cture #6: More Iteration: Sort an Array

out the command-line arguments in lexicographic or-

```
 the quick brown fox jumped over the lazy dog
x jumped lazy over quick the the
```

```
t {
rint WORDS lexicographically. */
void main(String[] words) {
, words.length-1);
;


 A[L..U], with all others unchanged. */
rt(String[] A, int L, int U) { /* "TOMORROW" */ }

 one line, separated by blanks. */
int(String[] A) { /* "TOMORROW" */ }
```

How do We Know If It Works?

refers to the testing of individual units (methods, classes) ram, rather than the whole program.

, we mainly use the JUnit tool for unit testing.

TestYear.java in lab #1.

testing refers to the testing of entire (integrated) set the whole program.

e, we'll look at various ways to run the program against uts and checking the output.

esting refers to testing with the specific goal of check- s, enhancements, or other changes have not introduced ssions).

Test-Driven Development

tests first.

nit at a time, run tests, fix and refactor until it works.

ally going to push it in this course, but it is useful and ollowing.

Testing sort

y easy: just give a bunch of arrays to `sort` and then ey each get sorted properly.

e sure we cover the necessary cases:

ses. E.g., empty array, one-element, all elements the

tative "middle" cases. E.g., elements reversed, elements ne pair of elements reversed, ...

Simple JUnit

ckage provides some handy tools for unit testing.

notation `@Test` on a method tells the JUnit machinery method.

on in Java provides information about a method, class, be examined within Java itself.)

f methods with names beginning with `assert` then allow ses to check conditions and report failures.

e.]

Selection Sort

```
 A[L..U], with all others unchanged. */
rt(String[] A, int L, int U) {

( Index s.t. A[k] is largest in A[L],...,A[U] )*/;
[k] with A[U] }*/;
ems L to U-1 of A. }*/;
```

Well, OK, not quite.

Selection Sort

```
s A[L..U], with all others unchanged. */
rt(String[] A, int L, int U) {

ndexOfLargest(A, L, U);
[k] with A[U] }*/;
ems L to U-1 of A. }*/;


[0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
lexOfLargest(String[] V, int i0, int i1) {
```

Selection Sort

```
s A[L..U], with all others unchanged. */
rt(String[] A, int L, int U) {

ndexOfLargest(A, L, U);
[k] with A[U] }*/;
 U-1);      // Sort items L to U-1 of A


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lexOfLargest(String[] V, int i0, int i1) {
```

Selection Sort

```
s A[L..U], with all others unchanged. */
rt(String[] A, int L, int U) {

ndexOfLargest(A, L, U);
 = A[k];  A[k] = A[U]; A[U] = tmp;
 U-1);      // Sort items L to U-1 of A


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terative version look like?

Selection Sort

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s A[L..U], with all others unchanged. */
rt(String[] A, int L, int U) {

ndexOfLargest(A, L, U);
 = A[k];  A[k] = A[U]; A[U] = tmp;
 U-1);      // Sort items L to U-1 of A
```

n:

```
J) {
ndexOfLargest(A, L, U);
 = A[k];  A[k] = A[U]; A[U] = tmp;
```

Find Largest

```
[0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
lexOfLargest(String[] V, int i0, int i1) {
```

Find Largest

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I0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
dexOfLargest(String[] V, int i0, int i1) {
)
;
(i0 < i1) */ {
```

Find Largest

```
I0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
dexOfLargest(String[] V, int i0, int i1) {
)
;
(i0 < i1) */ {
*( index of largest value in V[i0 + 1..i1] )*/;
( whichever of i0 and k has larger value )*/;
```

Find Largest

```
I0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
dexOfLargest(String[] V, int i0, int i1) {
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;
(i0 < i1) */ {
dexOfLargest(V, i0 + 1, i1);
( whichever of i0 and k has larger value )*/;
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Find Largest

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I0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
dexOfLargest(String[] V, int i0, int i1) {
)
;
(i0 < i1) */ {
dexOfLargest(V, i0 + 1, i1);
[i0].compareTo(V[k]) > 0) ? i0 : k;
0].compareTo(V[k]) > 0) return i0; else return k;
```

into an iterative version is tricky: not tail recursive.

e arguments to compareTo the first time it's called?

Iteratively Find Largest

```
I0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
dexOfLargest(String[] V, int i0, int i1) {
)
;
(i0 < i1) */ {
dexOfLargest(V, i0 + 1, i1);
[i0].compareTo(V[k]) > 0) ? i0 : k;
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/ Deepest iteration
 ...?; i ...?)
```

Iteratively Find Largest

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I0<=k<=I1, such that V[k] is largest element among
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dexOfLargest(String[] V, int i0, int i1) {
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(i0 < i1) */ {
dexOfLargest(V, i0 + 1, i1);
[i0].compareTo(V[k]) > 0) ? i0 : k;
0].compareTo(V[k]) > 0) return i0; else return k;




// Deepest iteration
 ...?; i ...?)
```

Iteratively Find Largest

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I0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
dexOfLargest(String[] V, int i0, int i1) {
)
;
(i0 < i1) */ {
dexOfLargest(V, i0 + 1, i1);
[i0].compareTo(V[k]) > 0) ? i0 : k;
0].compareTo(V[k]) > 0) return i0; else return k;



// Deepest iteration
- 1; i >= i0; i -= 1)
.compareTo(V[k]) > 0) ? i : k;
```

Iteratively Find Largest

```
I0<=k<=I1, such that V[k] is largest element among
 V[I1]. Requires I0<=I1. */
dexOfLargest(String[] V, int i0, int i1) {
)
;
(i0 < i1) */ {
dexOfLargest(V, i0 + 1, i1);
[i0].compareTo(V[k]) > 0) ? i0 : k;
0].compareTo(V[k]) > 0) return i0; else return k;



// Deepest iteration
- 1; i >= i0; i -= 1)
```

Another Problem

f integers, A, of length $N > 0$, find the smallest index, elements at indices $\geq k$ and $< N-1$ are greater than rotate elements k to $N-1$ right by one. For example, s

```
3, 0, 12, 11, 9, 15, 22, 12 }
```

as

```
3, 0, 12, 11, 9, 12, 15, 22 }
```

mple,

```
3, 0, 12, 11, 9, 15, 22, -2 }
```

```
4, 3, 0, 12, 11, 9, 15, 22 }
```

s like this?

```
3, 0, 12, 11, 9, 12, 15, 22 }
```

Finally, Printing

```
n one line, separated by blanks. */
int(String[] A) {
= 0; i < A.length; i += 1)
.print(A[i] + " ");
println();

provides a simple, specialized syntax for looping
entire array: */
s : A)
.print(s + " ");
```

Your turn

```
Shove {

e elements A[k] to A[A.length-1] one element to the
. where k is the smallest index such that elements
ugh A.length-2 are all larger than A[A.length-1].

d moveOver(int[] A) {
. IN
```

Another Problem

f integers, A, of length $N > 0$, find the smallest index, elements at indices $\geq k$ and $< N-1$ are greater than rotate elements k to $N-1$ right by one. For example, s

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s like this?

```
3, 0, 12, 11, 9, 12, 15, 22 }
```

changed. (No, the spec is not ambiguous.)