Chapter 8, Strings:

- General introduction; string sorting (**Today**)
- Tries (next week Monday)
- Other string topics (next week Wednesday)
    - Regular expressions
    - ~~Huffman encoding~~
    - ~~Edit distance~~
    - ~~Grammars and parsing~~

Today:

- Why we care about strings
- Sorting strings
    - String quick sort
    - String bucket sort
    - String radix sort

End-of-semester important dates

- Tues, Dec 2: Test 4 practice problems made available. ✓
- Thurs, Dec 4: Last "normal" lab ✓
- Mon, Dec 8: Last project assigned
- Tues, Dec 9: Last "normal" running of project grading script
- Wed, Dec 10: Test 3 & 4 Review sheet distributed.
- Thurs, Dec 11: Review lab (pick practice problems for Test 4)
- Fri, Dec 12, AM: "Two-minute warning" running of project grading script (Canvas gradebook will not be updated—see project report in your turn-in file)
  Note that Fri, Dec 12 is the *Last Day of Classes*.
- Fri, Dec 12, 11:59 PM: Official project deadline
- Sat, Dec 13, when I wake up: Permissions to turn-in folders turned off
- Mon, Dec 15: Project grading script run for final/semester grades
- Thurs, Dec 18, 10:30am-12:30pm: Tests 3 and 4 (in lab)

Why we care about strings

- Strings are different
- Strings are common
- Strings are a representative example

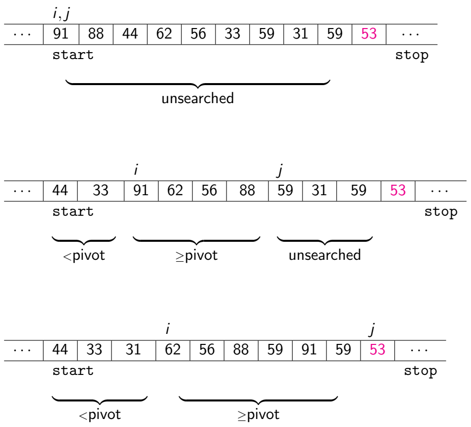
```java
public class DNASequence {
    /** An alphabet for DNA */
    private static enum Nucleotide { A, C, G, T }
    /** The string of nucleotides */
    private Nucleotide[] sequence;
}
```

```
public class BigInt {

    private byte[] digits;

    /** Compute the sum of this and another BigInt. */
    public BigInt add(BigInt other) {
        // The result object
        BigInt sum = new BigInt();
        // The result object has at most one more digit
        // than the larger number of digits of the two addends
        sum.digits = new byte[(digits.length > other.digits.length?
                digits.length : other.digits.length) + 1];
        // Add by column
        int carry = 0;
        for (int i = 0; i < sum.digits.length; i++) {
            // Digits in current columns of the two addends
            int a = digits.length <= i? digits[i] : 0;
            int b = other.digits.length <= i ? other.digits.length : 0;
            // The sum of the current digits plus carry from previous iteration
            int s = a + b + carry;
            // Mod that sum by 256 to get the appropriate digit in result,
            // divide to get the carry for next time.
            sum.digits[i] = (byte) (s % 256);
            carry = s / 256;
        }
        assert carry == 0;
        return sum;
    }
}
```

Quick sort:



Invariant 11 (Loop of `partition()`)

(a) $\texttt{start} \leq i \leq j < \texttt{stop}$.

(b) $\forall\ k \in [\texttt{start}, i)$, $\texttt{sequence}[k] < \texttt{sequence}[\texttt{stop} - 1]$.

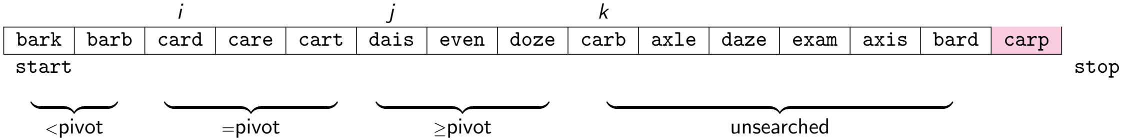
(c) $\forall\ k \in [i, j)$, $\texttt{sequence}[k] \geq \texttt{sequence}[\texttt{stop} - 1]$.

(d) $j - \texttt{start}$ is the number of iterations completed.

dais	card	bark	care	even	barb	doze	cart	carb	axle	daze	exam	axis	bard	carp

card	bark	care	barb	carb	axle	axis	bard	carp	dais	even	doze	cart	daze	exam

barb	axle	axis	bard	card	bark	care	carb	· · ·



Invariant 40. [Loop of `string_quick_sort_r()`]

Let c be the character in position `pre` in the string in position `stop` $- 1$.

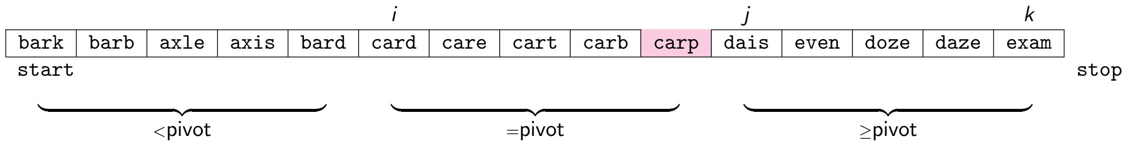
(a) `start` $\leq i \leq j \leq k <$ `stop`

(b) (Informal) For all the strings in range [`start`, i), their character in position `pre` is less than c.

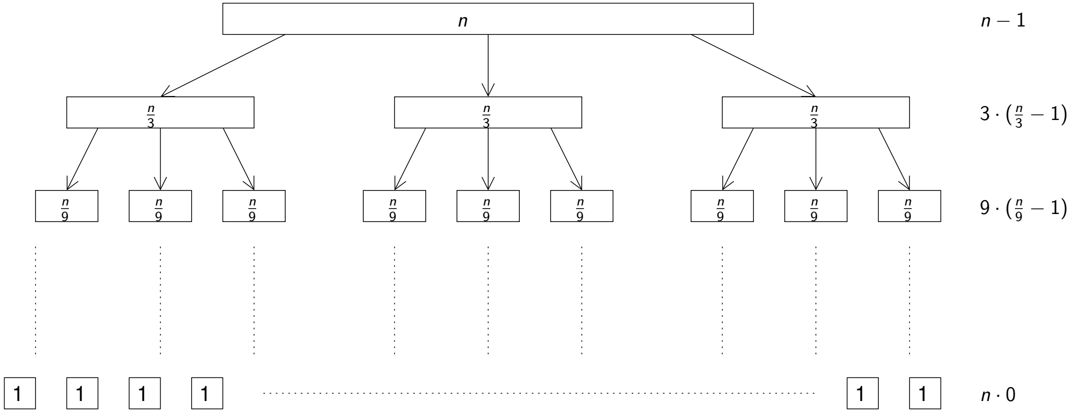
(c) (Informal) For all the strings in range $[i, j)$, their character in position `pre` is equal to c.

(d) (Informal) For all the strings in range $[i, j)$, their character in position `pre` is greater than to c.

(e) $k -$ `start` is the number of iterations completed.



Invariant 41. [Precondition of `string_quick_sort_r()`]
$\forall\ i, j \in [\texttt{start}, \texttt{stop}), \forall x \in [0, \texttt{pre}), \texttt{sequence}[i][x] = \texttt{sequence}[j][x]$.



dais	card	bark	care	even	barb	doze	cart	carb	axle	daze	exam	axis	bard	carp

dais	card	bark	care	even	barb	doze	cart	carb	axle	daze	exam	axis	bard	carp

barb	carb	card	bard	care	doze	axle	daze	bark	exam	even	carp	dais	axis	cart

exam	even	dais	axis	axle	barb	carb	card	bard	care	bark	carp	cart	doze	daze

dais	barb	carb	card	bard	care	bark	carp	cart	daze	doze	even	exam	axis	axle

axis	axle	barb	bard	bark	carb	card	care	carp	cart	dais	daze	doze	even	exam

beach	event	can	core	hope	any	front	ball	done	a	frond	an	i	give	eve

can	core	hope	any	ball	done	a	an	i	give	eve	frond	beach	event	front

can	any	a	an	i	eve	beach	core	hope	done	give	ball	frond	event	front

a	an	i	beach	eve	event	ball	can	done	frond	front	hope	core	give	any

a	i	ball	can	beach	give	an	any	done	hope	core	frond	front	eve	event

a	an	any	ball	beach	can	core	done	eve	event	frond	front	give	hope	i

Coming up:

Do **Perfect hashing** *project (due Mon, Dec 8)*

Due **Fri, Dec 5**
Read Section 8.1
Do Exercises 8.(4 & 5)
Take last quiz

Due **Mon, Dec 8**
Read Section 8.2
(No quiz or practice problems)