Programming in Java: lecture 9

- Searching and Sorting
  - Linear and binary search
  - Insertion Sort, Selection Sort
- Multi-dimensional Arrays
  - Two dimensional arrays
- Example

Slides made for use with "Introduction to Programming Using Java, Version 5.0" by David J. Eck
Some figures are taken from "Introduction to Programming Using Java, Version 5.0" by David J. Eck
Lecture 9 covers Section 7.4 to 7.5

Except where otherwise noted, this work is licensed under
http://creativecommons.org/licenses/by-sa/3.0

Searching

- Finding a particular element
- Linear search
- Association List
  - (key,value) pairs
  -
```
class PhoneEntry {
    String name;
    String phoneNum;
}
```

Linear Search

```
 * Searches the array A for the integer N.  If N is not in the array,
 * then -1 is returned.  If N is in the array, then return value is
 * the first integer i that satisfies A[i] == N.
 */
static int find(int[] A, int N) {

   for (int index = 0; index < A.length; index++) {
      if ( A[index] == N )
         return index;  // N has been found at this index!
   }

   // If we get this far, then N has not been found
   // anywhere in the array.  Return a value of -1.

   return -1;

}
```

Binary Search

- Why?
- Liniear search
  - 1000 items, max 1000 comparisons
  - 1000000 items, max 1000000 comparisons
- Binary search
  - 1000 items, 10 comparisons
  - 1000000 items, 20 comparisons
  - Data must be sorted

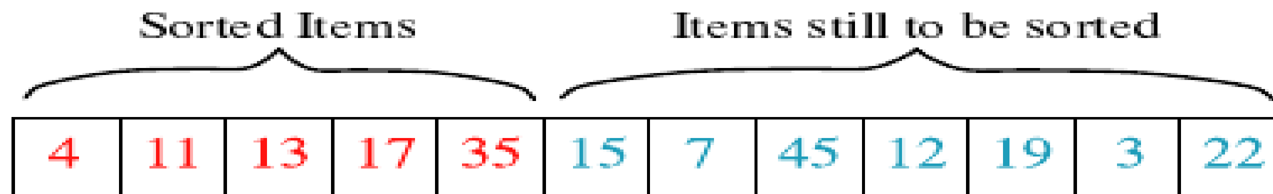
```
 * Searches the array A for the integer N.
 * Precondition:  A must be sorted into increasing order.
 * Postcondition: If N is in the array, then the return value, i,
 *    satisfies A[i] == N.  If N is not in the array, then the
 *    return value is -1.
 */
static int binarySearch(int[] A, int N) {

    int lowestPossibleLoc = 0;
    int highestPossibleLoc = A.length - 1;

    while (highestPossibleLoc >= lowestPossibleLoc) {
       int middle = (lowestPossibleLoc + highestPossibleLoc) / 2;
       if (A[middle] == N) {
                 // N has been found at this index!
          return middle;
       }
       else if (A[middle] > N) {
                 // eliminate locations >= middle
          highestPossibleLoc = middle - 1;
       }
       else {
                 // eliminate locations <= middle
          lowestPossibleLoc = middle + 1;
       }
    }

    // At this point, highestPossibleLoc < LowestPossibleLoc,
    // which means that N is known to be not in the array.  Return
    // a -1 to indicate that N could not be found in the array.

    return -1;

}
```

Sorting

- Insertion sort
- Selection sort

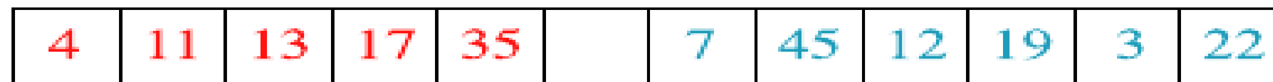
Insertion Sort

Start with a partially sorted list of items:



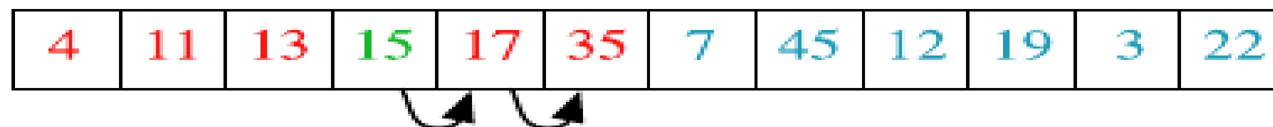
Temp: 15

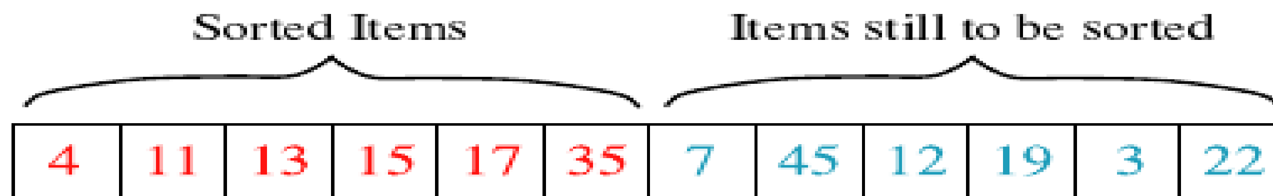
Copy next unsorted item into Temp, leaving a "hole" in the array.



Move items in sorted part of array to make room for Temp.

Temp: 15





Now, the sorted part of the list has increased in size by one item.

Insertion Sort

```
static void insertionSort(int[] A) {
      // Sort the array A into increasing order.

   int itemsSorted; // Number of items that have been sorted so far.

   for (itemsSorted = 1; itemsSorted < A.length; itemsSorted++) {

         // Assume that items A[0], A[1], ... A[itemsSorted-1]
         // have already been sorted.  Insert A[itemsSorted]
         // into the sorted part of the list.

      int temp = A[itemsSorted];  // The item to be inserted.
      int loc = itemsSorted - 1;  // Start at end of list.

      while (loc >= 0 && A[loc] > temp) {
         A[loc + 1] = A[loc]; // Bump item from A[loc] up to loc+1.
         loc = loc - 1;       // Go on to next location.
      }

      A[loc + 1] = temp; // Put temp in last vacated space.
   }
}
```

Selection Sort

```
static void selectionSort(int[] A) {
      // Sort A into increasing order, using selection sort

   for (int lastPlace = A.length-1; lastPlace > 0; lastPlace--) {
         // Find the largest item among A[0], A[1], ...,
         // A[lastPlace], and move it into position lastPlace
         // by swapping it with the number that is currently
         // in position lastPlace.

      int maxLoc = 0;  // Location of largest item seen so far.

      for (int j = 1; j <= lastPlace; j++) {
         if (A[j] > A[maxLoc]) {
               // Since A[j] is bigger than the maximum we've seen
               // so far, j is the new location of the maximum value
               // we've seen so far.
            maxLoc = j;
         }
      }

      int temp = A[maxLoc];  // Swap largest item with A[lastPlace].
      A[maxLoc] = A[lastPlace];
      A[lastPlace] = temp;

   }  // end of for loop

}
```

Sorting

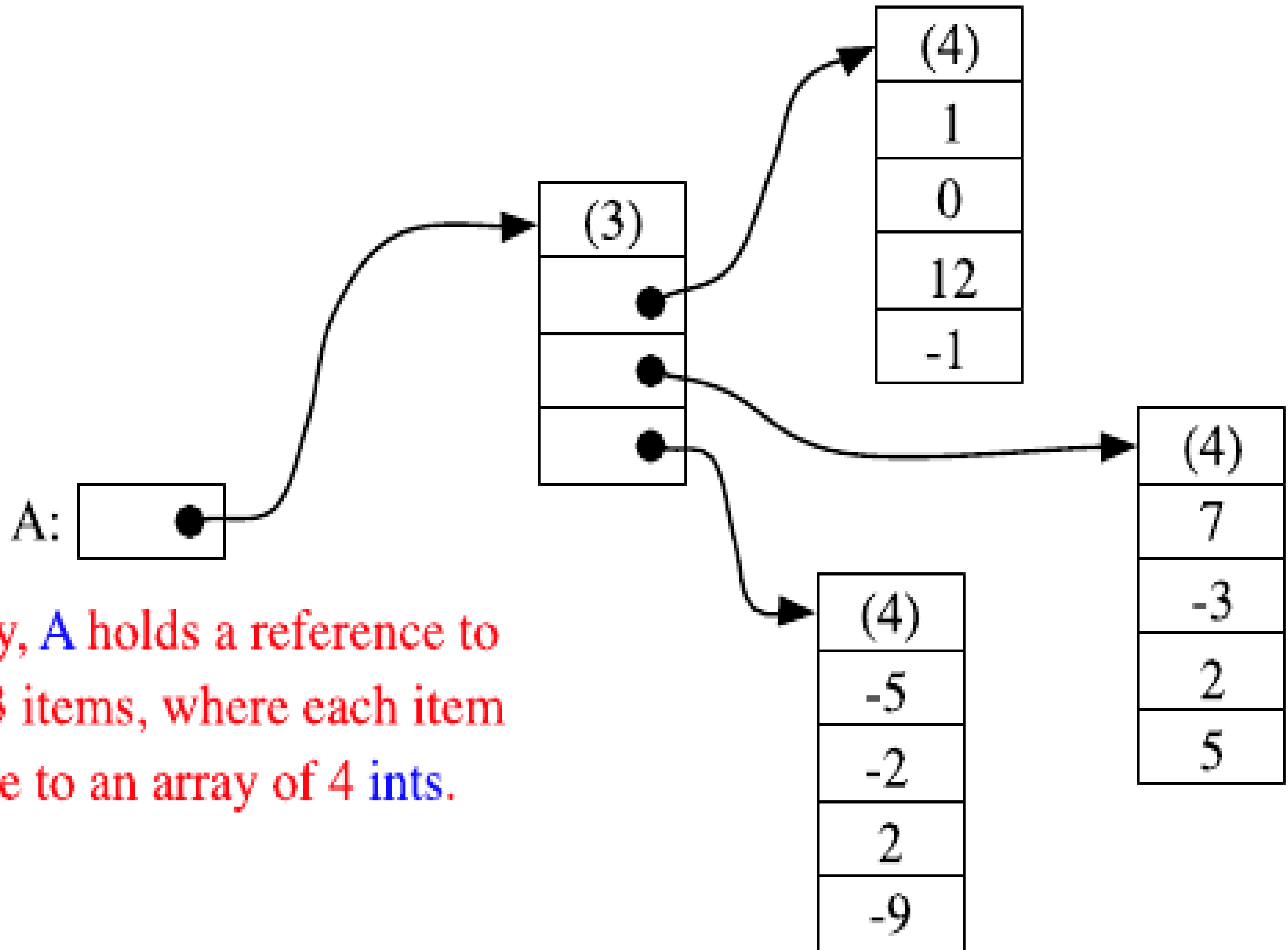
- Comparing is not always simple
-
```
if ( c1.getSuit() < c.getSuit() ||
        (c1.getSuit() == c.getSuit() && c1.getValue() < c.getValue()) ) {
```
- implemented on classes
-
```
str1.compareTo(str2)
```
- A lot already implemented in Java
- java.util.Arrays.binarySearch()
- Collections.sort()

Multi-dimensional Arrays

- int[][] A;
- A = new int[3][4];
- int[][] A = new int[3][4];

```
int[][]  A  =  {  {  1,  0, 12, -1 },
                  {  7, -3,  2,  5 },
                  { -5, -2,  2, -9 }
               };
```

Example



Example

A:

1	0	12	-1
7	-3	2	5
-5	-2	2	-9

A[0][0]	A[0][1]	A[0][2]	A[0][3]
A[1][0]	A[1][1]	A[1][2]	A[1][3]
A[2][0]	A[2][1]	A[2][2]	A[2][3]

Example

- Team programming