**Exercise 5.1.**

Design a register machine to compute factorial using the iterative algorithm specified by the following procedure. Draw data-path and controller diagrams for this machine.

```
(define (factorial n)
  (define (iter product counter)
    (if (> counter n)
        product
        (iter (* counter product)
              (+ counter 1))))
  (iter 1 1))
```

**Answer.**

A machine to carry out this factorial algorithm must keep track of two numbers, *product* and *counter*, and we assume that these numbers are stored in two registers with those names. Both registers has their contents iterate starting from 1. The basic operations required are testing whether contents of register `counter` exceeds the constant $n$, computing the product of the contents of register `counter` multiplied by the contents of register `product`, and computing the increment of the contents of register `counter`. On each cycle of the factorial algorithm, the contents of register `product` must be replaced by the product produced by multiplied itself to the contents of register `counter`, and the contents of register `counter` must be replaced by its increment. Figure 1 shows the data-path diagram for this machine, and figure 2 decribes its controller respectively.

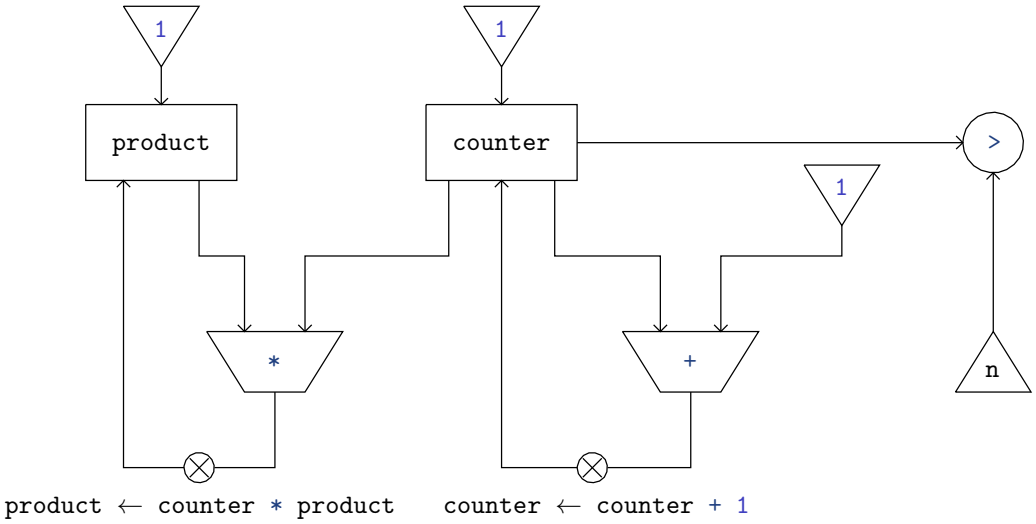


**Figure 1.** Data paths for a factorial machine.


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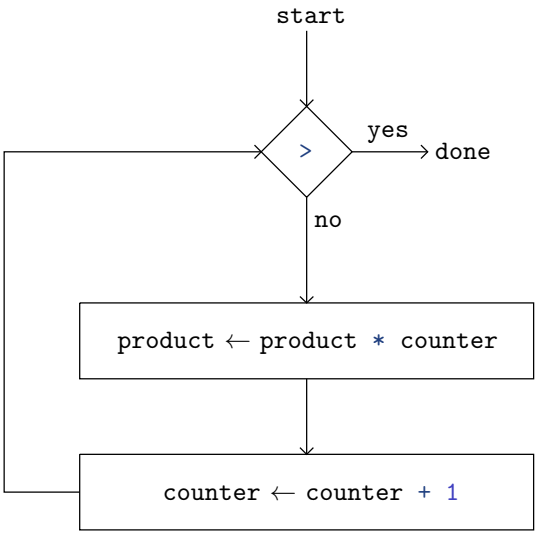


**Figure 2.** Controller for a factorial machine.