

CS231 Course Text

- *Introduction to Algorithms* (2nd Edition) by Thomas Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein.



Course Requirements

Problem Sets*	25%
Midterm 1	20%
Midterm 2	25%
Final Exam	30%
<hr/>	
Total	100%

*You are encouraged to work together. However, please acknowledge collaborative work.

Sorting a Hand of Hearts



Insertion Sort

U	N	S	O	R	T	E	D				
U	U	S	O	R	T	E	D				
N	U	U	O	R	T	E	D				
N	S	U	U	R	T	E	D				
N	O	S	U	U	T	E	D				
N	O	R	S	U	U	T	E	D			
N	O	R	S	T	U	U	T	E	D		
E	N	O	R	S	T	U	U	T	E	D	
D	E	N	O	R	S	T	U	U	T	E	D

Insertion Sort Pseudocode*

```

Insertion-Sort(A)
1  for j ← 2 to length[A]
2    do key ← A[j]           {Insert A[j] into }
3    i ← j - 1              { sorted sequence }
4    while i > 0 and A[i] > key { A[1..j-1]. }
5      do A[i+1] ← A[i]
6      i ← i - 1
7    A[i+1] ← key
    
```

*Be sure to read the authors' list of pseudocode conventions in section 2.1 of the text.

Correctness of Insertion Sort

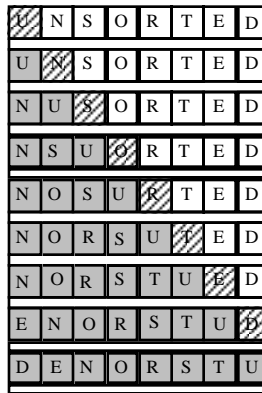
█	N	S	O	R	T	E	D
U	█	S	O	R	T	E	D
N	U	█	O	R	T	E	D
N	S	U	█	R	T	E	D
N	O	S	U	█	T	E	D
N	O	R	S	U	█	E	D
N	O	R	S	T	U	█	D
E	N	O	R	S	T	U	█
D	E	N	O	R	S	T	U

Loop Invariant:

At the start each **for** loop, subarray $A[1 \dots j - 1]$ consists of the elements originally in $A[1 \dots j - 1]$ but in sorted order.

Using Insertion Sort's Loop Invariant*

Initialization:
True prior to 1st iteration.



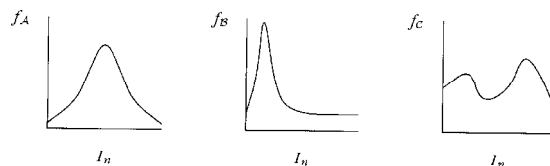
Maintenance:
If true before one iteration, it's true before the next.

Termination:
A useful property of the invariant helps establish algorithmic correctness.

*At the start each for loop, subarray $A[1 \dots j - 1]$ consists of the elements originally in $A[1 \dots j - 1]$ but in sorted order.

Efficiency

- It is natural to let $f(n)$ be "running time of an algorithm on an input of size n "



- The problem is $f(n)$ is not a well-defined function.

Analysis of Insertion Sort

	<i>cost</i>	<i>times</i>
Insertion-Sort(A)		
for $j \leftarrow 2$ to $\text{length}[A]$	c_1	
do $\text{key} \leftarrow A[j]$	c_2	
$i \leftarrow j - 1$	c_3	
while $i > 0$ and $A[i] > \text{key}$	c_4	
do $A[i+1] \leftarrow A[i]$	c_5	
$i \leftarrow i - 1$	c_6	
$A[i+1] \leftarrow \text{key}$	c_7	