PROGRAMMING, DATA STRUCTURES AND ALGORITHMS IN PYTHON

Week 3, Lecture 7

Madhavan Mukund, Chennai Mathematical Institute
http://www.cmi.ac.in/~madhavan

How to sort?

* You are a Teaching Assistant for a course

* The instructor gives you a stack of exam answer papers with marks, ordered randomly

* Your task is to arrange them in descending order

Strategy 2

* First paper: put in a new stack

* Second paper:

  * Lower marks than first? Place below first paper
    Higher marks than first? Place above first paper

* Third paper

  * Insert into the correct position with respect to first two papers

* Do this for each subsequent paper:
  insert into correct position in new sorted stack

Strategy 2 …

74   32   89   55   21   64

Strategy 2 …

74   32   89   55   21   64
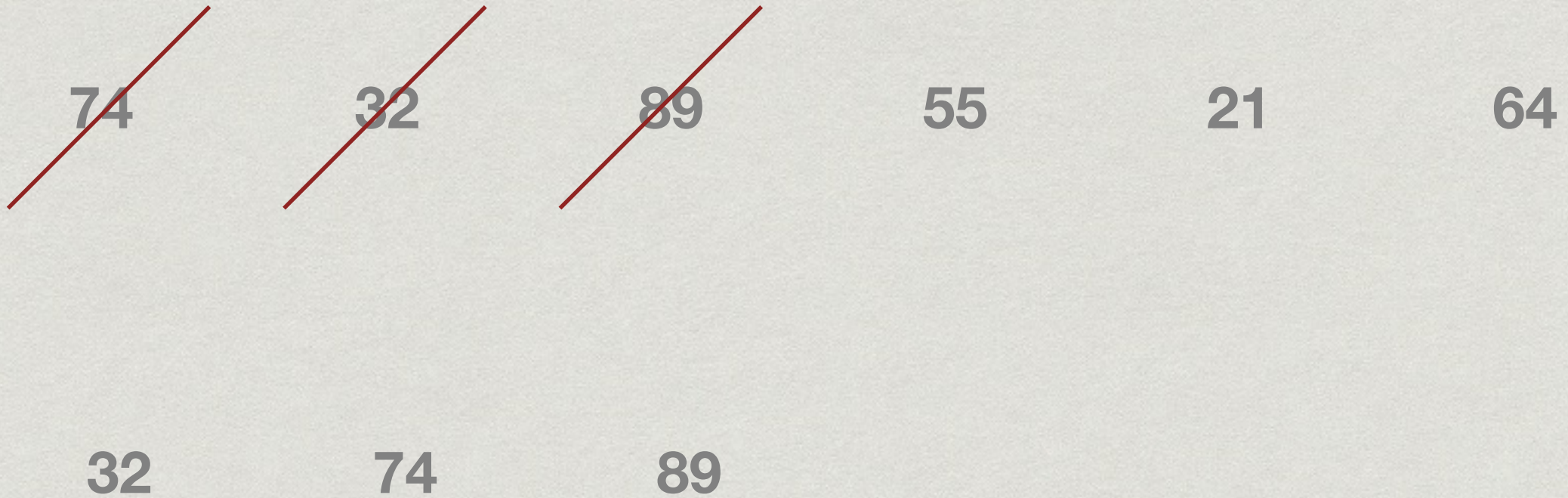
74

Strategy 2 …

74   32   89   55   21   64

32   74

Strategy 2 …

74 ~~~~~ 32 ~~~~~ 89 ~~~~~ 55 ~~~~~ 21 ~~~~~ 64

32 ~~~~~ 74 ~~~~~ 89

Strategy 2 …

~~74~~   ~~32~~   ~~89~~   ~~55~~   21   64

32   55   74   89

Strategy 2 …

74   32   89   55   21   64

21   32   55   74   89

Strategy 2 …

74   32   89   55   21   64

21   32   55   64   74   89
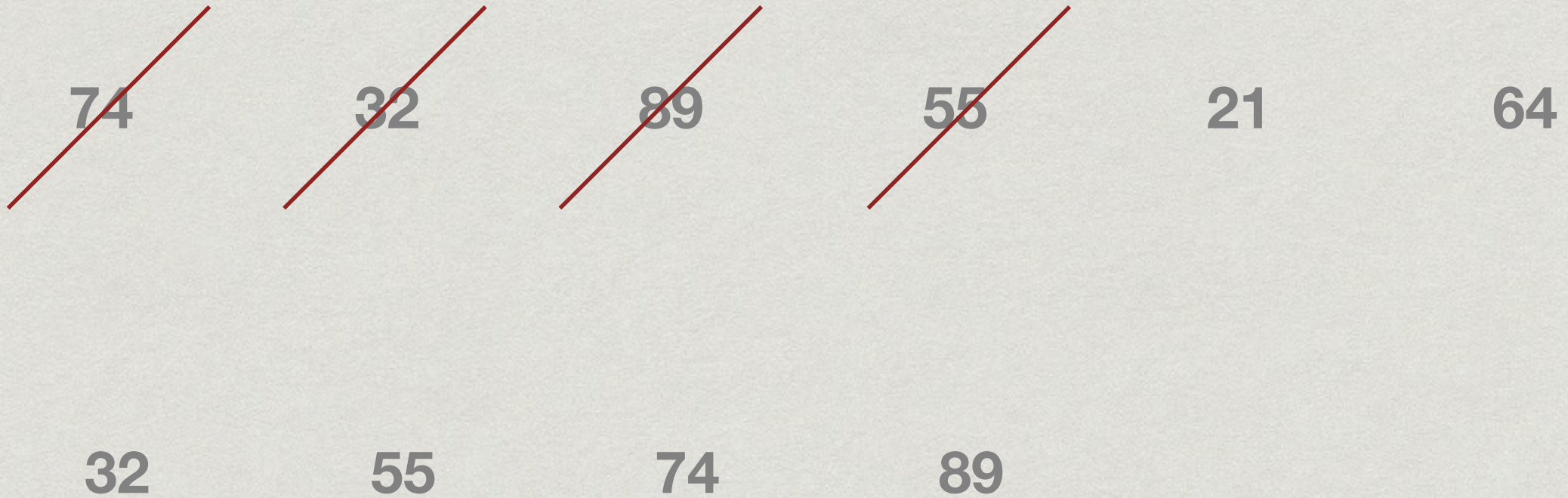
Strategy 2 …

Insertion Sort

* Start building a sorted sequence with one element

* Pick up next unsorted element and insert it into its correct place in the already sorted sequence

Insertion Sort

```python
def InsertionSort(seq):

 for sliceEnd in range(len(seq)):
    # Build longer and longer sorted slices
    # In each iteration seq[0:sliceEnd] already sorted

    # Move first element after sorted slice left
    # till it is in the correct place
    pos = sliceEnd
    while pos > 0 and seq[pos] < seq[pos-1]:
      (seq[pos],seq[pos-1]) = (seq[pos-1],seq[pos])
      pos = pos-1
```

Insertion Sort

74   32   89   55   21   64

Insertion Sort

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Insertion Sort

32 74 89 55 21 64

Insertion Sort

32   74   89   55   21   64

Insertion Sort

32   74   55   89   21   64

Insertion Sort

32   55   74   89   21   64

Insertion Sort

32   55   74   21   89   64

Insertion Sort

32   55   21   74   89   64

Insertion Sort

32   21   55   74   89   64

Insertion Sort

21   32   55   74   89   64

Insertion Sort

21   32   55   74   64   89

Insertion Sort

21   32   55   64   74   89

Analysis of Insertion Sort

* Inserting a new value in sorted segment of length k requires upto k steps in the worst case

* In each iteration, sorted segment in which to insert increased by 1

* $T(n) = 1 + 2 + \ldots + n-1 = n(n-1)/2 = O(n^2)$