Deadline: Wednesday, January 22, 2020 at 10:00am on MarkUs

Language level: Beginning Student

Coverage: Module 01

Files to submit: `a01q1.rkt, a01q2.rkt, a01q3.rkt`

Assignment Guidelines

- Submission details:
  - All solutions must be submitted through MarkUs. Solutions will not be accepted through email.
  - Verify your basic test results using MarkUs to ensure that your files were submitted properly and are readable on MarkUs.
    Note: passing the basic tests does not guarantee that you will pass all our correctness tests!
- For this assignment only,
  - your grade will be based entirely on correctness;
  - you are not required to use the design recipe (Module 02) when writing functions, though you may use it if you wish. Each file should include a file header as described on page 3 of the Style Guide. Otherwise, you are only required to include the function header and body;
  - tests are not required, but you are encouraged to do thorough testing on your own.
- Download the interface file from the course Web site to ensure that all function names are spelled correctly, and each function has the correct number and order of parameters.
- Restrictions:
  - Unless specifically allowed in the description of the question, you may only use the built-in functions and special forms introduced in the lecture slides in Module 01. For details, see `https://www.student.cs.uwaterloo.ca/~cs115/#allowed`
  - Read each question carefully to see if any additional restrictions apply.
  - Test data for correctness tests will always meet the stated assumptions for consumed values.
- The solutions you submit must be entirely your own work. Do not look up either full or partial solutions on the Internet or in printed sources.

Plagiarism: The following applies to all assignments in CS115.

All work in CS 115 is to be done individually. The penalty for plagiarism on assignments (first offense) is a mark of 0 on the affected questions and a 5% reduction of the final grade, consistent with School of Computer Science policy. In addition, a letter detailing the offence is sent to the Associate Dean of Undergraduate Studies, meaning that subsequent offences will carry more severe penalties, up to suspension or expulsion.

To avoid inadvertently incurring this penalty, you should discuss assignment issues with other students only in a very broad and high-level fashion. Do not take notes during such discussions, and avoid looking at anyone else's code, on screen or on paper. If you find yourself stuck, contact the ISA or instructor for help, instead of getting the solution from someone else. Do not consult other books, library materials, Internet sources, or solutions (yours or other people's) from other courses or other terms.

Read more course policies at: `https://www.student.cs.uwaterloo.ca/~cs115/#policies`

1. One of the requirements for passing CS115 is that you must pass the weighted exam component of the course. Assume the following:

   - marks received on the midterm is mm and the midterm is out of mt marks
   - marks received on the final is fm and the final is out of ft

   then the following calculation calculates the weighted exam average for the course:

   $$\frac{\frac{mm}{mt} \cdot 30 + \frac{fm}{ft} \cdot 45}{75} \cdot 100$$

   Complete the Racket function `exam-average`, that consumes four natural numbers:

   `midterm-marks`, `midterm-total`, `final-marks`, and `final-total`,

   where

   - `midterm-marks` $\leq$ `midterm-total`
   - `final-marks` $\leq$ `final-total`
   - `midterm-total` > 0
   - `final-total` > 0

   The function produces the value of the above formula, which is a number between 0 and 100.

   Place this function in the file `a01q1.rkt`.

2. The Fibonacci sequence starts 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, ... The nth Fibonacci number is equal to the sum of the previous two terms. So the next term of the sequence shown is $21 + 34 = 55$.

   You can also compute the nth term of the Fibonacci sequence with the following formula:

   $$F(n) = \frac{\phi^n - (-\frac{1}{\phi})^n}{\sqrt{5}}$$

   where ϕ is a special number, known as the Golden Ratio, and is equal to:

   $$\phi = \frac{1 + \sqrt{5}}{2}$$

   Complete the function `fibonacci-num` that consumes a natural number `n` produces the value of the nth Fibonacci number $F(n)$ as described in the formula above. Your solution should include and use a definition for a constant that assigned the calculated value of the Golden Ratio. The constant must be called `phi`. Note that $F(0)$ is equal to 0 which is the first Fibonacci number in the sequence.

   Note: Since your calculation is using the square root of a number, the resulting calculation is an inexact value. If you try out the function you have written in DrRacket, you will see #i, at the beginning of the result. These values will be considered correct as inexact numbers. You will probably also notice that the values produced by the function are not exactly integers. For example, `fibonacci-num(6)` *might produce #i8.000000000000002. This is one of the consequences of dealing with inexact values with computers. If you were to compute this value by hand for some value of* `n`*, you would end up multiplying the square roots values together to get an exact integer result.*

   Place these definitions into the file `a01q2.rkt`

3. There are many ways to solve a linear system of two equations with two unknowns. Consider the following equations:

$$a_1x + b_1y = c_1$$
$$a_2x + b_2y = c_2$$

You can find the values of the unknowns x and y given the values of a, b, and c from each of the equations. One technique uses the determinant. A determinant of a 2 x 2 matrix is calculated as follows:

$$\det \begin{bmatrix} m & n \\ p & q \end{bmatrix} = m \cdot q - p \cdot n$$

(a) Complete the function `determinant`. The function consumes the values `m`, `n`, `p`, and `q`, and produces the determinant as described above.

(b) To calculate the value of x in the system of equations, you can use the following formula:

$$x = \frac{\det \begin{bmatrix} c_1 & b_1 \\ c_2 & b_2 \end{bmatrix}}{\det \begin{bmatrix} a_1 & b_1 \\ a_2 & b_2 \end{bmatrix}}$$

To calculate the value of y in the system of equations, you can use the following formula:

$$y = \frac{\det \begin{bmatrix} a_1 & c_1 \\ a_2 & c_2 \end{bmatrix}}{\det \begin{bmatrix} a_1 & b_1 \\ a_2 & b_2 \end{bmatrix}}$$

Complete the functions `solve-for-x` and `solve-for-y`. These functions consume the values `a1`, `b1`, `c1`, `a2`, `b2`, and `c2`, and produce the values for x and y respectively based on the formulae above. Your solutions must use the `determinant` function that you defined in the part (a).

You may assume that the values used for testing will produce real number solutions for x and y. In other words, the denominators of the fractions in each case will not be 0.

Place these definitions into the file `a01q3.rkt`