start))
      leave crumb at start;
      for each square, x,
        adjacent to start (in reverse):
          if legal(start,x) && !isCrumb(x)
            push x on S
```



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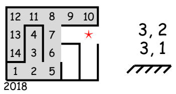

oices: Extension, Delegation, Adaptation

d `java.util.Stack` type *extends* `Vector`:

```
> extends Vector<Item> { void push(Item x) { add(x); } ... }
```

d have *delegated* to a field:

```
ack<Item> {
rayList<Item> repl = new ArrayList<Item>();
Item x) { repl.add(x); } ...
```

neralize, and define an *adapter:* a class used to make
ne kind behave as another:

```
StackAdapter<Item> {
st repl;
k that uses REPL for its storage. */
ckAdapter(List<Item> repl) { this.repl = repl; }
d push(Item x) { repl.add(x); } ...


ack<Item> extends StackAdapter<Item> {
) { super(new ArrayList<Item>()); }
```

Stacks and Recursion

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```
)


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t start;
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start,x) && !isCrumb(x)
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