Sorting

- Input is a list of n items that can be compared.
- Output is an ordered list of those n items.
- Fundamental problem that has received a lot of attention over the years.
- Used in many applications.
- Scores of different algorithms exist.

Task: To compare algorithms
- On what bases?
  - Time
  - Space
  - Other

Sorting Algorithms

- Selection Sort
- Insertion Sort
- Bubble Sort
- Shaker Sort
- Shell Sort
- Merge Sort
- Heap Sort
- Quick Sort
- Bucket & Radix Sort
- Counting Sort
Selection Sort

Algorithm  selectionSort(array a, integer N)
// given array a[0..N-1]
{
  for(int p = 0; p < N-1; p++)
  {
    Compute j, the index of the smallest item in a[p..N];
    Swap a[p] and a[j];
  }
}
Figure 8.3
Basic action of insertion sort (the shaded part is sorted)

<table>
<thead>
<tr>
<th>Array Position</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial State</td>
<td>8</td>
<td>5</td>
<td>9</td>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>After a[0..1] is sorted</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>After a[0..2] is sorted</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>After a[0..3] is sorted</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>After a[0..4] is sorted</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>After a[0..5] is sorted</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Figure 8.4
A closer look at the action of insertion sort (the dark shading indicates the sorted area; the light shading is where the new element was placed).

<table>
<thead>
<tr>
<th>Array Position</th>
<th>0</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial State</td>
<td>8</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After a[0..1] is sorted</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After a[0..2] is sorted</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After a[0..3] is sorted</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>After a[0..4] is sorted</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>After a[0..5] is sorted</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Insertion Sort

algorithm insertionSort( array a, integer N)

// given array a[0..N-1]
{
    for( int p = 1; p < N; p++ )
    {  // insert a[p] in its right location
        temp = a[p];
        int j = p;
        while (j > 0 && temp < a[j-1])
        {  
a[j] = a[j-1];
            j = j-1;
        }  
a[j] = temp;
    }  
}