DATA STRUCTURES AND ALGORITHMS
ASSIGNMENT 1, DUE DATE SATURDAY 12, 2015 - 11:59PM

Basic C

September 6, 2015

1. **Continued Fractions:**
   Continued fractions play an important role in number theory and in approximation theory. In this programming assignment, you will write some short procedures that evaluate continued fractions. There is no predefined code for you to load.

   An infinite continued fraction is an expression of the form

$$f = \cfrac{N_1}{D_1 + \cfrac{N_2}{D_2 + \ddots}}$$

   One way to approximate an irrational number is to expand as a continued fraction, and truncate the expansion after a sufficient number of terms. Such a truncation—a so-called *k-term finite continued fraction*—has the form

$$\cfrac{N_1}{D_1 + \cfrac{N_2}{\ddots + \cfrac{N_K}{D_K + 0}}}$$

   For example, if the N_i and the D_i are all 1, it is not hard to show that the infinite continued fraction expansion

$$\cfrac{1}{1 + \cfrac{1}{1 + \ddots}}$$

converges to $1/\phi \approx .618$ where ϕ is the *golden ratio*

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

The first few finite continued fraction approximations (also called *convergents*) are:

$$1, \frac{1}{2} = .5, \frac{2}{3} \approx .667, \frac{3}{5} = .6, \frac{5}{8} = .625, \cdots$$

EXERCISE 1 Suppose that `nValues` and `dValues` are functions of one argument (the term index) that return the n_i and d_i of the terms of the continued fraction.

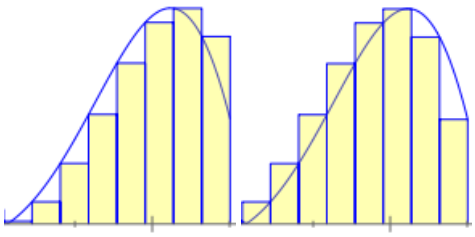
Define the function `cont-frac` such that evaluating `cont-frac(k)` computes the value of the k-term finite continued fraction. Check your procedures by approximating $1/\phi$ using constant functions `nValues` and `dValues` that return the value 1 for any input value.

EXERCISE 2 One of the first formulas for π was given around 1658 by the English mathematician Lord Brouncker:

$$4/\pi - 1 = 1/(2 + 9/(2 + 25/(2 + 49/(2 + 81/(2 + \cdots$$

Define a function `estimate-pi(k)` that uses `cont-frac` and appropriately defined `nValues` and `dValues` functions to estimate the value of π

2. **Approximating Area Under a Curve:**
An estimate of the area under a curve can be found by using rectangles, see figures below:



EXERCISE 3 Write a function `sinLeft(a, b, k)` that estimates the area under the sin function in the interval from a to b on the x-axis (where $a \leq b$) by dividing the interval into k sub-intervals and adding up the areas of the rectangles in each sub-interval. The height of a rectangle in a sub-interval is equal to the value of the sin function at the starting point of the sub-interval (see the figure on the left above).

Write a similar function `sinRight(a, b, k)` the only difference being that the height of a rectangle in a sub-interval is equal to the value of the sin function at the end-point of the sub-interval (figure on the right above)

3. **Basic Arithmetic Game** In this exercise we will program a game to help kids learn integer addition and multiplication. When the program starts the following menu will be presented to the user:

```
Choose the level of difficulty:
1. Easy (numbers will be in the 0 - 10 range)
2. Medium (numbers will be in the 0 - 100 range)
3. Hard (numbers will be in the 0 - 1000 range)
>>> _
```

Once the use chooses the level of difficulty, the following menu is presented:

```
Type the number of seconds that you want to play the game for:
>>> _
```

When the user has entered the duration of the game the program starts presenting the user with either an addition or a multiplication question (chosen randomly) involving two numbers (both chosen randomly). When the user enters an answer the program prints out whether the answer was correct or not and moves to the next question. At the end of the time period of the game the program presents the user with the total number of question and the percentage that the user got right. A Sample run of the game follows:

```
Choose the level of difficulty:
1. Easy (numbers will be in the 0 - 10 range)
2. Medium (numbers will be in the 0 - 100 range)
3. Hard (numbers will be in the 0 - 1000 range)
>>> 1

Type the number of seconds that you want to play the game for:
>>> 30

The value of 4 x 4 = 16
Correct! Score: 1/1 Time Left: 20 seconds

The value of 9 + 4 = 12
Wrong! Score: 1/2 Time Left: 10 seconds

The value of 8 x 4 = 32
Correct! Score: 2/3 Time Left: 0 seconds

G A M E   O V E R!
You attempted 3 question in 30 seconds and got 66.6% of them right.
```