Answers to Practice Final #1

Review session: Saturday, December 8, 11:00 A.M. – 1:00 P.M. (McCullough 115)
Scheduled final: Monday, December 10, 8:30 – 11:30 A.M. (380-380C)

Problem 1—Short answer (10 points)

1a) As written, the program leaves the array in the following state:

<table>
<thead>
<tr>
<th>list</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>10</td>
</tr>
</tbody>
</table>

If you had wanted mystery to “rotate” the array elements, you would need to run the loop in the opposite order to ensure that no elements are overwritten, like this:

```javascript
function mystery(array) {
    let tmp = array[array.length - 1];
    for (let i = array.length - 1; i > 0; i--) {
        array[i] = array[i - 1];
    }
    array[0] = tmp;
}
```

1b) Calling conundrum displays the value 28 on the console. The key to understanding this problem lies in figuring out which x and y values are used at each point. In the function returned by puzzle, the value of x comes from the closure and is therefore the value 17 passed to puzzle, and the value of y is the argument to the function f, which is 6. The body of the function computes 2 times x minus y, which is 28.
Problem 2—Simple graphics (15 points)

/**
 * Function: createPieChart
 * ------------------------
 * Creates and returns a GCompound object that represents a pie chart. Each value in the supplied data array relative to the sum of all values dictates the size of each slice in the pie chart. The reference point of the entire GCompound is the pie chart's center.
 */
function createPieChart(r, data) {
    let pie = GCompound();
    let total = sumArray(data);
    let start = 0;
    for (let i = 0; i < data.length; i++) {
        let fraction = data[i] / total;
        let sweep = fraction * 360;
        let slice = GArc(-r, -r, 2 * r, 2 * r, start, sweep);
        slice.setFill(true);
        slice.setFillColor(WEDGE_COLORS[i % WEDGE_COLORS.length]);
        pie.add(slice);
        start += sweep;
    }
    return pie;
}

/**
 * Function: sumArray
 * ------------------
 * Returns the sum of all the numbers residing in the supplied array. (This function would not need to be written, since it appears in a lecture slide and in the reader, on page 258.)
 */
function sumArray(array) {
    let sum = 0;
    for (let i = 0; i < array.length; i++) {
        sum += array[i];
    }
    return sum;
}
Problem 3—Interactive graphics (20 points)

/**
 * FifteenPuzzle.js
 * ----------------
 * This program animates the Fifteen Puzzle.
 */

/* Constants */
const SQUARE_SIZE = 60;
const INSET = 2;
const TILE_SIZE = SQUARE_SIZE - 2 * INSET;
const GWINDOW_WIDTH = 4 * SQUARE_SIZE;
const GWINDOW_HEIGHT = GWINDOW_WIDTH;
const TILE_FONT = "18px 'Times New Roman'";

/**
 * Function: FifteenPuzzle
 * -----------------------
 * Defines the factory function that manages the entire simulation.
 */

function FifteenPuzzle() {
  let gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
  initFifteenPuzzle(gw);
  let clickAction = function (e) {
    let tile = gw.getElementAt(e.getX(), e.getY());
    if (tile === null) return;
    if (tryToMove(gw, tile, SQUARE_SIZE, 0)) return;
    if (tryToMove(gw, tile, -SQUARE_SIZE, 0)) return;
    if (tryToMove(gw, tile, 0, SQUARE_SIZE)) return;
    tryToMove(gw, tile, 0, -SQUARE_SIZE);
  };
  gw.addEventListener("click", clickAction);
}

/**
 * Function: initFifteenPuzzle
 * ---------------------------
 * Constructs the initial state of the Fifteen Puzzle board by properly implanting fifteen numbered squares into the supplied GWindow.
 */

function initFifteenPuzzle(gw) {
  let x = 0;
  let y = 0;
  for (let number = 1; number < 16; number++) {
    gw.add(createNumberedSquare(number), x, y);
    if (number % 4 === 0) {
      // yes? time to advance down a row
      x = 0;
      y += SQUARE_SIZE;
    } else {
      // no? jimmy over to the right
      x += SQUARE_SIZE;
    }
  }
}
/**
 * Function: createNumberedSquare
 * ------------------------------
 * Constructs a GCompound consisting of a square (GRect) with
 * a centered number (GLabel) with a reference point set at
 * the upper left corner of the square.
 */
function createNumberedSquare(number) {
    let tile = GCompound();
    let square = GRect(0, 0, TILE_SIZE, TILE_SIZE);
    square.setFilled(true);
    square.setFillColor("LightGray");
    tile.add(square, INSET, INSET);
    let label = GLabel("" + number);
    label.setFont(TILE_FONT);
    let cx = (SQUARE_SIZE - label.getWidth())/2;
    let cy = (SQUARE_SIZE + label.getAscent())/2;
    tile.add(label, cx, cy);
    return tile;
}

/**
 * Predicate function: tryToMove
 * -----------------------------
 * Uses the upper left corner of the tile provided via the second
 * argument to compute the upper left corner of a neighboring tile.
 * If the neighboring (ulx, uly) corner is outside the bounds of the window,
 * or it's the upper left corner of an actual tile, then the original tile
 * is blocked and can't be moved, and tryToMove expresses failure by returning
 * false. If (ulx, uly) overlays the empty square, then the original tile
 * is shifted into the void and true is returned instead.
 *
 * Because my solution is slightly more styled than that required by the
 * problem, you didn't need to add INSET + 1 to get the ulx or uly values.
 */
function tryToMove(gw, tile, dx, dy) {
    let ulx = tile.getX() + dx + INSET + 1;
    let uly = tile.getY() + dy + INSET + 1;
    if (ulx < 0 || ulx >= gw.getWidth()) return false;
    if (uly < 0 || uly >= gw.getHeight()) return false;
    if (gw.getElementAt(ulx, uly) !== null) return false; // not empty!
    tile.move(dx, dy);
    return true;
}
Problem 4—Strings (15 points)

/**
 * Predicate Function: isAnagram
 * ---------------------------------
 * Returns true if and only if the two supplied
 * strings are anagrams, as per the definition of
 * anagram in the problem statement.
 */
function isAnagram(s1, s2) {
    let table1 = compileFrequencyTable(s1);
    let table2 = compileFrequencyTable(s2);
    for (let i = 0; i < 26; i++) {
        if (table1[i] !== table2[i])
            return false
    }
    return true;
}

/**
 * Function: compileFrequencyTable
 * ------------------------------
 * Compiles and returns a frequency table for the
 * supplied string. The table is of length
 * 26, and the 0th entry ultimately contains the number
 * of a's (and A's), the 1th entry ultimately contains the
 * number of b's and B's, and so forth.
 */
function compileFrequencyTable(str) {
    let table = createArray(26, 0);
    for (let i = 0; i < str.length; i++) {
        if (isLetter(str.charAt(i))) {
            let ch = str.charAt(i).toUpperCase();
            table[ch.charCodeAt(0) - "A".charCodeAt(0)]++;
        }
    }
    return table;
}

/**
 * Predicate Function: isLetter
 * ---------------------------
 * Returns true if and only if ch is of length one, and its
 * one character is a letter of the English alphabet. This
 * function did not need to be written out, since it
 * appears on page 239, and has appeared in several lecture slides.
 */
function isLetter(ch) {
    if (ch.length !== 1) return false;
    ch = ch.toUpperCase();
    return ch >= "A" && ch <= "Z";
}
/**
 * Function: createArray
 * ---------------------
 * Creates an array of the specified length where
 * every single element is equal to the supplied value.
 * This function did not need to be written, since it
 * appears on page 263 of the course reader, and it's also
 * appeared in one or more lecture slides.
 */

function createArray(length, value) {
    let array = [];
    for (let i = 0; i < length; i++) {
        array.push(value);
    }
    return array;
}
Problem 5—Arrays (10 points)

/**
 * Function: doubleImage
 * ---------------------
 * Accepts the fully loaded image, constructs a replica
 * of that image, save for the fact that it's twice as wide and
 * twice as tall, and then returns that image.
 */
function doubleImage(image) {
    let compact = image.getPixelArray();
    let expanded = [];
    for (let row = 0; row < compact.length; row++) {
        // introduce two rows in expanded on behalf of one in original
        expanded.push([]);
        expanded.push([]);
        for (let column = 0; column < compact[0].length; column++) {
            let pixel = compact[row][column];
            expanded[2 * row].push(pixel);
            expanded[2 * row].push(pixel);
            expanded[2 * row + 1].push(pixel);
            expanded[2 * row + 1].push(pixel);
        }
    }
    return GImage(expanded);
}

Problem 6—Working with data structures (15 points)

/**
 * Predicate function: playerSmellsWumpus
 * --------------------------------------
 * Searches the cave just enough to decide whether
 * the player is within one or two rooms of the wumpus.
 * We assume the player and wumpus are guaranteed to be
 * in distinct rooms.
 */
function playerSmellsWumpus(cave) {
    let room = cave.playerLocation;
    for (let i = 0; i < 3; i++) {
        let roomOneAway = cave.connections[room][i];
        if (roomOneAway === cave.wumpusLocation) return true;
        for (let j = 0; j < 3; j++) {
            let roomTwoAway = cave.connections[roomOneAway][j];
            if (roomTwoAway === cave.wumpusLocation) return true;
        }
    }
    return false;
}
Problem 7—Reading data structures from embedded XML (15 points)

/**
 * Function: ElectionData
 * ----------------------
 * Defines the factory function that constructs a class with two
 * exposed methods, as defined in the practice exam. constituencyNames
 * and constituenciesMap are immediately defined where they are so that
 * they are part of the closure accessed by the implementations of
 * getConstituencyNames and getResults.
 */
function ElectionData() {
    let constituencyNames = [];
    let constituenciesMap = {};
    parseXML(constituencyNames, constituenciesMap);
    return {
        getConstituencyNames: function() { return constituencyNames; },
        getResults: function(name) {
            let results = constituenciesMap[name];
            if (results === undefined) results = [];
            return results;
        }
    };
}

/**
 * Function: parseXML
 * ------------------
 * Accepts the empty constituencyNames array and the
 * empty constituenciesMap map, and populates them
 * with the names of all constituencies and the collection
 * of key/value pairs that represent the relevant
 * constituent-name -> election-results information.
 */
function parseXML(constituencyNames, constituenciesMap) {
    let electionXML = document.getElementById("ElectionData");
    let constituencies = electionXML.getElementsByTagName("constituency");
    for (let i = 0; i < constituencies.length; i++) {
        let constituency = constituencies[i];
        let constituencyName = constituency.getAttribute("name");
        constituencyNames.push(constituencyName);
        constituenciesMap[constituencyName] = [];
        let candidates = constituency.getElementsByTagName("candidate");
        for (let j = 0; j < candidates.length; j++) {
            let candidate = candidates[j];
            let entry = {
                candidate: candidate.getAttribute("name"),
                party: candidate.getAttribute("party"),
                votes: parseInt(candidate.getAttribute("votes"))
            };
            constituenciesMap[constituencyName].push(entry);
        }
    }
}