Semantics: the meaing of a program

1. Operational semantics: describes what an operation does in a machine using a different language (ex: Assembly, Java)  
   ex:what assembly instructions do: “x=5”
2. Axiomatic semantics: Logically describe the behavior of a program using pre-conditions + post-conditions
3. Denotational semantics: replace program structure with mathematical objects 🡪 use a math model of how the program state evaluates

Ex. Selection sort

Selection Sort (A: array of n integers)  
 For (i = n - 1; I > 0; i--) {  
 int max = 0;  
 for (j = 1; j < I; j++) {  
 if (A[j] > A[max])  
 max = j  
 }  
 if (A[max] > A[i]) {  
 int temp = A[max]  
 A[max] = A[i]  
 A[i] = temp  
 }  
 }  
}

(0) Goal: A is sorted, A[0] <= A[1] <= A[n-1]  
(1) (end of outer loop) we need the loop invariant of the outer loop

Loop invariant:  
1. True after each iteration  
2. LI and not condition implies loop goal  
3. A[I … n-1] is sorted and A[i] >= A[0 … i-1] (and is permutation of original array)  
  
(1.5) {weakest precondition} i-- or i = i -1   
(2) A[i-1, …, (n-1)] is sorted and A[i-1] >= A[0 … i-2]  
(3) A[i-1], tmp, A[i+1, … , n-1] is sorted and A[i-1] >= A[0 … i-2]