Sarai Gould & Laura Cruz-Albrecht
CS 106A

# CS 106A Practice Midterm Exam

**Midterm Time: Monday, July 22nd, 7:00PM–9:00PM**
**Midterm Location: Bishop Auditorium**

Based on handouts by Colin Kincaid and Nick Troccoli

This handout is intended to give you practice solving problems that are comparable in format and difficulty to those which will appear on the midterm examination. We do not guarantee that the number of questions in this sample exam will match the number on the real exam, nor that every kind of problem shown here will exactly match the kinds of problems shown on the final exam (though the real exam will be generally similar overall).

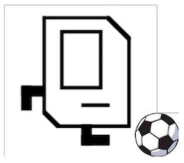
***The midterm exam is on your computer but closed-textbook and closed-notes.*** A "syntax reference sheet" will be provided during the exam (it is omitted here, but available on the course website). It will cover all material presented up to the midterm date itself. Please see the course website for a complete list of midterm exam details and logistics.

**General instructions**
Answer each of the questions included in the exam. If a problem asks you to write a method, you should write only that method, not a complete program. Type all of your answers directly on the *answer page provided for that specific problem*, including any work that you wish to be considered for partial credit.

Each question is marked with the number of points assigned to that problem. The total number of points is 120. We intend for the number of points to be roughly comparable to the number of minutes you should spend on that problem.

Unless otherwise indicated as part of the instructions for a specific problem, your code will not be graded on style – only on functionality. On the other hand, good style (comments, etc.) may help you to get partial credit if they help us determine what you were trying to do.

## Karel Prepares for the Olympics! (25 points)



Inspired by the events of the 2016 Rio Olympics (where Stanford athletes earned more medals than all but nine countries) as well as the 2018 Men's World Cup, Karel has decided to train for the 2020 Olympics in Tokyo. But in order to become the world's best striker, Karel first needs to learn ball control!

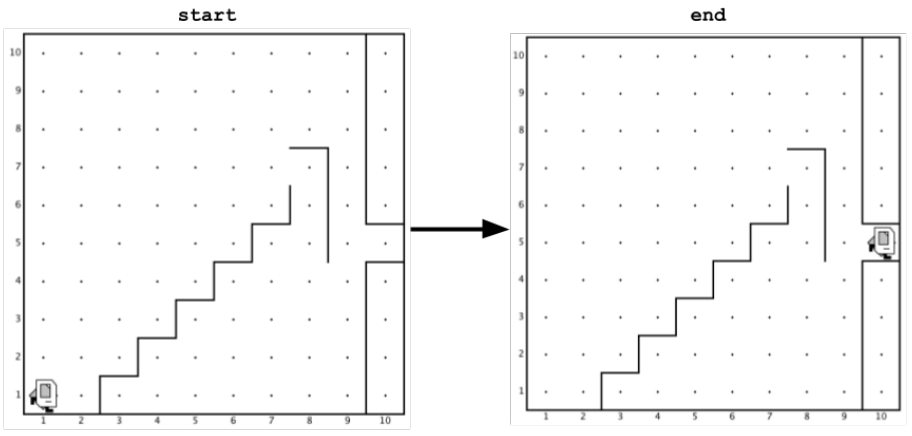
Write a program called `StrikerKarel` to help Karel learn the basics of the role:

```
public class StrikerKarel extends SuperKarel
```

Karel starts off at the corner of (1,1), standing on top of the ball (a beeper). Karel has no beepers in their bag and there are no other beepers in the world. There is one **"goal"** in the final column of the world, represented by an opening in a wall between the last and second-to-last columns. **Karel needs to move the ball from (1,1) to this "goal".**

Two challenges make Karel's task more difficult:

- In order to simulate dribbling, Karel cannot move more than once without the ball touching the ground. That is, the ball must be put down each time Karel changes location.
- In order to simulate defenders, there are walls blocking Karel's potential paths. Karel must move around these walls.

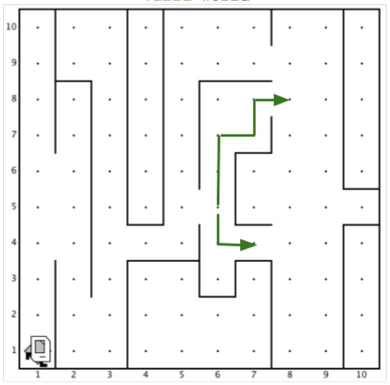


## Assumptions and Specifications

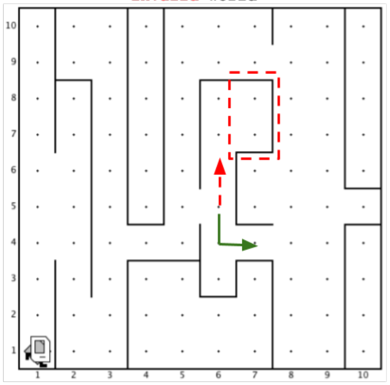
- The world will have at least two columns but may be any height.
- There will be exactly one "goal" in the final column. The goal corner is the only corner in the world that is blocked to the north, east, and south simultaneously.
- At every reachable corner other than the goal, Karel will be able to find an opening in the wall that allows them to move east without first moving west.
- Karel's ending direction does not matter, so long as Karel is in the goal and on top of a beeper.
- **You are limited to the Java instructions shown in the Karel coursereader.** This means the only variables allowed are loop control variables used within the control section of a `for` loop. You are *not* allowed to use syntax like local variables, instance variables, parameters, return values, Strings, `return` or `break` , etc.

For example, the world on the right is **not valid** because if Karel moves north following the red dashed arrow,
they will be trapped by walls to the north, south, and east in the column indicated by the red d ashed box.
Karel would have to move west in order to move east again. Your program **does not** need to handle this kind of world.

**valid world**



**invalid world**



## You Prepare to Be a Section Leader! (20 points)

### Part A: Getting grilled (10 points)

It's time for section, and your students are grilling you on how to evaluate complicated expressions!
For each expression below, determine its final value. Be sure to write a literal value of the appropriate type (e.g., 7.0 rather than 7 for a double, Strings in double quotes, chars in single quotes, true/false for a boolean).

```
i. (double)(16 / 5) * 10

ii. 'D' - 'A' == '3'

iii. 2 + 5 + "M" + 2 * 5 + 2

iv. 200 + 19 % 10 - (42 / 10.0 / 2) * 100

v. !((false || 3 != 4) && !(7 / 2.0 < 3.5))
```

### Part B: LaIR Lunacy (10 points)

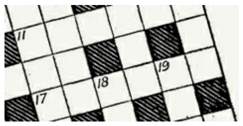
Now you are helping someone in the LaIR, but they have not named their variables or methods descriptively :-(
Trace through the program's execution to figure out what is happening. For each `println` call along the way, indicate what the program would output at that point in the execution.
**IMPORTANT:** You must enter your answers in the order the program prints them. To this end, each `println` has a comment indicating which answer it corresponds to. Correct answers in the wrong order will not earn full credit.

```
public void run() {
  int alexandria = 14;
  int ben = 18;
  alexandria = tinky(ben, alexandria);
  println(ben); // ii
  GOval cory = new GOval(19, 87, 19, 91);
  int deray = 66;
  winky(cory, deray);
  println(cory.getHeight()); // iii
  println(deray); // iv
  String elizabeth = "NSP";
  elizabeth.toLowerCase();
  println(elizabeth); // v
}

private int tinky(int alexandria, int ben) {
  alexandria /= 2;
  ben /= 2;
  println(alexandria);  // i
  return ben;
}

private void winky(GOval cory, int deray) {
  deray = 76;
  cory.setSize(19, 92);
  deray++;
}
```

# Colin Prepares for the Saturday Crossword! (40 points)



(The series of events described in this problem is 100% true.)

A few weeks ago, Colin got a subscription to the New York Times daily crossword puzzle. He has been having lots of fun solving the easier puzzles but also wants to work up to the harder ones. After one particularly frustrating attempt at a Saturday puzzle, Colin found a series of blog posts documenting one person's journey to solving a Saturday puzzle independently. In the posts, the blogger describes a Crossword Trainer program he wrote to help him improve.

Colin was intrigued, but he was too busy writing exam questions to write his own Crossword Trainer program. Instead, he wants you to write it for him!

## Part A: Test the Teacher (15 points)

Let's begin by writing the core strategy for the Crossword Trainer program. The program will display a clue to Colin, and he will have to guess the answer. To simulate solving a clue in a partially-completed puzzle, you should randomly reveal some, none, or all of the answer's letters to Colin before asking for his guess. Write a method called `testOneClue` :

```
private boolean testOneClue(String clue, String answer, double revealChance)
```

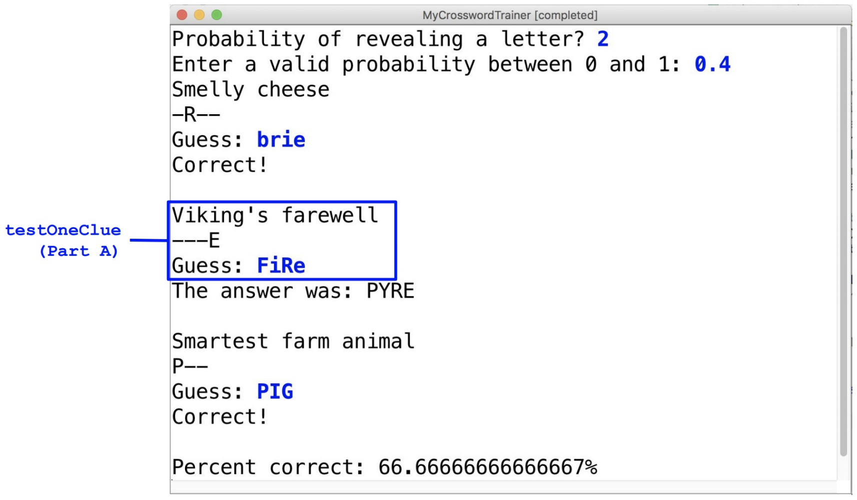
This method takes three parameters:

- `clue` : a clue to show Colin
- `answer` : the clue's answer
- `revealChance` : a number between 0 and 1 (inclusive) that serves as the probability that each letter in `answer` will be revealed as part of a hint before Colin makes a guess

This method should return `true` if the Colin's guess is correct and `false` if not.

### Assumptions and Specifications

- The method should begin by printing the crossword clue.
- After displaying the clue, you should print a hint in which each letter of `answer` is revealed with probability `revealChance` . If a letter should not be revealed, you should represent it as a dash `"-"` .
  For example, a hint for the answer `"PYRE"` could be `"---E"` .
- After displaying the hint, you should prompt Colin to enter a guess with `"Guess: "` .
- Your guess verification should be **case-insensitive**; that is, capitalization should not affect Colin's correctness.
- You may assume that all of the letters in `answer` will be capitalized.



```
Probability of revealing a letter? 2
Enter a valid probability between 0 and 1: 0.4
Smelly cheese
-R--
Guess: brie
Correct!

Viking's farewell
---E
Guess: FiRe
The answer was: PYRE

Smartest farm animal
P--
Guess: PIG
Correct!

Percent correct: 66.66666666666667%
```

## Part B: Feed in the File (25 points)

Now, let's build the rest of our Crossword Trainer. For this part, assume you have a perfect implementation of `testOneClue` from Part A. Here's how it works: You will be provided a text file named `"crossword.txt"`, which has the following format:

```
[number of clues]
[clue]#[ANSWER]
[clue]#[ANSWER]
[clue]#[ANSWER]
...
```

For example, `"crossword.txt"` might look like this:

```
3
Smelly cheese#BRIE
Viking's farewell#PYRE
Smartest farm animal#PIG
```

You should begin by asking Colin what probability he wants for revealing each letter. Then, test Colin on each clue in `"crossword.txt"`. After Colin has gone through all clues, print the percentage of clues he guessed correctly. You should be able to match the full sample run above.

## Assumptions and Specifications

- There will always be at least one clue in the file.
- You should make sure that Colin enters a probability between **0 and 1, inclusive**. If not, print `"Enter a valid probability between 0 and 1: "` and make him re-enter a probability.
- You may assume that Colin will enter a number for the probability.
- You may assume that the `'#'` character will not appear within any *answers*.
- **The '#' character may, however, appear within *clues*.**
- You should print `"Correct!"` on correct guesses and `"The answer was: [answer]"` on incorrect guesses.
- There should be an empty line between clues.

# Candidates Prepare for the Midterm Elections! (35 points)

Since winning their respective primaries, candidates for the contested Senate seat in Wyoming have been hard at work campaigning. Moreover, their campaign teams have been hard at work canvassing to gauge public opinion.

You are independent pollster employed by one of the campaign teams to gather data on how their candidate is doing. With midterm elections approaching, you are about to put together your final report... only to find that your intern was actually working for the other candidate and just deleted all of your data!

In a panic to provide *something* to the campaign manager, you decide to violate the real-life researcher honor code and fabricate all of your data. Sad times :-(

Write a program called `PollsterPanic`, described below, to generate your fake polling data:

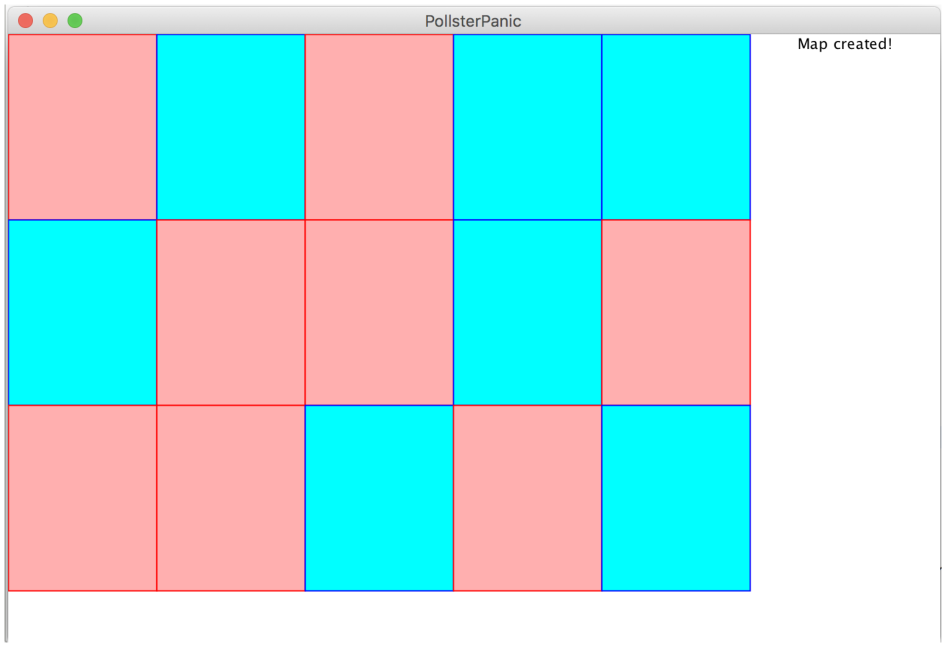
```
public class PollsterPanic extends GraphicsProgram
```

## Part A: Arbitrary Assignments (20 points)

First, generate a grid consisting of **15 equally-sized rectangular** zones within the conveniently rectangular state of Wyoming. When you are done creating the grid, you should display the message, `"Map created!"`. This message must be at the top of the screen, centered in the space between the right edge of the map and the right edge of the window.

You should set each zone to a color randomly chosen from the options of red and blue. If it is helpful, you may assume for this problem that these are the only two colors that exist. It is not important whether the zones have their colors filled in on the grid, but it is important that each zone be assigned a color.

As an example, a map that you create might look like this (note that we used a lighter fill color so that you can more clearly see the color assigned to each zone, but **you can use any fill color you want, or no fill color**):

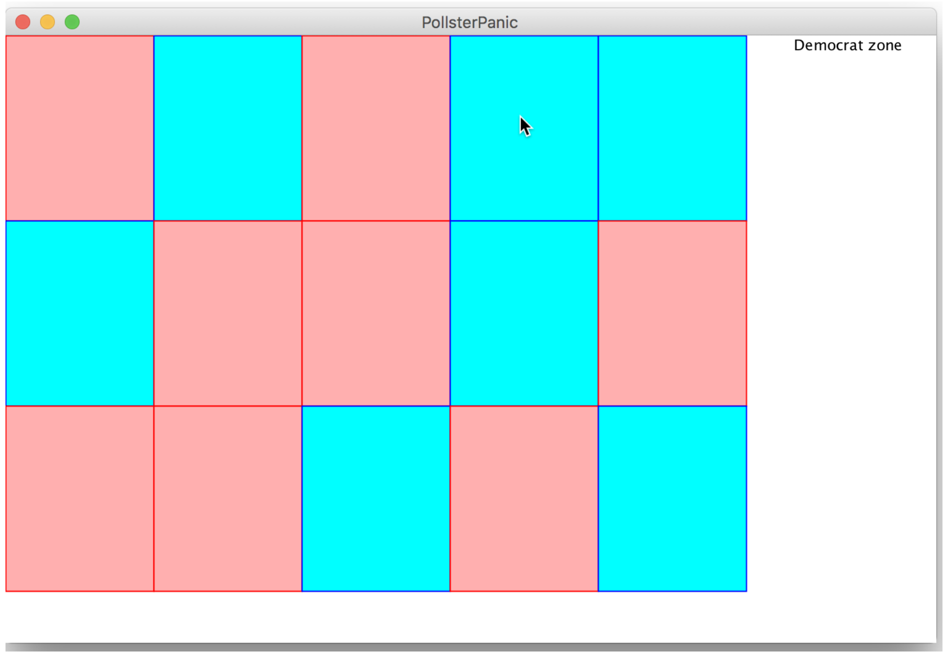


Map created!

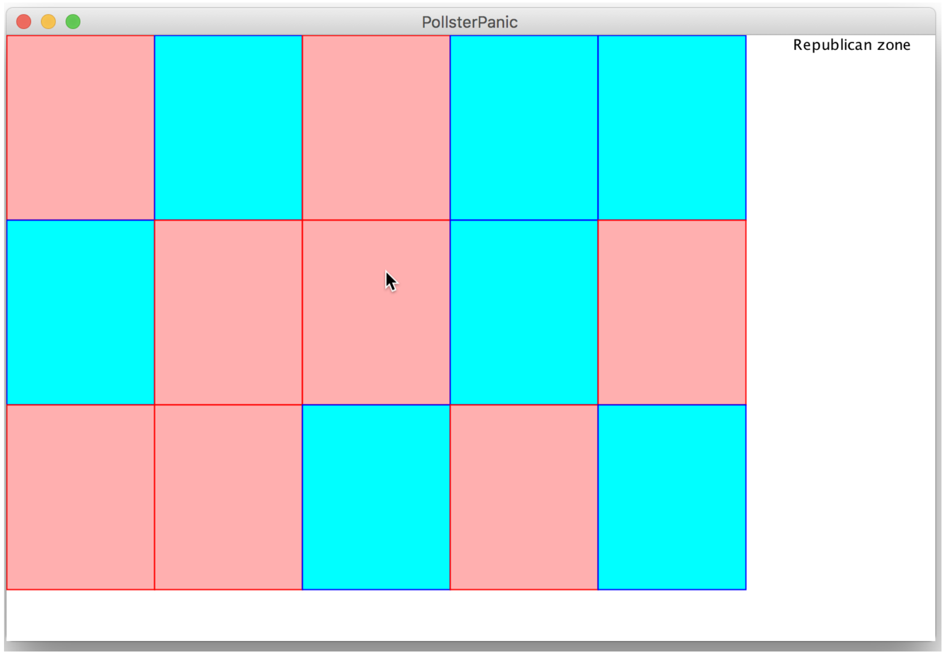
## Part B: Disseminate Deception (15 points)

Now, let's give the campaign manager a way to interpret the results you just made up. When they click on a zone on the map, your program should replace the "Map created!" message with one of three messages:

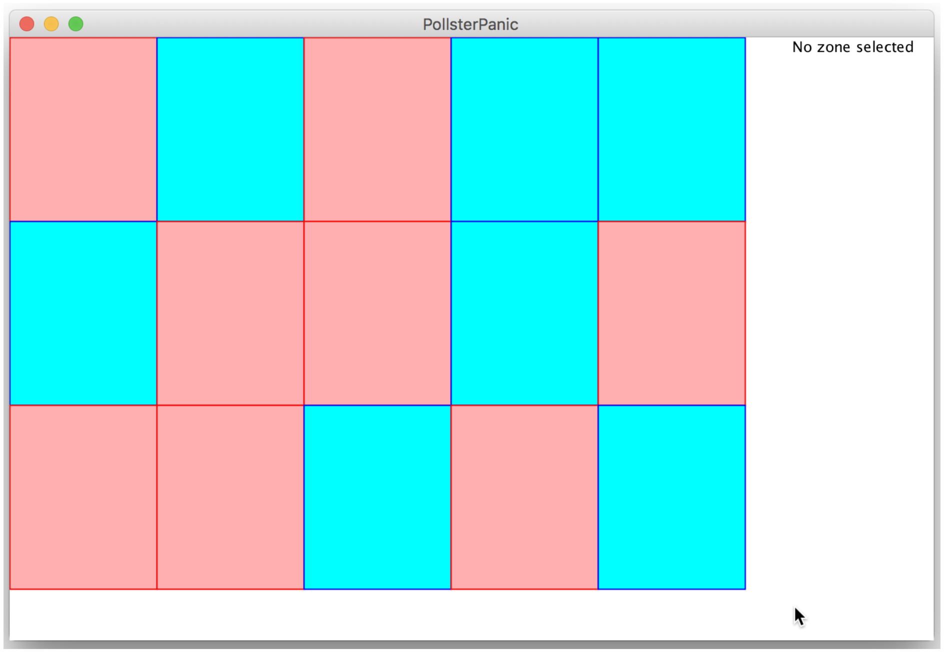
- `"Democrat zone"` if a blue zone is selected
- `"Republican zone"` if a red zone is selected
- `"No zone selected"` if they clicked somewhere off the grid



Democrat zone

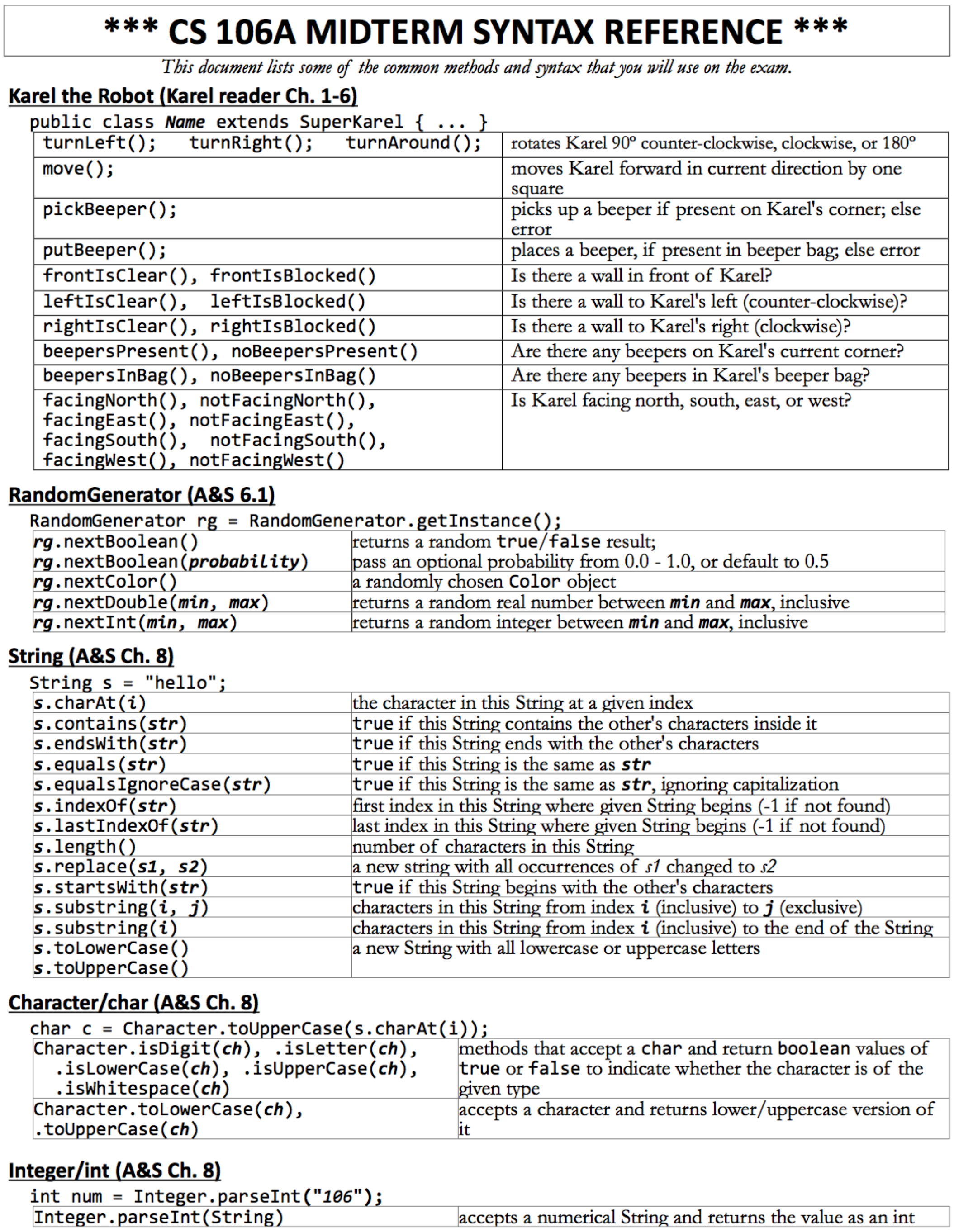


Republican zone



No zone selected

## Reference



# *** CS 106A MIDTERM SYNTAX REFERENCE ***

*This document lists some of the common methods and syntax that you will use on the exam.*

### Karel the Robot (Karel reader Ch. 1-6)

```
public class Name extends SuperKarel { ... }
```

| | |
|---|---|
| `turnLeft();` `turnRight();` `turnAround();` | rotates Karel 90° counter-clockwise, clockwise, or 180° |
| `move();` | moves Karel forward in current direction by one square |
| `pickBeeper();` | picks up a beeper if present on Karel's corner; else error |
| `putBeeper();` | places a beeper, if present in beeper bag; else error |
| `frontIsClear(), frontIsBlocked()` | Is there a wall in front of Karel? |
| `leftIsClear(), leftIsBlocked()` | Is there a wall to Karel's left (counter-clockwise)? |
| `rightIsClear(), rightIsBlocked()` | Is there a wall to Karel's right (clockwise)? |
| `beepersPresent(), noBeepersPresent()` | Are there any beepers on Karel's current corner? |
| `beepersInBag(), noBeepersInBag()` | Are there any beepers in Karel's beeper bag? |
| `facingNorth(), notFacingNorth(),` `facingEast(), notFacingEast(),` `facingSouth(), notFacingSouth(),` `facingWest(), notFacingWest()` | Is Karel facing north, south, east, or west? |

### RandomGenerator (A&S 6.1)

```
RandomGenerator rg = RandomGenerator.getInstance();
```

| | |
|---|---|
| `rg.nextBoolean()` | returns a random `true`/`false` result; |
| `rg.nextBoolean(probability)` | pass an optional probability from 0.0 - 1.0, or default to 0.5 |
| `rg.nextColor()` | a randomly chosen `Color` object |
| `rg.nextDouble(min, max)` | returns a random real number between **`min`** and **`max`**, inclusive |
| `rg.nextInt(min, max)` | returns a random integer between **`min`** and **`max`**, inclusive |

### String (A&S Ch. 8)

```
String s = "hello";
```

| | |
|---|---|
| `s.charAt(i)` | the character in this String at a given index |
| `s.contains(str)` | `true` if this String contains the other's characters inside it |
| `s.endsWith(str)` | `true` if this String ends with the other's characters |
| `s.equals(str)` | `true` if this String is the same as **`str`** |
| `s.equalsIgnoreCase(str)` | `true` if this String is the same as **`str`**, ignoring capitalization |
| `s.indexOf(str)` | first index in this String where given String begins (-1 if not found) |
| `s.lastIndexOf(str)` | last index in this String where given String begins (-1 if not found) |
| `s.length()` | number of characters in this String |
| `s.replace(s1, s2)` | a new string with all occurrences of *s1* changed to *s2* |
| `s.startsWith(str)` | `true` if this String begins with the other's characters |
| `s.substring(i, j)` | characters in this String from index **`i`** (inclusive) to **`j`** (exclusive) |
| `s.substring(i)` | characters in this String from index **`i`** (inclusive) to the end of the String |
| `s.toLowerCase()` `s.toUpperCase()` | a new String with all lowercase or uppercase letters |

### Character/char (A&S Ch. 8)

```
char c = Character.toUpperCase(s.charAt(i));
```

| | |
|---|---|
| `Character.isDigit(ch), .isLetter(ch),` `.isLowerCase(ch), .isUpperCase(ch),` `.isWhitespace(ch)` | methods that accept a `char` and return `boolean` values of `true` or `false` to indicate whether the character is of the given type |
| `Character.toLowerCase(ch),` `.toUpperCase(ch)` | accepts a character and returns lower/uppercase version of it |

### Integer/int (A&S Ch. 8)

```
int num = Integer.parseInt("106");
```

| | |
|---|---|
| `Integer.parseInt(String)` | accepts a numerical String and returns the value as an int |

## Scanner

```
Scanner input = new Scanner(new File("filename"));   // scan an input file
Scanner tokens = new Scanner(string);                 // scan a string
```

| | |
|---|---|
| `sc.next()`, `sc.nextLine()` | read/return the next token (word) or entire line of input as a string |
| `sc.nextInt()`, `sc.nextDouble()` | read/return the next token of input as an int or double |
| `sc.hasNext()`, `sc.hasNextLine()`, `sc.hasNextInt()`, `sc.hasNextDouble()` | ask about whether a next token/line exists, or what type it is, without reading it |
| `sc.useDelimiter(String)` | set the character(s) on which the scanner breaks input into tokens |
| `sc.close()` | closes the scanner |

## ConsoleProgram

```
public class Name extends ConsoleProgram { ... }
```

| | |
|---|---|
| `readInt("prompt")`, `readDouble("prompt")` | Prompts/reprompts for a valid int or double, and returns it |
| `readLine("prompt");` | Prompts/reprompts for a valid String, and returns it |
| `readBoolean("prompt", "yesString", "noString");` | Prompts/reprompts for either ***yesString*** or ***noString*** (case-insensitive). Returns **true** if they enter ***yesString***, **false** if they enter ***noString***. |
| `promptUserForFile("prompt", "directory");` | Prompts for a filename, re-prompting until input is a file that exists in the given directory. Returns the full file path (***"directory/filename"***). |
| `println("text");` | Prints the given text to the console, followed by a newline ('\n'). |
| `print("text");` | Prints the given text to the console. |

## GraphicsProgram

```
public class Name extends GraphicsProgram { ... }
```

| | |
|---|---|
| `add(shape)`, `add(shape, x, y);` | displays the given graphical shape/object in the window (at **x**, **y**) |
| `getElementAt(x, y)` | returns graphical object at the given x/y position, if any (else `null`) |
| `getHeight()`, `getWidth()` | the height and width of the graphical window, in pixels |
| `pause(ms);` | halts for the given # of milliseconds |
| `remove(shape);` | removes the graphical shape/object from window so it will not be seen |
| `setBackground(color);` | sets canvas background color |

## Graphical Objects (A&S Ch. 9)

```
GRect rect = new GRect(10, 20, 50, 70);
```

| | |
|---|---|
| `new GImage("filename", x, y)` | image from the given file, drawn at (x, y) |
| `new GLabel("text", x, y)` | text with bottom-left at (x, y) |
| `new GLine(x1, y1, x2, y2)` | line between points (x1, y1), (x2, y2) |
| `new GOval(x, y, w, h)` | largest oval that fits in a box of size w * h with top-left at (x, y) |
| `new GRect(x, y, w, h)` | rectangle of size w * h with top-left at (x, y) |
| `obj.getColor()`, `obj.getFillColor()` | returns the color used to color the shape outline or interior |
| `obj.getX()`, `obj.getY()`, `obj.getWidth()`, `obj.getHeight()` | returns the left x, top y coordinates, width, and height of the shape |
| `obj.move(dx, dy);` | adjusts location by the given amount |
| `obj.setFilled(boolean);` | whether to fill the shape with color |
| `obj.setFillColor(Color);` | what color to fill the shape with |
| `obj.setColor(Color);` | what color to outline the shape with |
| `obj.setLocation(x, y);` | change the object's x/y position |
| `obj.setSize(w, h);` | change the object's width and height |
| `label.setLabel(String);` | changes the text that a GLabel displays |
| `label.getAscent()`, `label.getDescent()` | returns a GLabel's ascent or descent from the baseline |

## Colors

```
rect.setColor(Color.BLUE);
```

```
Color.BLACK, BLUE, CYAN, GRAY, GREEN, MAGENTA, ORANGE, PINK, RED, WHITE, YELLOW
Color name = new Color(r, g, b);     // red, green, blue from 0-255
```

## Mouse Events (A&S Ch. 10)

```
public void eventMethodName(MouseEvent event) { ...
```

events: `mouseMoved`, `mouseDragged`, `mousePressed`, `mouseReleased`, `mouseClicked`, `mouseEntered`, `mouseExited`

| | |
|---|---|
| `e.getX()`, `e.getY()` | the x or y-coordinate of mouse cursor in the window |