

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:

- ▶ End-of-semester business
- ▶ Sorting strings
 - ▶ Why we care about strings
 - ▶ String quick sort
 - ▶ String bucket sort
 - ▶ String radix sort

Projects:

- ▶ Last regular project score update on Tues, Apr 26
- ▶ “Two minute warning” run of scripts on Fri, Apr 29 (*no Schoology update—see report file*)
- ▶ All projects due on the last day of *classes*, **midnight between Fri, Apr 29 and Sat, Apr 30**—*not last day of finals.*

Final exam

- ▶ Our final exam block is **Tues, May 3, 10:30am–12:30pm**
- ▶ The class will be split between the classroom and lab, same as with Test 2. If you want to switch, please ask.
- ▶ Test 3 (“written” /conceptual part) will be like Test 1, but covering graphs (ch 4) through strings (ch 8)
- ▶ Test 4 (programming part) will work the same way as Test 2, covering dynamic programming, hashing, and strings.

Why we care about strings

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

```
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;

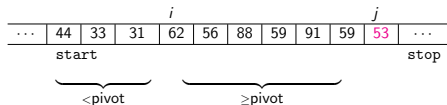
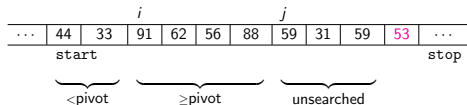
    /** Compute the sum of this and another BigInt. */
    public BigInt add(BigInt other) {
        // The result object
        BigInt sum = new BigInt();
        // The result object has at most one more digit
        // than the larger number of digits of the two addends
        sum.digits = new byte[(digits.length > 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;
    }
}
```

```
struct employee
{
    char surname[20];
    char first_name[20];
    double salary;
    char extension[4]
};

struct book
{
    char title[100];
    char author[50];
    int pages;
    char call_number[8];
    int status;
};

struct complex_number { double real, double imag };
```

Quick sort:



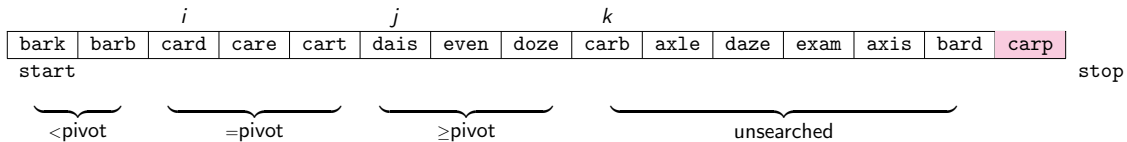
Invariant 11 (Loop of partition())

- (a) $\text{start} \leq i \leq j < \text{stop}$.
- (b) $\forall k \in [\text{start}, i), \text{sequence}[k] < \text{sequence}[\text{stop} - 1]$.
- (c) $\forall k \in [i, j), \text{sequence}[k] \geq \text{sequence}[\text{stop} - 1]$.
- (d) $j - \text{start}$ 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
------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

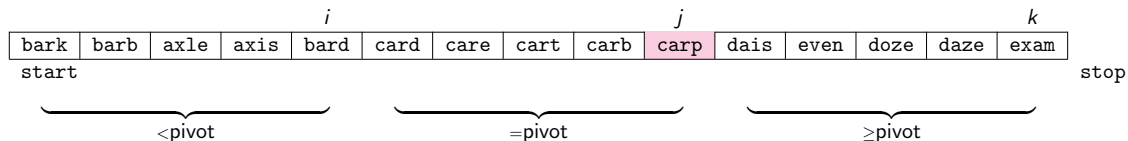
barb	axle	axis	bard	card	bark	care	carb	...
------	------	------	------	------	------	------	------	-----



Invariant 37. [Loop of `string_quick_sort_r()`]

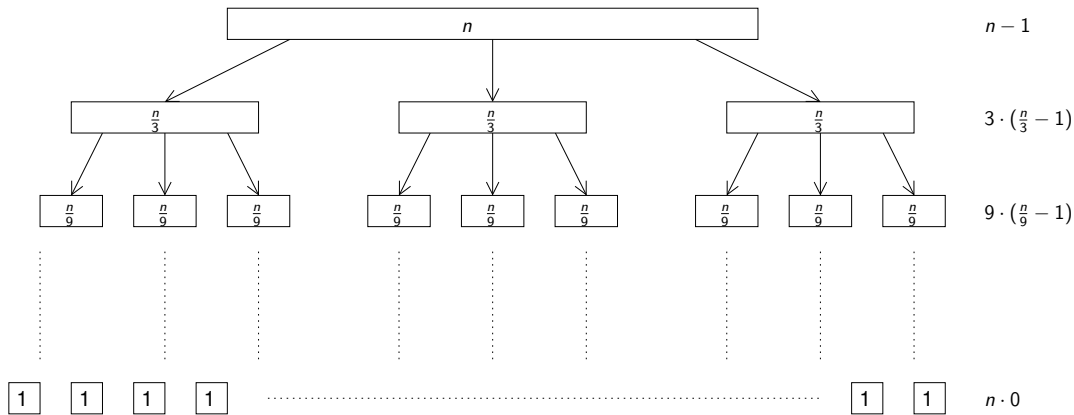
Let c be the character in position `pre` in the string in position `stop - 1`.

- (a) $\text{start} \leq i \leq j \leq k < \text{stop}$
- (b) (Informal) For all the strings in range $[\text{start}, i)$, 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 $[j, k)$, their character in position `pre` is greater than c .
- (e) $k - \text{start}$ is the number of iterations completed.



Invariant 38. [Precondition of `string_quick_sort_r()`]

$\forall i, j \in [\text{start}, \text{stop}), \forall k \in [0, \text{pre}), \text{sequence}[i][k] = \text{sequence}[j][k].$



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 **Open Addressing Hashtable** project (*suggested by this past Monday, Apr 18*)

Do **Perfect Hashing** project (*suggested by Wednesday, Apr 27*)

Due **Fri, Apr 22** (*end of day*)

Read section 8.1

Do exercises 8.(4 & 5) (from Section 8.1)

Due **Mon, Apr 25** (*end of day*)

Do exercises 8.(4 & 5) (*from Section 8.1*)

Take quiz (*on Section 8.1*)

Read Section 8.2