Calculus...from page 8

In Logo, the algorithm looks like this:

$$\int_a^b F(x)\,dx \approx \frac{b-a}{n}\left(\left(\Sigma F(x_i)\right) - \frac{1}{2}\,(F(a) + F(b))\right)$$

```
TO SIGMA :F :A :B :D
IF :A > :B [OP 0]
OP (APPLY :F :A) + (SIGMA :F ( :A + :D) :B :D)
END

TO BEGIN :F :A :B :D
OP (SIGMA :F :A :B :D) - (.5 * (APPLY :F :A) ) - ( .5 *
(APPLY :F :B))
END

TO MIDDLE :F :A :B :D
OP (BEGIN :F :A :B :D) * :D
END

TO DELTA :A :B :N
OP ( :B - :A ) / :N
END

TO TRAP :F :A :B :N
OP MIDDLE :F :A :B (DELTA :A :B :N)
END
```

These procedures approximate the integral of the function from *a* to *b* divided into *n* parts. Half of both the first and the last *Y* heights are then subtracted and the remaining area is then multiplied by *h* (by letting *h* equal *(b-a)/n.*)

We incorporated the program for this formula with that of **GRAPHTRAP** into a new program called **APPROX** and now we had achieved a major accomplishment. We could now sketch any function *F* over closed interval, sketch the trapezoids of the graph at the increments of the function and then calculate the area of these trapezoids using the trapezoid rule mentioned above.

One helpful feature of this program is the way the number of trapezoids can be changed. By changing the increment on which the graph is sketched the number of trapezoids will also vary. An increase in the increment will sketch a fewer number of trapezoids resulting in a less accurate approximation, while a decrease in the increment will sketch a greater number of trapezoids resulting in a more accurate approximation. The program for **APPROX** is as follows:

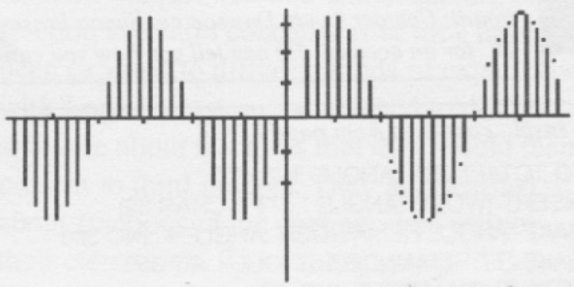
```
TO APPROX :FUNC :L :H :D
M&M&M "GRAPH :FUNC :L :H .2
M&M&M "GRAPHTRAP :FUNC :L :H :DJ
SHOW FINAL :FUNC :L :H (( :H - :L) / :D)
END
```

Here is an example of what APPROX produces when you type

```
TO UU :X
OP 3 * SINE (2 * :X)
END

APPROX "UU -5 5 .2
```

The output is -8.61533 N15. This what would be expected because the area above the X-axis is negated by the area below the X-axis resulting in an area very close to 0.



The above programs are useful with many mathematics courses because they are unlimited in the number of different graphs they can produce. It is set up in a fashion which is both easy to understand and execute. In the future we hope to add the facility to graph conic sections and possibly a procedure to visualize solid geometry.

Please Participate in CLIMEaction II!

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