CS2030 Programming Methodology
Semester 1 2024/2025

Week of 26 – 30 August 2024
Problem Set #1
Declarative Programming with Java Streams

1. The i^{th} omega number is the number of distinct prime factors for the number i (> 0). The first 10 omega numbers are $0, 1, 1, 1, 1, 2, 1, 1, 1, 2$.

   Write a method `omega` that takes in an integer `n` (> 0) and returns an `IntStream` containing the first `n` omega numbers.

   ```
   IntStream omega(int n)
   ```

   ```
   jshell> omega(10).forEach(x -> System.out.print(x + " "))
   0 1 1 1 1 2 1 1 1 2
   ```

2. Write a method `dot` that takes in two integer arguments a and b with $a \leq b$, and returns the cartesian dot-product defined as follows:

   $$\{i \cdot j \mid i \in S,\ j \in S\} \quad \text{where} \quad S = [a, b]$$

   For example, if $a = 1$ and $b = 3$, then $S \in [1, 3]$ and the result is

   $$\{1 \cdot 1,\ 1 \cdot 2,\ 1 \cdot 3,\ 2 \cdot 1,\ 2 \cdot 2,\ 2 \cdot 3,\ 3 \cdot 1,\ 3 \cdot 2,\ 3 \cdot 3\}$$

   ```
   jshell> dot(1,3).forEach(x -> System.out.print(x + " "))
   1 2 3 2 4 6 3 6 9
   ```

   Now write a method `product` that takes in two integer arguments a and b with $a \leq b$, and returns the paired cartesian product defined as follows:

   $$\{(i, j) \mid i \in S,\ j \in S\} \quad \text{where} \quad S = [a, b]$$

   Use the `Pair` record defined as follows:

   ```
   jshell> record Pair<T,U>(T t, U u) {}
   |  created record Pair

   jshell> new Pair<Integer,Integer>(1, 3)
   $.. ==> Pair[t=1, u=3]

   jshell> product(1,3).toList()
   $.. ==> [Pair[t=1, u=1], Pair[t=1, u=2], Pair[t=1, u=3],
   Pair[t=2, u=1], Pair[t=2, u=2], Pair[t=2, u=3],
   Pair[t=3, u=1], Pair[t=3, u=2], Pair[t=3, u=3]]
   ```

3. Write a method that returns the first n Fibonacci numbers as a `Stream<Integer>`.

   For instance, the first 10 Fibonacci numbers are $1, 1, 2, 3, 5, 8, 13, 21, 34, 55$.

   Hint: Use the `Pair` to keep two items in the stream