COS 126 Exam 2 Review Part 1

Programming Exam 2 Part 1 (ADT)

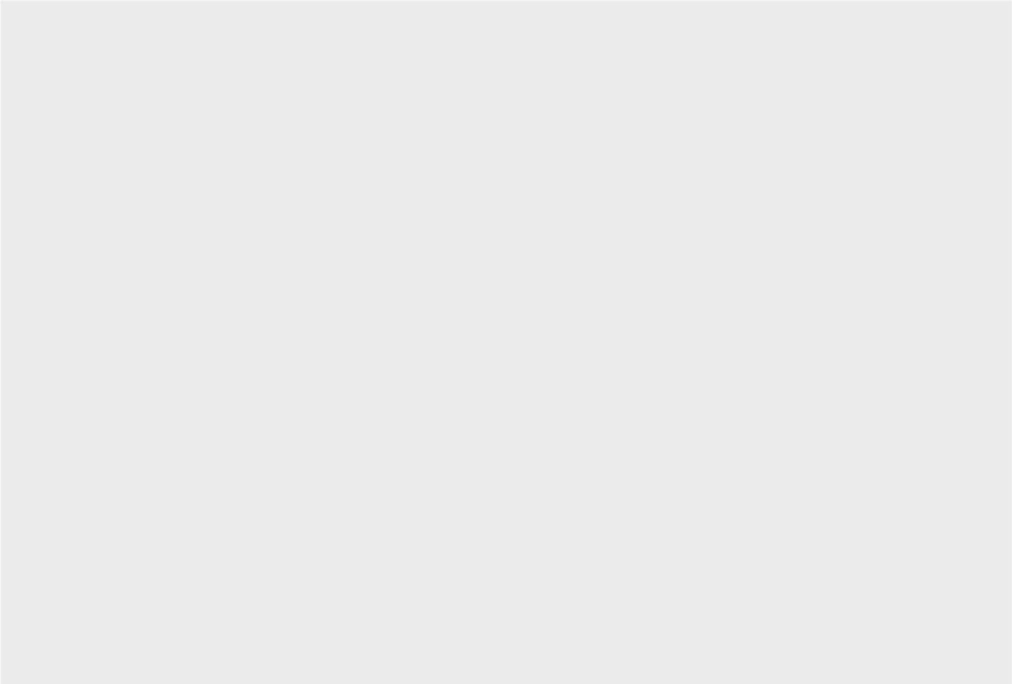
Q. *Can you implement a simple abstract data type ?*

Example (Fall 2016).

Part 1. Implement a data type ColorHSB.java for HSB colors.

```
      public class ColorHSB
---------------------------------------------------------------------------
           public ColorHSB(int h, int s, int b)              create a color
     public String toString()                          String representation
    public boolean isGrayscale()                                 is it gray?
        public int distanceSquaredTo(ColorHSB that)      "distance" to that
```

This time, you might start with a blank screen



Details.

An *HSB color* is defined by int values hue (0–360), saturation (0–100), and brightness (0–100).

An HSB color is *gray* if either its saturation or brightness (or both) is 0.

The *distance* between two HSB colors is given by the formula

$$\min((h_1 - h_2)^2, (360 - |h_1 - h_2|)^2) + (s_1 - s_2)^2 + (b_1 - b_2)^2$$

. . .

Advice: READ THE DETAILS CAREFULLY!

Programming Exam 2 Fall 2016 Part 1 (ADT) Strategy

First step. *Write a skeleton version of the solution* ***that compiles***.

```
public class ColorHSB
{
    private final int hue;          // the hue (between 0 and 359)
    private final int saturation;   // the saturation (between 0 and 100)
    private final int brightness;   // the brightness (between 0 and 100)

    // create a new color with specified hue, saturation, and brightness components
    public ColorHSB(int h, int s, int b)
    {  hue = h; saturation = s; brightness = b;   }

    // return string representation in the format (h, s, b)
    public String toString()
    {  return "";  }

    // is the color a shade of gray?
    public boolean isGrayscale()
    {  return true; }

    // return squared distance between the two colors
    public int distanceSquaredTo(ColorHSB that)
    {
       return 0;
    }

    public static void main(String[] args)
    {  }
}
```

easy-to-write code that you will need

(especially the comments)

placeholder code that compiles

Programming Exam 2 Fall 2016 Part 1 (ADT) Solution

```
public class ColorHSB
{
    private final int hue;          // the hue (between 0 and 359)
    private final int saturation;   // the saturation (between 0 and 100)
    private final int brightness;   // the brightness (between 0 and 100)

    // create a new color with specified hue, saturation, and brightness components
    public ColorHSB(int h, int s, int b)
    {  hue = h; saturation = s; brightness = b;  }

    // return string representation in the format (h, s, b)
    public String toString()
    {  return "(" + hue + ", " + saturation + ", " + brightness + ")";  }

    // is the color a shade of gray?
    public boolean isGrayscale()
    {  return saturation == 0 || brightness == 0; }

    // return squared distance between the two colors
    public int distanceSquaredTo(ColorHSB that)
    {
        int dh1 = this.hue - that.hue;
        int dh2 = 360 - Math.abs(dh1);
        int ds = this.saturation - that.saturation;
        int db = this.brightness - that.brightness;
        return Math.min(dh1*dh1, dh2*dh2)  + ds*ds + db*db;
    }

    public static void main(String[] args)
    {  }
}
```

the code you may need to think about

Programming Exam 2 Fall 2106 Part 2 (Client)

Q. *Can you implement* ***and use*** *a simple abstract data type ?*

Example (Fall 2016).

Part 2. Implement a test client `main()` that

- Takes three integer command-line arguments h, s, and b.
- Reads a list of pre-defined colors from standard input.
- Prints to standard output the input color that is nearest to (h, s, b).

```
% more web.txt
White     0    0    0
Silver    0    0   75
Red       0  100  100
. . .

% java ColorHSB 25 84 97 < web.txt
Red (0, 100, 100)
```

you will get test files and required output

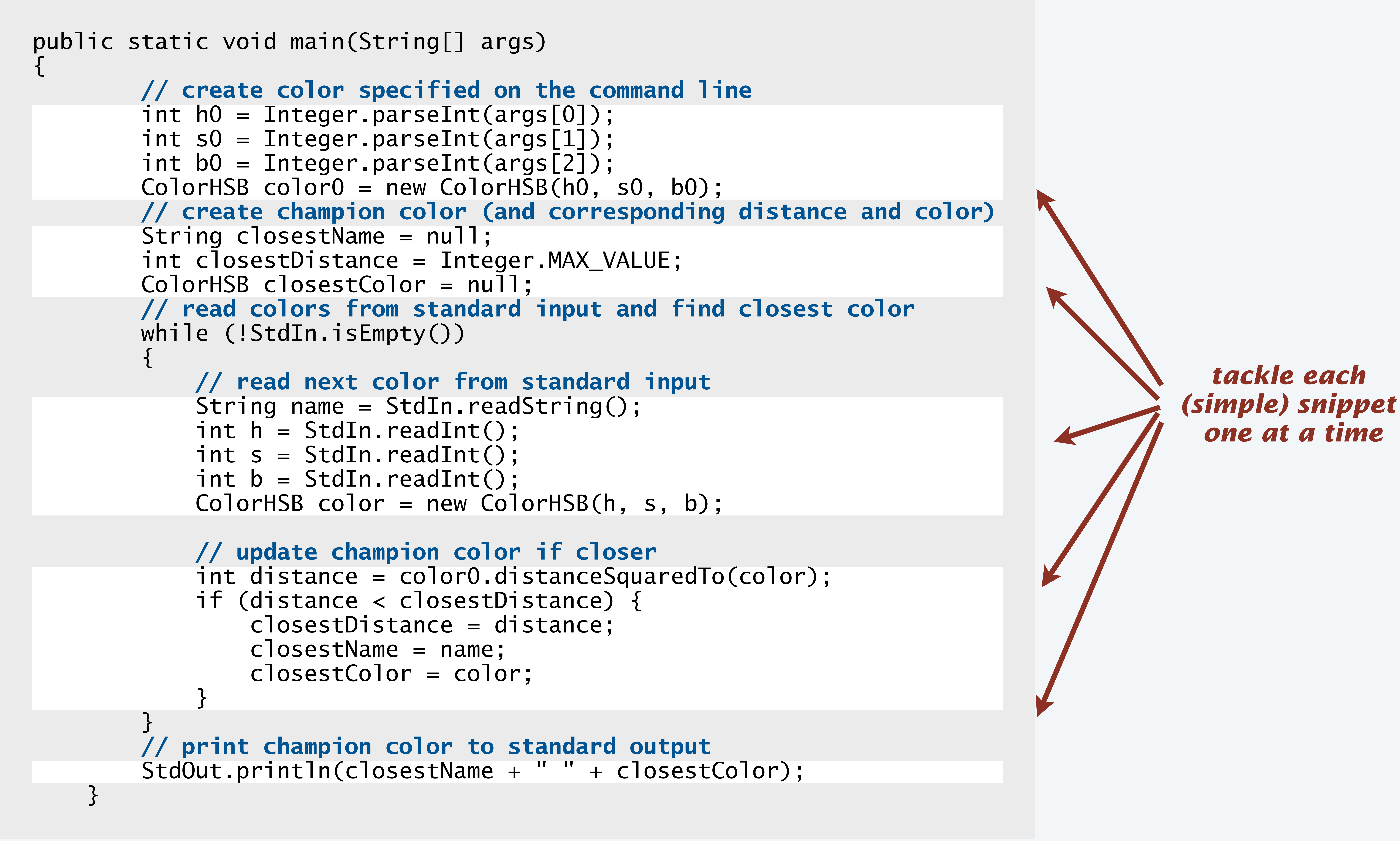
Programming Exam 2 Fall 2016 Part 2 (Client) Solution

First step. *Write a skeleton version of the solution* ***with comments***.

```
public static void main(String[] args)
{
        // create color specified on the command line


        // create champion color (and corresponding distance and color)


        // read colors from standard input and find closest color
        while (!StdIn.isEmpty())
        {
            // read next color from standard input

            // update champion color if closer
        }

        // print champion color to standard output

}
```

← ***a PLAN for solving the problem***

Programming Exam 2 Fall 2016 Part 2 (Client) Solution



```
public static void main(String[] args)
{
        // create color specified on the command line
        int h0 = Integer.parseInt(args[0]);
        int s0 = Integer.parseInt(args[1]);
        int b0 = Integer.parseInt(args[2]);
        ColorHSB color0 = new ColorHSB(h0, s0, b0);
        // create champion color (and corresponding distance and color)
        String closestName = null;
        int closestDistance = Integer.MAX_VALUE;
        ColorHSB closestColor = null;
        // read colors from standard input and find closest color
        while (!StdIn.isEmpty())
        {
            // read next color from standard input
            String name = StdIn.readString();
            int h = StdIn.readInt();
            int s = StdIn.readInt();
            int b = StdIn.readInt();
            ColorHSB color = new ColorHSB(h, s, b);

            // update champion color if closer
            int distance = color0.distanceSquaredTo(color);
            if (distance < closestDistance) {
                closestDistance = distance;
                closestName = name;
                closestColor = color;
            }
        }
        // print champion color to standard output
        StdOut.println(closestName + " " + closestColor);
    }
```

tackle each (simple) snippet one at a time

Written Exam Logistics

The second exam is on Thursday Dec. 13.

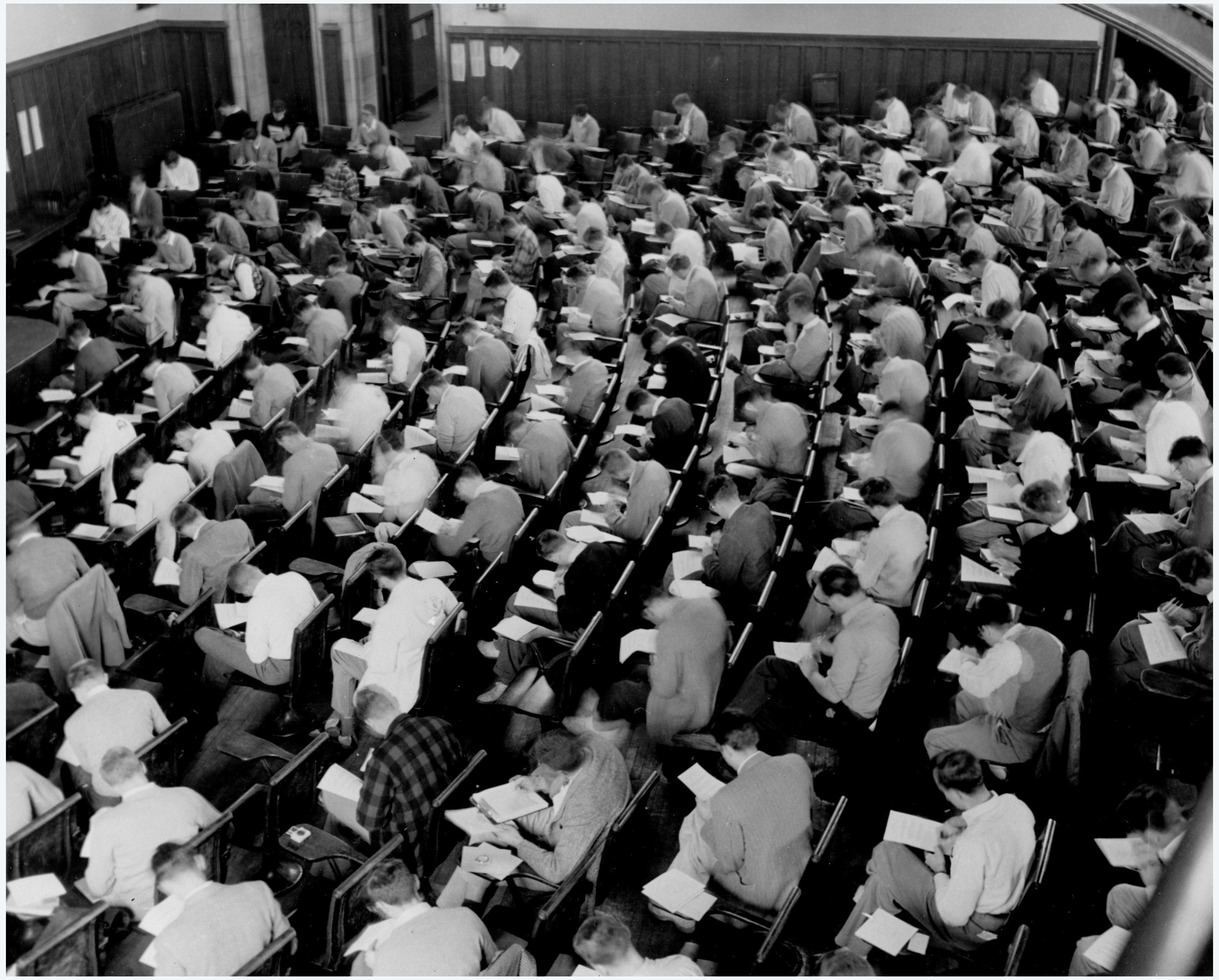
- Covers lectures since first written exam (*not* before).
- Prep session (ADTs, performance, algorithms and data structures) next.
- Prep session (theory and combinational circuits) Tuesday Dec. 11.

You don't all fit in this room.

- Pay attention and know where to go.
- Arrive early.
- No calculator/phone/computer/headphones

Advice.

- Review lectures/reading.
- Try an old exam (untimed).
- Try another one (timed).
- Review a few more.



Example question: Performance

Q. *Do you know how to estimate resource requirements of your programs?*

Ex. (Fall 2014 WE 1 Question 8) Characterize each of the specified quantities with reference to a function of N as linear, quadratic, cubic, logarithmic, or exp.

Memory use called for by

```
    int[][] a = new int[N][N*N];
```

cubic

Time required to execute

```
    int i = N; while (i>0) i/=2;
```

logarithmic

1000 500 250 125 62 ..

Time required to execute

```
    int i = N; while (i>0) { int[] a = new int[i]; i/=2; }
```

linear

1000 + 500 + 250 + 125 ..

Time required to execute

```
    String x = "hi"; for (int i=0; i < N; i++) x += x;
```

exponential

string length is 2^{i+1}

The order of growth of the running time of a program that runs for 30 seconds when N is 100,000, 1 minute when N is 200,000, and 1 hour when N is 12,000,000.

linear

Example question: Data types

Q. *Do you understand concepts and Java mechanisms for implementing and using ADTs ?*

Ex. (Spring 2013 Question 3) Indicate which keyword matches the description on each row.

	`class`	`public`	`static`	`void`	`main`	`private`	`this`	`null`	`new`
defines something as being part of the API									
creates an instance									
the value for uninitialized reference variables									
*defines something as being **not** part of the API*									
method name called to start a program									
return type of a method that returns no value									
belongs to a class (as opposed to its instances)									
contains definitions of methods and fields									
refers to the instance upon which the current method or constructor acts									

Example question: Sorting and searching

Q. *Do you know basic properties of classic algorithms for sorting and searching ?*

Ex. (Fall 2014 Question 6) Describe the order of growth of the running time of each specified algorithm/inputs below on a file of size *N*.

Insertion sort for a randomly ordered file	**quadratic (N^2)**
Mergesort for a randomly ordered file	**linearithmic ($N \log N$)**
Building a BST for a randomly ordered file	**linearithmic ($N \log N$)**
Insertion sort for a file that is in reverse order	**quadratic (N^2)**
Insertion sort for a file that is already in order	**linear (N)**
Mergesort for a file that is already in order	**linearithmic ($N \log N$)**
Building a BST for a file that is already in order	**quadratic (N^2)**

Example question: Sorting and searching

Q. *Do you know basic properties of classic algorithms for sorting and searching ?*

Ex. (Spring 2015 WE1 Q7) Two sorting algorithms, insertion sort and mergesort, will be used to sort the characters **MELTSNOW** into alphabetical order, left-to-right.

The following array contents may occur at some point during either, both, or neither of these sorts. Check all that apply.

	occurs during insertion sort	*occurs during merge sort*	*does not occur during either*
EMLTSNOW	✓	✓	
SMELTNOW			✓
ELMTNOSW		✓	
ELMSTNOW	✓		
ELMTSNOW	✓	✓	

Example question: Stacks and queues

Q. *Do you know basic properties of fundamental data types?*

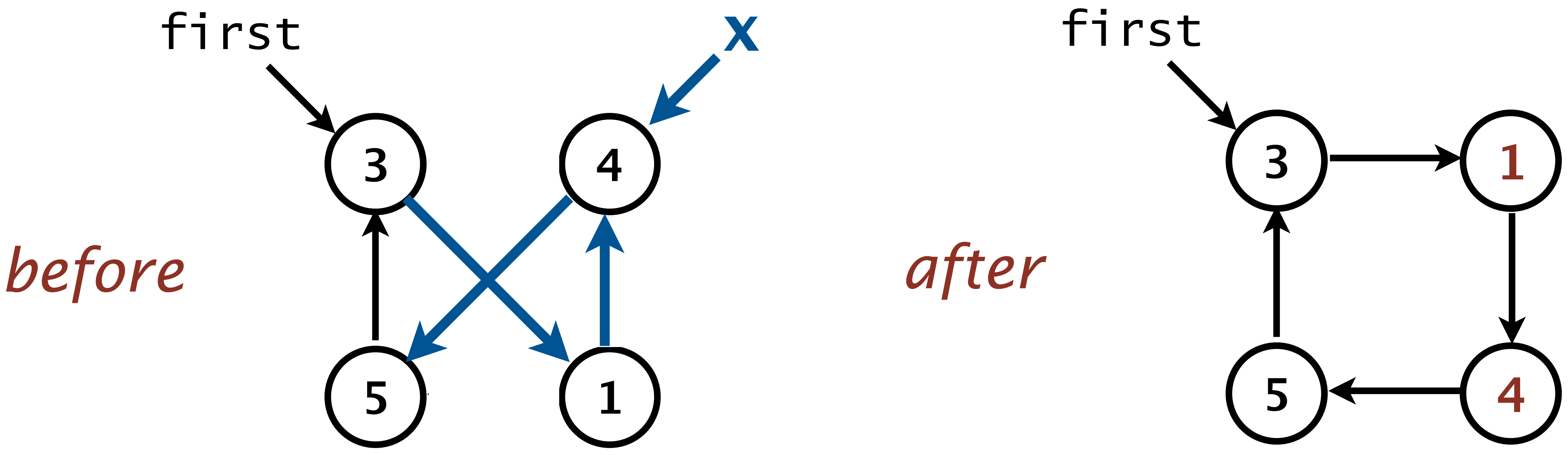
Ex. (MOOC) When is a stack not a stack? Mark all that apply.

When the only operations allowed are to insert an item and to remove the most recently inserted item.	
When the only operations allowed are to insert an item and to remove the least recently inserted item.	●
When the operation of removing an arbitrary item is supported.	●
When the maximum size needs to be specified.	●
When the order of growth of the time required to insert an item is logarithmic.	●
When the space required cannot be bounded by a constant times the size of the stack at all times.	●

Example question: Linked structures

Q. *Do you understand how to write code that manipulates linked structures ?*

Ex. (Spring 2017 Question 3) Give the code needed to exchange the order of the *second* and *third* nodes in a *circularly linked list.*



Fill in each blank with one of the code snippets shown at right.

```
private class Node
{
   private int item;
   private Node next;
}
```

```
Node x         =    first.next
first.next     =    x.next
x.next         =    x.next.next
first.next.next =   x
```

```
first
x
first.next
x.next
first.next.next
x.next.next
```

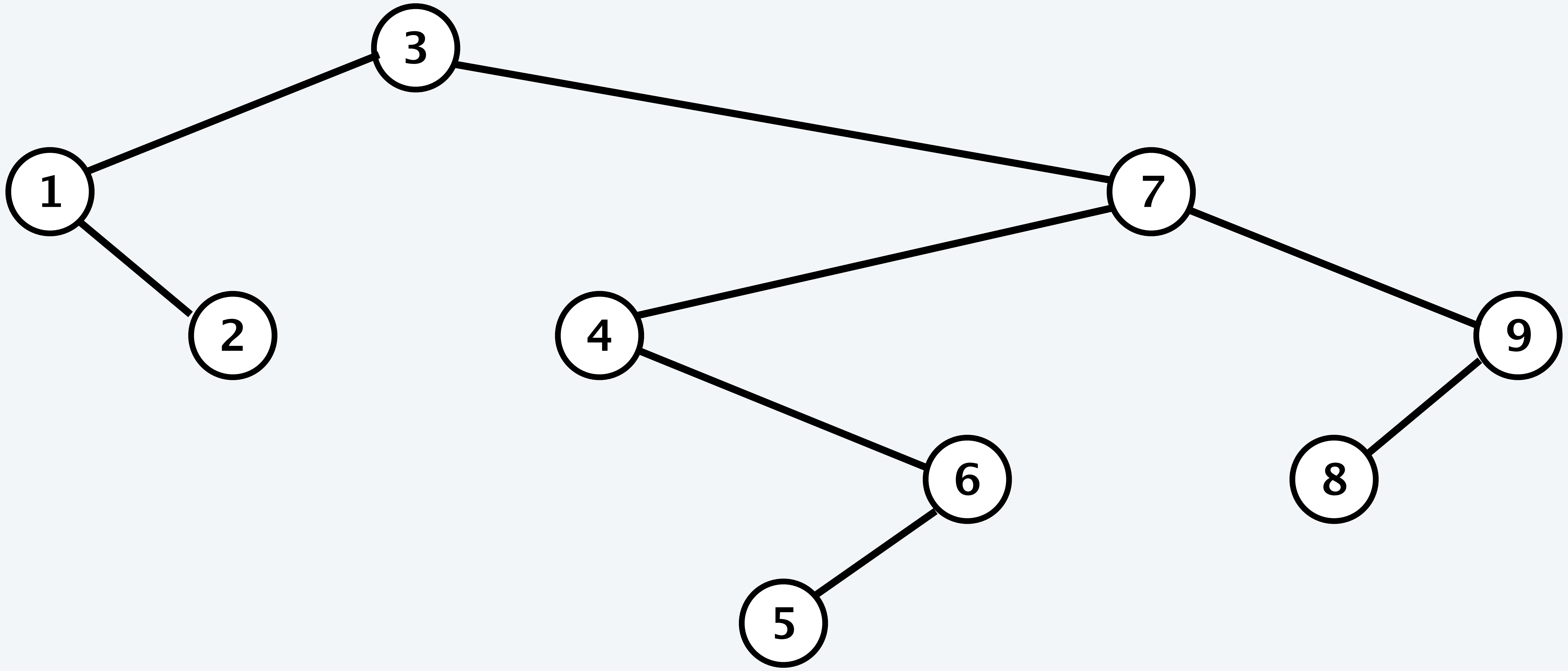
Example question: BSTs

Q. *Do you understand basic properties of binary search trees ?*

Ex. (1990s) Draw the BST that results when the keys

3 7 9 1 2 8 4 6 5

are inserted in that order into an initially empty BST.



Note. We do not ask questions like this any more. ← **TOO DIFFICULT TO GRADE!**

Example question: BSTs

Q. *Do you understand basic properties of binary search trees ?*

Ex. (Spring 2012 Question 7) Suppose that a BST has `int` values between 1 and 1000. For each sequence listed below, indicate whether or not it could occur during a search for **527**.

	could occur during a search for 527	*could **not** occur during a search for 527*
527	✓	
1 500 600 700 527		✓
605 256 490 300 527		✓
10 860 523 602 525 527	✓	
10 860 523 602 599 610 527		✓

Mark your calendar

***Thursday* Dec 6: PROGRAMMING EXAM 2**

***Tuesday* Dec 11: Written exam prep (part 2)**

***Thursday* Dec 13: WRITTEN EXAM 2**