

Question 4: 2D Arrays**9 points****Canonical solution**

a.

```
public SumOrSameGame(int numRows, int numCols)
{
    puzzle = new int[numRows][numCols];

    for (int row = 0; row < numRows; row++)
    {
        for (int col = 0; col < numCols; col++)
        {
            puzzle[row][col] = (int)(Math.random() * 9) + 1;
        }
    }
}
```

4 points

b.

```
public boolean clearPair(int row, int col)
{
    int val1 = puzzle[row][col];
    for (int currRow = row; currRow < puzzle.length; currRow++)
    {
        for (int currCol = 0; currCol < puzzle[0].length; currCol++)
        {
            int val2 = puzzle[currRow][currCol];
            if (currRow != row || currCol != col)
            {
                if (val1 == val2 || val1 + val2 == 10)
                {
                    puzzle[row][col] = 0;
                    puzzle[currRow][currCol] = 0;
                    return true;
                }
            }
        }
    }
    return false;
}
```

5 points

a. SumOrSameGame

Scoring Criteria		Decision Rules	
1	Constructs correctly sized 2D array of <code>int</code> and assigns to instance variable <code>puzzle</code>	Responses will not earn the point if they - fail to update the instance variable <code>puzzle</code>, e.g., by redeclaring as a local variable - print or return a value instead of or in addition to updating <code>puzzle</code>	1 point
2	Traverses 2D array (<i>no bounds errors</i>)	Responses can still earn the point even if they - fail to construct the 2D array, as long as traversal uses correct bounds - fail to assign to the 2D array elements Responses will not earn the point if they - fail to access an element of the 2D array in the traversal	1 point
3	Generates a random integer that is uniform in the range <code>[1, 9]</code>	Responses will not earn the point if they - fail to call <code>Math.random</code> or an equivalent method - make any incorrect call to <code>Math.random</code> or an equivalent method - call <code>random</code> without <code>Math.</code> - fail to cast to an <code>int</code>	1 point
4	Assigns values to 2D array elements (<i>algorithm</i>)	Responses can still earn the point even if they - generate the random value incorrectly - assign to a local 2D array instead of the instance variable - fail to assign some elements due to a bounds error Responses will not earn the point if they - assign a value other than the attempted randomly generated value - correctly initialized the 2D array but now assign somewhere else - assign the same value to all visited elements - fail to assign to all visited elements	1 point

b. `clearPair`

Scoring Criteria		Decision Rules	
5	Accesses all and only necessary elements of <code>puzzle</code> in rows <code>>= row</code> (no bounds errors)	Responses can still earn the point even if they - access additional rows, as long as they also guard against pairing them - pair the element at <code>row</code> and <code>col</code> with itself - omit extra elements due to incorrect self-pairing guard, as long as the bounds would otherwise support accessing all necessary elements - return early, as long as bounds and indices would otherwise support accessing all necessary elements Responses will not earn the point if they - fail to access elements of <code>puzzle</code> correctly	1 point
6	Guards against pairing an element with itself	Responses will not earn the point if they - omit extra potential pairs with their self-pairing guard - have no loop	1 point
7	Determines whether two elements are the same or sum to 10	Responses can still earn the point even if they - pair the element at <code>row</code> and <code>col</code> with itself - have no loop Responses will not earn the point if they - test only one of the conditions	1 point
8	Sets a 2D array element to <code>0</code> (in the context of a loop)	Responses can still earn the point even if they - set only one identified element to <code>0</code> - incorrectly identify elements - set more than 2 elements to <code>0</code>	1 point
9	Sets identified elements to <code>0</code> when match is found and returns appropriate <code>boolean</code> in both cases (algorithm)	Responses can still earn the point even if they - identify elements incorrectly, as long as there is some conditional selection Responses will not earn the point if they - set only one identified element to <code>0</code> - change more than 1 element besides the element at <code>row</code> and <code>col</code> - return an incorrect value due to an early return - return an incorrect value due to not returning after clearing once	1 point
Question-specific penalties			
None			

Question 4: 2D Array**9 points****Canonical solution**

(a)

```
public void repopulate()
{
    for (int row = 0; row < grid.length; row++)
    {
        for (int col = 0; col < grid[0].length; col++)
        {
            int rval = (int)(Math.random() * MAX) + 1;
            while (rval % 10 != 0 || rval % 100 == 0)
            {
                rval = (int)(Math.random() * MAX) + 1;
            }
            grid[row][col] = rval;
        }
    }
}
```

4 points

(b)

```
public int countIncreasingCols()
{
    int count = 0;

    for (int col = 0; col < grid[0].length; col++)
    {
        boolean ordered = true;

        for (int row = 1; row < grid.length; row++)
        {
            if (grid[row][col] < grid[row-1][col])
            {
                ordered = false;
            }
        }

        if (ordered)
        {
            count++;
        }
    }

    return count;
}
```

5 points

(a) repopulate

Scoring Criteria		Decision Rules	
1	Traverses <code>grid</code> (<i>no bounds errors</i>)	Responses will not earn the point if they - fail to access an element of <code>grid</code> - access the elements of <code>grid</code> incorrectly - use enhanced <code>for</code> loops without using a <code>grid</code> element inside the loop	1 point
2	Generates a random integer in a range based on <code>MAX</code>	Responses can still earn the point even if they - assume or verify that <code>MAX</code> ≥ 10 Responses will not earn the point if they - fail to cast to an <code>int</code>	1 point
3	Ensures that all produced values are divisible by 10 but not by 100	Responses can still earn the point even if they fail to use a loop	1 point
4	Assigns appropriate values to all elements of <code>grid</code> (<i>algorithm</i>)	Responses can still earn the point even if they - assume or verify that <code>MAX</code> ≥ 10 - produce some values that are not divisible by 10 or divisible by 100, if the range and distribution are otherwise correct Responses will not earn the point if they - use enhanced <code>for</code> loops and fail to maintain indices - produce values that are not equally distributed - produce values outside the specified range - exclude values that should be considered valid (other than errors in 10/100 handling)	1 point
Total for part (a)			4 points

(b) `countIncreasingCols`

Scoring Criteria		Decision Rules	
5	Traverses <code>grid</code> in column major order (no loop header bounds errors)	Responses can still earn the point even if they - access an out-of-bounds row or column index adjacent to the edge of the grid, if the loop bounds include only valid indices Responses will not earn the point if they - fail to access an element of <code>grid</code> - access the elements of <code>grid</code> incorrectly	1 point
6	Compares two elements in the same column of <code>grid</code>	Responses can still earn the point even if they - access elements of <code>grid</code> incorrectly - access elements in nonadjacent rows - compare elements with <code>==</code> - compare two elements in the same row instead of the same column	1 point
7	Determines whether a single column is in increasing order (<i>algorithm</i>)	Responses can still earn the point even if they - fail to reset variables in the outer loop before proceeding to the next column Responses will not earn the point if they - fail to access all pairs of adjacent elements in a single column - cause a bounds error by attempting to compare the first element of a column with a previous element or the last element of a column with a subsequent element - incorrectly identify a column with at least one pair of adjacent elements in decreasing order as increasing	1 point
8	Counts all columns that are identified as increasing (<i>algorithm</i>)	Responses can still earn the point even if they - detect increasing order for each row instead of each column - incorrectly identify increasing columns in the inner loop Responses will not earn the point if they - fail to initialize the counter	1 point

		fail to reset variables in the outer loop causing subsequent runs of the inner loop to misidentify columns	
9	Returns calculated count of increasing columns	Responses can still earn the point even if they calculate the count incorrectly	1 point
Total for part (b)			5 points
Question-specific penalties			
None			
Total for question 4			9 points

Alternate Canonical for Part (a)

```

public void repopulate()
{
    for (int row = 0; row < grid.length; row++)
    {
        for (int col = 0; col < grid[0].length; col++)
        {
            int rval = ((int)(Math.random() * (MAX / 10)) + 1) * 10;
            while (rval % 100 == 0)
            {
                rval = ((int)(Math.random() * (MAX / 10)) + 1) * 10;
            }
            grid[row][col] = rval;
        }
    }
}

```

Question 4: 2D Array**9 points****Canonical solution****(a)**

```

public static boolean isNonZeroRow(int[][] array2D, int r)
{
    for (int col = 0; col < array2D[0].length; col++)
    {
        if (array2D[r][col] == 0)
        {
            return false;
        }
    }
    return true;
}

```

3 points**(b)**

```

public static int[][] resize(int[][] array2D)
{
    int numRows = array2D.length;
    int numCols = array2D[0].length;

    int[][] result = new int[numNonZeroRows(array2D)][numCols];
    int newRowIndex = 0;

    for (int r = 0; r < numRows; r++)
    {
        if (isNonZeroRow(array2D, r))
        {
            for (int c = 0; c < numCols; c++)
            {
                result[newRowIndex][c] = array2D[r][c];
            }
            newRowIndex++;
        }
    }
    return result;
}

```

6 points

(a) `isNonZero`

Scoring Criteria		Decision Rules	
1	Compares an item from <code>array2D</code> with <code>0</code>	Responses will not earn the point if they fail to attempt the comparison, even if they access an item from <code>array2D</code>	1 point
2	Accesses every item from row <code>r</code> of 2D array (<i>no bounds errors</i>)	Responses can still earn the point even if they return early from an otherwise correctly-bounded loop	1 point
3	Returns <code>true</code> if and only if row contains no zeros	Responses can still earn the point even if they process a column of the 2D array rather than a row	1 point
		Responses will not earn the point if they fail to return a value in some cases	
Total for part (a)			3 points

(b) `resize`

Scoring Criteria		Decision Rules	
4	Calls <code>numNonZeroRows</code> and <code>isNonZeroRow</code>	Responses can still earn the point even if they fail to use or store the return value Responses will not earn the point if they - include incorrect number or type of parameters - call methods on an object or class other than <code>ArrayResizer</code>	1 point
5	Identifies rows with no zeros (<i>in the context of an if</i>)	Responses can still earn the point even if they call <code>isNonZeroRow</code> incorrectly, if the row being tested is clearly identified (index or reference)	1 point
6	Declares and creates a new 2D array of the correct size	Response will not earn the point if they transpose the dimensions of the created array	1 point
7	Maintains an index in the new array	Responses will not earn the point if they - fail to declare, initialize, and update a different index - maintain the index in a way that overwrites, skips, or duplicates rows	1 point
8	Traverses all necessary elements of <code>array2D</code> (<i>no bounds errors</i>)	Responses can still earn the point even if they - cause a bounds error by declaring and creating a new 2D array of an incorrect size - fail to maintain an index in the new array correctly, resulting in a bounds error - fail to access individual elements in a nested loop, if they access each row as an entire row Responses will not earn the point if they transpose coordinates, leading to a bounds error and/or copying columns	1 point
9	Copies all and only rows identified as having no zero elements into the new array	Responses can still earn the point even if they - copy a reference - identify rows incorrectly, if the logical sense can be determined and is correct - copy columns instead of rows, consistent with the dimensions of the created 2D array	1 point

Responses **will not** earn the point if they

- remove or overwrite data from `array2D` (instead of or in addition to copying it to the new array)
- reverse the logical sense of which rows to copy

Total for part (b) 6 points

Question-specific penalties

-1 (u) Use `array2D[].length` to refer to the number of columns in a row of the 2D array

Total for question 4 9 points

2019

AP[®]

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AP[®] Computer Science A

Scoring Guidelines

2019 SCORING GUIDELINES

Apply the question assessment rubric first, which always takes precedence. Penalty points can only be deducted in a part of the question that has earned credit via the question rubric. No part of a question (a, b, c) may have a negative point total. A given penalty can be assessed only once for a question, even if it occurs multiple times or in multiple parts of that question. A maximum of 3 penalty points may be assessed per question.

1-Point Penalty

- v) Array/collection access confusion (`[] get`)
- w) Extraneous code that causes side-effect (e.g., printing to output, incorrect precondition check)
- x) Local variables used but none declared
- y) Destruction of persistent data (e.g., changing value referenced by parameter)
- z) Void method or constructor that returns a value

No Penalty

- o Extraneous code with no side-effect (e.g., valid precondition check, no-op)
- o Spelling/case discrepancies where there is no ambiguity*
- o Local variable not declared provided other variables are declared in some part
- o `private` or `public` qualifier on a local variable
- o Missing `public` qualifier on class or constructor header
- o Keyword used as an identifier
- o Common mathematical symbols used for operators (`*` `*` `÷` `≤` `≥` `<>` `≠`)
- o `[]` vs. `()` vs. `<>`
- o `=` instead of `==` and vice versa
- o `length/size` confusion for array, `String`, `List`, or `ArrayList`; with or without `()`
- o Extraneous `[]` when referencing entire array
- o `[i,j]` instead of `[i][j]`
- o Extraneous size in array declaration, e.g., `int[size] nums = new int[size];`
- o Missing `;` where structure clearly conveys intent
- o Missing `{ }` where indentation clearly conveys intent
- o Missing `()` on parameter-less method or constructor invocations
- o Missing `()` around `if` or `while` conditions

Spelling and case discrepancies for identifiers fall under the “No Penalty” category only if the correction can be **unambiguously inferred from context, for example, “ArayList” instead of “ArrayList”. As a counterexample, note that if the code declares “`int G=99, g=0;`”, then uses “`while (G < 10)`” instead of “`while (g < 10)`”, the context does **not** allow for the reader to assume the use of the lower-case variable.*

2019 SCORING GUIDELINES**Question 1: Calendar**

Part (a)	<code>numberOfLeapYears</code>	5 points
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Intent: *Return the number of leap years in a range*

- +1** Initializes a numeric variable
- +1** Loops through each necessary year in the range
- +1** Calls `isLeapYear` on some valid year in the range
- +1** Updates count based on result of calling `isLeapYear`
- +1** Returns count of leap years

Part (b)	<code>dayOfWeek</code>	4 points
-----------------	------------------------	-----------------

Intent: *Return an integer representing the day of the week for a given date*

- +1** Calls `firstDayOfYear`
- +1** Calls `dayOfYear`
- +1** Calculates the value representing the day of the week
- +1** Returns the calculated value

Question-Specific Penalties

- 1** (t) Static methods called with `this`.

2019 SCORING GUIDELINES**Question 1: Scoring Notes**

Part (a) <code>numberOfLeapYears</code>			5 points
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Initializes a numeric variable		use the variable for loop control only
+1	Loops through each necessary year in the range		consider years outside the range
+1	Calls <code>isLeapYear</code> on some valid year in the range	do not use a loop	
+1	Updates count based on result of calling <code>isLeapYear</code>	- do not use a loop - do not initialize the counter	use result as a non-boolean
+1	Returns count of leap years	- loop from <code>year1</code> to <code>year2</code> incorrectly - do not initialize the counter	- do not use a loop - update or initialize the counter incorrectly - return early inside the loop
Part (b) <code>dayOfWeek</code>			4 points
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Calls <code>firstDayOfYear</code>		do not use the given year
+1	Calls <code>dayOfYear</code>		have arguments out of order
+1	Calculates the value representing the day of the week		make any error in the calculation
+1	Returns the calculated value	return the value from calling <code>firstDayOfYear</code> or <code>dayOfYear</code>	return a constant value

2019 SCORING GUIDELINES**Question 1: Calendar***Part (a)*

```
public static int numberOfLeapYears(int year1, int year2)
{
    int count = 0;
    for (int y = year1; y <= year2; y++)
    {
        if (isLeapYear(y))
        {
            count++;
        }
    }
    return count;
}
```

Part (b)

```
public static int dayOfWeek(int month, int day, int year)
{
    int startDay = firstDayOfYear(year);
    int nthDay = dayOfYear(month, day, year);
    int returnDay = (startDay + nthDay - 1) % 7;
    return returnDay;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2019 SCORING GUIDELINES**Question 2: Step Tracker****Class:** `StepTracker`**9 points****Intent:** *Define implementation of a class to record fitness data*

- +1** Declares all appropriate `private` instance variables
- +2** Constructor
 - +1** Declares header: `public StepTracker(int ____)`
 - +1** Uses parameter and appropriate values to initialize instance variables
- +3** `addDailySteps` method
 - +1** Declares header: `public void addDailySteps(int ____)`
 - +1** Identifies active days and increments count
 - +1** Updates other instance variables appropriately
- +1** `activeDays` method
 - +1** Declares and implements `public int activeDays()`
- +2** `averageSteps` method
 - +1** Declares header: `public double averageSteps()`
 - +1** Returns calculated `double` average number of steps

2019 SCORING GUIDELINES**Question 2: Scoring Notes**

Class StepTracker			9 points
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Declares all appropriate <code>private</code> instance variables		- omit keyword <code>private</code> - declare variables outside the class
+2	Constructor		
+1	Declares header: <code>public StepTracker(int ____)</code>	omit keyword <code>public</code>	declare method <code>private</code>
+1	Uses parameter and appropriate values to initialize instance variables	initialize primitive instance variables to default values when declared	- fail to use the parameter to initialize some instance variable - fail to declare instance variables - initialize local variables instead of instance variables - assign variables to parameters
+3	addDailySteps method		
+1	Declares header: <code>public void addDailySteps(int ____)</code>	omit keyword <code>public</code>	declare method <code>private</code>
+1	Identifies active days and increments count	put valid comparison erroneously in some other method	- fail to use the parameter as part of the comparison - fail to increment a count of active days - fail to increment an instance variable - compare parameter to some numeric constant
+1	Updates other instance variables appropriately		- update another instance variable only on active days - update another instance variable inappropriately - fail to update appropriate instance variable - update a local variable
+1	activeDays method		
+1	Declares and implements <code>public int activeDays()</code>	return appropriate count of active days where the instance variables were updated improperly in <code>addDailySteps</code> or <code>activeDays</code>	- declare method <code>private</code> - return value that is not the number of active days - fail to return a value

2019 SCORING GUIDELINES**Question 2: Scoring Notes (continued)**

Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+2	<code>averageSteps</code> method		
+1	Declares header: <code>public double averageSteps()</code>	omit keyword <code>public</code>	declare method <code>private</code>
+1	Returns calculated <code>double average</code> number of steps	- maintain instance variables improperly but calculate appropriate average - fail to handle the special case where no days are tracked	- use integer division - calculate something other than steps divided by days - fail to return

2019 SCORING GUIDELINES**Question 2: Step Tracker**

```
public class StepTracker
{
    private int minSteps;
    private int totalSteps;
    private int numDays;
    private int numActiveDays;

    public StepTracker(int threshold)
    {
        minSteps = threshold;
        totalSteps = 0;
        numDays = 0;
        numActiveDays = 0;
    }

    public void addDailySteps(int steps)
    {
        totalSteps += steps;
        numDays++;
        if (steps >= minSteps)
        {
            numActiveDays++;
        }
    }

    public int activeDays()
    {
        return numActiveDays;
    }

    public double averageSteps()
    {
        if (numDays == 0)
        {
            return 0.0;
        }
        else
        {
            return (double) totalSteps / numDays;
        }
    }
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2019 SCORING GUIDELINES**Question 3: Delimiters**

Part (a)	<code>getDelimitersList</code>	4 points
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Intent: *Store delimiters from an array in an `ArrayList`*

- +1** Creates `ArrayList<String>`
- +1** Accesses all elements in array `tokens` (*no bounds errors*)
- +1** Compares strings in `tokens` with both instance variables (*must be in the context of a loop*)
- +1** Adds delimiters into `ArrayList` in original order

Part (b)	<code>isBalanced</code>	5 points
-----------------	-------------------------	-----------------

Intent: *Determine whether open and close delimiters in an `ArrayList` are balanced*

- +1** Initializes accumulator(s)
- +1** Accesses all elements in `ArrayList delimiters` (*no bounds errors*)
- +1** Compares strings in `delimiters` with instance variables and updates accumulator(s) accordingly
- +1** Identifies and returns appropriate `boolean` value to implement one rule
- +1** Identifies and returns appropriate `boolean` values for all cases

2019 SCORING GUIDELINES

Question 3: Scoring Notes

Part (a) <code>getDelimitersList</code>			4 points
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Creates <code>ArrayList<String></code>	omit <code><String></code>	omit the keyword <code>new</code>
+1	Accesses all elements in array <code>tokens</code> (<i>no bounds errors</i>)	return incorrectly inside the loop	- treat <code>tokens</code> as a single string - access elements of <code>tokens</code> as if from an <code>ArrayList</code> (e.g., <code>tokens.get(i)</code>)
+1	Compares strings in <code>tokens</code> with both instance variables (<i>must be in the context of a loop</i>)	access elements of <code>tokens</code> as if from an <code>ArrayList</code> (e.g., <code>tokens.get(i)</code>)	- use <code>==</code> for string comparison - treat <code>tokens</code> as a single string
+1	Adds delimiters into <code>ArrayList</code> in original order	add a delimiter by accessing <code>tokens</code> incorrectly (e.g., <code>tokens.get(i)</code>)	- add a token that is not a delimiter - do not maintain the original delimiter order
Part (b) <code>isBalanced</code>			5 points
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Initializes accumulator(s)	initialize inside the loop	initialize an accumulator variable but don't update it
+1	Accesses all elements in <code>ArrayList</code> <code>delimiters</code> (<i>no bounds errors</i>)	return incorrectly inside the loop	access elements of <code>delimiters</code> as if from an array (e.g., <code>delimiters[i]</code>)
+1	Compares strings in <code>delimiters</code> with instance variables and updates accumulator(s) accordingly	access elements of <code>delimiters</code> as if from an array (e.g., <code>delimiters[i]</code>)	- use <code>==</code> for string comparison - adjust an accumulator without a guarding condition
+1	Identifies and returns appropriate <code>boolean</code> value to implement one rule	- check for more closing delimiters (inside a loop) and return <code>false</code> - return <code>true</code> if the number of open and close delimiters is the same, and <code>false</code> otherwise (after a loop)	
+1	Identifies and returns appropriate <code>boolean</code> values for all cases	have correct logic with the exception of a loop bounds error, accessing elements as if from an array, or using <code>==</code> for string comparison	- initialize accumulator inside a loop - fail to check for more closing delimiters inside a loop

2019 SCORING GUIDELINES**Question 3: Delimiters***Part (a)*

```
public ArrayList<String> getDelimitersList(String[] tokens)
{
    ArrayList<String> d = new ArrayList<String>();
    for (String str : tokens)
    {
        if (str.equals(openDel) || str.equals(closeDel))
        {
            d.add(str);
        }
    }
    return d;
}
```

Part (b)

```
public boolean isBalanced(ArrayList<String> delimiters)
{
    int openCount = 0;
    int closeCount = 0;

    for (String str : delimiters)
    {
        if (str.equals(openDel))
        {
            openCount++;
        }
        else
        {
            closeCount++;
        }

        if (closeCount > openCount)
        {
            return false;
        }
    }

    if (openCount == closeCount)
    {
        return true;
    }
    else
    {
        return false;
    }
}
```

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2019 SCORING GUIDELINES**Question 4: Light Board**

Part (a)	<code>LightBoard</code>	4 points
-----------------	-------------------------	-----------------

Intent: *Define implementation of a constructor that initializes a 2D array of lights*

- +1** Creates a new `boolean[numRows][numCols]` and assigns to instance variable `lights`
- +1** Accesses all elements in the created 2D array (*no bounds errors*)
- +1** Computes the 40% probability
- +1** Sets all values of 2D array based on computed probability

Part (b)	<code>evaluateLight</code>	5 points
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Intent: *Evaluate the status of a light in a 2D array of lights*

- +1** Accesses an element of `lights` as a `boolean` value in an expression
- +1** Traverses specified `col` of a 2D array (*no bounds errors*)
- +1** Counts the number of `true` values in the traversal
- +1** Performs an even calculation and a multiple of three calculation
- +1** Returns `true` or `false` according to all three rules

Question-Specific Penalties

- 1** (z) Constructor returns a value
- 1** (y) Destruction of persistent data

2019 SCORING GUIDELINES

Question 4: Scoring Notes

Part (a) <code>LightBoard</code>			4 points
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Creates a new <code>boolean[numRows][numCols]</code> and assigns to instance variable <code>lights</code>		- initialize a local variable that is never assigned to <code>lights</code> - omit the keyword <code>new</code> - use a type other than <code>boolean</code>
+1	Accesses all elements in the created 2D array (<i>no bounds errors</i>)	fail to create <code>lights</code> but assume <code>lights[numRows][numCols]</code>	
+1	Computes the 40% probability	use <code>Math.random() <= .4</code>	incorrectly cast to <code>int</code>
+1	Sets all values of 2D array based on computed probability	only assign <code>true</code> values	- compute a single probability but use it multiple times - reverse the sense of the comparison when assigning
Part (b) <code>evaluateLight</code>			5 points
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Accesses an element of <code>lights</code> as a <code>boolean</code> value in an expression		access <code>lights</code> as a type other than <code>boolean</code>
+1	Traverses specified <code>col</code> of a 2D array (<i>no bounds errors</i>)		
+1	Counts the number of <code>true</code> values in the traversal	- access too many or too few items in a single column - access a single row instead of a single column	count an item more than once
+1	Performs an even calculation and a multiple of three calculation		use <code>/</code> instead of <code>%</code>
+1	Returns <code>true</code> or <code>false</code> according to all three rules	have an incorrect column count but use the correct logic	- fail to return a value in some case - implement counting loop more than once with one loop that is incorrect

2019 SCORING GUIDELINES**Question 4: Light Board***Part (a)*

```
public LightBoard(int numRows, int numCols)
{
    lights = new boolean[numRows][numCols];

    for (int r = 0; r < numRows; r++)
    {
        for (int c = 0; c < numCols; c++)
        {
            double rnd = Math.random();
            lights[r][c] = rnd < 0.4;
        }
    }
}
```

Part (b)

```
public boolean evaluateLight(int row, int col)
{
    int numOn = 0;

    for (int r = 0; r < lights.length; r++)
    {
        if (lights[r][col])
        {
            numOn++;
        }
    }

    if (lights[row][col] && numOn % 2 == 0)
    {
        return false;
    }
    if (!lights[row][col] && numOn % 3 == 0)
    {
        return true;
    }
    return lights[row][col];
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2018**AP[®]** **CollegeBoard**

AP Computer Science A

Scoring Guidelines

2018 SCORING GUIDELINES

Apply the question assessment rubric first, which always takes precedence. Penalty points can only be deducted in a part of the question that has earned credit via the question rubric. No part of a question (a, b, c) may have a negative point total. A given penalty can be assessed only once for a question, even if it occurs multiple times or in multiple parts of that question. A maximum of 3 penalty points may be assessed per question.

1-Point Penalty

- v) Array/collection access confusion (`[] get`)
- w) Extraneous code that causes side-effect (e.g., printing to output, incorrect precondition check)
- x) Local variables used but none declared
- y) Destruction of persistent data (e.g., changing value referenced by parameter)
- z) Void method or constructor that returns a value

No Penalty

- o Extraneous code with no side-effect (e.g., valid precondition check, no-op)
- o Spelling/case discrepancies where there is no ambiguity*
- o Local variable not declared provided other variables are declared in some part
- o `private` or `public` qualifier on a local variable
- o Missing `public` qualifier on class or constructor header
- o Keyword used as an identifier
- o Common mathematical symbols used for operators (`*` `*` `÷` `≤` `≥` `<>` `≠`)
- o `[]` vs. `()` vs. `<>`
- o `=` instead of `==` and vice versa
- o `length/size` confusion for array, String, List, or ArrayList; with or without `()`
- o Extraneous `[]` when referencing entire array
- o `[i,j]` instead of `[i][j]`
- o Extraneous size in array declaration, e.g., `int[size] nums = new int[size];`
- o Missing `;` where structure clearly conveys intent
- o Missing `{ }` where indentation clearly conveys intent
- o Missing `()` on parameter-less method or constructor invocations
- o Missing `()` around `if` or `while` conditions

*Spelling and case discrepancies for identifiers fall under the “No Penalty” category only if the correction can be **unambiguously** inferred from context, for example, “ArrayList” instead of “ArrayList”. As a counterexample, note that if the code declares “`int G=99, g=0;`”, then uses “`while (G < 10)`” instead of “`while (g < 10)`”, the context does **not** allow for the reader to assume the use of the lower case variable.

2018 SCORING GUIDELINES

Question 1: Frog Simulation

Part (a)	<code>simulate</code>	5 points
-----------------	-----------------------	-----------------

Intent: *Simulate the distance traveled by a hopping frog*

- +1** Calls `hopDistance` and uses returned distance to adjust (or represent) the frog's position
- +1** Initializes and accumulates the frog's position at most `maxHops` times (*must be in context of a loop*)
- +1** Determines if a distance representing multiple hops is at least `goalDistance`
- +1** Determines if a distance representing multiple hops is less than starting position
- +1** Returns `true` if goal ever reached, `false` if goal never reached or position ever less than starting position

Part (b)	<code>runSimulations</code>	4 points
-----------------	-----------------------------	-----------------

Intent: *Determine the proportion of successful frog hopping simulations*

- +1** Calls `simulate` the specified number of times (*no bounds errors*)
- +1** Initializes and accumulates a count of `true` results
- +1** Calculates proportion of successful simulations using `double` arithmetic
- +1** Returns calculated value

2018 SCORING GUIDELINES

Question 1: Scoring Notes

Part (a) <code>simulate</code>			5 points
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Calls <code>hopDistance</code> and uses returned distance to adjust (or represent) the frog's position	use <code>hopDistance()</code> as a position, like <code>hopDistance() < 0</code>	only use <code>hopDistance()</code> as a count, like <code>hopDistance() < maxHops</code>
+1	Initializes and accumulates the frog's position at most <code>maxHops</code> times (<i>must be in context of a loop</i>)		do not use a loop
+1	Determines if a distance representing multiple hops is at least <code>goalDistance</code>	use some number of hops * <code>hopDistance()</code> as the frog's final position	
+1	Determines if a distance representing multiple hops is less than starting position		
+1	Returns <code>true</code> if goal ever reached, <code>false</code> if goal never reached or position ever less than starting position	have checks for all three conditions and correct return logic based on those checks, even if a check did not earn a point	- do not check all three conditions - only check for <code>goalDistance</code> after the loop - only check for starting position after the loop
Part (b) <code>runSimulations</code>			4 points
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Calls <code>simulate</code> the specified number of times (<i>no bounds errors</i>)	do not use the result of calling <code>simulate</code>	do not use a loop
+1	Initializes and accumulates a count of <code>true</code> results		- initialize the count inside a loop - do not use a loop
+1	Calculates proportion of successful simulations using <code>double</code> arithmetic	perform the correct calculation on an accumulated value, even if there was an error in the accumulation	fail to divide by the parameter
+1	Returns calculated value		- calculate values using nonnumeric types - return a count of simulations

2018 SCORING GUIDELINES**Question 1: Frog Simulation***Part (a)*

```
public boolean simulate()
{
    int position = 0;

    for (int count = 0; count < maxHops; count++)
    {
        position += hopDistance();
        if (position >= goalDistance)
        {
            return true;
        }
        else if (position < 0)
        {
            return false;
        }
    }
    return false;
}
```

Part (b)

```
public double runSimulations(int num)
{
    int countSuccess = 0;

    for (int count = 0; count < num; count++)
    {
        if(simulate())
        {
            countSuccess++;
        }
    }
    return (double)countSuccess / num;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2018 SCORING GUIDELINES

Question 2: Word Pair

Part (a)	<code>WordPairList</code>	5 points
-----------------	---------------------------	-----------------

Intent: *Form pairs of strings from an array and add to an `ArrayList`*

- +1** Creates new `ArrayList` and assigns to `allPairs`
- +1** Accesses all elements of `words` (*no bounds errors*)
- +1** Constructs new `WordPair` using distinct elements of `words`
- +1** Adds all necessary pairs of elements from word array to `allPairs`
- +1** **On exit:** `allPairs` contains all necessary pairs and no unnecessary pairs

Part (b)	<code>numMatches</code>	4 points
-----------------	-------------------------	-----------------

Intent: *Count the number of pairs in an `ArrayList` that have the same value*

- +1** Accesses all elements in `allPairs` (*no bounds errors*)
- +1** Calls `getFirst` or `getSecond` on an element from list of pairs
- +1** Compares first and second components of a pair in the list
- +1** Counts number of matches of pair-like values

Question-Specific Penalties

- 1** (z) Constructor returns a value

2018 SCORING GUIDELINES

Question 2: Scoring Notes

Part (a) <code>WordPairList</code>			5 points
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Creates new <code>ArrayList</code> and assigns to <code>allPairs</code>	<code>allPairs = new ArrayList();</code> <code>allPairs = new ArrayList<>();</code> <code>this.allPairs = ...</code>	initialize a local variable that is never assigned to <code>allPairs</code>
+1	Accesses all elements of <code>words</code> (<i>no bounds errors</i>)		
+1	Constructs new <code>WordPair</code> using distinct elements of <code>words</code>		
+1	Adds all necessary pairs of elements from word array to <code>allPairs</code>	- have a loop bounds error - add unnecessary pairs	- improperly add to an <code>ArrayList</code>, e.g., <code>allPairs.get(i) = x;</code> - only add consecutive pairs (<code>words[i], words[i+1]</code>)
+1	On exit: <code>allPairs</code> contains all necessary pairs and no unnecessary pairs	- improperly add to an <code>ArrayList</code>, e.g., <code>allPairs.get(i) = x;</code> - have a loop bounds error	add pairs <code>(i, i)</code> or <code>(i, j)</code> where <code>i > j</code>
Part (b) <code>numMatches</code>			4 points
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Accesses all elements in <code>allPairs</code> (<i>no bounds errors</i>)		access elements of <code>allPairs</code> as array elements (e.g., <code>allPairs[i]</code>)
+1	Calls <code>getFirst</code> or <code>getSecond</code> on an element from list of pairs		
+1	Compares first and second components of a pair in the list		compare using <code>==</code>
+1	Counts number of matches of pair-like values		fail to initialize the counter

Return is not assessed in part (b).

2018 SCORING GUIDELINES**Question 2: Word Pair***Part (a)*

```
public WordPairList(String[] words)
{
    allPairs = new ArrayList<WordPair>();

    for (int i = 0; i < words.length-1; i++)
    {
        for (int j = i+1; j < words.length; j++)
        {
            allPairs.add(new WordPair(words[i], words[j]));
        }
    }
}
```

Part (b)

```
public int numMatches()
{
    int count = 0;

    for (WordPair pair: allPairs)
    {
        if (pair.getFirst().equals(pair.getSecond()))
        {
            count++;
        }
    }
    return count;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2018 SCORING GUIDELINES

Question 3: Code Word Checker

Class: `CodeWordChecker`

9 points

Intent: *Define implementation of a class to determine if a string meets a set of criteria*

- +1** Declares header: `public class CodeWordChecker implements StringChecker`
- +1** Declares all appropriate `private` instance variables
- +3** Constructors
 - +1** Declares headers: `public CodeWordChecker(int __, int __, String __)` and `public CodeWordChecker(String __)`
 - +1** Uses all parameters to initialize instance variables in 3-parameter constructor
 - +1** Uses parameter and default values to initialize instance variables in 1-parameter constructor
- +4** `isValid` method
 - +1** Declares header: `public boolean isValid(String __)`
 - +1** Checks for length between min and max inclusive
 - +1** Checks for unwanted string
 - +1** Returns `true` if length is between min and max and does not contain the unwanted string, `false` otherwise

2018 SCORING GUIDELINES

Question 3: Scoring Notes

Class <code>CodeWordChecker</code>		9 points	
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Declares header: <code>public class</code> <code>CodeWordChecker</code> <code>implements</code> <code>StringChecker</code>	omit keyword <code>public</code>	- declare class <code>private</code> - declare class <code>static</code>
+1	Declares all appropriate <code>private</code> instance variables		- declare variables as <code>static</code> - omit keyword <code>private</code> - declare variables outside the class
+3	Constructors		
+1	Declares headers: <code>public</code> <code>CodeWordChecker</code> <code>(int __, int __,</code> <code>String __)</code> and <code>public</code> <code>CodeWordChecker</code> <code>(String __)</code>	omit keyword <code>public</code>	- declare method <code>static</code> - declare method <code>private</code>
+1	Uses all parameters to initialize instance variables in 3- parameter constructor		- fail to declare instance variables - initialize local variables instead of instance variables - assign variables to parameters
+1	Uses parameter and default values to initialize instance variables in 1- parameter constructor	initialize instance variables to default values when declared	- fail to declare instance variables - initialize local variables instead of instance variables - assign variables to parameters
+4	<code>isValid</code> method		
+1	Declares header: <code>public boolean</code> <code>isValid</code> <code>(String __)</code>		- fail to declare method <code>public</code> - declare method <code>static</code>
+1	Checks for length between min and max inclusive		- fail to use instance variables - fail to declare the method header
+1	Checks for unwanted string		- fail to use instance variables - fail to declare the method header
+1	Returns <code>true</code> if length is between min and max and does not contain the unwanted string, <code>false</code> otherwise	have incorrect checks for length and/or containment, but return the correct value based on those checks	- fail to declare the method header - fail to return in all cases - only check one substring location for containment

2018 SCORING GUIDELINES**Question 3: Code Word Checker**

```
public class CodeWordChecker implements StringChecker
{
    private int minLength;
    private int maxLength;
    private String notAllowed;

    public CodeWordChecker(int minLen, int maxLen, String symbol)
    {
        minLength = minLen;
        maxLength = maxLen;
        notAllowed = symbol;
    }

    public CodeWordChecker(String symbol)
    {
        minLength = 6;
        maxLength = 20;
        notAllowed = symbol;
    }

    public boolean isValid(String str)
    {
        return str.length() >= minLength && str.length() <= maxLength &&
            str.indexOf(notAllowed) == -1;
    }
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2018 SCORING GUIDELINES

Question 4: Latin Squares

Part (a)	<code>getColumn</code>	4 points
-----------------	------------------------	-----------------

Intent: Create a 1-D array that contains the values from one column of a 2-D array

- +1** Constructs a new `int` array of size `arr2D.length`
- +1** Accesses all items in one column of `arr2D` (*no bounds errors*)
- +1** Assigns one element from `arr2D` to the corresponding element in the new array
- +1 On exit:** The new array has all the elements from the specified column in `arr2D` in the correct order

Part (b)	<code>isLatin</code>	5 points
-----------------	----------------------	-----------------

Intent: Check conditions to determine if a square 2-D array is a Latin square

- +1** Calls `containsDuplicates` referencing a row or column of `square`
- +1** Calls `hasAllValues` referencing two different rows, two different columns, or one row and one column
- +1** Applies `hasAllValues` to all rows or all columns (*no bounds errors*)
- +1** Calls `getColumn` to obtain a valid column from `square`
- +1** Returns `true` if all three Latin square conditions are satisfied, `false` otherwise

Question-Specific Penalties

- 1** (r) incorrect construction of a copy of a row
- 1** (s) syntactically incorrect method call to any of `getColumn()`, `containsDuplicates()`, or `hasAllValues()`

2018 SCORING GUIDELINES

Question 4: Scoring Notes

Part (a) <code>getColumn</code>			4 points
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Constructs a new <code>int</code> array of size <code>arr2D.length</code>		only create an <code>ArrayList</code>
+1	Accesses all items in one column of <code>arr2D</code> (<i>no bounds errors</i>)	declare the new array of an incorrect size and use that size as the number of loop iterations	switch row and column indices
+1	Assigns one element from <code>arr2D</code> to the corresponding element in the new array		use <code>ArrayList</code> methods to add to array
+1	On exit: The new array has all the elements from the specified column in <code>arr2D</code> in the correct order		- switch row and column indices - do not use an index when assigning values to the array
Part (b) <code>isLatin</code>			5 points
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Calls <code>containsDuplicates</code> referencing a row or column of <code>square</code>	reference any row or column of <code>square</code>, even if the syntax of the reference is incorrect	
+1	Calls <code>hasAllValues</code> referencing two different rows, two different columns, or one row and one column	reference any two distinct rows, two distinct columns, or a row and column of <code>square</code>, even if the syntax of the reference is incorrect	
+1	Applies <code>hasAllValues</code> to all rows or all columns (<i>no bounds errors</i>)		only reference one array in the call to <code>hasAllValues</code>
+1	Calls <code>getColumn</code> to obtain a valid column from <code>square</code>		reverse parameters
+1	Returns <code>true</code> if all three Latin square conditions are satisfied, <code>false</code> otherwise	test the three sets of conditions and return the correct value	

Return is not assessed in Part (a).

2018 SCORING GUIDELINES**Question 4: Latin Squares***Part (a)*

```
public static int[] getColumn(int[][] arr2D, int c)
{
    int[] result = new int[arr2D.length];

    for (int r = 0; r < arr2D.length; r++)
    {
        result[r] = arr2D[r][c];
    }
    return result;
}
```

Part (b)

```
public static boolean isLatin(int[][] square)
{
    if (containsDuplicates(square[0]))
    {
        return false;
    }

    for (int r = 1; r < square.length; r++)
    {
        if (!hasAllValues(square[0], square[r]))
        {
            return false;
        }
    }

    for (int c = 0; c < square[0].length; c++)
    {
        if (!hasAllValues(square[0], getColumn(square, c)))
        {
            return false;
        }
    }

    return true;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2017**AP[®]** **CollegeBoard**

AP Computer Science A

Scoring Guidelines

2017 GENERAL SCORING GUIDELINES

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1-Point Penalty

- v) Array/collection access confusion (`[]` `get`)
- w) Extraneous code that causes side-effect (e.g., printing to output, incorrect precondition check)
- x) Local variables used but none declared
- y) Destruction of persistent data (e.g., changing value referenced by parameter)
- z) Void method or constructor that returns a value

No Penalty

- o Extraneous code with no side-effect (e.g., valid precondition check, no-op)
- o Spelling/case discrepancies where there is no ambiguity*
- o Local variable not declared provided other variables are declared in some part
- o `private` or `public` qualifier on a local variable
- o Missing `public` qualifier on class or constructor header
- o Keyword used as an identifier
- o Common mathematical symbols used for operators (`*` `*` `÷` `≤` `≥` `<>` `≠`)
- o `[]` vs. `()` vs. `<>`
- o `=` instead of `==` and vice versa
- o `length/size` confusion for array, `String`, `List`, or `ArrayList`; with or without `()`
- o Extraneous `[]` when referencing entire array
- o `[i,j]` instead of `[i][j]`
- o Extraneous size in array declaration, e.g., `int[size] nums = new int[size];`
- o Missing `;` where structure clearly conveys intent
- o Missing `{ }` where indentation clearly conveys intent
- o Missing `()` on parameter-less method or constructor invocations
- o Missing `()` around `if` or `while` conditions

Spelling and case discrepancies for identifiers fall under the “No Penalty” category only if the correction can be **unambiguously inferred from context, for example, “ArrayList” instead of “ArrayList.” As a counterexample, note that if the code declares “int G=99, g=0;”, then uses “while (G < 10)” instead of “while (g < 10)”, the context does **not** allow for the reader to assume the use of the lower case variable.*

2017 SCORING GUIDELINES

Question 1: Digits

Part (a)	Digits constructor	5 points
-----------------	--------------------	-----------------

Intent: *Initialize instance variable using passed parameter*

- +1 Constructs `digitList`
- +1 Identifies a digit in `num`
- +1 Adds at least one identified digit to a list
- +1 Adds all identified digits to a list (*must be in context of a loop*)
- +1 **On exit:** `digitList` contains all and only digits of `num` in the correct order

Part (b)	<code>isStrictlyIncreasing</code>	4 points
-----------------	-----------------------------------	-----------------

Intent: *Determine whether or not elements in `digitList` are in increasing order*

- +1 Compares at least one identified consecutive pair of `digitList` elements
- +1 Determines if a consecutive pair of `digitList` is out of order (*must be in context of a `digitList` traversal*)
- +1 Compares all necessary consecutive pairs of elements (*no bounds errors*)
- +1 Returns `true` iff all consecutive pairs of elements are in order; returns `false` otherwise

Question-Specific Penalties

- 2 (q) Uses confused identifier instead of `digitList`

2017 SCORING GUIDELINES

Question 1: Scoring Notes

Part (a) Digits constructor			5 points
Points	Rubric Criteria	Responses earn the point if they ...	Responses will not earn the point if they ...
+1	Constructs digitList		- initialize a local variable instead of digitList - create an ArrayList<int>
+1	Identifies a digit in num	identify one digit of num or a length one substring/character of the String representation of num	- treat num itself as a String - convert num to a String incorrectly
+1	Adds at least one identified digit to a list	call add for some ArrayList using the previously identified digit, even if that digit was identified incorrectly	add String or char to digitList without proper conversion to the correct type
+1	Adds all identified digits to a list (<i>must be in the context of a loop</i>)	call add for some ArrayList using previously identified digits, even if those digits were identified incorrectly	identify only 1 digit
+1	On exit: digitList contains all and only digits of num in the correct order	add to digitList even if it is not instantiated properly	- obtain a list with the digits in reverse order - omit one or more digits - add extra digits - mishandle edge case, e.g., 0 or 10 - make a bounds error processing the String representation of num
Part (b) isStrictlyIncreasing			4 points
Points	Rubric Criteria	Responses earn the point if they ...	Responses will not earn the point if they ...
+1	Compares at least one identified consecutive pair of digitList elements	- compare two consecutive Integers using compareTo - explicitly convert two consecutive Integers to ints and compare those with >=, <= etc. - use auto-unboxing to convert two consecutive Integers to ints and compare those with >=, <= etc.	- access digitList as an array or string - fail to call .get () - compare using !>
+1	Determines if a consecutive pair of digitList is out of order (<i>must be in context of a digitList traversal</i>)	determine the correct relationship between the two compared consecutive elements, even if the syntax of the comparison is incorrect	fail to consider the case where the two elements are equal for the false case
+1	Compares all necessary consecutive pairs of elements (<i>no bounds errors</i>)		return early
+1	Returns true iff all consecutive pairs of elements are in order; returns false otherwise	compare consecutive pairs for inequality, but fail to consider the case when two elements are equal	return prematurely via if (...) return false; else return true;

2017 SCORING GUIDELINES**Question 1: Digits***Part (a)*

```
public Digits(int num)
{
    digitList = new ArrayList<Integer>();

    if (num == 0)
    {
        digitList.add(new Integer(0));
    }

    while (num > 0)
    {
        digitList.add(0, new Integer(num % 10));
        num /= 10;
    }
}
```

Part (b)

```
public boolean isStrictlyIncreasing()
{
    for (int i = 0; i < digitList.size()-1; i++)
    {
        if (digitList.get(i).intValue() >= digitList.get(i+1).intValue())
        {
            return false;
        }
    }
    return true;
}
```

Note: The solutions shown above were written in compliance with the AP Java subset methods listed for `Integer` objects. Students were allowed to use the automatic "boxing" and "unboxing" of `Integer` objects in their solutions, which eliminates the need to use `"new Integer(...)"` in part (a) and `"intValue()"` in part (b).

2017 SCORING GUIDELINES

Question 2: MultiPractice

Class:	MultiPractice	9 points
---------------	---------------	-----------------

Intent: *Define implementation of class to produce multiplication practice problems*

- +1** Declares header: `public class MultiPractice implements StudyPractice`
- +1** Declares all necessary `private` instance variables
- +2** Constructor
 - +1** Declares header: `public MultiPractice(int __, int __)`
 - +1** Initializes all instance variables using parameters
- +3** `getProblem` method
 - +1** Declares header: `public String getProblem()`
 - +1** Builds string with current values of instance variables
 - +1** Returns constructed string
- +2** `nextProblem` method
 - +1** Declares header: `public void nextProblem()`
 - +1** Updates instance variable(s) to reflect incremented second number

2017 SCORING GUIDELINES

Question 2: Scoring Notes

Class MultPractice			9 points
Points	Rubric Criteria	Responses earn the point if they ...	Responses will not earn the point if they ...
+1	Declares header: public class MultPractice implements StudyPractice	omit keyword <code>public</code>	declare class <code>private</code>
+1	Declares all necessary private instance variables	declare the unchanging instance variable as <code>final</code>	- declare variables as <code>static</code> - omit keyword <code>private</code>
+2	Constructor		
+1	Declares header: public MultPractice (int ____, int ____)	omit keyword <code>public</code>	
+1	Initializes all instance variables using parameters		- fail to declare nonlocal variables - initialize local variables instead of instance variables - assign variables to parameters
+3	getProblem method		
+1	Declares header: public String getProblem()		fail to declare method <code>public</code>
+1	Builds string with current values of instance variables	- write appropriate code in a method other than <code>getProblem</code> - make capitalization or spacing errors	- fail to declare nonlocal variables - fail to use instance variables - miscast <code>(String) intVar</code> - call <code>intVar.toString()</code>
+1	Returns constructed string		return a literal string
+2	nextProblem method		
+1	Declares header: public void nextProblem()		fail to declare method <code>public</code>
+1	Updates instance variable(s) to reflect incremented second number		fail to declare non-local variables

2017 SCORING GUIDELINES**Question 2: MultiPractice**

```
public class MultiPractice implements StudyPractice
{
    private int first;
    private int second;

    public MultiPractice(int num1, int num2)
    {
        first = num1;
        second = num2;
    }

    public String getProblem()
    {
        return first + " TIMES " + second;
    }

    public void nextProblem()
    {
        second++;
    }
}
```

2017 SCORING GUIDELINES

Question 3: PhraseEditor

Part (a)	<code>replaceNthOccurrence</code>	5 points
-----------------	-----------------------------------	-----------------

Intent: *Replace the n th occurrence of a given string with a given replacement*

- +1** Calls `findNthOccurrence` to find the index of the n th occurrence
- +1** Preserves `currentPhrase` only if n th occurrence does not exist
- +1** Identifies components of `currentPhrase` to retain (uses `substring` to extract before/after)
- +1** Creates replacement string using identified components and `repl`
- +1** Assigns replacement string to instance variable (`currentPhrase`)

Part (b)	<code>findLastOccurrence</code>	4 points
-----------------	---------------------------------	-----------------

Intent: *Return the index of the last occurrence of a given string*

- +1** Calls `findNthOccurrence` to find the index of the n th occurrence
- +1** Increments (or decrements) the value used as n when finding n th occurrence
- +1** Returns the index of the last occurrence, if it exists
- +1** Returns -1 only when no occurrences exist

Question-Specific Penalties

- 1** (q) Uses `currentPhrase.findNthOccurrence`
- 2** (r) Confused identifier instead of `currentPhrase`

2017 SCORING GUIDELINES

Question 3: Scoring Notes

Part (a) <code>replaceNthOccurrence</code>			5 points
Points	Rubric Criteria	Responses earn the point if they ...	Responses will not earn the point if they ...
+1	Calls <code>findNthOccurrence</code> to find the index of the <code>nth</code> occurrence	do not use the result of calling <code>findNthOccurrence</code>	
+1	Preserves <code>currentPhrase</code> only if <code>nth</code> occurrence does not exist		fail to use a conditional
+1	Identifies components of <code>currentPhrase</code> to retain (uses <code>substring</code> to extract before/after)	identify start and end of substring to be replaced	
+1	Creates replacement string using identified components and <code>repl</code>		create a replacement string that is out of order
+1	Assigns replacement string to instance variable (<code>currentPhrase</code>)		
Part (b) <code>findLastOccurrence</code>			4 points
Points	Rubric Criteria	Responses earn the point if they ...	Responses will not earn the point if they ...
+1	Calls <code>findNthOccurrence</code> to find the index of the <code>nth</code> occurrence	do not use the result of calling <code>findNthOccurrence</code>	<code>return currentPhrase.lastIndexOf(str);</code> - call <code>findNthOccurrence</code> with an integer parameter of 0
+1	Increments (or decrements) the value used as <code>n</code> when finding <code>nth</code> occurrence	<code>return currentPhrase.lastIndexOf(str);</code> - advance through <code>currentPhrase</code> searching for <code>nth</code> occurrence of <code>str</code>	
+1	Returns the index of the last occurrence, if it exists	<code>return currentPhrase.lastIndexOf(str);</code> - compute the correct value to be returned in all cases, but no return statement exists for any case	- shorten string being searched - always return in first iteration of the loop
+1	Returns -1 only when no occurrences exist	<code>return currentPhrase.lastIndexOf(str);</code>	- compute the correct value to be returned in all cases, but no return statement exists for any case - always return in first iteration of the loop

2017 SCORING GUIDELINES**Question 3: PhraseEditor***Part (a)*

```
public void replaceNthOccurrence(String str, int n, String repl)
{
    int loc = findNthOccurrence(str, n);

    if (loc != -1)
    {
        currentPhrase = currentPhrase.substring(0, loc) + repl +
                        currentPhrase.substring(loc + str.length());
    }
}
```

Part (b)

```
public int findLastOccurrence(String str)
{
    int n = 1;
    while (findNthOccurrence(str, n+1) != -1)
    {
        n++;
    }
    return findNthOccurrence(str, n);
}
```

2017 SCORING GUIDELINES

Question 4: Successor Array

Part (a)	<code>findPosition</code>	5 points
-----------------	---------------------------	-----------------

Intent: *Find the position of a given integer in a 2D integer array*

- +1** Accesses all necessary elements of `intArr` (*no bounds errors*)
- +1** Identifies `intArr` element equal to `num` (*in context of an `intArr` traversal*)
- +1** Constructs `Position` object with same row and column as identified `intArr` element
- +1** Selects constructed object when `intArr` element identified; `null` when not
- +1** Returns selected value

Part (b)	<code>getSuccessorArray</code>	4 points
-----------------	--------------------------------	-----------------

Intent: *Create a successor array based on a 2D integer array*

- +1** Creates 2D array of `Position` objects with same dimensions as `intArr`
- +1** Assigns a value to a location in 2D successor array using a valid call to `findPosition`
- +1** Determines the successor `Position` of an `intArr` element accessed by row and column (*in context of `intArr` traversal*)
- +1** Assigns all necessary locations in successor array with corresponding position object or `null` (*no bounds errors*)

Question-Specific Penalties

- 1** (s) Uses confused identifier `Arr`
- 1** (t) Uses `intArr[0].length` as the number of columns
- 1** (u) Uses non-existent accessor methods from `Position`

2017 SCORING GUIDELINES

Question 4: Scoring Notes

Part (a) findPosition			5 points
Points	Rubric Criteria	Responses earn the point if they ...	Responses will not earn the point if they ...
+1	Accesses all necessary elements of <code>intArr</code> (<i>no bounds errors</i>)		- use <code>if (...) return;</code> else <code>return null;</code> inside loop - confuse row and column bounds - fail to traverse <code>intArr</code>
+1	Identifies <code>intArr</code> element equal to <code>num</code> (<i>in context of an <code>intArr</code> traversal</i>)		use <code>.equals</code> instead of <code>==</code>
+1	Constructs <code>Position</code> object with same row and column as identified <code>intArr</code> element		- omit keyword <code>new</code> - use <code>(r,c)</code> instead of <code>Position(r,c)</code>
+1	Selects constructed object when <code>intArr</code> element identified; <code>null</code> when not	- use <code>"null"</code> instead of <code>null</code> - construct a <code>String</code> object using row and column indices	- use <code>if (...) return;</code> else <code>return null;</code> inside loop - use <code>(r,c)</code> instead of <code>Position(r,c)</code>
+1	Returns selected value		
Part (b) getSuccessorArray			4 points
Points	Rubric Criteria	Responses earn the point if they ...	Responses will not earn the point if they ...
+1	Creates 2D array of <code>Position</code> objects with same dimensions as <code>intArr</code>		omit keyword <code>new</code>
+1	Assigns a value to a location in 2D successor array using a valid call to <code>findPosition</code>	call <code>Successors.findPosition(...)</code>	- reimplement the code from <code>findPosition</code> - call <code>findPosition</code> with a single argument - call <code>this.findPosition(...)</code>
+1	Determines the successor <code>Position</code> of an <code>intArr</code> element accessed by row and column (<i>in context of <code>intArr</code> traversal</i>)	reimplement the code from <code>findPosition</code>	- call <code>findPosition</code> using an integer that is not identified with a location in <code>intArr</code> - call <code>findPosition</code> with a single argument
+1	Assigns all necessary locations in successor array with corresponding position object or <code>null</code> (<i>no bounds errors</i>)	- use <code>SuccessorArray</code> dimensions correctly, even if <code>SuccessorArray</code> was not initialized properly - only assign non-null entries to <code>SuccessorArray</code>	- reimplement the code from <code>findPosition</code> but mishandle the null case. - fail to traverse <code>intArr</code>

Return is not assessed in Part (b).

2017 SCORING GUIDELINES**Question 4: Successor Array***Part (a)*

```
public static Position findPosition(int num, int[][] intArr)
{
    for (int row=0; row < intArr.length; row++)
    {
        for (int col=0; col < intArr[0].length; col++)
        {
            if (intArr[row][col] == num)
            {
                return new Position(row, col);
            }
        }
    }
    return null;
}
```

Part (b)

```
public static Position[][] getSuccessorArray(int[][] intArr)
{
    Position[][] newArr = new Position[intArr.length][intArr[0].length];

    for (int row=0; row < intArr.length; row++)
    {
        for (int col=0; col < intArr[0].length; col++)
        {
            newArr[row][col] = findPosition(intArr[row][col]+1, intArr);
        }
    }
    return newArr;
}
```

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2016 GENERAL SCORING GUIDELINES

Apply the question assessment rubric first, which always takes precedence. Penalty points can only be deducted in a part of the question that has earned credit via the question rubric. No part of a question (a, b, c) may have a negative point total. A given penalty can be assessed only once for a question, even if it occurs multiple times or in multiple parts of that question. A maximum of 3 penalty points may be assessed per question.

1-Point Penalty

- v) Array/collection access confusion (`[]` `get`)
- w) Extraneous code that causes side-effect (e.g., writing to output, failure to compile)
- x) Local variables used but none declared
- y) Destruction of persistent data (e.g., changing value referenced by parameter)
- z) Void method or constructor that returns a value

No Penalty

- o Extraneous code with no side-effect (e.g., precondition check, no-op)
- o Spelling/case discrepancies where there is no ambiguity*
- o Local variable not declared provided other variables are declared in some part
- o `private` or `public` qualifier on a local variable
- o Missing `public` qualifier on class or constructor header
- o Keyword used as an identifier
- o Common mathematical symbols used for operators (`*` `*` `÷` `≤` `≥` `<>` `≠`)
- o `[]` vs. `()` vs. `<>`
- o `=` instead of `==` and vice versa
- o `length/size` confusion for array, String, List, or ArrayList; with or without `()`
- o Extraneous `[]` when referencing entire array
- o `[i,j]` instead of `[i][j]`
- o Extraneous size in array declaration, e.g., `int[size] nums = new int[size];`
- o Missing `;` where structure clearly conveys intent
- o Missing `{ }` where indentation clearly conveys intent
- o Missing `()` on parameter-less method or constructor invocations
- o Missing `()` around `if` or `while` conditions

Spelling and case discrepancies for identifiers fall under the “No Penalty” category only if the correction can be **unambiguously inferred from context. For example, “ArayList” instead of “ArrayList”. As a counter example, note that if the code declares “Bug bug;”, then uses “Bug.move()” instead of “bug.move()”, the context does **not** allow for the reader to assume the object instead of the class.*

2016 SCORING GUIDELINES

Question 1: Random String Chooser

Part (a)	RandomStringChooser	7 points
-----------------	---------------------	-----------------

Intent: *Define implementation of class to choose a random string*

- +1** Uses correct class, constructor, and method headers
- +1** Declares appropriate `private` instance variable(s)
- +1** Initializes all instance variable(s) (*point lost if parameter not used in any initialization*)
- +4** Implements `getNext`
 - +1** Generates a random number in the proper range (*point lost for improper or missing cast*)
 - +1** Chooses a string from instance variable using generated random number
 - +1** Updates state appropriately (*point lost if constructor parameter is altered*)
 - +1** Returns chosen string or `"NONE"` as appropriate

Part (b)	RandomLetterChooser	2 points
-----------------	---------------------	-----------------

Intent: *Define implementation of a constructor of a class that extends `RandomStringChooser`*

- +1** `getSingleLetters(str)`
- +1** `super(getSingleLetters(str));` (*point lost if not first statement in constructor*)

2016 CANONICAL SOLUTIONS**Question 1: Random String Chooser**

Part (a):

```
public class RandomStringChooser
{
    private List<String> words;

    public RandomStringChooser(String[] wordArray)
    {
        words = new ArrayList<String>();

        for (String singleWord : wordArray)
        {
            words.add(singleWord);
        }
    }

    public String getNext()
    {
        if (words.size() > 0)
        {
            return words.remove((int) (Math.random() * words.size()));
        }
        return "NONE";
    }
}
```

Part (b):

```
public RandomLetterChooser(String str)
{
    super(getSingleLetters(str));
}
```

2016 SCORING GUIDELINES

Question 2: Log Messages

Part (a) `LogMessage` constructor

2 points

Intent: *Initialize instance variables using passed parameter*

- +1 Locates colon
- +1 Initializes instance variables with correct parts of the parameter

Part (b) `containsWord`

2 points

Intent: *Determine whether description properly contains a keyword*

- +1 Identifies at least one properly-contained occurrence of `keyword` in `description`
- +1 Returns `true` if and only if `description` properly contains `keyword`
Returns `false` otherwise (*no bounds errors*)

Part (c) `removeMessages`

5 points

Intent: *Remove log messages containing keyword from system log list and return these messages in a new list*

- +1 Accesses all items in `messageList` (*no bounds errors; point lost if no removal attempted*)
- +1 Identifies keyword-containing entry using `containsWord`
- +1 Adds all and only identified entries to new list (*point lost if original order not maintained*)
- +1 Removes all identified entries from `messageList` (*point lost if `messageList` reordered*)
- +1 Constructs and returns new `ArrayList<LogMessage>`

2016 CANONICAL SOLUTIONS

Question 2: Log Messages

Part (a):

```
public LogMessage(String message)
{
    int colon = message.indexOf(":");
    machineId = message.substring(0, colon);
    description = message.substring(colon + 1);
}
```

Part (b):

```
public boolean containsWord(String keyword)
{
    if (description.equals(keyword))
    {
        return true;
    }
    if (description.indexOf(keyword + " ") == 0)
    {
        return true;
    }
    if (description.indexOf(" " + keyword + " ") != -1)
    {
        return true;
    }
    if (description.length() > keyword.length())
    {
        if ((description.substring(description.length() -
                                   keyword.length() - 1).equals(
                                   " " + keyword)))
        {
            return true;
        }
    }
    return false;
}
```

Part (c):

```
public List<LogMessage> removeMessages(String keyword)
{
    List<LogMessage> removals = new ArrayList<LogMessage>();

    for (int i = 0; i < messageList.size(); i++)
    {
        if (messageList.get(i).containsWord(keyword))
        {
            removals.add(messageList.remove(i));
            i--;
        }
    }
    return removals;
}
```

2016 SCORING GUIDELINES

Question 3: Crossword

Part (a)	<code>toBeLabeled</code>	3 points
-----------------	--------------------------	-----------------

Intent: Return a *boolean* value indicating whether a crossword grid square should be labeled with a positive number

- +1** Checks `blackSquares[r][c]`
- +1** Checks for black square/border above and black square/border to the left (*no bounds errors*)
- +1** Returns `true` if square should be labeled with positive number; returns `false` otherwise

Part (b)	Crossword constructor	6 points
-----------------	-----------------------	-----------------

Intent: Initialize each square in a crossword puzzle grid to have a *color* (*boolean*) and an *integer label*

- +1** `puzzle = new Square[blackSquares.length][blackSquares[0].length];`
(or equivalent)
- +1** Accesses all locations in `puzzle` (*no bounds errors*)
- +1** Calls `toBeLabeled` with appropriate parameters
- +1** Creates and assigns new `Square` to location in `puzzle`
- +1** Numbers identified squares consecutively, in row-major order, starting at 1
- +1** On exit: All squares in `puzzle` have correct color and number (*minor errors covered in previous points ok*)

Question-Specific Penalties

- 2** (p) Consistently uses incorrect name instead of `puzzle`
- 1** (q) Uses `array[].length` instead of `array[num].length`

2016 CANONICAL SOLUTIONS

Question 3: Crossword

Part (a):

```
private boolean toBeLabeled(int r, int c, boolean[][] blackSquares)
{
    return (!(blackSquares[r][c]) &&
            (r == 0 || c == 0 || blackSquares[r - 1][c] ||
             blackSquares[r][c - 1]));
}
```

Part (b):

```
public Crossword(boolean[][] blackSquares)
{
    puzzle = new Square[blackSquares.length][blackSquares[0].length];
    int num = 1;

    for (int r = 0; r < blackSquares.length; r++)
    {
        for (int c = 0; c < blackSquares[0].length; c++)
        {
            if (blackSquares[r][c])
            {
                puzzle[r][c] = new Square(true, 0);
            }
            else
            {
                if (toBeLabeled(r, c, blackSquares))
                {
                    puzzle[r][c] = new Square(false, num);
                    num++;
                }
                else
                {
                    puzzle[r][c] = new Square(false, 0);
                }
            }
        }
    }
}
```

2016 SCORING GUIDELINES

Question 4: String Formatter

Part (a)	<code>totalLetters</code>	2 points
-----------------	---------------------------	-----------------

Intent: Calculate the total number of letters in a list of words

- +1** Accesses all strings in `wordList` and adds length of each to accumulated count (*no bounds errors*)
- +1** Initializes and returns accumulated count

Part (b)	<code>basicGapWidth</code>	2 points
-----------------	----------------------------	-----------------

Intent: Calculate the minimum number of spaces (*basic gap width*) to be placed between each word in the formatted string

- +1** Calls `totalLetters` correctly and uses result
- +1** Returns correct calculated value

Part (c)	<code>format</code>	5 points
-----------------	---------------------	-----------------

Intent: Return a formatted string consisting of words from `wordList` separated by one or more spaces

- +1** Calls `basicGapWidth` and `leftoverSpaces` correctly and uses results
- +1** Adds all strings in `wordList` to formatted string in original order (*no bounds errors*)
- +1** Inserts *basicGapWidth* spaces between each pair of words in formatted string
- +1** Inserts one space between first *leftoverSpaces* pairs of words in formatted string
- +1** Initializes and returns formatted string (*no extra or deleted characters*)

2016 CANONICAL SOLUTIONS**Question 4: String Formatter**

Part (a):

```
public static int totalLetters(List<String> wordList)
{
    int total = 0;

    for (String word : wordList)
    {
        total += word.length();
    }
    return total;
}
```

Part (b):

```
public static int basicGapWidth(List<String> wordList, int formattedLen)
{
    return (formattedLen - totalLetters(wordList)) / (wordList.size()-1);
}
```

Part (c):

```
public static String format(List<String> wordList, int formattedLen)
{
    String formatted = "";
    int gapWidth = basicGapWidth(wordList, formattedLen);
    int leftovers = leftoverSpaces(wordList, formattedLen);

    for (int w = 0; w < wordList.size() - 1; w++)
    {
        formatted = formatted + wordList.get(w);
        for (int i = 0; i < gapWidth; i++)
        {
            formatted = formatted + " ";
        }
        if (leftovers > 0)
        {
            formatted = formatted + " ";
            leftovers--;
        }
    }
    formatted = formatted + wordList.get(wordList.size() - 1);

    return formatted;
}
```