CS 367 - Introduction to Data Structures
Tuesday, February 16, 2016

Homework 4 due 10 pm Friday, February 19th
Program 2 due 10 pm Sunday, March 6th

Last Time

LinkedList Class
Linked List Variations
- header node
- tail reference

LinkedListIterator Class
Iterable and For-Each Loops

Today

Iterable and For-Each Loops (from last lecture)
More Linked List Variations
- double linking
- circular linking

Complexity
- concept
- big-O notation
- analyzing algorithms practice
- analyzing Java code
- practice analyzing Java code

Next Time

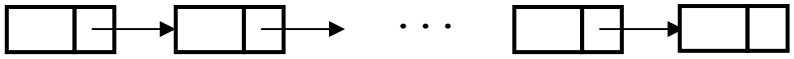
Read: finish *Complexity*
Complexity
- best/worst cases
- significance of scaling
- complexity caveats

Comparing ArrayList vs LinkedList
- shadow array - improving array resizing

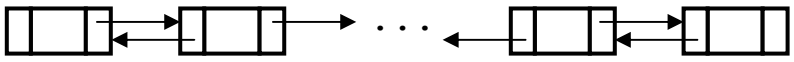
Double and Circular Linking

Doubly-Linked Chains of Nodes

Circular Singly-Linked Chains of Nodes



Circular Doubly-Linked Chains of Nodes

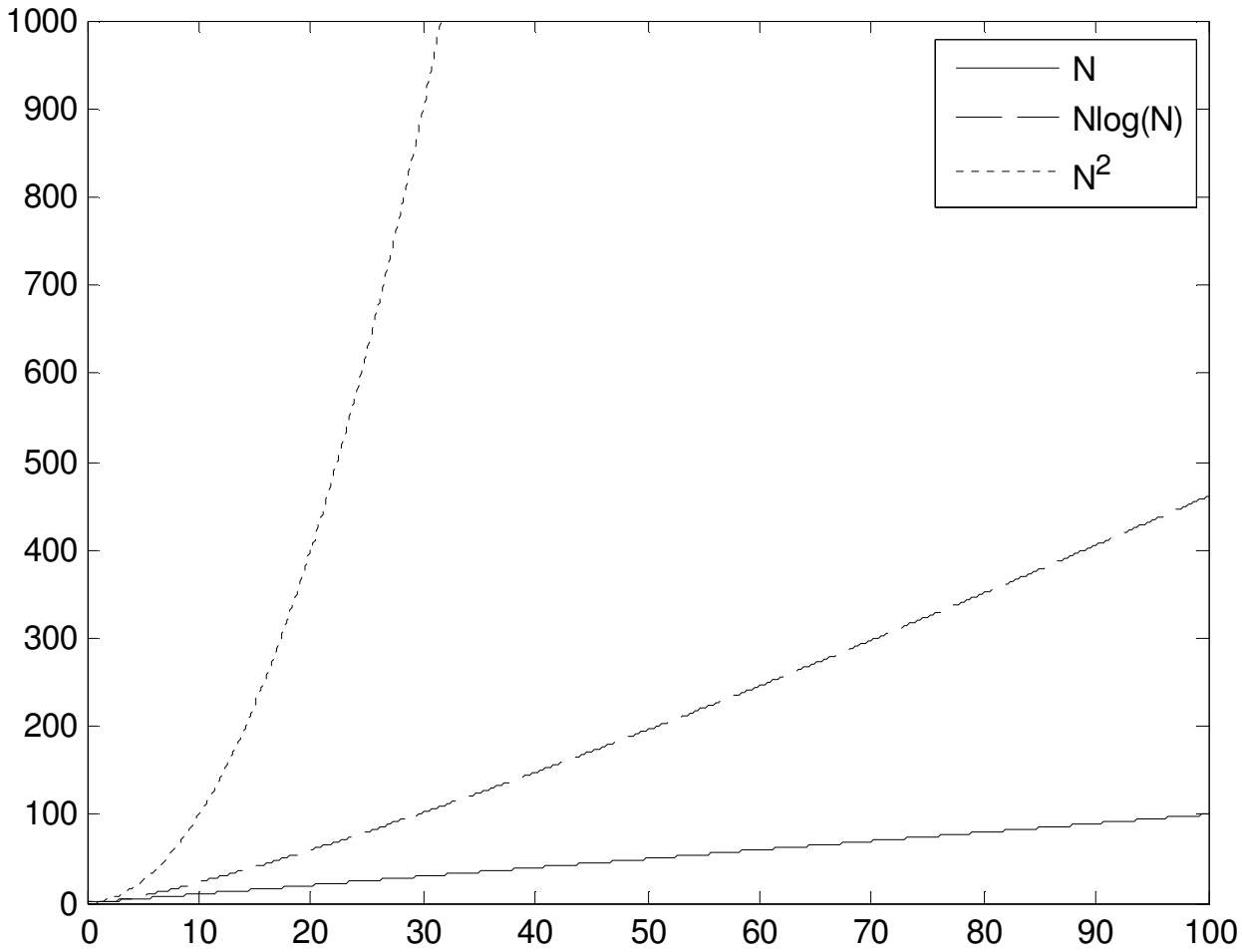


Analyzing Algorithm Efficiency

Complexity

If problem size doubles and the number of operations:

Example: Giving a Toast



Complexity Analysis:

-

-

Big-O Notation

Concept

some growth rate functions:

Simplifying Equations

Formal Definition

Complexity of Java Code

Basic operations

Sequence of statements

```
statement1;
statement2;
...
statementk;
```

If-else

```
if (cond) {
   //if sequence of statements
}
else {
   //else sequence of statements
}
```

Complexity of Java Code (cont.)

Basic loops

→ What is the problem size based on?

```
for (i = 0; i < j; i++) {
   //sequence of statements
}
```

Nested loops

→ What is the problem size based on?

```
for (i = 0; i < N; i++) {
   for (j = 0; j < M; j++) {
      //sequence of statements
   }
}
```

Loops with nested method calls (assume problem size based on N)

```
for (i = 0; i < N; i++) {
   f1(i);  //assume O(1)
}
```

```
for (i = 0; i < N; i++) {
   f2(N);  //assume O(N)
}
```

```
for (i = 0; i < N; i++) {
   f3(i);  //assume O(i)
}
```

Practice - Complexity of Java Code

method1

→ What is the problem size based on?

```
public void method1(int[] A) {
   for (int i = 0; i < A.length - 1; i++)
      method2(A, i);
}
```

method2

```
public void method2(int[] B, int s) {
   for (int i = s; i < B.length - 1; i++)
      if (B[i] > B[i+1])
         method3(B, i, i+1);
}
```

method3

```
public void method3(int[] C, int x, int y) {
   int temp = C[x];
   C[x] = A[y];
   C[y] = temp;
}
```

Practice - Complexity of Java Code

method4

→ What is the problem size based on?

```
public void method4(int Q) {
   int sum = 0, R = 1000;

   for (int i = Q; i >= 1; i--)
      for (int j = 0; j < R; j++)
         sum += j;
}
```

method5

→ What is the problem size based on?

```
public void method5(int X) {
   int tmp, arr[];

   arr = new int[X];
   for (int i = 0; i < X; i++)
      arr[i] = X - i;

   for (int i = 0; i < X - 1; i++) {
      for (int j = i; j < X - 2; j++) {
         if (arr[j] > arr[j+1]) {
            tmp = arr[j];
            arr[j] = arr[j+1];
            arr[j+1] = tmp;
         }
      }
   }
}
```