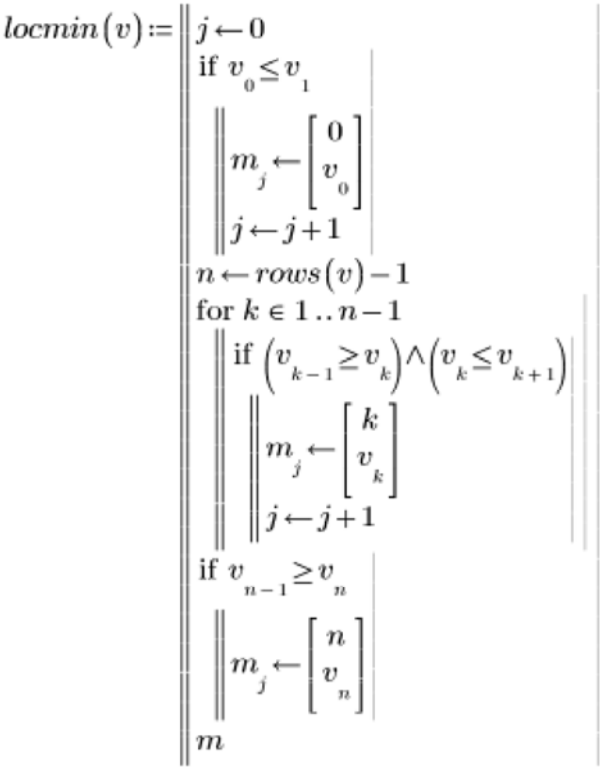
Example: Finding Local Min/Max of Vectors

1. Write a program, using a combination of conditional statements and loops, to find the local minimums of data sets:



```
$locmin(v) :=$
    $j \leftarrow 0$
    if $v_0 \le v_1$
        $m_j \leftarrow \begin{bmatrix} 0 \\ v_0 \end{bmatrix}$
        $j \leftarrow j+1$
    $n \leftarrow rows(v) - 1$
    for $k \in 1..n-1$
        if $(v_{k-1} \ge v_k) \wedge (v_k \le v_{k+1})$
            $m_j \leftarrow \begin{bmatrix} k \\ v_k \end{bmatrix}$
            $j \leftarrow j+1$
    if $v_{n-1} \ge v_n$
        $m_j \leftarrow \begin{bmatrix} n \\ v_n \end{bmatrix}$
    $m$
```

Function *locmin* scans input vector *v* and compares each element with its two neighbors. If element *k* is smaller than the element before it and the element following it, then it is a local minimum and its value and index are added to output vector *m*.

2. Utilize the above program to write a second program to find the maximums of the same data set:

```
$locmax(v) :=$
    $m \leftarrow locmin(-v)$
    for $j \in 0 .. rows(m)-1$
        $M_j \leftarrow \begin{bmatrix} (m_j)_0 \\ -(m_j)_1 \end{bmatrix}$
    $M$
```

Copy Expressions

Function *locmax* uses the results received from calling *locmin* with *-v*. A local minimum of *-v* is a mirror image of a local maximum at the same index. Therefore, each value of a local minimum is multiplied by −1. The index-value pair is saved as a single element in output vector *M*.

3. Define function *f* that uses the built-in function **dbinom** that returns the probability density for value *k*:

$n := 10$

$N := 30$

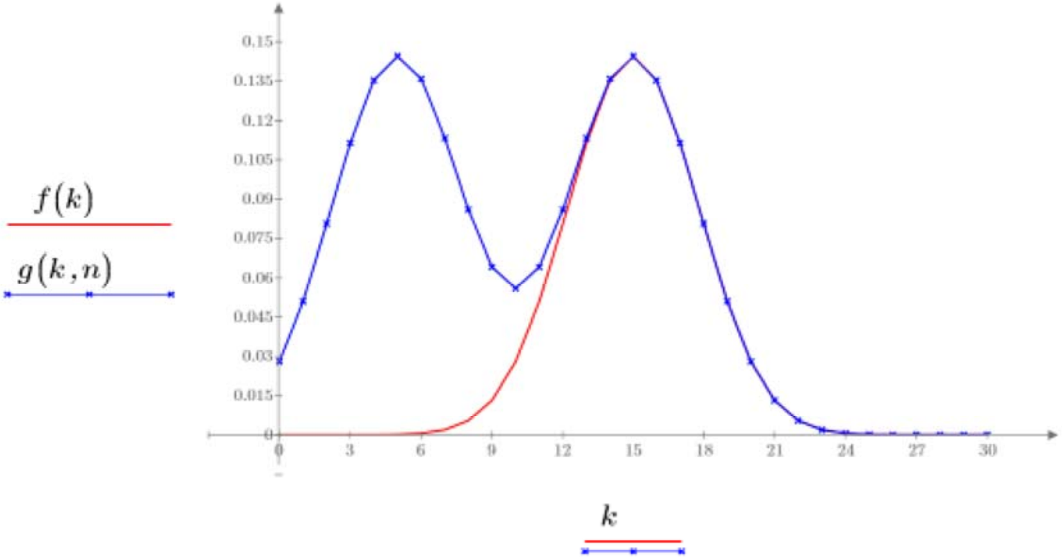
$q := 0.5$

$k := 0 .. 30$

$f(k) := dbinom(k, 30, q)$

$g(k, n) := f(k) + f(n + k)$

4. Plot the above two functions:



5. Save the elements of *g(k,n)* into an array so it can be passed to the programs that you defined

$u_k := g(k, n)$

6. Use the built-in length function to see how many *locmin* and *locmax* points were found by your programs:

   $length(locmin(u)) = 3$

   Copy Expressions

   $length(locmax(u)) = 2$

7. Use your programs to find the three local minimum points for the function:

   $locmin(u)_0 = \begin{bmatrix} 0.000 \\ 0.028 \end{bmatrix}$

   $\left(locmin(u)_0\right)_0 = 0$

   $\left(locmin(u)_0\right)_1 = 0.028$

   $locmin(u)_1 = \begin{bmatrix} 10.000 \\ 0.056 \end{bmatrix}$

   $\left(locmin(u)_1\right)_0 = 10$

   $\left(locmin(u)_1\right)_1 = 0.056$

   $locmin(u)_2 = \begin{bmatrix} 30.000 \\ 9.313 \cdot 10^{-10} \end{bmatrix}$

   $\left(locmin(u)_2\right)_0 = 30$

   $\left(locmin(u)_2\right)_1 = 9.313 \cdot 10^{-10}$

8. Use your programs to find the two local maximum points for the function:

   $locmax(u)_0 = \begin{bmatrix} 5.000 \\ 0.145 \end{bmatrix}$

   $\left(locmax(u)_0\right)_0 = 5$

   $\left(locmax(u)_0\right)_1 = 0.145$

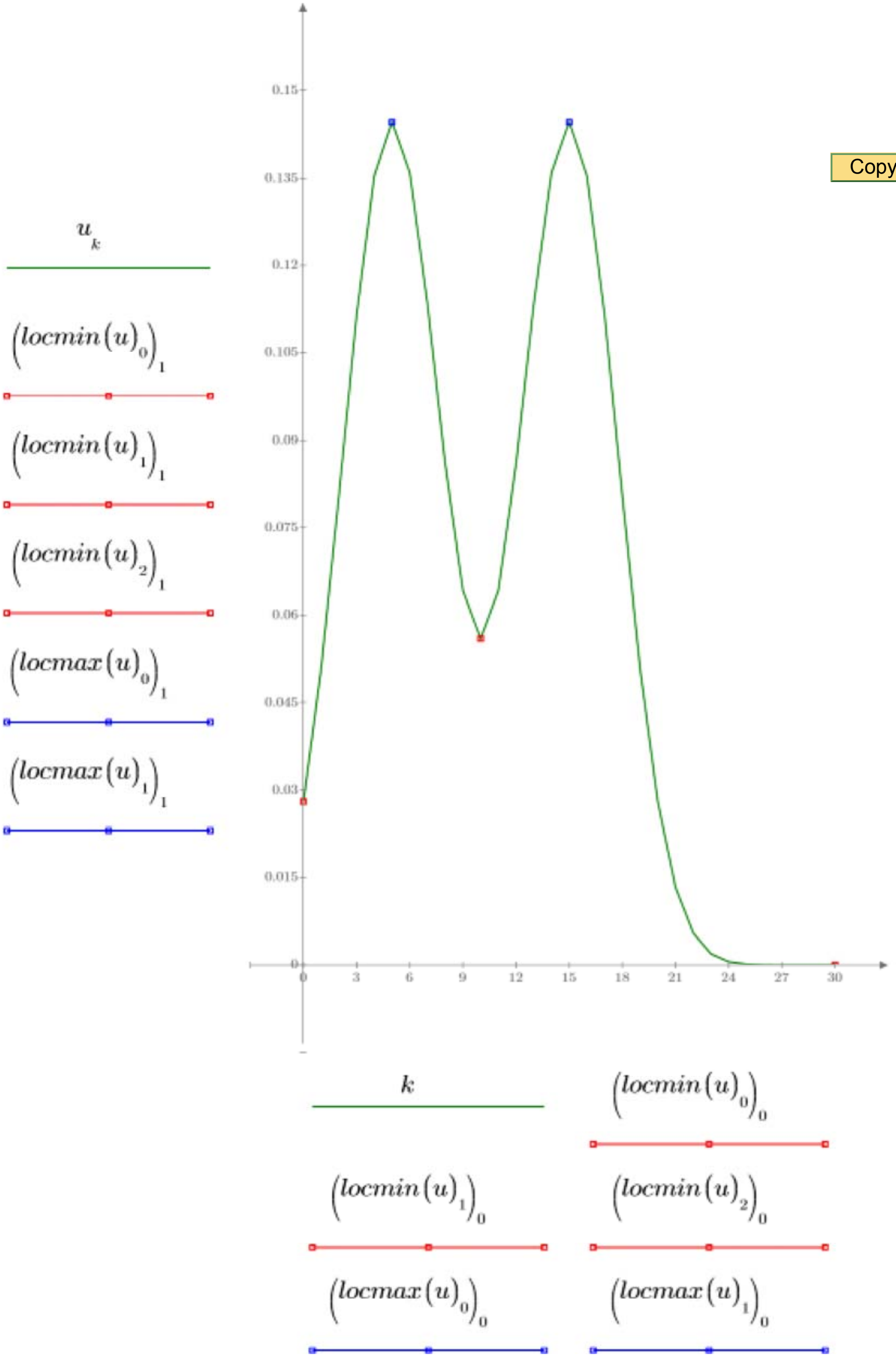
$$locmax(u)_1 = \begin{bmatrix} 15.000 \\ 0.145 \end{bmatrix}$$

$$\left(locmax(u)_1\right)_0 = 15$$

$$\left(locmax(u)_1\right)_1 = 0.145$$

Copy Expressions

9. Plot the function and show its three local minimum and two local maximum points:



Copy Expressions

10. Compare the obtained results using your programs with those obtained using the built-in functions **localmin** and **localmax** (which require as input an *nx2* matrix):

a. Build the *nx2* input matrix:

$$C0_k := k$$

$$C1_k := u_k$$

$$A := augment(C0, C1)$$

Copy Expressions

b. Use the built-in functions to obtain the local minimum and maximum points:

$$localmin(A) = \begin{bmatrix} 0 & 0.028 \\ 10 & 0.056 \\ 30 & 9.313 \cdot 10^{-10} \end{bmatrix}$$

$$localmax(A) = \begin{bmatrix} 5 & 0.145 \\ 15 & 0.145 \end{bmatrix}$$

The results agree.

Note

Always check the availability of built-in functions before writing new programs.

Related Links

About Programs

Local Maximum and Minimum

Binomial Distribution