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High-Performance Computing With Java™ Technology

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Rules for Optimization (Trad.)

- Don’t
- Use the right algorithms and data structures
- 90/10-rule
- Use a profiler
- Measure before and after
- (Don’t optimize as you go)

Optimization

- Algorithms and data structures
- Code tuning

Code Lives Longer Than Hardware

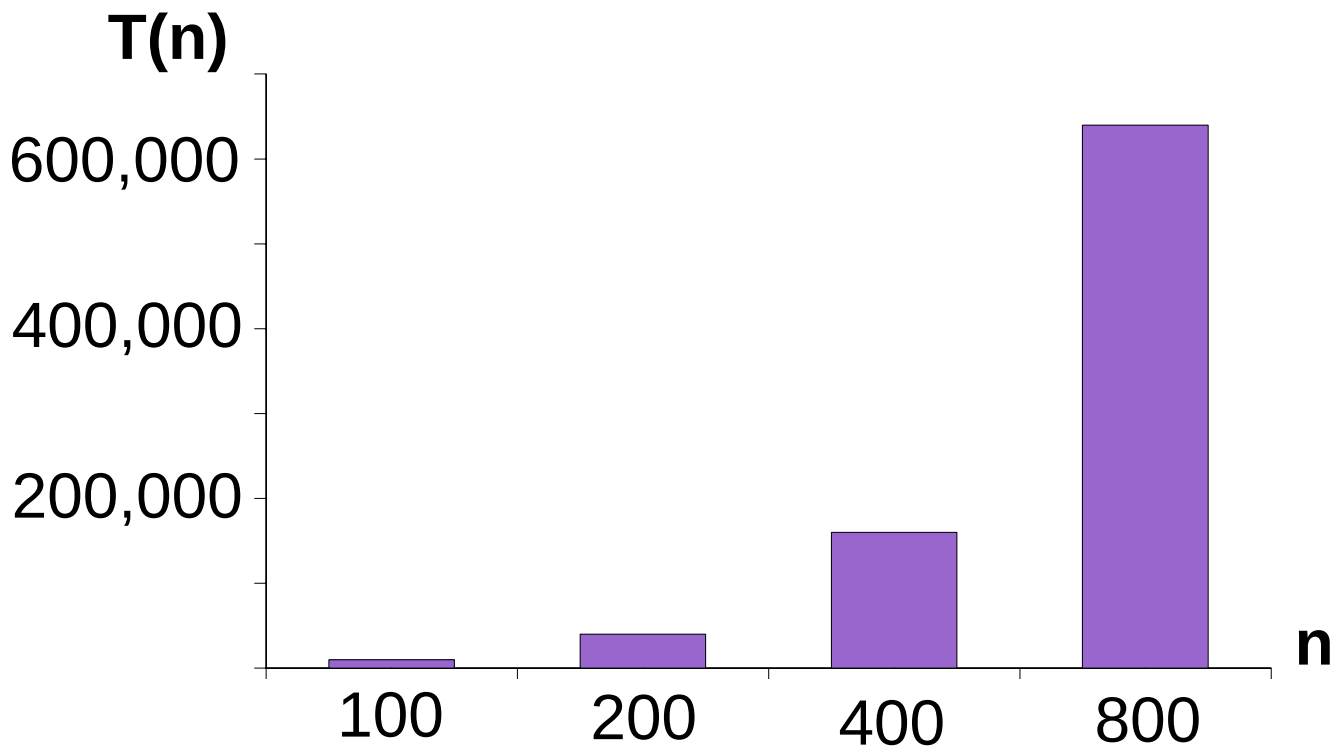
- TeX
- Y2K
- Genetic programs

A Changing World

- Processors get faster
- Memory gets larger
- Problems grow larger
- Programs either improve or degrade

Program Degradation Due to Quadratic Growth

$T(n) = n^2$, where n is size and T(n) time



Spot the Square

```
String str = "";

for (int i = 0; i < 10000; i++) {
    str += i;
}

System.out.println(str);
```

Remove the Square

```
StringBuffer strBuf = new StringBuffer();

for (int i = 0; i < 10000; i++) {
    strBuf.append(i);
}

System.out.println(strBuf);
```

What Really Happened?

```
> javap -c MyClass

...
 8 new #3 <Class StringBuffer>
11 dup
12 invokespecial #4 <Method StringBuffer()>
15 aload_1
16 invokevirtual #5 <Method StringBuffer append(String)>
19 iload_2
20 invokevirtual #6 <Method StringBuffer append(int)>
23 invokevirtual #7 <Method String toString()>
26 astore_1
27 iinc 2 1
30 iload_2
31 sipush 10000
34 if_icmplt 8
...
```

Spot the Square (2)

```
List myList = new ArrayList();
Random rand = new Random();

for (int i = 1; i < 75000; i++) {
    int k = rand.nextInt(i);
    myList.add(k, new Object());
}
```

Remove the Square (2)

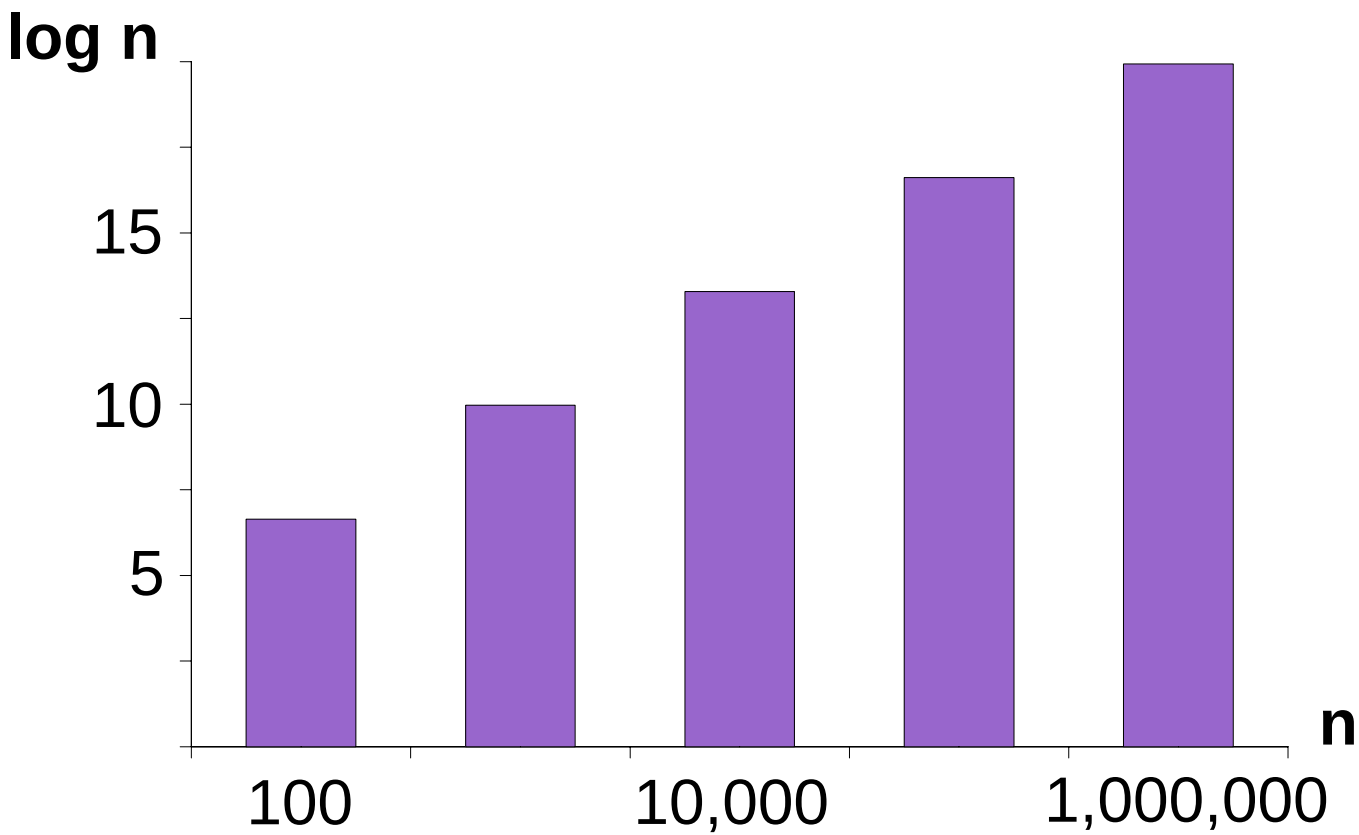
```
List myList = new IndexTreeList();
Random rand = new Random();

for (int i = 1; i < 75000; i++) {
    int k = rand.nextInt(i);
    myList.add(k, new Object());
}
```

List Operations

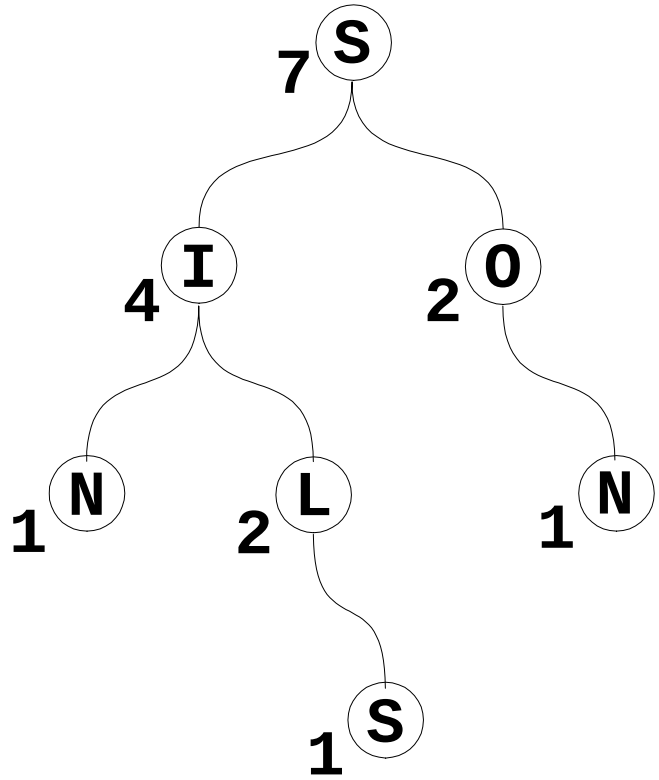
	Array	Linked	IndexTree
add(i, x)	n	n	log n
remove(i)	n	n	log n
get(i)	1	n	log n
get(0)	1	1	log n

Logarithmic Growth



Index Tree

0	N
1	I
2	L
3	S
4	S
5	O
6	N



Object Pool

```
class Node {
   private static Node[] pool = new Node[50];
   private static int topOfPool = 0;
   ...

   public static Node create() {
      if (topOfPool > 0)
         return pool[--topOfPool];
      else
         return new Node();
   }

   public static void destroy(Node n) { }
}
```

Spot the Square (3)
[Trick Question]

```
StringBuffer strBuf = new StringBuffer();
BigInteger k;

for (int i = 0; i < 25000; i++)
    strBuf.append("7");
k = new BigInteger(strBuf.toString());
k = k.multiply(k);
System.out.println(k);
```

Use a Profiler

```
> java -Xrunhprof ClassName

TRACE 259:
java.math.MutableBigInteger.divide(<Unknown>:Unknown line)
java.math.BigInteger.toString(<Unknown>:Unknown line)
java.math.BigInteger.toString(<Unknown>:Unknown line)
java.lang.String.valueOf(<Unknown>:Unknown line)
```

Alt: Perform Explicit Timings

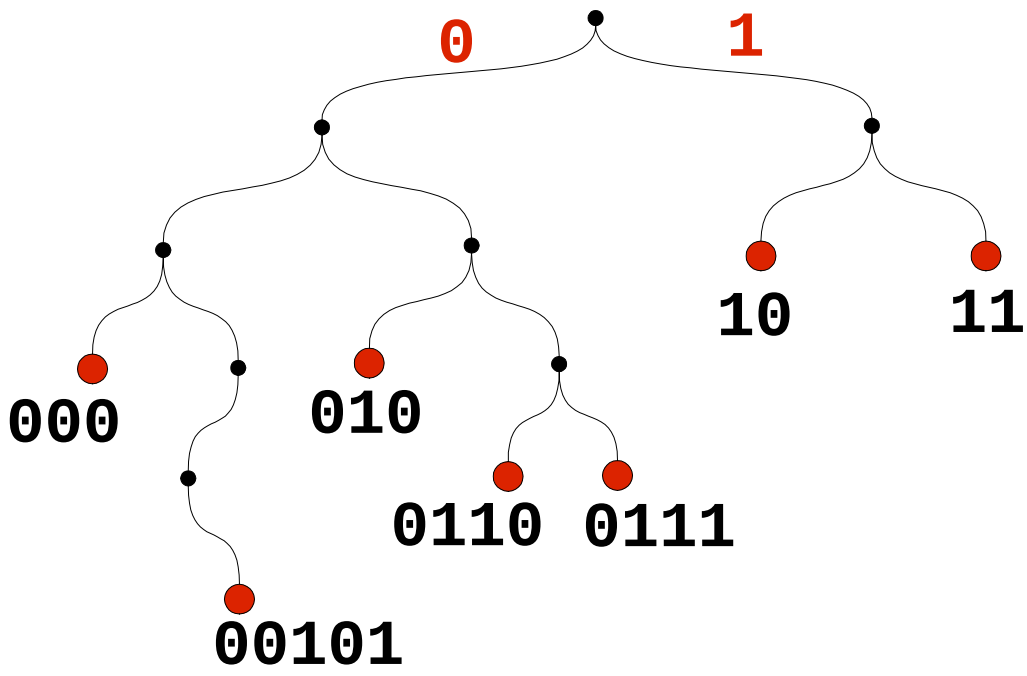
```
PrintStream o = System.out;

o.print("multiply: ");
long time = System.currentTimeMillis();
k = k.multiply(k);
o.println(System.currentTimeMillis()-time);

o.print("toString: ");
time = System.currentTimeMillis();
String str = k.toString();
o.println(System.currentTimeMillis()-time);
```

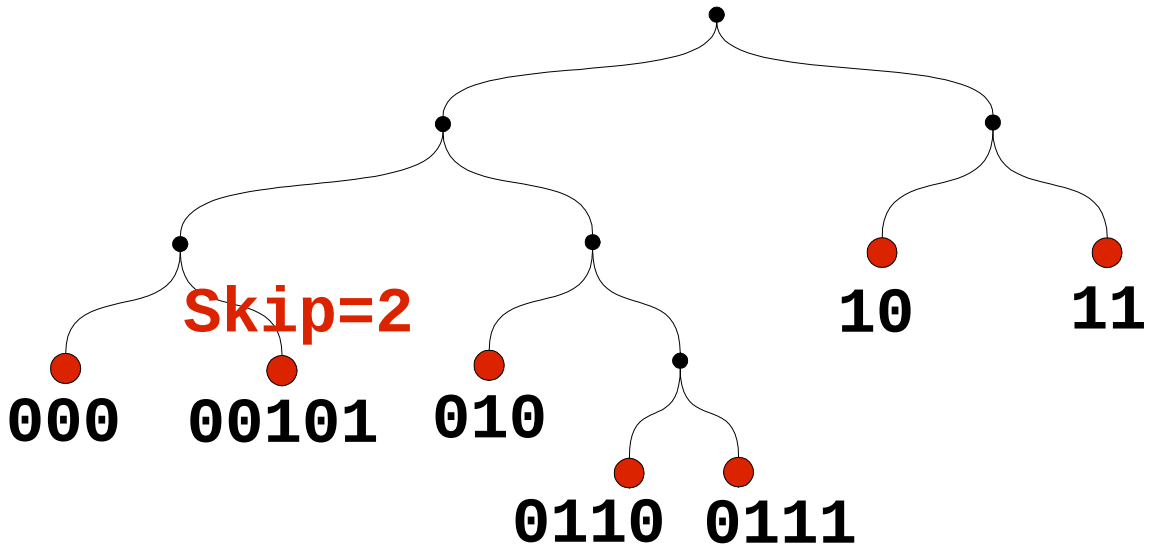
Routing Table as Trie

```
000
00101
010
0110
0111
10
11
```



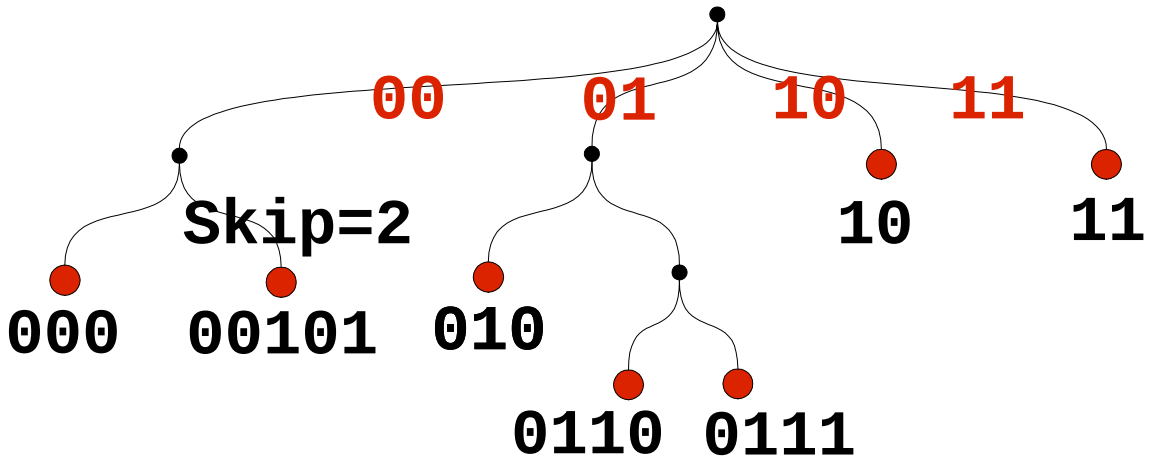
Path Compression

```
000
00101
010
0110
0111
10
11
```



Level Compression

```
000
00101
010
0110
0111
10
11
```



Routing Table Lookup

```
int node = trie[0];
int pos = getSkip(node);
int branch = getBranch(node);
int adr = getAdr(node);
while (branch != 0) {
  node = trie[adr + extract(pos, branch, s)];
  pos += branch + getSkip(node);
  branch = getBranch(node);
  adr = getAdr(node);
}
```

References

- http://www.research.ibm.com/journal/sj39-1.html
- http://www.javagrande.org
- http://www.nada.kth.se/~snilsson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